

ENERGY TECHNOLOGY INNOVATION POLICY RESEARCH GROUP

THE POLITICS OF THIRST:

MANAGING WATER RESOURCES UNDER SCARCITY IN THE YELLOW
RIVER BASIN, PEOPLE'S REPUBLIC OF CHINA

BY SCOTT MOORE



HARVARD Kennedy School

BELFER CENTER for Science and International Affairs

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Abstract

Northern China, including the capital, Beijing, and the area's major waterway, the Yellow River, is experiencing conditions of acute water scarcity, which has become an issue of growing concern to scholars, policymakers, and the public at large in both China and abroad. Most assessments of this water scarcity tend to emphasize ecological and economic aspects of the challenge, rather than the political actors, interests, and processes which decisively shape China's response to water scarcity. Yet because of China's distinctive political system, in which policymaking is highly centralized but implementation is largely delegated to provincial and local governments, these actors, interests, and processes are key to understanding China's progress and prospects toward meeting the challenge of water scarcity. This Discussion Paper analyzes the current and future response of the Chinese government to conditions of water scarcity in the Yellow River Basin.

This Discussion Paper is divided into five sections. The Introduction highlights the major dimensions of water scarcity in the basin, focusing on the role of political relationships and institutions in determining who gets how much water. The first section describes the political and institutional actors responsible for water resource management and allocation in mainland China; the second reviews the economic, ecological, and political issues surrounding water scarcity in the Yellow River Basin; and the third section assesses the government's responses to water scarcity. The Conclusion draws implications for the future of water resource management and allocation in both the Yellow River Basin and China at large. Throughout, particular emphasis is placed on implications for the energy sector and the development of new energy resources in the Yellow River Basin.

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Introduction:

Dimensions of Water Scarcity in the Yellow River Basin

Water scarcity has emerged as one of the most significant challenges to China's economic and social development. In 2011, China's Vice-Minister for Water Resources confided that the country's water scarcity challenge was "increasingly grim" (J. Zhang 2011). Part of the reason that the challenge is so great is that water scarcity in China is the product of natural, demographic, and economic factors. Acute regional variation in precipitation and climate causes water availability to vary greatly across China, with the northeast, south, and southwest generally enjoying abundant water resources, and northern and central regions experiencing severe scarcity (Nickum 1998). These regional variations are exacerbated by the distribution of population and economic activity, which is concentrated disproportionately on the arid North China Plain. Moreover, economic and population growth means that China is now one of the most water-scarce countries in the world when measured on an annual per-capita basis, with an endowment of approximately 2,000 m³ per person per year as opposed to a global average of over 6,000 m³/person/year in 2011 (World Bank 2011).

The challenge of water scarcity is a particular concern to the energy sector, where concerns have mounted that shortage of water might constrain the development of new energy resources, including shale gas, as well as increase costs for power generation from existing sources. A report issued this year by Bloomberg New Energy Finance concluded, for example, that the power sector may account for a quarter of China's total water withdrawals by 2030 (Bloomberg New Energy Finance 2013). Given China's continued dependence on coal-fired power generation, which consumes approximately 17% of China's water, more than other energy generation processes, water scarcity is likely to constitute a significant constraint on energy production and development in some parts of the country (Hamlin 2013).

Nonetheless, these statistics say little about how water scarcity may impact politics and economics in the coming decades. This Discussion Paper expands upon the numbers behind China's water scarcity challenge to offer an analysis of how water scarcity is likely to be accommodated by the country's political and decision-making institutions. In particular, this Discussion Paper focuses on decision-making institutions, processes, and actors responsible for water resource allocation and management in the Yellow River Basin, an area which spans most of Northern China, including the capital, Beijing, the major coal-producing province of Shanxi, and the focus of new energy resource development in the province-level units of Inner Mongolia and Gansu. Although the challenges of water scarcity are markedly different for other parts of the country, close analysis of the Yellow River Basin facilitates a focus on the region where water scarcity will be of greatest impact and concern for China's economic and social development.

The regional focus of this Discussion Paper, apart from isolating the part of China most affected by water scarcity, also stresses an important but almost un-noticed aspect of China's sustainability challenge: how to overcome pervasive tensions and rivalries both between central and local levels of government, and between multiple governments at the local level. These inter-governmental conflicts play a critical role in determining which central government policies are implemented, and how effectively. In the field of water resource management, where access to water varies

tremendously across regions, these central-local and local-local conflicts are particularly important.

The Yellow River Basin is located in the North China Plain and spans seven provinces and two autonomous regions, encompassing about 10% of China's total population (Cheng 2008, 189). By convention the river basin is divided into three geomorphologic units: the Lower Reaches (*xiayou* 下游), including Shandong, Henan, and Hebei Provinces; the Middle Reaches (*zhongyou* 中游), including Henan, Shanxi and Shaanxi Provinces as well as the Inner Mongolia and Ningxia Autonomous Regions; and finally the Upper Reaches (*shangyou* 上游), including Gansu, Sichuan, and Qinghai Provinces (Giordano, et al. 2004, 2). As a whole, the Yellow River basin flows laterally, with basin political jurisdictions oriented on an upstream-downstream basis (see Figure 1). The river also forms the boundary between Shaanxi and Shanxi Provinces.

Water resources in the Yellow River Basin are divided unevenly between these regions. The Upper and Middle reaches contribute the majority of the Yellow's flow, with the headwaters lying primarily in Qinghai Province. The basin produces the majority of China's wheat, approximately half its coal, and some 25% of its oil (Giordano, et al. 2004, 5-6). The two largest tributaries, the Wei and Fen Rivers, are also of considerable economic importance to Shaanxi and Shanxi Provinces, respectively. As a whole the Yellow is especially notable for its high sediment loads (Osterkamp and Gray 2003, 1-3). These have shifted the river's course over time, leading farmers dependent on the rich alluvial soils to build an elaborate system of dikes which has in turn elevated the bed of the Yellow relative to the surrounding farmland, creating a substantial risk of flooding on the Lower Reaches of the river. Consequently, flood control has traditionally been the dominant externality issue in the Yellow River Basin, with government intervention historically focused on ensuring the durability of dikes and water diversion works (Giordano, et al. 2004, 4; 10).



Figure 1: Physical and Political Features of the Yellow River Basin

(Source: Circle of Blue, http://www.circleofblue.org/Waternews_MultiMedia/BYU/CPC_YellowRiverMap/)

In recent decades, however, water scarcity and related allocation issues have become the dominant management and governance challenges along the Yellow River. Basin water resources are extremely limited in comparison to the population that depends on them, and irrigation water use accounts for approximately 80% of total withdrawals in the Yellow River Basin (Giordano, et al. 2004, 3). Such intensive irrigation use, along with increasing aridity, have led to the emergence of significant water scarcity issues, which also serve to exacerbate water pollution by preventing dilution of pollutant loads. These externalities are most dramatically illustrated by a phenomenon known as “desiccation of the Yellow” or *Huanghehe duanliu* (黄河断流), in which the Yellow fails to reach the sea. From 1995-1998, the Yellow failed to reach the sea for about 120 days each year, devastating riverine ecosystems in the lower reaches (Giordano, et al. 2004, 19). In recent years, strengthened oversight and regulation have ensured that the Yellow consistently reaches the sea, though flows remain paltry in the Lower Reaches. Perhaps more clearly than any other phenomenon, therefore, the desiccation of the Yellow clearly illustrates the stakes posed by water scarcity in the Yellow River Basin.

The remainder of this paper analyzes the challenge of water scarcity in the Yellow River Basin in three parts. First, it describes the major actors responsible for water resource allocation and management in the basin, and how they interact. Second, the paper outlines the major issues at play in

the basin, with a focus on how water scarcity has engendered political conflict, particularly between the various province-level units which share the Yellow's waters. Third, the paper discusses the government's policy responses to the challenge of water scarcity since 1978, namely strengthening regulation and institutional capacity, revising an inter-provincial water resource allocation plan first introduced in 1987, implementing demand-side management strategies, and finally augmenting supply through the South-North Water Transfer Project (SNWTP). This Discussion Paper concludes by drawing some implications for the future impact of water scarcity on particular sectors and regions, with a particular focus on the energy sector.

Actors: Central-Local Relationships and Rivalries

China is unique among the world's large countries in making policy decisions at the central government level while leaving provincial and local leaders extensive leeway to determine how to implement policy in their respective jurisdictions. Under its Soviet-inspired political system, the People's Republic of China centralizes decision-making within small organs of the state bureaucracy and the Chinese Communist Party (CCP) (X. Wang 2002); (Landry 2008). However, sub-national governments, particularly at the province-level, are responsible for a large fraction of total government expenditures, giving officials at these levels a critical role in determining how, and with what degree of success, national policies are enacted. Because of this practical decentralization, addressing regional-scale challenges like water scarcity within the Yellow River Basin amounts to a complex exercise in inter-governmental coordination between both bureaucracies such as ministries, as well as sub-national political jurisdictions, such as provinces. This combination of central-local and local-local relationships complicates decisions concerning the allocation of scarce water resources, including for energy production versus other purposes.

The Chinese Central Government's Role in Water Resource Management¹

Water resource management, and particularly the construction and operation of waterworks for flood control, has been a core central government function in China for centuries and perhaps even millennia (Chi 1963). This focus has been continued by the People's Republic, for which water resource management in general, and Yellow River management in particular, possesses special historical and political significance. A disastrous 1938 flood, which killed nearly a million people, was cited by Mao and other senior Chinese Communist Party officials as being deeply affecting, ensuring that water resource issues received special attention in postwar policymaking (Gustafsson 1984, 67). After 1949, the newly-established People's Republic expanded earlier Nationalist regional economic development plans by proposing a profusion of new dams, reservoirs, and other waterworks in major river basins (Kirby 1990). Perhaps the best example is a 1954 Yellow River basin development plan (*Huanghe Zonghe Liyong Guihua Jishu Jingji Baogao* 黄河综合利用规划技术经济报告), which proposed a number of dams for hydropower generation, flood control, and irrigation along the upper and middle reaches of the Yellow. Planning and construction of several of these waterworks represented some of the Communist government's

¹ Much of this section is adapted from Scott Moore, "Water Resource Issues, Policy and Politics in China," *Brookings Issue Brief*. John L Thornton China Center, Brookings Institution, February 12, 2013. Available at <http://www.brookings.edu/research/papers/2013/02/water-politics-china-moore> (accessed May 1, 2013).

most important activities during the 1950s and 1960s.

Since 1978, legislative and institutional reforms have generally strengthened the center's role in water resource management. Most fundamentally, Article 9 of the 1982 Constitution provides that water is the property of the State, a provision reiterated by the 2002 Water Law which currently forms the legislative basis for water resource management and policy in China. The most important actor in water resource management in China is the central Ministry of Water Resources (MWR). MWR's responsibilities include the planning, financing, and construction of major water infrastructure projects, including dams, reservoirs, and irrigation systems, the formulation of plans and regulations concerning water use and allocation, providing input on water quality issues, overseeing the implementation of water pricing, collecting and maintaining hydrological data, soil conservation, and flood control (Ministry of Water Resources 2012). The Ministry of Environmental Protection (MEP) has general responsibility for pollution control, while various other bureaucracies play minor roles in particular water resource management issues. For instance, the Ministry of Agriculture provides input on irrigation systems, the Ministry of Commerce on navigation issues, and the State Forestry Bureau has implementation responsibilities for soil erosion control.

All major water resource policy decisions, particularly the construction of major dams or other water works, also involve higher levels of central government. All such decisions must be approved both by the formal state apparatus as well as be sanctioned by a parallel and inter-locking but more informal CCP structure. Within the formal state structure, the principal entity responsible for making major policy decisions is the State Council (*Guowuyuan* 国务院), which is analogous to a cabinet. Large infrastructure projects, as well as policies that might have a significant impact on the economy, must also be approved by the National Development and Reform Commission (NDRC; *Fagaiwei* 发改委). The largest, most important, and contentious water resource issues, including the Three Gorges and South-North Water Transfer Projects, are also ratified by the CCP Politburo or its Standing Committee (*Zhongguo Gongchandang Zhongyang Zhengzhi Ju* 中国共产党中央政治局), each of which is composed of the most senior Party leaders. Though functionally consultative bodies, the National People's Congress and the China People's Political Consultative Committee, collectively known as the "two congresses," (*lianghui* 两会) occasionally play a notable role in water resource policy decisions. In 1989, for example, renegade People's Congress delegates came close to de-railing the Three Gorges project (He and Si 1994, 25). Such instances have been rare in recent years, however.

Over the past decade the influence of non-governmental actors in water resource management has increased. Water pollution and dam construction have emerged as significant political and social issues, and media and civil society groups have been occasionally successful in halting the pollution of waterways by local enterprises (Mertha and Lowry 2006); (Mertha 2008). In large urban areas, the private sector plays a significant role in the water sector, particularly in the construction of sewage treatment plants (Qi 2011, 67); (Perard 2012). Nonetheless, the influence of these non-governmental actors remains extremely limited; almost 100% of investment in the water sector comes from government, which consequently guides virtually all important decisions concerning water resource management (Bennett 2013). Importantly, however, the governmental sector is not monolithic: sub-national governments play a critical role in water resource management, and their interests frequently diverge from those of the central government.

Sub-National Governments in China and their Interests in Water Resource Management²

In practical terms, sub-national governments are of equal importance to central government bureaucracies, particularly in the field of water resource management. Indeed, province-level governments possess the same bureaucratic rank and status as central ministries like MWR. Although MWR is ultimately responsible for water resource allocation, for example, sub-national governments are almost entirely responsible for implementing allocation plans within their respective jurisdictions, including the assignment of water rights to individual water users. In order to accomplish these objectives, every province-level government has a water resource management bureau whose functions broadly match those of the central MWR, and most county-level governments also possess a water resource unit whose responsibilities typically encompass water resource conservation, protection, flood control, irrigation, and water supply (Liu and Speed 2010, 12). In addition to these jurisdictional entities, various water-related special-purpose bodies exist, including dike maintenance committees, irrigation and reservoir district committees, and water user associations, all of which include representation from higher-level jurisdictional officials (Hubei Sheng Huanggang Diqu Shuili Dianli Ju [Huanggang Prefecture, Hubei Bureau of Water Conservancy and Electric Power] 1977).

Sub-national governments have gained significant power as a result of economic reform and decentralization, particularly at the provincial level. China's economic reform policies since 1978 have encouraged local governments to develop close relationships with enterprises within their jurisdictions; indeed, many enterprises are owned directly by local governments (Oksenberg and Tong 1991); (Oi 1995); (D. Yang 2004). The closeness of this relationship has helped to stimulate economic growth, but has also encouraged protectionism, and reduces the incentives of local leaders to take water pollution issues seriously. A recent news report on pollution in a large town in Anhui Province, for example, attributes the fact that "the government and the town's largest employer are all but indistinguishable" to the town's lax approach to pollution regulation (Stanway 2012). In the water resource arena, these protectionist tendencies mean that local governments tend to pursue individual interests to the detriment of cooperation with their neighbors.

Industrial enterprises typically compromise the majority of the tax base for individual local governments, and as a result local leaders often find it in their interest to adopt a lax approach to water quality regulation, passing the problem on to their neighbors downstream (Jahiel 1997); (Ge and Ma 2008, 41). This "local-benefit thinking [*bendi liyi de kaolu* 本地利益的考虑]" undermines trust and cooperation with neighboring jurisdictions (B. Zhang 2009), in turn contributing to a growing number of trans-boundary water disputes (*kua xingzheng quyue de shuishih jiu fen* 跨行政区域的水事纠纷) between provincial and municipal-level governments (Li, Liu and Huang 2010). This lack of inter-jurisdictional cooperation is particularly evident in the Yellow River Basin, where sharp differences in the interest of provinces in the Lower, Middle, and Upper Reaches present a significant challenge to attempts to address water scarcity.

In the Yellow River Basin, provincial-level interests break down along an upstream-downstream axis. The dominant concerns for the Lower Reaches have traditionally been flooding and siltation

² Much of this section is adapted from Scott Moore, "Hydropolitics and Central-Local Relations in China: The Pursuit of Localized Preferences in a Centralized System," *The China Quarterly* [Forthcoming].

(Greer 1979, 14), as well as water scarcity and quality in recent decades, which increasingly involve urban drinking water demands for Beijing and Tianjin. For the Middle and Upper Reaches, water quantity issues are pre-eminent. Both regions have witnessed dramatic increases in consumptive water demand for all water uses, but particularly for industrial and domestic purposes. In the Middle Reaches, industrial water use grew from 0.38 to 1.6 billion m³ from 1988-2004, while domestic consumption increased from 0.28 to 1.37 billion m³ over the same period. Similar increases were recorded for the Upper Reaches (Yang and Jia 2008, 269). Hydropower is a particularly important issue for the upper reaches in light of a number of proposed hydroelectric power plants and the central government's Great Western Development strategy.

Differences in the interests of upstream and downstream provinces along the Yellow River pose a considerable challenge to water resource managers and policymakers at the central government level. Because the Yellow River flows through many such jurisdictions, it is easy for upstream entities to divert large quantities of water or pollute the waterway before it passes downstream, thereby transferring the costs of water resource management to its downstream neighbors (Y. Wang 2007, 402); (Ge and Ma 2008, 42). Consequently, disputes are rife between the provinces of the Yellow River, with each blaming failures to limit water use and pollution on their neighbors (RMIT International 2003, 51-52). These behaviors undermine the central government's approach to addressing water scarcity in the Yellow River Basin, which relies on relatively weak river basin management institutions.

River Basin Management Institutions in China and their Limits

China's major river basins are formally managed by regional institutions called Water Conservancy Commissions (WCCs), which are part of the central Ministry of Water Resources. The WCCs are the lead bureaucratic entities responsible for management within China's major river basins, including water resource allocation. WCCs have been established in all of China's major inter-jurisdictional river basins as well as for Lake Tai. Their legal authority has been progressively strengthened, including via the 1997 Flood Control Law and the 2002 Water Law, which granted the WCCs the authority to develop basin-wide water resource development and water allocation plans. In a few cases, including in the Yellow River Basin, the WCC exercises direct operational control of major dams and reservoirs. However, for the most part the functions of the WCCs are limited to coordination and planning within their respective river basins (Shen 2009).

As currently constituted, the power of the WCCs is insufficient to reconcile the interests of different provincial and local governments. The WCCs are classified as "dispatched organs" (*paichujigou* 派出机构) of the central Ministry of Water Resources (Shen 2009, 488-492), meaning that they do not include representation from river basin stakeholders, including the provincial governments. Instead, the members of the commissions are technocrats with little political experience or authority in brokering consensus. Of the Yellow River Water Conservancy Commission's eight members, for example, five are hydraulic engineers and two are economists (Huanghe Shuili Weiyuanhui [YRCC] 2011).

The Yellow River Basin plays host to the longest-standing WCC, the Yellow River Conservancy Commission (YRCC; *Huanghe Shuili Weiyuanhui* 黄河水利委员会). The YRCC was established in its present form in 1950, when MWR issued directions stipulating that it should act as

a basin-scale management structure (*liuyuxing jigou*流域形机构), with the governments of the riparian provinces acting subject to its direction (Shuilibu Huanghe Shuili Weiyuanhui [YRCC] 2006, 83). Notably, and in sharp contrast to most bureaucracies established by the new Communist regime, the YRCC was placed directly under the central government out of a desire that it “be free of entanglements and squabbles between provincial governments” (Greer 1979, 41), and instead reporting directly to the Ministry of Water Resources.

Throughout the early years of the People’s Republic, the YRCC steadily gained prestige and importance as the lead entity in implementing the central government’s Comprehensive Yellow River Basin Development Plan. Its regional focus was strengthened by a 1952 State Council decision calling for basin-wide planning (*liuyu guihua*流域规划) (Shuilibu Huanghe Shuili Weiyuanhui [YRCC] 2006, 83-87). Moreover, the power of the YRCC was made evident in a unique case of bureaucratic precedence. In the mid-1960s, the central government determined that MWR’s predecessor, then called the Ministry of Water and Power, should be responsible for hydropower generation while the Ministry of Agriculture should be responsible for irrigation development. In the Yellow River Basin, however, the center directed that operational authority for both tasks be ceded by both line ministries to the YRCC (US Joint Publications Research Service 1965, 155).

In recent decades, the legal and regulatory authority of the YRCC and the other WCCs has been progressively increased, motivated in large part by a desire to improve water pollution control. Joint MWR-MEP water quality bureaus have been created within the RBCs in order to more effectively supervise provincial-level authorities within river basins (Shen 2009, 495). In addition, the 2008 Water Pollution Law mandated water resource planning on a regional rather than jurisdiction-by-jurisdiction basis (Wouters, et al. 2004); (Shen 2009). Moreover, recent attempts to develop inter-provincial pollution compensation mechanisms reflect the central government’s commitment to a Basin-wide approach to solving water resource management challenges (Xinhua 2012).

In the Yellow River Basin, these efforts have seen little success in combating pollution, but have been successful in addressing two of the basin’s most long-standing water resource management issues: disastrous flooding has been avoided, and the desiccation of the lower Yellow River has been effectively halted, with the river reaching the sea every year since 1999. However, this form of centralized bureaucratic management has been possible only because water resource management in the Yellow River basin is almost entirely a state function; all dams and reservoirs on the main stem of the river are state-owned, and flow rates are maintained through administrative orders issued to dam and reservoir operators by the YRCC, without economic compensation despite the high costs thereby imposed (Yang and Jia 2008, 270).

As this example illustrates, water scarcity issues in the Yellow River Basin have been addressed principally by allocating water resources between provincial-level jurisdictions. This task has been undertaken in the Yellow River basin through centralized bureaucratic management rather than through inter-jurisdictional negotiations or cooperation. Consequently, the YRCC and provincial governments have often been at odds. As Charles Greer, one of modern China’s earliest observers of water resource politics, writes, “Administrative problems arose because the YRCC superseded provincial governments, but it came into conflict with other agencies of the central government...Its various project bureaus were little more than advisory adjuncts to project bureaus

of the Ministry of Water Conservancy or the State Council. Thus the YRCC functioned more as an interagency coordinating unit than as a strong and autonomous executive unit for basin development” (Greer 1979, 75). Despite being one of the most powerful water resource management institutions in China, these gaps in the YRCC’s institutional capacity render it increasingly unable to meet emergent water scarcity and pollution challenges.

Greater inter-jurisdictional cooperation is needed to meet these inter-linked challenges. Over 60% of monitored sections of the river are classified as Grade V, the worst in China’s water quality rating scheme (RMIT International 2003, 6). Moreover, ecological flows required to maintain vegetation and wildlife habitat are virtually non-existent on the Lower Reaches (Giordano, et al. 2004, 20). Both of these challenges are at least partly rooted in a lack of effective supervision and coordination of local governments in the Yellow River Basin. An Asian Development Bank (ADB) report, for example, blamed the “overwhelming protectionism exercised by local governments” for the Yellow River’s ecological and water quality problems. Such political conflict continues to hamper water resource management and allocation, particularly under the circumstances of acute water scarcity which now plague the Yellow River Basin.

Issues: Water Scarcity and Political Conflict

Water scarcity in the Yellow River Basin has several causes, including changes in both climate and hydrology. The dominant factor, however, has been economic development and consequent changes in demand for Yellow River water. Because of its roots in processes of economic change and development, water scarcity has inevitably become a deeply political problem. In the process, water scarcity has engendered conflicts and tensions between both central and local levels of government as well as between sub-national governments themselves. Accordingly, this section reviews water scarcity challenges present in the Yellow River Basin as well as the political conflict between different levels of government within the Basin which has resulted.

Water Scarcity Challenges in the Yellow River Basin

As the sole major waterway for a populous and largely arid region, the Yellow River has always been subject to water scarcity. However, the problem of water scarcity has become particularly acute since 1978. For example, total basin runoff in the period 1990-2000 was 24% below average for the time period since 1956 (Giordano, et al. 2004, 18). At the same time, economic growth and change have dramatically increased demand throughout the Yellow River Basin. Although historically water use had been predominantly for agriculture and geographically concentrated in the Lower Reaches, urban and industrial water demands have increased dramatically in the Middle Reaches. A significant portion of the increase in industrial water demand, particularly in the Middle Reaches, has in turn been due to rapid increases in coal mining in Shanxi and Inner Mongolia.

Over the past twenty years, water demand in the Yellow River Basin has undergone two profound shifts. First, overall demand has increased across all sectors, but most dramatically in industry, where water usage in the 1998-2000 period represented an increase of 109% over the 1988-1992 period. Second is a marked regional shift in water usage. By 2000, water consumption

in the Middle Reaches had increased by 95% above the 1988-1992 period, as against an overall increase of 21% throughout the basin as a whole. This regional shift is even more notable when put alongside data on sectoral water use: industrial water consumption in the Middle Reaches increased by a staggering 286% in the 1988-2000 time period, as against only 9% in the Lower Reaches (Giordano, et al. 2004, 19). These changes are shown in Figure 2 below, which depicts changes in sectoral water use on the left side of the panel, and geographic changes in water use on the right side.

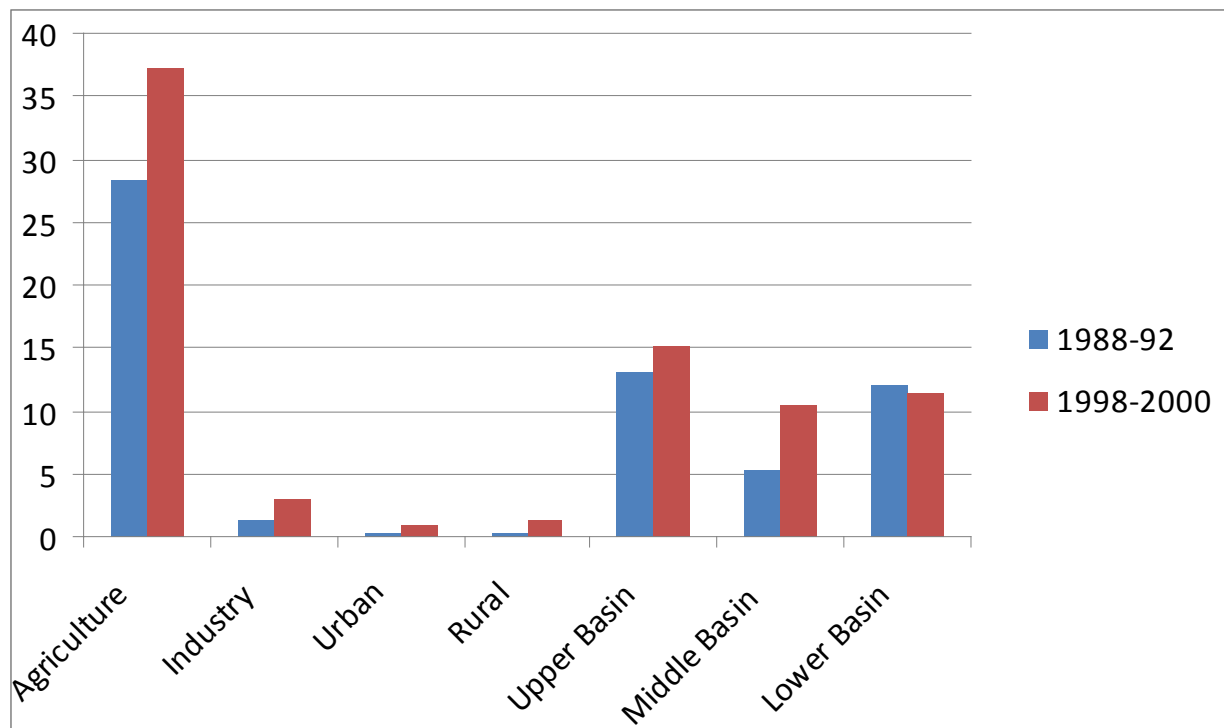


Figure 2: Water Use Changes in the Yellow River Basin by Sector and Region, 1988-2000
(Adapted from Giordano, et al., 2004, 19)

China's coal production has sky-rocketed in recent years, increasing by nine percent from 2010 to 2011 alone and making China the world's largest coal producer (US Energy Information Administration 2013). Much of this production has been concentrated in the Middle Reaches of the Yellow River Basin, with a dramatic impact on water use. Producing one ton of coal requires between 800 and 3,000 gallons of water, and in China as a whole coal production consumed some 4 trillion gallons annually according to 2011 data (Schneider 2011). These requirements are reflected in dramatic increases in water use for coal production in two of China's largest coal-producing provinces, Shanxi and Inner Mongolia, both of which fall within the Middle Reaches of the Yellow River. The water requirements of coal production have approximately doubled in Henan, Shanxi, and Gansu, and increasing by more than four times in the cases of Shaanxi and Inner Mongolia (Circle of Blue 2013). These increases are depicted in Figure 3 below, which shows increases in the water requirements of coal in 2010 versus 1997 for each of the nine provinces through which the Yellow River flows.

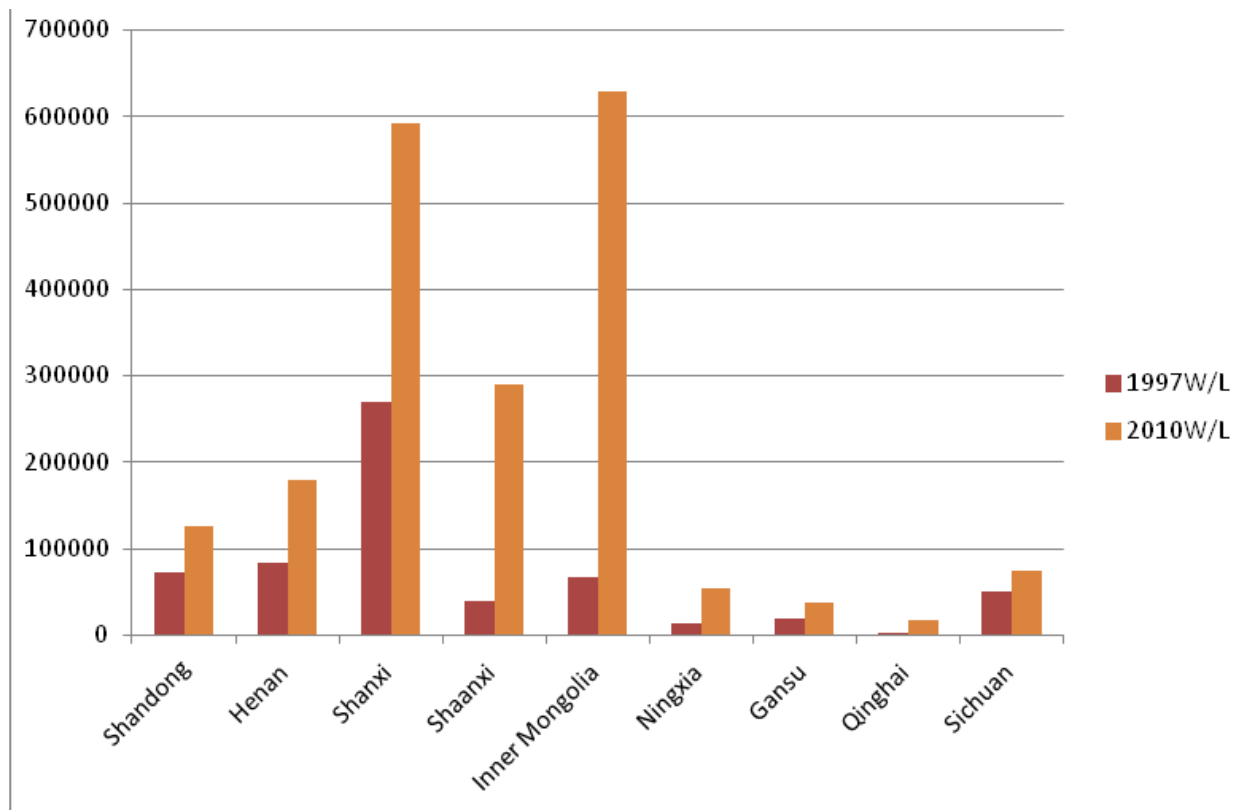


Figure 3: Water Requirements of Coal Production in Yellow River Basin Provinces, 1997 vs. 2010
(Data from Circle of Blue, 2013)

Although coal production accounts for the single largest portion of increasing demands for Yellow River Basin water resources in recent years, development of shale gas resources is likely to be a future source of water stress. Of China's six major identified shale gas basins, four fall partly within the Yellow River Basin (US Energy Information Administration 2011). Of these, two in particular, the Ordos and North China Plain Basins, are located in areas of acute water scarcity. Development of shale gas resources in these basins would likely severely strain local water resources. Generic estimates of water requirements for US shale gas development suggest that 400-4,000 m³ of water are required to drill a single well, and 7,000-18,000 m³ are required for hydraulic fracturing (Gregory, Vidic and Dzombak 2011, 183). Verified water use statistics for Texas shale gas wells range from a total water requirement of 10,600 m³ to 21,500 m³ per well (Nicot and Scanlon 2012, 3582).

Little commercial shale gas drilling has taken place in China, and local water requirements for shale gas production are thus difficult to estimate. Nonetheless, data from the United States indicate that large-scale development of shale gas basins in Northern China would be extremely water-intensive. Yet it remains unclear whether these basins will be tapped in any case. Shale gas resources in the Yellow River Basin are estimated to be China's least productive (US Energy Information Administration 2011), and recent news reports indicate that China is preparing to tap shale gas basins located in Sichuan, where water resources are more abundant (Mufson 2013). Nonetheless, the prospect of shale gas development in the Yellow River Basin illustrates how little water exists to meet new demands, and the political challenge of allocating its scarce water resources.

Political Conflict in the Yellow River Basin

Historically, political conflict in the Yellow River Basin centered on major development projects. In particular, dam and reservoir construction was marked by bitter infighting between various central bureaucracies. MWR's predecessor was called the Ministry of Water Resources and Electric Power (MWP), and those elements of the Ministry concerned with water quantity issues typically opposed those concerned with hydropower production; indeed the durability of such conflicts led to the creation of MWR and the transfer of the energy portfolio to other bureaucracies (Lieberthal and Oksenberg 1988, 284). Unlike in federal countries like the United States, there is essentially no divergence between national- and sub-national water resource legislation, and those elements of provincial- and county-level government concerned with water resources are formally subject to central bureaucratic supervision and direction (Shaanxi Province General Office 2008). However, as water scarcity has increased in the Yellow River Basin, inter-jurisdictional disputes and conflicts have assumed greater importance, and significantly constrain the central government's ability to deal with these problems.

These conflicts reliably break down according to the geographic positions of administrative units within the basin. Lower Reach leaders tend to oppose project development on the Upper and Middle Reaches, and complain about flooding and siltation issues (Cheng 2008). In recent years, major planned developments in the Upper Reaches have produced a similar oppositional dynamic between it and the Middle Reaches. A proposed dam near the border of Ningxia and Gansu Province, for example, has been delayed for over sixty years as a result of continued squabbling between the two provinces, which has in turn prevented the central government from reaching a final decision (Moore [Forthcoming]). This basic geographic divide has been modulated only by the role of the central government in Yellow River Basin management issues, which is in turn influenced by lobbying on the part of provincial governments.

The means by which the sub-national governments of the Yellow River basin pursue these geographically-differentiated interests is through informal lobbying. The Chinese system provides very few direct, formal mechanisms for consensus-building and negotiation between provincial-level governments, and as a result regional water resource interests are addressed primarily through informal bargaining within the CCP (Gustafsson 1984, 153). Accordingly, the crucial actors are sub-national leaders, who act as preference-aggregators within their jurisdictions. Though not directly accountable to particular interests within these jurisdictions, the fact that provinces derive much of their revenues from local enterprises ensures that sub-national leaders prioritize economic interests within their jurisdictions, particularly those of state-owned enterprises (Z. He 2000, 247). This behavior is illustrated by the comments of a Ningxia deputy to the National People's Congress, who despite being unelected pledged to his constituents to be "duty-bound to help advance Ningxia's socioeconomic development" (Ningxia Ribao [Ningxia Daily] 2010). Such political negotiations and conflicts have decisively shaped the government's response to water scarcity in the Yellow River Basin.

Responses: Evolution in Water Resource Regulation, Allocation, and Infrastructure in the Yellow River Basin

The period after 1978 was marked by direct competition between central and local levels regarding water resources, as well as between riparian jurisdictions. The root cause of this new dynamic was the increasing number of economic and political interests which resulted from the liberalization of the Chinese economy, known as “reform and opening” (*gaige kaifang* 改革开放). This process is reflected in two distinct phenomena in Yellow River Basin management. First, inter-jurisdictional tensions regarding water resource allocation and project construction were accentuated because the economic stakes of possessing water water increased. Second, water quality issues became much more pronounced, primarily because both central and local governments possessed insufficient regulatory authority and incentives over newly-privatized polluting enterprises. This section reviews the central government’s attempts to address these issues and the challenges which remain in doing so, particularly reform of the water resource allocation system in the Yellow River Basin and the South-North Water Transfer Project (SNWTP).

Strengthening Central Government Capacity

Throughout the late 1990s and early 2000s, the central government progressively expanded its direct operational control over water resource allocation within the Yellow River basin. In 1998, MWR, under orders from the State Council and the powerful National Development and Reform Commission, issued new regulations in response to the desiccation of the Yellow which gave YRCC authority to adjust inter-provincial allocations based on current and predicted flows, including by issuing monthly water usage guidelines to provincial authorities and requiring them to submit water usage requests and reports (Guojia Fazhan Jihua Wei yuanhui [National Development Planning Commission] / Shuilibu [Ministry of Water Resources] 1998). Though intended to manage basin flows “according to a theory of balance,” (*dui pingheng lilun* 对平衡理论), the system relies on strict hierarchical control, with annual water usage requests being submitted first by provincial governments to YRCC, and then from YRCC to MWR (G. Li 1999, 54); (Shen 2012, 589). These legal reforms have been complemented by a 400 million RMB “digital Yellow River” project (*Shuzi Huanghe* 数字黄河) to install a network of sensors that permits near-real-time monitoring of water quantity and quality along the Yellow’s course, intended to improve supervision of actual water use at provincial boundaries (Xinhua 2006).

The remaining challenges to this approach are illustrated in attempts to develop market mechanisms, particularly water rights trading systems, to promote water conservation in the Yellow River Basin. The 2002 Water Law established a basic framework for water rights in a three-tiered system by which territorial governments, major water users such as factories and irrigation districts, and individual water users such as farmers can be assigned water rights. In practice, however, water rights have been only assigned in specific areas, and title is unclear in most of the country. However, the Yellow River Basin has been the site of several important water rights trading initiatives. A government-financed project lined hundreds of kilometers of irrigation canals, creating water use savings which were then allocated on an administrative, not market, basis to industrial water users. Some limited water rights trading at the farmer level has also been practiced in parts of the Yellow

River Basin, but anecdotal accounts suggest that uptake is low (Speed 2009, 275-276).

These accounts also suggest the broader challenges facing implementation of market mechanisms like water rights trading in China. Water rights trading schemes are complex, and participation rates are low, particularly among farmers (J. Zhang 2007). Because implementing regulations are unclear, there is also wide regional variation in how water rights are assigned and the procedures that govern their sale and transfer. Allocation of water rights is primarily achieved by administrative review of applications, although there is limited experimentation with auctions in some areas. Robert Speed's assessment concisely summarizes these barriers to the use of water rights trading to solve the Yellow River Basin's water scarcity challenge: "Despite efforts since the introduction of the 2002 Water Law, water rights in most cases in China are not well established, either at the regional, abstractor, or farmer level. Rights have often not been granted at all, and where they have, the rules surrounding the rights are often ambiguous" (Speed 2009). Under this scenario, where market-based allocation mechanisms are not functional, political relationships and conflicts continue to shape management of the Yellow River and its waters.

Inter-Provincial Water Resource Allocations³

Another consequence of rapid economic growth has been increased pressures on the Yellow River's water resources such that by the early 1980s not all water use demands could be satisfied. MWR and the YRCC reacted by returning to the integrated, comprehensive, basin-wide management structure which defined the center's approach to RBM in the 1950s. Stressing that "all parts of the river are intimately related" (*jinmi guanxi* 紧密关系), MWR and the YRCC initiated an ambitious effort to revise earlier inter-provincial water resource allocations to reflect new economic realities (Shuilibu Huanghe Shuili Weiyuanhui [YRCC] 2006, 300). Accordingly, the YRCC engaged provincial governments in extensive consultations regarding present and future water demands, attempting to account for factors such as Shanxi's demand for water for coal extraction and processing (D. Li 2010). A preliminary plan was formulated by the then-Ministry of Water and Power (MWP) and approved by the State Council in 1987. This inter-provincial allocation plan is depicted in tabular form in Figure 4 below (Guowuyuan [State Council] 1987).

| Area | Qinghai | Sichuan | Gansu | Ningxia | Inner Mongolia | Shaanxi | Shanxi | Henan | Shandong | Hebei & Tianjin | Total |
|-----------------------|---------|---------|-------|---------|----------------|---------|--------|-------|----------|-----------------|-------|
| Annual Water Quantity | 14.1 | 0.4 | 30.4 | 40.0 | 58.6 | 38.0 | 43.1 | 55.4 | 70.0 | 20.0 | 370.0 |

Figure 4: Yellow River Available Water Quantity Allocation Plan (Prior to SNWTP) (Hundred Million m³)
(Source: State Council, 1987)

Nonetheless, the process of these negotiations underlines the central government's weakness relative to province-level governments in the Yellow River basin: consultations were both extensive and deferential to the views of sub-national officials. Initial discussions on an inter-provincial

³ Much of this section is adapted from Scott Moore, "Hydropolitics and Central-Local Relations in China: The Pursuit of Localized Preferences in a Centralized System," *The China Quarterly* [Forthcoming].

allocation took place at a 1984 conference of all Yellow River basin provinces intended to produce a plan to “fully utilize” the Yellow’s flows. Employing common practice for important policy issues, MWR established a “leading group” to produce a report based on these consultations, which eventually resulted in the Yellow River Water Quantity Allocation Plan which was approved by the State Council in 1987. A similar consultative process was undertaken by YRCC regarding the “Revised Yellow River Administration and Development Plan” which was discussed at a major conference in 1988 and which proposed to accelerate development throughout the Yellow River basin. Reflecting the increased willingness of MWR to defer to views of sub-national leaders, only after the agreement of provincial officials that the plan was “basically correct” were implementing instructions for the plan issued (Shuilibu Huanghe Shuili Weiyuanhui [YRCC] 2006, 298-299).

Despite this extensive consultation and the efforts of MWR and YRCC to develop a comprehensive water resource allocation plan, water demands continued to rise rapidly, and by the late 1990s the desiccation of the Lower Reaches had become an acute problem, imperiling urban drinking water supplies and oil production in the Middle Reaches (Shuilibu [MWR] 1999). These water scarcity challenges induced the center to adopt a practice of greater direct control and supervision, which it pursued by formulating a successor to the 1988 Revised Yellow River Administration and Development Plan that rivaled the 1954 comprehensive basin development plan in scale. This revised plan proposed to simultaneously address flooding, siltation, as well as the more recent challenge of water scarcity. The resulting “Yellow River Framework Plan for Administration and Development,” issued in 1997, codified the principle of centralized bureaucratic control over water resource allocation. Though it retained earlier policies related to flood and siltation control, the plan’s water resource provisions promised to improve and strengthen “overall control, active administration, and strict supervision” (E 1999).

Yet despite the central government’s substantial investment in this system, the riparian jurisdictions along the Yellow attempt to escape the center’s water resource allocations by regularly exceeding their allocated withdrawals. This over-appropriation is accomplished by withdrawing large quantities of water from tributaries rather than the main stream of the Yellow River, where YRCC monitoring is more effective. Referring to the 1998 regulations, a 2011 YRCC report admitted that “In implementing the Yellow River water quantity regulations, there exist some localities which do not put into practice the water quantity allocation and dispatch plan, and exceed the allocation limits in using water resulting from inter-provincial flows not according with control limits” (Huangshuihui [YRCC] 2011). Thus for all its renewed attempts to address basin externality issues in a comprehensive, coordinated fashion, gaps in inter-jurisdictional cooperation continue to undermine the central government’s attempts to meet water scarcity challenges in the Yellow River Basin.

Increasing Supply: the South-North Water Transfer Project

Central-local conflicts in water resource management have increasingly been matched by inter-regional tensions, particularly as a result of long-distance water transfers under the South-North Water Transfer Project (SNWTP). The idea of easing water scarcity in the Yellow River basin and North China Plain by transferring water from the south originated with Mao, who is said to have proposed that “since the south has a great deal of water, and the north very little, perhaps we should borrow a bit of it” (Renmin Ribao [People’s Daily] 1979). Planning for long-distance, inter-basin

water transfers began as early as 1959, when a research and evaluation workshop was convened in Beijing with representatives from the YRCC and several Upper-Reaches provinces (Xinhua 1959). However, serious discussion of construction of the SNWTP began in the late 1970s, as water scarcity pressures in the north became more acute. The SNWTP became an official part of the center's economic development policy at the 1978 Party Conference, when it was decided to construct three separate water-diversion channels, termed the Eastern, Central, and Western Routes. The Eastern Route was to be constructed first in order to alleviate Tianjin's pressing water shortage, and was also intended to stimulate commerce because it would entail the renovation and expansion of the ancient Grand Canal which had historically linked the north and south (Hua 1978); (Renmin Ribao [People's Daily] 1979b).

The Three Routes of the South-North Water Transfer Project



Figure 5: Planned Routes of the South-North Water Transfer Project
(Source: Moore/Brookings Institution, 2013)

In its conception, the SNWTP thus reflected the central government's long-standing preference for multi-purpose water infrastructure projects to expand supply rather than to reduce demand for water. Almost from the outset, however, the center recognized the potential for inter-regional conflict as a result of large-scale water transfers. A 1979 People's Daily editorial acknowledged that "some may see the SNWTP as robbing Peter to pay Paul," and called for "comprehensive, all-around planning" to alleviate such concerns (Renmin Ribao [People's Daily] 1979b, 3). Despite such warnings, a failure to anticipate water use trends now threatens to render the SNWTP inadequate to meet water demands in the Yellow River Basin, especially for urban drinking water. By the late 1980s, the People's Daily began acknowledging that water conservation would be necessary to meet urban water demand along the Eastern Route (Renmin Ribao [People's Daily] 1989), and by 1992 the State Council had expressed concern that far higher-than-anticipated levels of water pollution risked contaminating Eastern-Route water to the extent that it would be unfit for human consumption by the time it reaches Northern China (Renmin Ribao [People's Daily] 1992). Similar warnings were issued regarding the increased risk of flooding in the southern provinces

which were designated to supply water for the Eastern Route (Renmin Ribao [People's Daily] 1991).

The center has reacted by establishing new institutions and mechanisms to attempt to address these inter-jurisdictional issues. In 1996, an expert group recommended that SNWTP construction be financed on a principle of “whoever benefits, invests,” (*sheishouyi, sheitouzi* 谁受益,谁投资) as a result of which the center has levied special taxes on water-receiving regions in North China, principally the Beijing region (Renmin Ribao [People's Daily] 1996). In order to coordinate the project, an office was established directly under the State Council, with parallel offices in many of the provinces (Jiangsusheng Nanshuibeidiao Bangongshi Zonghechu [Jiangsu Province SNWTP Office General Department] 2005). This office has engaged in extensive consultation with provincial-level leaders (Shuilibu Nanshuibeidiao Guihua Sheji Guanliju [MWR SNWTP Planning, Design, and Management Bureau] 2011), and helped to establish a “clean water corridor” (*qingshui zouliang* 清水走廊) designed to forestall trans-boundary pollution issues along the heavily-populated Eastern Route by constructing water treatment plants (Zhongguo Huanjingbao [China Environment Report] 2008).

These institutional attempts to capture the inter-jurisdictional cooperation issues engendered by the SNWTP represent the center's continued engagement in addressing water resource management and allocation issues within the Yellow River Basin. However, the sheer scale of these issues, combined with dramatic increases in the number and types of water users, have created governance challenges that have so far outstripped institutional responses.

Conclusion: the Future of Water Scarcity in the Yellow River Basin

For over fifty years, the control, development, and management, of the Yellow River Basin have been important undertakings of all levels of government in the People's Republic. As a result of their efforts, an impressive institutional structure has been created centered around the YRCC, which both directly controls water resource allocation and also plays a coordinating and convening role between and among provincial-level water affairs entities. Substantial progress has been achieved regarding the two major water resource management issues of historical importance, siltation and flooding. Some measurements suggest that siltation has been reduced by least 300 million tons annually, while the threat of flooding along the Yellow, once one of China's greatest natural hazards, has been largely eliminated thanks to diligent monitoring and extensive construction and maintenance of flood-control works (Giordano, et al. 2004, 27; 36). In addition, the “holistic water management” measures implemented by the YRCC have halted the desiccation of the Yellow's Lower Reaches, even if ecological flows remain minimal and flow rates are insufficient for sediment removal (Yang and Jia 2008, 270).

Nonetheless, the management and governance of the Yellow River Basin has been plagued by political conflict. As an International Water Management Institute (IWMI) report concludes, “From its founding to the present, the YRCC has not had power to act as a true basin authority...

national, provincial and local agencies have been able to place varying claims and priorities on the river's resources and development" (Giordano, et al. 2004, 35). Consequently, attempts to address basin-wide water quantity and quality issues remain plagued by both inter-bureaucratic and inter-jurisdictional conflicts. These challenges are perhaps most visible with respect to water quality, where "the political negotiation and bargaining process between provinces within the basin" undermines efficient allocation (Yang and Jia 2008, 270). Moreover, despite their significance to water quality, inter-jurisdictional issues also impede responses to growing water scarcity issues.

In particular, inter-regional conflict is likely to increase as water shortages become more pronounced. The current inter-provincial allocation of water resources in the Yellow River basin is inadequate, and future demand can be met only through expanded water transfer under the SNWTP (Yang and Jia 2008, 273). Even then, however, it will be necessary to achieve dramatic gains in water use efficiency, which the government is attempting through higher water usage fees, water rights reform, and other market mechanisms (Zhonggong Shuilibu Dangzu [MWR Party Committee] 2008). Implementing such policies is deeply contentious, and a task for which current institutional structures for Yellow River Basin management may not be well-suited. As the IWMI's report concludes, "The YRCC was established primarily to defeat the threat of flooding and develop irrigation. While it has had much success in this regard, the problems today are much broader with less easily definable solutions or even preferred outcomes" (Giordano, et al. 2004, 35). It is with respect to these more amorphous, regional issues that the Chinese system of centralized decision-making and decentralized implementation, poses the greatest challenges to addressing water scarcity.

This conclusion augurs ill for the latest shift in Chinese government policy toward water resources in general, and the Yellow River Basin in particular, which attempts to improve water resource policy implementation through uniform national-level regulation. In 2010, the Communist Party Central Committee and State Council announced the establishment of "Three Red Lines" (*santiao hongxian* 三条红线) intended to establish clear and binding limits on water quantity usage, efficiency, and quality. In early 2012, the State Council clarified, as part of the annual No. 1 Policy Document, that the "three red lines" policy would limit total national water consumption to less than 700 billion cubic meters per year, amounting to approximately three-quarters of China's total annual exploitable freshwater resources. In addition, the policy mandates that 95% of tested water must meet national water quality guidelines and that an increase in irrigation use efficiency of 60% both be achieved by 2030 (State Council 2012).

The Three Red Lines policy represents China's centralized decision-making at its most ambitious. As an MWR official states, "There are no other countries that have set such detailed targets to restrict their own development by limiting usage of water resources" (Wu 2012). Yet despite its ambition, few details have been released concerning how such a strict nation-wide set of policy measures will be implemented in different regions. Moreover, even this highly centralized policy contains an implicit recognition of the crucial role of sub-national interests and preference divergence. To ensure that the targets are being met at local levels, the government announced a plan to establish some 14,000 monitoring stations throughout the country to continuously monitor water quality and quantity (China Daily 2012).

In the coming decades, political conflicts and tensions between both central and local levels of

government as well as between sub-national administrative jurisdictions will shape water resource allocation in the Yellow River Basin and China at large. These tensions are particularly likely to shape the allocation of water resources for development of new energy resources. In this scenario the interests of the Middle and Upper Reaches provinces diverge substantially. For the latter, large dam construction will be the priority because of its co-benefits for hydropower generation as well as irrigation and water storage. The Upper Reaches are therefore likely to push for greater large dam construction, thereby impounding greater quantities of the Yellow's total flow. For the Middle Reaches, in contrast, the priority is likely to remain coal production and combustion, with its ensuing demands on water resources. The Middle Reaches are therefore likely to demand greater flows from the Upper Reaches. Any further large-scale development of hydropower, shale gas, coal or oil in the Yellow River Basin will have to take these tensions into account.

Nonetheless, there are several steps that the Chinese government could take to improve water resource management in the Yellow River Basin and ensure that political conflict does not undermine its attempts to address water scarcity. First, the government could change the composition of the Water Conservancy Commissions to include multiple stakeholders, especially provincial-level governments. This step might help to facilitate negotiation and build consensus over major water resource management issues, especially those concerning allocation. Second, the Ministry of Water Resources could accelerate the set-up of water rights trading systems, particularly in the Yellow River Basin, and could mandate that water rights be assigned through an auction system rather than by bureaucracies. Such market-based mechanisms would likely serve to reduce the protectionism that hinders implementation of centrally-formulated water resource policies at the local level.

A distinguishing feature of water resources in China is that they are unevenly distributed among the country's many sub-national jurisdictions. Yet as these jurisdictions have gained greater responsibility for promoting economic growth, the stakes for possessing water have increased dramatically, promoting substantial political conflict, especially in the Yellow River Basin. In order to successfully adapt to water scarcity, the Chinese government will have to take these politics into account and enhance its capacity to contain, mediate, and resolve inter-governmental disputes. China will need to navigate these politics of thirst carefully in order to conserve and protect perhaps its most valuable natural resource.

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