ZEF Bonn
Zentrum für Entwicklungsforschung
Center for Development Research
Universität Bonn

The Dilemma of Water Allocation between Humans and Nature - A Case from Northern China.

Patricia Woedem Aidam, ZEF b
Jennifer Hauck, ZEF c

November, 2006
Interdisciplinary Term Paper
International Doctoral Studies Program

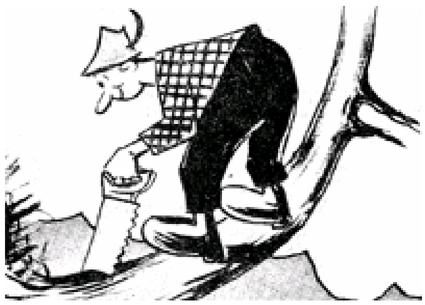
Source of picture: http://dspace.library.cornell.edu/bitstream/1813/2856/19/Fig+1-x+Yellow+River.jpg

Table of contents

List of Maps, Table and Figures

1. Introduction

Today, about 700 million people in 43 countries live below the water-stress threshold of 1.700m^3 per person. By 2025 this figure will reach 3 billion, as water stress intensifies in China, India and Sub-Saharan Africa (UNDP, 2006). These facts are reflected in the UN's Millennium Declaration Goal: "to halve, by the year 2015 the proportion of people who are unable to reach, or to afford, safe drinking water"(UNDP, 2000). The United Nations Committee on Economic, Social and Cultural Rights (2002) came to the conclusion that "the human right to water entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic use". Bearing this in mind one has to seriously ask the question then:



(source:http://waldbauernmuseum.at/images/noast.gif)

Why bother for nature when not even humans have enough to drink? The answer to this question is fairly simple: Not providing enough water for the needs of nature is like cutting the branch on which we are sitting. Apart from this there is an old (Leopold, 1949) but still lively discourse on ecological justice that asserts that "the environment has a standing" quite apart from its provision of services to humans (e.g. Priscoli, et al, 2004).

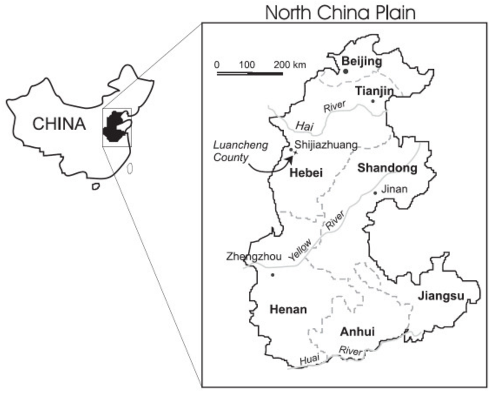
River systems that no longer reach the sea, shrinking lakes and sinking groundwater tables are among the most noticeable symptoms of water overuse (UNDP, 2006). Declining fish catches and pollution due to reduced water flows, salinization due to sinking groundwater tables or the loss of biodiversity of delta vegetation are only some of the consequence of not allowing the minimum or so called environmental flows. For the purpose of this paper we pick up a definition of environmental flows from Arthington et al (2006) where they define environmental flows as: "the water regime of a river, wetland or coastal zone necessary to maintain the biophysical components, ecological processes and health of aquatic ecosystems, and associated ecological goods and services". For the purpose of this paper we add the ground water systems to this definition, since they also provide important services, which in turn depend on environmental flows. The result of not allowing water flows towards ecosystems is that they cannot provide goods and services, humans fundamentally depend on (MEA, 2005). In addition a large water-based ecological debt accumulates which is mostly imposed on the poor and will be transferred to future generations (UNDP, 2006).

The next problems is the question of how much water needs to be allocated towards the environment. In this paper 'Environmental Water Allocation' is used according to Naiman et al (2006) to "acknowledge the provision of specific amounts of water with particular timing, frequency, duration and variability to sustain river ecosystems", again this definition is extended to include ground water systems. Estimates of how much natural flow is needed differ greatly starting with 95% and go as low as 15% of water having to remain (Tennant, 1976, Dysen et al, 2003, UNDP, 2006). This is posing another question. Who is really able to make a decision on how water is allocated where? The answer is fairly simple for cases were there is enough water. But our case study on the North China Plain shows that this question can really cause a dilemma. In northern China human withdrawals currently leave less than 10% of water for river ecosystems. The reduced run-off was to a large extent replaced by tapping the groundwater. But also the groundwater is now used faster than it can be replenished with serious environmental degradation. China starts "feeling" the consequences of this overuse and problems enter stages were they cannot be ignored any longer. On the one hand several steps are now taken by the Chinese government to overcome these problems and improve their water allocation to include needs for environmental flows. On the other hand in the North China Plain, naturally much less than 1000m^3 per capita of water can be provided to humans (Cai, 2006), which is far below the water-stress threshold of 1.700m^3.

The next chapter will give an insight into the current situation of water stress and resulting consequences for humans and environment in the North China Plain. Thereupon we will discuss current "coping" strategies adopted by the Chinese government to improve the situation or at least stop further agricultural production losses or environmental degradation. This review of current strategies showed that the steps taken by the government are not enough to deal with the current situation. Thus the next part of our paper will deal with a tool called water allocation plan. Such a plan provides means to cope with the complexity of the problem and allows for decision making based on a comprehensive scheme, which has a legal foundation and which can be monitored and evaluated.

2. Case Study: North China Plain

The complex nature of the topic makes it necessary to narrow the focus of our analysis. Geographically we will limit our review to the North China Plain (Map 1). Furthermore we will deal mainly with water scarcity. Problems of flooding especially in the Yellow River basin or issues of waste water disposal will be on the margins of the discussion.



(Map1: North China Plain (source: Kendy et al, 2003).

The North China Plain, which is also known as Huang-Huai-Hai Plain is drained by three of Chinas biggest rivers. The Huai River borders the plain in the south, the Huang (Yellow) River in the center, and the Hai River flows in the north (3-H). The plain covers an area of about 409,500 km^2 and two out of five people in China live in the 3-H basins which host 424 million people including the inhabitants of Chinas capital Beijing (World Bank, 2001). The semi-humid monsoonal climate of the plain with moderate temperatures and cold, dry winters and hot, humid summers allow the cultivation of a wide variety of temperate climate crops. The highly variable, annual precipitation amounts to less than 500 mm in the north to 800 mm in the south of the North China Plain. Together with ground water and other sources this precipitation provides less than 8% of the country's water resources for the plain. On consequence is the low supply of 500-800m^{3}of water per year and per head (Cai, 2006). The plain was formed by enormous sedimentary deposits brought down by the Huang Ho and Huai River from the Loess Plateau (Encyclopedia Britannica, 2006). The soils provide together with the climate very good conditions for agriculture. The plain contains about 40% of the agricultural land and a huge and fast growing industrial sector and produces 32% of the country's GDP (Cai, 2006).

The next section will highlight the water demand and supply in detail, in order to provide a better insight into the water scarcity problem. In the second section of this chapter the consequences of water overuse will be depicted.

2.1 Water demand and supply in the 3-H basins

Various studies have assessed water demand and supply in the Huang-Huai-Hai Plain, using either informed extrapolation (IWHR, 1998) or modelling of water systems (RCNCWR, 1994; WB, 2001). Berkhoff (2003) presented Table 1, based on numbers derived from the World Bank (2001), which gives a good overview of both the demand and the supply side.

	1997				2050[a]			
	Hai	Yellow	Huai	Total	Hai	Yellow	Huai	Total
Supply[a]								
Surface water[b]	15.1	21.9	34.7	71.7	17.3	24.6	33.2	75.1
Groundwater	15.9	13.0	16.5	45.3	19.4	15.2	25.7	60.3
Transfers[c] from Yellow River	3.7	(–10.0)	6.3	10.0	0.0	0.0	0.0	0.0
Transfers[c] from Yangtse	0.0	0.0	2.9	2.9	6.8	0.0	12.8	19.6
Total	*34.7*	*34.9*	*60.4*	*129.9*	*43.5*	*39.8*	*71.7*	*155.0*
Demand[a,d]								
Urban domestic	2.6	1.5	2.4	6.5	6.7	3.7	6.1	16.5
Rural domestic	1.7	1.2	3.0	5.9	1.8	1.4	2.5	5.7
Industry	6.6	5.9	9.4	21.9	9.2	11.8	17.4	38.4
Irrigation	34.7	33.3	44.3	112.3	32.5	30.2	39.2	101.9
Forestry, livestock and fisheries	0.5	1.7	4.6	6.8	0.5	4.0	6.5	11.0
Total	*46.2*	*43.6*	*63.6*	*153.4*	*50.7*	*51.2*	*71.8*	*173.6*
Shortage[d]								
Priority (non-irrigation)	2.1	1.6	2.1	5.8	0.3	0.3	. . .	0.6
Irrigation	9.4	7.1	1.1	17.6	7.0	11.1	0.1	18.2
Total	*11.5*	*8.7*	*3.2*	*23.4*	*7.2*	*11.4*	*0.1*	*18.8*

Table 1: World Bank estimates: supply and demand for 50 years, 1997 and 2050 (projected): km3. (Source: Berkoff 2003, based on World Bank 2001).

According to this table, water is used to satisfy urban and rural domestic demand, water demand from industry, forestry, livestock and fisheries. But the biggest share between 70% and 75% (World Bank, 2001; Cai, 2006) goes to the agricultural sector. Irrigated agriculture accounts for two thirds of the total agricultural production in the 3-H basins. Furthermore, it can be inferred from the table that irrigated agriculture uses the residual water left over by the priority users, like industry. The irrigation water shortage in 1997 was equal to 17.6 billion m^3 per year and will increase to 18.2 billion m^3 per year in 2050. The estimates for 2050 of the World Bank already include improvements resulting from an action plan recommended by the Bank (World Bank, 2001). These recommendations are based on the knowledge that huge amounts of water are wasted, for example through overflow methods and open channels

(Henry, 2004). These water shortages will reduce grain production by about 9 million tons (7 percent) by 2050 (World Bank, 2001).

Besides being an area of most intensive irrigation, northern China supports some of the country's largest and fast growing industrial concentrations (Rosengrant et al, 2002, Cai, 2006). The same applies for the municipal or urban domestic demand as can be seen in Figure 1.

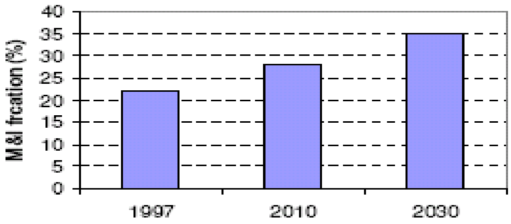


Figure 1: Municipal and Industrial share of water use in the 3-H basins together (Cai, 2006, derived from CEA, 2001).

The industrial sector in particular has priority in the competition of scarce water resources, prior to agriculture and especially prior to environment (Hong und Zehnder, 2005; Cai, 2006; Lohmar, et al, 2001, 2003; Crook & Diao, 2000).

Plenty of numbers can be found on the demand of those three major uses of water. When it comes to environmental water demand or environmental flows, the availability of numbers becomes fairly low. For the North China Plain the ecosystem water demand includes (Hong und Zehnder, 2005): “1) the minimum in-stream ecosystem water use, 2) urban river and lake environmental water use, 3) wetland recovery and protection water use, 4) groundwater replenishment water use, 5) water use for land conservation in hilly areas, 6) water use for sediment transport and estuary ecosystems, 7) pollution dilution water use”. In order to allocate water, a decision needs to clarify whether the current status quo should be maintained or water should be made available for rehabilitation of degraded ecosystems. For example Pan and Zhang, (2001 derived from Hong and Zehnder, 2005), estimated an amount of 43 billion m^3 water, which would be needed in 2030, to restore ecosystems, a minimum of water for ecosystems, to keep them as they are would require 25 billion m^3. Even the smaller number is a lot of water considering the fact that in most demand projections, like the one from the World Bank (2001), the environmental water demand is not even accounted for.

Against this huge demand for water stands the supply of water currently taken from surface and ground water sources and to some extend water is available due to transfer from other regions.

Most of the clean surface water, depicted in the Table 1 is diverted into cities for municipal use, leaving industries and agriculture in competition for diminishing groundwater resources, even as production continues to increase (Kendy et al 2003). In the 3-H system withdrawals range from more than 50% for the Huang (Yellow) River, to 65% for the Huai River and more than 90% for Hai-Luan River basin. This is well beyond the bounds of sustainability. A good example of the problem is the flow of the Huang River, once referred to as China's sorrow because high waters caused so much flooding. Today, the lower streams of the river have been reduced to a trickle that barely reaches the sea. Low-flow periods increased from 40 days in the early 1990s to more than 200 at the end of the decade (Yunpeng, 2005). For the groundwater the situation does not look any different. Nowadays freshwater aquifers (Figure 2) are the main source of water supply. But the history of groundwater use in China is full of extremes. Before the 1960s, it was almost neglected as water source and only a small amount was used (Nickum, 1998). Since the mid 1970s, however, the amount of water pumped from aquifers has risen dramatically. Over the past thirty years agricultural producers, factory managers and city officials discovered the resource and an era of extensive exploitation began (Brown and Halweil, 1998). For the Hai basin as an example the sustainable groundwater withdrawal is about 17.3 billion m^3 a year, which equals to the amount of replenishment, while withdrawals exceed 26 billion m^3; water tables are falling very rapidly (UNDP, 2006). Water tables in northern China are estimated to fall up to 3 meters per year because of over-extraction (Henry, 2001). The fall of the water table has been called one of China's most serious environmental problems (Liu and Diamond, 2005).

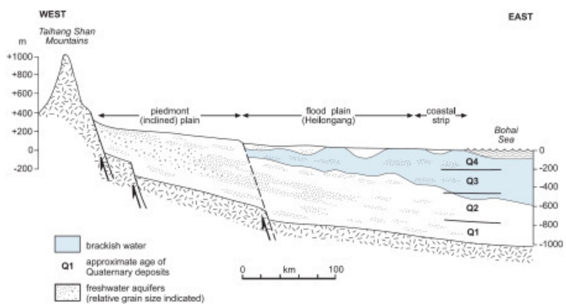


Figure 2: Cross-section of the North China Plain showing the general hydro-geological structure (source: Foster & Héctor 2004).

2.2 The consequences of an overuse of scarce water resources

More than 80% of the surface waters of Hai and Huai basins are highly polluted and thus not appropriate for human use and thus severe drinking water shortages arise and even public health is threatened. Half of the pollution is caused by agricultural and rural industrial waste. The fast growing textile, chemical, and pharmaceutical industry account for a quarter, and untreated human wastewater for the rest (World Bank, 2001, UNDP, 2006). On the other hand river flows from the 3-H rivers, which could cope with some of the pollutants by dilution and transport to the ocean, have fallen by 60% since 1956–1979 and by now all rivers run completely dry at least part of the year (World Bank, 2001). Lake eutrophication, biodiversity and habitat loss are other consequences of declining environmental flows. This overexploitation of surface water causes frequently huge agricultural production losses, in cases, where precipitation patterns fail to bring enough rain.

A number of issues arise from the overuse and resulting draw down of groundwater. Some of them are nitrate pollution in the groundwater, salinization and salt water intrusion, as well as land subsidence (Chen et al, 2004a). The accumulation of salt in the unsaturated zone and regional salinization are becoming worse under the condition of extra water transferred from pumping water from the south though the groundwater level is expected to recover to some extent. Nitrate pollution pattern and nitrate transport along groundwater flow system under new condition remain to be resolved as complicated biochemical processes are involved in the nitrogen cycle (Chen et al, 2004a). In the case use of deep, non-renewable aquifers, salt- or brackish water intrusion, from both fossil salt water lenses between shallow and deep aquifers, as well as sea water intrusion in costal areas which is a result of the exploitation of such deep lying aquifers, adds another problem (Huang, 2005). Besides these problems land subsidence from aquifer compaction becomes a real problem especially in urban areas (Foster and Giordano, 2004). Of course this is not a complete list of problems, but it tries to point at some of the most severe problems.

In order to cope with these alarming developments, the Chinese government came up with a number of demand- and supply-side policies. These policies are subject matter in the next chapter, where these “coping” strategies are discussed.

3. Current management of water resources in the North China Plain

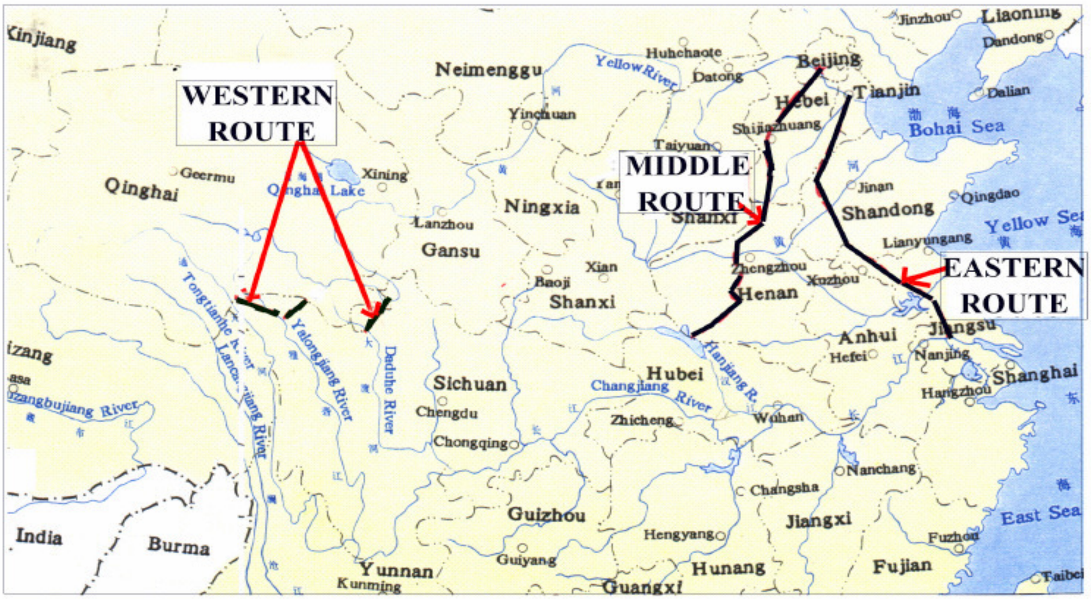
The allocation of water for environmental flow was long neglected completely as was environmental protection as a whole. In 1998 China established the State Environmental Protection Administration (SEPA), which is a ministry-like institution, responsible for environmental protection all over China. Since this time, research on the concept of environmental flow entered the research agenda (Yunpeng, 2005). These and other trends reflect the rising awareness for the severity of environmental degradation.

Water allocation towards ecosystems is playing a role now in Chinese attempts of integrated water resources management. The most prominent way of solving the problem of limited water resources is still water transfer (Henry, 2004), which can be seen in the following section, describing the "South-North Water Transfer"-Project (SNWT). We will have a look at institutions involved in water management and analyse their performance on current trends in water savings and privatization of water markets.

3.1 Increasing water supply through the South-North Water Transfer Project

From small, village level projects to huge, billion dollar canals and dams, increasing supply is the response of the Chinese government to scarcity. Among the most prominent examples of such water transfers are the planned south-north water pipelines. Interbasin water transfers are recommended by Kendy et al 2004 as one long-term, integrated path to sustainable water use in the North China Plain. The idea of transferring water from the Yangtze River to northern China, the so called "South-North Water Transfer (SNWT), is a rather old project idea and first came up in the early 1950s by the leader Chairman Mao (Hong and Zehnder, 2005). Since serious water shortages have occurred in the last 20 years, the three schemes were planned in detail to divert water from the Yangtze (Changjiang) River to the North China Plain (Wang and Ma, 1999). The eastern route was initiated in 2002.

The western route is planned to have a length of 170 km, the amount of water transferred is calculated with 20 km^3, and the related costs with 3 billion USD; the middle route will have an approximate length of 1230 km with 9 km^3 of water transferred at the costs of 7 billion USD; the eastern route length will be 1150 km. The amount of water transferred, will amount to 9.5 km^3, with 37 billion USD of associated costs.



Map 2: Sketch map of the South–North Water Transfer Project (Berkhoff, 2003).

The easiest way to solve the dilemma of water allocation between humans and nature is to increase the amount of water available for allocation. The Chinese government recognized that and induced this project. But this is not the ultimate solution especially when taking into considerations the impacts on areas of origin (Chen et al, 2004b, Henry, 2004). Furthermore, even the lowest demand projections estimate that not much is left over from the transferred water, when the economic sector takes its share. In addition, this whole project becomes problematic considering Ma et al (2006) who argue that taking into account the virtual water flow, more water in form of agricultural products is exported from the north to the south than total water will be transferred from the south to the north. The SNWT costs a huge amount of money and it needs to be reassessed, whether it would be cheaper to try and produce more food in the south, although natural conditions might be not as optimal as in the north. This is especially important when the serious environmental consequences are taken into account in the areas of water origin and on the people that will be displaced. Nevertheless the additional water that is supplied from the water transfer will indeed not be enough for ecosystem restoration (Hong and Zehnder, 2006), but it will certainly reduce the pressure on natural water resources (Duan et al, 2004).

3.2 Overview of water management institutions

Over the last 50 years, China built a huge and complex bureaucracy, to manage its water resources. Within these management efforts the saving of water was almost of no concern until recent years, rather the effective exploitation of water sources for agricultural and industrial development (Lohmar et al, 2001).

The Ministry of Water Resources (MWR) has the overall control of water management in China (Henry, 2004). **P11** The policy task of the ministry is the creation and implementation of national price and allocation policies, and in recent years to oversee water conservancy investments (Lohmar et al, 2001). On the operational level, its specific functionaries for flood protection and water management are implemented through seven River Basin Commissions. The authority of the MWR is limited in many areas, because of a high degree of autonomy of China's provinces and overlapping jurisdiction of other ministries and agencies (World Bank, 2001). For the agricultural sector the MWR has to share its responsibilities with the Ministry of Agriculture. In urban areas, Urban Construction Commissions are in charge of managing water resources, for both industrial and domestic use. Furthermore they take care of groundwater resources that lie beneath the municipality's land area. In addition groundwater levels are monitored by the Ministry of Geology and Mining. Further more SEPA is in charge of wastewater and sewage treatment. The MWR is along with the State Price Bureau setting guidelines for water pricing on provincial level (Lohmar et al, 2001).

On a sub-national level there are a fast-growing number of institutions that are responsible for the administration of water management and local implementation. These so called sub-national Water Resources Bureaus act on provincial, prefecture, county, and township level.

Every single institution interprets the policies around local needs, and problems across jurisdictional boundaries are the consequence (Wang, 2004). In addition there is the problem that watersheds and ways do not follow jurisdictional boundaries. In order to cope with this fact, commissions were developed to manage water resources on a watershed level (Lohmar et al, 2003). These commissions have received some power by the MWR. Furthermore, they are controlled by the next higher level of responsible Water Resources Bureau for the area (Henry, 2004). As a result of this amount of different actors, the current water management system is somewhat confused, not cohesive, and full of opportunities for over allocation (World Bank, 2001).

This complicated system of water managing intuitions is based on the Water Law of 1988, which was newly modified in 2002. But bureaucratic institutions work only partly along the lines of the formal policies and organizational structures. The term *guanxi* refers to social networks of personal relationships, which are used to acquire power, status and resources. (Bhatia et al, 2002). This applies for the water sector as well. The difficulties of water management lie within this complex cultural and legal-administrative mixture and the upper levels of government to monitor and enforce programs or policies and they have great difficulties in enforcing restrictions on their subordinates (Wang, 2006). Local governments in turn become tools for rent-seeking, by helping politically powerful water users to use more water while paying less fees (Wang, 2006). Since the local government is responsible for the economic growth of their areas, they were rather looking for the maximization of water abstraction (Wang, 2006). Thus success or any policy or reform is limited, however, because of selective application of the laws and weak enforcement at the local level and the absence of mass-based standards. Inappropriate settings of standards that are not capable of being met, because of low levels of technology and affordability as well as low fines also work against an effective implementation (Crook and Diao. 2000). The problems of scarcity remain, even with the transfer of water. Increasing the number of institutions which deal with the problem, seems also not the ultimate solution. This is also recognized by China and the idea of increasing water for allocation through saving water in some sectors is not new. The next chapter seeks to give an overview of attempts to increase water saving through technologies and incentives to save water, for example through pricing.

3.3 Water management and reforms

The Article 3 of the 1988 "Water Law of the People's Republic of China" clearly states that water resources are owned by the state. Based on this law a license system was established, as well as a system of user fees, for water abstraction (Wang, 2006). The MWR allocates water quotas to provinces, counties and cities which have examination and approval power over their quotas. The MWR is responsible for examination and approval of any license above and beyond the allocated quota for each large river basin and large reservoir. In addition, a water use fee is collected for both surface water and groundwater. During the time in which water was managed with the license system which is still partly in place and only slowly transforming, government at all levels did hardly restrict the total water consumption (Lohmar et al, 2003, Huang, 2006, Wai, 2006). Furthermore, there was no and is still hardly any monitoring in place for the actual water abstraction. This gave and gives way for the massive squeezing out of water from surface as well as groundwater sources (Wang, 2006, Wei, 2006, Blanke et al, 2005, Duan et al, 2004). Besides fees, additional regulations apply for the use of groundwater that arrange for permits for drilling wells, control on pump spacing, control of pumped volume, or the control price of water charged by private well owners. The success of these regulations is also very limited, mostly due to a lack of implementation (Huang et al, 2006). Another problem is the low adoption of water saving technologies. This applies especially for technologies that increase water use efficiency in irrigated agriculture, where water wastage is far above average (e.g. Cai and Rosengrant, 2003). This can assigned to the low water fees (Henry 2004, Blanke et al, 2005). Furthermore the adoption is discouraged by high costs of adoption, strong risk-aversion and low education, encouragement and support from extension agencies to induce farmers to adopt water-saving irrigation techniques (Blanke, et al, 2005, Wei, 2006). This happened despite the fact that according to Huang et al (2006) many technologies from low cost to expensive ones exist.

The system of water management is undergoing a slow transformation process as a response to failure in the past and as a result of the realization of the fact that the growing water demand cannot be met with water transfers only (Wang et al, 2006).

In 2002, the Water Law was revised and enacted. The newly-revised law reiterates the state ownership of water resources. At the same time it also defines water use rights for local user groups such as Water User Associations or water management contractors on local level, adds some control systems such as water amount allocation system and the combination of the Total Quantity Control and quota management. The introduction of water rights is seen as a significant step in the right direction– yet it is severely restrained by the existing power hierarchy which resulted from the license system (Wang, 2006, Cai, 2006). In addition, this system lacks a consistent legislative framework, and thus does not guarantee the security of water rights. This might be the one reason why Wang et al (2006) could not find many positive impacts, such as increased water saving, from an involvement of local water users, such as WUAs, if the theory of the 'Tragedy of the Commons' is kept in the back of the head (Hardin, 1968).

Another step which is advocated by many scientists is to significantly increase incentives to save water through higher water prices (e.g. Blanke et al, 2005; Huang, 2006, Wang et al, 2005, 2006, Wei, 2006). On the one hand, this would have a great potential to lower demand partly through increased water saving. On the other hand, the negative effect would be to expose poor farm households to poverty and putting national food security at risk (Huang, 2006). Policies, like subsidies or compensation payments would need to be found to intercept these negative consequences. Webber et al (2006:130) state that: "If it is to be implemented, water pricing will require careful central government control in establishing, maintaining, and monitoring water markets and their potential social repercussions".

4. A water allocation plan for the North China Plain

It is clear that the government of China has recognized its problems of water scarcity for its growing population in northern China, as well as the resulting consequences for ecosystems (UNDP, 2006). But the latest news on the homepage of the Chinese Ministry of Water Resources frequently announce yet another drought, the decline of river health or continuously rising pressure from human water demand. This shows the fact that there is still no solution in place to at least stop further environmental degradation. This chapter seeks to discuss the option or a water allocation plan which could assist in overcoming the dilemma of allocating water between humans and nature.

4.1 The rational ground for a water allocation plan in the North China Plain

Much has been written on water rights, water saving and water pricing. We don't want to write another paper, which emphasises these steps. We assume that there is no other way then to increase water saving and that this can be reached with transfer of water rights and careful, fair water pricing. We are also not arguing against 'Integrated Water Resources Management' (IWRM). IWRM is here defined following the Global Water Partnership (2000) as: "A process promoting the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems". A water allocation plan for the whole North China Plain must be build on the basis of a sound IWRM. However it is clear that a water allocation plan cannot solve the dilemma of water allocation itself, since the rules for distribution are not inherent. They must be defined in a participatory manner, including all stakeholders, which would be the core piece in the process of the development of an allocation plan, as described below.

From the review of literature it becomes evident that an overall management scheme is needed to seriously address the complexity of the problem of environmental degradation

(Wang, 2006, Webber, 2006). Provincial Water Resources Bureaus (WRB) are somehow responsible for the establishment of water allocation plans on provincial level. In the early years of the Peoples Republic of China, this mainly meant that WRBs were in charge of surface water development and management (Lohmar et al, 2001). In recent years, groundwater resources were added in order to control the exploitation. But with rising demand and a growing number of actors, like private well drilling companies, these institutions are overstrained, especially against the background of the connection of groundwater layers across provinces (Wang, 2006).

There are also several international cooperation and partnerships which are working together with Chinese policy makers, scientists or practitioners on issues of water management. The World Bank (2001) helps setting up a 'Country Water Resources Assistance Strategy'. The "Water Resource Demand Management Assistance Project (WRDMAP)" (Mott MacDonald, 2006) funded by the UK's Department for International Development (DFID), gives assistance to manage water demand. The GWP (2000) also wants to contribute to awareness for IWRM by providing a platform, in order to facilitate dialogs and cooperation. Interestingly these attempts are not visibly connected, and thus substantially increase the large number of actors already involved in Chinese water management. Furthermore, none of these projects is suggesting a comprehensive plan of water allocation for the North China Plain which shows serious attempts to include both water for surface ecosystems and efforts to include water for groundwater systems.

Another problem which has to be dealt with is the weak data base for water management. Available data are generally out-of-date and inaccurate and through the involvement of so many actors from village to international level they are highly inconsistent. This is facilitated by the absence of an overall assessment framework of water resources from the government, which could set certain standards. Partial existing assessments of the government tend to overestimate the total amount of water resources, and underestimate actual water consumption (Wang, 2006).

Some success of basin level projects such as the "Gansu-Inner Mongolia Water Allocation Plan (GIWAP)" (Cai, 2006) show that thinking in the direction of environmental flow allocation seems promising. In the late 1990s, the Chinese government initiated activities for the ecological restoration of the Hei River region. The GIWAP was set up and the Bureau of Hei River Management was established, to coordinate and supervise plan implementation. The releases of water towards the river ecosystem according to the allocation plan have at least prevented further degradation of the downstream ecosystem (Cai, 2006).

The question is now, why basin wide management plans are not enough. This can be answered with the fact that some important issues request to address the whole North China Plain. Amongst others the groundwater layers are connected across basins (Chen et al, 2004a, Kendy et al, 2004) and impacts, for example from the water pipelines will also have cross-basins effects. An overall allocation plan could be used to reduce some of the bureaucracy, by pooling some of the personal and responsibilities. This has also the advantage of an increased exchange of knowledge, experience and expertise. Furthermore such a plan could provide a comprehensive overview of water supply and demand, including standard guidelines for data collection and quality control. If set up properly an allocation plan could significantly promote equity objectives across the plain as well as the allocation of water towards the environment with particular timing, frequency, duration and variability. This is achieved through the detailed and comprehensive acquisition of demand and supply which is the basis for calculations for optimized allocation. The outcomes of the calculations or optimization scenarios assist the participatory discussion process for the setting of water allocation rules.

Although in the first place a water allocation plan might sound like just another top-down approach, it is actually a merging of top-down and bottom-up. The Chinese society is currently hierarchically structured and it may need decades to change this. That might be too long for ecosystems. Thus we are arguing that rather than relying on bottom-up and democratic suggestions only, the proposed water allocation plan would use some of the hierarchical structures on national level, for the data collection, the monitoring of the performance of the plan or the representation of environmental and equity interests, for the purpose of assisting and facilitating more democratic setting of rules and implementation.

4.2 General outline of water allocation plans

Regulations

The first step is the establishment of a legal basis for the allocation plan and allocation rules. The wording of the law should contain the regulation of water resources assessment and the definition of water allocation rules based on a participatory discussion. The assessment of water resources provides the basis for this discussion. This discussion must be set up in a participatory manner as suggested by Dougill et al (2006), using social network analysis to structure stakeholder engagement and a range of participatory approaches that can facilitate more inclusive environmental planning and policy development. As mentioned above the Chinese government knows about the ecological consequences of water overuse. Does this also apply for all water users? It is of utmost importance that the discussion of water allocation rules includes total clarification of the facts and the finding of solutions, by water users themselves, in order to make the implementation of such a plan possible. Furthermore, care needs to be taken that all interests are represented. This must include environmental interests as well as interests of future generations. If it comes to the actual demand of ecosystems a decision needs to be made, whether enough water should be provided to conserve the status quo or whether there should be attempts for restoration. A decision towards the restoration evocates a second decision on how much the ecosystem should be restored.

Institutions

The present water allocation and resources management system in China is based on the Water Law, which was approved in 1988 and amended in 2002 (Liu, 2003, Hu, 2006). As described above this system is functioning sub-optimally and the solution for new institutions of the actual water allocation proposed by Wang (2006) could be the introduction of water rights as a decentralized, “bottom-up” approach. It would be a legal system where water is privately owned by local groups such as Water User Associations (WUAs) which is believed to conserve water and improve use efficiency, using tradable water rights (Meinzen-Dick et al, 1997, Dinar et al 1997, Wang, 2006). Pilot projects where such WUAs were set up to implement irrigation management reforms are promising, when it comes to collection of water fees as well as for the improvement of irrigation efficiency (Bhatia et al, 2002). In other regions Wang et al (2006) found that the performance of WUA in saving water was very low. Further research would be needed to find out what increases the participation of farmers in water management. These associations would be part of the institutional mechanisms for water allocation which would need to be supported by administrative allocation mechanisms which ensure that environmental needs are sufficiently considered. Beyond that, the recently introduced water pricing can be taken into consideration as an allocation mechanism as well as the introduction of water markets where water use rights can be sold and bought freely.

Objectives

The next step in the development of such an allocation plan should include the definition of its objectives. UNESCAP (2000) suggested societal, economic and environmental objectives. Societal objectives include the provision of clean drinking water, water for sanitation and food security. Economic objectives are to maximize economic values of production from agricultural an industrial development as well as for power generation or local economies. Furthermore there are environmental objectives that aim at sustainability through, for example, providing environmental flows for ecosystems.

Operational level

After regulations are set und institutions are identified, a general comprehensive water allocation procedure at the operational level is proposed, following Wang (2005). It starts with an investigations of physical and social patterns in combination with hydrological and water quality modelling need to be accomplished and complemented by an economic and social analysis. These investigations need to follow an overall water resource accounting framework that produces consistent data for all water sources of the North China Plain, including the collection of data for the deeper aquifers that are connected across basins (Kendy et al, 2004).

The investigations are integrated into a comprehensive water resources assessment which in turn provides scenarios for optimized water allocation to assist the discussion of water allocation rules. Afterwards the actual plan can be obtained and implemented. A participatory monitoring and evaluation framework must be set up to ensure a good performance of the plan. Results of the evaluation provide improvements for the next iteration.

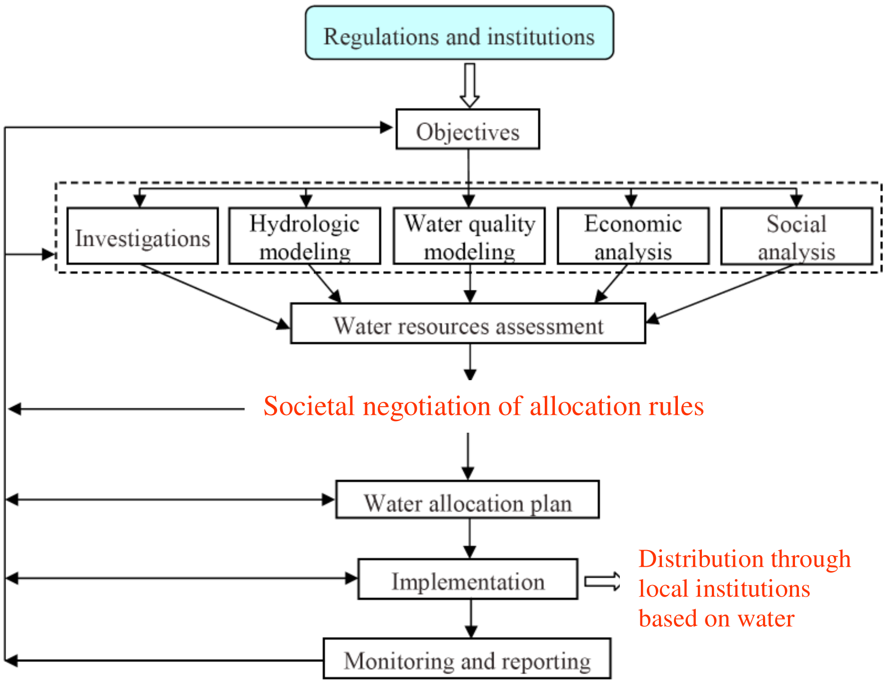


Figure 3: Water allocation planning procedure at the operational level (Wang, 2005:19, modified)

5. Conclusions

The easiest way to solve the dilemma of water allocation between humans and nature is to increase the amount of water available for allocation. In the North China Plain this is to some extent possible through the transfer of water out of other regions into the ecosystems. But this is not the ultimate solution especially when taking into considerations the impacts on areas of origin as well as the demand projections that estimate that not much is left over from the transferred water when the economic sector take its share. Another option to increase the supply of water for reallocation is to further develop and strictly implement policy reforms towards water saving and water pricing. But even the most conservative projections give evidence that the shortage of water will remain in the future, when the demand will not be drastically reduced. This could happen when China changes its food policy and follows Allan (1997), who came up with the suggestion that countries which face water scarcity, could cope with water shortage problems by importing food, and save the water which would be necessary to grow the food. In the case of China predictions of China's future water problems were made and the effects they will have on international grain markets (Brown & Halweil, 1998). A serious concern is evoking from the fact that with rising imports of grains, prices for grain on the international markets increase and grain importing countries, and their political stability might be affected due to mass starvation (Brown & Halweil, 1998). Nowadays China is already one of the biggest net importers of virtual water (Hoekstra, 2003) and the whole world is looking with great sorrows to this fact.

Certainly these points do not help to solve the dilemma since the situation is highly complex. Institutions responsible for dealing with it are overstrained and most of the proposed solutions deal only with part of the problem, far too often neglecting the needs of environmental flows.

A sound water allocation plan as proposed above could be a substantial help for attempts to cut this Gordian knot. It provides a framework to sum up the situation on a superior level, and is able to offer suggestions for optimized water allocation. Nevertheless, this plan cannot solve the dilemma of how to allocate water between humans and nature itself. We believe that the rules of allocation cannot be set by a single party only, being it politicians, scientists, environmentalists, human rights activists, economists or religious leaders, etc. The rules for allocation must be identified in a public discussion process under participation of all water users, including representatives of ecosystem interests and if possible with representatives of future generations. This process must be transparent and accompanied by a comprehensive awareness raising campaign for the consequences of overuse of water for the environment for each and every single inhabitant of the North China Plain. This discussion must be part of the development of the plan and it is at the same time its indispensable basis.

6. References

Allan, J.A. 1997. Virtual Water: A Long Term Solution for Water Short Middle Eastern Economies? Paper presented at the 1997 British Association Festival of Science, Roger Stevens Lecture Theatre, University of Leeds, Water and Development session.

Arthington, A.H., S. E. Bunn, N. L. Poff, and R. J. Naiman. 2006. The challenge of providing environmental flow rules to sustain river ecosystems. Ecological Applications 16, pp. 1311-1318.

Berkhoff, J. 2003. China: The South–North Water Transfer Project—is it justified? Water Policy 5, pp. 1–28.

Bhatia, A.M., G. Hong and P.P. Mollinga. 2002. Irrigation Reform in the People's Republic of China. Institutional Transformation in Shijin, Jingxing Mianyou and Zaohe Irrigation Systems. CWP Research Papers 13, pp. 52.

Brown, L. and B. Halweil.1998. China's Water Shortages Could Shake World Food Security World Watch 11 (2), pp.10-18.

Cai,X and M.W.Rosegrant. 2004. Optional Water Development Strategies For The Yellow River Basin : Balancing Agricultural And Ecological Water Demand. Water Resource Paper 40, No. W08504

Cai, X. 2006. Water Stress, Water Transfer and Social Equity in Northern China: Implications for Policy Reforms. Human Development Report Office, Occasional Paper 37. Washington DC.

Chen, J., C. Tang, Y. Sakura, A. Kondoh, J. Yu, J. Shimandas, Tanaka, T. 2004a. Spatial geochemical and isotopic characteristics associated with groundwater flow in the North China Plain. Hydrological Processes. 18, pp. 3133–3146

Chen, J., C. Tang, Y. Sakura, Y. Fukushima, M. Taniguchi. 2004b. Environmental problems associated with groundwater flow system in the North China Plain. American Geophysical Union, Fall Meeting . San Francisco.

Chinese Academy of Engineering (CAE). 2001. Water resources assessments and supply and demand projections. Vol.2, Reports on Water Resources Development Strategies / Sustainable Development in China.

Crook, F. and X. Diao. 2000. Water resource in China: Growth strains resources. U.S. Department of Agriculture, Economic Research Service. Agricultural Outlook 68. pp25. 29. Washington, DC.

Dinar, A., M.W. Rosegrant and R.Meinzen-Dick. 1997. Water Allocation Mechanisms – Principles and Examples. Policy Research Working Paper WPS1779. World Bank Publications.

Dougill A. J., E. D. G. Fraser, J. Holden, K. Hubacek, C. Prell, M. S. Reed, S. Stagl and L. C. Stringer. 2006. Learning from Doing Participatory Rural Research: Lessons from the Peak District National Park. Journal of Agricultural Economics, vol. 57(2), pp. 259-275.

Duan, G.M., J. Z. Zhao, G.H. Liu, B. Ke, H. Xiao, G. Wu and H.B. Denk. 2004. Eco-Environmental Benefit Assessment of China's South-North Water Transfer Scheme. Journal of Environmental Science China. 16(2), pp. 308-15.

Dyson, M., G. Berkam, and J. Scanlon. 2003. Flow: The Essentials of Environmental Flows. IUCN, Gland, Switzerland and Cambridge.

ECOSOC (United Nations Committee on Economic, Social and Cultural Human Rights). 2002. General Comment Nr. 15 on the Right to Water, at http://www.ilo.org/public/english/dialogue/sector/papers/utilit/ecosoc.pdf.

Encyclopedia Britannica. 2006. North China Plain. On-line entry available at http://www.britannica.com/eb/article-9056189/North-China-Plain.

Engelman, R., and P. LeRoy. 1993. Sustaining Water: Population and the Future of Renewable Water Supplies. Population Action International Washington, DC .

Falkenmark, M., and J. Rockström. 2004. Balancing Water for Humans and Nature. The New Approach in Ecohydrology. London.

Foster, S. and H. Garduno. 2004. China: Towards Sustainable Groundwater Resource Use for Irrigated Agriculture on the North China Plain. Case Profile Collection, Number 8. Global Water Partnership Associate Program. World Bank, Washington D.C.

Global Water Partnership. 2000. Integrated Water Resources Management. TAC Background Paper 4. Global Water Partnership, Stockholm.

Hardin, G. 1968. Tragedy of the Commons, Science, 162 .pp.1243-1248

Henry, E. 2004. Water Scarcity in the North China Plain: Water Saving Irrigation and its Implications for Water Conservation. P.R.E.M.I.U.M. Program. Michigan

Hoekstra, A.Y. 2003. Virtual water trade: Proceedings of the International Expert Meeting on Virtual Water Trade. Value of Water Research Report Series No. 12.

Hong, Y., A.J.B. Zehnder. 2005. The South-North Water Transfer Project in China. International Water Resources Association. Water International, vol 30, Number 3, pp. 339–349.

Hu, D. 2006. Water Rights - An International and Comparative Study. Water Law and Policy Series. IWA Publishing

Huang, Q.S. 2005. Optimal Allocation of Groundwater Resources in the Hai River Basin -Managing Quantity and Quality. Dissertation prospectus.

Huang, J.K., S. Rozelle and M.W. Rosegrant. 1999. China's Food Economy to the Twenty-First Century: Supply, Demand, and Trade, Economic Development and Cultural Change, 47. pp.737-76.

Huang, Q., S. Rozelle and R. Howitt. 2006. Irrigation Water Pricing in China. Paper Presented at the IAAE Pre-conference, Gold Coast, Australia

IWHR, 1998. China: Water Availability and Projection on Water Demand in the Future. China Institute of Water Resources and Hydropower Research, Ministry of Water Resources, Beijing.

Kendy, E., D. J. Molden, T. S. Steenhuis, C.M. Liu, J. Wang, 2003. Policies drain the North China Plain: Agricultural policy and groundwater depletion in Luancheng County, 1949-2000. Research Report 71. Colombo, Sri Lanka: International Water Management Institute.

Kendy, E. Y. Zhang, C. Liu, J. Wang, T. Steenhuis. 2004. Groundwater recharge from irrigated cropland in the North China Plain: Case study of Luancheng County, Hebei Province, 1949-2000. Hydrological Processes 18,pp. 2289–2302.

Leopold, A. (1949): The land ethic. In: A. Leopold: A Sand County almanac and Sketches here and there. New York 1949, 201-226.

Liu, B. 2003. Water rights in China. International Working Conference on Water Rights: Institutional Options for Improving Water Allocation, Hanoi, Vietnam.

Liu, J. and J. Diamond. 2005. China's environment in a globalizing world. Nature 435, pp.1179-1186.

Lohmar, B., , J. Wang, S.Rozelle, J. Huang, and D. Dawe. 2003. China's Agricultural Water Policy Reforms: Increasing Investment, Resolving Conflicts, and Revising Incentives. U.S. Department of Agriculture. Agriculture Information Bulletin Number 782.

Ma, J., A. Hoekstra, H. Wang, A. Chapagain, and D. Wang. 2006. Virtual versus real water transfers within China. Philosophical Transactions of the royal society. pp. 835–842

Meinzen-Dick, R. M. Mendoza, L. Sadoulet, G. Abiad-Shields and A. Subramanian. 1997. Sustainable water user associations: Lessons from a literature review. In User organizations for sustainable water services,(eds.): A. Subramanian, N.V. Jagannathan and R. Meinzen-Dick, World Bank Technical Paper No. 354, World Bank, Washington, D.C.

Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.

Mott MacDonald. 2006. Water Resource Demand Management Assistance Project (WRDMAP). At: http://www.mottmac.com/projects/?id=5672.

MWR (Chinese Ministry of Water Resources). 2006. http://www.mwr.gov.cn/english1/search.wct?ChannelID=7944.

Naiman, R., S. E. Bunn, M.E. McClain, C. J. Vörösmarty, M. Zalewski. 2006. The Science of Flow-Ecology Relationships: Clarifying Key Terms and Concepts. Unpublished paper.

Nickum, J. 1998. Is China Living on the Water Margin? The China Quarterly, 156.

Priscoli, J.D., Dooge, J., Llamas, R. (2004) Water and Ethics. Overview. In: Series on Water and Ethics, vol 1. Paris.

RCNCWR (Research Center of North China Water Resources). 1994. Water Resources Management in North China. Research Center of North China Water Resources, China Institute of Water Resources and Hydropower Research, Ministry of Water Resources, Beijing. CPR/88/068, United Nations Development Programme, New York.

Rosegrant, M.W., X. Cai, and S. Cline, 2002. World Water and Food to 2025: Dealing with Scarcity. The International Food Policy Research Institute, Washington DC.

Tennant, D.L. 1976. In-stream Flow Regimens for fish, wildlife, recreation and related environmental resources in Fisheries 1, pp. 6-10

UNFPA, Population Issues population and Sustainable Development, at www.unfpa.org/modules/6billion/populationissues/development.htm

UNDP. 2000. Millennium Development Goals, at http://www.undp.org/mdg/

UNDP. 2006. Human development report 2006, http://hdr.undp.org/hdr2006/

UNESCAP (United Nations, Economic and Social Commission for Asia and the Pacific). 2000. Principles and Practices of Water Allocation among Water-Use Sectors. ESCAP Water Resources Series No. 80, Bangkok, Thailand.

Wang, J., B. Amelia, G. Mark, J. Huang, H. Quiqiong and S. Rozelle. 2005. Quenching China's Thirst: Analyzing The Trend and Policies In Northern China's Rural Water Economy. Working Paper, Centre for Chinese Agricultural Policy ,Chinese Academy Of Sciences. China.

Wang, J., Z. Xu, J. Huang, S. Rozelle. 2006. Incentives To Managers Or Participation Of Farmers In China's Irrigation Systems: Which Matter Most For Water Savings, Farmers Income And Poverty. In Agricultural Economics, 34.pp.315-330

Wang Y. 2004. Water Disputes in the Yellow River Basin: Challenges to a Centralized System. China Environment Series Issue 6. pp. 94-98.

Wang, L. 2005. Cooperative Water Resources Allocation among Competing Users. Dissertation prospectus. University of Waterloo.

Wang, X. 2006. Water governance in China: The failure of a top-down approach. In: Oknonski (eds.): The Water Revolution: Practical Solutions to Water Scarcity. Sustainable Development Network. pp. 147-175.

Wang L.S., C. Ma. 1999. A study on the environmental geology of the Middle Route Project of the south–north water transfer. Engineering Geology 51 pp. 153–165.

Wei, Y., D. Chen, R. Edis, R. White, B. Davidson, J. Zahng, B. Li. 2006. The Perspectives of Farmers on Why The Adoption Rate of Water Saving Irrigation Techniques Is Low In China. In: Willet, I.R. and G. Zhanyi (ed.): Agricultural Water Management In China. Proceedings Of A Workshop Held In Beijing, China. Canberra, ACIAR Proceedings No. 123.

World Bank. 2001. China: Agenda for Water Sector Strategy for North China. Report prepared by World Bank, Washington, DC.; Sinclair Knight Merz & Egis Consulting, Australia, General Institute of Water Resources & Hydropower Research, Beijing; Institute of Hydrology and Water Resources, Nanjing; and Chinese Research Academy for Environmental Sciences, Beijing. World Bank Report No. 22040-CHA.

Yunpeng X. 2005. Environmental Water Demand and the Initiative to keep the Yellow River Healthy: The Chinese Approach: Environmental flows. Environmental perspectives on River Basin Management in Asia. Vol. 2 (1)

Zhu, Z., X. Cai, M. Giordano, D. Molden, S. Hong, H. Zhang, Y. Lian, H. Li, X. Zhang, Y. Xue. 2003. Yellow river comprehensive assessment: Basin features and issues. Working Paper 57. Colombo, Sri Lanka: International Water Management Institute.

Zhu, Z., M. Giordano, X. Cai, and D. Molden. 2004. The Yellow River basin: Water Accounting, Water Accounts, And Current Issues. Water International, Vol, 29 (1) pp.2-10 Publisher International Water Resources Association, Carbondale, IL, Etats-Unis.

Zuo, D.K. 1992. Growing crops according to moisture conditions on the North China Plain, J. Shalhevet, Liu Changming and Xu Yuexian (ed). In: Water Use Efficiency in Agriculture—Proceedings of the Binational China-Israel Workshop Beijing: Priel Publishers. pp. 53-62.