

The construction of a water rights system in China that is suited to the strictest water resources management system

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ABSTRACT

Establishing a modern water rights system (WRS) that is suited to the Strictest Water Resources Management System (SWRM) is an important reform in China's water resources management in terms of addressing current water issues. However, there are still several problems in the construction of a WRS, such as ambiguity in the definition of water rights, weakness in the infrastructure of water rights and imperfect WRS legislation. Moreover, water rights allocation (WRA) and water rights trading (WRT), which are two core components of water rights, still have some problems that remain to be solved. The 'Three Red Lines', which make up the core of the SWRM, are expounded upon, and the relationship between the WRS and the SWRM is analyzed. Finally, some appropriate recommendations based on the 'Three Red Lines' are provided to perfect the WRS so that it is suitable for the SWRM. In this paper, we conclude that the WRS is a type of water resource management that can effectively solve the current water issues in China. Significant efforts have been made in the construction of the WRS, which has achieved remarkable success in a period of exploration and practice in China. The construction of the WRS supports sustainable social and economic development and results in harmonious relationships between humans and nature.

Key words | strictest water resources management system, Three Red Lines, water resources management, water rights allocation, water rights system, water rights trading

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INTRODUCTION

Water is a fundamental natural and strategic economic resource that comprises a significant component of socio-economic development. This resource has contributed to the socioeconomic prosperity and remarkable accomplishments since China's Reform and Opening. However, uneven temporal and spatial distributions as well as certain prominent issues, such as the excessive utilization of water resources, low efficiency of water use and severe deterioration of the water environment, have become major factors that are restricting socioeconomic development in China. In addition, rapid industrialization on an extensive scale and the large increase in the urban population have

led to increasing demands on water resources over a fairly long time. All of these issues have aggravated the imbalance between water supply and demand (Fan *et al.* 2015). About two-thirds of Chinese cities are water-needy, while nearly 300 million rural residents lack access to safe drinking water, leading to a national water shortage of over 50 billion cubic metres on average every year (Xinhua News 2012). Meanwhile, the contradiction between water supply and demand has been exacerbated by serious water pollution, including sewage discharge that lacks appropriate treatment. According to *The Report on the State of the Environment in China* issued by the Ministry of

Environmental Protection (MEP), the water quality of 25.3% of the 469 river sections of the ten major water systems in China was considered Grade IV or worse based on a five-class grading, and 13.7% failed to meet Grade V standards (MEP 2011). In other words, China has been suffering from a severe water resources crisis that includes both water quantity and quality issues. Each of these issues has attracted considerable attention from the government and the public. The government in China has realized that it is urgently necessary to highlight the sustainable use of water resources and cease the excessive pursuit of profit, which is done at serious costs to the environment (Vennemo *et al.* 2009; Yu 2011). Against this backdrop, the construction of a water rights system (WRS) has been emphasized, which is seen particularly in the wave of water rights pilot programs across seven provinces and autonomous regions, such as the Inner Mongolia Autonomous Region, Ningxia Autonomous Region, Henan and other provinces. To some extent, the process of constructing a new WRS suited to the Strictest Water Resources Management System (SWRM) is the top priority in the management of China's water resources.

The construction of a WRS, which is not a novel concept in China, has shown vigorous development trends. For example, a 'water-drawing permit system' was implemented as a basic system for China's water resources management, similar to the 'water use permits' in America, Germany, Hungary and other countries. The implementation of the water-drawing permit system is an important strategy for strengthening water resource management in China to coordinate and balance the difference between water supply and demand, which is a reliable guarantee for the sustainable utilization of water resources. The construction of a WRS is clearly proposed in the SWRM, and water rights trading (WRT) is encouraged to allocate water resources rationally through the application of market mechanisms. So it is necessary for China to strengthen the research on water rights allocation (WRA) and WRT and actively explore the use of a WRS to meet the demands of the SWRM and ensure the sustainable development of water resources. We intended to combine the SWRM with the WRS and have analyzed the relationship between them. And specific recommendations for promoting the construction of a WRS suited to the SWRM are put forward to

accelerate the effective implementation of the WRS. In the end, the prospect of harmony between humans and nature is what is intended to be achieved.

AN OVERVIEW OF THE WRS IN CHINA

The current situation of the WRS in China

The first Water Law of the People's Republic of China, which was promulgated in 1988, explicitly stipulated that water resources belonged to the nation, which meant that people had the right to use its water resources but did not have proprietorship over the water resources. Subsequently, the Water-drawing Permit System was implemented, and a correlative set of laws supporting the water law were passed. The provision on water-drawing rights was confirmed in the new Water Law, which was revised in 2002, and attention was shifted to integrated water resources management, in which water-drawing rights could only be obtained after applying to the water resources administrative department or river basin management bureau and paying the corresponding fees. The term 'Water Rights' was first used in the formal regulatory document *Several Opinions on the Transfer of Water Rights* that was issued by the Ministry of Water Resources (MWR) in 2005. Subsequently, support for the construction of a WRS thrived, even in the report to the 18th National Congress of the Communist Party of China (CPC), which cited WRT as a way of promoting the construction of ecological civilization. The report also indicated that the construction of a WRS was encouraged to 'Establish a Water Saving Society' in the 12th Five-Year Plan (2010–2015). A number of water rights pilot programs were developed at the same time, most notably the South-to-North Water Diversion Project, an ambitious inter-basin water transfer project in which the middle line could pump 9.5 billion cubic metres of water each year from the Danjiangkou reservoir in central China's Hubei Province to the northern provinces of Hebei and Henan as well as Beijing and Tianjin, benefiting some 100 million people (Xinhua News 2014). To actively drive the construction of water rights that would provide the basis for a range of strategies, such as WRA, WRT and an electronic trading platform, the *Notice for the Water*

Rights Pilot was released by the MEP on July 1, 2014, and it was mainly distributed in the northern and eastern developed areas of China. This document sought to create breakthroughs in WRT and the construction of a related system and provide a reference and example for the construction of a WRS at the national level. Since then, China has made great efforts and attempted to construct a WRS, which has progressed, but there is still a long path to realize sustainable development.

Main problems in China's WRS

China has been facing severe water issues. These issues are especially reflected in the increasing imbalance between the supply and demand on water resources and serious water pollution, which have typically been given little attention by enterprises and local governments. The neglect of these issues has led to an increasingly precarious relationship between nature and humans (Zhao *et al.* 2014). In this context, water issues are again at the center of attention for the government and public. A WRS is regarded as the basic system in modern water resource management that oversees WRA and WRT among different water users. China is constructing an ambitious WRS, but several problems have accompanied the establishment of China's modern WRS. First, there is ambiguity in terms of water-drawing rights and the proprietorship and usufruct of water rights. For example, the water rights for the Yellow River are unclear in definition. According to the Water Law of the People's Republic of China, the water resources for the Yellow River belong to the nation, and the Yellow River Water Conservancy Committee, which is affiliated with the MWR, has the right to plan for the future of the water resources of the Yellow River with the local water administrative departments of each province along the river. The usufruct of water resources mainly reflects the water appropriation rights of the Yellow River, which are ambiguous (Wang *et al.* 2008). Moreover, some waterworks and reservoirs with water-drawing rights may sell water to profit-seekers who offer a high price, which may lead to basic water requirements not being met. Second, the weakness in the infrastructure of water rights is another issue. At present, most water rights distribution schemes of inter-district rivers and rivers across the province have not yet

been finished, but the schemes that have been established have not been executed due to the lack of implementation infrastructure. The weakness in the informationization in the construction of water resources has led to a low level of water resources management. Moreover, the imperfect water resources monitoring system has resulted in the WRS facing huge obstacles. Third, the legislation on the WRS is imperfect, which is highlighted by the fact that a discussion on water rights is absent from the Constitution of the People's Republic of China. An examination evaluation system for the WRS, and laws to ensure that the water quality meets the requirements of the water users in the WRA and WRT processes, are necessary. Remarkably, the existing issues mentioned above as well as other issues, such as the price of WRT and the investment in water market construction, have delayed water rights construction.

THE RELATIONSHIP BETWEEN THE WRS AND SWRM

China's water resources management model under the previously planned economic system cannot meet the demands of modern water resources management with the rapid economic development that is accompanied by river pollution. Therefore, it is urgently necessary to develop innovative plans with respect to the water resources management system, particularly the construction of a WRS that is suited to the SWRM. The SWRM is an important system innovation with respect to China's water issues. The SWRM was first expounded upon at the 2009 National Work Conference on Water Resources. The decision on *Accelerating Water Conservancy Reform and Development* in the Central Committee No.1 Document in 2011, issued by the State Council on December 31, 2010, aimed at promoting steady and rapid long-term economic development and enhancing social harmony (CPC 2010). In the document, the basic content of the SWRM was discussed in detail and 'Three Red Lines' was refined – namely, 'control of the development and utilization of water resources' sought to strictly control total water consumption, 'control of water use efficiency' aimed to resolutely curb the waste of water, and the 'restriction of pollutants in water function areas' was designed to strictly

control total pollutant discharge, which marked the point at which the Central Committee of the CPC attached great importance to the work of water conservancy reform and showed the determination of the CPC Central Committee to promote the SWRM (Zuo *et al.* 2014). The *Opinions of the State Council on Implementing the Strictest Water Resources Management System* was promulgated by the State Council of China on 12 January 2012, which was the overall layout and specific arrangements that explicitly required the implementation of the SWRM, and it would guide China's water resources management at the present and for a certain period of time (China News 2012). On the whole, the implementation of the SWRM could realize the rational development, effective utilization and protection of water resources, which would promote a better match between socioeconomic development and the carrying capacity of water resources and the water environment.

The SWRM and WRS are closely linked and interdependent with one another (as shown in Figure 1). The construction of the WRS attempts to achieve 'human-water harmony', in line with the SWRM to create a harmonious society (Ding *et al.* 2014). The 'human-water harmony' actually is the harmonious development state between humans and water. And the WRS and the SWRM restrict each other. The first red line works in the process of WRA, while the other two red lines work in the process of WRT. The 'Three Red Lines' form the core of the SWRM, which has the goal of accelerating social and economic development while remaining within the carrying capacity

dictated by the water resources and water environment and effectively protecting water resources. SWRM is a new concept in water resources management. In the process of implementing SWRM, problems of water rights definitions and allocations will inevitably be encountered. In a manner of speaking, total water consumption distribution is actually a form of WRA. If the amount of water usage per user is greater than the amount allowed by the WRA, the water user will be punished with penalties, even administrative penalties. The control of the red line of water use efficiency is achieved by restricting WRA and WRT, which is designed to improve the efficiency of water use. If the water use efficiency of the actual water user is below the prescribed standard, they do not have the right to use their water rights to earn profit. The red line restriction of pollutants in water function areas is considered from the perspective of water quality, in which the restricted level controls the amount of sewage in terms of the water environment carrying capacity in water function areas to guarantee that the water quality remains acceptable in a standard concentration of control sections. From the perspective of management, the behaviors of WRA and WRT are restrained by the SWRM, which means that the SWRM provides an external environment for water rights construction. In turn, the WRS provides legal protection for water users to utilize and transfer water resources as a guarantee for the implementation of SWRM. The object of SWRM is the government, not individual users, and regional water planning is still dominated by the government. So the government attaches great importance to the work of water resources management. More funds will be invested in the engineering construction of water resources allocation to save water. What is more, water price can be adjusted by the government to encourage saving water in an efficient water utilization way. At present, China is in a critical period of water management system reform, and now is the best opportunity to build a WRS with Chinese characteristics. On the one hand, the implementation of the SWRM provides an opportunity for the integration of the WRS into the SWRM. On the other hand, the basic conditions will be significantly improved with the great-leap-forward development of water conservancy and the refinement of water conservancy informationization. Hence, the government should seize the opportunity to explore a modern WRS

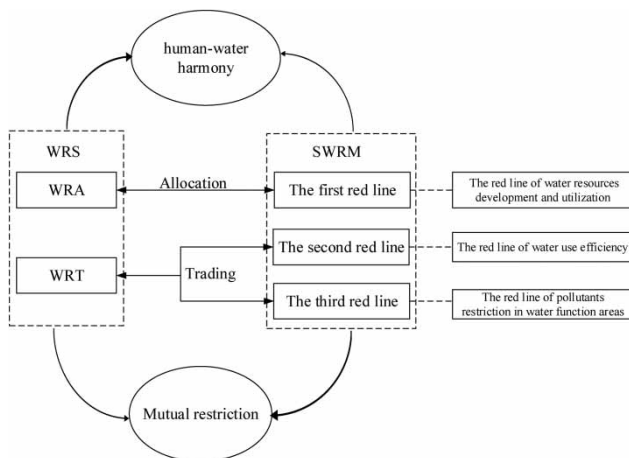


Figure 1 | The relationship between the WRS and the SWRM.

suited to SWRM to accelerate the integration of the WRS and SWRM.

COUNTERMEASURES FOR PROMOTING THE CONSTRUCTION OF THE WRS SUITED TO SWRM

Recommendations for WRA on the basis of water consumption control

An ideal administrative mechanism for the initial water rights is the fundamental requirement for water rights construction provided by water resources management in the new period. An appropriate definition of water rights is a precondition of WRA. However, ambiguities with regard to management organization responsibilities have resulted in inefficiency of WRA, with an example being the water allocation of the Yellow River. Therefore, the stipulation of water rights concepts in laws is an urgent task. Considering that sustainable initial WRA is critical to solve water conflicts that are triggered by increasing water resource shortages, it is necessary to standardize the methods of WRA, which are mainly distributed by application of single and multi-objective optimization techniques after the clear definition of water rights (Roozbahani *et al.* 2015). For instance, an application of linear programming methods for the optimal allocation of water among competing stakeholders was also described in a paper written by Roozbahani in 2013 (Roozbahani *et al.* 2013). More importantly, the amount of WRA should be controlled according to the range of the total water consumption – namely, meeting the requirements for the first red line of ‘control of the development and utilization of water resources’ in different administrative areas (as shown in Table 1). If not, water resources may be in a situation of excessive development over a long period. In the process of initial water rights distribution, the benefit to the water users should be given full consideration, and some appropriate principles should be stipulated as well. First, the government needs to give priority to basic domestic water use to ensure human survival. In addition, protecting ecological environmental water consumption is necessary to maintain minimum subsistence requirements. At the same time, the use of domestic water and ecological environmental water

Table 1 | The control of total water consumption in different administrative areas of China

Administrative area	The total water consumption (10 ⁸ m ³)	Administrative area	The total water consumption (10 ⁸ m ³)
Beijing	41	Hubei	312
Tianjin	33	Hunan	336
Hebei	226	Guangdong	447
Shanxi	80	Guangxi	307
Inner Mongolia	206	Hainan	48
Liaoning	155	Chongqing	89
Jilin	129	Sichuan	275
Heilongjiang	316	Guizhou	121
Shanghai	123	Yunnan	188
Jiangsu	494	Tibet	36
Zhejiang	225	Shaanxi	96
Anhui	239	Gansu	122
Fujian	207	Qinghai	33
Jiangxi	233	Ningxia	70
Shandong	254	Xinjiang	505
Henan	254	In total	6,200

consumption for industrial purposes should be strictly prohibited. Aside from this, fairness and feasibility still need to be taken into consideration in the process of distributing water rights (Babel *et al.* 2005). Thus, the water demands of various regions and trades can be coordinated, and the contradiction between economic and social development and ecological environmental protection will be assuaged. In addition, the government should play a leading role in WRA, giving full consideration to the impact of national macroeconomic regulation. New theories and methods, such as the quantitative methods of human–water harmony, are also needed to guide the initial water rights distribution, which can address the contradictory needs of human beings and nature and reduce the impact of humans on the environment (Zuo *et al.* 2015).

Explore WRT on the basis of the water use efficiency red line

The target of pursuing WRT, which was stated in the third plenary session of the 18th Central Committee of the CPC,

is the core requirement for the construction of a WRS (China News 2014). WRT is not only an inevitable outcome of the contradiction between the water resources supply and demand but is also one basic method of SWRM. The goal of WRT is to promote the transfer of water from users with lower value to users with higher value. It is, in fact, the reallocation of water rights – to some extent – that can reflect the shortage of water resources in China. WRT allows water users with tradable water rights, which are obtained by saving water, to sell their water for profit. This process can incentivize water users to save water of their own initiative. If WRT is not allowed, water users will not have any incentives to save water and will not be aware of the water situation in our country, which will result in serious competition between water users. Through research, Calow and his team concluded that WRT in China was vital for mediating the claims of competing users (Calow *et al.* 2009). A scientific and reasonable trading procedure is a precondition in WRT. It is necessary for the government to take measures to reduce the risk of WRT by formulating satisfactory trading rules in the market and improving the transparency of trading information. The trading rules that are associated with water rights transactions should be taken into consideration, especially with regard to efficiency and equity in enhancing the utilization of water resources, which is in line with the second red line of the ‘control of water use efficiency’. The WRT market is a semi-market that may be suffering from a market monopoly, which is not conducive to the allocation of water resources. Therefore, the government can supervise WRT through price adjustments with the modality of selling and buying water rights. Additionally, a WRT platform to improve the transparency of WRT and standardize the order of water market transactions should be constructed as a priority. Moreover, it is extremely important to explore water rights trading modes with different levels and forms. A democratic consultation mechanism urgently needs to be established to provide a sufficient platform for public involvement. The transaction price as a key factor in the water market should not be too high or too low. A price that is too high is detrimental to the optimal distribution of water resources, and a price that is too low may lead to wasted water or even environmental pollution. Therefore, a national or local ‘water bank’ should be established to balance the price of water rights. In addition, it is

urgently necessary to encourage investment in the water rights pilot programs to provide water supply security and accelerate the construction and generation of the water rights market.

Suggestions for water rights construction on the basis of the red line restriction of pollutants in water function areas

Water rights are the embodiment of water resources in law or economics. Considering that water resources have the dual nature of water quality and quantity, namely that water resources can only be available with a certain water quality, so water resources regardless of water quality cannot be regarded as resources. Also in the WRA process, the water quality and quantity of the assigned water rights to different users should meet their needs. To facilitate the management of water resources, water function zoning is implemented, and this process will result in a positive effect for controlling emissions and protecting the water supply source. The third red line, the red line restriction of pollutants in water function areas, is mainly designed to control water quality in two ways, one of which is the control of the amount of sewage into the river within a water function area to avoid local water pollution. The other method is having the water quality concentration of control sections be lower than the target concentration stipulated by the MEP. The concentration of the different kinds of pollutants going into the river should also be controlled to within the corresponding water quality standards, with industrial users prohibited from dumping excess emissions into the water. The standard rate of water function area in different administrative areas of China can be seen in Table 2. These two aspects can induce an improvement in the efficiency of wastewater treatment, especially for industrial users. The first step of implementing the third red line is to establish water quality monitoring stations in various river sections to enhance water quality monitoring, and it being forbidden to discharge sewage into protected water resource areas. The government should then establish a mechanism with effective supervision and management to enforce these measures to prevent the illegal discharge of sewage. Enterprises can be encouraged to improve water purification technologies,

Table 2 | The standard rate control of water function area in different administrative areas of China

Administrative area	The standard rate of water function area (%)	Administrative area	The standard rate of water function area (%)
Beijing	52.4	Hubei	69
Tianjin	60.3	Hunan	72.8
Hebei	67	Guangdong	66.8
Shanxi	46	Guangxi	92.4
Inner Mongolia	68.6	Hainan	88.9
Liaoning	66.5	Chongqing	83.5
Jilin	58.7	Sichuan	50.4
Heilongjiang	51.5	Guizhou	60.9
Shanghai	47.9	Yunnan	96.3
Jiangsu	58.5	Tibet	61.6
Zhejiang	67.5	Shaanxi	67.4
Anhui	73.8	Gansu	76.8
Fujian	87.2	Qinghai	45.9
Jiangxi	71.4	Ningxia	87.1
Shandong	48.1	Xinjiang	77.9
Henan	80.1	In total	62.4

transform water supply pipeline networks, and establish and perfect emergency plans for the water supply (Dou *et al.* 2014). It is imperative to improve WRS legislation, which is a prerequisite for China to execute its construction, the improvement of which plays an important role in water resource development, utilization and protection. These laws are also necessary to effectively solve current water problems with regard to corruption, intergovernmental rivalries and illegal sewage discharge from enterprises. Given that preserving water resources and the ecological environment has become a major challenge for the construction of the WRS, the central and provincial financial administration departments should significantly increase subsidies to water rights pilot programs, and municipal and country-level governments should effectively expand their investments in the construction of the water market and encourage water users to save water with the intention of protecting the environment. Greater efforts must be made regarding the construction of the WRS, which would facilitate a shift in the water resources management mode.

CONCLUSIONS

The construction of a WRS plays an irreplaceable role in realizing the value of water resources, which has achieved remarkable success over a long period of exploration and practice in China. A series of assessment methods have been issued, which has contributed to the formation of the relatively stable assessment mechanism, and every province in China has been assessed since 2013. With the implementation of the SWRM, water resources development and utilization indicators have been distributed to the provinces from the nation, and then they have been allocated to cities, counties and other administrative regions to achieve the allocation of water resources indicators. From the point of water use efficiency, industrial water use reuse rate and irrigation water use coefficient are restricted to control high water consumption industries and water use in large irrigation districts, which leads to a large increase in water use efficiency. The government has implemented measures with regard to legal, administrative, technical and economic changes to facilitate the development of a WRS. We believe that the WRS in China will improve gradually in the near future and can play a significant role in the optimal allocation of water resources, which can promote industry upgrading and economic structure adjustment to support sustainable social and economic development.

ACKNOWLEDGEMENTS

The opinions in this paper reflect the personal views of the authors. This study was supported by the Major Program of the National Social Science Fund of China (No. 12&ZD215), the Natural Sciences Foundation of China (No. U1304509), the Outstanding Young Talent Research Fund of Zhengzhou University (1521323001) and the Program for Science and Technology Innovation Talents in Universities of Henan Province (17HASTIT031).

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First received 30 March 2016; accepted in revised form 26 July 2016. Available online 9 August 2016