

River chief system: an institutional analysis to address watershed governance in China

Bo Wang ^{a,*}, Jingjing Wan^b and Yuchun Zhu^c

^a Research Institute of County Economic Development, Lanzhou University, Lanzhou, Gansu 730000, China

^b School of Economics and Management, Huazhong Agricultural University, Wuhan, Hubei 430070, China

^c School of Economics and Management, Northwest A&F University, Xianyang, Shaanxi 712100, China

*Corresponding author. E-mail: bwang@lzu.edu.cn

 BW, 0000-0003-1909-6498

ABSTRACT

China suffers from frequent water crisis events caused by ecological pollution in watersheds. The river chief system policy is an institutional innovation by the government to deal with the ecological environmental crisis in the river basin. This study focuses on China's watershed environmental governance policy and describes the origin, operation mode, and governance effect of its river chief system policy. This study comparatively analyses the advantages of the policy in basin environmental governance, such as clear government responsibility, enhanced coordination among government departments, the accountability mechanism of the one-vote veto system, and the disadvantages of the policy in terms of high costs, information asymmetry, and lack of public participation. Furthermore, this study proposes suggestions on the sustainable development of watershed environmental governance from three aspects: regional characteristics, investment, and institutional innovation of policy implementation.

Key words: Ecological pollution, Institutional analysis, River chief system, Watershed environmental governance

HIGHLIGHTS

- The innovation system of river management in China is introduced.
- The Chinese experience was discussed.
- The advantages of the Chinese system are analyzed.
- The disadvantages of the Chinese system are analyzed.
- The corresponding policy suggestions are put forward.

INTRODUCTION

This study focuses on China's institutional innovation in managing the environmental crisis in watersheds. It introduces, in detail, the practice, origin and operation model of the river chief system (RCS) in the context of river basin governance in China and analyses the governance effect of the RCS. Furthermore, it uses new institutional economics to analyse the advantages and disadvantages of the RCS.

For a long period, water pollution has been the most prominent problem in China's environmental security (Guan *et al.*, 2008). China's excessive extensive industrialisation has pushed environmental protection behind GDP growth, increasing environmental risks (Zhang *et al.*, 2017; Cao *et al.*, 2019). Two-thirds of China's cities suffer from varying degrees of water scarcity, one-sixth suffer from severe water scarcity. Statistics from the

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China Environmental Bulletin (2019) show that China has entered the peak period of water accidents. In the ten years from 2005 to 2014, the Ministry of Environmental Protection directly handled 561 water pollution emergencies and more than 50% of all environmental emergencies. Pollution in rivers and lakes in China is common, with 75% of the lakes showing varying degrees of eutrophication, and 30% of the water quality of the lakes in the V category, making it impossible to use directly, reducing the function of the water body and aggravating water shortages (Wang *et al.*, 2019).

As for the relationship between watershed governance policy and watershed ecological environment quality, theoretical and practical studies are in dispute. The policy debate focuses on whether the devolution of greater management authority to local governments can promote the environmental governance effect under their jurisdiction. Some scholars believe that this is possible (Oates & Wallace, 1999). This is because in terms of environmental regulation and procedure setting, local governments can formulate policies according to local conditions, and the decentralisation of decision-making power provides experimental opportunities for different watershed management systems. Some empirical studies on the decentralisation of environmental governance from the central to the state level appear to support this view (Johnsson & Kemper, 2005; Sigman, 2014). However, other studies find that such decentralisation did not improve the watershed eco-environmental governance effect, but led to the deterioration of the watershed eco-environment and other unexpected results in some regions (Ruoyin, 2006; Burgess *et al.*, 2012). These different conclusions may not depend on the watershed management rights themselves but the relationship of the participants and policy implementation mode under the decentralised system (Konisky & Woods, 2016). The effect of watershed governance policies on the watershed ecological environment depends on the adjustment of relations among governments at all levels, enterprises, and people (Brannstrom, 2004).

Compared with science and technology, reasonable institutional arrangements are more important in the ecological environment management of river basins (Janicke & Weidner, 1997). Therefore, which types of watershed management institutional arrangements are effective? Overcoming the difficulty of water policy implementation is now a core topic in watershed management system research (Qidong & Jiajun, 2019). Many studies attribute this difficulty to a lack of communication and adaptability among governments at all levels (Macatangay & Rieu-Clarke, 2018). Research demonstrating the importance of improving the flexibility of the 'rigid' structure of watershed management agencies further confirms this view (Folke *et al.*, 2010). However, improving the ability of different levels of the government to coordinate is not sufficient to improve the functioning of environmental mechanisms. The distribution of power among different environmental management agencies, the degree of specialisation among different departments, and the specific political culture will also affect the implementation of policies (Pahl-Wostl *et al.*, 2007). Increasingly, researchers are concluding that watershed environmental management agencies and institutions work better in an open, pluralistic society, ensuring the effective participation of civil society, academia, private enterprises, and the media (Estrella-Luna, 2000; Chen *et al.*, 2017). Public participation in watershed environmental governance can reduce institutional bias and power imbalance and contribute to environmental governance.

This study takes the following steps to achieve the research goal: First, it introduces the practice, origin, operation mode, and governance effect of the RCS in China. Second, it discusses the dilemma of the principal-agent problem, the participation of social forces, and the administrative accountability system in the operation of the RCS. The concluding section discusses the public participation mechanism design of the RCS and reflects on the objectives achieved.

CHINESE CASE STUDY OF THE RCS

The RCS is an institutional innovation whose practice precedes theory in river basin environmental governance (Yongjian, 2019). It promotes the overall planning of river management systems, strengthening river management

authority, and supervising the responsibilities of river management organisations (Man-Hong, 2018). The remainder of this section introduces the Chinese RCS from three aspects: its origin, operation mode, and operation effect.

Practice origin of RCS

The RCS in China is widely believed to have originated in Wuxi, Jiangsu Province, due to the blue-green algal crisis in Taihu Lake. In 2007, cyanobacterial pollution broke out in Taihu Lake in Wuxi City. The government of Wuxi City presented the idea of segmental closure, which led to the first policy formulation to govern rivers, followed by lakes, and the water pollution control model of the RCS emerged. Wuxi issued the policy of 'water quality control objectives and assessment methods for cross-sections (trial)', emphasising the management of river cross-sections. It assigns the chief executive of each district (county) as the principal responsible person and makes water quality monitoring and the results of governance effectiveness the basis for the assessment of the responsibility of the subject. The above-mentioned principal responsible person is the rudiment of the 'river chief'. In 2008, the Wuxi municipal government issued the 'comprehensive establishment of the river and lake chief system' policy and systematically explained the organisational structure, system principles, work path, assessment, and accountability methods. According to the top to bottom governance action logic, the RCS is implemented in the entire city, from the municipal river chief, to the village or community river chief. Since then, the RCS as a type of local experience and institutional innovation is studied and imitated by other areas, because it is considered to have remarkable positive effects and strong operability in controlling water pollution. This period can be regarded as the local diffusion stage of the RCS (Jianguo & Ye, 2017). In 2016, the Chinese government issued the policy document containing 'opinions on comprehensively implementing the river chief system', which established the RCS as a national institutional model for water management in China.

Operation mode of RCS

The RCS operates according to the four levels of province, prefecture-level city, county, and township. Each province should have the first river chief, who is the chief official of the government. Provincial officials hold chief positions with regard to the major rivers and lakes under the jurisdiction of each province. The prefecture-level cities, counties, and townships, where rivers and lakes are located, should set up river chiefs at different levels and be monitored by responsible officials at the same level. Units above the county level establish corresponding RCS offices (Figure 1).

River chiefs at various levels should be responsible for organising the management and protection of the respective rivers and lakes, including the protection of water resources, management of water shorelines, prevention and control of water pollution, and treatment of the water environment. River chiefs should organise to clean up and rectify prominent problems such as encroachment on river courses, reclamation of lakes, excessive sewage discharge, illegal sand mining, destruction of waterways, and coordination of the settlement of major river basin management problems. River chiefs should also be responsible for coordinating the implementation of joint prevention and control on the upper and lower reaches of the river, supervising the performance of relevant departments and river chiefs at the next lower level, assessing the completion of targets and tasks, and strengthening incentives and accountability. The RCS office is responsible for the organisation and implementation of specific work to implement the matters determined by the river chief.

Governance effect of RCS

The emergency plan for the blue-green algal crisis in Taihu Lake is the embryonic form of the RCS (Luo Zhong & Rui, 2018). Therefore, the improvement of water quality in the Taihu Basin is an important indicator for evaluating the effectiveness of RCS policy (Wang & Li, 2018). The surface water quality in China can be divided into five classes. Class I water is mainly suitable for source water and national nature reserves. Class II water is mainly suitable for centralized drinking water source level protection areas, precious fish protection areas, fish and

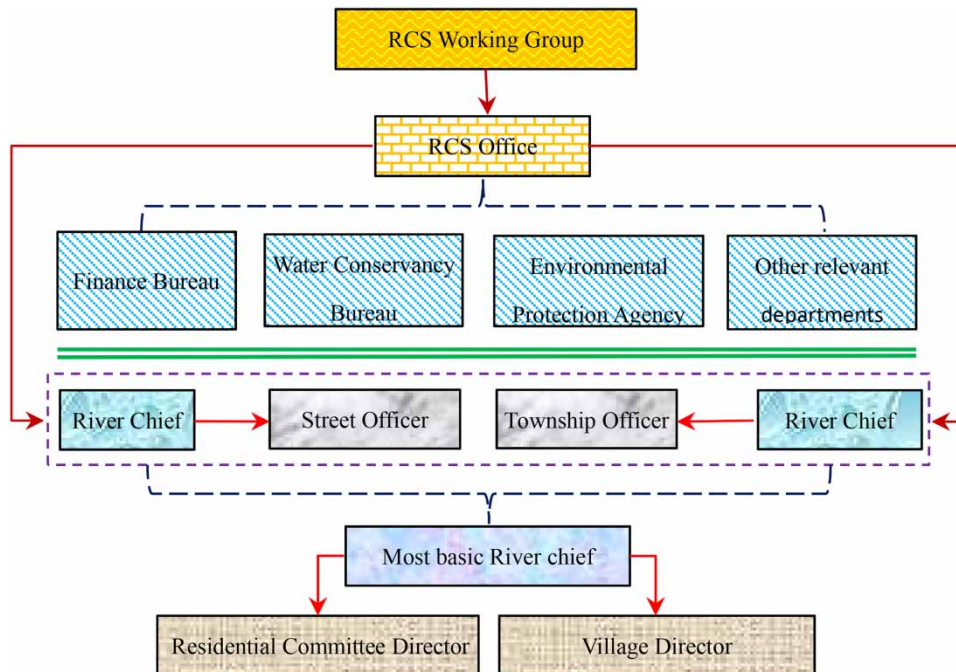


Fig. 1. | Structure and the concrete operational process of the RCS at the county level.

shrimp spawning grounds. Class III water is mainly suitable for centralized drinking water sources, secondary protection areas, general fish protection areas and swimming areas. Class IV water is mainly suitable for general industrial water areas and recreational water areas, where human bodies are not in direct contact. Class V water is mainly suitable for agricultural water areas and general landscape water areas. In 2007, the water quality in Taihu Lake water went from V stability to IV stability, which is a significant achievement. According to the annual mean method, from 2007 to 2017, the water quality compliance rate of the Taihu Lake Basin showed a steady upward trend (Figure 2). During this period, the proportion of water quality in Taihu Lake better than class III from 22.5% in 2007 to 58.3% in 2017. As the most economically developed region in China, the Taihu Lake Basin has made remarkable achievements in ecological and environmental governance.

Thus far, 108 water functional zones (42 in Jiangsu, 15 in Zhejiang, 6 in Shanghai, and 45 in provincial boundaries) have been monitored, and 63 have reached the water quality standard. In 2017, the potassium permanganate index in Taihu Lake basin belonged to class III, ammonia nitrogen class I, total phosphorus class IV, and total nitrogen class V. Ammonia nitrogen and total nitrogen concentrations reached the target, while the potassium permanganate index and total phosphorus index did not (Figure 3).

The water system in Zhejiang Province is an important part of the Taihu Lake basin and it is the first province to implement the RCS policy. According to the *Zhejiang Environmental Status Bulletin (2018)*, the change in surface water quality in Zhejiang fluctuated from 2006 to 2011. Since the implementation of the RCS policy in 2011, there has been a stable class proportion rise in high-quality water I and II, and a steady decline in the inferior water V class (Table 1). In Zhejiang province, the proportion of surface I class water increased from 6.8% in 2011 to 10.4% in 2017; class II water proportion increased from 25.8% in 2011 to 48.0% in 2017, and class V water proportion decreased from 22.5% in 2011 to 2.3% in 2017. RCS policy has achieved remarkable results in improving surface water quality in Zhejiang Province.



Fig. 2. | Water qualification rate of Taihu Lake basin (2007–2017). Data source: Health report of Taihu Lake (2017) (<http://www.tba.gov.cn/contents/45/55609.html>).

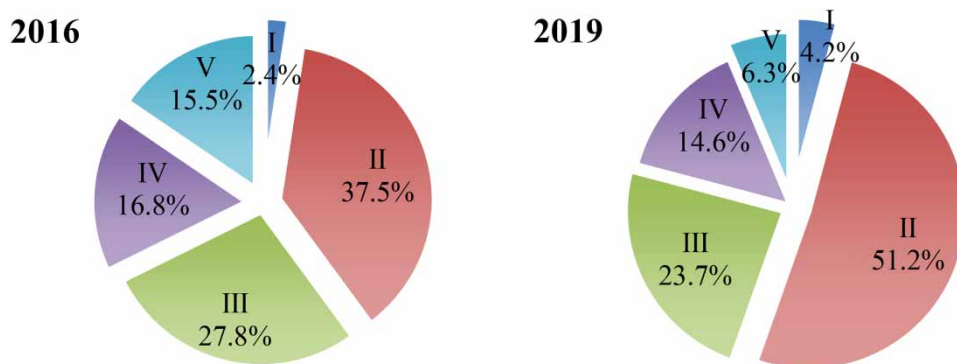


Fig. 3. | Water quality of Taihu Lake basin (2007–2017). Data source: Health report of Taihu Lake (2017) (<http://www.tba.gov.cn/contents/45/55609.html>).

China promoted and implemented the RCS policy in 2016. The change in national water quality after the implementation of the policy can fully illustrate the effect of the RCS policy. According to the [China Environmental Bulletin \(2019\)](#), there have been significant changes in surface water quality in China from 2016 to 2019 ([Figure 4](#)). In China, the proportion of surface I class water increased from 2.4% in 2016 to 4.2% in 2019; the proportion of class II water increased from 37.5% in 2016 to 51.2% in 2019, class IV water proportion decreased from 16.8% in 2016 to 14.6% in 2019 and class V water proportion decreased from 15.5% in 2016 to 6.3% in 2019. Since the implementation of RCS policy nationwide in 2016, the proportion of high-quality surface water in China has steadily increased, while the proportion of low-quality water has steadily reduced, indicating

Table 1. | Changes in surface water quality in Zhejiang province (2006–2017).

| Year | I | II | III | IV | V |
|------|------|------|------|------|------|
| 2006 | 2.9 | 30 | 26.1 | 17 | 24 |
| 2007 | 4.7 | 28.6 | 33.9 | 11.7 | 21.1 |
| 2008 | 4.1 | 32.7 | 33.9 | 9.9 | 19.3 |
| 2009 | 3.5 | 28.7 | 42.7 | 7.6 | 17.6 |
| 2010 | 6.4 | 36.3 | 31.6 | 15.2 | 10.5 |
| 2011 | 6.8 | 25.8 | 30.3 | 12.7 | 22.5 |
| 2012 | 6.8 | 27.6 | 29.9 | 17.2 | 18.5 |
| 2013 | 9.1 | 27.6 | 27.1 | 15.4 | 20.8 |
| 2014 | 10.4 | 28.1 | 26.2 | 17.7 | 18.5 |
| 2015 | 9.1 | 33.9 | 29.9 | 15.8 | 11.3 |
| 2016 | 10.9 | 38.5 | 28 | 15.8 | 6.8 |
| 2017 | 10.4 | 48.0 | 26.2 | 13.1 | 2.3 |

**Fig. 4.** | Comparison of surface water quality in China in 2016 and 2019.

that China's watershed ecological environment is constantly improving. The RCS policy has achieved remarkable results in river and lake basin governance in China.

ANALYSIS OF RCS POLICY

As a new solution to environmental problems in river basins, the essence of RCS policy is to turn water environment management into governance. Traditional watershed environmental management focuses on the function of the government, while watershed environmental governance emphasises the collaborative participation of diverse societies (Koontz & Sen, 2013). The successful cases of governance of Lake Biwa in Japan, the Murray-Darling River in Australia, and the Seine River in France all demonstrate the importance of public participation in watershed governance (Dwyer, 2005; Yu, 2013; Tatiana *et al.*, 2018). Simultaneously, the public nature of river basins determines that their governance must involve many countries and many government departments. The successful governance of the Rhine River is the result of the cooperation of nine countries, including Germany, Luxembourg, the Netherlands and Belgium. The successful governance of the

Cheonggyecheon River in Korea is the result of coordination among the Land, Infrastructure, and Transport Ministry's Water Resources Bureau, urban Policy Bureau, and the Environment Ministry (Schiff, 2017; Zhao, 2018). It is necessary to study and reference the successful models and experiences of river basin governance in the continuous improvement of river basin governance model of RCS in the future.

Advantage analysis of RCS

The RCS policy is the embodiment of problem-oriented pragmatism in river basin environmental governance. Pragmatism emphasises the determination method and pursuit of utility maximisation (Scott, 2014). In the pragmatic mode of thinking, the right way depends on whether it is conducive to the realisation of the goal, which is the optimisation of the utility (Goldkuhl, 2012). In current practice, the working method of the RCS policy has the following three advantages:

First, the RCS clarifies the specific responsibility of the river basin management body. In essence, the RCS is a type of water environment management method for administrative or official contracting. From the superior to the subordinate, the responsibilities of government departments and responsible officials for water environment management in the river basin are clear. The head of the local government, as the river chief, is responsible for the water ecology of the river basin in their jurisdiction and is the first responsible person. Thus, the responsibility of government departments in the environmental protection of the watershed can materialise and overcome the ambiguous responsibility of government departments in watershed environmental management. Local government leaders will actively achieve the watershed environmental governance objectives of their jurisdictions to strengthen the administrative authority of environmental protection in the river basins.

Second, the RCS makes the collaboration of different government departments in the river basin water environment management more flexible. The head of the local government will take an active part in river basin water environment management affairs within their jurisdiction. The RCS office is specifically responsible for the coordination, supervision, guidance, inspection, and communication of work, rather than replacing existing water-related functional departments. Through the regional water resources management committee or the inter-departmental joint meeting system, river chiefs at all levels can solve transfer problems and responsibility, policy goals and conflicts, lack of communication, and service omission of the watershed environment between different administrative departments (finance, water, environmental protection, agriculture, forestry, etc.), thereby reducing the obstacles from the fragmentation of bureaucratic management. The RCS policy is an innovation in the management system of the river basin environment and has an excellent adjustment function of administrative authority.

Finally, the environmental management policy of the RCS uses a one-vote environmental accountability mechanism to highlight the importance of watershed water environment governance. This mechanism makes local government officials consider local water environment management while developing the economy. The assessment method of river basin environmental governance brings more political responsibility and pressure to bear on local government heads and stimulates them to attach importance to environmental governance. Simultaneously, the results of natural resources and environmental governance during the administration of local government heads are taken as the main assessment items of their performance, and therefore, the system of life-long accountability for ecological and environmental damage is implemented.

RCS dilemma analysis

Judging from the current practices of China's ecological environment management policies in river basins, the RCS has strengthened the responsibility of local governments for ecological environment protection and enhanced the attention of local government officials towards water environment management. It has the functional advantage of clarifying the main body of responsibility for the ecological environment management of

the river basin, organising and coordinating different administrative departments to participate in the ecological management of the river basin, with a one-vote veto system performance appraisal. The implementation of the RCS policy in China has achieved fundamental results (Wang & Chen, 2019). The local ecological environment has significantly improved in areas where the policy is well implemented (Liu *et al.*, 2019). However, there are still three difficulties in implementing the RCS policy in China.

First, the economic efficiency of the policy of the RCS is relatively low. The implementation of RCS policies in watershed ecological environment governance has shown unprecedented efforts in water environment management. Local government officials tend to approve any monetary costs to solve the water pollution problem in their jurisdictions. Although it promotes water ecology protection, water resource conservation, and water environment management in the river basin, it also results in a high cost of ecological environment management in the river basin. In some places, the budget of the government for environmental protection exceeds the total revenue of local governments, resulting in a sharp rise in the debt ratio of local governments. In addition, the implementation of the RCS policy in the entire country increases the demand for environmental treatment projects and technologies in the river basin to exceed the supply, causing the sellers to raise their prices with time, resulting in a gradual rise in environmental treatment costs. When the projects and technologies of environmental treatment in the river basin become scarce, collusion between rights and capital occurs in some places, and the rent-seeking problem in the ecological management of the river basin is inevitable.

Second, information asymmetry leads to increased governance risks. The assessment of local officials' achievements in river basin environmental treatment is a method for society to check if RCS policies are being properly implemented. However, the existing assessment of local officials' performance in river basin environmental governance is an internal self-assessment from the top to the bottom. When evaluating government officials' achievements in environmental treatment, the assessor is more important than the assessment mechanism itself. The internal assessment system of local officials' performance in river basin environmental treatment may lead to the joint concealment of information within the administrative departments. In addition, social members lack effective information acquisition channels. This information asymmetry between the public and the government in environmental treatment will cause the government sector to generate moral hazards in environmental management in the river basin. The difficulty of public access to environmental management information makes administrative departments lack sufficient motivation to maximise the interests of the entire society or improve the ecosystem of the river basin, causing adverse effects on policy implementation.

Third, participation in social forces is low. Watershed environmental governance is difficult to achieve by relying only on the government's workforce. Every member of the society is a part of the ecological environment system; stimulating the enthusiasm and responsibility of the public to participate in environmental governance is an indispensable part of every ecological environmental policy. However, the current RCS policy in China still belongs to the category of unilateral government management. The operation of policy and performance appraisal is entirely within the bureaucratic system. In the process of developing, utilising, and protecting water resources in the river basin, the public has become a marginal force in environmental governance. The lack of a platform for public participation in environmental governance results in the loss of public voice in environmental governance and is an important defect of the RCS policy.

CONCLUSIONS

After nine years of local practice, the RCS has achieved significant results in river basin environmental management. The state has adopted it as a national macro-level watershed management system, taking only two years to become popularised nationwide. This paper studies the environmental management policy of the RCS in China and describes its origin, operational mode, and governance effect. Based on the current implementation of the

RCS policy in China, this study also analyses the advantages and disadvantages of RCS policy in river basin environmental governance. It also proposes the following three suggestions to solve these difficulties, hoping to provide useful reference values for the river basin environmental governance of China.

China is a vast country with different ecological environments. All local government departments must take measures according to local conditions when implementing RCS policies, enhance the flexibility of policies, and avoid the phenomenon of river basin environmental governance in the form of political movements.

River basin ecological environment management is a complicated systematic project, and its management mechanism, construction, and policy formulation require significant investment. Government departments must strengthen investment in capital, manpower, and technology when promoting the policy of the RCS and enlisting the support of community members.

Finally, from the perspective of the implementation status of the RCS policy in China, the policy itself has many advantages and disadvantages. Government departments must focus on the shortcomings of the policy itself and make continuous policy amendments and innovations.

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CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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