Academic Journal of Management and Social Sciences
ISSN: 2958-4396 | Vol. 5, No. 2, 2023

Study on the Mechanism and Optimization Strategy of River-Chief System in River Basin Development

-- Take the Qinhuai River in Nanjing as an Example

Xuechu Zhao *, Beibei Jiang and Ming Chen

School of Nanjing Normal University, Nanjing 210000, China

*** Corresponding author:** Xuechu Zhao (Email: zhaoxuechu123@outlook.com)

Abstract: The river-chief system is an important measure to implement the construction of ecological civilization and maintain the healthy life of rivers and lakes in the new era. In order to deeply understand the effect of the river-chief system on the development of the river basin, this paper selects the Qinhuai River in Nanjing as the specific research object to study the implementation effect of the Qinhuai River's river-chief system from three aspects: work progress, publicity and popularization, and river regulation. The study shows: (1) the river-chief system of Qinhuai River works well and promotes the optimization and improvement of specific measures; (2) the policy publicity work is actively implemented and most residents have some understanding of the river-chief system; (3) the water quality of the system has improved and the results of river regulation are obvious. However, there are also some problems in the Qinhuai River's river-chief system, such as insufficient policy popularization and poor long-term river regulation. This paper puts forward optimization suggestions for the Qinhuai River's river-chief system according to the deficiencies found in the research, in order to promote the long-term and sustainable development of the river-chief system.

Keywords: River-chief System; River Basin Development; Mechanism.

1. Foreword

Water resources has always been one of the most important natural resources in China. Since 1988, China has begun to implement comprehensive management measures. However, its supervision and governance capacity has not been enough to support the exploitation and utilization of China's water resources recently. Since then, the river-chief system comes into being. In 2016, the General Office of the CPC Central Committee and the State Council issued the "Opinions on Comprehensively Implementing the River-Chief System", which proposed the establishment of a responsibility system with the Party leadership responsibility system as the core, marking that the river-chief system has officially become the will of the state. From then on, local governments have actively followed up the implementation of the river-chief system, and have issued local standards.

Nanjing officially began to implement the river-chief system in 2017. As an important node city with the strategic intersection of the eastern coastal economic belt and the Yangtze River Economic Belt, Nanjing has developed rapidly in recent years. However, with the continuous development of the economy, the water pollution problem in Nanjing is becoming more and more serious. Among them, the Qinhuai River, known as Nanjing's "mother river", is also plagued by water pollution. As the largest regional river in Nanjing, the Qinhuai River has always played an important economic role since ancient times. However, with the development of the city, a large number of domestic sewage and industrial wastewater flow into the river, leading to a sharp decline in the water quality of the Qinhuai River, which was once called "gutter" by the residents nearby. But with the implementation of the river-chief system, the water quality of the Qinhuai River has improved significantly. This paper selects the Qinhuai River in Nanjing as the research object to study the work performance and implementation effect of the Qinhuai River's river-chief system from three aspects: work progress, publicity and popularization, and river regulation. At the same time, in view of some problems and deficiencies in the implementation of the river-chief system, suggestions on the optimization of the river-chief system will be made to promote the policy to play a better role in river management.

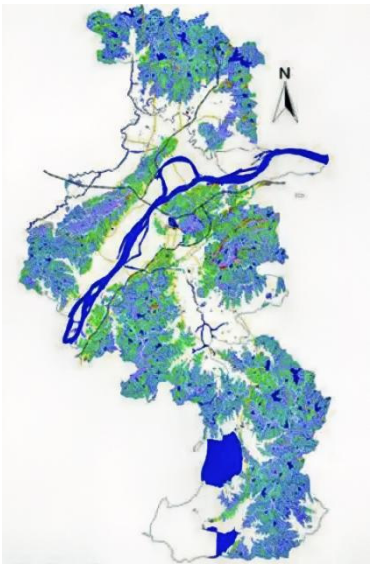


Figure 1. Map of Nanjing

2. Literature Review

2.1. Research Status of River-chief System

The river-chief system is an innovative policy in China's modern river and lake management system. Around this measure, Chinese scholars have carried out a lot of

discussions and studies.

In terms of the research perspective, Wang Shuming et al. (2011) commented and analyzed the river-chief system based on the perspective of new institutional economics, believing that the river-chief system policy can make full use of the rights of administrative principals to promote the functional transformation of local governments, and thus promoting the change of China's environmental system. At the same time, however, the emergency transition of the river-chief system also makes itself have some defects; Ren Min (2015) focused on the "cross-departmental collaboration" mechanism. This paper studied the mechanism and effect of cross-department coordination under the river-chief system and the influencing factors of the hierarchical coordination mode; Yan Haina et al.(2019) explored the practical dilemma of the river-chief system based on the perspective of collaborative governance, putting forward that the cause lies in the lack and deficiency of internal and external value, structure, system and technology; Wang Banban et al.(2020) focused on the diffusion and promotion of local environmental policy innovation, and took the promotion of the river-chief system in the Yangtze River Delta region as an example to test the regional differentiation effect of the diffusion and implementation of environmental policies under different modes; Li Xuesong et al.(2023) focused on the relationship between environmental policy innovation of local governments and enterprise environmental performance, studying the environmental protection and emission reduction situation of enterprises in the Yangtze River Delta region under the river-chief system policy. It was proposed that the environmental performance of enterprises was significantly improved under the influence of the river-chief system.

In terms of the effect and optimization of the river-chief system, Zhou Jianguo et al. (2017) believed that the river-chief system has effectively improved the performance of river and lake governance. But there are also a series of problems, such as the organizational logic dilemma. Innovation and optimization should be carried out by changing the "responsibility contract" into the "responsibility chain", consolidating the organizational foundation, strengthening the system supply, mobilizing multiple forces, and optimizing the combination of policy tools; Shen Kunrong et al.(2018) found that the river-chief system has achieved a preliminary water pollution control effect through empirical research, but it did not significantly reduce the depth of pollutants in the water. In this regard, better governance benefits should be promoted by setting reasonable goals, designing accountability mechanisms, and introducing third-party water quality testing institutions for supervision to avoid treating symptoms rather than root causes; Ren Binbin et al.(2021) studyed different policy tool choice preferences by constructing the selection model of policy tools for the local government river-chief system, and proposed optimization paths for the use of different policy tools by local governments, thus promoting the long-term operation of the river-chief system.

2.2. Research Status of Water Quality Evaluation Methods

Many studies have been carried out at home and abroad. Zhenya Li et al. (2018) used TOPSIS-based informative weighting and ranking (TIWR) approach for the water quality assessment of Shitoumenkou reservoir and the Lake Tai; Pan Luo et al.(2019) selected three common water quality evaluation methods: single factor evaluation method, Nemero pollution index method and Canadian water quality index method to test the water quality of the Tuojiang River system in Jintang County, Sichuan Province; Li Su et al.(2020) used the improved Nemero pollution index method to study and evaluate the water quality of Huangbizhuang reservoir, based on the traditional Nemero pollution index method; Ye Wei et al.(2021) used water quality evaluation method based on a T-S fuzzy neural network to comprehensively evaluate the water environment of the Taihu Lake basin.

2.3. Review of Research

Based on the above contents, it is showed that there is a lot of discussion and research on the "river-chief system". In terms of research perspective, some scholars carried out researches from the perspectives of new institutional economics and collaborative governance, while other scholars focused on the cross-departmental coordination mechanism or policy innovation and diffusion of the river-chief system. Furthermore, many scholars carried out in-depth research on the optimization and improvement of the river-chief system, and proposed to promote the long-term operation of the river-chief system from the aspects of policy mechanism design, tool selection and so on.

However, most of the current research focuses on a large range of policy implementation areas such as the Yangtze River Delta, and few studies focus on a specific region. In this paper, Qinhuai River in Nanjing is selected as the specific research object to deeply study the implementation effect of the river-chief system in a specific river basin, and put forward targeted suggestions for optimization and improvement. In the water quality evaluation method, the improved Nemero index method is selected.

3. Research Methods and Case Applications

In order to further study the role and effect of the river-chief system in the development of the river basin, this paper focuses on the specific regions and basins, the Qinhuai River in Nanjing, to specifically study the work performance and implementation effect of the river-chief system, and put forward corresponding optimization suggestions for the implementation of the Qinhuai River's river-chief system according to the problems found in the research.

3.1. Research Methods

The Nemero pollution index method was proposed by Professor Nemero of the University of Syracuse. Based on the measured concentration and standard value of the selected water quality index, this method calculates the pollution index and the standard index respectively, and then compares the pollution index to the corresponding grade standard to obtain the evaluation grade. The traditional Nemero index method considers the average and the highest value of the single factor pollution index, but ignores the weight of each pollution factor in the water quality evaluation. The improved Nemero index method considers the proportion of each pollution factor, which makes the evaluation results reflect the water environmental quality more objectively and comprehensively. The standard value of water in Class III is taken as the benchmark in the calculation. The detailed methods are as follows:

(1) Calculate the weight of each pollution factor in the

water quality evaluation:

$$w_i = r_i / \sum_{i=1}^{m} r_i \quad (1)$$

$$r_i = S_{\max} / S_i \quad (2)$$

w_i is the weight of the i pollution factor; r_i is the correlation ratio of the i pollution factor; S_i is the standard value of each pollution factor; $S_{\max}$ is the maximum standard value of the i pollution factor; m is the number of evaluated pollution factors.

(2) Calculate the improved Nemero pollution index:

$$F_i = C_i / S_{ij} \quad (3)$$

$$i = 1,2,3\ldots\ldots,n$$

$$j = 1,2,3\ldots\ldots,m$$

$$P_{improved} = \sqrt{(F_{\max}^2 + F'^2)/2} \quad (4)$$

C_i is the measured concentration of the class i evaluation factor; S_{ij} is the class j standard concentration of the class i evaluation factor; $F_{\max}$ is the maximum of the F_i; F' is the F value corresponding to the contamination factor with the largest weight; $P_{improved}$ is the improved Nemero pollution index.

3.2. Case Application

3.2.1. Work Progress of the Qinhuai River's River-chief System

In February 2017, the Nanjing Municipal Government issued "the Implementation Opinions on the Comprehensive Implementation of the river-chief System", and then the Nanjing river-chief system has been formally implemented. Up to now, Nanjing has established a three-level system structure of general river chief and four-level river and lake chief of city, district, town, street and village (community). Moreover, it has continuously improved the accountability system of river-chiefs.

The Qinhuai River has also continued to improve the river-chief system. It not only innovates the "1 + N" comprehensive management mode of the river-chief system, promoting the extension of the river-chief system from single river patrol dispatching to river basin comprehensive management, but also promotes the establishment of a four-level river inspection mechanism: grid inspection, business inspection, maintenance unit inspection and "1 + 1" inspection of the person in charge, so as to promote the timely discovery and solution of river problems.

In the field investigation, it can also be found that the establishment of the Qinhuai River's river-chief system is in good condition. The river-chief bulletin board can be seen in each river section, and the information on the public board is relatively rich, covering the general situation of the river, river chiefs at all levels, relevant contact details and other information.

3.2.2. Policy Publicity and Popularization of the Qinhuai River's River-chief System

Focusing on the construction of ecological civilization of rivers and the policy construction of the river-chief system, Nanjing has set up public accounts in WeChat such as "Nanjing River Chief", "Nanjing Water Affairs" and "Nanjing Ecological Environment". It actively publicizes and popularizes the policy of the river-chief system with the help of various media channels. Among them, the "Nanjing Ecological Environment" official account was read by more than one million people in 2022.

In the further research, this article interviewed the residents of the Qinhuai River basin to investigate the publicity and popularization of the Qinhuai River's river-chief system. The details are shown in the following Figure 2:

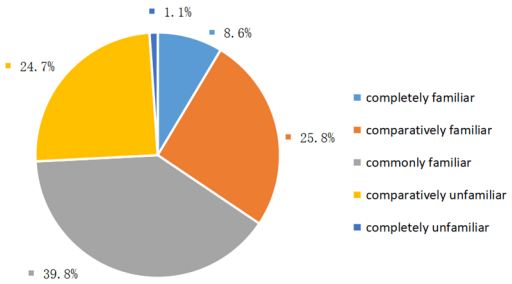


Figure 2. Residents' understanding of the river-chief system

As can be seen from the figure above, residents have a relatively close understanding of the river-chief system. Most of them are in general understanding, and the number of people who know very well or do not know are both very little. Generally speaking, the popularization of the river-chief system needs to be further improved.

3.2.3. River Regulation of the Qinhuai River's River-chief System

With the improved Nemero index method, three pollution factors of permanganate index, ammonia nitrogen and total phosphorus are selected to study and evaluate the water quality of Qinhuai River since the implementation of the river-chief system. First, according to the standard concentration of each pollution index, the standard Nemero pollution index corresponding to all levels of standards is calculated, as shown in Table 1:

Table 1. List of Nemero Pollution Index

Grade	Index Number
I	$P_{improved} < 0.33$
II	$0.33 \leq P_{improved} < 0.67$
III	$0.67 \leq P_{improved} < 1.00$
IV	$1.00 \leq P_{improved} < 1.67$
V	$1.67 \leq P_{improved}$

The specific calculation results of the Qinhuai River's Nemero index are shown in Table 2. According to the calculation results, the water quality of the Qinhuai River has improved since the implementation of the river-chief system in 2017, and the evaluation grade rose from III to II level. Among them, the Nemero index rose between 2019 and 2021, but quickly fell to 0.48 in 2022. Although there are short-term fluctuations, the Qinhuai River's river-chief system has obvious effect on the river regulation.

Table 2. Water quality evaluation results

	2017	2018	2019	2020	2021	2022
The Nemero Pollution Index	0.91	0.85	0.52	0.57	0.65	0.48
Evaluation Results	III	III	II	II	II	II

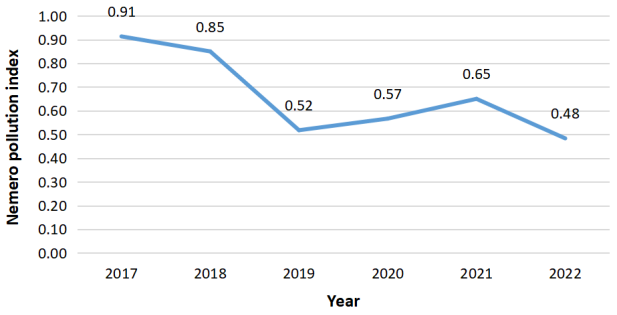


Figure 3. Nemero pollution index in the Qinhuai River

4. Conclusion

After the research and analysis of the Qinhuai River's river-chief system in Nanjing, the following three conclusions are formed:

(1) The Qinhuai River's river-chief system in Nanjing has made good progress. The specific work such as the establishment of river-chief public board has been implemented, and the relevant policy and measures have also been innovated and improved;

(2) The publicity work of the river-chief system is relatively in place. Relevant departments have actively publicized and popularized the work of the river-chief system through multiple media channels. In the practical research, it is also found that most residents have a certain degree of understanding of the river-chief system;

(3) The river regulation of the Qinhuai River's river-chief system is in good condition. Through the study and evaluation of the water quality of Qinhuai River since the implementation of the river-chief system, it can be seen that the water quality of Qinhuai River has improved significantly under the river-chief system.

In addition, this paper puts forward the following two suggestions in view of the current problems of river-chief system in Nanjing Qinhuai River. Firstly, more efforts should be made to popularize the policies. According to the results of the field research, it can be seen that the publicity work of the river-chief system still needs to be continued, not only to let more citizens know about this policy, but also to deepen the residents' understanding of this policy, so as to make the policy more deeply rooted among the people. Moreover, the long-term regulation of rivers should be promoted. As the study shows, short-term backward phenomenon was found about the river regulation of the Qinhuai River's river-chief system in recent years. The related staff should realize that the river protection and management is a need for a long-term work. As the result, they not only need to adhere to the down-to-earth, persistent good daily tasks in the actual work, but also innovate the management measures according to the new problems in the work progress, to promote the long-term and healthy development of long river system.

In short, the protection of the ecological environment is a continuous and long-term process, which requires the joint efforts and cooperation of all parties. In the future, it is hoped that the river-chief system can play the leading role more effectively and make a greater contribution to the management of rivers.

Acknowledgments

This article was supported by the following grants:

1 Provincial Program for College Students' Innovation and Entrepreneurship Training: Study on the Mechanism and Optimization Strategy of River-Chief System in River Basin Development --Take the Qinhuai River in Nanjing as an Example (Project No.2023 10319121Y).

2 Summer Social Practice Project of Nanjing Normal University in 2023: Observation and Practice of the River-chief System in the Qinhuai River.

3 National Natural Science Foundation of China Project: Dynamic Coupling Mechanism and Path Optimization of Industrial Transformation and Water Resources Bearing in the Yangtze River Economic Belt (Project No.41901244).

References

[1] Wang Shuming, Cai Mengmeng: Critique of the System of River-leader Based on the Perspective of New Institutional Economics, China Population Resources and Environment, Vol. 21 (2011) No.9, p.8-13.

[2] Ren Min:The River-chief Mechanism: A Case Study of China's Inter-departmental Coordination for Watershed Treatment, Journal of Beijing University of Administration, (2015) No.3, p.25-31.

[3] Yan Haina, Zeng Dong: The Dilemma of and the Reflection on Water Environment Governance Innovation by the RiverChief System: From the Perspective of Collaborative Governance, Journal of Beijing University of Administration, (2019) No.2, p.7-17.

[4] Wang Ban, Mo Qionghui, Qian Haoqi: The Diffusion Models and Effects of the Local Environmental Policy Innovation--A Micro-econometric Evidence from the Diffusion of River Chief Policy, Industrial Economy of China, (2020) No.8, p.99-117.

[5] Li Xuesong, Zhou Min, Wang Chengpeng: Local Government Environmental Policy Innovation and Corporate Environmental Performance: a Micro-econometric Analysis Based on the River Chief System Policy in the Yangtze River Delta, China Population, Resources and Environment, Vol.33 (2023) p.77-90.

[6] Zhou Jianguo, Xiong Ye: "The River Chief System": How Is Continuous Innovation Possible? —a Two-Dimension Analysis on the Basis of Both Policy Text and Reform Practice, Social Science in Jiangsu Province, (2017) No.4, p.38-47.

[7] Shen Kunrong, King Kong: The Policy Effects of the Environmental Governance of Chinese Local Governments: A Study Based on the Progress of the River Chief System, Social Sciences in China, (2018) No.5, p.92-115 + 206.

[8] Ren Binbin, Zhou Jianguo: Policy Tool Model of River-leader in the Local Government: Choice Preference and Optimization Path—Empirical Study on Policy Text Based on Grounded Theory, J. Cent. South Univ (Social Sciences), Vol.27(2021) No.6, p.145-157.

[9] Zhenya Li, Tao Yang, Ching-Sheng Huang, Chong-Yu Xu, Quanxi Shao, Pengfei Shi, Xiaoyan Wang, Tong Cui: An Improved Approach for Water Quality Evaluation: TOPSIS-based Informative Weighting and Ranking (TIWR) Approach, Ecological Indicators, (2018) No.89, p.356-364.

[10] Pan Luo, Huang Xiaorong, Wei Xiaoyue, Zhang Lang: A Comparative Analysis of Three Common Water Quality Evaluation Methods, China Rural Water and Hydropower, (2019) No.6, p.51-55.

[11] Li Su, Yan Zhihong, Xu Dan, Wang Shuqian: Application of Improved Nemero Index Method in Reservoir Water Quality Evaluation, Science, Technology and Engineering, Vol.20 (2020) No.31: p.13079-13084.

[12] Ye W, Song W, Cui C-F, Wen J-H: Water Quality Evaluation Method Based on a T-S Fuzzy Neural Network--Application in Water Environment Trend Analysis of Taihu Lake Basin, Water, Vol.13(2021) No.21, p.3127.

[13] Yang Leilei, Lu Wenxi, Huang He, Chu Haibo: Application of Improved Nemero Pollution Exponential Method and Fuzzy Comprehensive Evaluation Method Used in Water Quality Assessment, Water Resources and Power, Vol.30(2012) No.6, p.41-44.