

Analysis of the Status and Rational Allocation of Water Resources in China in View of the New Era

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Abstract: This paper examines the current status of water resource management and conservation in China, along with strategies to address the water resource crisis. Given the current situation, the paper highlights issues such as incomplete legal mechanisms, limited environmental awareness among enterprises, and insufficient government investment. To address these challenges, the paper proposes a series of strategies, including improving the ecological environment, enhancing production techniques, strengthening management systems, rationalizing water resource allocation, and implementing water-saving measures in both industrial and agricultural production. These strategies serve to achieve sustainable water resource management, reduce water pollution, and effectively tackle the pressing water resource issues faced in China currently.

Keywords: Water resources; Ecological environment; Water security, protection, and utilization

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1. Introduction

Water resources are among the most critical natural assets for sustaining life and promoting economic development. In China, a nation characterized by its vast territory and diverse geographical features, water plays an even more pivotal role in shaping its socio-economic landscape. However, the management and conservation of water resources in China have become increasingly challenging in the face of growing water demand, pollution concerns, and the need for sustainable development.

This paper delves into the current state of water resource management and protection in China, shedding light on the multifaceted issues that pose significant threats to the nation's water security. These issues encompass legal and regulatory gaps, limited environmental consciousness among industrial enterprises, insufficient investment in conservation efforts, and complex challenges related to water allocation and ecological balance.

In response to these challenges, this paper outlines a comprehensive set of strategies aimed at mitigating the water resource crisis in China. These strategies encompass the enhancement of the ecological environment, the adoption of advanced production techniques, the strengthening of management systems, the optimization

of water resource allocation, and the implementation of water-saving measures in industrial and agricultural practices.

By addressing these issues and adopting these strategies, China can embark on a path towards sustainable water resource management, safeguarding its vital water supplies, reducing pollution, and ensuring that water remains an abundant and accessible resource for its people and industries alike. In doing so, China can not only secure its water future but also serve as a model for effective water resource management on a global scale.

2. Current status of China's water resources

2.1. Lack of a comprehensive legal mechanism for water resource conservation and utilization

In China, legislation concerning water resource protection and utilization primarily resides in laws and regulations such as the “Water Law of the People’s Republic of China” and the “Law of the People’s Republic of China on the Prevention and Control of Water Pollution.” However, in practice, there are issues such as inadequate allocation and management of water resources, a lack of protection and oversight, and the misuse of administrative authority. Efforts are underway to enact relevant laws and regulations for water resource conservation.

2.2. Limited environmental awareness among enterprises

In the rapidly developing modern economy, many industrial factories release industrial wastewater and pollutants into river basins without proper treatment. With the improvement of people’s living standards, there has been a shift in priorities towards living environments that enhance the quality of life. This includes preferences for scenic areas nestled near mountains and rivers, as well as a strong emphasis on access to clean and fresh air. However, due to insufficient environmental consciousness, a significant amount of pollutants and wastewater are generated through human activities, which ultimately find their way into rivers, causing severe water pollution. Therefore, it is imperative to raise awareness of environmental protection among the public.

2.3. Low investment in water resource conservation and protection

Water resource conservation and protection efforts will be directly affected if they are not prioritized by the government. China’s current fiscal expenditure system does not include sufficient funding for water resource management and protection. Consequently, the investment in water resource management, protection, and governance is relatively low. This leads to a lack of regular replacement and maintenance of water resource management and protection equipment. This, in turn, hinders the effective development of water resources and the timely detection of water pollution. Even when pollution is identified, a lack of management funds prevents the procurement of suitable equipment for remediation.

3. Strategies to address China's water resource crisis

3.1. Improving the ecological environment

Planting trees and expanding vegetation coverage can enhance water retention. Constructing water conservancy projects with due consideration for ecological impacts, such as flood control and water storage, can be beneficial. Besides, strengthening water body protection and soil conservation is crucial for the rational distribution and utilization of water resources.

3.2. Enhancing production techniques to improve water resource efficiency

Production processes should be modified regularly to reduce water consumption per unit of product and minimize industrial water usage and wastewater discharge. Besides, traditional agricultural irrigation techniques should be improved or replaced with methods that are more advanced like using sprinklers and drip irrigation, to reduce agricultural irrigation water usage. Furthermore, it is important to develop new wastewater treatment technologies to reduce wastewater discharge. Wastewater treatment plants should be constructed to increase wastewater treatment rates, thus protecting existing usable water resources from contamination. New wastewater treatment technologies should also be developed to improve purification efficiency, reduce purification costs, and achieve wastewater recycling to increase water reuse. Furthermore, it is important to ensure that urban and regional water supply in different areas aligns with the quality requirements. Watershed water resource management principles and administrative coordination schemes should also be analyzed. Sequential and cyclical water use should be implemented for efficient water reuse. The direct use of treated wastewater creates recycled water as a secondary source, thereby alleviating water resource shortages, reducing wastewater discharge, and safeguarding the environment and water resources ^[1].

3.3. Strengthening management

The water resource management system should be improved. It involves transforming disorganized water resource management, establishing and refining corresponding regulations and systems, and advancing the scientific management of water usage. This ensures water resource assurance for sustainable development. Three compensation mechanisms under a unified management system: compensation for water consumption, compensation for water pollution, and compensation for aquatic ecosystem destruction. Additionally, three restoration mechanisms should be employed: ensuring water supply-demand balance, meeting water quality standards, and achieving water environment and ecological requirements. A regulatory framework with rules and clear responsibilities, ensuring enforcement, and accountability ^[2].

3.4. Striking a balance between economic and ecological benefits and strengthening government oversight

Government environmental regulations positively influence industrial water resource efficiency. Local governments should optimize industrial production resource allocation, adhere to supply-side structural reforms, and promote industrial transformation and upgrading. Recognizing the need for improvement in China's environmental management and evaluation systems, it is crucial to formulate a new green environmental management system centered around pollutant discharge permits. This includes enhancements to environmental laws and regulations, with a focus on resolving conflicts between industrial production and the ecological environment. This will promote continuous improvement in industrial water resource utilization efficiency.

3.5. Comprehensive consideration of potential issues in water resource allocation

From a macro perspective, when using and coordinating water resources, it is essential to comprehensively consider potential issues in resource allocation and propose scientifically sound solutions. A typical project in China for water resource allocation is the "South-to-North Water Diversion Project," which transfers water through three main routes ^[3]: the Eastern, Central, and Western routes. However, this project has its limitations. Currently, water is transferred mainly to address urban and industrial water use in northern and northwestern China, which does not fully address the comprehensive utilization of water resources. To make more efficient use of the water diversion scheme and fundamentally alleviate water shortages in recipient areas, some of the coordinated water resources can be used to restore the water environment in water-scarce regions through scientific means, gradually rehabilitating the local water ecology.

At the present level of use, there are still several issues to address:

Firstly, when water resources are used improperly, pollution may worsen, increasing the cost of ecological remediation in already water-scarce areas.

Secondly, the timing of water diversion covers the entire year, which does not guarantee sufficient water resources for allocation. Water use should not be limited to urban and industrial applications, as water is a finite resource that can also support ecological restoration, effectively addressing local water scarcity.

Thirdly, the water availability in supply areas varies unpredictably, with dry periods far outnumbering wet periods. During these times, supply areas also experience water scarcity.

Fourth, most water diversion points are in regions with fragile ecosystems and small total water flows, so the transfer may have adverse effects on the ecological stability of the upstream areas.

Lastly, when transferring water resources from supply areas to receiving areas, both regions are part of the national territory and share equal status. Therefore, addressing the interests and losses of both regions is a challenge that requires careful consideration. There may be many more issues in practice, and how to coordinate and solve these derivative problems deserves deep consideration.

3.6. Adoption of water-saving measures in industrial and agricultural production

Industrial and agricultural activities are the two major consumers of water resources in China. Therefore, implementing corresponding water-saving measures is essential in both industrial and agricultural sectors.

3.6.1. Water-saving measures in industrial production

(1) Optimizing water management practices

Strengthening water management within enterprises is a critical step in water conservation. Only by improving water management within enterprises can water resources be utilized efficiently, leading to increased production while conserving water. Industrial enterprises must ensure that water planning, water-saving targets, water-saving measures, and water management systems are effectively implemented. They should actively engage in the creation of water-saving enterprises and implement various water conservation measures effectively.

(2) Enhancing water-saving technologies within enterprises

A fundamental measure involves improving production processes to reduce water consumption, emissions, and pollution. This approach determines the amount of water required in the production process. Water-saving technologies encompass three aspects: altering production materials, changing production techniques and equipment or water usage methods, and adopting waterless production methods. Water-saving technology focuses on improving the reuse of water, with its efficiency surpassing conventional water-saving methods. However, the development of water-saving technologies often requires changes to existing production processes and may have a broader scope of application. For new construction and retrofitting enterprises, adopting water-saving technologies remains a convenient and rational approach compared to simple water recycling and reuse, making process water-saving technology a higher-level technique for water conservation.

(3) Using water recycling processes to enhance the reuse of industrial water

The reuse rate of industrial water is a crucial indicator of industrial water efficiency. According to relevant regulations, China aimed to achieve a reuse rate of over 70% for industrial water by 2010, with a recovery rate exceeding 95% for indirect cooling water^[4]. Therefore, the primary method for industrial water conservation is to develop technologies for recycling industrial water and improving

the efficiency of water reuse.

(4) Vigorously developing water-saving cooling technologies

Water is often used as a cooling agent in production processes. Water consumption in this aspect is relatively high, but the quality of the water will not be affected other than being subjected to thermal pollution. Various means should be employed to reuse it. Developing efficient water-saving cooling technologies, improving the efficiency of cooling water utilization, and reducing the amount of cooling water used are among the key priorities of industrial water conservation. Industrial cooling water accounts for over 80% of industrial water usage and 30–40% of industrial water intake^[5].

3.6.2. Water-saving measures in agriculture

According to China's agricultural water irrigation efficiency coefficient, the level of water utilization for agricultural irrigation in China is still below expectations. With years of effort, China has made some progress in improving its agricultural irrigation water use efficiency, which currently stands at 0.5. However, there remains a significant gap when compared to developed countries with coefficients exceeding 0.8. Additionally, there is a considerable disparity in water use efficiency in China's agriculture. For instance, the average water use efficiency in the canal system in Xinjiang is 0.4; while in Inner Mongolia's Hetao Plain, the canal system's water use efficiency is 0.4, and the field-level water use efficiency is 0.7. Even in major irrigation areas like Shaanxi's Guanzhong region, where water use efficiency has received substantial attention from the government, the average efficiency is only around 0.5^[6]. Therefore, there is an urgent need for the adoption of new water-saving agricultural production measures.

(1) Comprehensive consideration of agricultural water conservation

The current state of water scarcity cannot be fundamentally improved by the existing agricultural water conservation methods. The current strategy involves using the water saved from irrigation to expand the irrigated area while also drilling deep wells. This approach does not represent true resource-oriented water conservation for drought resistance, ensuring bumper harvests, and increasing grain production. Therefore, agricultural water conservation needs to be considered from the perspective of sustainable development and a more macroscopic angle.

(2) Rational planning

Analyzing the multi-year water supply resource processes, including internal storage and external water diversion systems within irrigation districts, can yield insights into the utilization of surface water resources within the irrigation district. This analysis can determine the amount of groundwater recharge from surface water and its corresponding recharge area. It can also establish reasonable extraction intensities based on the recharge methods and extraction intensity under specific mining layout conditions or determine the extraction layout within the region under certain extraction intensities.

(3) Increasing investments in agricultural water conservation

Water-saving projects should be funded through methods such as collective fundraising, farmer contributions, and government subsidies. Many projects require significant upfront investments, with limited government subsidies, so most of the funds need to be raised by farmers. However, many local residents may not have the financial capability to contribute to agricultural water conservation projects. Therefore, governments at all levels should establish systems to promote water conservation, foster a culture of cherishing and protecting water resources, and prioritize agricultural water conservation, making it an essential part of their agendas.

(4) Focusing on water-saving irrigation for low and medium-yield fields

Plans should be formulated based on local conditions, with suitable water-saving irrigation technologies, and the use of water-saving irrigation should be encouraged. Appropriate flushing quotas and water-saving technology should be developed to improve saline-alkali land water flushing, reduce alkali pressure, and improve soil quality. Simultaneously, irrigation priorities should be allocated according to field yield levels ^[7].

4. Conclusion

China, as a country facing severe water resource scarcity, is confronted with the growing contradiction between high water demand and the natural distribution of water resources. Therefore, the optimization of water resource allocation and strategic research is crucial. It is necessary to propose methods for optimizing water resource system configuration, provide management strategies and principles, and address the problems in water resource development and utilization. This will fundamentally solve the problems of water scarcity and water resource pollution that we are currently facing.

Disclosure statement

The author declares no conflict of interest.

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