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ARTICLE

RESEARCH ON DRINKING WATER SAFETY AND WATER QUALITY MANAGEMENT

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ABSTRACT

The continuous improvement of the quality of life makes the public put forward higher requirements for the drinking water quality. And the general deterioration of water environment quality makes it necessary to consider the safety of drinking water. Based on a brief introduction to the current situation of water resources in China, the paper expounds on the importance of water quality problems and the severity of water environment quality in China and points out that water quality problems not only restrict social and economic development but also directly affect drinking water safety. Also, water quality has become the main contradiction of the water resources problems in the 21st century in China. Based on analyzing the existing problems of water resources water quality management in China, this paper focuses on strengthening water resources water quality management and solutions from the aspects of laws, regulations, policies, economics, etc., also discuss the relationship between supply and demand, ensure water resources and drinking water safety.

KEYWORDS

Water quality disaster; water quality management; drinking water

1. INTRODUCTION

Since the 1980s, the water resources problems have attracted worldwide attention in China. The successive water crises in Tianjin triggered emergency Yellow River and Luan River diversion projects. Beijing has experienced several water crises. The water shortage in the (west) northern cities is because of water quantity. While in (eastern) southern cities it is because of water quality. The Yellow River and Haihe River have dried up many times in recent years. Inland rivers and lakes are gradually drying up and shrinking. Last year, the water supply in many large and medium-sized cities in my country was in emergency. Since the 1980s, the availability of water sources has been decreasing. Since the 1990s, the water quality of water sources has generally deteriorated. It has been realized that water in the 21st century will be a major issue that threatens the human living environment and social and economic development. The water resources problem is more serious and difficult to manage than the environmental problems currently plaguing various places [1], and it has become one of the core issues in the macro-decision of sustainable urban development in China [2].

This paper focuses on water quality management and discusses the relationship between strengthening water quality management and ensuring drinking water safety.

2. WATER QUALITY ISSUES

2.1 The importance and safety of water quality problems

Water quality problems affect the effective use of water resources, thereby affecting social stability and national security. Meanwhile, it

shows huge economic value. More importantly, it directly affects the health and safety of users, which is related to the improvement and enhancement of public quality of life. Therefore, the importance of water quality issues can be recognized from three aspects: availability of water resources, economic value, and safety of use. As a resource, water has two connotations of quality and quantity. As a commodity, water has value and use value. Quality and quantity influence and restrict each other. Without quantity, there is no quality; without quality, there is no quantity.

The economic value of water quality problems is mainly reflected in three aspects: the economic loss due to "quality-based shortage", the economic investment in sewage treatment, and the health loss from drinking unclean water. At present, the direct economic loss caused by water shortage in China is 200 billion yuan/a [2]. The economic losses caused by water quality problems are even greater. It is estimated that the pollution control of Dianchi Lake alone needs to invest hundreds of billions of yuan. Although it is difficult to assess the health loss caused by drinking unclean water, 80% of the disease and half of the deaths in developing countries are related to drinking unclean water [4-6]. Meanwhile, due to the potential of certain diseases, health loss will increase over time [7].

Regarding water security, Chinese scholars have discussed its connotation in recent years [8, 9], mainly including water scarcity, water quality pollution, and deterioration of the water environment. This article focuses on the safety of drinking water or domestic water quality, and its meaning includes the guarantee of water quantity and the reliability of water quality. The latter not only affects the effective supply of water but also involves the health and safety of users. It is

the primary issue of water supply and the main aspect discussed in this paper.

2.2 The severity of drinking water quality problems in China

(1) Seriously polluted drinking water sources in China

According to the international standard proposed by the United Nations Population Action Organization in 1993 that the per capita water quantity is 1000m³/a as the minimum line and 2000m³/a as the edge of water shortage. 18 provinces and cities in China are close to the edge of water shortage, and 10 provinces and cities are close to water shortage [5, 6]. However, while the water is in short supply, more serious water quality problems might be lurking.

According to the Bulletin of the State of the Environment in China in 1999, the monitoring results of the cross-sections of major water systems in my country show that only 36.9% of the river reaches or is better than the third section of the national "surface water environmental quality standard". 63.1% of the river reaches the water quality of grade IV and loses water quality, losing its function as a source of drinking water. At present, 90% of the urban river sections in China are not suitable for drinking water sources. Dianchi Lake, Chaohu Lake, Taihu Lake, and other freshwater lakes are generally eutrophic. More than 50% of urban groundwater is polluted. As a result, only 30% of urban water sources in the country meet sanitation standards, and more than 65% of the drinking water is contaminated [5]. The water condition in China has reached a very dangerous situation. Without effective measures. China might be trapped by water quality disasters shortly.

(2) The deterioration of water quality and water safety

At present, more than 65% of residents in China drink contaminated water. In some northern areas with severe water shortages, the long-term exploitation and drinking of harmful deep groundwater have caused the spread of endemic diseases such as fluorosis and thyroid disease. Due to the potential effects of water source pollution in the past, infectious diseases and intractable diseases related to drinking water have frequently appeared in China in recent years, posing a serious threat to public health. Ames mutagenicity test research shows that ①, the mutagenicity of most urban water sources in my country is positive (unsafe for human drinking). Because the traditional urban water supply turbidity removal and disinfection processes cannot effectively remove the micro-pollutants in the water, the factory water after chlorination disinfection is mostly positive. The safety of drinking water is difficult to guarantee.

Currently, around 30% of the world's population (about 1.5 billion) does not have access to safe drinking water. 80% of illnesses are related to citing unclean water. Ten million die every year because of this [5, 6]. Even in the most developed United States, the occurrence of waterborne diseases cannot be eliminated. From March to April 1993, a drinking water infectious disease caused by *Cyptosporidium* broke out in Milwaukee Wisconsin, USA [11]. More than 400,000 residents were sickened. More than 4,000 were hospitalized, and 122 died.

(3) Low drinking water quality standards in China

The serious pollution of the water environment in China makes it necessary to consider the safety of drinking water. Meanwhile, the improvement of living standards has prompted public demand for drinking water to change from quantity to quality, and it is required that drinking water should be beneficial to health. The popularity of various commercial water in the market in recent years reflects strong demand for the improvement of drinking water standards. However, the current drinking water quality standards in China require 35 testing items (revised in 1985), which is still far behind that in developed countries. For example, in the 1980s, the World Health Organization and the European Community stipulated the levels of 49 and 66 contaminants in drinking water, respectively. So far, more than 2,000 micropollutants have been detected in water at home and abroad, and China has proposed a blacklist of 68 priority pollutants [12]. A large number of trace organic pollutants with carcinogenic effects have been detected in water sources, making it urgent and necessary to add new water quality items to drinking water standards.

The above shows that the water quality problem has become the main contradiction of the Chinese water resources problem. Although there are objective reasons for the worrisome situation of water resources and water quality such as natural shortage and uneven distribution of water resources, man-made reasons cannot be ignored. Especially, the backward management of water resources and water quality shall be the direct reason.

3. THE MANAGEMENT OF WATER RESOURCES AND WATER QUALITY FOR THE SAFETY OF DRINKING WATER QUALITY

3.1 The water resources and water quality management system and the construction of water quality management institutions

Water resource management includes the development, utilization, management, and protection of surface water and groundwater. For a long time, the Chinese water resources management system has been decentralized management of multiple departments (water conservancy, electricity, transportation, urban construction, geology, mining, agriculture, etc.). Such management results in the artificial division of water resources, which leads to conflicts between departmental interests and overall interests that are difficult to coordinate. The lack of an authoritative unified management agency makes water resource management a disordered state. Water resource management includes both water quantity and water quality, but China has not established a unified water quality management agency. In 1984, the "Water Pollution Prevention and Control Law" stipulates that the national and local environmental protection departments shall supervise the prevention and control of water pollution. In 1998, "Water Law" stipulated that the water administrative department of the State Council (Ministry of Water Resources) is responsible for the unified management of water resources throughout the country. This brings up the problem of both environmental protection and water conservancy departments managing water quality at the same time. However, the water conservancy department attaches great importance to the adjustment and supply of water and ignores the ideological understanding of water quality change protection, which makes it difficult to coordinate the contradiction between it and the environmental protection department in terms of water resources and water quality. Water quality management is ineffective and weakened. Meanwhile, Chinese urban water supply and drainage institutions are separated. The contradictions between them are becoming more and more prominent.

To this end, the state must straighten out the management system and establish an effective water resource and water quality management agency. Institutional reforms below may be considered: Due to the systemic, recoverable, and regulated characteristics of water resources, the management of water resources and water quality must break the pattern of regional and departmental segmentation. A watershed management branch shall be established in the state water resources management agency. The branches of each river basin shall be responsible for the unified planning and management of the development, utilization, and protection of water resources by the characteristics of river basin water resources and the needs of social and economic development. (2) At present, there is the International Association for Water Quality (IAWQ) in the world, and the United States established the National Commission on Water Quality in the 1970s. Because of the seriousness of water quality problems in China, to strengthen water quality management and ensure water safety, a national water quality management agency can be established. (3) Urban water supply and drainage are inseparable unity in the social cycle of water. At present, the separate management mode of urban water supply and drainage in China must be abandoned. The two must be integrated for overall management.

3.2 Supplement and improvement of laws and regulations

China promulgated the Water Pollution Prevention and Control Law in 1984, and the Water Law in 1998. Since then, it has also promulgated laws and regulations such as the "Measures for the Implementation of the Water Draw Permit System" and the "Sewage Discharge Fee Collection System". However, due to the defects of these laws and regulations, they are not enough to provide a strong legal guarantee for Chinese water resources management. For example, the "system combining unified management with grading and sub-departmental management" stipulated in the Water Law does not have a clear meaning, and there

is no clear regulation on the planning, implementation, supervision, and management of water resources development, utilization, and protection. Various resources in nature are interrelated, but all the laws and regulations on water resources management in China do not specify the relationship between the development, utilization, and protection of water resources and other natural resources. Surface water and groundwater are a unified organic whole. However, there is currently no specific law on groundwater in my country, which leads to confusion in groundwater management. The disorderly and unreasonable exploitation of groundwater not only causes a series of environmental problems such as land subsidence, desertification, and ecological degradation but also affects changes in the quantity and quality of surface water.

Therefore, in the construction of water resources laws and regulations, firstly, it is necessary to revise, supplement and improve the unclear clauses or conflicting contents of existing laws and regulations. The second is to formulate comprehensive laws that can coordinate the contradictions in the development, utilization, and protection of various natural resources. The third is to formulate special regulations for groundwater exploitation, utilization, and protection. The fourth is to establish policies and regulations suitable for the development, utilization, and protection of water resources in various river basins. Fifth, special legislation on water quality issues may be considered based on the Water Pollution Prevention and Control Law. Meanwhile, it is necessary to establish and improve an effective water administrative law enforcement and judicial organization system to ensure the implementation and supervision of various laws and regulations on water resources.

3.3 Revision and improvement of drinking water quality standards

The "Sanitation Standards for Drinking Water" currently implemented in China were promulgated in 1985 and have not changed so far. There is a big gap between the number of projects required to test water quality and the standard requirements of some projects and international standards. The industry standard "Water Quality Standard for Drinking Water" (CJ94-1999), promulgated by the Ministry of Construction and implemented on March 1, 2000, provides a specification for quality water supply, but its application is limited. The types of toxic and harmful micro-pollutants in water sources are increasing. The public is paying more and more attention to health.

In the case of China's accession to the WTO, the relevant state departments should base on strengthening the monitoring of water source water quality, revise the water quality standards for a water supply according to the actual conditions and refer to international standards, and put forward the target plan for improving water quality in the future, to be in line with international standards sooner.

3.4 Establishment of a water price regulation system that reflects the economic value of water quality

For a long time, the water price policy in China has been based on state compensation. The low water price and poor management have resulted in a large per capita comprehensive daily water consumption in cities (556.1L in 1998, 1 time higher than that in developed countries in Europe and America [3]). The water consumption per unit of product output value is high. The public awareness of water saving is weak. The waste of water resources is serious. The commodity and economic value of water cannot be realized. In 1998, the State Planning Commission and the Ministry of Construction issued the "Urban Water Supply Price Management Measures", which proposed that the water price should be set so that the net asset profit rate of water supply enterprises could reach a "reasonable profit level" of 8% to 10%. However, the current situation of the overall loss of Chinese water supply enterprises shows that the total loss of the urban water supply enterprises is increasing with each passing year. From 1991 to 1997, the total amount of government subsidies to municipal public water supply enterprises reached 2.8124 billion yuan. In 1997, the total loss of the national urban water supply industry was 1.228 billion yuan if government subsidies were included [3]. At present, there are various complex water price problems in China, involving cost recovery of water supply enterprises, different demands and affordability of users for water quality, protection and utilization of water resources, etc., which need to be studied and solved urgently. This is both a cognitive problem and a management problem.

First of all, 80% of the cities in China are short of water, but the price of water is very low. The proportion of water bills in public living expenses and the cost of industrial enterprises is negligible. This violates the economic law of input and output in a market economy. The current water price only considers the supply of water and does not reflect the cost of sewage discharge or sewage treatment. The most fundamental problem is that the low water price makes it difficult for cities to use water to support water, which affects the self-development of water supply and drainage projects and the sustainable use of water resources. The safety of drinking water is not guaranteed, and the ultimate victim will be the user.

The unreasonable and perfect setting of water prices, which is an important economic control means, has greatly affected the effective management of water resources in China and has brought catastrophic consequences to many aspects of water resources development, utilization, and protection in China. It is imperative to formulate and implement a reasonable water price policy and the system as soon as possible.

3.5 Supervision and management of wastewater discharge to improve wastewater treatment and utilization

At present, the sewage treatment rate in my country is about 15%. About 100 million tons of untreated sewage is poured into rivers and lakes with toxic and harmful pollutants per day. The annual increase in urban sewage discharge and the low sewage treatment rate are the main reasons for the general deterioration of water environment quality. Under the long-term influence of the idea of valuing water supply and ignoring drainage, the development of urban drainage in my country has been slow. Although the urban municipal public sewage treatment capacity has grown rapidly in recent years, its growth rate is far lower than the growth rate of urban water supply capacity [3]. Insufficient funds and high operating costs restrict the construction and development of drainage facilities. Although China has formulated policies and systems related to drainage and sewage treatment, only some cities currently levy "sewage treatment fees", and the amount of charges is much lower than the cost of sewage treatment. The idea that "whoever causes pollution is responsible for its treatment" cannot effectively restrain polluters. The proposal that "whoever causes pollution pays bills" cannot be reasonably implemented. Meanwhile, the lack of understanding of "sewage recycling" has also led to the low utilization rate of sewage treatment. Based on global experiences, sewage can be converted into usable water resources after treatment and purification. Its effective utilization can not only alleviate the contradiction of water shortage but also reduce the pollution to the water environment and form a benign water cycle.

To solve the above problems, the focus is to increase the capital investment in the construction of drainage facilities and the rate of sewage treatment and utilization. Under the current situation of limited national financial investment, water users and dischargers should and must be the main bearers of sewage treatment funds. The collection of this fee should be included in the water price and managed and used uniformly. Also, The State shall formulate relevant laws and regulations, and policies to ensure the implementation of the comprehensive and full collection of sewage discharge fees for sewage treatment to guide and encourage the regeneration and recycling of sewage wastewater.

3.6 Effective water quality monitoring system to ensure the safety of drinking water

To solve the problem of water quality, it is necessary to first understand the dynamics of water quality accurately in real-time. Therefore, water quality monitoring is an important prerequisite for effective water resources and water quality management, and it is also the technical key to ensuring the safety of drinking water. Water quality monitoring is more difficult and complex than water quantity monitoring, and requires more advanced professional knowledge and equipment. Although China has carried out water quality monitoring in major rivers and lakes in recent years, most of them rely on manual monitoring, which is inefficient and poor in quality. An effective and extensive water quality monitoring network has not yet been established. The implementation of water quality monitoring is far from perfect. The monitoring of drinking water quality is even weaker. To this end, it may be considered to establish an authoritative organization for national water quality monitoring, which

is responsible for the monitoring and management of various water bodies in the country, including surface water, groundwater, drinking water, sewage, purified water, beverages, etc., and regularly publishes water quality bulletins to the whole country. The establishment of a nationwide practical automatic and networked system for water quality monitoring requires consideration of institutional settings, effective station networks, selection of monitoring indicators, determination of monitoring points and monitoring frequency, training of high-quality analysts, and dissemination and release of information and other factors. Although this is difficult, if there is no active and effective development of the basic work, there will be no effective water quality management in China in the 21st century, and drinking water will not be reliably guaranteed.

4. CONCLUSION

For a long time, public understanding of water resources has been more about quantity and less about quality. It only considers development and utilization and does not pay attention to protection. It only knows its use value and ignores its value. This is due to the lack of awareness of the commerciality of water and the safety of (drinking) water, and also a lack of unified planning and effective management of water resources development, utilization, and protection. There is a lot of discretion in taking and discharging water. The current serious pollution of the water environment has exposed the hidden dangers of water safety. However, due to the lack of necessary or effective water quality monitoring and management, in many cases, we are not aware of the potential impact or serious consequences of water pollution. And this can easily make us form a false sense of security. Therefore, it can be said that the "natural" shortage of water resources and the "acquired" management defects of water quality are the reasons for the severe situation of water resources in China today.

The importance and severity of the water quality problem, the high attention and concern of the party and the government to the water problem, and the strong desire of the public to put forward high standards for drinking water quality due to the improvement of the living standards of the people indicate that China will enter the era of water quality in the 21st century. The water quality problem will become the theme of the water problem in the 21st century. Strengthening the management of water resources and water quality and ensuring the safety of drinking water will become an important strategic goal of China.

REFERENCES

- [1] Liu, H. J., Jiang, Z. C., Zhao, L. H. 2000. Water Resources Problems and Countermeasures for Sustainable Urban Development in My Country. *Environmental pollution control technology and equipment*, 1, 10-13
- [2] Zhang, Z. H. 1996. Analysis and Countermeasures of Water Resources Problems in My Country. *Proceedings of the Chinese Academy of Sciences*, 1, 54-57
- [3] Zhang D. Y. 1999. Protect Freshwater Resources to Achieve Sustainable Development. *Petrochemical Environmental Protection*, 1, 1-8
- [4] Fei J. 1996. The Development Direction of Groundwater Resource Management Research. *Pre-level of Earth Science*, 3, 156-160
- [5] Cao D. 1997. *The Economics of Pollution in China*. Beijing: China Environmental Science Press, 1997
- [6] Yang, H., Luan, S. J. 1998. Water Security in The Twenty-First Century. *Environmental Management in China*, 4, 4-7
- [7] Xiong Z. W. 2000. Discussion on Water Pollution and Safety Issues. *Chinese Journal of Safety Science*, 10, 40-43
- [8] Xu B. J. 2000. On Water Quality Science and Engineering and On Water Treatment Technology in the 21st Century. 20, 1-4
- [9] Jin X. C. 1990. *Organic Compound Pollution Chemistry*. Beijing: Tsinghua University Press, 5, 22-24
- [10] Wang Z. S. 2000. Water Supply by Quality And "Water Quality Standard for Drinking Water". *Water Supply and Sewerage*, 26, 74-75.
- [11] Song X. T. 2000. Development Characteristics and Countermeasures of Urban Water Supply and Drainage in China. *China Water Supply and Drainage*, 16, 21-25
- [12] Chen J. S. 2000. Advances in Research on Changes in Terrestrial Water Quality at Home and Abroad. *Journal of Environmental Science*, 20, 10-13.

