

Commentary

The Safety of Drinking Water in China: Current Status and Future Prospects

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Editorial The idea for a world day for water was proposed in 1992, the year that the United Nations Conference on Environment and Development in Rio de Janeiro took place. That same year, the United Nations General Assembly adopted a resolution by which March 22 of each year was declared World Day for Water, to be observed starting in 1993. Since then, March 22 became an international day that focuses on the importance of freshwater. The theme of World Water Day 2020 is about water and climate change and how the two are inextricably linked.

Climate change will have a direct impact on precipitation, evaporation, and other hydrological factors and will change the global hydrological cycle, thus leading to the spatial and temporal redistribution of water resources, causing a series of water safety issues. With rapid socioeconomic development and urbanization over the past 40 years, China's water environment situation has become increasingly complex, and the health impact of water safety has become one of the important public health issues. Access to safe drinking water is an important basis for population health.

The Chinese Government issued the Action Plan for Prevention and Control of Water Pollution (the State Council, 2015) to strengthen the prevention and control of water pollution and ensure drinking water safety. The Outline of the "Healthy China 2030" Initiative addressed the importance of enhancing health risk assessment systems in environmental health issue.

On the World Water Day 2020, *China CDC Weekly* launch the commentary, summarizing the status of the hydrological environment and the actions taking place to protect drinking water in China and discusses the prospects on challenges of climate change and drinking water safety that China may face in the future.

Water safety refers to the ability of a state or a region to obtain needed water resources and water resource products and the ability to maintain sustainable ecological practices to protect the environment. The current state of water safety in China could be characterized by challenges in water scarcity, uneven distribution of water resources both spatially and temporally, and poor water quality (1).

Therefore, China will experience severe water stress based on shortages in the availability of water and the quality of water in the near future. Besides taking measures to reduce global warming and fighting against water pollution, China should address the issues of drinking water scarcity and safety, conduct health risk evaluation and management, improve the environmental health surveillance, establish health risk assessment systems, and focus on major public health issues that emphasizes the crucial transition from data monitoring to health risk assessment.

In this paper, the status of the water environment and the actions taking place on drinking water in China are summarized. Finally, the prospects on challenges of climate change and drinking water safety we may face in the future are discussed.

CURRENT STATUS OF THE WATER ENVIRONMENT

The total volume of freshwater resources in China is 2.8 trillion cubic meters, accounting for 6 percent of global water resources and ranking fourth in the world behind Brazil, Russia, and Canada. However, China's water resources are estimated to be only 2,000 cubic meters per capita, a quarter of the world's average level. China, with a large area, varied topography, and an uneven distribution of water resources, has been listed as one of the 13 countries with a water shortage by the United Nations (2).

Pollution also exacerbates water scarcity in China. Discharge of industrial wastewater, domestic sewage, agricultural hazardous pesticides and manure has

polluted the surface water and ground water. According to the 2018 “China’s Water Resource Bulletin” (Ministry of Water Resources 2018) (3), only 81.6% of the rivers, 25.0% of lakes, 87.3% of reservoirs, and 23.9% of shallow groundwater met the criteria for drinking water supply sources. In 2018, the Ministry of Water Resources evaluated 1,045 centralized drinking water sources from 31 provincial-level administrative divisions (PLADs) and found that the percentage of water sources for qualified centralized water supply was 83.5%. Even southern China, with relatively well-stocked water resources, also faced scarcity issues for providing safe and clean drinking water (3). In addition, given the rapidly developing economy, more and more newly-emerging contaminants are attracting widespread public attention. The effects of perfluorinated compounds (PFCs), pharmaceutical and personal care products (PPCPs) on drinking water quality also cannot be ignored.

Due to the increasing population and accelerated urbanization, the demand for safe drinking water is also rising. In 2018, water consumption was 225 L/day in urban areas and 89 L/day in rural areas compared with an average water consumption per capita (>350 L/day) for Japan and the USA (1). Currently 59.6% of China’s population lives in cities and the demand for drinking water is expected to increase significantly as urbanization progresses (4). The population of China is predicted to arrive at the peak in 2030, and alarmingly, the annual per capita water resources will drop to 1,760 m³, only 4% higher than the water stress threshold (1,700 m³/year) (1).

Safe drinking water is closely related to public health. Currently, 5.5% of reservoir water sources and 16.1% of the lake water sources in China are not compliant with regulations (5). Water purification technology is relatively out of date. Many companies still use the conventional water treatment processes and some even have no water treatment measures. There is also secondary pollution risk because of aging water supply networks. Byproducts of disinfection affect water quality, and drinking water quality compliance rates must continue to be improved (6).

Global climate change is inextricably linked to water as it increases the variability of hydrological cycle, induces extreme weather events, affects water quality, and threatens sustainable development and biodiversity worldwide (7). Under the changing climate, extreme weather events are making water scarcer, more unpredictable, and more polluted. Action plans to

tackle climate change need to be integrated with different disciplines and coordinated across different sectors. They must have one thing in common: safe and sustainable water management.

HEALTH RISKS OF WATER POLLUTION

Surveillance data from the National Health Commission of China show that the reported number of incident cases of national notifiable infectious diseases in 2018 was 7.8 million, including 18.9% water-borne diseases (4). Fluorosis due to drinking water and arsenic poisoning still threaten Chinese residents’ health. According to 2018 China’s Health Statistics Yearbook, there were 77,292 villages with fluorosis due to drinking water nationwide, which represents 2.1% of all villages in China. Although the number of drinking water arsenic poisoning patients has declined since 2011, China still had 2,667 villages with drinking water arsenic poisonings by the end of 2018, with an exposed population of 1.6 million (4).

Villages with high-relative prevalence of cancer in the Huai River Basin are a major health issue, drawing huge public and media concern in recent years. Among the 14 counties in key areas of the basin, cancer deaths were found to be at low or normal historical levels in 1970s according to total cancer mortality and its changes over the last 30 years. However, presently, cancer mortality is high. For example, Yingdong District in Anhui Province, Shenqiu County in Henan Province, and cities in Hubei Province experienced significant increases in cancer mortality over the past 30 years with rates as high as 9.27, 7.14, and 2.71 times the national average, respectively (8). In 2013, a book named Atlas of the Huai River Basin Water Environment and Digestive Cancer Mortality (9) was published. A review of variation in trends in the causes of death in the Huai River Basin over the past 30 years showed that the areas having the most polluted water for the longest time were precisely the areas with the highest increase in digestive-system cancer deaths. The increase of mortality was several times than that of the national average increase for the respective cancers. Spatial analysis shows a high level of correlation between the seriously polluted areas and areas with high mortality from cancer (9).

ON-GOING ACTIONS ON DRINKING WATER SAFETY

In recent decades, climate change has had a

profound impact on the global natural ecosystem and human society and brought human health risks on water shortages and pollutions. It is necessary to pay more attention to water safety problems. Faced with this challenge, some critical actions have been taken in China.

Treatment of Water Pollution and Protection of Sources of Water

The State Council promulgated and implemented the Action Plan for Water Pollution Prevention and Control (“Water” in Article 10) in 2015 (10), which clarified that the local governments are the main body and responsible for the improvement of water pollution. The Ministry of Ecological Environment, in conjunction with other ministries, guided the local governments to implement the “Water” in Article 10. Until 2017, prefectural cities, provincial capitals, and municipalities directly under central government control have completed goals to ensure no large floating objects appeared on river surfaces, no garbage appeared on the river banks, and no illegal sewage was discharge. In addition, the percentage of black and odorous water is to be reduced to less than 10% of all water resources by the end of 2020.

For the protection of sources of drinking water, laws and regulations have been basically established including the Water Law, “Water” in Article 10, the Regulations on the Prevention and Control of Pollution in Drinking-Water Source Protection Areas, Regulations on the Urban Water Supply, Measures for Supervision and Administration of Drinking Water Hygiene, and the Standards for Drinking Water Quality. The protection of drinking water sources is mainly subject to compulsory management by all-levels of government. All provinces, cities, and counties have implemented water protection measures based on their actual conditions and level of pollution.

Surveillance of Water Quantity and Quality

The Ministry of Ecological Environment and the Ministry of Water Resources are responsible for monitoring the quantity and quality of water in the environment including surface water and groundwater, production of domestic water, and emergency incidents, and seawater and freshwater resources. The extensive surveillance of the quantity and quality of water provides data and information for environmental management and also provides a basis for quality

assessments of river and marine water.

The National Health Commission is responsible for monitoring drinking water quality. At the end of 2018, China’s monitoring of drinking water quality in urban and rural areas had basically covered all prefectures, counties, and 90% of towns and townships, and aims to cover all townships and towns by 2020. In addition, the quality of drinking water in urban and rural areas has been significantly improved in recent years, especially in rural areas (11). In 2018, the National Health Commission, in collaboration with other ministries, launched a revision of the standards for drinking water quality, which is expected to be released and implemented in 2020.

Centralized Water Supply and Rural Drinking Water Safety Projects

Currently, centralized water supplies have basically covered all urban areas and most rural villages and townships in China providing continuous and qualified domestic water for urban residents (12). For remote rural areas, where residents usually live separately, China launched a project to consolidate and improve the safety of drinking water in rural areas, giving priority to solving the problem of drinking water safety for the poor. In this rural drinking water safety project, a total of 14.3 billion CNY had been invested by the central government, and a total of 100.2 billion CNY had been invested in all localities, which helped to improve the safety of drinking water for 136 million people. The main goal of this project is to comprehensively solve the problem of drinking water safety for the poor by 2020. Besides, centralized drinking water supply and disinfection of drinking water has been promoted in rural areas with better economic conditions, but the coverage rate of the centralized water supply is still lower than that in cities (11).

Surveillance of Water-borne Infectious Diseases

The morbidity and other related statistical data of urban and rural water-borne diseases were collected for health surveillance through the information system for infectious diseases and all-cause disease surveillance. In the national notifiable infectious diseases, for example, cholera, typhoid and paratyphoid, bacterial and amoebic dysentery, viral hepatitis (A and E), and other infectious diarrheal diseases could be spread by water. Effective surveillance could provide a scientific basis for

formulating strategies for the prevention and control of water-borne infectious diseases

Health Risk Assessment and Management of Drinking Water

As human health and the safety of drinking water are severely threatened, China has established national monitoring systems of environmental health and risk assessment since 2016. The current risk assessment system for human health has been transformed from single element assessment focus to a multi-elemental, multi-approach, and multi-disciplinary assessment. In 2018, the National Health Commission started a new round of revisions for drinking water standards, which introduced the environmental health risk assessment to set the limit value of the standard. In 2019, the National Institute of Environmental Health of China CDC, launched the pilot project on environmental health risk assessment under the leadership of the National Health Commission. The aims and goals of this pilot work were to understand the present situation of environmental health risk assessment and to build an environmental health risk assessment system in China, which would demonstrate and apply relevant technologies including methods and products in pilot provinces and cities. In 2020, we will conduct a drinking water-related health risk assessment in the pilot areas using monitoring data and a developed risk-assessment package. The findings of this pilot project will greatly enhance China's drinking-water health risk assessment technology. In doing so, corresponding measures may be taken for integrated water treatment and pollution control.

SUGGESTIONS ON THE NEXT STEPS FOR DRINKING WATER SAFETY

Water Safety Measures under Climate Change

With an increasing impact of human activities on climate change, measures should be taken to slow down climate change and improve the ability of human beings to cope with water safety problems. The fundamental way to mitigate climate change is to conserve available energy, develop alternative energy, and reduce greenhouse gas emissions. According to the current challenges of water shortages and uneven distribution of water resources in China, opening new

water sources, reducing resource expenditure, and improving utilization rates of water resources is necessary. In addition, it is necessary to monitor the hydrology and water quality of rivers and lakes in real time. We need to enhance the development and utilization of water resources through further research of the environment, function, and structure, the interactions among the components of the aquatic ecosystem, and the implementation of the real-time early warning and prediction systems for water safety.

Supporting Scientific Research on Water and Climate Change

Climate change will have a direct impact on precipitation, evaporation, surface runoff, and soil moisture and will affect the status of the global hydrological cycle causing spatial and temporal redistribution of water resources. Further research on the impact of climate change on water, such as studying the formation mechanisms of extreme weather events on flooding, could provide a scientific basis for the rational utilization of water resources and sustainable development of the economy and society. Epidemiological studies to understand the relationship between water pollution and health and new technology and other innovations for improving the water supply and water treatment are especially needed to address the water safety issue under the changing climate.

Formulating Laws and Regulations on Environmental Health Risk Assessment and Management

The lack of a structured scientific designs, macro-level policies, and coordinated mechanisms to respond to environmental health problems at the national level must be addressed and strengthened. Although there has been successive promulgation of a series of laws and regulations dealing with prophylaxis and control of environmental pollution, we lack effective approaches to tackle health problems. There are several prominent problems in the field of environmental health. First, the construction of environmental health monitoring and scientific management is lacking and the monitoring methods are not uniform. Second, there is a shortage of strategies for addressing emergency health issues in environmental pollution. Lastly, the environmental health information disclosure system is very new and lacks an extensive public participation mechanism. In addition, China's environmental health

field does not sufficiently emphasize long-term, continuous, and systematic research-based data collection plans.

Enhancing National Drinking Water Monitoring and Establishing Relevant Health risk Assessment Systems

Departments related to drinking-water safety should strengthen infrastructure construction and drinking water treatment technology, gradually improve the monitoring network for drinking water and the ability to respond to emergency situations of drinking water pollution. Regulation of drinking water hygiene and health risk assessments and drinking water safety should be also strengthened (12). In particular, safe management of urban centralized water supplies and engineering quality control should be prioritized. Rural drinking water monitoring work should also be implemented. We should advance implementation strategies prioritizing health prevention and protection and focus on improving waterways with high fluoride, high arsenic, and high iodine.

The comprehensive environmental health monitoring and health risk assessment should be performed in representative cities, provinces, regions, and countrywide. It is essential to construct basic environmental and health interdisciplinary datasets, select nationally representative environmental and health monitoring sites, collect environmental and health data, and establish a comprehensive environmental and health monitoring data center. Data analysis and forecasting/warning software platforms should be utilized to augment related research in environmental health risk assessment and early warning mechanisms of drinking water quality with a focus toward human health. Finally, nationwide environmental health risk assessment systems should be built in China through pilot work conducted in representative areas.

Coordination of Environmental and Health Departments at National and Local Levels

Multi-sectoral coordination mechanisms of environmental health institutions should be established and improved, especially for water safety-related ministries. Furthermore, it is their responsibility to allocate responsibility, obligations, and working procedures to improve the quality of drinking water

and responding to emergency situations. This should be done for all levels of water agencies based on their function, work base, and technical advantages. The Ministry of Ecological Environment, Ministry of Water Resources, Ministry of Housing and Urban-Rural Development, and the National Health Commission collaborate to enhance the safety of drinking water and are responsible for organizing and coordinating the management of drinking water nationally. They develop laws and regulations on sanitary standard for drinking water, quality monitoring, information management, risk assessment, and tackling environmental pollution.

Establishing an Emergency Water Supply System

The urban emergency water supply system plays an irreplaceable role in dealing with water emergency issues, such as severe water shortage and major water pollution. Therefore, the emergency water supply system should be incorporated into urban infrastructure construction and the planning of water resource development on the basis of local water resources and water safety status.

Expanding Awareness Through Publicity, Information Exchange, and Health risk Communication

The potential of environmental health promotion and education should also be considered to increase public awareness of environmental health and drinking water safety. Other suggestions include conducting national surveys on knowledge, attitudes, and practices (KAP), compiling scientific health hazard materials from experts regarding pollutants, raising public awareness of health protection, and establishing environment and health interfaces. This will lead public efforts toward the understanding of environmental indicators and scientific regulations and standards. It is also essential to establish a public environmental health information exchange platform for risk communication to address environmental health issues of great social concern, thereby enhancing the evaluation of environmental health risks and reducing public panic.

On World Water Day 2020, we should call for the following: First, we cannot afford to wait, and climate policy makers must put water at the heart of action plans. Second, water can help fight against climate change through sustainable, affordable, and scalable water and sanitation solutions. Finally, everyone can

play a role in taking surprisingly easy steps to address climate change in our daily lives.

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