Problems and Countermeasures in Protection of Drinking Water Sources in Hubei Province

Xin Lin1*, Ji Zhang2

1 Hubei Province Engineering Consulting Co., LTD., Wuhan, Hubei, 430071, China
2 Yangtze River Water Resources Protection Scientific Research Institute, Wuhan, Hubei, 430071, China

*Corresponding author’s e-mail: 754726516@qq.com

Abstract. This paper introduces the current situation of drinking water sources in Hubei Province, and points out that in the new period of harnessing the Yangtze River, the drinking water sources are faced with prominent contradictions such as low annual water consumption and prominent non-point source pollution. At the same time, the emergency standby water source is insufficient, and the water production technology of water supply enterprises needs to be improved. In order to ensure the optimal allocation and rational utilization of water resources, some suggestions are put forward, such as controlling the non-point source pollution system, actively promoting the construction of standby water source, and timely upgrading the water supply treatment process of water plants.

1. Basic situation of drinking water sources in Hubei Province

1.1. Surface water quality
Most of the drinking water sources in Hubei Province are rivers and lakes and reservoirs, and the surface water environment directly affects the quality of drinking water sources. In 2018, there were 179 surface water monitoring sections in the province, and the proportion of sections with good water quality was 89.4%; the water quality of 20 monitoring sections in the main stream of the Hanjiang River were all Grade I to II, and the overall water quality of the main stream of the Hanjiang River remained stable; the overall water quality of the main stream and tributaries in the Danjiangkou reservoir area It is excellent. 91.7% of the 24 sections are of class I-III water quality.

1.2. Quality of drinking water sources
There are 147 centralized drinking water sources above county level in Hubei Province (including 87 river type water sources, 58 lake reservoir type water sources and 2 groundwater type water sources). Among them, there are 33 urban water sources and 114 County water sources. There are 129 centralized drinking water sources in use (the rest are standby or out of service).

According to the monitoring data from the Department of Ecological Environmental of Hubei Provincial in 2018, there are 39 water plants and 36 centralized drinking water sources in 13 key cities of the province, quality of all water sources is up to standard; there are 103 centralized drinking water sources in county-level cities and towns in 13 cities, 3 cities directly under the jurisdiction of the province and Shennongjia forest region, quality of all water sources is up to standard.
2. Protection status of drinking water sources

2.1. Implement the strictest water resources protection and management system
Hubei Province has implemented the most rigorous water resources management system in the Hanjiang River Basin, clarifying the "three red lines" indicators for the total water consumption, water efficiency, and pollution control of water function zones in the Hanjiang River Basin. Assessment results are used in the assessment of provincial management cadres by the Department of Organization and Off-Office Auditing of Cadres of natural resource.

In view of the lack of water from Hanjiang River in recent years and the formal transfer of water from the middle route of South to North Water Diversion, the Department of water resources and the Department of Ecology Environment have established an emergency linkage mechanism for water pollution of Hanjiang River, and carried out the study on water resources protection planning of Hanjiang River Basin. It is planned to protect, treat and allocate the water resources of Hanjiang River as a whole, and minimize the impact of water diversion on the ecological environment of the middle and lower reaches of the Hanjiang River.

2.2. Improve the delineation of drinking water source protection zones
Since 2018, in accordance with legal requirements and relevant technical specifications, protected areas have been designated for centralized drinking water sources at the county level and above in the province. For centralized drinking water sources at or above the county level in the whole province, vector maps of protected areas have been drawn, and clear geographic landmarks and obvious warning signs have been set up on the boundaries of protected areas. Set up isolation protection facilities and monitoring facilities as required.

2.3. Remediation of environmental problems in drinking water sources
Comprehensively investigate whether there are sewage outlets, illegal construction projects, illegal cage culture and other problems in the primary and secondary protection zones of drinking water sources. In 2018, through three rounds of national and provincial investigations, 272 outstanding environmental problems in centralized drinking water source protection zones above county level were cleared, and the problem list was established and made public.

![Figure 1. Natural inflow of different series of Danjiangkou reservoir (billion m³)](image)
3. Water source protection in the new era

3.1. The Han River's runoff varies greatly from year to year, and the contradiction is prominent in the dry year

The annual average natural inflow runoff of Danjiangkou reservoir from 1956 to 2016 is 37.4 billion m³, but the annual average runoff in recent ten years (1999-2016) is only 34.1 billion m³, which is 4.7 billion m³ less than that of long series.

Due to the large inter-annual variation of Danjiangkou Reservoir's inflow, if there is a dry year, Danjiangkou will reach its maximum load in a series of water diversion projects such as the first phase of the South-to-North Water Transfer Project, the Shanxi River Diversion Project, and the North Hubei Water Resources Allocation Project. The amount of water released from the reservoir to the lower reaches of the Han River will be significantly reduced, which will put great pressure on the water intake and water quality assurance of the mainstream downstream.

3.2. The impact of non-point source pollution is prominent, and water blooms occur frequently

Although the annual average water quality of 129 drinking water sources above county level in Hubei Province is up to the standard, the water quality indexes of water sources in the year and month still fluctuate.

Rural non-point sources, especially livestock and poultry breeding and aquaculture, have the most significant impact on the water quality of drinking water sources. In the rainy season, pollutants are washed into rivers and lakes, which is the most obvious period of water quality decline in drinking water sources.

Since the 1990s, algal blooms have been recorded in the middle and lower reaches of the Hanjiang River. Around February each year, the algae density in the middle and lower reaches of the Hanjiang River will increase significantly. At present, 11 representative water blooms have occurred. The main characteristics of the previous blooms are shown in Table 1.

| Year | Month | Place | Dominant population |
|------|-------|-------|----------------------|
| 1992 | Mid-February to early-March | Qianjiang to Wuhan | Diatom(Cyclotella) |
| 1998 | Mid-February to early-March, early and middle April | Xiantao to Wuhan | Diatom Green algae |
| 2000 | Late-February to mid-March | Qianjiang to Wuhan | Diatom, Green algae, blue-green algae |
| 2003 | Late-January to early-February | Xiantao to Wuhan | Diatom(Cyclotella) |
| 2008 | Late-February | Dongjing river | Diatom(Cyclotella) |
| 2009 | Early-January to late-January | Xiangyang to Wuhan | Diatom(Sargassum coronatum) |
| 2015 | Mid-January, mid-February | Downstream of Shayang | Diatom(Cyclotella) |
| 2016 | Early-March | Shayang, Zhongxiang and Qianjiang sections | Diatom(Cyclotella) |
| 2018 | Late-February and early-March | Downstream of Shayang | Diatom(Cyclotella) |
| 2019 | April | Jiefangshan reservoir | Gymnosperms |

The algae density increased significantly in a short period of time, which was closely related to the nutrient concentration (total nitrogen, total phosphorus), river water velocity, water temperature and other conditions. Although diatoms and naked algae blooms are non-toxic, taking water during the bloom will lead to water pump blockage, obvious changes in water colour and smell, which will bring about sensory discomfort and cause drinking water safety incidents.

Generally, in order to deal with the problem of water bloom, Danjiangkou reservoir increases the discharge or diverts water from the Yangtze River to the Han River. However, from the dispatching situation, it is found that the discharge of Danjiangkou has increased from about 500m³ / s before 2014 to 800-1200m³ / s in 2018 and 2019, and the downstream Xinglong hydropower station should
According to the relevant research on the causes of Hanjiang River water bloom from February to March 2018, after the water flows through Xiangyang from Danjiangkou reservoir area, the contents of ammonia nitrogen and nitrate nitrogen in yujiahu section have increased to a certain extent, which indicates that Xinglong reservoir area has accepted a part of upstream pollutants, including the sewage from Xiangyang and other upstream cities. The content of nitrogen and phosphorus in Xiantao and Jijiazui (estuary) also increased gradually. It can be seen that the middle and lower reaches of Hanjiang River are suffering from the non-point source pollution along the river.

The root cause of water bloom in the main stream of Hanjiang River is eutrophication in the middle and lower reaches of Hanjiang River. Therefore, in the current situation, we should strengthen the prevention and control ability of non-point source in the basin, and promote the effective control of non-point source pollution along the Hanjiang River.

3.3. The emergency standby water source is insufficient, and the environmental risk prevention and control ability is poor

There are 129 centralized drinking water sources above the county level in the province, and only 8 reserve water sources. 56 counties did not build standby water sources, including Jingzhou, Huanggang, Ezhou, Xiangyang, etc. Among them, Tianmen, Qianjiang, Xiantao and other counties and cities have a single water source. Due to the sudden environmental risk in some river sections, the water plant can only be forced to stop water supply, and the drinking water can only be solved by water truck supply and combined water supply, resulting in negative public opinion.

3.4. Water making process of water supply enterprises needs to be upgraded

At present, only in Wuhan and Jingzhou, the waterworks are equipped with algae removal, desalination and desalination processes. The water production processes of other water plants are basically at the basic treatment level of coagulation sedimentation filtration disinfection, which can not cope with the increase of algae concentration in river channels before and after the Spring Festival every year. Fishy smell in tap water is a common phenomenon, and these basic processes are also difficult to adapt the fluctuating state. The phenomenon of high salinity and residual chlorine in the effluent is common. It is difficult to meet the people's growing needs for a better life.

4. Suggestions on the protection of drinking water sources in the new period

4.1. Improve the ability of optimal allocation of water resources in the Hanjiang River

On the basis of guaranteeing the water quality of Danjiangkou Reservoir, in view of the current situation of large inter-annual runoff changes in the Hanjiang River, fully consider the water demand of the upper and lower reaches of the Hanjiang River in the Danjiangkou Reservoir area in dry years. It is suggested to actively promote the implementation of water diversion and replenishment project, increase the water resources of Hanjiang River and relieve the pressure of water resources allocation of Hanjiang River.

Based on the extremely dry year, especially under the extreme weather conditions of South to North Water Transfer Project, Hanjiang River water diversion project to Weihe River, and North Hubei water resources allocation project, the joint dispatching scheme is formulated, taking into account the water demand of upstream and downstream. In view of the high concentration of algae in the middle and lower reaches of Hanjiang River in the first quarter, the emergency operation of Xinglong project was carried out to increase the discharge, reduce the water level of the reservoir, and raise the water surface velocity of the lower reaches of the Hanjiang River, so as to control the propagation of algae.

Give full play to the ecological benefits of the existing water resources compensation project. There is a water diversion project under Xinglong of Hanjiang River. At present, the project has been
completed for nearly four years and has transferred 11.819 billion cubic meters of water, effectively replenishing the water reduced by the middle route of South to north water transfer. Next, according to the demand of water quantity, water environment and water ecology in different periods in the lower reaches of Hanjiang River, the project scheduling scheme should be optimized to give full play to the ecological and environmental benefits.

4.2. Strengthen risk control and carry out systematic control of non-point source pollution
To further strengthen the monitoring of drinking water sources, 129 drinking water sources above the county level have planned automatic water quality monitoring facilities (49 automatic monitoring stations have been built, and 80 more need to be built). Warning and monitoring sections should be set up in the upstream of water sources where "water blooms" are easy to occur and where risk sources (points) are complex.

It is suggested to systematically promote rural non-point source control, conduct a general survey of livestock and poultry pollution in the whole province, and formulate pollution prevention and control plan in rainy season.

4.3. Actively promote the construction of reserve water source
Department of Housing and Urban-Rural Development of Hubei Province issued a document in May 2019, requiring cities with a population of more than 200000 to build standby water sources. In order to promote the work actively and orderly, it is suggested that the Development of Housing and Urban-Rural should take the lead to set up a working group for the construction of standby water sources, with the Department of Water Resources, the Department of Ecology and Environmental, the Water Authority and other relevant departments as members. Among them, the Department of Water Resources shall implement the site selection of the standby water source as soon as possible, the Department of Ecology and Environmental shall be responsible for the water quality assessment and later supervision of the reserve water source area, and the Development of Housing and Urban-Rural and Water Resources shall implement the construction scheme of the reserve water source.

4.4. It is suggested to improve the water treatment process of water plant
In order to ensure the effluent quality and cope with the rising algae concentration in the dry season, it is suggested to install high potassium chloride and powdered activated carbon dosing equipment in water plants that take water from the main stream, tributaries, lakes and reservoirs of the Hanjiang River.

It is suggested that the waterworks with a daily water supply scale of 50000 tons or above should be improved, and the functions of softening, desalination, nitrogen and phosphorus reduction should be added to improve the water quality.

It is suggested to strengthen public publicity, improve the water price adjustment and pricing mechanism, and fully mobilize the enthusiasm of water plants and water companies.

5. conclusion
The drinking water sources in Hubei Province are still facing some problems. Including the shortage of water resources, water pollution factors not eliminated, low risk prevention ability and so on. It is suggested to promote the implementation of various guarantee and treatment measures, gradually eliminate the potential water safety hazards in drinking water sources, and provide more reliable water supply guarantee for the masses.

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