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Protection Planning for Rural Centralized Drinking Water Source Areas in Chongqing

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Abstract Protection planning is made for rural centralized drinking water source areas according to current situations of rural drinking water and existing problems of centralized drinking water source areas in Chongqing, and in combination with survey, analysis and evaluation of urban-rural drinking water source areas in whole city. There are engineering measures and non-engineering measures, to guarantee drinking water security of rural residents, improve rural ecological environment, realize sustainable use of water resource, and promote sustainable development of society. Engineering measures include conservation and protection of water resource, ecological restoration, isolation, and comprehensive control of point-source and area-source pollution. Non-engineering measures include construction of monitoring system for drinking water source area, construction of security information system for rural centralized drinking water source area, and construction of emergency mechanism for water pollution accidents in rural water source areas.

Key words Rural areas, Water source areas, Drinking water security, Water resource protection, Protection

In October 2005, the Fifth Plenary Session of the Sixteenth Central Committee of the Party called for new socialist countryside construction, finally to build rural areas into new civilized and harmonious socialist countryside with prosperous economy, perfect facilities, and beautiful environment. During construction of this goal, the water resource security of rural drinking water source areas is the basic condition for promoting social economic development, improving human quality, and stabilizing social order. In December 12, 2007, in line with gist of documents of the Party Central Committee, Chongqing Municipal Government worked out important strategy of "Livable Chongqing, Forest Chongqing, Safe Chongqing, Smooth Chongqing, and Healthy Chongqing". The water resource security issue of drinking water source areas becomes more important. Safeguarding people's drinking water security is the basic precondition of construction of the above "Five Goals of Chongqing", also one of important contents in the Twelfth – Five Plan of Chongqing's Water Conservancy Reform and Development, as well as specific indication of central No. 1 document of 2011. Protection of rural drinking water source areas plays a significant role in guaranteeing drinking water security of rural residents, realizing sustainable utilization of water resource and sustainable development of economy, and promoting integrated urban-rural planning.

1 Current situations of rural drinking water in Chongqing

Chongqing City has 40 districts, including 19 municipal districts, 17 counties and 14 autonomous counties. The survey of rural drinking water source area in 39 districts and counties of

Chongqing (excluding Yuzhong District that has no rural people) indicates that the total population of 39 districts and counties is 23.696 6 million, the population that has received water up to 5.400 3 million, population with centralized water supply up to 2.217 7 million, respectively accounting for 22.79% and 9.36% of total rural population; among people with decentralized water supply, 9.285 7 million people receive water with aid of facilities and 5.025 9 million people receive water without help of facilities, separately taking up 39.19% and 21.21% of total rural population^[1].

Among 7 975 rural drinking water source areas, surface water source takes up 44.63% and ground water source accounts for 55.37%. The total rural population of 39 districts and counties is 23.696 6 million with 9.92 million people (41.86%) drinking unsafe water. Among people drinking unsafe water, 4.099 9 million people are resulted from water quality below the standard; 5.820 1 are caused by convenience degree and water source guarantee rate, respectively accounting for 17.30% and 24.56% (Fig. 1) of total rural population. Areas with drinking water quality below standard mainly include Kaixian County, Fengjie County, Yongchuan County, and Tongliang County; areas with low water source guarantee rate mainly include Tongnan County, Kaixian County, Liangping County and Pengyong County.

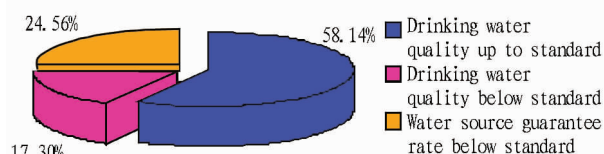


Fig. 1 Proportion of people with drinking water quality up to standard

It is shown that the proportion of rural people drinking wa-

ter exceeding standard is relatively large, mainly fecal coliform group exceeding standard and excessive manganese and fluorine. Most water supply projects lack water purification facilities, and only 17.96% ones are provided with such facilities. The population is up to 2.158 million for drinking water with excessive fecal coliform group exceeding standard. Manganese (>0.5 mg/L) and fluorine (>1.2 mg/L) are major ones of containments, and population of people drinking water with manganese and fluorine respectively up to 0.546 5 million and 0.324 5 million; and about 0.225 6 million people drink water with excessive iron (>1.0 mg/L). Water source areas of water containing excessive manganese are mainly in Wuxi County and Fuling County, and that of water containing excessive fluorine mainly in Wuxi County and Bishan County.

2 Existing problems in rural drinking water source areas

Rural drinking water source areas of Chongqing mainly include surface water source areas and underground water source areas. Pollution is the major problem faced by rural drinking water source areas, most secondary rivers in districts

and counties have small average annual flow rate. Self-cleaning capacity of water body is vulnerable to pollution of industrial and domestic pollution source and area source pollution. As a result, water quality in some water source areas is low.

Water quality of reservoir type water source areas is polluted mainly because: firstly, reservoirs are situated in rural areas. Pesticides and fertilizers applied on farmlands and residues on surface of land are washed and flow to reservoirs along with surface run-off. Such pollutants as total phosphorus (TP) and total nitrogen (TN) exceed standard. Secondly, rich water fish feeding and chicken and duck raising in some reservoirs lead to serious pollution of water quality, and TP, TN, CODmn, and fecal coliform group exceeding standard. Thirdly, Chongqing has high temperature and strong sunlight, which are favorable to growth of chlorophyll. In addition to slow water flow and long time of replacement in reservoirs, pollutants are easy to build up, consequently leading to deterioration of water quality of reservoirs^[1]. In view of the above reasons, water quality of some reservoir type water source areas is lower than Category II water standard, and some even equal to or lower than Category IV water standard.

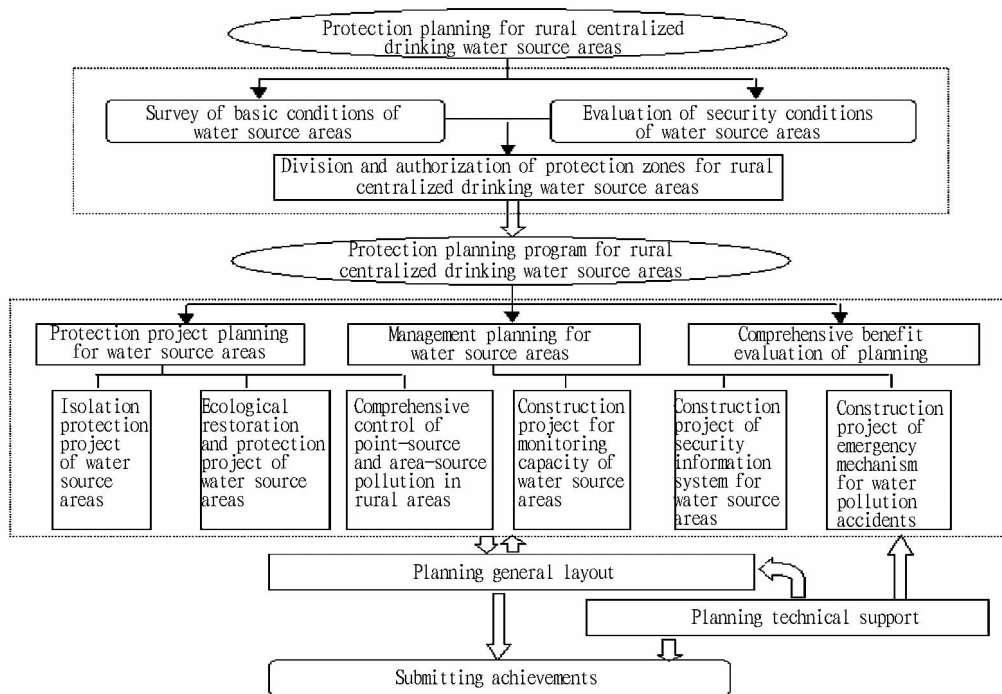


Fig.2 Technical road map of protection planning for rural centralized drinking water source areas

3 Protection planning for rural centralized drinking water source areas

On the basis of current situations of rural drinking water source areas in Chongqing, the protection planning for rural centralized drinking water source areas was prepared during June 2008 to October 2010. This plan covers an area of over 500 people and 2 929 rural centralized drinking water source areas, including 969 river channel water source areas, 961 small reservoir water source areas, and 999 underground water source

areas. Technical road map of the plan is shown in Fig.2.

3.1 Security of water resource in drinking water source areas

According to evaluation results of rural drinking water security evaluation index system carried out by Hou Xin *et al.*, only some districts and counties have high security of rural drinking water source areas, accounting for 18%, and up to 39% districts and counties have the problem of low security of water source areas^[2]. The proportion of security grade of rural drinking water source areas in districts and counties of

Chongqing is shown in Fig. 3. To guarantee security of water source areas, following measures can be adopted. Firstly, distribute water source areas properly, select high quality water source through unified planning, improve water supply security of villages and towns, reduce quantity of polluted water source areas, and provide certain quantity of backup water source areas. Secondly, divide protection zones, implement measures in drinking water source areas, and adopt many measures in protection zones, such as construction of forests for water supply conservation, and control of pollution sources, to improve water quality of water source areas and prevent exhaustion of water source. Thirdly, control pollution source, reduce and control pollutants for pollution sources influencing water quality security of water source areas, investigate sewage outfalls directly leading to drinking water source areas, and take mandatory measures to cut off pollution sources as necessary.

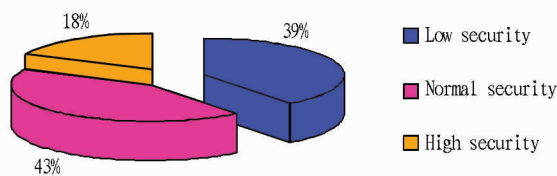


Fig. 3 Evaluation results of rural drinking water sources in districts and counties

3.2 Protection planning for water resource in rural drinking water source areas Principles of planning construction of protection projects for rural centralized drinking water source areas; firstly, mature technology, feasible and low or no energy consumption manual or ecological handling units. Secondly, convenient project operation and management, stable water quality of effluents, safe, stable and reliable long term running. Thirdly, on condition of guaranteeing protection target of water source areas and satisfying design of ecological engineering design, projects should cover small areas and have small investment, low operational costs and high technical and economic feasibility. Protection planning for rural centralized drinking water source areas in Chongqing is determined on the basis of this principle. For 2010 to 2020, the protection planning for rural centralized drinking water source areas includes 2 409.26 hm² area of manual wetland ecological restoration project, 32 415.55 hm² area of forests for water supply conservation, 135.20 km waste water interception project, 999 isolation projects for underground water, 2 929 monitoring section construction projects, and 6 964.60 m² area of floating bed ecological restoration projects, 1 080.00 hm² area of desilting and dredging project, 13 445 methane-generating pits, 1 917 sewage treatment projects, and 5 979 waste collection stations, with respective investment of 433.667 5 million, 1 296.622 1 million, 479.96 million, 19.98 million, 54.08 million, 406.732 6 million, 17.28 million, 40.335 million, 38.863 5 million, and 38.863 5 million yuan.

3.2.1 Isolation and protection projects for rural drinking water source areas. Isolation and protection projects for rural drinking water source areas are mainly aimed at water source areas with serious water loss and soil erosion^[3]. Such projects include

physical isolation projects (guardrails, fences) and biological isolation projects (ecological forests for water supply conservation)^[4]. Isolation projects for surface water source areas adopt forests for water supply conservation. Woods select local types of woods with high suitability and resistance. According to soil and climate conditions of Chongqing, forests for water supply conservation mainly use China fir, cinamomum camphor, cypress and bamboo^[5-6]. Isolation projects for underground water mainly adopt physical isolation measures, such as guiderails and fences, preventing pollutants entering protection zone of water source areas through separating activities of human beings and activities.

3.2.2 Ecological restoration and protection projects. These projects are mainly aimed at water source areas that have potential pollution trend, and mainly include desilting and dredging projects, ecological floating bed and wetland restoration projects. Desilting and dredging projects are planned for water source areas with polluted sediment, while ecological floating bed and wetland restoration projects are planned for water source areas requiring water body restoration^[7].

3.2.3 Comprehensive control projects for rural point-source pollution. It is planned to conduct comprehensive control of rural point-source pollution in centralized and decentralized ways. We should make suitable planning for sewage treatment in line with local situations, to seek methods suitable for rural domestic sewage handling in Chongqing City. The planned comprehensive control projects for rural point-source pollution include sewage interception projects, manual wetland sewage treatment project, ecological pool, small sewage treatment projects, etc^[8].

Sewage interception projects are aimed at discharge of rural domestic sewage in areas near cities and towns. The key to proper planning is selection of proper channel routes. Manual wetland sewage treatment system is planned for regions with centralized sewage discharge around reservoirs of water source areas, and on both banks of rivers. This treatment system consists of collection and pretreatment system, distribution and collection system, and plant pond^[9], adopts anaerobic hydrolytic/acidification section + manual wetland and pre-aeration section + manual wetland^[10]. Ecological pool sewage treatment projects are planned for waste water receiving rivers, and rural domestic sewage from mountain sewage pond is treated in situ using secondary or tertiary pond treatment systems. In water source areas where rural residents live in concentrated ways or that are far from cities and towns and so it is impossible to intercept sewage to urban sewage treatment plant, it is planned to adopt small sewage treatment project and powerless treatment facilities. It is recommended to use buried powerless sewage treatment equipment. The treatment process is mature and reliable and simple, requires few facilities and pipelines, little maintenance work, free of energy consumption, and low requirement of maintenance technology, so it is convenient for administrative staff to accept and manage^[11].

3.2.4 Comprehensive control projects for rural area-source pollution. It is planned to build methane-generating pit in some rural drinking water source protection zones, to prevent and control pollution of water source areas from area-source pollution. Methane-generating pits are distributed in areas with com-

paratively decentralized residents, to reduce pollution sources through standardizing rural human and animal excreta, reduce rural demand for firewoods and manmade destruction of protection forest. It is planned to build garbage collection pit beside roads in residential communities, to collect domestic rubbish and prevent and control water source pollution from rubbish. For protection zones with underground water as water source, the garbage disposal station should be built in resident living areas; for protection zones with river water as water source, waste treatment station may be built along river banks considering possible pollution. After construction of garbage disposal pit, it is required to coordinate and communicate with municipal administration department, to guarantee incorporation into rubbish collection and transportation works of municipal administration department, to form benign development trend.

3.3 Planning for management of rural centralized drinking water source areas Planning for management of rural centralized drinking water source areas mainly involves construction of monitoring system for rural drinking water source areas, construction of security information system for rural centralized drinking water source areas, and construction of emergency mechanism for water pollution accidents in rural water source areas.

Firstly, we should build monitoring system for drinking water source areas. At present, existing monitoring stations of rural drinking water source areas in Chongqing City are far to satisfy monitoring requirements of water source areas. To effectively control pollutant discharge, accurately know water quality change of water source areas, and better control water resource quality and effectively manage rural centralized drinking water source areas, it is planned to distribute water quality monitoring section in rural drinking water source areas and improve construction of monitoring system.

Secondly, we should build security information management system for drinking water source areas. Planning for security information management system of rural centralized drinking water source areas will coordinate with *Water Conservancy Informatization Planning of China and Eleventh Five Year Plan for National Hydrological and Water Conservancy Informatization*. It should set up security information management system of rural centralized drinking water source using existing public information network, mainly including database for rural drinking water source areas, monitoring data acquisition and transmission system, monitoring management system, and monitoring (supervision) center construction.

Thirdly, we should build emergency mechanism for water pollution accidents. Now, emergency mechanism has not been established for water pollution accidents in rural water source areas. To timely, rapidly and effectively respond to various water pollution accidents and guarantee security of rural drinking water in Chongqing City, we should plan and build rapid response mechanism, and put forward strict timelimit and technical requirements for emergency investigation and comprehensive control works.

4 Conclusions

The protection planning for rural centralized drinking water source areas of Chongqing City is prepared on the basis of current situations of projects implemented in rural drinking water

source areas and in line with rural pollution prevention and control technologies. It is expected to improve ecological environment of rural drinking water source areas, guarantee security of rural water supply, promote sustainable use of water resource, and realize sustainable development of society and economy. First batch of pilot projects of this plan has been implemented in Beipei District, Banan District, Jiangbei District, Qianjiang District, Yunyang County, Fengjie County, Shizhu County, Dazu County, Rongchang County and Tongnan County of Chongqing City in February to July of 2011. At present, summarizing experience in achievements made in these pilot districts and counties, and combining the *Twelfth – Five Year Water Conservancy Reform and Development Plan of Chongqing City*, Chongqing Municipal Bureau organized experts to optimize and adjust *Protection Planning for Rural Centralized Drinking Water Source Areas in Chongqing*. From August 2011, it started to implement second batch of pilot projects in nine rural centralized drinking water source areas (including Yubei District, Dadukou District, Beipei District and Nan'an District). This will play a significant role in new socialist countryside construction, urban and rural integration and protection of drinking water source areas of Chongqing City.

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