

The present condition and perspective of urban water management in China

Luo Sha¹, Lin Lin² and Zhang Baoxiang^{1*}

¹Departments of College of Water Conservancy and Environmental Engineering, University of Jinan, Jinan 250022, China

^{1, 2, 1*}Departments of Rural Water Safety, Water Resource Research Institute of Shandong Province, Jinan 250013, China

Luo Sha; E-mail:867232552@qq.com; phone: 15650572597

Zhang Baoxiang; E-mail:baoxiang.zh@126.com; phone: 18615239172

Lin Lin; E-mail: llin_mail@126.com; phone: 18615282307

Abstract. On the basis of the relationship between human development and water, this paper discusses the importance of water in the development of Chinese culture. And then, in view of urban water management agency and their responsibilities, Water intake, water consumption, drainage and water conservation, the present conditions and the existing problems of urban water management are discussed in China in this paper. And from the aspects of administrative law enforcement, law, economics, technology and education, the perspectives of urban water management are taken into account, for achieving accurate and efficient urban water management in the future.

1. Introduction

Throughout the history of human development, tracing back to the development of the world's five civilizations and the origin of ancient civilization, water has been playing an important in this process. China is the first country to have hydrological records that originated from the Yellow River basin in East Asia. The importance of water in human development has been particularly prominent in this process of Chinese culture development. Brilliant Yellow River civilization is one of the main Chinese civilization and paternal regime are created in the Yellow River which is the Chinese mother river. The Wuyue culture in the lower reaches, the Jingchu culture in the middle reaches and the Bashu culture in the upper reaches are connected by the first long river Yangtze. At the same time, because the Three Gorges like a huge knot, connects the Jiangnan Plain with the Chengdu Plain and combines the Bashu civilization with the Jingchu civilization, the Yangtze River civilization has become complete.

The importance of water management has been highlighted in human development because of the importance of water. It was a period that Dayu's water management advocated unchoke, Li Bing and his son built Dujiangyan water conservancy, the Qin State promulgated "Tianlu" and the Tang Dynasty when the thought of water management was pioneered promulgated "Water Ministry Style" [1]. The city was the product in which social productive forces to a certain historical stage, for example, the Chinese seven ancient capitals all around the riverside. It was a period of early urban water management that the city's water supply was mainly. The urban drainage could be traced back to



the Shang Dynasty and spring up in Chang'an of the Tang Dynasty. A complete drainage system was formed inside and outside the Forbidden City during the Ming and Qing Dynasties [2-4].

At present, the urban scope is gradually expanding, the urbanization process is accelerating, the urban structure is more and more complex, and the demand for water is also growing, so urban water resources are facing seriously challenges. The "three-water" crisis (water shortage, waterlogging, water-pollution) have become a common problem and are highly comprehensive and complex. These series of problems need to be solved urgently in urban water management, and are also the significance in the urban water management [5].

2. The present condition

2.1. Management Department

At present, it is a goal that many cities in China have abolished the Water Conservancy Bureau and set up a water bureau to realize a unified management mode of water supply and drainage integration on the original basis, realizing the integrated operation of raw water, water supply, drainage, sewage treatment and reclaimed water reuse, and the integrated operation of water-related production, service and capital.

The water affairs (group) limited company was set up that the aim is to separate government and enterprises, define the responsibilities, establish the modern enterprise system, demarcate the responsibilities and boundaries with the government departments, and coordinate the functions of urban flood control and drainage, water supply and drainage, water environment management, sewage treatment and water-saving treatment and so on. The water affairs group becomes an independent and self-responsible market subject that has the responsibility of making water, supplying water and sewage treatment. In terms of the system and mechanism, the problems of resource dispersion, low efficiency and ineffective mechanism in management are initially alleviated [6].

2.2 Water intake, Water supply, Water consumption and Drainage

(1) The present condition of water intake and supply. Surface water is the main source of urban water intake in China. The amount of surface water is about 80%, groundwater is about 18%, and other are about 2% referencing to figures (Fig. 1). In view of the management of urban water intake and supply, the safety of water supply should be improved firstly. 1) to strengthen the comprehensive planning and management of urban water resources and establish a water supply security system, 2) to strongly advocate water conservation and pay equal attention to both open source and be throttled, 3) to strengthen the technological transformation of water production and study and develop the technology of sewage reuse for greatly improving water reuse rate and water treatment capacity, 4) to establish strict and effective water pollution supervision mechanism for strictly implement the environmental impact assessment and the "three simultaneous"[7-9]. Secondly, leakage rate of water supply network should be increased: 1) to reasonable ascertain water leakage control objectives of water supply network and optimize water supply network design for improving water supply network design standards, 2) to apply new pipes of light weight, convenient transportation and installation, low cost, compressive strength, low fluid resistance, strong corrosion resistance and no impact on water quality, such as PPR, PE pipes, 3) to use flexible interface to cut losses, 4) to strictly check and accept raw materials, 5) to optimize pipeline foundation treatment task and perfect the files of water supply network completion, 6) to strengthen the construction of pipe network leak detection and accident repair teams for improving the level of leak detection, 7) to strengthen the quality of construction management for avoiding high-pressure operation [10-11].

(2) Water consumption. The changes of urban population and water consumption per capita in China have been showed in China in the past 10 years that referencing to figure (Fig. 2). Since 2006, that the daily urban water consumption per capita has reduced from 188L to 170L shows that China has made great efforts in urban water use. In the urban water consumption management, it is important for water price, water-saving equipment, water laws and regulations. 1) The awareness of water saving

is improved by water-saving laws and regulations construction. Urban water saving construction is legalized and standardized by intensifying the enforcement of relevant departments and strictly follows the rules. And on the basis of relevant national laws and regulations, some local regulations and policies on urban water conservation have also been introduced by local governments. 2) Vigorously promoting water-saving. In the life aspect, water-saving products are spread widely, while in the industry, focusing on cleaner production, strengthening water recycling, improving cooling water system and promoting unconventional water resources, sea brackish water, rainwater and sewage use. 3) A reasonable water price system is established by promoting water price reform. Adjusting urban water use with price leverage, for example, most cities in China have put forward the “ladder water price” of residents and the “water quota system” of enterprises [12-16].

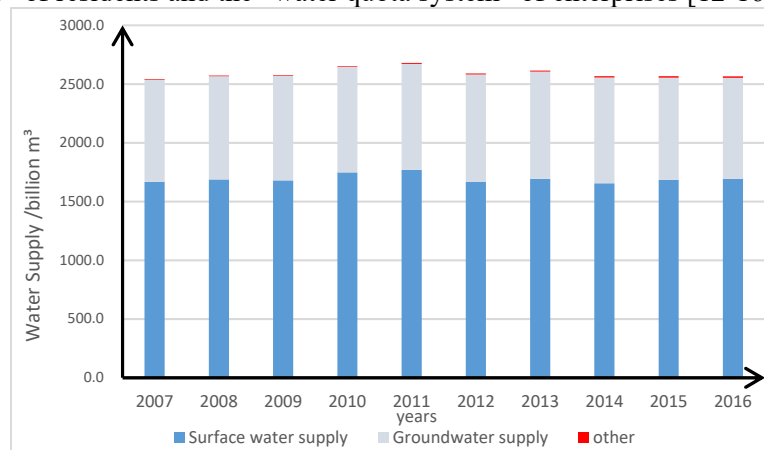


Figure1. Types of urban water supply

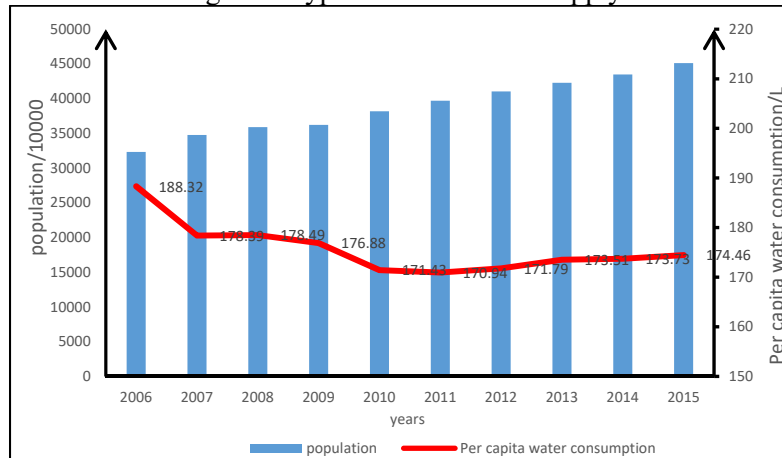


Figure 2. Urban population and daily water use per capita in China over the years

(3) Drainage management. In urban drainage management, the number of urban sewage treatment plants built and the daily sewage treatment capacity of the sewage treatment plants have been increasing since 2006 that referencing to figures (Fig. 3 and Fig. 4). Great progress has been made in drainage management. 1) The overall trend of wastewater treatment capacity has been increasing every year by the development of new processes and new equipment. 2) Comprehensive consideration of function district throughout the city. Rational planning and building the urban drainage system. Scientific designing wastewater treatment system. And combining short demand with long-term planning. 3) Changing absolutely the design concept of "attach importance to rain and ignore sewage". Increasing construction funds for underground drainage pipes. And drawing on the current advanced foreign drainage system design technology and vigorously introducing professional and excellent designers. 4) That fully considering the specific economic conditions and construction condition of the city. Scientific choosing the urban drainage system are aims to prevent the recurrence of disorderly

phenomena. 5) Increasing law enforcement [17-18].

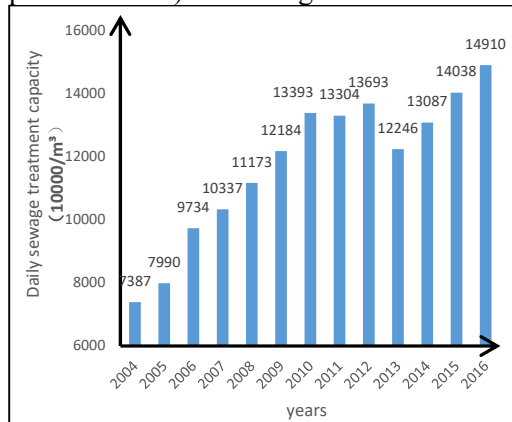


Figure3. Urban sewage daily treatment capacity

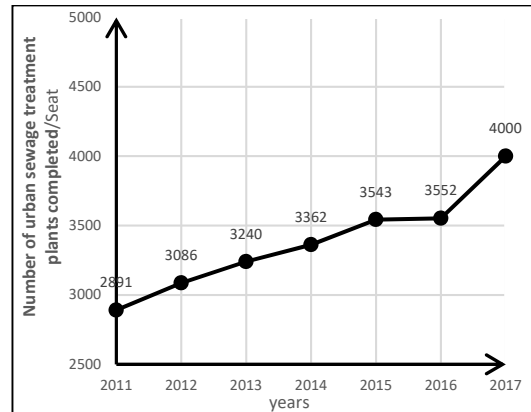


Figure4 .Number of urban sewage treatment plants completed

3.Problems

3.1 water management institutions and responsibilities

In urban water management, great adjustments have been made in the functions of water management institutions that great progress has been made. However, there are still some problems. 1) The internal cooperative management mode, which mainly consists of government and monopoly enterprises, leads to the serious disjunction of vertical management functions. The local water bureaus could not achieve integrated water management why the relevant links of water management are disconnected and unable to coordinate. 2) The function departments are partial to urban water management, resulting bias towards urban water source management. The implementation of drainage permit system is imperfect in which the drainage behavior is supervised not enough after the event. 3) That management collaboration mechanism is absent generates Multi-management situation which responsibility of Water Affairs Bureau, environmental protection bureau and construction bureau is vague [19-20].

3.2. The problems of water supply, water consumption and drainage.

(1) Water supply. At present, the security of water supply and the inefficiency of water supply network are the main matters in China's urban water supply. There are main following aspects. 1) The continuous increase of urban population leads to the continuous increase of urban water demand, referencing to figure (Fig. 2). 2) The water resource maldistribution leads to water shortages in urban water supply, which is one of safety hazards in urban water supply. 3) Water pollution is more and more serious. water supply equipment and technical level restrictions result in the risk of secondary pollution of water supply, which is reason that clean water supply is not guaranteed. 4) Urban water supply pipe network transformation is not in place, resulting in serious leakage in the process of water supply. Comparing China with typical developed countries for several years, the average leakage rate of urban pipe network in China is 16.43%, however, 13.3% in developed countries. In recent years, the minimum leakage rate is 12.4%, and 4.9% in Germany and Switzerland, which China is equivalent to 2.5 times. Referencing to figures (Fig. 5 and Fig. 6) [21].

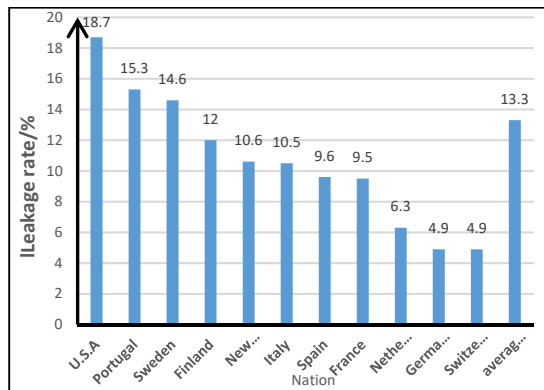


Figure5 .Average leakage rate of urban water supply in typical countries in recent years

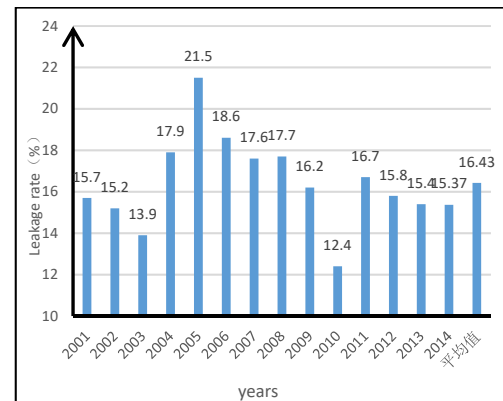


Figure6. National urban water supply leakage rate over the years

(2). Water consumption. In terms of water consumption, there are still some problems in reducing the use of water resources and increasing the secondary utilization of water resources in China. China's per capita daily water use has maintained at about 170L in recent years, comparing with 2006, reduces by about 10L which referencing to figure (Fig. 3). But comparing with Singapore, perfection is still required. There still some problems in urban water consumption in China, such as weak public awareness of water conservation, imperfect implementation of water laws and regulations, low legislative quality, imperfect water administrative law enforcement, a lack of important legal systems in some fields, and weak public awareness of water laws and regulations [22]. Furthermore, comparing with the principles of water price abroad, China's water price system needs to be further improved, such as cost recovery, reasonable profit, user participation and affordability [12].

(3) Drainage. It is main reasons for low design standards, poor drainage capacity, pipe aging and pipeline interface leakage and blocked seriously of urban drainage system that result in urban waterlogging and groundwater pollution in China. 1) The function of urban drainage system is imperfect. 2) The distribution of urban drainage system is confused. 3) The choice of urban drainage system is unreasonable. The distribution system is not perfect. Combined system is not scientific [17-18]. In terms of flood control and drainage, that the consideration of the drainage network is not deep enough results in low flood control standards, and that only a portion of the core facilities have been updated and the infrastructure has not been updated accordingly results in which the old flood control infrastructure has been unable to adapt to the development needs of the city because of budget limitations, all which result in the occurrence of urban danger [23].

(4) Urban water ecological construction. In recent years, the important measures for urban water ecological construction are "sponge city" and "urban water ecological civilization construction". For urban water ecological construction, China is still in the exploratory stage and mostly takes example by foreign experience, so there are some problems. 1) The scientific urban water ecosystem research system has not been formed. 2) The "natural-human-water body" water ecosystem construction model is not coordinated enough. 3) The essential content of urban water ecosystem construction is not clearly defined. 4) The lacking theoretical basis of urban aquatic ecosystem construction and the blindness implementation lead to dissatisfaction [24]. At the same time, there are some problems, too. 1) it is not closely connected with existing municipal facilities and does not match existing pipe standards, which deaden the ability of the drainage system. 2) Improper planning and lacking of overall awareness lead that the construction is just staying in urban rainwater and flood facilities. 3) The related standards are imperfect and post management is weak [25-26].

4.Conclusion

"water" is the focus of the urban water management which covers urban environment, economy and system and so on. as far as water intake, water supply, water use and drainage are concerned, great

efforts have been made and considerable achievements have been made in national consciousness, technology and capital input. At the same time, the promotion of integration of urban water has great performance, too. However, some problems still exist and there is still a big gap between China and developed countries. For instance, we do not have a clear understanding of our own national conditions, resulting in the implementation process is not ideal.

5. Perspective

With the acceleration of urbanization and the expansion of city scale, the demand for water and water quality will be higher and higher, and the challenges of urban water management will be heavier and heavier. Therefore, in the future, urban water management must combine administration, law, economy, technology and education, which we can do to promote the unified management of urban water and improve the efficiency and optimize the allocation.

(1) Administrative measures. The integrate urban water management is that the construction of the Urban Water Authority should be implemented and the management pattern of water related affairs should be established by the water bureau and supplemented of relevant departments. Its purpose is to integrate the development, utilization, protection and management of urban water.

(2) Legal measures. Water regulations should be perfect strict enforcement standards should be drawn up, and law enforcement officials' law enforcement actions should be regulated. At the same time, it is considered that the compensation mechanism for current flood and drought disasters is not perfect. Based on existing basic laws, specific regulations should be promulgated make it legislation. Moreover, major water resources damage cases should be investigated for criminal responsibility of offenders.

(3) Economic measures. Urban water management should be promoted through economic means. Urban water use structure should be adjusted by economic measures such as price, taxation and market. Water conservation should be promoted by encouraging consumers to use water reasonably and limiting water resources damages.

(4). Technical means. The advantages of computers should be fully utilized. On the basis of "water network", the intelligent water supply dispatching and management information platform, integrated water environment management service system and intelligent flood prevention and control platform system should be established, which include water information collection, transmission, processing, storage, management, service and application, and so on. It will manage the production, management and service of urban water systems in a more sophisticated and dynamic manner, achieving intelligent, digital, standardized and informatized water management operations.

(5). Educational measures. Through the Internet platform, the new concept of urban water management will be conveyed and the old ideas will be changed, which the public's acceptance will be enhanced in reclaimed water reuse and water price reform.

At the same time, water conservation activities should be close to the public to promote water-saving by carrying out water-saving demonstration activities. Water-saving activities should be close to the public for promoting water conservation.

Note: data sources: Water Resources Bulletin (2007-2016) in Ministry of water resources, "Research Report on the development trend and investment strategy of China's water conservancy industry in the past 2017-2022 years".

Acknowledgements

This research was financially supported by Shandong Provincial Natural Science Foundation, China (Grant No. ZR2015EM007), Shandong provincial water conservancy scientific research project (Grant No. SDSLKY201601), and Key research and development plan of Shandong Province (Public welfare special) (Grant No. 2017GSF20101).

References

- [1] Liu, P.F.(2017) Analysis of the current situation and problems of urban water management in China. J. Heilongjiang Hydraulic Science and Technology, 45(08):221-223.
- [2] JIN H.CH. (2005) Chinese Ancient Cities and Water ——Taking the Ancient Capitals as an example. J. Journal of Hohai University(Philosophy and Social Sciences), 7(4):26-32.
- [3] Du, P.F. (1999) City Drainage in ancient China. J. Studies in the History of Natural Sciences, 2:136-146.
- [4] Tan, X.M., Zhou, K.Y. (1996) Municipal Function and Environmental Function of Water Conservancy in Ancient Chinese Cities. J. Chengdu Water Resources, 4: 30-38.
- [5] Liu, SH.Q, Xv, Y.M. (2012) Analysis of Urban Water Problems and Countermeasures in the Rapid Urbanization in China. J. Reform of Economic System, 5:57-61.
- [6] Luo, ZH.CH. (2015) Integration of urban water management studies-----Take Ningbo as an example. D. Ningbo University.
- [7] Jia, CH.M. (2017) Analysis of urban Water Supply Safety and Its Countermeasures in China. J. Manager Journal, 14.
- [8] C, J.H. (2010) Problems and countermeasures of Urban Water Supply Safety. J. New Technology & New Products of China, 8: 45-46.
- [9] Li, H., Wu, H.Y. (2014) Analysis and Measures of Urban Water Supply Safety. J. Jiangxi Building Materials, 7:73-73.
- [10] Jin, W.R. (2015) Analysis on City Water Supply Network Leakage Causes and Countermeasures. J. Water & Wastewater Engineering, s1: 359-361.
- [11] Zhang, Y.SH. (2016) Analysis of City Water Supply Network Leakage Causes and Control Measures. J. Building Technology Development, 19.
- [12] Liu, SH.Q., Xv, Y.M. (2012) A summary of Studies on Urban Water Price Mechanism and Reform Path in China. J. Economics Perspective, 1:91-95.
- [13] Yang, X.F. (2017) The path study of deepening Urban Water Price Reform. J. Enterprise Reform and Management, 23:196-196.
- [14] Teng, X.H. (2015) The Study of Jinan Water Price Reform. D. Shandong University.
- [15] Luo, L., Tao, L.L. (2010) Measures and Current Situation of Water Saving in cities. J. Pioneering with Science & Technology Monthly, 10:94-96.
- [16] Li, Y.G., Peng, Y.H. (2011) On connotation of urban water saving and analysis of water saving measures. J. Shanxi Architecture, 37(22):199-200.
- [17] Yi, K. (2015) Problems and Countermeasures of Urban Drainage System in China. J. Modern Business, 12.
- [18] Yang, J.CH. , Li, X.Y., Han, L. (2017) Current Situation and Countermeasures of Urban Drainage System. J. Housing and Real Estate, 26.
- [19] Yang, F. (2017) Research on the Implementation Status of Urban Water Management. J. Technology Innovation and Application, 29: 118-119.
- [20] Wang, X.CH. , Liu, ZH.X. , Li, X.Y. (2017) Integrated management of water affairs of major cities in China. J. China Water Resources, 1: 47-49.
- [21] Zhou, J., Liu, J. (2016) Analysis on the Current Situation of Urban Water Supply Safety and Its Safeguard Measures. J. Urban Construction Theory Research, 13.
- [22] Liu, H.R. (2008) Talking about China's legal system for the improvement of water. China Law Society Association of Environment Resources Law CLS-AERL, in: Nanjing.
- [23] Du, Y.T., Wang, H. (2016) Problems and Countermeasures in Construction of Urban Flood Control and Drainage System. J. Science and Technology, 26(5):00267-00267.
- [24] Zhang, J.Y., Li, Y., Wang, X.J. (2016) Reconsideration on issues related to water ecological civilization construction in China. J. China Water Resources, 19: 8-11.
- [25] Tan, SH.K., Zhang, N. (2016) Evaluation of the construction status of Chinese sponge cities -- a case study of 16 Chinese sponge cities. J. Urban Problems, 6: 98-103.
- [26] Yue, R.W., Yue, H.H. Development status and corrective action of Sponge City. J Science &

Technology vision, 11:122-123.