The research on present situation and formulation of water pollutant discharge standards of river basins in China

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Abstract. In this paper, the water pollutant discharge standards of river basins in China are comprehensively combed, and the development and present situation of watershed water pollutant discharge standards are introduced. Based on the above, the composition and the controlled pollutants of watershed water pollutant emission standard system and the methods of setting discharge limits of pollutants are summarized. Finally, focused on the problem of the definition of watershed discharge standard, controlled pollutants and the means of determining the discharge limits, the paper puts forward some suggestions for formulating and revising the watershed water pollutant discharge standard system.

1. Introduction

The water pollutant discharge standard is a restrictive technical requirement for the emission of water pollutants by sewage disposal units within the scope permitted by law. China's water pollutant discharge standard system includes national and local levels. The national water pollutant discharge standard reflects the basic control requirements for sewage discharge in the whole nation. The local water pollutant discharge standard supplements the national standard and is stricter, which can reduce more local pollutant disposal and raise the threshold to enter into an industry, and improve regional water environmental quality. According to China Environmental Quality Status Bulletin in 2017, 32.1% of the 1940 surface water quality assessment sections of the country is inferior to the third level water quality standard (State Environmental Protection Administration, 2002). Because water pollution distributes along the watershed, it is necessary to set water pollutant discharge standards of watersheds for improving the water environment quality of river basins. At present, some provinces in China have formulated water pollutant discharge standards of local river basins, among which there are differences about setting methods, the scope of application and implementation of the standards. It lacks of systematic research of water pollutant discharge standards in basins. This paper has comprehensively studied and summarized on the formulation and characteristics of current water pollutant discharge standards in basins, in order to provide reference for the formulation and revision of watershed standards in the future.

2. The history of water pollutant discharge standards in river basins of China

The formulation of watershed pollutant discharge standards in China began in the 1990s. In 1996, the Shaanxi Provincial Government published the Integrated Wastewater Discharge Standard for the river reach in Shaanxi of the Weihe River Basin (DB 61/224-1996), which marked the beginning of setting watershed pollutant discharge standards in the country (Zhou, 2016). During 1996-2010, Jiangxi Province, Fujian Province and Shandong Province Government successively formulated
watershed discharge standards applicable to the regions. Among them, Shandong Province published four watershed discharge standards in 2006 and 2007, which cover the whole province (Shi et al., 2011). From 2010 to 2015, four provinces set or revised eight watershed sewage discharge standards, in which six standards were issued by Henan Province Government.

However, before 2015, the development of formulating watershed discharge standards was slow. By 2015, as China's environmental management has changed from controlling total emission of pollutant to managing environmental quality target, and the requirement of improving water environmental quality has been strengthened. So a number of discharge standards of river basins have been released in several provinces (Lu et al., 2016). From 2016 to 2018, fifteen standards of watersheds were set or revised, of which, nine standards were released in the single year of 2018. By 2018, there are 22 current water pollutant discharge standards of watershed published by seven provinces, including those will be implemented in 2019. And the current standards are shown in Table 1.

Table 1. The current watershed water pollutant discharge standards in China

| Province            | Name of Standard                                                                 | Number of Standard |
|---------------------|----------------------------------------------------------------------------------|--------------------|
| Henan Province      | Water pollutant discharge standard of Mangqin River Basin                         | DB 41/776-2012     |
|                     | Water pollutant discharge standard of Haihe River Basin in Henan Province         | DB 41/777-2013     |
|                     | Water pollutant discharge standard of Qingyi River Basin                          | DB 41/790-2013     |
|                     | Water pollutant discharge standard of Jialu River Basin in Henan Province        | DB 41/908-2014     |
|                     | Water pollutant discharge standard of Huiji River Basin in Henan Province        | DB 41/918-2014     |
|                     | Water pollutant discharge standard of Jianhe River Basin in Henan Province       | DB 41/1258-2016    |
|                     | Water pollutant discharge standard of Honghe River Basin                          | DB 41/1257-2016    |
|                     | Integrated water pollutant discharge standards for watersheds Part 1:            |                    |
|                     | Nansi Lake and Dongping Lake Basin                                               | DB 37/3416.1-2018  |
|                     | Integrated water pollutant discharge standards for watersheds Part 2:            |                    |
|                     | Yishu River Basin                                                               | DB 37/3416.2-2018  |
| Shandong Province   | Integrated water pollutant discharge standards for watershed Part 3:             |                    |
|                     | Xiaoqing River Basin                                                            | DB 37/3416.3-2018  |
|                     | Integrated water pollutant discharge standards for watershed Part 4:             |                    |
|                     | Haihe River Basin                                                               | DB 37/3416.4-2018  |
|                     | Integrated water pollutant discharge standards for watershed Part 5:             |                    |
|                     | Peninsula Basin                                                                 | DB 37/3416.5-2018  |
| Guangdong Province  | Water pollutant discharge standard of Fenjiang River Basin                       | DB 44/1366-2014    |
|                     | Water pollutant discharge standard of Danshui River and Shima River Basin        | DB 44/2050-2017    |
|                     | Water pollutant discharge standard of Lianjiang River Basin                      | DB 44/2051-2017    |
|                     | Water pollutant discharge standard of Maozhou River Basin                        | DB 44/2130-2018    |
| Hebei               | Water pollutant discharge standard of Daqing River Basin                         | DB 13/2795-2018    |
3. Positioning of water pollutant discharge standards in river basins

At present, there are three types of standards in the national water pollutant discharge standards system, such as comprehensive standards, industrial standards, and special discharge limits of water pollutants (Zhou, 2016). There are also four types of standards in the local water pollutant discharge standards system including comprehensive standards, industrial standards, watershed standards, and special discharge limits. Nowadays, watershed standards are mainly formulated by local governments, and the scope of implementation is limited to the waters within the province. With the promotion of unified supervision of river basin environmental protection, water pollutant discharge standards for trans-provincial watersheds will be issued in the future, which will be set by the national department responsible for environmental protection, and watershed standards will be added to the national water pollutant discharge standard system. The Ministry of Environmental Protection is formulating a cross-provincial basin standard, *Water Pollutant Integrated Emission Standard in Beijing-Tianjin-Hebei Key Basin*, which is scheduled to be released in 2020 (Ministry of Environmental Protection, 2017).

China's environmental management has changed from pollutant emission control to environmental quality target management, and it is necessary to link water pollutant discharge standards with water environment quality. Among the four types of emission standards, comprehensive and industrial water pollutant discharge standards are mainly based on technical and economic assessment, and are positioned as entry barriers to industries, and do not directly link to water environmental quality targets in specific watersheds. The special emission limit value of water pollutants aims at typical pollutants in an industry or locality rather than a specific basin, and it is not enough to support reaching the water environmental quality objectives of the basin (Lu et al., 2016). Only the basin standard is based on the water environment quality target of the watershed, and sets stricter emission limits of pollutants whose concentration exceeds the water environment quality target.

3.1. Selection of the indicators for water pollutant discharge standards in river basins

The pollutants whose concentration is over or near the water environment quality target are usually chosen as indicators of water pollutant discharge standards in river basins. For example, five major pollutants whose concentration exceeds water environmental quality target, such as chemical oxygen demand (COD), biochemical oxygen demand for five days (BOD5), ammonia nitrogen (NH3-N), total phosphorus and total nitrogen are chosen as control indicators in discharge standards of Daqing River, Ziya River, and Heilonggang Basins in Hebei Province. In Maozhou River Basin emission standard of Guangdong Province, four major pollutants whose concentration exceeds the water quality target, such as COD, ammonia nitrogen, total phosphorus, and anionic surfactants are chosen as control indicators.

In some river basins, the specific pollutants in key industries, the pollutants which affect drinking water quality such as heavy metals, and the major pollutants which cause regional ecological and environmental risks are also chosen as control indicators for emission standards. For example, there are seven over-target pollutants in the Hanjiang River Basin of Hubei Province, like COD, BOD5, ammonia nitrogen, total phosphorus, petroleum, fluoride, and volatile phenol. Finally, there are fifteen pollutants whose concentration is over or near the water environment quality target.
pollutants indicators, which consist of not only over-target factors, but also the typical pollutants of the key industries, heavy metals and cyanide, in the Hanjiang River Basin sewage emission standard.

3.2. Determination of the indicators limits for water pollutant discharge standards in river basins

There are three methods for formulating water pollutant discharge limits of river basins, such as water quality planning method, technical and economic feasibility analysis method and the analogy method with relevant standards. When using the water quality planning method, the input-output response relationship between water environmental quality, environmental capacity and water pollutant emission amount is established, the allowable discharge amount of all the sewage outlets into the river is determined, then the allowable discharge amount of each pollution source is allocated, and the emission limits of pollution sources are further calculated as the basis for setting the basin emission standards. The key of this method lies in the determination of water quality model and parameters. Water quality models and estimation of parameters are recommended in Technical Principles and Methods for Formulating Local Water Pollutant Emission Standards (GB 3839-83) and Technical Guidelines for the Formulating and Revising Watershed Water Pollutant Emission Standards (Exposure draft in 2017).

In the technical and economic feasibility analysis method, emission limits are determined basing on the optimal pollution treatment technologies. In the analogy method, the emission limits are ascertained by comparing the emission control levels with relevant standards at home and abroad. The current determination of the pollutant discharges limits in some river basins are based on the above three methods. In the other watersheds, water quality planning means are not used, and only the best available techniques and referring to the relevant standards are utilized.

For example, when formulating the water pollutant discharge standards of the Daqing River Basin in Hebei Province, the emission limits are determined through the above three methods. The Daqing River Basin is divided into three water environmental function zones, which include the core control zone, the key control zone and the general control zone. The core control zone covers the whole area of Xiongan New District. The water quality target of Baiyangdian Lake, which lies in Daqing river basin, is to achieve water quality standard between the third and the forth level, which is proposed in the Planning Outline of Hebei Xiongan New District. So the water quality target of the core control zone in Daqing river basin is between the third and the forth level standard.

The discharge of five pollutant factors whose concentration in the river is over water quality target as mentioned above is investigated from the 56 sewage treatment plants and 60 industrial enterprises discharging treated sewage directly into water body of the basin. And water environment quality of the basin is also surveyed. Based on the investigation, the response relationship among water quality, pollutant emissions and environmental capacity is established by the water environment model, and the emission limits of five pollutants factors in the three kinds of control zones of the basin are estimated.

Then, according to synergetic development of Beijing-Tianjin-Hebei, the emission limits of the Daqing river basin are linked to the discharge standards of Beijing and Tianjin. For instance, the COD emission limits of the core control zone and the key control zone are respectively equal to Grade A and Grade B emission limits of Water Pollutant Discharge Standard of Municipal Wastewater Treatment Plant in Beijing (DB11/890-2012), and the COD emission limit of the general control zone is equal to the limit of Water Pollutant Discharge Standard of Municipal Wastewater Treatment Plant in Tianjin (DB12/599-2012). So the COD emission limits of the core, key and general control zone in Daqing River Basin are determined as 20mg/l, 30mg/l and 40mg/l respectively. And the feasibility of implementing the above emission limits is analyzed basing on current COD treatment technique. The emission limits of main water quality assessment factors in China such as COD, ammonia nitrogen, BOD5, total phosphorus and total nitrogen of industrial enterprises in several provincial watershed pollutant discharge standards are shown in Table 2.
4. Discussion

The water pollutant discharge standard of the river basin is directly related to the water environment quality target, and more attention should be paid to the application of the water quality planning method in formulation and revision of watershed discharge standards (Lu et al., 2016). But the water quality planning method is more theoretical than the best available technology method and the analogy with relevant standards, and there is more complicated calculation in planning method. So only the way of best available technology or the analogy is used to formulate some watershed discharge standards rather than water quality planning method. The key to the water quality planning method is the choice of water quality model and the calculation of parameters. And detailed data of hydrology and water quality of rivers is essential. Therefore, it is necessary to collect and analyse basic data, get

| Water pollutant discharge standards of river basins | Execution areas of river basins | COD | BOD₅ | Ammonia nitrogen | Total phosphorus | Total nitrogen |
|---------------------------------------------------|--------------------------------|-----|------|------------------|------------------|--------------|
| Henan Province: Water pollutant discharge standard of Haihe River Basin | Unpartitioned | 50  | 10   | 5                | 0.5              | 15           |
| Shandong Province: Integrated water pollutant discharge standards for watersheds Part 1: Nansi Lake and Dongping Lake Basin¹ | Key protected area | 40/50 | 10   | 3/5              | 0.3              | 10/12/15     |
|                                               | General protected area | 50/60 | 10/15/20 | 3/5/8           | 0.5              | 10/15/20     |
| Guangdong Province: Water pollutant discharge standard of Danshui River and Shima River Basin¹ | Unpartitioned | 50/60 | Not set | 5/8             | 0.5              | Not set      |
| Hebei Province: Water pollutant discharge standard of Daqing River Basin² | Core control zone | 20   | 4    | 1.0(1.5)         | 0.2              | 10           |
|                                               | Key control zone     | 30   | 6    | 1.5(2.5)         | 0.3              | 15           |
|                                               | General control zone | 40   | 10   | 2.0(3.5)         | 0.4              | 15           |
| Shaanxi Province: Comprehensive sewage discharge standard in the Yellow River Basin (Shaanxi Section) | First level | 50   | 20   | 12               | Not set          | 20           |
|                                               | Secondary            | 300  | 150  | 25               | Not set          | Not set      |
| Sichuan Province: Water pollutant discharge standard of Minjiang River and Tuojiang River Basin¹ | Unpartitioned | 40/50/60 | 15/20 | 10/15        | 0.5/5(inorganic phosphorus) /10(organophosphorus) | 15/20/25 |
| Hubei Province: Integrated sewage discharge standard for the middle and lower reaches of the Hanjiang River Basin² | Key protected waters | 50   | 10   | 5(8)            | 0.3/10           | 10           |
|                                               | General protected waters | 60   | 20   | 8(15)           | 0.5/10           | 15           |

Note: 1. The different values before and after the “/” in COD, ammonia nitrogen, BOD₅, total phosphorus and total nitrogen emission limits are applicable to different industries.
2. The value outside the parentheses of the ammonia nitrogen index is the control index when the water temperature is higher than 12°C, and the value in the parentheses is the control index when the water temperature is less than or equal to 12°C.
the hydraulic parameters of the main river basins in the nation or regions, and study to determine water quality models adapted to the basins.

Most of the current control items of watershed pollutant discharge standards are the national water environmental quality assessment indicators, and there is lack of attention of specific indicators, which are the potentially dangerous factors to cause regional or basin water environmental accident. Therefore, it is recommended to investigate of water pollution sources and identify the main water pollutants, especially the specific pollutants in major river basins and key industries.

The control scope of the basin discharge standards and other local discharge standards is not clear, so there is a huge difference among local water pollutant discharge standard system. For instance, there are only five river basin water pollutant emission standards in the newly revised local standards system of the Shandong province, so all the sewage disposal enterprises of the province implement the watershed discharge standards. At the same time, the regional water pollutant emission standard system of Guangdong province is composed of comprehensive, industrial and river basin standard. And the standard system of Henan province is composed of industrial and river basin standard and specific pollutants. In this kind of standard system including both watershed and industrial standard, the emission limits of some watershed discharge standards usually differ in industries, which may conflict with local industrial emission standards when implemented. Therefore, it is necessary to clearly define the control range of the national watershed emission standards and the local river basins, comprehensive and industrial emission standards, and provide a basis for the scientific setting of emission standards.

References
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