Research on Spatial Management of Water Environment in Chaoyang City

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Abstract. The research put forward the technical methods for dividing the water environment management units in Chaoyang City. Based on the river basin and the characteristics of urban drainage, the catchment units with "monitoring section-control and section-corresponding and land area" were constructed for the main rivers in Chaoyang City. The sensitive areas and fragile areas were identified based on the water environment control units. Pollutant discharge surveys on key water environment control units were conducted. And this paper calculated the water environment capacity, analysed the potential improvement of the water environment quality. Water environment management and control requirements were also proposed in this paper.

1. Introduction
With the rapid advancement of the refined water environment management, the role of the water environment management model with the water environment control unit as the basic unit has become increasingly prominent. Research on proposing a reasonable method for dividing the water environment control unit was an important research topic. This paper took Chaoyang as an example to study the division method of water environment management unit. Based on the analysis of the main pollutant discharge characteristics and the division result of water environment units, the allowable discharges of water pollutants were measured and the requirements for water environment space control were proposed in Chaoyang City.

2. Research area Introduction

2.1. Research on the characteristic of hydrology and climate in the Chaoyang city
The city of Chaoyang had several important rivers, such as Daling River, Xiaoling River, Qinglong River and Laoha River. Among them, The Daling River was the longest river in Chaoyang and it also was one of the longest rivers in Northeastern China. The total flow of Daling River in Chaoyang City was 205 kilometers, and the total drainage area was 13,000 square kilometers. There were 7 main branches of the west branch of Daling River. The River distribution map was showed in figure 1.
2.2. The trend analysis of water environment quality in Chaoyang City

The water quality monitoring sections of the main river were shown in table 1. In this paper, the single-factor evaluation method was used to evaluate the water quality, and the water ribbon goals were used as the evaluation standard. The evaluation results were showed in Table 1.

**Table 1** water quality evaluation results

| The River Name       | The Section Name | Water quality goal | Compliance rate (%) | 2014 | 2015 | 2016 | 2017 | 2018 |
|----------------------|------------------|--------------------|---------------------|------|------|------|------|------|
| Main stream of Daling River | Nanda Bridge      | III                |                     | 100  | 100  | 87.5 | 80   | 100  |
|                      | Changbaodukou     | III                |                     | 8.3  | 8.3  | 33.3 | 41.7 | 25   |
|                      | Zhangjiiying      | III                |                     | 50   | 41.7 | 41.7 | 36.4 | 50   |
| Liangshui River      | Xialiangshuihe    | III                | 0                   | 0    | 0    | 0    | 0    | 0    |
| Mangniu River        | Mangniuhe Bridge  | III                | 70                  | 100  | 100  | 100  | 58.3 |      |
| Dalinghexizhi River  | Dalinghexi Colli  | III                | 45.5                | 91.7 | 100  | 90   | 58.3 |      |
| Diermangniu River    | Shuiquancun Bridge| III                | 25                  | 40   | 40   | 18.2 | 20   |      |
| Laohushan River      | Lijiawan Bridge   | III                | 81.8                | 100  | 91.7 | 100  | 100  |      |
|                      | Laohushanhe Bridge| III                | -                   | -    | -    | 85.7 | 100  | 90.9 |
| Liaohe river         | Xiaowujiaci       | III                | 100                 | 66.7 | 100  | 100  | 100  |      |
| Daling river         | Yanwangbizi Reservoir | III              | 66.7                | 66.7 | 100  | 100  | 100  |      |
| Xiaoling River       | Songlingmen       | III                | -                   | -    | 100  | 91.7 | 100  |      |
According to the results of cross-section water quality assessment, the water quality of the rivers in Chaoyang City was generally good. However, the water quality of some main river sections was still substandard, such as the Main stream of Daling River. The water quality was still needed to be improved.

3. Research methods
The sub-basin division module under the ArcSWAT model was used to extract the catchment area of the main rivers in Chaoyang. Through trial and error method, 3000Ha was selected as the minimum watershed threshold area. Under this threshold, the generated river channel was more reasonable.

In this paper, the water features such as importance, sensitivity and the environment function were analysed. And according to the results, water environment management units were identified. The Priority water environment protection areas mainly include drinking water source protection areas, wetland protection areas, sources of rivers, spawning grounds, feeding grounds, overwintering grounds, rare and endangered aquatic organisms and important aquatic planting resources, migration channels, rivers and lakes and their ecology Buffer zone, etc.

According to the results of pollution factor identification and pollution source analysis, control units based on industrial sources, over-standard control units based on urban life sources and over-standard control units based on agricultural sources were identified as water key control units. Other areas were identified as water general control areas.

4. Main research conclusion
The primary and secondary protection areas for centralized drinking water sources, wetland parks and important wetlands, and nature protection areas were identified as priority protection areas for water environment. The city had been designated to 34 water environment priority protection units, with the total area of about 1699.4 square kilometres, accounting for about 8.59% of the city’s land area.

The city had been designated to 12 key water environment management units, with the total area of about 5,936.53 square kilometres, accounting for about 30.01% of the city’s land area. And nine of them were key water environment management units for agriculture pollution, and the other three were key water environment management units for urban life pollution.
According to the estimated result, the total discharge of urban domestic sewage in Chaoyang City in 2017 was 57.2308 million tons, and the total discharge of rural domestic sewage was 14.7555 million tons.

Based on the calculation results of ideal water environment capacity of each water environment control unit in Chaoyang City and the current water environment pollutant discharge, the allowable discharge of main pollutants in each water environment control unit was calculated.

In 2020, the allowable COD emission of Chaoyang City was -54666.3 tons. The allowable emission of ammonia nitrogen was -1290.59 tons. And the allowable emission of total phosphorus was -716.81 tons. In 2025, the allowable COD emission of Chaoyang City was -54803.87 tons. The allowable emission of ammonia nitrogen was -1305.24 tons. And the allowable emission of total phosphorus was -720.10 tons.

Figure 3 Allowable Discharge of Major Water Environmental Pollutants in Chaoyang City

5. Research on Water Environment Management and Control Countermeasures

For the priority areas of water environment protection, such as the water environment space control of drinking water sources, important wetlands and other high-functional water areas should be protected strongly. In drinking water source protection areas, activities that would pollute drinking water environment and activities that would disrupt the ecological balance of the water environment were prohibited. In wetland reserves, discharging pollutants into the wetland beyond the water quality standard should be forbidden.

For the key pollutant management units, the treatment of industrial pollution sources and urban life pollution sources should be strengthened. The wastewater in the industrial park must be pre-treated to meet the requirements of the centralized treatment standard and then it could be allowed to discharge into the centralized sewage treatment facility. The sewage collection pipe network of the towns and
villages in the river basin should be improved. In order to fundamentally avoid direct sewage discharge, all sewage from the towns and villages should be collected. Non-point source pollution should be controlled more powerfully. For villages where farming and production activities were concentrated, comprehensive utilization infrastructures for livestock and poultry farming wastes should be built. And the comprehensive utilization of farming wastes should be promoted.

For the general water environment management units, it was important to optimize the industrial structure and strictly plan the residential areas and industrial function areas. Protecting the habitat of rivers and lakes and wetlands should also be valued. For these water environment management units, water environment protection was also important. In order to ensure the discharge of sewage standards, the treatment of urban and rural domestic sewage should be promoted and the agricultural non-point source pollution should be controlled.

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