Water Quality Evaluation and Analysis of Main Pollutants Along the Weihe River

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Abstract. Through the analysis of the water quality evaluation and the change of main pollutants along the course of 13 national control monitoring sections of Weihe river main stream (Shaanxi section), the theoretical basis is provided for the formulation of effective prevention and control measures. The chemical oxygen demand (COD) and ammonia nitrogen (NH₃-N) were determined by investigating and collecting water samples, and the trend curves of cod and NH3-N pollution were drawn. Results from 2006 to 2009, the main stream of Weihe river (Shaanxi section) 13 In addition to the water quality of the four sections from linjia village to changxingqiao, the water quality of the other nine sections exceeds the water quality function standard, and the water quality is worse than grade v, the pollution is very serious. Promote the Weihe river (Shaanxi section) industrial structure adjustment, strict sewage standards, strengthen the sewage treatment plant and urban environmental protection infrastructure construction and other five aspects of prevention and control measures.

1. Introduction

The Weihe River Basin is an important industrial, agricultural, scientific research and production base in Shaanxi Province with a dense population. However, the water quality of the dry and tributary rivers of the Weihe River has been deteriorating, and the living and production water of urban residents have been seriously affected. Therefore, the prevention and control of water pollution cannot be delayed. According to statistics, the amount of waste water flowing into the Weihe River accounts for about 80% of the Yellow River Basin in Shaanxi [1-3]. In order to ensure yellow water quality and water supply security, starting from the objectives of management requirements and water quality protection, based on a large number of survey data, the distribution of water pollution sources and characteristics of pollutants entering the river in the study area were analyzed, and the water quality monitoring data of the study area was analyzed. The evaluation of water quality in the water environment functional area has important scientific value for the water environment management, water pollution control and water resources protection planning of the Weihe River in Shaanxi [4-6].

In this study, we use the Shaanxi section of the Weihe River as a research section to collect data on socio-economic conditions, water quality status, development and utilization of water resources, carry...
out surveys of river discharge outlets and water quality monitoring, and conduct water quality assessment and trend analysis. This will provide a basis for the comprehensive management of the Weihe River basin and promote the sustainable development of the Guanzhong area.

2. Assessment section and water functional zoning

2.1. Evaluation section selection
Weihe River pollution mainly occurred in Shaanxi province, Shaanxi linjia village section upstream canyon, shoal, water flow is urgent, less industrial and agricultural pollution, river water quality is good. Therefore, in order to reflect the water environment pollution of Weihe River, 13 monitoring sections of Shaanxi section of Weihe River were selected as evaluation sections. These sections fully take into account the distribution of water systems, the location of major pollution sources and river functional zoning in the Weihe River basin, and can accurately represent the water quality status of the Weihe River mainstream.

2.2. Water function division and water quality objectives
The government of the People's Government of China and Shaanxi Province has divided water function zones in the Shaanxi section of the Weihe River basin. With reference to the Shaanxi Provincial Environmental Protection Bureau's water environment functional zoning, that is, “The Surface Water Function Regionalization Plan for the Weihe River Mainstream (Shaanxi Section)” (DB61-224-1996), the surface water environmental quality standard to be implemented is “Surface Water Environmental Quality Standard” (GB3838-2002), The division of the functional sections of the Shaanxi section of the Weihe River and the water quality target requirements are shown in Table 1.
Table 1. Water function section differentiation and water quality target of Shannxi reach of the Weihe River

| No | Grade 1 water function zone name                                      | Secondary water function zone name | Starting section | End section | Length (km) | Water quality aims |
|----|----------------------------------------------------------------------|-----------------------------------|------------------|-------------|-------------|-------------------|
| 1  | Weihe Baoji, Weinan development and utilization zone                 | Weihe river Baoji agricultural water district | Yan Jiahe        | Lin Jiacun   | 43.9        | III               |
| 2  | Weihe Baoji, Weinan development and utilization zone                 | Weihe Baoji Landscape             | Lin Jiacun        | Wolong Temple| 20.0        | III               |
| 3  | Weihe Baoji, Weinan development and utilization zone                 | Weihe river Baoji                 | Wolong Temple     | Guo Town    | 12.0        | IV                |
| 4  | Weihe Baoji, Weinan development and utilization zone                 | Weihe river Baoji                 | Guo Town          | Cai Jiapo   | 22.0        | IV                |
| 5  | Weihe Baoji, Weinan development and utilization zone                 | Weihe river Baoji                 | Cai Jiapo         | Yongan Village | 44.0      | III               |
| 6  | Weihe Baoji, Weinan development and utilization zone                 | Weihe river Yangling agricultural water district | Yongan Village | Qishui River Entrance | 16.0 | III               |
| 7  | Weihe Baoji, Weinan development and utilization zone                 | Weihe river Xianyang agricultural water district | Qishui River Entrance | Xianyang Highway Bridge | 63.0 | IV                |
| 8  | Weihe Baoji, Weinan development and utilization zone                 | Weihe river Xianyang landscape entertainment water area | Xianyang Highway Bridge | Xianyang Railway Bridge | 3.8 | IV                |
| 9  | Weihe Baoji, Weinan development and utilization zone                 | Weihe river Xianyang Sewage Disposal Control Area | Xianyang Railway Bridge | Fenghe River entrance | 5.4 | IV                |
| 10 | Weihe Baoji, Weinan development and utilization zone                 | Weihe river Xianyang transitional area | Fenghe River entrance | Caotan town | 19.0 | IV                |
| 11 | Weihe Baoji, Weinan development and utilization zone                 | Wei Xi'an Agricultural Water District | Caotan town       | Zero River Entrance | 56.4 | IV                |
| 12 | Weihe Baoji, Weinan development and utilization zone                 | Weihe river Weinan agricultural water area | Zero River Entrance | Luo River Entrance | 96.8 | IV                |
| 13 | Weihe river Huayin buffer zone                                      | Huayin into the yellow buffer     | Luo River Entrance | Yellow entrance | 29.7 | IV                |

3. Water quality evaluation method
In order to evaluate the impact of multiple pollutants on the integrated pollution of water quality, comprehensive pollution index method was used to evaluate the selected areas [7]. Calculated as follows:

\[ P_j = \frac{1}{n} \sum_{i=1}^{n} P_{ij} \]  (1)
\[ P_j = \frac{C_{ij}}{C_{i0}} \]  

(2)

Where: \( P_j \) — j river water pollution composite index; \( P_{ij} \) — j river pollution index of the \( i \) pollution index; \( C_{ij} \) — i pollution index of the average concentration of each water period of the \( j \) river course; \( C_{i0} \) — Evaluation criteria value of the \( i \) pollution index of the 0 river course; \( n \) — Number of pollution indicators.

From the actual situation of rivers in China, when the comprehensive pollution index of the river is \( P \leq 2.0 \), the river is dominated by type I~II water, and the water quality is excellent; at \( 2.0 < P \leq 4.0 \), the river is mainly type II~III water, and the water quality is good; at \( 4.0 < P \leq 8.0 \), the river is dominated by Type IV water and its water quality is generally good. At \( 8.0 < P \leq 12.0 \), the river is dominated by Type V water and the water quality is poor. At \( P > 12.0 \), the river is dominated by poor Type V water and the water quality is very poor.

When using the above formula, the following formula is used for DO with a decreasing degree of pollution as the concentration increases [8]:

\[ P_{ij} = \frac{C_{\text{max}} - C_{ij}}{C_{\text{max}} - C_{i0}} \]  

(3)

Where: \( C_{\text{max}} \) is the maximum possible DO concentration in water.

4. Evaluation Results and Analysis

According to the monitoring data of the major water quality sections from January 2012 to December 2014, the watershed period will be evaluated. The evaluation period of the Weihe River is divided into three periods of the year, the flood season, and the non-flood season. The water pollution process and control of the 13 sections in the Weihe River Basin are systematically studied. The site evaluation results are shown in Table 2.
Table 2. Surface water quality assessment of Weihe River sites

| Section name       | Water period   | Water quality category | Excess factor                                         |
|--------------------|----------------|------------------------|-------------------------------------------------------|
| Wenfeng            | annual         | Inferior V             | COD, Ammonia nitrogen                                  |
| Wenfeng            | flood season   | Inferior V             | COD, Ammonia nitrogen, BOD                            |
| Wenfeng            | Non-flood period | Inferior V          | Ammonia nitrogen                                      |
| Wushan             | annual         | V                      | COD                                                   |
| Wushan             | flood season   | V                      | COD                                                   |
| Wushan             | Non-flood period | V                   | COD                                                   |
| Gangu              | annual         | V                      | Volatile phenol                                       |
| Gangu              | flood season   | V                      | COD, Total nitrogen                                    |
| Gangu              | Non-flood period | V                   | Volatile phenol                                       |
| North              | annual         | Inferior V             | Total nitrogen                                         |
| North              | flood season   | Inferior V             | Total nitrogen                                         |
| North              | Non-flood period | Inferior V           | Ammonia nitrogen, Total nitrogen                       |
| Tuoshi             | annual         | IV                     | COD                                                   |
| Tuoshi             | flood season   | IV                     | COD                                                   |
| Tuoshi             | Non-flood period | IV                   | COD                                                   |
| Linjia             | annual         | III                    | COD, Ammonia nitrogen                                  |
| Linjia             | flood season   | III                    | COD, Ammonia nitrogen                                  |
| Linjia             | Non-flood period | III                  | COD, Ammonia nitrogen                                  |
| Xianyang Highway Bridge | annual     | Inferior V             | COD, Ammonia nitrogen, BOD, Total nitrogen           |
| Xianyang Highway Bridge | flood season | Inferior V             | BOD, Total nitrogen                                    |
| Xianyang Highway Bridge | Non-flood period | Inferior V | COD, Ammonia nitrogen, BOD, Total nitrogen, Permanganate index |
| Geng Town          | annual         | Inferior V             | COD, Ammonia nitrogen, BOD, Total nitrogen            |
| Geng Town          | flood season   | Inferior V             | COD, Ammonia nitrogen, BOD, Total nitrogen            |
| Geng Town          | Non-flood period | Inferior V          | COD, Ammonia nitrogen, BOD, Total nitrogen            |
| Huaxian            | annual         | Inferior V             | COD, Ammonia nitrogen, BOD, Total phosphorus, Permanganate index |
| Huaxian            | flood season   | Inferior V             | Ammonia nitrogen                                       |
| Huaxian            | Non-flood period | Inferior V          | COD, Ammonia nitrogen, BOD, Total phosphorus, Permanganate index |
| Suspension Bridge  | annual         | Inferior V             | COD, Ammonia nitrogen                                  |
| Suspension Bridge  | flood season   | Inferior V             | Ammonia nitrogen                                       |
| Suspension Bridge  | Non-flood period | Inferior V          | Ammonia nitrogen, Total phosphorus                     |

①Through the comprehensive analysis of dissolved oxygen (DO), permanganate index, BOD, ammonia nitrogen (NH3-N), volatile phenol, petroleum and other six indicators, the pollution status of
the Weihe River in Shaanxi was classified and evaluated. In the cross sections, with the exception of the Linjia Village section, the comprehensive evaluation of other sections was inferior V class, accounting for 78% of the evaluation section, and it was a serious pollution.

②Through the statistical analysis of the indexes in wet season, flat water period and dry season, it is shown that the proportion of dry seasons reaching poor V category is much higher than that of wet season, and the proportion of permanganate index in dry season accounts for 61.2% of the controlled river length. The wet period is 30.2%. The reason for the increased pollution is mainly due to the reduction of the amount of ecological water in the river course and the decrease in self-purification capacity, that is, the pollution in the dry season is even more serious.

③Through the analysis of the pollution sources in each section of the river basin, the non-point source pollution in the river basin is considered to be the main cause of ammonia nitrogen pollution. The amount of ammonia released is 76.54%, while the ammonia emission from point sources only accounts for 23.46%. The permanganate index is mainly caused by point source pollution, that is, the pollution of industrial wastewater and urban domestic sewage.

5. Conclusion
The basic requirement of river water quality assessment is to understand the law of movement of major river pollutants [9]. Therefore, it is necessary to master the dynamic changes of pollutants in different periods and seasons in time; in the space, it is necessary to grasp the environmental changes of different river sections, different parts of upstream and downstream, and the contrast of quality changes. Only by understanding and mastering these basic laws can the river water quality evaluation be typical and representative, so as to accurately reflect the basic characteristics of different river water quality.

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