

Calculating NH₃-N pollution load of wei river watershed above Huaxian section using CSLD method

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Abstract: Huaxian Section is the last hydrological and water quality monitoring section of Weihe River Watershed. So it is taken as the research objective in this paper and NH₃-N is chosen as the water quality parameter. According to the discharge characteristics of point source pollutions and non-point source pollutions, a new method to estimate pollution loads—characteristic section load (CSLD) method is suggested and point source pollution and non-point source pollution loads of Weihe River Watershed above Huaxian Section are calculated in the rainy, normal and dry season in the year 2007. The results show that the monthly point source pollution loads of Weihe River Watershed above Huaxian Section discharge stably and the monthly non-point source pollution loads of Weihe River Watershed above Huaxian Section change greatly. The non-point source pollution load proportions of total pollution load of NH₃-N decrease in the normal, rainy and wet period in turn.

1. Introduction

Since the occurrence and sources of non-point source pollution is random, and pollution load vary widely in time and space, those bring much difficulty to the calculation of non-point source pollution load. With the point source pollution gradually brought under control, non-point source pollution problem of river basin is increasingly prominent. Although there are many relatively comprehensive, advanced methods can be used to estimate non-point source pollution load, such as runoff segmentation method^[1], the output coefficient method^[2], water quality & quantity method^[3], Rainfall deduction method^[4], Mean concentration method^[5], etc. But these parameters are numerous, and some parameter measurements are difficult to obtain^[6]. In this paper, According to the characteristics of point source pollution and non-point source pollution, a new method—characteristic section load method is proposed to estimate NH₃-N pollution load. Taking Weihe River Watershed above Huaxian Section as the research object, the point source and non-point source pollution loads in the rainy, normal and dry season are calculated in the year 2007. Huaxian Section is the last hydrological and water quality monitoring section of Weihe River, the quantitative count of pollutant loads is the basis of researches on environmental problems such as improving water quality.

2. Research Methods

How to estimate the amount of non-point source pollution load based on limited information has become an important basis for the prediction of water quality and water quality planning. Since monitoring non-point source pollution is difficult and high cost, there is almost no continuous



monitoring data in our country. The characteristics load method proposed in this paper is a new method to estimate annual pollutant emissions, which based on the characteristics of the point source pollution and non-point source pollution. Non-point source pollutants enter the earth's surface and groundwater in a form of wide-area dispersion and trace. Such pollution load is very huge, with a great randomness, uncertainty and complexity, and influenced by the external climate to a large extent, hydrological conditions in a large extent. Point source pollution is the pollution that mainly includes the fixed outfall discharge of city life sewage and industrial wastewater. In a particular year, under the premise of no significant changes in the urban population, and the monthly emissions of pollutants in urban living is relatively stable, while industrial waste water amount changes a little during the year, the point source pollutant discharge is relatively stable. Since the non-point source pollution load vary large in a year and calculating the total pollution load is relatively easy and simple, the non-point source pollution load estimation can be obtained indirectly in the way that the total pollution load minus the watershed point source pollution load. Rainfall runoff is the main reason for the watershed non-point source pollution. In the dry season the basin has little rain and the pollutants load is mainly point source pollution load. So above the river characteristic sections, the basin point pollution monthly load L_{ppm} can be determined by the minimum value of the average concentration C_i multiplied the average flow W_i in the dry season.

$$L_{ppm} = \text{Min}(C_i W_i) \quad (1)$$

The monthly river basin pollution total load L_{tm} is determined by the water quality concentration C_i multiplied the average flow W_i in the characteristics section.

$$L_{tm} = C_i * W_i \quad (2)$$

The monthly river basin non-point source pollution load L_{nppm} equals the monthly total watershed pollution load L_{tm} minus the basin point source pollution load L_{ppm}

$$L_{nppm} = L_{tm} - L_{ppm} \quad (3)$$

The basin yearly point source load L_{ppy} can be counted by

$$L_{ppy} = 12 * \text{Min}(C_i * W_i) \quad (4)$$

The basin yearly point source total load L_{ty} can be computed by

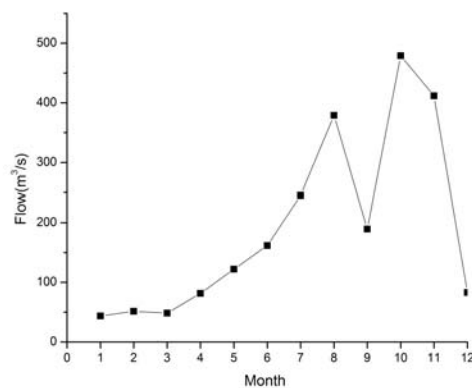
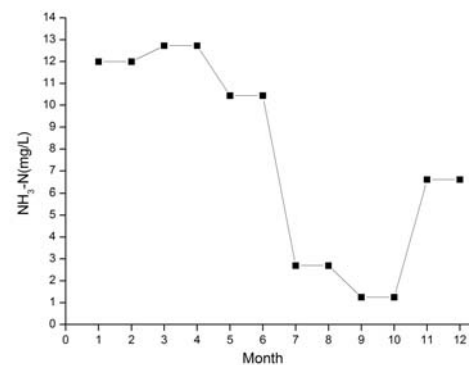
$$L_{ty} = \sum_{i=1}^{12} C_i * W_i \quad (5)$$

The basin yearly non- point source load L_{nppy} can be calculated by

$$L_{nppy} = L_{ty} - L_{ppy} \quad (6)$$

The characteristic section load method is applied to estimate the pollution load of Weihe River Basin above Huaxian Section. $\text{NH}_3\text{-N}$ is the water quality parameter. 2007 is selected as the current year. The water phase is divided as follows: July, August, September and October are wet periods. April, May, June and November are flat water periods. January, February, March and December are dry seasons.

The river flow changes of Huaxian Section in 2007 are shown in figure 1.

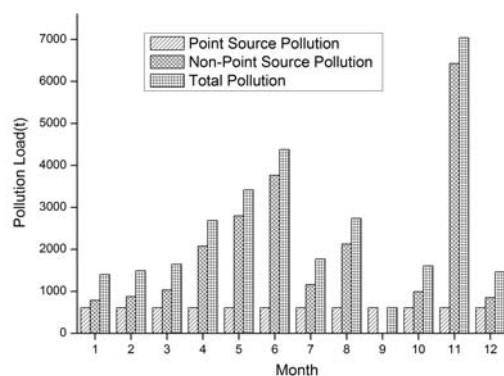
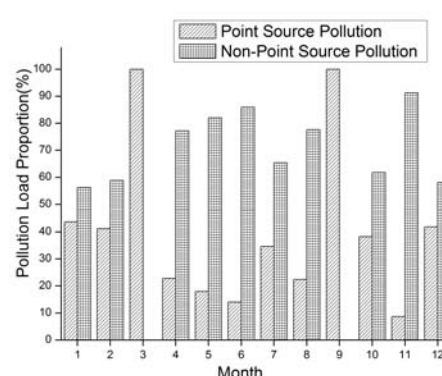
**Fig.1** Flow changes of Huaxian Section in 2007**Fig.2** NH₃-N concentration changes in 2007

As can be seen from Figure 1, the flow of Huaxian Section increases from January to August and declines in September. Then the flow increases to maximum flow in October and reduces in November and December. January's average flow is 43.66 m³/s, 379.05 m³/s in August, 479.19 m³/s in October, and 82.89 m³/s in December. The average flow is 323.22 m³/s in the wet period, 194.25 m³/s and 56.55 m³/s in the normal and dry season.

The NH₃-N concentration changes of Weihe River Watershed above Huaxian Section in 2007 are shown in figure 2. As can be seen from Figure 2, the minimum of NH₃-N concentration is 1.25 mg/L in September and October and the maximum is 12.73 mg/L in March and April. The annual average concentration is about 7.62 mg/L. The NH₃-N concentration is 1.98 mg/L in wet period, 10.05 mg/L and 10.83 mg/L in the normal and dry season.

3. Results

The equations (1) to (6) of characteristic section load method are used to calculate the NH₃-N point source and non-point source pollution load. The results are shown in Figure 3 and Figure 4.

**Fig.3** NH₃-N pollution loads in 2007**Fig.4** NH₃-N pollution loads proportion in 2007

As can be seen from Figure 3 and Figure 4, the total annual NH₃-N discharge is 30260.81 t. Among them, the point source emission is 7364.65 t, accounting for 24.34% of the total annual emissions. The non-point source is 22896.16 t, accounting for 75.66% of it. The NH₃-N point source pollution load stabilize emission in each month, the monthly average load is 613.72 t. Non-point source pollution load emission changes largely in each month. The largest NH₃-N non-point source pollution load is in the normal period. The total emission is 15066.71 t, accounting for 65.80% of the annual total

emissions. Followed is the wet season, total emission is 4277.69 t, accounting for 18.68% of the total annual emissions. The minimum is in dry period, the total emission is 3551.76 t, accounting for 15.51% of the total annual emissions. The average monthly $\text{NH}_3\text{-N}$ non-point source pollution load is 3766.68 t in the normal period, 1069.42 t and 887.94 t in the dry and wet season.

4. Conclusions

This paper established a new method- characteristic load method to estimate non-point source pollution loads. The $\text{NH}_3\text{-N}$ pollution load above Huaxian Section of Weihe River Basin is estimated in 2007. The conclusions are following:

- 1) The point source pollution load discharge stably each month throughout the year above Huaxian Section of Weihe River Basin. $\text{NH}_3\text{-N}$ monthly average load is 613.72 t, and its annual average load is 7364.65 t.
- 2) The non-point source pollution emissions vary widely each month throughout the year above Huaxian Section of Weihe River Watershed and the annual load is 22896.16 t.
- 3) In the rainy, flat and dry season, non-point source pollution load of $\text{NH}_3\text{-N}$ proportion accounting for the total pollution load is 18.68%, 65.80% and 15.51%.

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