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# Changing Regulations of COD Pollution Load of Weihe River Watershed above TongGuan Section, China

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**Abstract:** TongGuan Section of Weihe River Watershed is a provincial section between Shaanxi Province and Henan Province, China. Weihe River Watershed above TongGuan Section is taken as the research objective in this paper and COD is chosen as the water quality parameter. According to the discharge characteristics of point source pollutions and non-point source pollutions, a method—characteristic section load (CSLD) method is suggested and point and non-point source pollution loads of Weihe River Watershed above TongGuan Section are calculated in the rainy, normal and dry season in 2013. The results show that the monthly point source pollution loads of Weihe River Watershed above TongGuan Section discharge stably and the monthly non-point source pollution loads of Weihe River Watershed above TongGuan Section change greatly and the non-point source pollution load proportions of total pollution load of COD decrease in the rainy, wet and normal period in turn.

## 1. Introduction

Because the occurrences of non-point source pollution are random and pollution loads vary widely in time and space, those bring much difficulty to calculate the non-point source pollution load. The point source pollutions are gradually under control and non-point source pollution problems of river basins are increasingly prominent. 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] and etc. But these parameters are numerous and some parameters measurements are difficult to obtain[6]. In this paper, according to the characteristics of point source pollution and non-point source pollution, a method—characteristic section load method is proposed. Chemical Oxygen Demand (COD) of point and non-point source pollution loads are calculated by this simple and practical method. Weihe River Watershed above TongGuan Section is chosen as the research object. The point source and non-point source pollution loads are calculated in the rainy, normal and dry season in the year 2013. TongGuan Section of Weihe River Watershed is a provincial section between Shaanxi Province and Henan Province, China. The quantitative computing of pollutant loads is the basis of many researches on environmental problems such as preventing water pollutions and so on.

## 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 and planning of water quality. Since monitoring non-point source pollution is difficult and cost highly, there is almost no continuous monitoring data in China. The characteristic section load method proposed in this paper is a method to estimate annual and monthly pollutant emissions which based on the characteristics of the point and non-point source pollution. Non-point source pollutants enter the earth's surface and groundwater in the form of wide area and dispersion. Such pollution load is very huge with a great randomness, uncertainty and complexity and influenced by climatic and hydrological conditions in a large extent. Point source pollution is the pollution that mainly includes the fixed discharge outfall of city life sewage and industrial wastewater. In a year, urban population and the monthly emissions of urban living pollutants are relatively stable. While industrial wastewater amount changes a little during the year, the point source pollutant discharge is relatively stable. Since the non-point source pollution load vary largely 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, there is little rain in the basin 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.

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

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

$$L_{tm} = C_i * W_i \tag{2}$$

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 $L_{ppm}$

$$L_{nppm} = L_{tm} - L_{ppm} \tag{3}$$

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

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

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

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

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

$$L_{nppy} = L_{ty} - L_{ppy} \tag{6}$$

The characteristic section load method is applied to estimate the pollution load of Weihe River Basin above TongGuan Section. COD is the water quality parameter. 2013 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 TongGuan Section in 2013 are shown in figure 1.

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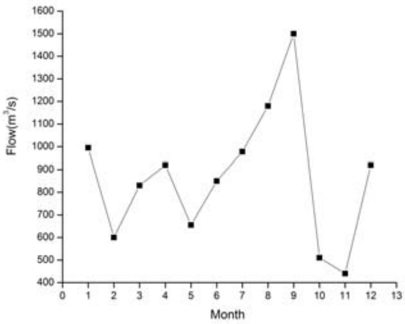


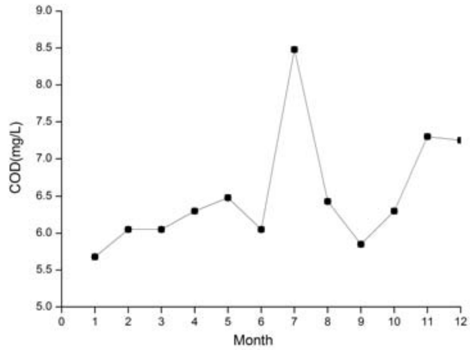



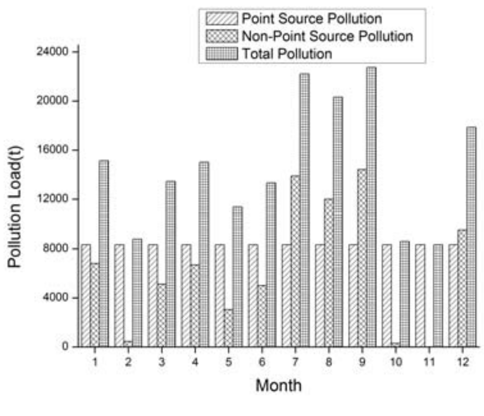

**Fig.1** Flow changes of TongGuan Section in 2013 **Fig.2** COD concentration changes in 2013

As can be seen from figure 1, the maximum flow of TongGuan Section is 1500.00 $m^3/s$ in October and the minimum flow is 440.00 $m^3/s$ in November. Average flows in January, April and December are 995.00 $m^3/s$, 920.00 $m^3/s$ and 920.00 $m^3/s$ respectively. Average flows in February and May are 600.00 $m^3/s$ and 655.00 $m^3/s$ respectively. The annual average flow is about 864.83 $m^3/s$. The average flow is 1042.00 $m^3/s$ in the wet period, 716.25 $m^3/s$ and 836.25 $m^3/s$ in the normal and dry season.

The COD concentration changings of Weihe River Watershed above TongGuan Section in 2013 are shown in figure 2. As can be seen from Figure 2, the maximum of COD concentration is 8.48 mg/L in July and the minimum is 5.68 mg/L in January. The annual average concentration is about 6.52 mg/L. The COD concentration is 6.77 mg/L, 6.53 mg/L and 6.26 mg/L in the wet, normal and dry season respectively.

## 3. Results

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



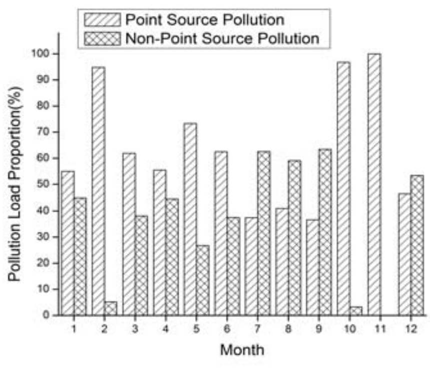




**Fig.3** COD pollution loads in 2013 **Fig.4** COD pollution loads proportion in 2013

As can be seen from Figure 3 and Figure 4, the total annual COD discharge is 177165.49 t. Among them, the point source emission is 99906.05 t accounting for 56.39% of the total annual emissions. The non-point source is 77259.45 t accounting for 43.61% of it. The COD point source pollution load discharges stably in each month and the monthly average load is 8325.50 t. Non-point source pollution load emission changes largely in each month. The largest COD non-point source pollution load is in the dry period. The total emission is 40583.73 t accounting for 52.53% of the annual total emissions. Followed is the dry period and total emission is 21931.44 t accounting for 28.39% of the total annual emissions. The minimum is in the normal season and the total emissions is 14744.28 t accounting for

19.08% of the total annual emissions.

## 4. Conclusions

Characteristic section load method is established to estimate non-point source pollution loads in this paper. The COD pollution load above TongGuan Section of Weihe River Basin is estimated in 2013. The conclusions are following:

1) The point source pollution load discharge stably each month throughout the year above TongGuan Section of Weihe River Basin. COD monthly average load is 8325.50 t and its annual average load is 99906.05.

2) The non-point source pollution emissions vary widely each month throughout the year above TongGuan Section of Weihe River Watershed and the annual load is 77259.45 t.

3) In the rainy, flat and dry season, non-point source pollution load of COD proportions accounting for the total pollution load are 52.53%, 19.08% and 28.39% respectively.

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