Pollution Source Analysis of KL River Basin in Hefei
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Abstract. To analyze the status of regional natural environment in KL River basin, and the establishment of pollution source survey list, to classify the pollution sources in the river basin, estimated the emissions of point source and non-point source pollution in the basin and discharge to river. It turns out that the pollution sources were mainly non-point source pollution, including rural domestic pollution, livestock and poultry pollution, agricultural pollution, urban surface runoff pollution and aquaculture pollution. In the amount of pollutant emissions, large-scale livestock and poultry breeding accounted for 74.8% of the total annual COD\textsubscript{Cr} emissions, 35.62% of the total \textsubscript{NH}_{3}-N emissions, 39.14% of the total TN emissions and 71.46% of the total TP emissions. It is the main source of regional pollutants. Hereby this paper analyzed the source of the pollutant in the basin.

Introduction
KL River is the upper part of a river in Hefei. It is about 25.1 kilometers long and owns an watershed area of about 168km\textsuperscript{2} \cite{1-3}. The KL River is a tributary of the river debouches into the Chao lake. The analysis of pollution source of KL River is of great significance for comprehensive pollution control. By the integration and promotion of the system, and research on regional water pollution, which provide the fundamental data support for the river pollution control project, and put forward the measures to protect the ecological safety of water, providing reference for the analysis of pollution sources of rivers in similar conditions.

Analysis of River Pollution Source

Conception of Pollution Source Analysis
The analysis of river pollution sources refers to the qualitative and quantitative identification of pollutants in rivers and the sources of pollutants in rivers. Through the analysis of the sources of various pollutants, the relative contributions of various sources are determined, and the sources of pollutants are attributed to different sub basins or different output sectors of the river basins.

Methods of Pollution Source Analysis
In present time, at home and abroad, the methods of pollution sources analysis are mainly analytical method based on pollution load estimation including coefficient method; index method based on the analysis of potential pollution ;source analysis method based on the pollutant
characteristics of source to receptor, etc. According to the characteristics of the natural environment in the study area, the pollution source investigation method is established. By the combined method of data investigation and on-the-spot investigation, the basic information of the social and economic development of the basin is obtained. Then the key sources of pollution and pollution control unit of the basin is determined. To establish the key sources of pollution emissions list, and get acquaintance of the regional pollution.

Pollution Source Investigation

Pollutant Classification and the Estimation of River Intake

The point source pollution of rivers mainly includes the discharge of urban domestic sewage and the discharge of industrial pollution and wastewater\(^4\). The non-point source pollution is mainly caused by the discharge of rural household garbage and percolate, the discharge of rural breeding and agricultural pollution\(^5\)\(^-\)\(^7\). Internal pollution mainly refers to the discharge of pollutants from the river substrate sludge\(^8\)\(^-\)\(^10\).

Point Source

**Pollution Source from the Urban.** The pollution of the urban is mainly caused by the treatment of uncut discharge of sewage from urban residents but not by the pipe. Given the survey results, the KL River basin got a urban population of 30225. The majority of the sewage go through the ditch into the KL River. According to the prophase investigation of the parameter survey, combining the parameter given by the first national census of pollution sources(urban pollution sources), calculate the domestic sewage on basis of the following formula.

\[
W = P \times k_1 \quad (1)
\]

\[
L = P \times k_2 \quad (2)
\]

W: Sewage quantity
P: Number of people
L: Pollution Emissions
K1: Coefficient of sewage discharge(every person everyday)
K2: Coefficient of pollutant discharge (every person everyday)

According to the regional division provide by *Handbook of coefficients of producing and emitting pollutants in the first national census of pollution sources(urban pollution sources)*, Anhui province belongs to zone 3. On the basis of the city classification, Hefei belongs to category I. Relying on the table lookup, the quantity of domestic sewage is 180 L(for each person every day). The emission factor (by septic tank) of COD\(_{Cr}\),NH\(_3\)-N,TN,TP are 65g(for each person every day),10.7g(for each person every day),0.77g(for each person every day).

**Industrial Pollution Source.** The industrial waste of the KL River basin are mainly come from the factory of Y town, which bring 295.4thousand tons of waste water per year. As the construction of sewage plant is not finished, all the factory gathered their sewage in the Oxidation pond except one. (located Southeast of Y town 31°50' 13.50"N, 117° 3' 18.38"E).And drain into the KL River after simple treatment. The emissions of the industrial pollution within the basin are calculated based on the actual pollutant concentration.

<table>
<thead>
<tr>
<th>Source Type</th>
<th>COD(_{Cr})</th>
<th>NH(_3)-N</th>
<th>TN</th>
<th>TP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban domestic</td>
<td>650.9</td>
<td>88.26</td>
<td>110.32</td>
<td>7.94</td>
</tr>
<tr>
<td>Industrial pollution</td>
<td>33.15</td>
<td>1.99</td>
<td>0.04</td>
<td>0.02</td>
</tr>
</tbody>
</table>

The generation and discharge coefficient of TN, TP are not available in most industries. So the value of TN are inferior to the value of NH\(_3\)-N.
According to the table, the pollution from the urban accounts for a large scale among the point source pollution, mainly due to the shortage of treatment facilities. The industrial waste water get a lower emission thanks to its storage in the Oxidation pond located in Y town.

**Non-Point Source**

**Rural Domestic Pollution.** The rural domestic pollution are mainly rural residents’ domestic sewage and fecal sewage. Y town has a total permanent population of 23203(within the basin), without collection and processing facilities.

According to the geographic classification, the process mode of the percolate and the form of the toilet set by Technical manual of a demonstrative project with Continuous improvement in the rural environment of Anhui province, Handbook of coefficients of producing and emitting pollutants in the first national census of pollution sources(urban pollution sources), the discharge of rural domestic sewage is 70L(for each person every day), the value of COD$_{Cr}$, NH$_3$-N, TN, TP is 50g(for each person every day), 3.2g(for each person every day), 6.5g(for each person every day), 0.7g(for each person every day). Then calculate the emission of rural domestic sewage within the basin with these values.

**Pollution of Livestock and Poultry Breeding Industry.** There are about 1180000 chickens and ducks, 230000 pigs, 883 sheep, were cultured. The small-scale farming has 12000 chickens and ducks, 100 pigs, 40 sheep. According to the data collected in the survey, the pattern of livestock and poultry, the race, quantity, excreta disposal, and above all, Handbook of coefficients of producing and emitting pollutants in the first national census of pollution sources(livestock industry). The process mode of the excrement is rinse. The farm owns more than 500 pigs set the value parameter as the following number: COD$_{Cr}$,186.67, NH$_3$-N,94, TN,12.36, TP,2.58.(g, for each animal every day).The farm owns pigs more than 50 but less than 500 set the value parameter as the following number: COD$_{Cr}$,278.79, NH$_3$-N8.68, TN,21.70, TP,2.76.(g, for each animal every day). The pigs raise in free range has the dry collection process mode of the excrement. And the coefficient waste of COD$_{Cr}$,NH$_3$-N, TN, TP,70.16,5.17,13.19,0.70( g, for each animal every day). The species of livestock in large scale henry is broiler. The process mode of the excrement is rinse. The rearing phase: commercial broiler. The coefficient waste of COD$_{Cr}$,NH$_3$-N, TN, TP,37.88, 0.38, 0.95, 0.41( g, for each animal every day). The livestock with dry collection process mode of the excrement set the value parameter as the following number: COD$_{Cr}$,2.32, NH$_3$-N0.03, TN0.07, TP,0.02.( g, for each animal every day). The chicken and ducks raise in free range treat the excrement in the mode of dry collection. And the coefficient waste of COD$_{Cr}$,NH$_3$-N, TN, TP,1.55, 0.02, 0.05, 0.03(g, for each animal every day). The cattle both raise in free range and in the farm treat the excrement in the mode of dry collection. The coefficient of waste as the following number: COD$_{Cr}$,141.15, NH$_3$-N21.67, TN,55.24, TP,3.20.(g, for each animal every day). The parameter of the sheep set based on the experience: 3 sheep equals to a pig. Then calculate the emissions as the following formula:

$$L=M\times k\times 365\times 10^{-6}$$  \(3\)

L: Emissions of the pollutant(t/a)
M: Number of livestock and poultry
k: Coefficient of the emissions of the pollutant (g, for each animal every day)

**Agriculture Pollutant.** By keep a tally to the pesticide and fertilizer applied in KL River basin., there are 25443mu dry land and vegetable field ,49129mu paddy field, 55162mu forest , 835mu garden plot. Based on Handbook of the first national census of pollution sources(agriculture pollution source). The terrain , crop rotation, crop species are considered in the calculation of pollutant discharge. The pollution coefficient of the dry land and vegetable field is COD$_{Cr}$,3.68, NH$_3$-N0.15, TN1.60, TP0.11(kg per mu every year). The paddy field: COD$_{Cr}$,3.87, NH$_3$-N0.39, TN1.18, TP0.07(kg per mu every year). The forest and the garden plot: COD$_{Cr}$,1.67, NH$_3$-N0.03, TN0.32, TP0.03(kg per mu every year).

**Urban Surface Runoff.** Pollutions from the urban surface runoff are mainly the pollutant carried by the initial surface rain$^{[11-12]}$. According to the actual surface runoff concentration test of the urban
built-up area in the upper reaches of Shiwuli river. The pollutant concentration of initial rainwater is relatively high in downtown area. The coefficient of waste as the following number:

COD,71.72,NH$_3$-N1.10,TN3.28,TP 0.21.(mg/L) The total area of built-up area is 13.40km$^2$.

Aquiculture. The area of the aquiculture is 5939mu in KL River basin. And the species are mainly the four major Chinese carps. According to the “Handbook of the first national census of pollution sources(aquiculture)”, freshwater pool culture in the KL River basin, then the effluent coefficient can be find in the handbook. The effluent coefficient of black carp in this area is COD$_{Cr}$15.35,NH$_3$-N0.41,TN1.03,TP0.19(g/kg). The effluent coefficient of chub in this area is COD$_{Cr}$15.95,NH$_3$-N0.84,TN2.11,TP0.37(g/kg). The effluent coefficient of bighead in this area is COD$_{Cr}$8.06,NH$_3$-N0.58,TN1.46,TP0.17(g/kg). The effluent coefficient of grass carp in this area is COD$_{Cr}$65.72,NH$_3$-N2.31,TN5.77,TP1.13(g/kg). Pollutant emissions can be calculated by the value of units increased in production.

<table>
<thead>
<tr>
<th>Table 2. Emission of Non-Point Source Pollution in KL River Basin in 2014 [t].</th>
<th>COD$_{Cr}$</th>
<th>NH$_3$-N</th>
<th>TN</th>
<th>TP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural domestic</td>
<td>433.73</td>
<td>27.76</td>
<td>56.38</td>
<td>6.07</td>
</tr>
<tr>
<td>Livestock breeding</td>
<td>In scale</td>
<td>6580.99</td>
<td>96.28</td>
<td>240.83</td>
</tr>
<tr>
<td></td>
<td>Scattered-fed</td>
<td>9.7</td>
<td>0.28</td>
<td>0.76</td>
</tr>
<tr>
<td>Agricultural pollution</td>
<td>565.72</td>
<td>43.82</td>
<td>174.57</td>
<td>11.36</td>
</tr>
<tr>
<td>Urban surface runoff</td>
<td>367.63</td>
<td>5.69</td>
<td>16.95</td>
<td>1.09</td>
</tr>
<tr>
<td>Aquiculture</td>
<td>156</td>
<td>6.18</td>
<td>15.83</td>
<td>2.73</td>
</tr>
</tbody>
</table>

Summary of the Pollutant Emission. The annual pollution discharge amount of each pollution source is aggregated into the following table:

| Table 3. The Emission Statistics of Pollution Source Survey in KL River Basin. |
|---|---|---|---|---|
| Classification | Type | Emission of pollution per year (t/a) | COD$_{Cr}$ | NH$_3$-N | TN | TP |
| | Amount of sewage (ten thousand t/a) | | | |
| Point source | Residential pollution | 187.55 | 650.9 | 88.26 | 110.32 | 7.94 |
| | Industrial pollution | 29.54 | 33.15 | 1.99 | 0.04 | 0.02 |
| | Sum | 217.02 | 684.05 | 90.25 | 110.36 | 7.96 |
| | Rural domestic | 60.72 | 433.73 | 27.76 | 56.38 | 6.07 |
| | Scatter-fed | 9.7 | 0.28 | 0.76 | 0.16 |
| | Large-scale livestock breeding | 6580.99 | 96.28 | 240.83 | 73.54 |
| Non-point source | Agricultural pollution | 565.72 | 43.82 | 174.57 | 11.36 |
| | Urban surface runoff | 367.63 | 5.69 | 16.95 | 1.09 |
| | Aquaculture | 156 | 6.18 | 15.83 | 2.73 |
| | Sum | 60.72 | 8113.78 | 179.99 | 504.89 | 94.94 |
| Total | 277.81 | 8797.83 | 270.24 | 615.25 | 102.91 |

From the data shows in the table, the main pollution source of the KL River basin are non-point source. The emissions of COD (non-point source pollution) counts for 92.22% of the annual pollution discharge. And NH$_3$-N,66.60%.TN,82.06%,TP,92.26%. Visibly, non-point source pollution is the main source of pollutant in the basin. However, large-scale livestock breeding accounts for a large proportion in non-point source pollution discharge. The emissions of COD (large-scale livestock breeding pollution) counts for 81.12% of the annual non-point source pollution discharge. And NH$_3$-N,53.49%.TN,47.69%,TP,77.46%. Secondly, the proportion of agricultural pollution is also large.
Conclusion

From the analysis above we can see that the pollution in the KL River basin is dominated by non-point sources. Although the amount of sewage is only about 21.86% of the total emission, COD$_{Cr}$, NH$_3$-N, TN and TP emissions account respectively for 92.22%, 66.6%, 82.06% and 92.26% of the total emissions. Large-scale livestock and poultry breeding counts for a large proportion. It’s annual emissions of COD$_{Cr}$, NH$_3$-N, TN and TP respectively accounted for 81.1%, 53.49%, 47.70% and 77.46% of non-point source pollution emissions. From the six sampling points, TN generally exceeded the standard, the sampling points of No.5 upstream exceeded the maximum number of exceed standard items.

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Reference


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