The effect of agricultural non-point Source Pollution of nitrogen and phosphorous on Lake Eutrophication

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Abstract. Based on the data from investigation, the evaluation by equal standard pollution loading method was used to study the agricultural non-point source pollution caused by nitrogen and phosphorous from livestock's feces pollution, chemical fertilizer pollution and fish breeding pond pollution in Liangzi Lake wetland. The results revealed that: The lost amount of nitrogen and phosphorous was separately 1276.49T, 103.04T; the equivalent standard pollution loading amount was separately 12.76X10^8 m^3, 5.15X10^8 m^3. The lost amount of nitrogen was highest in chemical fertilizer. Based pollution on the understanding of the cause of agricultural non-point source in Liangzi Lake wetland, some countermeasures were suggested according to different pollution source.

1. Introduction
Eutrophication of water body is one of the most difficult problems in the world. Agricultural non-point source pollution is one of the main causes of water pollution. In order to control the eutrophication of the water body, it is also important to control the agricultural non-point source pollution and control the industrial point source pollution. It is of great theoretical and practical significance to understand the current situation and characteristics of agricultural non-point source pollution in water environment. There are many studies on the effects of agricultural non-point source N and P pollution on the water environment at home and abroad, especially the eutrophication of surface water [1, 2]. Study on the environmental capacity of the receiving water, the application of the model to study non-point source N, P pollution load has also been reported [3,4]. This paper used equal standard pollution loading method to evaluate pollution source. This paper will provide the basis for the control of agricultural non-point source pollution in Liangzi Lake wetland.

2. Research method

2.1. Evaluation method
In this study, used equal standard pollution loading method to evaluate pollution source. The equal standard pollution load method is the conversion of various pollutants into a unified comparable amount, the results can reflect the impact of pollutants on quality for the environment [5].

The main content of the method: the pollution source concentration or the total amount, after standardized treatment, it can be transformed to the same scale and can be compared with each other. The main pollutants, the key pollution and the total pollution load can be determined according to the
value. The main characteristics of the three identified: Equal standard pollution index, equal standard pollution load and pollution load ratio. Equal standard pollution index refers to the number of pollutants emitted by the pollutant is more than that of the pollution evaluation standard. The equal standard pollution load is the representation of the total pollutant discharge. The pollution load ratio refers to the ratio of the equivalent pollution load of a certain pollution source or a pollutant to the total equivalent standard pollution load, which reflects the pollution contribution of a pollution source [6].

Calculation formula:
- The standard emission of pollutants = the amount of pollution loss / threshold concentration of pollutants.
- Rate of loss of pollutants = the amount of pollutants entering the water environment / total pollutant emission
- Loss of pollutants = Rate of loss of pollutants × emission of pollutants
- The diffusion concentration of pollutants = the source of pollution in the region / the total amount of water resources in the region
- The equal standard pollution index = standard emission of pollutants / the total amount of water resources in the region.

2.2. Evaluation factors:
The evaluation factors were TN (total nitrogen) and TP (total phosphorus).

2.3. Evaluation standard
According to the national evaluation standard of "environmental quality standard for surface water (GB3838-2002)". The threshold concentration of TN is 1mg/L, TP is 0.2mg/L.

2.4. Data sources
Chemical fertilizer, fishponds area, livestock and poultry breeding stock data from the statistical yearbook of Hubei province 2015.

3. Results Analysis

3.1. Nitrogen and phosphorus pollution of chemical fertilizer
2015 total fertilizer consumption was 20098T. According to the survey the present situation of fertilization in the region, the problem of farmland fertilization are that amount of nitrogen more, phosphorus and potassium less, fertilizer utilization rate is low; the proportion of organic fertilizer and inorganic fertilizer is not reasonable; the unreasonable fertilization method. The crop needs a ratio of N: P2O5:K2O should be 1:0.3-0.4:0.6-0.7. The actual fertilization ratio N:P2O5:K2O was 1:0.28:0.24. The part of the fertilizer that is not absorbed by the crops will flow into the water body through the surface runoff, infiltration and so on. According to the nitrogen fertilizer and phosphate fertilizer loss fixed point test report [7, 8] that nitrogen and phosphorus loss accounted were 11% and 1.28% of the year's fertilizer, respectively.

Emissions of pollutants from chemical fertilizer sources= Discharge coefficient × Fertilizer application

The emissions of N and P were 1283.7T and 107.89T (Table 1). The diffusion of N and P were 3.36mg/L and 0.11mg/L, respectively. According to the calculation formula, the equivalent emissions of N and P of chemical fertilizer sources 12.84×10^8m^3 and 5.45×10^8m^3 were obtained. The standard pollution index of N and P were 5.63 and 2.39, respectively.
Table 1. The pollution of chemical fertilizers

|        | emissions T | standard pollution index | equivalent emissions $10^8$ m$^3$ |
|--------|-------------|--------------------------|----------------------------------|
| TN     | 1283.7      | 5.63                     | 12.84                            |
| TP     | 107.89      | 2.39                     | 5.45                             |

3.2. Nitrogen and phosphorus pollution of fishpond

After a period of pond aquaculture activities, the gradual deterioration of water quality, mainly in the water total nitrogen, total phosphorus and BOD, COD were significantly increased, like living in the water with high organic content in algae formed advantage species, leftover feed and fish waste accumulation, water eutrophication [9], easy to outbreak of fish diseases and even cause a lot of dead fish. In this case, the water of fish pond must be changed, the waste water discharged to the nearby streams and lakes will cause some pollution, become an important factor in rural non-point source pollution.

According to the research reports [10], in the normal level of investment, the amount of TN and TP discharged to the environment from the fishponds was 101 kg and 11 kg each hectare in a year.

Emissions of pollutants from fishpond= Discharge coefficient×Fishpond area

According to the above data, we can find out the loss of pollution source of the fishpond (Table 2).

In 2015, the total amount of pollutants discharged from the fishponds was 958.83 T, N and P were 864.66T and 94.17T, respectively. The diffusion of N and P were 1.70mg/L and 0.18mg/L, respectively. According to the calculation formula of the standard emission, the N, P equivalent standard emissions of $8.65\times 10^8$ m$^3$ and $4.71\times 10^8$ m$^3$ in the pollution source of the fish ponds were calculated. N, P equivalent standard pollution index were 3.79 and 2.07, respectively.

Table 2. The pollution of fish breeding ponds

|        | emissions T | equivalent standard pollution index | equivalent standard emissions $10^8$ m$^3$ |
|--------|-------------|----------------------------------|----------------------------------|
| TN     | 864.66      | 3.79                             | 8.65                             |
| TP     | 94.17       | 2.07                             | 4.71                             |

3.3. Nitrogen and phosphorus pollution of livestock manure pollution sources

Livestock and poultry are mainly pigs, cattle, sheep, etc. Livestock pollution source is mainly caused by livestock manure. Refer to the domestic research reports [11-13], the annual pollutant discharge coefficient of livestock is shown in table 3.

Table 3. Pollutant discharge coefficients of livestock's feces (kg / year)

|        | cow dung | Cow urine | sheep manure | pig manure | Pig urine | Poultry manure |
|--------|----------|-----------|--------------|------------|-----------|----------------|
| TN     | 31.9     | 29.2      | 2.28         | 2.34       | 2.17      | 0.275          |
| TP     | 8.61     | 1.64      | 0.45         | 1.36       | 0.34      | 0.115          |

According to the results of the survey, the amount of pollutants discharged into the water body is 10%.

There are 244700 live pigs, 13077 cattle, 7743 sheep, and poultry 4740000 in Liangzi lake region.

Emissions of pollutants = Discharge coefficient× feeding livestock.

According to the formula to calculate the pollutants of livestock and poultry manure and the amount of livestock and poultry manure pollutants into the water (Table4). Livestock and poultry pollution sources N, P loss were 121.68T and 35.77T. The concentrations of N and P in livestock and poultry pollution sources were 5.33mg/L and 1.57mg/L, respectively. According to the calculation formula of the equivalent emissions, the N and P emissions of livestock and poultry pollution sources were calculated as $1.21\times 10^8$ m$^3$ and $1.79\times 10^8$ m$^3$. The N, P equal standard pollution index of livestock and poultry pollution sources were 5.53 and 0.78, respectively.
### Table 4. The discharge amount and lost amount of livestock's feces (t/a)

| Emissions of pollutants | Loss of pollutants |
|-------------------------|-------------------|
|                         | TN    | TP    | TN    | TP    |
| Cow dung                | 417.16| 112.59| 41.72 | 11.26 |
| Cow urine               | 381.85| 21.45 | 38.19 | 2.15  |
| Sheep manure            | 17.65 | 3.48  | 1.77  | 0.35  |
| Pig manure              | 572.60| 332.79| 57.26 | 33.28 |
| Pig urine               | 531.00| 83.20 | 53.10 | 8.32  |
| Poultry manure          | 1303.50| 545.10| 130.35| 54.51 |

### Table 5. Equivalent standard discharged amount of different non-point pollution sources ($10^8$ m$^3$)

| Fertilizer | Livestock manure | Fishponds | Total |
|------------|------------------|-----------|-------|
| TN         | 12.84            | 3.22      | 8.65  | 24.71 |
| TP         | 5.45             | 5.49      | 4.71  | 15.65 |

### Table 6. Equivalent standard discharged rate of different non-point pollution sources (%)

|                      | Fertilizer | Livestock manure | Fishponds | Equivalent standard discharged rate |
|----------------------|------------|------------------|-----------|------------------------------------|
| TN                   | 31.82      | 7.98             | 21.43     | 61.23                              |
| TP                   | 13.50      | 13.60            | 11.67     | 38.77                              |
| Equivalent standard  | 445.31     | 21.58            | 33.10     |                                    |

3.4. The contribution of pollutants to water pollution

In 2015, the amount of pollutants discharged into water by various agricultural non-point source pollution was 2782.68T, TN and TP were 2470.75T and 311.93T, respectively. Fertilizer emissions of TN, TP amounted to 1391.59T, accounting for 50.01%. The total equivalent load of pollution sources was 40.36$\times10^8$ m$^3$, TN and TP were 24.71$\times10^8$ m$^3$ and 15.65$\times10^8$ m$^3$ (Table 5). The loss of TN in fertilizer is the highest among all kinds of pollution sources (Table 6).

3.5. Pollution control measures

Because of the complexity of factors affecting agricultural non-point source pollution, it is difficult to control agricultural non-point source pollution. In order to reduce agricultural non-point source pollution, we can start from controlling the source of non-point source pollution and controlling the diffusion path of non-point source pollutants.

3.5.1. Control strategy of fertilizer pollution

First of all, according to the requirements of sustainable development, guided by the theory of ecology, through the adjustment of industrial structure, take measures to optimize the allocation of agricultural land resources, the adjustment of crop distribution, radically reduce the input of chemical fertilizer. The terrain around lake is low hilly, the higher to the
cultivation of economic forest such as fruit, the lower planting lotus or rice. Secondly, balanced fertilization and nutrient controlled release technology were used to improve the utilization rate of fertilizer. Some measures such as to improved fertilization method, the combination of conventional fertilizer and biological fertilizer, inorganic fertilizer and organic fertilizer.

3.5.2. Control strategy of livestock manure pollution For the pollution prevention and control of livestock and poultry breeding, vigorously promote the livestock and poultry intensive breeding model, this is conducive to centralized treatment of livestock and poultry manure. Using pig-fish-duck-three-dimensional ecological farming model, the three-dimensional model can also be used for the recycling and full utilization of the nutrition elements. To reduce the content of organic nutrients such as nitrogen and phosphorus in the excreta of livestock and poultry by scientifically formulated feed and change feeding, improve the utilization rate of nutrients.

3.5.3. Control strategy of fish pond pollution The control strategy of fish pond pollution include that vigorously develop the high quality aquatic products, such as mandarin fish, snakehead, crab, reduce the amount of fertilizer and fish medicine. Reasonable bait feeding, attention to the size of the feed particle. Timely change water and silt, reduce internal pollution.

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