

Water Resources Value Evaluation from Their Economic Losses*

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Abstract: *This paper has calculated the economic losses resulted from water pollution within the district of south Jiangsu Province of Taihu Lake water system in industry, agriculture, drinking, fishery and tourism. It has also evaluated the value of the water resources in the district by a value-function loss model. A new method of natural resources evaluation has been put forward in the paper and a new way in which natural resources can be priced reasonably has been discussed as well.*

Keywords: *water pollution; economic loss; water resources value*

Traditionally, people think that natural resources are valueless, since they are the natural results. For many years people have used natural resources without paying. Therefore, natural resources have been wasted and lost, even destroyed. Great majority of natural resources has been in short supply actually and this sets a serious limit to the existence and development of the human race. People have to reconsider the relations between human race and nature. More and more people have recognized the value of natural resources and have begun to study its evaluation. In early 1970's, this kind of study was begun in Norway. Since middle 1980's, there had been more than 20 countries and some important international organizations which have already engaged in this kind of study. It was in 1985 that China began the study of natural resources evaluation. This paper has tried to evaluate natural resources by the value-function model of natural resources.

1. The value-function loss model of natural resources

According to the function-value theory of natural resources, the function of natural resources is

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that natural resources can meet some needs of human race. One function of one resource can be regarded as the function of its quality when other factors are not taken into consideration or may be omitted. When the quantity of natural resources is constant, the function of natural resources is dropping with their decreasing quality. Professor Yu Liansheng from Jilin University and his co-operators put forward a model of function loss of natural resources. The formula of value-function model is:

$$\Delta F = - \int_{T_1}^{T_2} \frac{Q}{b} K dc \quad (1)$$

where, Q - the quantity of natural resources, b - function parameter, K - function value of natural resources, c - the quality of natural resources, Ft_1 and Ft_2 are the natural resources values under states T_1 and T_2 respectively. ΔF - the value of function loss of natural resources.

Yu (Yu Liansheng) put forward a function value model of water resources on the basis of the natural resources function value theory.

2. The loss model of function-value of water resources

Regarding water resources in one area, water pollution causes economic loss of each function of them. The relations between the value and the function loss of water resources can be expressed by the value-function loss model as follows:

$$K_i = S_i / R_i \quad (2)$$

where, K_i - the i th function value of water resources, S_i - economic loss value of the i th function of water resources, R_i - value loss rate of the i th function, i - the quantity of water resources functions. The loss rate can be calculated according to the model of "Loss-Concentration", put forward by some authors (James, L. Douglas, Zhu Faqing):

$$R_{ij} = 1 / (1 + a_{ij} \exp(-b_{ij} c_i)) \quad (3)$$

where, a_{ij} and b_{ij} denote pollutant value loss parameters, c_i denotes the i th pollutant concentration.

When there are more than 1 kind of pollutant in water, the aggregative loss rate is:

$$R_i^{(n)} = R_i^{(n-1)} + (1 - R_i^{(n-1)}) R_{in} \quad (4)$$

where, $R_i^{(n)}$ and $R_i^{(n-1)}$ respectively denote the pollution loss rates of the i th function influenced by n kinds and $n-1$ kinds pollutants, R_{in} denotes the pollution loss rate of the i th function influenced by the n th pollutant. The function value of water resources should be the sum of the values of each subfunction:

$$K = \sum_{i=1}^m K_i \quad (5)$$

where, K denotes the function value of water resources, m denotes the quantity of kinds of subfunctions of water resources.

3. Evaluating the value of water resources of Taihu Lake water system by a model

Taihu lake district is one of the most developed districts in our country. With the rapid economic development, environmental pollution is becoming more and more serious. As a result, the area economy sustains heavy losses. Thus it is very important to evaluate the value of water resources of this district.

The functions of water resources in Taihu Lake district can be divided into the following 7 kinds: Water for industry, agriculture irrigation, drinking, fishery, tourism, shipping and flood control.

Organic pollution and eutrophication are the main problems of water pollution problem of Taihu Lake, so COD, BOD, TN and TP are selected as water quality indices in this area. The index values in 1987 are shown in tab.1. a_{ij} and b_{ij} are parameters which are only connected with character of pollutants and functions of water resources and they can be determined by toxicity test and damage test. R_{ij} is got from (3) and R_i from (4).

In 1987, in the 4 cities (i.e. Su Zhou, Wu Xi, Chang Zhou and Zheng Jiang) there were 17 781 enterprises whose sewage disposal quantity was 820.7826 million tons. Although it had been treated in various ways, there was 765.4143 million tons of waste water, which was not in accordance with the standard discharged into water environment.

In addition, there was a large quantity of domestic waste water. The economic loss caused by them are as follows:

3.1 Industry economic loss

The industry economic losses caused by water pollution mainly include: the loss caused by industry enterprises' lacking water because of water pollution; the cost increase of disposing of water for industry caused by water pollution; the loss resulted from the quick depreciation and scrap of the equipment and piping because of using polluted water.

The limited water resources are polluted, so they lose their values and the problem of water deficiency becomes very serious. By estimate, subtracting the water which can be used again and again from the total needed quantity, there is still a water deficiency of 360 million tons in the area, of which about 42.3 million tons are caused by water pollution. In 1987, the water used in industry was about 900 million tons, the net output of industry was RMB 2051.8 million yuan. On the basis of this, the coefficient of net output was calculated RMB 22.79 yuan \cdot t⁻¹. The net output couldn't be got owing to the industry's lacking water. The opportunity cost of water was RMB 22.79 yuan \cdot t⁻¹. The industry economic loss caused by water pollution was calculated RMB 964 million yuan by means of opportunity cost method.

Water pollution increased industry water treatment cost. Subtracting the water, which can be reused from the total quantity of water used, the remaining 792 million tons of water needed disposing. The estimated value of loss was RMB 239 million yuan by means of restoring cost

method and market value method.

Industry equipment depreciation and damage was aggravated because of polluted water. According to foreign relative data, the loss value was about 2 % of the fixed asset investment of that year. The total amount of the fixed asset investment in the 4 cities in 1987 was RMB 4 450 million yuan. The loss value was calculated RMB 89 million yuan by replacement cost method.

From the above the industry economic loss caused by water pollution is RMB 1 292 million yuan. It did not include the losses by interrupted production and decreasing quality of the products because of using polluted water.

3.2 Agriculture economic loss

It made soil secondary pollution because of using the water which had not been treated and had not come up to the standard. This made crops decrease in output and quality, and at the same time, caused water pollution accidents.

The polluted cultivated land was 0.95 million ha² in the 4 cities in 1987. The reduction of output was 615 kg·ha⁻¹. The price of grain was RMB 0.64 yuan·kg⁻¹ in 1987. The loss evaluated by market value method was RMB 26.74 million yuan.

There were 74 water pollution accidents in the 4 cities in 1987. Economic loss was RMB 1.99 million yuan. Total agriculture economic loss was RMB 28.73 million yuan by adding up the 3 items above.

3.3 Fishery economic loss

The fishery economic losses caused by water pollution mainly include: the direct losses by fishery production conditions being damaged and water products output decrease because of water pollution, and, the protection costs of avoiding damage to fishery production by water pollution.

The water area in the 4 cities was 4 827 km², it was 27.8 % of that of the whole province. About 51 333 ha water area was seriously polluted in Taihu lake district. Reduction of fishery output was 375 kg·ha⁻¹. The average unit price was RMB 4 yuan·kg⁻¹ in 1987. The fishery economic loss was evaluated RMB 77.32 million yuan.

3.4 Tourism resources economic loss

Taihu lake district is an important tourism spot in China. There were 0.35 million foreign tourists and 0.1189 million internal tourists in 1987. Their tourism incomes were RMB 528.4 yuan from each foreign person and RMB 165 yuan from each internal person respectively. The annual tourism income was RMB 201.1632 million yuan. The water there was seriously polluted by the sewage discharged and the rubbish thrown by tourists. This resulted in the increase in the cost of disposing. Sewage discharge amount was 4 tons from every foreign tourist and 1.35 ton from every internal tourist. Quantity of refuse was 14.3 kg from every foreign tourist and 3.6 kg from every internal tourist. The treatment costs of waste water and refuse from living were 15 yuan·t⁻¹

and 4 yuan·kg⁻¹ respectively. The treatment cost was RMB 45.26 million yuan by means of restoring cost method.

3.5 Human health economic loss

Human health economic loss was RMB 361 million yuan according to the investigation in 1987.

From the above, the economic loss in the 4 cities in 1987 was 18.0431 billion yuan. It was 5.3 % of GNP. The loss values are shown in table 1. R_i and S_i are shown, K_i is got from (2) and K from (5), RMB 186.36 billion Yuan.

The water resources value was 0.91 yuan·m⁻³ according to the total water resources amount, 204.56 billion m³·a⁻¹.

4. Conclusion

(1) The actual value of water resources should be higher than its evaluation value, i.e. RMB 0.91yuan·m⁻³. There are 3 reasons: (1) The evaluation did not include the function values of shipping and flood control; (2) The evaluation did not include the loss of esthetics value regarding the loss of the tourism spot value. The loss of the tourism resources comfort was 376.175 million yuan by using land rent method. K =RMB 850.88 million yuan accordingly. Thus, the value of water resources was increased by 0.04 yuan·m⁻³, i.e. 0.95 yuan·m⁻³; (3) The grain which was polluted and didn't come up to standard was 0.5211 million tons in the 4 cities. Its loss was 333.49 million yuan·m⁻³, K = RMB 504.7 billion yuan accordingly. Therefore, the water resources value should be increased by 2.05 yuan·m⁻³. The actual value was 3.00 yuan·m⁻³ in 1987.

(2)The number of water environment quality indices is connected with the result. The more the indices, the more R_i accordingly, the less the value of water resources. The most representative indices should be used to reflect the facts.

(3) The water resources price can be fixed on the basis of water resources value.

(4) The difference between water resources value and water price reflected that compensation of water resources value wasn't enough. It should be compensated.

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