Assessment on the Indirect Use Value of Ecosystem's Service Function of Binfen Wetland Park in Suining

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Abstract: In this study, the Binfen Wetland Park located at the Wucai Binfen Road of Hedong New District, Suining is taken as the research object. The indirect use value of seven ecological service functions of the park are quantitatively evaluated through forestry ecology and statistic theories, in order to provide reference for the planning of wetlands in Suining and the management of this park. The indirect use value of the park is 1.85 times of Suining's gross national product (GDP = 736.61×10^8 yuan) of that year. The indirect use value of the ecological service functions of the wetland park is related to the health status of wetlands. The ecological service value grows with the increase of biomass and biological species in the wetland. The ecological service value of a park is also related to its design. A wetland park with great ecological service value should be free from the disturbance of human activities, keep complete wetland ecological patches, possess large number of wetland ponds and ecological islands, and have convenient transportation as well as tourist attractions.

1. Introduction

The research on wetland's ecosystem service function started relatively late in China. However, after decades of development, remarkable achievements have been made in evaluation methods and theoretical research; cases about urban wetland evaluation have increased year by year. Based on the classification of wetland ecosystem service functions proposed by Zhong Ma and other scholars, this study applied several existing methods and techniques to evaluate the indirect use value of the ecosystem's service function. Through evaluating the indirect use value of its ecological service function, the ecological and economical benefits created by Suining Wetland Park can be found. The paper also provides scientific and effective guidance for preventing the degradation of ecosystem's service function, and for the reasonable usage and management of wetland resources in Suining. At the same time, the value evaluating methods and influencing factors of wetland ecological service functions are also scientifically analyzed.

2. Overview on the Research Object

The Binfen Wetland Park is built in the Hedong New District of Suining; it is located at the eastern part of Chuanshan District of Suining. The park covers a total area of 584.62 mu. The climate of Binfen Wetland Park belongs to subtropical humid monsoon climate. The annual average temperature is 16.7-17.4; the average temperature in the hottest month (August) is above 27.2; the average temperature in the coldest month (January) is 6.0-6.5; the annual rainfall is about 950 mm. There are more than 110 species of plants and animals, including 62 species of trees, 42 species of shrubs, 14 species of herbaceous vines and 5 species of aquatic plants. More than 10 species of birds live in the park, including egret, wild duck and kingfisher. According to the Special Report on the Aquatic Ecological Impact of Tunnel Project under Shengping Island of Guanyin Lake in Suining, 44 species of fishes are found in the waters of the Binfen Wetland Park, including the rare fish resources

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such as Spinibarbus sinensis and yellow-head catfish.

3. Research Contents and Research Methods

3.1 Carbon Tax Method.

Usually, this method is used to evaluate the value of carbon fixation and oxygen release of wetlands. The value of carbon fixation and oxygen release can be obtained by calculating and adding the carbon tax standard and afforestation cost of the object according to standard of that area. The negative value of methane (CH_4) should also be considered.

The value of carbon fixation and oxygen release is estimated by carbon tax / afforestation cost method. The photosynthesis equation is used:

$$6CO_2 + 6H_2O - C_6H_{12}O_6 + 6O_2$$
$$264g \quad 108g \quad 180g \quad 193g$$

From the equation, it is known that each plant produces 1 g dry matter (i.e. biomass), consuming 1.47g CO_2 and releasing 1.07 g O_2. Combined with the biomass of all wetland plants in the park, the total amount of CO_2 and O_2 can be calculated. The value of fixing CO_2 or releasing O_2 in wetlands is

$$V_i = YP_i$$

Vi is the value of fixing CO_2 or releasing O_2 in wetlands; Y is the amount of CO_2 absorption or O_2 production; Pi is the cost of carbon tax rate or afforestation per CO_2 or O_2 unit..

3.2 Efficiency Alternative Method.

The Efficiency Alternative Method is used for evaluating climatic regulation value. This method can be used calculate the value of some ecological service functions which cannot be directly estimated.

$$V = \sum CM_i \Delta T_i . P$$

In the formula, V is the value of climate regulation; C is the specific heat capacity of water; Mi is the amount of evaporated water from water areas of the park in the ith month; △Ti is the difference between the temperature of waters in the park of the ith month and100 degrees; P is the electricity price in Suining.

3.3 Pollution Cost Method.

Water purification value is estimated by Pollution Cost Method. The function of wetland in purifying water quality can be calculated by estimating the cost of treating the same amount of sewage in a sewage treatment plant.

$$V = QP = MaxQ_1 P$$

In the formula, V is the value of water purification services; Q is the amount of sewage treatment; P is the cost of sewage treatment; $MaxQ_1$ is the total amount of sewage purified by wetland, namely Q.

3.4 Shadow Engineering Method.

According to data, the area of Suining Binfen Wetland Park is S_1 m^2, which is the water storage area. The water-storage depth is determined by the average precipitation of that year X mL/m^2; the storage volume is calculated by multiplying the two factors. According to the input cost of 2014, namely P yuan/m^3 annually, the value of flood regulation of wetland can be obtained by Shadow Engineering Method through the formula S_1 $m^2 \times X$ $mL/m^2 \times 10^{-3} \times P$ yuan /m^3=P $S_1X \times 10^{-3}$ yuan. The construction cost is calculated by the national investment standard in reservoir construction. If P is 0.67 yuan/m^3, the average flood regulation will be P $S_1X \times 10^{-3}$yuan = 0.67 $SX \times 10^{-3}$ yuan.

3.5 Result Reference Method.

Some value of the project needs to be estimated by directly applying existing research fruits. The scientific research and cultural values of the park are estimated by the formula which is built on the basis of evaluation indexes proposed by authorities and the actual situation of the study area.

$$V_i = P_i S$$

In the formula, V_i is the value of service functions of an ecosystem; P_i is the coefficient of the service value of an ecosystem; S is the area of land which provides the service function.

4. Results and Analysis

Statistic data and analysis on indirect use value of Suining Binfen Wetland Park.

The value of carbon fixation and oxygen release. The total biomass of the park is the sum of shrub, lawn, vine, tree, reed and sedge; the carbon fixation and oxygen release value is the sum of their carbon fixation and oxygen release values. According to above discussion, the positive effect value of carbon fixation and oxygen release (fixing CO_2 + releasing O_2) should be subtracted by the negative effect value of methane (CH_4) emission. The annual economic loss of CH_4 is $4.191S\times10^{-3}$ yuan; the park area S is 389744.66m^2; the loss value is 1633.357 yuan / year. The final value of carbon fixation and oxygen release in the wetland park is 13639038.557×10^4 yuan / year.

The value of climate regulation. According to the formula $V=\sum(CM_i\triangle T_i)\bullet P$, the annual average amount of evaporation is used to calculate the value of climate regulation. The average annual evaporation of Suining in 2014 was 910.7-1128.3 mm, with the median value X of 1019.15 mm. The water area of Suining Binfen Wetland Park was 124068.49 m^2. The temperature of Suining is obtained from the 2013 Annual Yearbook. The specific heat capacity of water is 4.2×10^3J/(kg•℃); $\triangle$ T=100-16.8=83.2℃. According to the *Notice of Adjusting the Civil Electricity Price in Suining*, the price of civil electricity is 0.6436 yuan / degree, namely 0.6436 yuan / kw•h = 0.6436 yuan / 3.6×10^6 J. All values are substituted into the formula: $V = S_1X (100\text{-}T) \times 1.1667P \times 10^{-6}$ yuan = 1124068.49 × 1019.15 × 83.2 × 0.6436 × 1.1667 × 10^{-6} yuan = 0.790 × 10^4 yuan.

The value of water purification. According to the Sewage Discharge Standard of Municipal Sewage Treatment Plant (GB18918-2002), the main sewage treatment methods are removing chemical oxygen demand (COD) and ammonia nitrogen. The COD value is the amount of oxygen required by reductive substances (such as organic matter, $NO_{2\text{-}}$, Fe^{2+} and sulfide) in the sewage in the process of oxidation. It is expressed in terms of oxygen content (mg/L). Therefore, the value of water purification can be estimated through calculating the purification value of total nitrogen, phosphorus and potassium. The water area in the wetland park is 124068.49 m^2; the normal water level is 275.50 m; the total water storage is 3.418 × 10^7m^3, namely 3.418×10^7L. The concentrations of nitrogen, phosphorus and potassium at each sampling point are obtained by test measurement and curve graphs. Finally, the average values of measured data are taken as the final concentrations of nitrogen, phosphorus and potassium, which are 3.103 mg·L^{-1}, 0.0936 mg·L^{-1} and 4.1542μg·mL^{-1} respectively. The total contents of nitrogen, phosphorus and potassium are 1060.6×10^5kg, 31.99×10^5kg and 1.4199×10^5kg respectively. The prices of N, P and K are 1.5 yuan/kg, 2.5 yuan/kg and 2.0 yuan/kg respectively. The value of water purification is 16737.148×10^4 yuan/year.

The value of flood regulation. According to *Sichuan Statistical Yearbook* of 2013, the precipitation of Suining is obtained. The area of the wetland park S is 38974.66 m^2; the annual rainfall X is 1082.9 mm. Using the calculation method mentioned above, the average flood regulation value is = $0.67SX \times 10^{-3}$yuan = 0.67 × 389744.66m^2 × 1082.9 × 10^{-3}m = 28.28 × 10^4 yuan per year.

The research and cultural values. According to the research result of Robert Costanza, the average scientific and cultural value of wetlands is 3897.8 yuan / hm^2. The area of Suining Binfen Wetland Park is 38.9745 hm^2; its scientific and cultural value of is 15.192×10^4 yuan / year.

The value of biodiversity maintaining. The Result Reference Method is used. Suining Binfen Wetland Park provides habitats for birds such as egrets and wild ducks and more than 40 species of fish. According to the research result of Robert Costanza, the value of biodiversity maintaining is 304

$ / hm^2. The area of park is 38.9745 hm^2, so the value of biodiversity maintaining is 1188.24 US dollars per year. According to the exchange rate of 1:6.204 in 2013, the final value is 7.35×10^4 yuan / year.

5. Discussion and Conclusions

5.1 The indirect use value of Suining Binfen Wetland Park and influencing factors.

The relationship between the six components of the indirect use value of Suining Binfen Wetland Park is: carbon fixation and oxygen release value (13639038.56×10^4 yuan / year) > water purification value (16737.15×10^4 / year) > flood regulation value (28.28×10^4 yuan / year) > scientific research and cultural value (15.19×10^4 yuan / year) > biodiversity maintenance value (7.35×10^4 yuan / year) > climate regulation value (0.790×10^4 yuan / year).

Carbon fixation and oxygen release value accounted for 99.88% of the total indirect use value. The value of carbon fixation and oxygen release is directly related to biomass. Binfen Wetland Park has abundant and reasonable designed plants. Most roads in the garden are elevated form the ground, which make full use of the three-dimensional space, and provides more growth space for plants. Therefore, the carbon fixation and oxygen release value of the park is high in this experiment.

Among the values of indirect use functions, climate regulation value is the smallest, followed by the value of biodiversity maintaining. The results show that plants in the park are well grown and in large biomass; they can improve the small environment through plant transpiration, adjust the temperature through waters, and provide habitats and food for wildlife. The park roads are elevated form the ground to avoid the impacts of human activities on ecology. Consequently, the biodiversity maintenance value of the wetland parks should be higher than the calculated value, indicating that the Result Reference Method is not suitable for evaluating of value of urban wetlands with good ecological environments; the value of climate regulation may be also higher than the experimental results.

5.2 Conclusions.

The indirect use value of park is 1365.58×10^8 yuan/ year, which is 1.85 times of Suining's gross national product (GDP = 736.61×10^8 yuan) of that year.

The indirect use value of the ecological service functions of the wetland park is related to the health status of wetlands. The ecological service value grows with the increase of biomass and biological species in the wetland.

The ecological service value of a park is also related to its design. A wetland park with great ecological service value should be free from the disturbance of human activities, keep complete wetland ecological patches, possess large number of wetland ponds and ecological islands, and have convenient transportation as well as tourist attractions.

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