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武功山国家森林公园生态系统服务功能价值评估

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摘 要 采用定量方法评估武功山国家森林公园的生态系统服务功能价值,为武功山国家森林公园建设提供依据。武功山国家森林公园生态系统服务功能的总价值每年达 26.954×10^8 元。在各类服务功能价值中,调蓄功能最高,占生态系统服务价值总值的33.4%,其次是涵养水源价值,占总价值的25.3%,水源供给价值和固碳释氧价值也较高。说明武功山国家森林公园主要的作用表现为水资源保护和调节大气。在武功山国家森林公园生态系统服务价值中,直接经济价值为 3.48×10^8 元,间接经济价值为 23.474×10^8 元,是直接经济价值的6.75倍,应该在保护好现有良好生态环境的前提下发展生态旅游,促进公园可持续发展。

关键词 森林公园 生态系统 服务功能价值 评估 武功山国家

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Forest park serves as an important public place for people to return to nature and relax to their hearts' content. Many forests have been developed into forest parks to enrich people's cultural life and yield good economic returns. However, in this process, ecological environment destruction hasn't been completely avoided and meanwhile relevant damage has been caused in such an indirect way that it failed to draw enough attention. So it entails to evaluate the ecosystem functions of forest parks and set standard for their development programs.

Wugongshan National Forest Park (WNFP) is located in Anfu town, at longitude 114°04′ ~ 114°28′ east and latitude 27°16′ ~ 27°34′ north, with Wugongshan Mountains as mainline, it covers a total area of 25 467 hm^2 including 20 682 hm^2 of woodland, forest coverage rate marking 85.5%. Its Tenglong Lake reservoir (the largest one in Jiangxi province) takes 42 700 hm^2 as water-collecting area and 1 150 hm^2 as water surface area, impoundment registering 1.74×10^8 m^3.

1 Methods and Results

There are great differences among the forests because of the variation in the geographical position and the conditions of climate, soil and precipitation. Zhao Tongqian, Ouyang Zhiyun, *et al.* has evaluated the forest ecosystem services value in China in detail, and the vegetation in China was classified into 10 types. They have obtained precise data by studying on every type. The vegetation of the WNFP belongs to subtropical evergreen broadleaved forest. The appropriate evaluation methods were used in the different ecosystem services[1] (Table 1). At last, the total ecosystem services value of the WNFP was calculated.

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Table 1　The ecosystem services of the WNFP and the evaluation methods

Function types	Evaluation methods	Calculation methods
Recreation	Tourist income method	The national forest tourist income × the area ratio
Water Supply	Market Value Approach	Aggregate supply × Unit Price
Water source conservation	Shadow project price method	The amount of water conservation × the construction cost of the unit storage capacity of reservoir
Water purification	Substitution engineering method	The amount of water conservation × the purifying cost of the unit volume of water
Fixing carbon and making oxygen	Market valuation method	The content of fixed CO_2 × the cost of fixing carbon The content of released O_2 × the cost of making oxygen by industrial method
Soil conservation	Opportunity cost method	The reducing erosion land area × the general income of the unit farmland
Nutrient circulation	Market valuation method	The content of N, P,K × the market price of fertilizer
Air purification	Production cost method	The content of absorbed SO_2 × the engineering cost of reducing unit SO_2 The content of absorbed NOx × the engineering cost of reducing unit NOx The content of reduced dust × the cost of reducing dust by industrial method
Biodiversity conservation	Opportunity cost method	The reduced forest product area × the general income of the unit area of forestland
Reservoir Function	Shadow Engineering Method	Water-holding Capacity × Unit Construction Cost of the Reservoir

1.1　Direct economic value

The direct economic value was recreation value, because the forest park was under strict protection. In 2005, the direct tourist income from the forest park in China was 83×10^8 yuan, and the comprehensive benefit was 750×10^8 yuan. The comprehensive recreation value of the WNFP was 1.411×10^8 yuan, as the area was 0.17 the total forest park area in China.

1.2　Indirect economic value

1.2.1　Value of water source conservation function

The value of water source conservation is calculated as follows: $W = (R - E)A = \theta RA$. Where W is the annual amount of water conservation (m^3/a), R is the annual average rainfall (mm/a), A is the research area (hm^2), E is the annual average evapotranspiration (mm/a), θ is the runoff coefficient. In WNFP, the water source conservation area of the forest park is 2.068×10^4 hm^2, the annual average rainfall is 1 600 mm, and the annual average evapotranspiration is 60% of the rainfall in the forest. So that, the amount of water source conservation of the forest park was 1.32×10^8 m^3. As the cost of the unit storage capacity was 5.171 4 yuan/m^3, the value of annual rainfall interception of the WNFP was 6.83×10^8 Yuan.

1.2.2　Value of water purification function

By the research of Zhao Jingzhu[2], the water quality which was under the protection of the water resource conservation forest can reach to the drinking water standard. The value of water purification of the WNFP was 1.32×10^8 yuan, as the purifying cost of the unit volume of water was 1 yuan/m^3.

1.2.3　Value of water supply

Impoundment registering 1.74×10^8 m^3 multiplied by supply price of 2 yuan/ m^3, total value of water supply equals 3.48×10^8 yuan.

1.2.4　Value of fixing CO_2 and making O_2 function

Based on the net primary production (NPP) data of the forest ecosystem, the content of fixed CO_2 and released O_2 was calculated by the photosynthesis equation. The cost of fixing CO_2 and making O_2 was 260.9 yuan/t and 400 yuan/t. By the statistical data, the NPP of the unit forest was 5.732 t/(hm^2.a), and the total NPP of the WNFP was 35.72×10^4 t. The annual total content of fixed CO_2 and released O_2 of the WNFP was individually 58.16×10^4 t and 45.76×10^4 t. They were calculated by the photosynthesis equation and the

NPP calculation results. By the reforestation cost method, the ecological economic value of fixing CO_2 and making O_2 of the forest park ecosystem was respectively 1.52×10^8 yuan and 1.83×10^8 yuan, and the total value was 3.35×10^8 yuan.

1.2.5 Value of soil conservation function

The amount of material is calculated as follows: $A_t = A_w + A_s$. Where A_t is the amount of soil conservation of the forest ecosystem, A_w and A_s is respectively the amount of soil conservation in the water and wind erosion area. The amount of soil conservation of temperate and subtropical deciduous broadleaved forest, by water and wind erosion resisting, was individually 76.59 t/(hm^2. a) and 0.28 t/(hm^2. a), and the total amount of soil conservation was 76.87 t/(hm^2. a). Therefore, the total amount of soil conservation of the WNFP was 159×10^4 t. The ecological economic value of forest ecosystem was brought by controlling soil erosion and reducing abandoned land, and it was calculated by the opportunity cost method. The average thickness of the surface soil was 0.5 m, and the annual average income of the unit farmland was 1.76×10^4 yuan (By the Statistical Yearbook of Jiangxi Province in 2006: the agricultural total output value was 524.6×10^8 Yuan, the total area of agricultural land was 297.49×10^4 hm^2). In the equation: $E_s = A_t B/(0.5 \times 10\,000\ \rho)$, where E_s is the ecological economic value which is brought by reducing abandoned land, A_t is the amount of soil conservation, B is the annual average income of the unit farmland, ρ is the soil bulk density. In the WNFP, the soil bulk density was 1.3 g/cm^3, and the soil conservation value of the WNFP was 0.043×10^8 yuan.

1.2.6 Value of nutrient circulation function

In the WNFP, the main soil type is brown soil. The content of N, P and K in soil was respectively 0.88 g/kg, 0.4 g/kg and 9.83 g/kg, and the total content was 11.11 g/kg[3]. The forest park can reduce the amount of soil loss by 159×10^4 t. The amount of reduced losing N, P, K and organic matter was 1.77×10^4 t. By the present market price (2 549 yuan/t) of the fertilizer, the value of nutrient loss which was reduced by the WNFP was 0.45×10^8 yuan.

1.2.7 Value of air purification function

The environmental function of the forest ecosystem includes pollutants absorption, dust reduction, pathogen controlling and noise reduction. The content of SO_2, NO_x and dust which were absorbed by the broadleaved forest was respectively 0.088 7 t/(hm^2. a), 0.006 t/(hm^2. a) and 10.11 t/(hm^2. a)[4]. The investment and treatment cost of SO_2 was 600 yuan/t. By the air pollutants emission charge standard in China, the price of NO_x was 1 340 yuan/t which was the average charge. The cost of reducing dust was 170 yuan/t. According to the above data, in WNFP, the content of SO_2, NO_x and dust which were reduced by the WNFP was individually 0.183×10^4 t、124.1 t and 20.9×10^4 t. The function value was respectively 0.011×10^8 yuan, 0.0016×10^8 yuan and 0.356×10^8 yuan, and the total value was 0.37×10^8 yuan.

1.2.8 Value of biodiversity conservation function

Profound wildlife resources of WNFP play a crucial role in maintaining biodiversity. Taken price of 3 363.6 yuan /(hm^2. a), value of biodiversity will mount to 0.7×10^8 yuan.

1.2.9 Value of reservoir

Impoundment registering 1.74×10^8 m^3 multiplied by average cost of yuan 5.171 4 m^3, the value of Tenglong Lake reservoir reaches 9×10^8 yuan.

Table 2　The result of evaluation of the ecosystem services of WNFP ($\times 10^8$ yuan)

Service function	Provide production	Accommodation function							Culture function	Support function	
	water supply	Photosynthetic carbon fixation	Water source conservation	Soil conservation	Water purification	Air purification	reservoir	Nutrient circulation	Recreation	Photosynthetic oxygen release	Biodiversity conservation
Evaluation result	3.48	1.52	6.83	0.043	1.32	0.37	9	0.45	1.411	1.83	0.7
Percentages in total amount	0.129	0.056	0.253	0.002	0.049	0.014	0.334	0.017	0.052	0.068	0.026
The total of classification	3.48	19.533							1.411	2.53	
Percentages in total amount	0.129	0.725							0.052	0.094	
Total	26.954										

2　Conclusion

(1) High value of WNFP in terms of reservoir, water conservation, water supply, CO_2 absorption and release of oxygen contributes to its two major functions—protection of water resources as well as air conditioning[5] (Table 2).

(2) Indirect economic value is 6.75 times more than direct value. And development of tourism should take into consideration the conservation of ecosystem and water resources.

(3) WNFP has shown a great potential as a tourist and recreational site. All in all, we determine its nature to be a forest recreational site with comprehensive functions featuring group traveling, holiday resort, public health, entertainment and science education.

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Evaluation on Ecosystem Service Value of Wugongshan National Forest Park

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[**Abstract**] To provide basis for construction of the Wugongshan national forest park, the quantitative method was

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Linear Interpolation Method for Solving Linear Algebraic Equations of the Five-diagonal Matrix

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[**Abstract**] To aim at special large-scale block linear algebraic equations of the five-diagonal matrix, a linear interpolation method is designed. Operational quantity of the method increases by linear when the subequations increase, but the Gauss expunction method inceases by cubic.

[**Key words**] linear algebraic equations　　five-diagonal matrix　　linear interpolation method

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used to evaluate the forest park ecosystem services. The total value of the ecosystem services of the Wugongshan national forest park was 26.954×10^8 yuan. The direct economic value was 3.48×10^8 yuan, and the indirect economic value was 23.474×10^8 yuan. The latter was 6.75 times of the former. In all kinds of the services, the value of was the highest, and it was 33.4% of the total value. The second was the value of water source conservation which was 25.3% of the total value. It indicated that the main services of the forest park ecosystem were water resources protection, air-conditioning. The forest park should be actively constructed to protect ecological environment and satisfy the public recreation.

[**Key words**] forest park　　ecosystem　　service function value　　evaluation

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Study on Acoustic Absorption of Military Ship Engine Room

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[**Abstract**] The engine room noise was the main noise radiant resource. The noise signal of a ship engine room had been analyzed. The main radiation frequency was found out. The influence of reverberation sound to engine room noise was studied too. The scheme was worked out about reverberation sound control, which carries on sound absorption facing. The parameters of sound absorption facing material were made certain. The sound absorption facing was equipped in the engine room and then tested. The noise of the engine room was reduced 6.2 dB(A), arriving at the requirements.

[**Key words**] engine room noise　　spectral analysis　　reverberation sound　　sound absorption