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Tourism Resources and Ecosystem Service Value in Heilongjiang Province, Northeast China

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Abstract: The objective of this study is to evaluate the economic value of ecosystem services of water-based tourism resources in Heilongjiang Province and to provide theoretical support in tourism resources conservation and development planning. Based on the characteristics of water-based tourism resources, the market value approach, substitution engineering method and replacement cost method were used to evaluate the ecosystem services value of water-based tourism resources. Results showed that the total ecosystem service value was 116.95 billion Yuan in 2010, which direct services value was 46.17 billion Yuan and indirect services value was 70.78 billion Yuan. The ranking of various services was water storage>water supply>flood mitigation>leisure entertainment>culture research>biodiversity maintenance>aquatic product>hydropower>shipping. The results suggest that water resources exert an indispensable function to maintain the whole ecosystems health and people's life and wealth safety.

Keywords: Ecosystem services, ecosystem functions, economic value, heilongjiang province, water-based tourism resources

INTRODUCTION

Water, as a special ecological resource, is the basis of earth life system. Meanwhile, as an essential factor of tourism resources, water resource has great significance on water-based tourism and tourism transportation. Water-based tourism is an appealing component of many tourism and recreational pursuits (Hall and Härkönen, 2006). Water-based tourism resources refer to various tourism attractions composed of waters, which exist in various forms, such as rivers, lakes, streams, wetlands, reservoirs, waterfalls, springs, ice and snow, glaciers and even some coastal water bodies. Water-based tourism activities mainly rely on the aesthetic values and use values of these water-based tourism resources. Water-based tourism covers a wide range of environmental, cultural and social criteria, which can improve the regional economic development in tourism regions (Rudiger, 2005).

Ecosystem services have become a central topic of research at the interface of social and natural systems. Ecosystem services can be defined as the goods and services provided by ecosystem which contribute to human welfare, both directly or indirectly (Costanza *et al*., 1997), or the natural processes and products that support human existence and enhance human well-being (Daily, 1997), or the benefits people obtain from ecosystems (Millennium Ecosystem Assessment, 2005). The service function of water ecosystem refers to the environmental conditions and effectiveness for human survival and development in the process of water ecosystem. It is not only the economic foundation of the society, but also the ecological condition of human existing (Ouyang *et al*., 2004).

A number of literatures have focused on the influence of runoff and water quality on river recreation functions. Loomis *et al*. (2000) measured the total economic value of five ecosystem services of restoring ecosystem services in the Platte river by a contingent valuation survey. Jewitt (2002) assessed the concept of an ecosystem approach to the management of water resources in the light of a reanalysis of the hydrological cycle to maintenance of ecosystem functioning in South Africa through the so-called Resource Directed Measures. Turner *et al*. (2003) proposed managing wetlands through an ecological economics approach. Young (2005) summarized concepts and methods of determining the economic value of water. Weber and Berrens (2006) investigated recreation use value for access to a Sonoran Desert canyon and associated instream flow through a case study of Aravaipa Canyon Wilderness. Ojeda *et al*. (2007) estimated the economic value of environmental services provided by restored instream flows in the water-scarce Yaqui River Delta in Mexico. Garrick *et al*. (2009) developed a conceptual framework to examine factors enabling and constraining successful policy reform and implementation in market-based environmental water allocation. Korsgaard and Schou (2010) concluded that economic valuation is vital for bringing ecosystems to decision-making agendas in developing countries and that great effort must be made to bridge the gap between scientists and decision makers. Li *et al*. (2010) used a water equivalent method

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to calculate the human occupation on the freshwater ecosystem services in Beijing from 1998 to2007 and assessed the human stress effect on the freshwater ecosystem, based on the total amount of water resources.

"Great Ice-snow, Great Wetlands, Great Lakes, Great Boundary Rivers" makes Heilongjiang Province popular water tourism resort. For Heilongjiang Province, quantitative knowledge on ecosystem services of water-based tourism resources at this region is limited. The objectives of this study are to analyze the characteristics of water-based tourism resources in Heilongjiang Province and to evaluate ecosystem service value of water tourism resources. This research is good for an overall comprehension of the value of water resource, assures the service functions are of the greatest importance to the sustainable development of the society. Therefore, it provides a reference to the decision-making of water-based tourism development and landscape constructions.

The objective of this study is to evaluate the economic value of ecosystem services of water-based tourism resources in Heilongjiang Province and to provide theoretical support in tourism resources conservation and development planning. Based on the characteristics of water-based tourism resources, the market value approach, substitution engineering method and replacement cost method were used to evaluate the ecosystem services value of water-based tourism resources. Results showed that the total ecosystem service value was 116.95 billion Yuan in 2010, which direct services value was 46.17 billion Yuan and indirect services value was 70.78 billion Yuan. The ranking of various services was water storage>water supply>flood mitigation>leisureentertainment>cultureresearch>biodiversitymaintenance>aquaticproduct>hydropower>shipping. The results suggest that water resources exert an indispensable function to maintain the whole ecosystems health and people's life and wealth safety.

STUDY AREA

Study area survey: Heilongjiang Province is located in Northeast China, from 43°25′N to 53°33′N and from 121 °11′E to 135 °05′E, with a total area of 473000 sq. km (Fig. 1). There are 1918 rivers possess a basin area more than 50 sq. km., such as, Songhua River, Nen River, Heilong River, Wusuli River and Suifen River and 6026 lakes, such as, Xingkai Lake, Ching-po Lake and Wudaliangchi. The total area of wetland is 43148 sq. km., which is located on the Sanjiang Plain, Songnen Plain and Xing'an Region and so on. At the end of 2010, there are about 63 natural reserves of inland wetlands, water ecosystems and water resources.

- The characteristics of water-based tourism resources of study area: Abundant resources and diversified types. Heilongjiang province, with a total 23320 km^2. water area, is located in the northeast of China. Many rivers run across it and lakes and wetlands are located here and there. There are 1918 rivers possess a basin area more than 50 km^2., such as, Songhua River, Nen River, Heilongjiang, Wusuli River, Suifen River and so on. Among the 6026 lakes, there are some famous ones, such as, Xingkai Lake, Ching-po Lake and Wudaliangchi. The total area of wetland is 43148 km^2., which is located on the Sanjiang Plain, Songnen Plain and Xing'an Region and so on. There are also 3000 plus reservoirs and there are ice and snow scenic spots in winter periods.

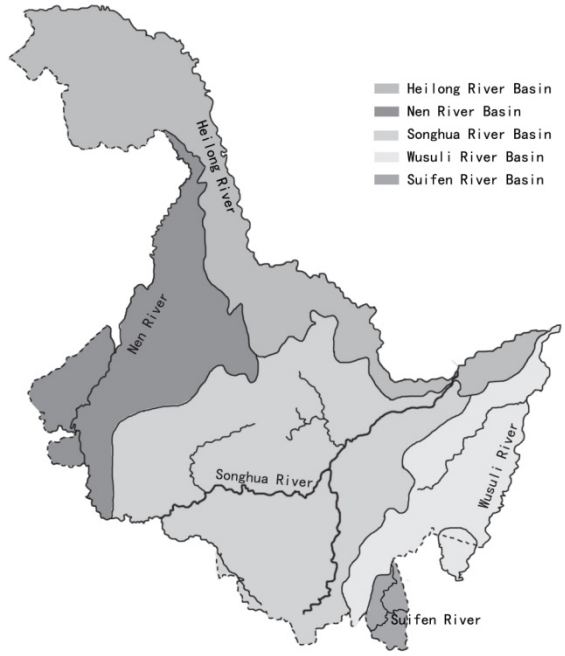

Fig. 1: The sketch map for watershed of Heilongjiang province in China

- High-qualities resources and outstanding characteristics. Heilongjiang province has 202 natural reserves in 2010, including 23 national ones, which covers an area of 6.41 million km^2. More than one third of the natural reserves in the region are inland wetlands, water ecosystems and water resources. For example, Ching-po Lake, the biggest barrier lake in China, Wudalianchi is the hometown of mineral water in China, the Zhalong Wetland Natural Reserve listed in the United Nations Convention on Wetlands, boundless forest and endless snow in Xing'an mountains region, rime landscape along the frozen Songhua River in winter time and so on. The water tourism resources have driven up the ecological economic value in the region.
- Well-allocation and outstanding characteristics. The water-based tourism resources in Heilongjiang province are a combination of natural resources and cultural connotations. For example, Zhalong

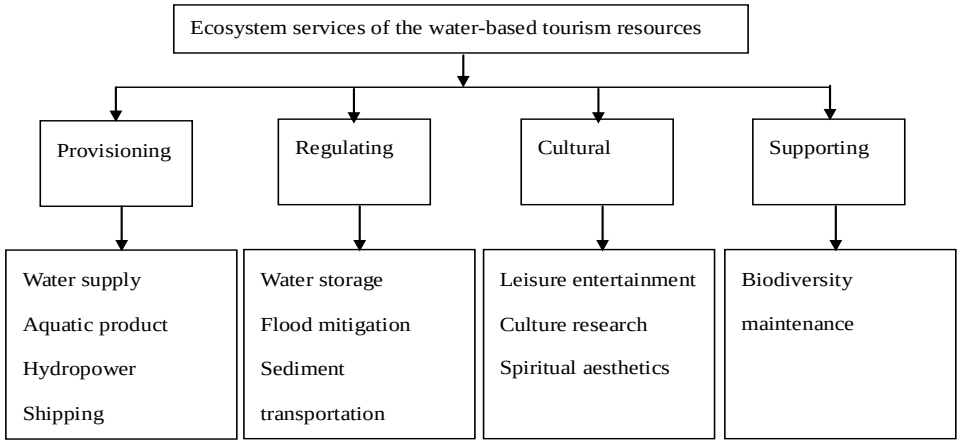

Fig. 2: Classification of ecosystem services of the water-based tourism resources of Heilongjiang province

Wetland Natural Reserve is set up for the Red-Crowned Crane, Wudalianchi combines volcanic landforms with mineral springs, the border areas, including Heilongjiang River, Xingkai Lake and Ussuri River, combine minority folk-custom and exotic landscapes, the Bohai Kingdom Sites of Heilongjiang River and Site of the Upper Capital of the Jin Dynasty are also rich in cultural elements and so on. The well-allocation of water-based tourism resources enriches the cultural connotations and provides a flexible development and a higher cultural value.

BASIC THEORY AND METHODS

Classification of ecosystem services of the water-based tourism resources: Based on the principles of systematization, independence, representative and maneuverability, in accordance with the classification of Millennium Ecosystem Assessment (Ouyang *et al*., 2004; Millennium Ecosystem Assessment, 2005), this paper divides ecosystem services of water-based tourism resources to four major categories including provisioning services, regulating services, cultural services and supporting services in Heilongjiang Province. The relationship is shown in Fig. 2.

Data collection and preparation: Based on the characteristics of water-based tourism resources and data availability, we divided the ecosystem services of water-based tourism resources into two categories: direct services and indirect services. Direct services can be exchanged in the market, including water supply, aquatic product, shipping, hydropower and leisure entertainment. Indirect services cannot be exchanged in the market, including water storage, flood mitigation, culture research and biodiversity maintenance. The data originated from related statistics yearbook issued by the National Statistics Bureau. Take 2010 as appraisal datum year.

Calculation methods:

- **Water supply:** Market value approach is used to estimate this service:

$$V_1=\sum Q_i \times P_i \quad (1)$$

where,
V_1 = The value of water supply
Q_i = Water consumption for i purpose
P_i = Unit cost price for i purpose

- **Aquatic product:** Using of market value approach to estimate:

$$V_2 = \sum W_j \times P_j \quad (2)$$

where, V_2 is the value of aquatic product; W_j, P_j respectively is the total products and unit cost price of j kind of aquatic product.

- **Hydropower:** The value of such service is estimate as:

$$V_3 = E \times P_e \quad (3)$$

where,
V_3 = Hydro-energy value
E = Annual energy production of hydroelectric power station
P_e = Cost price of per-unit electricity

- Shipping. Using of the methods of market value to estimate this service:

$$V_4 = T_c \times P_c + T_p \times P_p \quad (4)$$

where, V_4 is shipping value; T_c, T_p respectively is the annual turnover of cargo and passenger; P_c, P_p, respectively is the price of freight and passenger transport.

- **Leisure entertainment:** Here takes the income of water tourism scenic spots to substitute for the leisure entertainment value. Replacement cost method is used:

$$V_5 = \gamma \times M \quad (5)$$

where,
V_5 = Leisure entertainment value
γ = The percentage of water tourism accounted for the total tourism revenue
M = The total tourism revenue

- **Water storage:** Making use of the methods of substitute engineering to assess such service:

$$V_6 = Q_r \times P_c \quad (6)$$

where,
V_6 = The value of water storage
Q_r = The potential storage capacity of water resources
P_c = The unit cost of water storage

- **Flood mitigation:** Flood mitigation means the role of storage flood and regulation peak of reservoirs, lakes, wetlands and so on. Limited by data, this study mainly appraised the regulation flood of reservoirs by computed the value of protected farmland, formula as followed:

$$V_7 = A_p \times P_e + P_o \quad (7)$$

where,
V_7 = The value of flood control
A_p = Protected farmland
P_e = The benefit of farmland
P_o = Other benefit (including protected people, livestock and buildings and so on) substituted for the fee of preventing floods

- **Culture research:** Here use the following formula to calculate the value of culture research:

$$V_8 = A_w \times C_r \quad (8)$$

where,
V_8 = The value of culture research
A_w = The acreage of water tourism resources
C_r = The cost of per unit area for culture research

- **Biodiversity maintenance:** The value of biodiversity maintenance can be calculated by the following formula:

$$V_9 = A_w \times C_w \quad (9)$$

where,
V_9 = The value of biodiversity maintenance
A_w = The acreage of water tourism resources
C_w = The cost of per unit area for biodiversity maintenance

RESULTS

Direct use value:

- **Water supply:** The water consumption for industrial, agricultural and household purpose respectively was 5.61 billion m^3, 24.96 billion m^3 and 1.76 billion m^3 according to the Bulletin of Songliao River Water Resources in 2010. The unit price of each purpose, respectively was 3.60, 2.60 and 0.04 Yuan/m^3 based on China Price Yearbook in 2010. Therefore, the value of water supply was 25.77 billion Yuan.
- **Water product:** Limited data availability, this study takes fishery value to substitute for the value of water product, was equal to 5.37 billion Yuan in 2010 from Heilongjiang Statistical Yearbook.
- **Hydro-energy:** In 2010, the energy production of hydroelectric power station was 2.25 billion kWh from China Electric Power Yearbook. Taken 0.52 Yuan/kWh as the average price of power supply from China Price Yearbook in 2010, the value of hydro-energy was 1.17 billion Yuan.
- **Shipping:** In 2010, the annual turnover of cargo and passenger respectively was 0.7 billion t·km and 0.03 billion person·km from Heilongjiang Statistical Yearbook. The price of freight and passenger transport, respectively was 0.06 Yuan/t·km and 0.24 Yuan/person·km (Ouyang *et al*., 2004). So the value of shipping was 0.05 billion Yuan.
- **Leisure entertainment:** According to Sample Survey released by China National Tourist Administration, the interest of tourists for mountain and water scenery was 33.2% in Heilongjiang Province in 2010. Assume the attraction of water scenery was 50% in the mountain and water scenery. So the percentage of water tourism accounted for the total tourism revenue was 16.60%. The total tourism revenue of Heilongjiang Province was 83.2 billion Yuan in 2010. Therefore the leisure entertainment value was 13.81 billion Yuan.
- **Total direct use value:** As shown in Table 1, preliminary evaluation results show that the direct use value of ecosystem services of water-based tourism resources in Heilongjiang Province was 46.17 billion Yuan in 2010. Water supply and leisure entertainment were the two top service functions with high service value, contributing about 85.73% of the total direct use value. The results suggest that water ecosystem supply freshwater for human being and safeguard people's

Table 1: Direct use value of ecosystem services of water-based tourism resources in Heilongjiang Province

Services	Value/billion Yuan	Proportion/%
Water supply	25.77	55.82
Aquatic product	5.37	11.63
Hydropower	1.17	2.53
Shipping	0.05	0.11
Leisure entertainment	13.81	29.91
Total direct use value	46.17	100

Table 2: Indirect use value of ecosystem services of water-based tourism resources in Heilongjiang Province

Services	Value/billion Yuan	Proportion/%
Water storage	40.03	56.56
Flood mitigation	16.85	23.81
Culture research	7.81	11.03
Biodiversity maintenance	6.09	8.6
Total indirect use value	70.78	100

Table 3: Economic value of ecosystem services of water-based tourism resources in Heilongjiang Province

	Services	Value/billion Yuan	Proportion/%
Direct use value	Water supply	25.77	22.04
	Aquatic product	5.37	4.59
	Hydropower	1.17	1.00
	Shipping	0.05	0.04
	Leisure entertainment	13.81	11.81
	Sub-total	46.17	39.48
Indirect use value	Water storage	40.03	34.23
	Flood mitigation	16.85	14.41
	Culture research	7.81	6.68
	Biodiversity maintenance	6.09	5.21
	Sub-total	70.78	60.52
Total value	Final total	116.95	100

basic life need. At the same time, it also provides rich tourism resources for people's recreation (Tang and Shang, 2008).

Indirect use value:

- **Water storage:** By the theory of International Organization Dam that the volume of ecological water is not less than 30%, the potential storage capacity should be 70% of the whole water resources (Wang *et al*., 2006). According to Heilongjiang Statistical Yearbook, the whole water resources were 85.35 billion m^3, so the potential storage capacity was 59.75 billion m^3 in Heilongjiang Province. The unit value of water storage was 0.67 Yuan by the cost of constructing 1 m^3 reservoirs capacity (Ouyang *et al*., 2004). Therefore, the value of water storage was 40.03 billion Yuan.
- **Flood mitigation:** By 2010, there had built river embankments 12585 km where protected 3.03 million hm^2 farmland and protected 13.56 million population. The average net return of grain was 5450.24 Yuan/hm^2; the fee of flood fighting was 25Yuan/person (Wang *et al*., 2006); so the value of flood control was 16.85 billion Yuan.
- **Culture research:** According to the scholars' research, the cost of per unit area for culture research was 2050.14 Yuan/hm^2 (Xie *et al*., 2008). The acreage of water, wetlands, rivers and lakes reserves was 3.81 million hm^2 from the Directory of Heilongjiang Natural Reserves, so the value of biodiversity maintenance was 7.81 billion Yuan.
- **Biodiversity maintenance:** According to the scholars' research, the cost of per unit area for biodiversity maintenance was 1598.8 Yuan/hm^2 (Xie *et al*., 2008). The acreage of inland wetlands reserves was 3.81 million hm^2 in Heilongjiang Province, so the value of biodiversity maintenance was 6.09 billion Yuan.
- **Total indirect use value:** As shown in Table 2, preliminary evaluation results show that the indirect use value of ecosystem services of water-based tourism resources in Heilongjiang Province was 70.78 billion Yuan in 2010. Water storage and flood mitigation were the two top service functions with high service value, contributing about 80.36% of the total indirect use value. The results suggest that water resources exert an indispensable function to support and safeguard the sustainable development, maintain the whole ecosystems health and people's life and wealth safety in Heilongjiang Province.

Total Economic Value of ecosystem services of water-based tourism resources: As shown in Table 3, the total economic value of ecosystem services of water-based tourism resources in Heilongjiang Province was 116.95 billion Yuan in 2010, equivalent to the GDP of 11.28%, which direct services value was 46.17 billion Yuan, accounting for 39.48% of the total value, indirect services value was 70.78 billion Yuan, accounting for 60.52% of the total value. It indicated except for the provision of direct service value, water tourism resources also provided significant indirect value that had more remarkable effect on human society than direct service value.

The values of various services were ordered as waterstorage>watersupply>floodmitigation>leisureentertainment>cultureresearch>biodiversitymaintenance>aquatic product>hydropower>shipping. In all ecosystem services, water storage, water supply and flood mitigation respectively was 40.03 billion Yuan, 25.77 billion Yuan and 16.85 billion Yuan, accounting for 70.67% of the total value. So the three services are the dominant service function. Heilongjiang Province was rich in water resources and played a vital role in all economic activities. Moreover the services of water storage and flood mitigation maintain the water balance to a certain extent. Therefore, it is an important task to protect and use water resources in Heilongjiang Province.

The value of leisure entertainment, culture research and biodiversity maintenance, respectively was 13.81, 7.81 and 6.09 billion Yuan. Heilongjiang province abounds in biological resources in the water ecosystem, such as, rivers, wetlands and lakes, where are the living environment with high qualities and outstanding characteristics. It provides an opportunity and site for science popularization and scientific research and is the habitat for the wildlife to breed, migrate and over winter. At the same time, it also improves the value of aquatic product and leisure entertainment.

The value of aquatic product, hydropower and shipping were relatively small. But their services cannot be ignored. Aquatic product was the raw material and food for people's productivity and life. Hydropower was one of the clearest energies. Shipping was a kind of important transports for the water scenic spots. Hence all ecosystem services must be given overall consideration so as to preserve the ecological environment and achieve sustainable development in Heilongjiang Province.

CONCLUSION

Heilongjiang Province abounds in water-based tourism resources with high-qualities and outstanding characteristics, such as, well-allocation, abundance in cultural connotations and so on. On the classification of ecosystem services of water-based tourism resources, this study evaluated the economic value of ecosystem services of water-based tourism resources in Heilongjiang Province by market value approach, substitution engineering method and replacement. The results show that the total economic value of ecosystem services of water tourism resources was 116.95 billion Yuan in 2010, equivalent to the *GDP* of 11.28%, which direct services value was 46.17 billion Yuan, accounting for 39.48% of the total value, indirect services value was 70.78 billion Yuan, accounting for 60.52%. The ranking of various services was water storage>watersupply>floodmitigation>leisureentertainment>cultureresearch>biodiversitymaintenance>aquatic product>hydropower>shipping. Water storage, water supply and flood mitigation were the top two service functions with high service value, contributing about 70.67% of the total service value. Although the value of other services were small, but played the very important role in maintaining the balance of regional ecosystem. Therefore, the development of water tourism resources should be subordinated to the general interests, particularly should meet the demand of water supply, hydropower, flood mitigation, shipping, drinking water and so on.

The process of knowing ecosystem services value is gradually deepening. Limited by the basic data, this study only estimated part of ecosystem services value and not accurately reflected full value of ecosystem services of water tourism resources, which should be improved in further research.

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