

## Research Article

# Ecological Assets Evaluation with Case Study for Yellow River Delta in China

Bo Feng <sup>1,2</sup>

<sup>1</sup>School of Intellectual Property, Nanjing University of Science and Technology, Nanjing 210094, China

<sup>2</sup>Nanjing Audit University Jinshen College, Nanjing 210023, China

Correspondence should be addressed to Bo Feng; [jwfeng@naujsc.edu.cn](mailto:jwfeng@naujsc.edu.cn)

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The relationship between ecological environment and human's living habitat is becoming more and more close, which provides the necessary material conditions for human's living. The progress and development of society cannot be separated from the supply of ecological resources' raw materials. However, because of the characteristics of ecological asset value, it is difficult to express its value directly in the form of money. Therefore, human beings often ignore part of its actual hidden value, which leads to the failure to treasure and rationally use natural resource. Man's influence on the ecological environment is increasing day by day. Taking the Yellow River Delta as an example, this paper analyzes and evaluates the value of its ecological resource assets, calculates the value of various ecological resource assets by using the recovery cost method, the market method, and the results reference method, and finally obtains the total value of ecological assets. In the form of concrete data, it shows the actual value of the ecosystem and improves people's understanding of the ecological value.

## 1. Introduction

Economic development brings better living space for enterprises, where there are enterprises, there is cooperation, and where there are people, there are interests. Progress at the economic level brings hope to various industries and enterprises of all sizes have emerged to shoulder the big network connecting production and sales, and the supply chain network of product production for enterprises is becoming more and more complex. See following Table 1.

Ecosystem is the homeland that human beings depend on for survival. It contains huge energy and value and provides necessary conditions for human survival and social progress and development. The functional value of the ecosystem is very complex, the ecosystems on the earth are also diverse, and the functions and functions of different systems are different.

Only part of the huge value of the ecosystem can be calculated directly in the form of money, but the value of the part that cannot be measured in money is more important to human beings. Since a large amount of value cannot be

directly measured or exchanged with currency, human beings ignore the huge value of their existence, and they destroy the ecosystem.

Before the assessment begins, review and study advanced assessment methods and achievements at home and abroad, and classify various functions of the ecosystem, making the assessment process more scientific and reasonable. This paper classifies and sorts out different functions in the ecosystem to be assessed according to the former's empirical results, and systematically and comprehensively processes and summarizes various raw data information. According to the different types of value provided by various ecosystem functions, the market method, the achievement reference method, the shadow value method, etc. are used to evaluate the value of each function, and the final results are expressed in the form of monetary measurement. Through the evaluation results of the value of the Yellow River Delta, it is confirmed that the potential value of the existence of the ecosystem is far greater than the direct economic value that can be directly measured. Therefore, it is necessary to deepen human's awareness of the importance of the

TABLE 1: The value composition and assessment method of ecological assets in the Yellow River Delta Nature Reserve in Shandong Province.

Evaluation items	Ecosystem services	Index	Evaluation method
Direct use value	Material production value	Food	Market value method
	Tourism and leisure value	Travel	Travel expense law
	Cultural value of scientific research	Research culture	Market law
Indirect use value	Climate regulation value	Carbon fixation and oxygen release	Carbon tax law
	Water storage and flood transfer value	Water storage and flood control	Shadow value method
	Road and land value	Increase area	Market value method

existence of ecosystems, enhance human's awareness of its protection, make rational use of existing ecological resources, and improve the utilization rate of ecosystem resources.

The ecosystems on the earth are complex and diverse, and human beings rely on the living places and material conditions provided by the ecosystems to continuously develop and progress. It not only creates the necessary environment for human survival but also a good ecosystem can resist the losses caused by natural disasters to human beings to a certain extent. The photosynthesis of plants in the ecosystem can continuously release oxygen and adsorb harmful substances. Allows the air to be purified. Because its value is different from the value of other types of resources, most of them cannot be measured directly in currency, which leads humans to ignore its value. Because of this, the ecosystem has been destroyed a lot, and the balance and stability of the ecosystem have been damaged step by step, such as over-grazing, deforestation, and land reclamation. In 2020, my country's ecological environment status index value reached 51.7, and the ecological quality was average. About half of our country's land ecological quality reaches excellent and good standards. The functions of some ecosystems in my country have been improved, but global warming, the invasion of alien species, and man-made damage to the environment still have huge impacts. Ecological environmental issues still need to be paid attention to.

It is of great significance to measure correctly the development of national economy and the protection of ecological resources. The development of industry and the progress of society are inseparable from the supply of ecological resources, and the protection of ecosystems is an important foundation to ensure that our society can achieve sustainable development. At present, a large number of resources such as mineral and oil fields in my country have been reclaimed and used, and land occupation, tree felling, and excessive grazing have led to desertification of the land. By using different assessment methods, the value of ecological resources in the assessed area is assessed, so that the actual value of the protected area can be correctly measured. Promoting people to pay more attention to ecological assets and cherish the rational use of natural resources, social progress, and development cannot be exchanged at the expense of ecology.

In this paper, basic concepts of ecological resource or assets related defined. An evaluation index system for ecological assets value is proposed. Assessment method is developed, and a case study is presented.

## 2. Literature Reviews

*2.1. Status of Foreign Research.* With the increasing development of human society, the importance of research on ecosystem assets is increasing with the development of human society. There are various ecosystems on the earth; the most important of which is the forest multi-functional ecosystem, which has created many favorable conditions for human life with its abundant resources. Barbier et al. pointed out that because the potential value of forest ecosystems is not clear, people often pursue immediate interests, ignore the long-term contribution of forest resources to human beings in the future, and cut down forest trees and over-cultivated [1]. Wetland ecosystem is also one of the more important multi-functional ecosystems on the earth. Turner et al. proposed that on a global scale, the wetland area is constantly shrinking and degrading due to the continuous intervention of human activities. The main reason for this phenomenon is that the value of wetlands cannot be correctly recognized and measured, so its important role and value are ignored, which in turn leads people to destroy wetlands and change their original uses. The continuous intervention of large-scale human activities has caused the wetland area to shrink and degrade continuously [2]. In terms of domestic and foreign research, the earlier research on the function and value of wetland ecosystem diversity is Turner's 1991 study on wetland ecosystems. The total economic value and the functional value of the tropical wetland ecosystem environment are discussed by Barbier in 1994 [3]. In 1997, Gowdy believed that human's cognition of ecosystem value is only limited to the value that can be calculated directly with currency in the market, but its most important value is the contribution to the human living environment [4]. Many scholars believe that environmental problems need to be solved by multidisciplinary methods, because environmental problems are not affected by a single factor but are the result of the interaction and influence of their own systems and social and economic systems.

In ecosystem value composition, the classification methods used by various scholars in different periods are different. In the early 20th century, Peare divided the service value of the ecosystem into two types, namely, use value and non-use value. Among them, use value can also be divided into direct use value, indirect use value, and choice value; non-use value can be divided into existence value and heritage value [5]. In 1990, McNeely divided the ecosystem into direct value and indirect value. Direct value includes consumptive use value and productive use value; indirect value

includes existence value, choice value, and non-consumable use value [6]. In 1997, Constanza, on the basis of the research of other scholars, unified the goods and services provided by the ecosystem to human beings as ecosystem services [7]. He divided the global biosphere ecosystem into 16 types and divided ecosystem services into gas regulation, climate regulation, disturbance regulation, water regulation, water supply, erosion control and sediment retention, soil formation, nutrient cycling, and waste disposal, pollination, biological control, refuge, food production, raw materials, genetic resources, leisure, and culture 17 kinds. However, in the evaluation of ecosystem value, the use of classification to calculate its value may lead to double calculation of ecological asset value. Serafy believes that when evaluating ecological value, if the independent calculation of various values does not consider the difference between the values, substitutions and mergers tend to be over or undervalued. At present, most of the research on ecosystem value is about the service value of ecosystems and biological diversity. The establishment of nature reserves provides a basis for research on ecosystem-related aspects. Function, species protection function, and the habitat of organisms are also discussed [8].

Different scholars use different methods to evaluate the value of ecosystems. In 1997, Constanza evaluated ecosystems according to different existing ecosystem evaluation methods. He calculated the monetary price per square hectare of each value type in a single ecosystem. Calculate, multiply the number of units of measurement by the total area in the ecosystem, and multiply the value of different ecosystems by the area occupied by the ecosystem on the earth, and finally obtain the value of the earth's ecosystem [9]. Specific methods include market value method, expense method, substitution cost method, production cost method, travel expense method, hedonic price method, and conditional value method.

*2.2. Current Status of Domestic Research in China.* Domestic research on ecosystem value started relatively late, but it has developed rapidly. Ecosystem research is affected by the complexity and uncertainty of ecological resource assets themselves. "Explanation of Economics" defines "resources" as inputs used in the process of production [10]. The value of ecological assets is gradually increasing in the continuous development. Huang Xingwen believes that the evaluation of ecological assets is the necessary basis for the division of ecological assets. Ecological assets are actually a kind of physical landscape for the implementation of rights to obtain benefits, including the efficiency of the ecosystem and the value of ecological assets. Ecological assets can bring actual economic benefits to the owner [11]. Liu Jian and Chen Ping and others believe that it is very important and necessary to evaluate ecological resources; it is conducive to safeguarding the rights and interests of owners and can better improve the utilization rate of ecological resources [12]. The research direction of the ecosystem should pay attention to various problems and difficulties in the evaluation process and analyze the impact of humans on various functions of the ecosystem in a multi-angle and multi-faceted way [13]. The evaluation of ecosystems needs to construct comprehensive

evaluation indicators and scientific parameters. In addition to the impact of data sources and evaluation methods, the evaluation results are different from the selection preferences of human beings, which also affect the evaluation results [14]. Starting from the two aspects of function and ecosystem, the abstract potential value of ecosystem is embodied in the form of currency, reflecting the importance of ecosystem to social development. The significance of evaluating ecological assets is to understand the resource structure and ecological functions in the region, so that people can clarify the value of ecological assets, which is conducive to the protection of ecosystems and the increase of sustainable development of ecosystems [15].

The value composition of ecosystems. At present, most of the research on ecosystem value is about the service value of ecosystems and biological diversity. The establishment of nature reserves provides a basis for research on ecosystem-related aspects. function and species protection function, and also the habitat of organisms [8]. The natural environment is the only ecological home for human beings. It provides human beings with the resources and environment they need and provides non-physical ecological services in addition to physical ecological products. Although the non-physical ecological value is ignored due to many reasons such as difficulty in quantification, this part of the ecological service accounts for most of the total services provided by the ecosystem and has huge economic value [16].

Ouyang et al. made a detailed estimate of the economic value of China's terrestrial ecosystem. They divided it into carbon and oxygen balance value, organic matter production value, biodiversity and sustainable development value, water and soil conservation, water and soil conservation, environmental purification, etc. [17]. Yao, Yu, and others believe that China already has a certain foundation for the value calculation and method of ecological resource assets, and they adopt the method of first calculating the quality of the material and then evaluating its value [18]. Shang, Xu, and others believe that ecological resources have three attributes: capital, assets, and resources. Capital refers to ecological capital that can bring capital inflows in the future, assets are the specific manifestation of resource value, and ecological resources refer to the survival of human beings. The content of ecosystem value includes its own natural resource value, multiple ecosystem service value, and social and cultural value [19].

There are many ways to assess the value of ecosystems. The selected method should pay attention to the service value, existence value, and community development value of the ecosystem, combined with relevant theoretical knowledge such as ecology and biology. Grassland ecology is an ecosystem with the largest land area in my country and plays an important role in maintaining the balance of the ecological environment and protecting ecological diversity. The resources provided by the ecosystem are irreplaceable, and in order to calculate its value, consumers' willingness to pay valuation method and market valuation method can be used to evaluate [20]. Forest ecosystem is one of the more important ecosystems, with continuous regeneration and sustainable development, providing direct forest products and indirect benefits for human beings.

For the value of forest ecological assets, alternative cost method, opportunity cost method, and market value method can be used [21]. From the perspective of ecological economics, the value is transformed between the paths of natural resources, ecological assets, and ecological capital and ecological products, and the value of different ecological assets is assessed to distinguish the distribution of assets with higher values within the scope of assessment, which can better reduce the error value generated in the evaluation [22]. Domestic assessment methods for ecosystems mainly include market assessment method and shadow engineering method in alternative methods, alternative cost method, opportunity cost method, etc.

Learning and researching various evaluation knowledge, related concepts, theoretical basis, and methods of ecosystems by referring to the achievements of domestic and foreign scientific research and scientific and advanced evaluation methods. Design the index system for ecological value assessment, determine various assessment indicators, and build an ecosystem value assessment method [23, 24]. Obtain the original data information related to the Yellow River Delta Nature Reserve and understand the composition and proportion of resources such as various animals and plants in the Yellow River Delta Nature Reserve. According to the difference of various resource function types, choose different value types to classify them scientifically. Classify its various ecological functions and functions, and use different types of evaluation methods to calculate the value of various types of resources according to the obtained relevant data and information, and finally add and evaluate the functional values of various resources. Summarize and then analyze the relationship between various functions and the size of the role played [25–27].

On the basis of summarizing and researching various methods, the Yellow River Delta Nature Reserve is selected as the object of analysis and research, and the relevant resource data in the nature reserve is collected and searched. According to the unique characteristics and actual situation of the Yellow River Nature Reserve, select the appropriate value type for statistical analysis and select the evaluation method suitable for each type for analysis. Build an evaluation index system suitable for this research object. The functions of various ecological assets are evaluated systematically, and various indicators are compared and calculated. Through the comparative analysis of each value, the relationship between each type of ecosystem and the value of the value are obtained. Through the display of the final result, people can correctly recognize the actual value and importance of the ecosystem. Improve human's awareness of the protection of natural ecosystems, so that the cognition of value is no longer limited to the external value that can be measured directly in money, but also its intrinsic value.

Ecological asset assessment refers to the overall evaluation and estimation of the characteristics and total amount of ecological assets. By means of ecological asset accounting or comprehensive evaluation, more scientific and objective data can be obtained. Recent literatures [28–34] discussed a lot of methods to evaluate the value, which lay the foundation of this study.

### 3. Concepts and Theoretical Basis of Ecological Resources

#### 3.1. Related Concepts

*3.1.1. Resource and Asset Value.* Resources refer to all things that are useful to human beings.

Resources usually include the general term for labor, property, and materials that exist within a country or region. Resources can be divided into natural resources and human-created resources. Natural resources include forests, land, water, light, and wind. Social resources refer to the material possessions created by human beings through continuous work and labor.

Assets refer to resources that are formed from past transactions or events of an enterprise, owned or controlled by the enterprise, and are expected to bring economic benefits to the enterprise. Anything of commercial or exchange value owned by any business unit, enterprise, or individual.

The value of an asset is owned or controlled by a specific owner, is expected to bring inflow of economic benefits, and is measured in cash currency.

*3.1.2. Ecological Resources and Ecological Assets.* In the human ecosystem, all the materials, energy, information, time, and space used by the survival, reproduction, and development of living things and humans can be regarded as ecological resources of living things and humans.

In a broad sense, “ecological assets” are the value forms of all ecological resources. In a narrow sense, they are ecological and economic resources that are owned by the state, can be measured in currency, and can bring direct, indirect, or potential economic benefits. “Ecological resources” or “ecological economic resources” are the source of the material composition and ecological functions of the ecosystem that human beings rely on for survival and development. Traditional economics regards ecosystems as pure natural things, and thinks that there are only natural attributes, and natural resources are inexhaustible, and does not regard natural systems as an integral part of the total social assets. In recent decades, due to the global problems of resources, environment, and ecology, people have reflected on the limitations of historical understanding in order to seek ways and means to solve global problems and found that the economic root of the problem is “natural valuelessness”. Put forward new theories and new viewpoints on the values and ecological assets of resources, environment, and ecology, initially formed the framework of natural economics, and formed the natural economics of different departments from different perspectives, such as resource economics, environmental economics, and ecological economics [28].

Ecological resources are the continuous provision of various resources for people to live on and can provide direct biological products and indirect ecological services for human development. Natural ecosystems arise from the interaction of various biological communities on the earth with the local geographical environment. Ecosystems include forests, grasslands, oceans, wetlands, and cities. Ecosystems can be divided into natural ecosystems and artificial ecosystems. Among

them, the natural ecosystems are not interfered by humans, and the artificial ecosystems are built by humans [29].

**3.1.3. Ecological Resources or Ecological Assets Valuation.** In ecological assets valuation, in a broad sense, the value of ecological resource assets refers to the value form of all ecological resources; in a narrow sense, it refers to the ecological economic resources that are owned by the state and can be measured in the form of monetary value and can bring economic benefits. Ecological resource assets have clear ownership. Like assets, ecological resource assets can be divided into intangible assets and tangible assets.

**3.1.4. Ecological Asset Assessment or Evaluation.** Ecological asset evaluation refers to the evaluation of ecological resources by qualified professional evaluation institutions and professional evaluators, in accordance with the requirements of relevant laws and regulations on asset evaluation, in accordance with the specific evaluation purpose signed by the contract agreed by both parties, and following specific evaluation procedures. The resource selects the appropriate evaluation value and determines the evaluation base date to evaluate the value of the appraised object. Ecosystem assets are inherently diverse and complex, and the requirements for evaluation are more stringent. Therefore, appraisers should strictly require themselves to improve their mastery of professional knowledge of ecosystem asset value evaluation and require continuous accumulation of evaluation experience in actual evaluation work [30].

Ecological asset assessment is an overall evaluation and estimation of the characteristics and total amount of ecological assets. It aimed at different regions, different scales, and different ecosystems, using ecological and economic theories, combined with ground surveys, remote sensing, and geographic information technology. By all means, carry out ecological asset accounting or comprehensive evaluation to obtain relatively scientific and objective data [31].

Ecological asset assessment is not completely equivalent to asset assessment in the economic sense. Asset evaluation in economics is mainly the value evaluation of economic entities, serving production and life; ecological asset evaluation is the evaluation of the quality of regional ecosystems with biological resources as the main object and is a part of ecological protection and ecosystem management. Maintain a good regional ecological environment and serve. The value accounting part of ecological asset assessment cannot be simply regarded as green GDP accounting. Green GDP includes resource accounting and environmental accounting. The value accounting part of ecological asset assessment includes the value of ecological services and the value of products provided by biological resources, which is a comprehensive measurement of the entire regional ecosystem, which can be used as a part of green GDP accounting.

The evaluation of ecological assets is reflected mainly in the value of assets, paying attention to the stock and flow of ecological assets, which is the product of the combination of ecology and economics. Ecosystem assessment focuses more on ecosystem structure and its ecological products and services.

### 3.2. Theoretical Basis

**3.2.1. Labor Theory of Value.** It is the labor theory of value that human beings make the created commodities have value through continuous labor. Human needs make commodities used, and this value is the use value brought by the natural attributes of commodities. In addition to natural attributes, commodities also have social attributes, which are created by human tangible or intangible labor. Marx believed that price is determined by value, and the exchange relationship and exchange value of commodities enable value to be reflected in commodities [32].

**3.2.2. Utility Value Theory.** Since human needs are constantly changing due to the influence of many factors, consumers' consumption desire and breeding purchasing power determine the demand for a certain commodity. The degree to which humans are satisfied with their desires is called utility. Human desires and abilities affect their demand for goods, which in turn affects the quantity of goods purchased [33].

**3.2.3. Equilibrium Value Theory.** Equilibrium price theory specifically refers to the amount of money at which the supply and demand of a commodity in the market are consistent. Because in the actual market, the fluctuation between supply and demand relationship is very active and frequent. Equilibrium price is used in the analysis of the price ceiling stipulated by the government to protect the interests of consumers and the analysis of the protection price stipulated by the government [34].

**3.2.4. Ground Rent Theory.** The monetary value obtained by the owner of the land title by leasing the land he owns to the lessor of the land within an agreed period of time. Ground rent can be divided into two kinds of extreme rent and absolute rent, and extreme rent can be divided into differences caused by natural factors other than human factors and differences caused by improving labor efficiency. Because of the influence of land ownership, the use of the land needs to pay the agreed land rent, which is called absolute land rent.

## 4. Design of Ecological Assets Value Evaluation Index System

**4.1. Construction of Evaluation System.** Based on the evaluation criteria, according to the status of the ecological assets of the Yellow River Delta Nature Reserve, a suitable ecological system will be constructed, as shown in the table below.

**4.2. Evaluation Indicators.** Ding et al. [26] mentioned in his paper named "Enterprise Asset Appraisal Indicators and Fuzzy Appraisal" that the following principles should be considered when selecting appraisal indicators: the principle of relevance, the principle of purpose, the principle of principal, the principle of matching, the principle of measurable data, the principle of objectivity, and the principle of comparability.

### 4.2.1. Direct Use of Value

**(1) Evaluation Method.** Due to its multi-functional characteristics, ecosystem resources can provide human beings

with food products, forest products, forest by-products, and fishery products. The rivers and lakes in the Yellow River Delta Nature Reserve have freshwater ecosystems accounting for 6.51% of the natural wetland area, and 48.12% of the natural wetlands are terrestrial ecosystems, including concentrated reeds, shrubs, forests, and saline-alkali land. In the wetland area, man-made ponds and reservoirs occupy 57.69% of the wetland area. The production value of the material = the average price of the material product  $\times$  the annual production of the material in the ecosystem under study.

The formula for the value of material production is:

$$U = P \times C, \quad (1)$$

$U$  - asset value;  $P$  - average price;  $C$  - total output

(2) *Tourism and Leisure Value.* There are abundant forests, animal, and plant landscape resources in the ecosystem with excellent ornamental value, which can provide tourism, leisure vacation, jungle adventure, etc. It brings benefits to the nature reserve. The value of tourism and leisure can be measured by the market value method. According to the data report published by the Dongying Municipal Government, the average monthly income is about 1.5 million. The main income of the Yellow River Delta Nature Reserve comes from the income of tickets and entertainment facilities.

(3) *Cultural Value of Scientific Research.* There are abundant animals, plants, and cherished resources in the ecosystem, which is of great significance to ensure the diversity of biological species. Abundant animal and plant resources provide sufficient conditions for research, enabling humans to better protect the cherished resources in the ecosystem, the value of which can be calculated and evaluated with the funds invested in nature reserves.

#### 4.2.2. Indirect Use Value

(1) *Climate Regulation Value.* The climate regulation function of the ecosystem is to fix carbon dioxide and release oxygen. The carbon dioxide in the air is absorbed continuously by the continuous photosynthesis of plants, which reduces the greenhouse effect. At the same time, oxygen is also continuously released into the air following photosynthesis.

The equation for photosynthesis is  $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6(\text{CH}_2\text{O}) + 6\text{O}_2$ .

It can be concluded that the production of 1 gram of plant dry matter can absorb 1.63 g of carbon dioxide and release 1.19 g of oxygen.

(2) *The Value of Water Storage and Flood Transfer.* The ecosystem has a good function of water storage and flood regulation. The trees and vegetation in the nature reserve can well conserve and protect the water and soil. First of all,

there are plant branches and leaves above the surface soil to block and undertake, which can buffer rainwater. Remove impurities carried by rainwater. Below the surface, the root system of the plant is developed, which reduces the speed of the water flow. Through the respiration and transpiration of the plant, the water has been absorbed, and the plant will retain a certain amount of water. The value of water resources in nature reserves can be measured by the area of the ecosystem, the average local runoff, and the benefits of reducing runoff.

It can be calculated through the shadow engineering method, which is based on the value it would take to recreate the same kind of ecosystem. Reservoirs and reeds in the Yellow River Delta Nature Reserve play an important role in water storage and flood regulation. Water storage can be valued by the price required to store the same flood [25].

(3) *The Value of Building Land by Way of Road.* Compared with other ecosystems, the Yellow River Delta ecosystem has a growing area due to the accumulation of sediment at the estuary. The annual price of land can be calculated by the newly added land area  $\times$  the local market price per hectare of land.

## 5. Construction of Ecological Asset Value Assessment Methods

5.1. *The Principles of Evaluation Method Design.* When evaluating the object being evaluated, the principles of asset evaluation must be strictly followed. In the work, we should evaluate from the standpoint of a third party and maintain the working principle of seeking truth from facts. The evaluation method should be used flexibly in the evaluation work, and different evaluation methods should be adopted according to different evaluation purposes to make the evaluation results more scientific. In the process of asset evaluation, in order to reduce the influence of subjective factors, economic and technical principles should also be followed. When evaluating, the future benefits that the appraised object can generate and the impact of other assets similar to the appraised object should be considered. In addition, the principle of supply and demand under the relationship between supply and demand, the principle of evaluation time point at a fixed time point, and the highest and best use principle should be used in the evaluation of value under the permission of legal, technical, and financial purposes. In addition to its own factors, the externality principle of the impact of external factors on the value of the assets being assessed should also be considered.

### 5.2. Evaluation of Comprehensive Index Analysis Method

5.2.1. *Analytic Hierarchy Process.* Analytic hierarchy process (AHP) was proposed originally by American operations research experts for the rational distribution of electricity according to the size of the contribution. AHP is a multi-criteria decision-making method that combines quantitative

and qualitative analysis to solve various target problems. It is relatively simple, flexible, and accurate.

Analytic hierarchy process (AHP) analyzes and judges the relative importance of each factor, and then arranges and combines them to give the scheme weights reasonably. AHP has four methods to obtain the weight, and the difference between the weight vectors obtained by the four methods is small. Although this difference is small, it will cause different results when it is used actually to solve problems.

**5.2.2. Principal Component Analysis.** Principal component analysis is also called principal dimension analysis, and its analysis method is to extract a small number of relatively important variables from many variables. In practical social application research, there are many factors related to the research object, and each factor responds more or less to the information characteristics of the research object, and it is more comprehensive after summarizing all these factors. However, there are many variables in the subject without analysis, and simply listing it will increase the complexity of the subject and increase the workload. Therefore, by means of dimensionality reduction statistics, a large number of original variable data are replaced with as few comprehensive indicators as possible. The new variables established are independent and uncorrelated and can reflect the original data information as comprehensively as possible.

### 5.3. Evaluation Index Analysis Method

**5.3.1. Market Value Method.** The market method is one of the most frequently used methods in the appraisal process. It takes assets similar to the appraised object in the market as the comparison object. The data required for the appraisal is relatively easy to obtain, and the appraised object can be calculated quickly and effectively. Value is the main object of evaluation.

**5.3.2. Travel Expenses Act.** The travel expense method is a method for evaluating non-price goods. It uses the consumption behaviors consumed by people to evaluate the value of products and services provided by non-market environments. The travel expense method mainly calculates transportation expenses and tourist places' tourists. Factors such as traffic and ticket costs are calculated. But this method is less credible than the market value method.

**5.3.3. Carbon Tax Law.** The carbon tax law is based on the characteristics of absorbing and fixing carbon dioxide and releasing oxygen in the process of over-synthesis of plant life activities. It is based on the amount of carbon dioxide and oxygen that can be absorbed and released by 1 g of dry matter production in plant over-synthesis. The value of this part of the ecosystem is calculated based on the average international carbon tax rate index.

**5.3.4. Shadow Price Method.** The shadow value method is an alternative method, also known as the optimal plan price or calculated price. By applying the linear rule method, the value of the optimal use effect of the resource is calculated.

By taking the price required to create an equivalent biological ecosystem under the current market conditions, and taking the cost of reconstruction as the value of the ecosystem, it reflects the real economic value of the asset and reflects the supply and demand conditions in the market, and the scarcity of the object being assessed.

**5.3.5. Recovery Fee Method.** When resources are abused, wasted, and polluted, in order to restore the original good ecological environment quality, it is necessary to pay certain practical methods, and the cost of restoring the original ecological resources to the original state can be used to evaluate the value of the lost ecological resources.

## 6. Case Analysis of Ecological Asset Value Evaluation in the Yellow River Delta

**6.1. Regional Overview.** The main purpose of the establishment of the Yellow River Delta Nature Reserve is to protect the new wetlands and rare birds. The nature reserve covers an area of about 153,000 hectares. The wetland area reached 113,100 hectares, with the largest area ratio, accounting for 74% of the total area. The Yellow River Delta Nature Reserve is rich in plant resources, with 685 plant species. Numerous apocynum, tamarind, and *Suaeda salsa* grow in the nature reserve, a large number of reeds are concentrated, covering an area of 33,000 hectares, and 65,000 mu of national second-class key protected plants wild soybean are concentrated in the area. Area covered by plants. However, due to the influence of its geographical location, it is located in a relatively low-lying place, close to the Bohai Sea, and the land has a large salt content and a serious degree of salinization of the land. Since about three quarters of the land type is wetland, and other land types are less, the existing forest resources are less species, mostly natural willow forest [22].

### 6.2. Research Process

#### 6.2.1. Direct Use of Value

**(1) Material Production Value.** The material production value is created in the ecosystem, and it is the most direct function among many ecological functions. This paper selects reeds, wild soybeans, and forest products as the main products and uses the market value method to evaluate the production value created by the ecosystem substances. Among them, forest products are worth 50 million yuan, reeds are valued at 190 million yuan, and wild soybeans are valued at 142 million yuan. The total estimated value of the material production value of the Yellow River Delta is 382 million yuan.

**(2) Tourism and Leisure Value.** According to the Dongying National Economic and Social Development Statistical Bulletin issued by the Dongying Municipal Government, the advantageous geographical conditions make the tourism industry in Dongying continue to rise. There are total of 56 tourist attractions with A-level qualifications in the city. The annual tourism revenue generated 20.57 billion yuan, an increase of 12.7% compared with that of the previous

year. The total number of tourists reached 20.177 million, an increase of 9.5%. Among them, the consumption amount of foreign tourists was about 45.5943 million US dollars, an increase of 0.3%; about 65,100 overseas tourists arrived in Dongying, and the number of tourists increased by 2.2%. Since the number of tourists to the Yellow River Delta accounts for 80% of the total number of tourists, the tourism and leisure value of the Yellow River Delta ecosystem is calculated to be 16.456 billion yuan.

(3) *Cultural Value of Scientific Research.* The value of scientific research culture can be calculated and assessed with the funds invested in nature reserves. The tourism industry in the Yellow River Delta has carried out numerous projects for better prospects. Among them, total of 95 million yuans was invested in low-altitude tourism and the dredging of the Beicha River. Total of 530 million yuans was invested in the protection and improvement of the wetland ecosystem with the largest area. In order to better attract tourists and develop itself. The advantages make Bai Stork Lake open boat support to entertain tourists, resume the theme of the Yellow River into the sea, VR experience hall and other projects with a total investment of 190 million yuan. The total value of scientific research and culture in the Yellow River Delta is 815 million yuan.

#### 6.2.2. Indirect Use Value

(1) *Climate Regulation Value.* From the calculation results, it can be concluded that in order to obtain 1 gram of plant dry matter, the plant needs to absorb 1.63 grams of carbon dioxide and release 1.19 grams of oxygen. The concentrated distribution area of reeds is 33,000 hectares. According to the average annual productivity of reeds of 7.9 tons per square hectare, the average annual biomass of reeds is 260,700 t. The area of artificial acacia forest is 5,603 square hectares, and the annual average biomass of the acacia forest is 5.7 tons per square hectare, so the biomass of the Yellow River Delta Nature Reserve is 31,937.1 tons.

The formula for climate adjustment value is:

$$Q = 1.63 \times P \times S, \quad (2)$$

Q - asset value; P - total biomass; S - unit area value.

According to the formula, the total fixed carbon dioxide value = total biomass  $\times$  1.63  $\times$  carbon tax rate = 590 million yuan, the total fixed oxygen value = total biomass  $\times$  1.19  $\times$  unit oxygen value = 350 million, and climate regulation in the Yellow River Delta ecosystem research area. The total value is 940 million.

(2) *The Value of Water Storage and Flood Transfer.* It is calculated by the shadow engineering method, and its formula is that the value of the flood storage is equal to the water storage volume multiplied by the unit water demand cost. Compared with the proportion of other types of land, the wetland area in the Yellow River Delta covers a larger area of about 117,300 hectares. The terrestrial ecosystem

accounts for 48.12% of its area, which is 56,000 hectares. The water storage capacity per square hectare is 8,100 cubic meters. The value of water diversion is 2.592 billion yuan. The Yellow River Delta Nature Reserve is rich in water resources. There are many reservoirs built for development advantages. Among them, seven most representative reservoirs are selected, including four reservoirs under 10 million cubic meters, 2 reservoirs of 20 million cubic meters, and one reservoir of 11.54 million cubic meters [18].

The formula for the value of water storage and flood transfer is:

$$Q = A \times J, \quad (3)$$

Q - asset value; A - total amount of water storage; J - cost per unit area.

According to the formula, the value of reservoir flood regulation and storage = total amount of water storage  $\times$  unit cost = 5.23 billion yuan. The estimated value of water storage and flood diversion in the Yellow River Delta is 7.822 billion yuan.

(3) *The Value of Building Land by Way of Road.* Due to accumulation, the area of the ecosystem in the Yellow River Delta Nature Reserve is constantly increasing, and the land area for road formation is the land price multiplied by the annual land area. Taking the average value of the third-level benchmark land price in Dongying City, it is 1143 yuan, and the annual new land area is 2650  $\text{hm}^2$ . The annual land area is 0.0303 billion yuan.

6.3. *Analysis of Results.* The total value of the Yellow River Delta Nature Reserve is 26.418 billion yuan, including the total evaluation value of the material production value of the ecosystem is 382 million yuan, the tourism and leisure value is 16.456 billion yuan, and the scientific research and cultural value is 815 million yuan. The assessment value of climate regulation value is 940 million yuan, the assessment value of water storage and flood adjustment value is 7.822 billion yuan, and the assessment value of land construction area is 0.303 million yuan.

Among them, the largest proportion of water storage regulation in the indirect use value is the value of water storage and flood regulation, indicating that the indirect value of the Yellow River Delta is mainly based on water storage regulation, supplemented by climate regulation and land reclamation value.

## 7. Conclusions

Ecosystems are closely related to the survival and development of human beings. The Yellow River Delta Nature Reserve has a variety of functions. This time, we mainly evaluate and analyze its main functions from two aspects: direct value and indirect value, including the production of animals and plants in the ecosystem. Those includes the production value caused by the material, the value created by tourism and leisure for tourists, the value of scientific



research and cultural development provided by the existence of a variety of rare animals and plants in the system, and the continuous release of oxygen by plants to adjust the climate in the ecosystem. The value of the developed plant root system and the reservoir in the system to the regulation of flood disasters by the existing water source, the value of land-building due to the accumulation of sediment on the assessed land, etc. There is a relationship between different ecosystem value types, and there is some overlapping calculation of values in the value evaluation process, which leads to a high possibility of errors. It is necessary to select an appropriate range and appropriate evaluation object. Ecosystem resource functions are complex and diverse, and assessment methods lack standardization and unification. Using different assessment methods will result in different assessment results.

Through the evaluation and research on the ecosystem value of the Yellow River Delta Nature Reserve, many deficiencies have been exposed. First of all, the emphasis on the ecosystem is insufficient, the accurate data records of the ecosystem are incomplete, or the data is outdated. The subjective factors of evaluators lead to very different choices of evaluation methods, and there is a lack of relatively normative guidelines. Personally, it is necessary to strengthen my understanding of asset valuation knowledge, the application of valuation methods, and the application of valuation principles.

## Data Availability

The data used to support the findings of this study are included within the article.

## Conflicts of Interest

The authors declare that there are no conflicts of interest.

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