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Ecosystem Service Value Evaluation of Saline—Alkali Land Development in the Yellow River Delta—The Example of the Huanghe Island

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Abstract: Saline–alkali land is an important land resource with high development potential and an important ecological product with high potential ecosystem service value (ESV). It is of great significance for rational development and protection of saline–alkali land resources to carry out research on the evaluation methods of the ESV of saline–alkali land and to scientifically quantify the ESV of saline–alkali land development. Taking typical saline–alkali land in the Yellow River Delta on the Huanghe Island of China as an example, this research constructed an ESV evaluation index system from the perspective of functional value containing three first-level indicators such as economic value, four second-level indicators such as supply service, and eight lowest-level indicators such as food production. It also considered production and operation costs and evaluated the ESV of the Huanghe Island using the ecological economics method. The results showed that the ESV of the Huanghe Island is CNY 133.586 million, and the unit area value is 50,200 CNY/hm^2, which is a relatively high value. Among them, the supply service value was the highest, accounting for more than half. In recent years, the development of the Huanghe Island has produced high supply and service value, but due to weak background conditions and low vegetation coverage, regulation and support service values are relatively low, the cultural service value is still to be explored, and there is great potential for ecological and social value. This research can provide references for scientific evaluation of the ESV of saline–alkali land and provide a basis for rational development and utilization of the Huanghe Island.

Keywords: Yellow River Delta; saline–alkali land; ecosystem services; evaluation of value; the Huanghe Island

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1. Introduction

Saline–alkali land is a special natural resource with high salt content in soil. It not only has grassland, wetland, and other types of cover but also is an important wildlife habitat. At present, the contradiction between people and land is increasingly prominent [1]. As an important land resource, saline–alkali land has high development and utilization value. The development and utilization of saline–alkali land in China [2,3] has had a profound impact on ensuring food security and building ecological civilization. Ecosystem services refer to all benefits provided by ecosystems for human survival, including material products and non-material services [4–6]. Ecosystems include wetlands, forests, farmland, etc. Different types of ecosystems can provide different types, quantities, and qualities of services [5,7], and their formed values are also different. The supply and service capacity of ecosystems of the same type are also different due to quality differences and social activities. In recent years, with the rapid advancement of industrialization and urbanization, ecosystem services, as the hub connecting the natural ecosystem and the social and economic system [8,9], have been continuously impacted and destroyed, and their value has been greatly affected.

However, since it is difficult to quantify and manifest all ecosystem services through market transactions, the exact ESV is not completely clear, nor is the impact of human activities on them [10]. As an important kind of land resource, the ESV of rational development and utilization of saline–alkali land is not clear. Therefore, the value of ecosystem services and the evaluation of ecosystem services in saline–alkali land development have become important scientific issues.

With the impact of human activities on ecosystems and the deterioration of ecological environments, the value and evaluation of ecosystem services have become the focus of global research since 1990. In 1997, Costanza formulated the global ecosystem service equivalent factor table, which estimated the monetary amount of the global ecosystem value for the first time [5]. The ecosystem service equivalent factor was also widely used [11]. Xie Gaodi, a Chinese scholar, compiled the value equivalent table of ecosystem services in China and calculated the monetary value of ecosystem services on the Qinghai Tibet Plateau [12]. In recent years, scholars have carried out studies on the ESV of forest [13], grassland [14], farmland [15], wetland [16], marine [17], and other ecosystems. They have also studied value evaluation methods [18], value evaluation index systems [19], value spatio-temporal evolution and tradeoff relationships [20], and driving factors of value change [21]. Evaluation models and methods mainly include the InVest model [22], meta regression [23], etc. In addition, the ESV is always combined with studies of land use change [24,25] and ecological compensation standards [26] to explore the changing rules of ESVs [27], influencing factors [28], and the response relationship between land use change and ecosystem service [29]. The research results have provided good support for territory spatial planning, ecological security pattern construction, and economic decision making [30]. At present, some scholars refer to the equivalent factor of per unit area ESV constructed by Xie Gaodi [31] to evaluate the ESVs in different regions through regional correction [32]. The equivalent factor method is simple but ignores differences in actual service value caused by different quality of similar ecosystems. Farmland, forests, and other ecosystems have high production and tourism value as well as high production and operation costs. Some scholars use the ecological economics method to evaluate ESVs [33–35], but they rarely consider production and operation costs. Therefore, it is also necessary to strengthen the research on evaluation methods of the actual service value of various ecosystems, divide various functional types based on the perspective of functional value, build an evaluation index system of ESVs, study the calculation methods of different value types, deduct the objective production and operation costs, scientifically and accurately quantify the actual ESVs, and provide a reliable basis for the decisions regarding ecosystem development and utilization. There are certain explorations and practices in the field of development and utilization of saline–alkali land around the world, such as the action plan on salinity and water quality in southern Australia [36]. Chinese scholars' studies on the development of saline–alkali land have mostly been concentrated in the Songnen Plain [37], the Yellow River Delta [38], and other typical areas. China's forestry ecological project [39], farmland forest network project [40] to control the increase in soil salt content, and other attempts to develop and utilize saline–alkali land have had a profound impact on food security and ecological civilization construction, but recent studies rarely considered the impact of saline–alkali land development and utilization on the ESV. Saline–alkali land is an important land resource with high ESV and development value. It is of great significance for scientific quantification of the ESV of saline–alkali land and rational development and protection of saline–alkali land resources to strengthen the research on the ESV of saline–alkali land ecosystem services. However, at present, there are few relevant studies on the evaluation of the ESV of saline–alkali land, and a few studies only focus on the evaluation of the ESV under a single utilization mode such as planting a plantation in saline–alkali land [41]. Additionally, there are few studies on the evaluation of the ESV of comprehensive development and utilization of saline–alkali land. The Yellow River Delta is one of the main saline–alkali land distribution areas in China, and it is rich in land resources. However, the ecological environment is fragile, the anti-interference ability is poor, and it needs to be developed and reasonably utilized. In April 2013, China launched a Bohai Sea granary construction project in the Yellow River Delta to develop and transform saline–alkali land and increase grain production and income. In 2021, China issued "the Outline of the Plan for Ecological Protection and High-quality Development in the Yellow River Basin", which proposed to protect the Yellow River Delta, prevent soil salinization, and explore the value accounting for ecosystem services. At present, the research objects on the ESV of the Yellow River Delta are concentrated in the wetland of nature reserves [33,42], and there is a lack of relevant research on the index system, evaluation methods, and development value of the ESV of saline–alkali land. Therefore, it is necessary to carry out research on the evaluation of the ESV of Yellow River Delta saline–alkali land exploitation, so as to evaluate and reveal its ESV and development value, which is of great significance for scientific exploitation, protection, and utilization of saline–alkali land.

The Huanghe Island is a typical saline–alkali land in the Yellow River Delta, and the degree of soil salinization is high. Since 2003, in accordance with Yellow River Delta development, National Wetland Park Construction and Bohai Granary Demonstration Area Construction, and other projects, the Huanghe Island has managed saline–alkali land, developed forestry and grassland industries, developed tourism, built wetland parks, and achieved good results. In this research, the Huanghe Island was used as the study area, and according to the current development and operation situation and different functional types, considering its quality and actual output, the market price method, alternative cost method, and other ecological economic methods were used to evaluate the ESV for the development of the Huanghe Island. Additionally, the costs of supply services and cultural services were deducted to obtain more objective and realistic estimation results, which provide a basis for scientific quantification of the value of saline–alkali land and protection of saline–alkali land resources. It also provides references for ecological development and green ecological construction in the area of the Huanghe Island, and it provides references for the evaluation of ESVs of saline–alkali land in other areas.

2. Overview of the Study Area and Data Sources

2.1. Overview of the Study Area

2.1.1. Natural Resource Conditions

The Huanghe Island (118°1′1″–118°4′1″ E, 37°54′57″–38°0′18″ N) is located in Binzhou City of Shandong Province, and it has a total area of 26.61 km^2 (see Figure 1). It was formed by the deposition of the ancient Yellow River, and it is located in the hinterland of the Yellow River Delta at the junction of the coastal plain and the coastal beach. It faces the Bohai Sea. Affected by river siltation and sea tide overflow, the terrain is high in the south and low in the north and is distributed in strips. It has a marine climate, with an average annual temperature of 14.5 °C and an average annual precipitation of 569 mm. The Huanghe Island is a typical saline–alkali land in the Yellow River Delta, and the soil salt content is 0.00–21.02 g/kg. Moreover, there are many types of saline–alkali lands with severe, moderate, and low degrees. The land utilization status of the island is mainly water surface, and there are rich wildlife resources, such as reeds, tamarisk, tamarix, other salt-tolerant plants, hares, foxes, swans, wild ducks, and other wild animals. The Huanghe Island is surrounded by water on all sides, and it borders the Bohai Sea in the northeast and the Yellow River in the south. It is surrounded by the Taoer River and the Qinkou River, and it has a beautiful environment and good ecology. It is also a superposition of the Yellow River Delta Efficient Ecological Economic Zone, the Blue Economic Zone of Shandong Peninsula, the Bohai Rim Economic Circle, and the provincial capital city cluster economic circle.

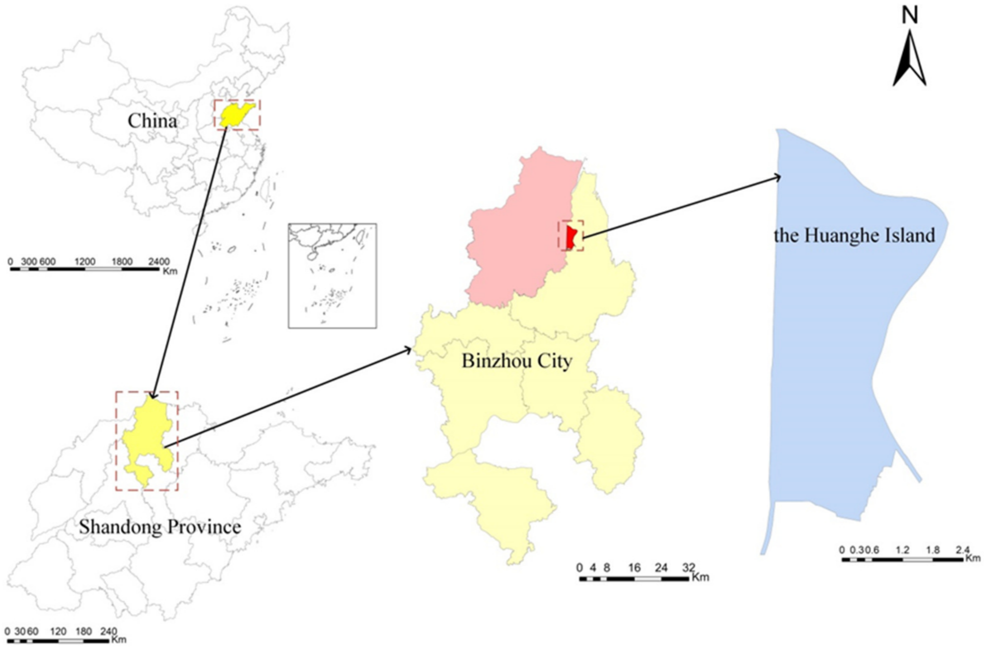

Figure 1. Overview of the study area.

2.1.2. Development and Utilization Status

Since 2003, relying on the advantages of natural geography and resources and seizing the opportunities of the development of the Yellow River delta, the construction of the blue economic zone, and the Bohai granary, the Huanghe Island has made great efforts to develop aquaculture and tourism. It has also carried out an underground pipe salt drainage land renovation project, developed resources of cultivated land, developed ecological agriculture, and built a conservation resource nursery of the native salt-tolerant plant community. It has been developed into an AAAA national tourist attraction, a national wetland park, and a national field scientific observation and research base. At present, the Huanghe Island has completed the construction of water, electricity, roads, networks, and other infrastructure; planted a large number of green trees; and formed five parks, including the "agricultural ecological demonstration park". Now the Huanghe Island has formed a variety of land use models, such as economic forest grass ecological agriculture and aquaculture, and gradually formed an ecological and efficient sightseeing belt that combines planting, breeding, and tourism. The development and construction of the Huanghe Island has provided good economic and ecological benefits.

The Huanghe Island has vigorously developed forestry and forage industries, and it has vigorously promoted the development of the forest grass intercropping planting mode. The "three in one" of the road forest network, farmland forest network, and river forest network has been preliminarily formed, and salt- and alkali-resistant tree species have been introduced and cultivated. In order to vigorously develop the forage industry, alfalfa greenhouses have been built, equipped with mowers and other agricultural machinery, and the quality of alfalfa products is guaranteed. The Huanghe Island has made great efforts to develop fishery, including standard pond aquaculture and recreational fishery. The varieties of aquaculture include razor clams and prawns, which have significant economic benefits. It has also developed recreational fishery, such as pond fishing and experiential mining, to provide tourists with special services and to effectively promote the comprehensive and modern development of fishery. The Huanghe Island has made great efforts to develop animal husbandry, including seed conservation, breeding, cross improvement, breeding and promotion of improved sheep, supporting the construction of feed warehouses and other infrastructure, and has applied for national invention patents and utility model patents. The Huanghe Island has made great efforts to develop the tourism industry, including agriculture, forestry, animal husbandry, fishing, tourism, and other industries. It has been rated as a national water conservancy scenic spot, a national wetland park, and a national leisure fishery demonstration base. It has integrated the planning of agriculture, forestry, animal husbandry, fishing, tourism, and other industries. It has also highlighted agricultural characteristics and worked hard to build a national first-class agricultural tourism demonstration base to further develop scenic spots and create a brand. In the future, the Huanghe Island will continue to be characterized by idyllic scenery and organic ecology, integrating wetland culture, agricultural reclamation culture, the culture of the old Yellow River, the culture of Yellow River changes, folk culture, painting, and calligraphy art, which will make it an ecological cultural tourism island in the Yellow River Delta that integrates multiple tourism functions.

2.2. Data Sources

(1) Land use data are from the Shandong Institute of Territorial and Spatial Planning. Through a field survey, land use types were changed and refined based on the development status of the Huanghe Island, and fine-scale land use and vegetation cover information were obtained. The land use status of the Huanghe Island was obtained after a field survey and verification (see Table 1 and Figure 2).

Table 1. Land use status of the Huanghe Island.

Land Use Type	Area (km^2)	Percent (%)	Land Type	Area (km^2)	Percent (%)
Woodland	1.34	5.04	Grassland	3.41	12.81
Mixed forest and grass	4.22	15.86	Water surface	11.37	42.73
Farmland	0.17	0.64	Ditch	4.03	15.14
Garden	0.02	0.08	Construction land	2.05	7.70

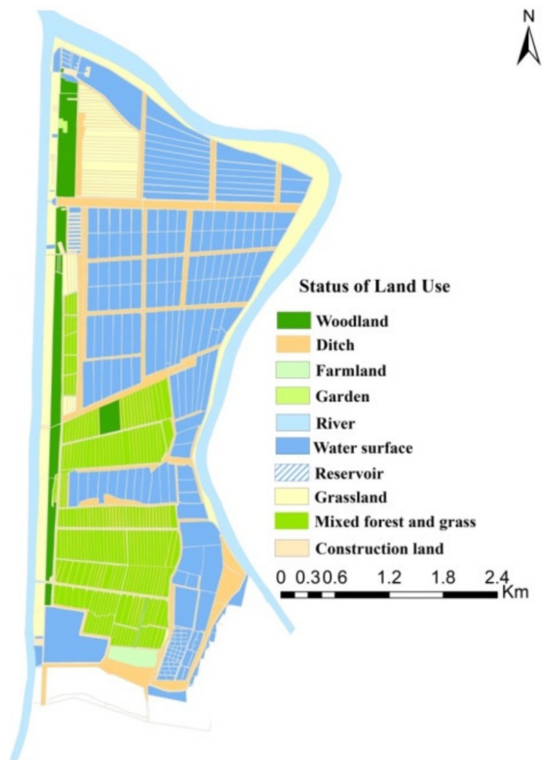

Figure 2. Status of land use.

(2) Soil data, grassland biomass data, plant diversity, and other data were obtained from sampling and measurement. Some parts of the study area have been developed as

aquaculture water surfaces, which was not within the sampling scope; the sampling scope was land. Following the principles of uniform distribution of points and dense distribution of points in key areas, 53 sample points were arranged (see Figure 3). The undisturbed soil was collected with a ring knife, and the soil organic matter, available phosphorus, available potassium, alkali-hydrolyzed nitrogen, and bulk density were determined in the laboratory. Additionally, 1 m × 1 m and 10 m × 10 m squares were laid in the vegetation-covered area to count the number and types of herbs and woody plants, which were dried and weighed in the laboratory.

Figure 3. Distribution of sampling points.

(3) Meteorological data were from the China Meteorological Data Network (http://data.cma.cn/) in 1/18 2021, Meteorological Bureau of Wudi County, and Binzhou Statistical Yearbook. These data included rainfall, temperature, solar top atmospheric radiation, and other meteorological data.

(4) The statistical output and price of grain, relevant production and operation costs, wage standards, and other data were obtained from the China Statistical Yearbook, Binzhou Statistical Yearbook, Wudi County Statistical Yearbook, China's agricultural product cost income data collection, relevant news reports of the Huanghe Island, etc., and these were obtained from relevant websites and the Statistical Bureau of Binzhou City and Wudi County.

(5) The data of food, raw materials, and tourism income of the Huanghe Island were obtained from the statistical data of the Huanghe Island Development Company.

(6) Other data were from China's Technical Guide for Delineation of Ecological Protection Red Line, Code for Assessment of Forest Ecosystem Service Functions (GB/T 38582-2020), CNKI database, and the Web of Science database.

3. Research Methodology

3.1. Construction of Value Evaluation Index System

The Millennium Ecosystem Assessment (MA) divided ecosystem services into four categories: supply, regulation, support, and culture [4]. Costanza divided ecosystem service functions into 17 categories, such as gas regulation, climate regulation, and interference regulation [5]. Although the classification is scattered and not systematic, it is widely used globally. Xie Gaodi divided ecosystem services into four categories: supply, regulation, support, and culture [31]. He also adjusted and optimized the classification of secondary services many times and proposed the value equivalent of ecosystem services per unit area of various land use types, which has been widely used in relevant studies in China. Saline–alkali land is a natural resource with high soil salt content. It not only includes cultivated land, forest land, grassland, marshes, and other land use types but is also an important wildlife habitat. Saline–alkali land can provide corresponding ecosystem services for human beings, but its environment is complex, and the conditions are special, so the service value generated should be further screened. This research refers to MA [4], Costanza [5], Xie Gaodi [31], and other ESV classifications, and it considers the land use type, terrain, vegetation, and saline–alkali land characteristics and data availability of the Huanghe Island. Through field research, three first-level indicators including economic, ecological, and social value; four second-level indicators including supply, adjustment, support, and culture service; and eight lowest-level indicators including food production, raw material production, etc. (see Figure 4) were defined. The connotation of each evaluation index was also defined (see Table 2).

Table 2. Connotation definition of the ESV evaluation index system.

Lowest-Level Indicators		Connotation
V11	Food Production	The function and value of saline–alkali land directly providing edible animal and plant products for human beings
V12	Raw Material Production	The function and value of saline–alkali land providing people with building raw materials, animal feed, and other products
V21	Gas Regulation	The function and value of plants in saline–alkali land fixing CO_2 and releasing O_2 through photosynthesis to maintain the dynamic balance of CO_2 and O_2 in the atmosphere, so as to realize the function and value of mitigating the greenhouse effect and regulating gas and climate
V22	Conservation of Water Sources	The function and value of saline–alkali land intercepting, absorbing, and storing precipitation through plants, soil layers, and water surfaces, thus playing the valuable role of conserving soil moisture and supplementing surface fresh water and groundwater
V31	Maintenance of Biodiversity	Saline–alkali land is an important genetic source, evolutionary base, and habitat of wild animals and plants, and it has the function and value of maintaining biodiversity
V32	Maintenance of Nutrient Cycling	Saline–alkali land has the function and value of maintaining material exchange and nutrient cycling between organisms and the environment, with soil organic matter, nitrogen, phosphorus, and potassium as the main cycling substances
V41	Leisure and Entertainment	Saline–alkali land can provide functions and values of leisure tourism, cultural activities, and landscape appreciation
V42	Research and Education	Saline–alkali land can provide the function and value of the site for related scientific research, education, and teaching

3.2. Value Evaluation Method Based on Ecological Economics

3.2.1. Selection of Value Evaluation Methods

The ecosystem service value of saline–alkali land is diverse, and a single method cannot accurately evaluate it. Ecological economics is a discipline that studies the structure and movement law of the ecological economic system, which is composed of economic systems and ecosystems approached from the perspective of economics [43].

The equivalent factor method is used to construct value equivalents of various functions of different types of ecosystems based on different types of ecosystem services and quantifiable standards, and it estimates the ESV through the equivalent factor table. One standard unit ecosystem product value equivalent factor is the economic value of the annual grain yield of the farmland with the national average yield of one hectare. The estimation process is relatively simple, and the data demand is not much, but the accounting results do not always reflect the actual situation of the study area [5,12]. Different from the equivalent factor method based on regional differences, the commonly used value research methods in ecological economics include the market price method, shadow price method, willingness survey method, etc. Additionally, they involve many parameters and complex calculations, but the results are more consistent with the actual situation of the study area. In particular, the accounting results of the supply function are more accurate [33]. Based on the perspective of functional value, this research divided the service value function of saline–alkali land ecosystem; used ecological economics methods; considered the indicator characteristics, method applicability, and data availability of the ESV of saline–alkali land; and comprehensively used the market value method, alternative cost method, opportunity cost method, and other ecological economics methods to evaluate the ESV of the Huanghe Island.

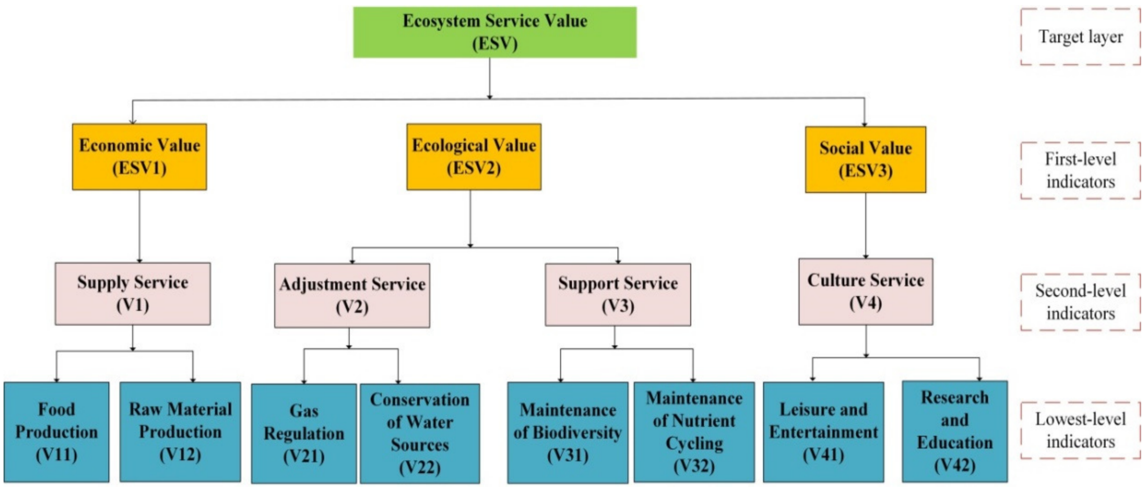

Figure 4. Construction of evaluation index system.

3.2.2. Evaluation of Supply Service Value

Evaluation of Food Production Value

The development and utilization of the Huanghe Island for many years has realized the organic combination of agriculture, forestry, animal husbandry, and fishery production. The fruits, vegetables, seafood, grains, meat products, and other animal and plant food products produced by the Huanghe Island can be directly traded in the market, although they have high production costs. In this research, the market value method was used to evaluate the total income of food production, and the cost input was deducted to obtain the food production value. The calculation is shown in Formula (1)

$$V_F = \sum_{i=1}^{n} (A_i \times B_i - \mathrm{S}_i \times \mathrm{B}_i) \times T \quad (1)$$

where V_F represents the average annual food production value (ten thousand CNY/year), n is the total number of food categories, A_i is the average annual unit price of the ith food (ten thousand CNY/t), S_i is the average annual cost of the category ith food (ten thousand CNY/t), B_i is the average annual production of the category ith food (t), and T is the time (a), which was one year in this study. According to statistical data from the Huanghe Island Development Company, the annual fruit output of the Huanghe Island includes apples, pears, grapes, dates, etc., with an average annual output of 41.00 t and an average price of 5540 CNY/t. Vegetables include eggplants, peppers, carrots, etc., with an average annual yield of 45.21 t and an average annual price of 2330 CNY/t. Animal husbandry is mainly the raising of green goats, with an average annual yield of 16.59 t and an average annual price of 21,000 CNY/t. Aquaculture mainly includes shrimp and razor clam. The average annual output of shrimp is 490.33 t, with an average annual price of 29,330 CNY/t, and the average annual output of razor clam is 5957.50 t, with an average annual price of 19,730 CNY/t. Referring to the grain production data of Wudi County in recent years, Wudi County has three major grain products: wheat, corn, and sorghum.

Their annual output value is 13594.34 CNY/hm^2, and the farmland area of the Huanghe Island is 0.17 km^2. Based on the data compiled from China's agricultural product data, Wudi County's grain production data, and local data collection, including production costs, labor costs, land costs, etc., it was estimated that the production costs of aquaculture, fruits, vegetables, and green goats are 8.58, 2.99, 0.86, and 21.98 CNY/kg, respectively, and the production cost of grain is 840 CNY/mu. The annual average food production value was calculated after deducting the production costs.

Evaluation of Raw Material Production Value

The Huanghe Island is a typical saline–alkaline area. It can improve the vegetation cover and soil conditions of saline–alkaline land by planting saline-tolerant plants such as alfalfa and white wax. It can also be used as a raw material to obtain certain economic benefits through market sales. Raw material production mainly includes pastures and adult trees (excluding seedling trees). In this paper, the market value method was adopted to evaluate the total production revenue of raw materials, and the production value of raw materials was obtained by deducting the production cost. The calculation is shown in Formula (2)

$$V_M = \sum_{j=1}^{n} (A_j \times B_j - S_j \times B_j) \times T \quad (2)$$

where V_M is the production value of raw materials (ten thousand CNY/year), n is the total number of raw materials, A_j is the unit yield of the category *j-th* raw materials (t), B_j is the market price of the category *j-th* raw materials (ten thousand CNY /t), S_j is the average annual cost of the category *j-th* raw materials, and T is the time (a), which was one year in this study. According to the statistical data and relevant data collected by the Huanghe Island Development Company, the average annual forage grass output is 2973.33 t, the average unit price is 1800 CNY/t, and the average cost is 800 CNY/t. On average, 600 adult trees are sold every year, with an average unit price of 690 CNY/tree and an average cost of 49.59 CNY/tree. Based on this, the annual average production value of raw materials was calculated.

3.2.3. Evaluation of Adjustment Service Value

Evaluation of Gas Regulation Value

The Huanghe Island has grassland, forest land, mixed forest and grass, and other vegetation types, which produce high gas regulation value through photosynthesis. In this study, alternative cost methods such as carbon fixation cost, afforestation cost, and oxygen production cost of plants were used to evaluate their value, as shown in Formula (3)

$$V_G = 0.44 \times Q \times P_C + 1.2 \times Q \times P_O \quad (3)$$

where V_G is the value of gas regulation (ten thousand CNY/year), Q is the biomass (kg), and P_C is the cost of carbon fixation (CNY/kg). In this research, afforestation cost was used, and P_O is the cost of oxygen production (CNY/kg). Additionally, industrial oxygen production price was used in this study. For every 1.00 g of dry matter produced by plants, 1.63 g of CO_2 is fixed, which means 0.44 g of C [44] and 1.20 g of O_2 are released [45]. Biomass data were obtained through field investigation and references to the relevant literature. Grassland biomass was obtained by field investigation, and the area biomass was 381.47 g/m^2 as assessed by a spatial interpolation tool in ArcGIS 10.2. Parameters of afforestation cost, oxygen production price, and forest biomass (stand net productivity) were determined and calculated by referring to the relevant literature [41,46]. The cost P_C of carbon fixation and the price P_O of oxygen production were based on public data, and their values were 1200 CNY/t [41] and 1000 CNY/t [41], respectively. Based on the forest stand net productivity determined by the forest stock expansion method [46], the forest land of the Huanghe Island is mainly planted with ash, and the biomass of ash is 8.73 t/(hm^2 •a) [41].

Evaluation of Water Sources Conservation Value

The Huanghe Island can store water through water conservancy facilities, intercept rainfall through vegetation and soil, and produce a certain water conservation value. The market value method and water balance method were used to calculate the value of water storage of water conservancy facilities and rainfall interception by soil and vegetation, as shown in Formulas (4)–(8)

$$V_W = Vc + V_R \tag{4}$$

where V_W is the total value of water conservation (CNY/year) and Vc is the water storage value of water conservancy facilities (CNY/year), as shown in Formula (5). V_R is the value of soil and vegetation interception of rainfall (CNY/year), as shown in Formula (6).

$$Vc = S_w \times P_W \tag{5}$$

S_w is the water storage capacity of water conservancy facilities (m^3). There is an irrigation water storage reservoir on the Huanghe Island, and the basic data collected show that its water storage capacity S_w is 1.219×10^7 m^3.

$$V_R = (R - E) \times A \times P_W \tag{6}$$

R is the average annual rainfall (mm/a), and E is the annual average evapotranspiration (mm/a), which is calculated by rainfall, solar top radiation, temperature, etc. according to the China's Technical Guide for Delineation of Ecological Protection Red Line issued by the Ministry of Ecology and Environment of China, as shown in Formula (7). A is the area of various land use types (hm^2), and the land use mode of the Huanghe Island is shown in Table 3. P_W refers to the unit storage cost (CNY/m^3). In earlier studies, P_W was usually taken as the constant price of the cost of building 1 m^3 of storage capacity in China in 1990, meaning the cost of unit storage capacity was 0.67 CNY/m^3 [47–50]. Later, scholars modified this parameter [51], and this research determined that P_W is 0.92 CNY/m^3 [51].

$$\mathrm{E} = \frac{\mathrm{P} \times \left(1 + \omega \frac{\mathrm{PET}}{\mathrm{P}}\right)}{1 + \omega \frac{\mathrm{PET}}{\mathrm{P}} + \frac{\mathrm{P}}{\mathrm{PET}}} \tag{7}$$

PET is the multi-year average potential evaporation (mm), and the calculation is shown in Formula (8). The highly generalized ω coefficient of land cover factor in China's Technical Guide for Delineation of Ecological Protection Red Line issued by the Ministry of Ecology and Environment of China was adopted (see Table 3). P is the annual average rainfall for many years (mm).

$$PET = \mathrm{C} \times \mathrm{Ra} \times (T_a + 17.8) \times TD^{\frac{1}{2}} \tag{8}$$

Table 3. The referencing values of parameter ω for evaluating the importance of water conservation.

Land Use Type	Arable Land	High Coverage Forest Land	Low Coverage Forest Land	Bush Wood	Grassland	Artificial Land Use	Other Land Use
Values of ω	0.5	2.0	1.0	1.0	0.5	0.1	0.1

In Formula (8), C is the temperature coefficient, which has a value of 0.0023 [52] according to the cited study. Ra is the atmospheric radiation at the top of the sun (MJ/(m^2·d)). Ta is the average temperature (°C), and TD is the temperature difference (°C). According to the basic data of the Meteorological Bureau of Wudi County, the Ra of the Huanghe Island is 234285.23 MJ /(m^2·d), the Ta is 14.5°C, the TD is 30.45°C, and the calculated PET is 96043.71 mm.

3.2.4. Evaluation of Support Service Value

Evaluation of Maintenance of Biodiversity

Saline–alkali land can provide a habitat for many animals and is an important source of the animal and plant gene pool. The Huanghe Island is rich in animal and plant species, including animals such as swans, hares, ducks, and plants such as reeds, alkali buns, and tamarisk, which have a value in maintaining biodiversity. As animals often move, the number is difficult to determine, so only the diversity value of plants was calculated in this research. According to the connotation of plant diversity index, the opportunity cost method was used to estimate plant diversity by combining the plant quantity and relevant parameters determined by the investigation, as shown in Formula (9)

$$V_B = \sum_{k=1}^{n} Y_k \times S_k \quad (9)$$

where V_B refers to the value of biodiversity (CNY/a), n refers to the number of biodiversity levels, Y_k refers to the land area (hm^2) of the category k-th biodiversity location, and S_k refers to the annual opportunity cost of species loss per unit area of the category k-th biodiversity (CNY/(hm^2•a)). The calculation of plant diversity value in this study did not include water surfaces or ditch land.

We calculated the Shannon–Wiener index H of plant diversity at the sampling point, as shown in the Formula (10), and then determined the value of S_k. The distribution of the Shannon–Wiener index H in the study area was obtained through spatial interpolation, and, with reference to the Code for Assessment of Forest Ecosystem Service Functions (GB/T 38582-2020), the biodiversity level was determined to be seven, the area of each level Y_k was calculated, and the unit value (i.e., opportunity cost) S_k was determined (see Table 4).

$$H = -\sum_{m=1}^{n} P_m \log_2 P_m \quad (10)$$

Table 4. Value division of the grades of Shannon–Wiener Index H grades.

The Number	Shannon–Wiener Index H	Class of Biodiversity	Unit Value S_k(CNY/hm^2*a)
1	<1	7	3000
2	[1,2)	6	5000
3	[2,3)	5	10,000
4	[3,4)	4	20,000
5	[4,5)	3	30,000
6	[5,6)	2	40,000
7	≥6	1	50,000

H is the Shannon–Wiener index of plant diversity, P_m is the proportion of the individual number of species m to the total individual number, and n is the number of species.

Evaluation of the Maintenance of Nutrient Cycling

Soil nutrients are an important indicator of soil quality, which not only affects plant growth and development but also plays an important role in nutrient cycling. The Huanghe Island is a typical saline–alkali land distribution area, and the high salt content and low nutrient level of the soil are important factors limiting plant growth. After land development, construction, and remediation in recent years, soil salinization has improved, the contents of soil organic matter, nitrogen, phosphorus, potassium, and other nutrients has increased, and the value of maintenance of nutrient cycling has gradually increased. Based on the relevant data of organic fertilizers and nitrogen, phosphorus, and potassium fertilizers, this research used the shadow price method to estimate the maintenance of nutrient cycling of soil [53], as shown in Formula (11). The types of land use involved included garden plots, farmland, forest land, forest grassland, and wasteland.

$$V_N = \sum_{p=1}^{n} Y_p \times d \times \rho \times M_p \times P_F \quad (11)$$

V_N refers to the maintenance of nutrient cycling (CNY), n refers to the number of land use types involved, Y_p refers to the area of type p land (m^2), and d refers to the soil depth (m). In this research, the soil depth was set as 0.4 m according to crop growth. ρ is the soil bulk density (kg/m^3), M_p is the organic matter and N, P, K contents (mg/kg) in the soil of type p land, and P_F is the price of fertilizer (CNY/mg for compound fertilizer and CNY/g for organic fertilizer).

The soil organic matter, soil bulk density, and nitrogen, phosphorus, and potassium contents of various land uses were obtained by spatial interpolation after sampling and measurement and by land classification statistics (see Table 5). Among them, the conversion coefficient of organic matter and organic carbon is 1.724 [54], and this research adopted the organic carbon price determined by Hou Yuanzhao [55] according to the afforestation cost method, meaning the fixed carbon afforestation cost constant price in northern China is 273.3 CNY/t. This result was also adopted by other relevant studies [56,57], and the price of nitrogen, phosphorus, and potassium fertilizers was determined according to the price of nitrogen, phosphorus, and potassium compound fertilizers and data of nitrogen, phosphorus, and potassium elements provided by the Statistics Bureau of Wudi County.

Table 5. The soil physical and chemical properties of different land types.

Land Type	Organic Matter (g/kg)	Nitrogen (mg/kg)	Phosphorus (mg/kg)	Potassium (mg/kg)	Soil Bulk Density (g/cm^3)
Grassland	9.01	16.53	7.81	83.97	1.51
Forest land	9.31	14.69	6.10	107.80	1.50
Mixed planting of forest and grass	14.37	44.14	6.14	180.62	1.49
Farmland	8.54	22.74	4.83	339.85	1.53
Garden	6.91	15.33	5.00	90.97	1.55

3.2.5. Evaluation of Culture Service Value

Evaluation of Leisure and Entertainment Value

Saline–alkali land is a natural tourism resource. The Huanghe Island has been developed into an AAAA national tourist attraction, which has a high value of tourism, health care, vacation, leisure, and entertainment. It is popular with an increasing number of tourists, and it can obtain high tourism income. In recent years, the number of tourists to the Huanghe Island has increased year by year, and the economic income has gradually increased. According to the number of tourists and consumption data provided by its development company, the alternative market method and market price method were used to estimate its leisure and entertainment value, as shown in Formulas (12) and (13).

$$V_L = (C_A \times N - C_p \times P - C_d) \times T \cdot \quad (12)$$

In Formula (12), V_L is the total annual income of the tourism industry (CNY/year), C_A is the per capita tourism consumption (CNY/person), N is the average annual number of tourists (person), C_p is the labor cost, that is, the salaries of scenic spot staff (CNY/year), P is the number of staff, C_d is the daily maintenance cost of park facilities and equipment, T is the calculation time (a), and the value is one year. The wage standard was calculated according to the average per capita disposable income of urban residents in Wudi County. According to the statistics of the Huanghe Island Development Company, the Huanghe

Island has received 226,900 tourists annually in the past three years, and the per capita consumption is about CNY 63.20. The Huanghe Island scenic spot has an annual staff of 40.

$$C_d = C \times S\cdot \quad (13)$$

This research referred to relevant studies [58] to calculate the daily maintenance cost of facilities and equipment in parks. In formula (13), C is the maintenance cost of park infrastructure and S is the construction land area of the park. Referring to studies on the standard of park maintenance and management expenses [58], the standard of expenses in 2017 was 0.50 CNY/m^2. This research modified it according to the residents' consumption level index, and the maintenance cost of park infrastructure was 0.555 CNY/ m^2.

Evaluation of Research and Education Value

Saline–alkali land is of high scientific research value. More and more scientific research projects and topics are carried out in saline–alkali land, which aim to improve saline–alkali land and make rational use of saline–alkali land resources [59–61]. According to the LetPub Science Fund query system, during 2011–2020, a total of 186 fund applications for saline–alkali land were supported by the National Natural Science Foundation of China. The funded projects mainly belonged to the ministry of earth sciences and the ministry of life sciences. The projects of the ministry of life sciences were aimed at promoting soil improvement of saline–alkali land through relevant studies and playing the role of reserving land resources of saline–alkali land. The projects of the ministry of earth sciences aimed at monitoring and evaluating soil salinity in saline–alkali land through remote sensing and other technical means. In addition, saline–alkali land was also used to carry out teaching and research activities, such as research and learning practice for middle school students. The scientific research value of saline–alkali land mainly consists of scientific research activities and teaching activities. In this research, the scientific research value was quantified by the number of papers published, and the scientific research value was evaluated by considering the input and research cycle of each paper. According to the statistical data of the Huanghe Island Development Company, the teaching activities were evaluated through the number of teaching activities and amount of income. The calculation method is shown in Formula (14)

$$V_S = V_R + V_E \quad (14)$$

where V_S is the total value of scientific research and education (ten thousand CNY), V_R is the value of scientific research (ten thousand CNY), and V_E is the value of education (ten thousand CNY). The Huanghe Island is a typical saline–alkali land, with high, medium, and low salinization types distributed throughout. It has more wetlands, rich biological varieties, and diverse animals and plants, which is of high scientific research and education value. The scientific research value refers to the value of the Huanghe Island as an experimental scientific research base, which is evaluated by the alternative cost method. As the Huanghe Island as an experimental base has a short period of scientific research, while the large-scale Yellow River Delta has a longer period of research, this study took the Yellow River Delta as a reference and quantified results according to the publication of relevant papers in 2021. The results of relevant journal papers with the research theme of the Yellow River Delta were retrieved on CNKI, and 269 journal papers were published in one year. This study searched the Web of Science database for 319 English papers with the theme of "Yellow River Delta" published by China's scholars in one year. According to the references [62,63], the investment in each scientific research paper was about CNY 357,600, and the scientific research cycle of China-funded projects was generally three years. Therefore, the average annual investment in each paper was 1/3, which is CNY 119,200, and the value of the Yellow River Delta per unit area was converted to the Huanghe Island [64]. The educational value refers to the value of the Huanghe Island as a place for teaching and research training. Based on the number of participants and charging standards, the market value method was used to evaluate its value.

4. Results and Analysis

4.1. Comprehensive Analysis of the Total ESV of the Huanghe Island

Based on the constructed saline–alkali land ESV index system and the functional value evaluation methods of ecological economics, the total annual ESV of the Huanghe Island was CNY 133.586 million (see Table 6), and the unit value was 50,200 CNY/hm^2.

Table 6. The results of the ecological economic method to evaluate the ESV of the Huanghe Island.

First-Level Indicators	Value ($\times 10^4$ CNY)	Percent (%)	Second-Level Indicators	Value ($\times 10^4$ CNY)	Percent (%)	Lowest-Level Indicators	Value ($\times 10^4$ CNY)	Percent (%)
Economic Value	8015.05	60.00	Supply Service	8015.05	60.00	Food Production	7679.29	57.49
						Raw Material Production	335.76	2.51
Ecological Value	3807.00	28.50	Adjustment Service	1917.50	14.35	Gas Regulation	795.98	5.96
						Conservation of Water Sources	1121.52	8.40
			Support Service	1889.50	14.15	Maintenance of Biodiversity	341.18	2.55
						Maintenance of Nutrient Cycling	1548.32	11.59
Social Value	1536.56	11.50	Culture Service	1536.56	11.50	Leisure and Entertainment	1166.89	8.73
						Research and Education	369.67	2.77
Sum Value	13,358.60	100.00	Sum	13,358.60	100.00	Sum	13,358.60	100.00

The values of the first-level indicators are ranked as economic value > ecological value > social value; the values of secondary indicators are ranked as supply service > adjustment service > support service > culture service (the value of adjustment and support services were relatively close); and the values of the lowest-level indicators are ranked as food production > maintenance of nutrient cycling > leisure and entertainment > conservation of water sources > gas regulation > research and education > maintenance of biodiversity > raw material production. The food production value was the main ESV component of saline–alkali land development, as it accounted for more than half the value. Except for food production value, the value of other value types was relatively average. The values of raw material production, the maintenance of biodiversity, and research and education accounted for a small proportion, which has great potential.

4.2. Classification Analysis of ESV of the Huanghe Island

4.2.1. Supply Service Value Analysis

The value of supply services of the Huanghe Island was CNY 80.1505 million, accounting for 60.00% of the total value. The value of food production was the main value component, which reached up to CNY 76.7929 million. This accounted for 57.49% of the total value. The value of raw material production was CNY 3.3576 million, accounting for 2.51% of the total value. The Huanghe Island used to be a saline–alkali wasteland, and after years of development and construction, it has formed a new pattern of coordinated development of agriculture, forestry, animal husbandry, and fishing industries. With its advantages of being close to the river and the sea, water is diverted into the island to develop aquaculture water surfaces in a large area. Shrimp, razor clam, and other seafood products have high output, good quality, high price, and high sales volume, and they have produced significant economic benefits. The cost of aquaculture is relatively high, and this research deducted the cost of aquaculture on the basis of the ecological economics method to estimate the net income. The Huanghe Island also obtained certain agricultural economic benefits by planting fruits and vegetables. Ash, alfalfa, and others can be used as raw materials for pastures and economic trees and have contributed obvious economic benefits. Ash and alfalfa can be used as raw materials for foraging and economic trees, and they have contributed obvious economic benefits. It can be seen that through reasonable development and utilization, saline–alkali land resources can provide high economic benefits, high supply service value, and high economic value.

4.2.2. Adjustment Service Value Analysis

The adjustment service value of the Huanghe Island was CNY 19.175 million, accounting for 14.35% of the total value. The values of gas regulation and conservation of water sources were CNY 7.9598 and 11.2152 million, respectively, accounting for a respective 5.96% and 8.40% of the total value. There was a certain value gap between the two. In recent years, although the large-scale economic development of the Huanghe Island has brought good economic benefits, it has exerted certain pressures on the stability of the ecosystem and the magnitude of ecological value. As a large area of land has been developed as aquaculture water surfaces, the vegetation coverage is low, and the vegetation types are mainly shrubs and grass. Compared with mature forest land, the biomass in these areas is small, and the gas regulation capacity is limited. In addition, the interpolation data of biomass had possible errors, which also makes the calculated gas regulation value limited. The Huanghe Island is saline–alkali land with relatively poor soil nutrition, insufficient freshwater resources, a weaker vegetation growth and development level than non-saline–alkali land. It also has low vegetation coverage, strong evaporation, and inability to intercept rainfall, which leads to weak water conservation capacity. Therefore, when developing saline–alkali land to obtain economic benefits, attention should also be paid to the size of vegetation coverage and economic and ecological benefits should be taken into account.

4.2.3. Support Service Value Analysis

The support service value of the Huanghe Island was CNY 18.895 million, accounting for 14.15% of the total value. Maintenance of nutrient cycling was the main component of its value, which was CNY 15.4832 million. This accounted for 11.59% of the total value. The natural environmental advantages of the Huanghe Island have provided a good growth environment for animals and plants, and there are abundant wild animals and plants. Even if the soil conditions are poor, there are still many plant species, which are also natural habitats for animals. Considering the availability of data, it is difficult to determine the number of animals, and this study only accounted for the diversity value of plants. In addition, the field survey was uncertain, and the spatial interpolation of the Shannon–Wiener index H may have some errors, so the calculated value of maintenance of biodiversity is not relatively high. The Huanghe Island is saline–alkali land with poor nutrient conditions. In recent years, with the implementation of projects such as underground pipe salt drainage, water-saving sprinkler irrigation, and planting salt-tolerant plants, soil conditions of the Huanghe Island have improved, and the soil nutrient content has also increased significantly. However, it still needs to be further improved. It can be seen that scientific development and regulation of saline–alkali land can reduce soil salinity, improve soil physical and chemical properties, improve the ability to maintain nutrient circulation, and thus improve support service value.

4.2.4. Culture Service Value Analysis

The culture service value of the Huanghe Island was CNY 15.3656 million, accounting for 11.50% of the total value. Leisure and entertainment value was the main value component, which was CNY 11.6689 million, accounting for 8.73% of the total value. This research considered the daily maintenance of service facilities and equipment and the remuneration cost of management service staff, which makes the results more reliable. As an AAAA level national ecotourism resort, the Huanghe Island has gradually formed an ecological sightseeing tourism model that combines planting, breeding, tourism, and entertainment. Five parks, including the "Yellow River Cultural Creative Industrial Park", have been established, attracting a large number of tourists for sightseeing, health preservation, vacation, and leisure. The annual economic income has gradually increased, reflecting a high value of leisure tourism. The value of research and education was relatively low at CNY 3.6967 million, only accounting for 2.77% of the total value. As a typical saline–alkali land, the Huanghe Island has become a base for teaching, scientific research, and training in recent years. It has attracted national, provincial, and ministerial scientific research teams to perform scientific research, and it has attracted a large number of young people to participate in research, education, and training. However, due to the short development time and few achievements in scientific research projects, this research only estimated and converted the data of the Yellow River Delta papers that could be found, and the average annual scientific research value was CNY 345,400, which is relatively low. The average annual income of youth research training and summer camp activities reached CNY 3.3513 million. It can be seen that saline–alkali land has a certain culture service value, is an important eco-tourism resource, and has considerable economic benefits. However, the value of research and education needs to be further explored. In particular, the investment in related scientific research needs to be further improved.

5. Discussion and Conclusions

5.1. Discussion

In this research, the ESV of Huanghe Island development was calculated as 50,200 CNY/hm^2 using the ecological economic evaluation method. Li Yongtao [42] and Xu Yumei [65] also used this theory and method to estimate the ESV of the Yellow River Delta, with unit values of 59,300 and 24,600 CNY/hm^2, respectively. The calculated value of this study differed somewhat from the results of these two studies and was in the middle to upper range. There are three possible reasons for this. The first reason is differences in research scope and development and utilization level. The study area was relatively small, and the development and utilization levels were relatively high. The first two research areas were the core area of the Yellow River Delta and the modern Yellow River Delta, respectively, which are large in scope, early in time, and average in development and utilization level. Differences in regional conditions and development levels may have caused the differences in value. The second reason is that there were differences in value evaluation methods. In Xu Yumei's research, the calculation of several indicators was based on the research of Costanza [5], which is not necessarily consistent with the actual situation of the Yellow River Delta. The data used in this research were reflective of the actual situation of the Huanghe Island. Based on the value function perspective, the value function of ecosystem services was divided, the ecological economics method was used for evaluation, and the equivalent factor method was not adopted simply and directly. The third reason is that there were differences in the selection of evaluation indicators. Li Yongtao calculated the value of silting and land production in the Yellow River Delta, i.e., the value of increasing land area, and Xu Yumei calculated the value of salt production, while the Huanghe Island does not have such value. To compare the differences in the results of the equivalence factor method and the ecological economics method, this study also applied the equivalence factor method [31] to estimate the ESV in the study area. To improve the accuracy of the evaluation, the unit value equivalent factor of the hydrological regulation (conservation of water sources) function was adjusted by applying the spatial and temporal regulation factor of precipitation [31], and the ESV was calculated to be CNY 366.5986 million, and the per unit area the ESV was 137,800 CNY/ hm^2. The hydrological regulation (conservation of water sources) value accounted for 91.24%, while the food production value accounted for only 0.91%, which was quite different from the results of the evaluation methods based on ecological economics. This difference is mainly because of differences in the principles, data sources, indicator meanings, operability, appropriate evaluation scales, and evaluation processes of the two methods. The supply service value of the Huanghe Island calculated in this research was high, and the food production value was more than 50%, which was mainly related to the long-term underground pipe salt drainage control of the Huanghe Island and the development and construction of aquaculture projects. Existing studies on the ESV of saline–alkali land generally did not consider production, operation, and development costs [33,42,65]. In fact, the reason why the economic value of the ESV of developed saline–alkali land accounts for a large proportion is not that the saline–alkali land itself has a high production value but that the saline–alkali land has been developed and utilized for a long time and has been invested with a certain amount of development, production, and operation costs. In this research, higher production and management costs such as food production and tourism operation were taken into account and deducted from the ESV to obtain more objective evaluation results. Due to the long development time of the Huanghe Island, it is difficult to obtain comprehensive development input data, so this research did not fully estimate the development cost. In the future, research on the development input and output of the Huanghe Island will be continued to investigate the impact of development costs on the ESV of saline–alkali land.

Based on existing research conditions, this study considered the characteristics and data availability of the study area and then selected some indicators. Saline–alkali land does not only have the ecosystem service functions described in this research, and the evaluation methods of each function also refer to other types of ESV evaluation studies. The evaluation results were closely related to the selected indicators and the applied methods. The suitability of the evaluation methods and the reliability of the results need to be further verified. In other saline–alkali regions, the evaluation indicators of the ESV should be adjusted according to the actual situation, and the evaluation method should also be further improved.

Current studies on the evaluation of ESV have not formed a unified index system, and there are many types of ecosystem services, great differences in attribute characteristics, inconsistent understanding of the estimation range, double-calculation and inflated phenomenon of some indicators, and huge differences in conditions in different places of the same type. These factors may reduce the accuracy of estimation results, resulting in low repeatability and strong subjectivity. Therefore, the actual economic significance of the estimated results remains to be explored. In 2023, we should strengthen studies on the standardization of ESVs, construct a unified index system, and develop a standardized evaluation process. Reasonable assessment parameters should also be determined, and the comparability of the evaluation should be improved.

5.2. Conclusions

Considering the attributes of saline–alkali land and the characteristics of the Huanghe Island, this study constructed a saline–alkali land ecosystem service value evaluation index system, which includes three first-level indicators of economic, ecological, and social value; four second-level indicators of supply, adjustment, support, and culture; and eight lowest-level indicators of food production and raw material production. Using the value evaluation method based on ecological economics, the daily production and operation costs were considered, and it was estimated that the ESV of the Huanghe Island development is CNY 133.586 million and the unit value is 50,200 CNY/hm^2, indicating that the Huanghe Island has relatively high ESV and development value. The research verifies that saline–alkali land is an important land resource with high ESV and development value. Reasonable exploitation and utilization of saline–alkali land resources can provide higher economic benefits.

From the first-level indicators, economic value accounted for the largest proportion, followed by ecological value and then social value. From the perspective of second-level indicators, the supply service value was the highest, and the food production value was the main component. This was directly related to the comprehensive development of agriculture, forestry, husbandry, and fishery in the Huanghe Island in recent years. The second was the adjustment service value. Due to the low vegetation coverage of the Huanghe Island, although it has certain gas regulation and water conservation capacities, it was still relatively weak. The third was the support service value. Measures such as engineering improvement and vegetation planting of the Huanghe Island have had a certain impact on its nutrient cycle and gas regulation, which have improved its ability to maintain nutrient cycles. However, the maintenance of biodiversity value needs to be improved. The lowest was the culture service value, among which the leisure and entertainment value was the main component. As a typical saline–alkali land, the Huanghe Island has great scientific research value. However, due to the short period of scientific research that could be searched, the estimated value of research and education was relatively low.

The research did not directly use equivalent factor tables and regional correction coefficients to estimate the ESV but instead comprehensively used the market value method and other ecological economic methods to evaluate the ESV of the Huanghe Island. In the value evaluation, higher production and management costs such as food production and tourism operation were considered, and they were deducted in the calculation of the ESV, making the evaluating results more objective and more consistent with the actual situation of the study area.

The evaluation method based on ecological economics is different from the equivalent factor method in terms of method principle, data source, indicator connotation, and price basis. It accounts for the value at a specific time point. The data collection has certain difficulties and workloads but does not require coefficient correction. Moreover, the data collected by the ecological economics method is actual production data, which have strong timeliness, can be more intuitive, and can accurately display the current ESV.

Through the research results, management suggestions that are conducive to the ESV of saline–alkali land and the measures to promote the sustainable utilization of saline–alkali land resources were obtained. Saline–alkali land can be exploited and utilized to obtain economic value. While obtaining economic benefits, the ecological benefits should not be ignored. Through water-saving sprinkler irrigation and other projects, soil conditions of saline–alkali land can be improved, and its ecological value can be increased. Managers of saline–alkali land can develop tourism industries according to local conditions, create scenic spots with unique characteristics, and explore various tourism functions. At the same time, they can attract scientific research projects to carry out scientific research activities on the improvement of saline–alkali land, so as to increase its social value. The purposes of this research were to provide references for the rational development and utilization of saline–alkali land resources in the Yellow River Delta and to further promote ecological protection and high-quality development of the Yellow River Basin. Although saline–alkali land can be developed into forest land and cultivated land, compared with general forest land and cultivated land, its background conditions are poor. In the process of development, the vulnerability of its ecosystem should be fully considered, and scientific and reasonable development and utilization should be given attention.

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