Research Article

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Research on comprehensive benefits and reasonable selection of marine resources development types

<https://doi.org/10.1515/geo-2022-0341>

received June 09, 2021; accepted January 19, 2022

Abstract: The comprehensive benefit evaluation of marine resources developmental model is of great significance to choose the appropriate types of marine resources development and promote the intensive utilization and sustainable development of marine resources. This article examined five types of marine resources development, such as marine protected areas, mariculture, offshore wind power, sewage dumping, and land reclamation, and constructed a three-level evaluation index system for the comprehensive benefits of marine resources development. The projection pursuit clustering model was used to evaluate and analyze the comprehensive benefits and main influencing factors of 15 marine resources development projects in Jiangsu Province, China. It was found that the comprehensive benefit projection values of marine protected areas and offshore wind power are higher. The projection value of comprehensive benefit of land reclamation is the lowest. The main influencing factors include but not limited to the change rate of total output of aquatic products, contradiction between management and marine use, negative impact on residents' lives, etc. The research results have important guiding significance for promoting the rational development and utilization of marine resources and the high-quality development of the oceans.

Keywords: marine resources development, high-quality marine development, the projection pursuit cluster model, influencing factors

1 Introduction

With the rapid development of global marine economy, the attraction of marine resources development is increasing. Reducing the loss of marine resources development, preventing the destruction of ecological environment, alleviating the pressure of marine resources and environment, improving the efficiency of intensive utilization of marine resources, and promoting the rational development and utilization of marine resources have become the focus of attention [1]. Many scholars mainly studied the value of marine resources from the aspects of utilization, protection, and sustainable development of marine resources development [2]. From the perspective of ecosystems, the main impact of marine resource development is analyzed in detail [3,4]. From the perspectives of rational development and utilization of marine resources [5,6], optimization of marine environment [7] and sustainable development of marine [8], combined with socioeconomic, resource loss and overflow, ecological environment, and other indicators [9], deeply discuss the relationship between the components of the comprehensive evaluation system for marine resources development. Other scholars consider that the development and utilization of marine resources has economic, social, ecological, and environmental benefits and their researches on marine resources emphasize its economy [10]. On one hand, the comprehensive benefits of marine resources development and utilization are categorized into social benefits, marine economic benefits, and marine environmental benefits, and the intensity and spatial pattern evolution of marine resources development are analyzed in depth [11]. Chen et al. constructed the postreclamation evaluation index system covering five aspects: economic benefits, social benefits, sea space development and utilization, ecological and environmental benefits, and implementation of management requirements [12]. Tang et al. constructed the comprehensive benefit accounting index system of marine resources utilization, and determined the combination weight of each index based on analytic hierarchy process and entropy weight

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method [13]. Moreover, the comprehensive benefit model was used to calculate the comprehensive benefit of the main types of marine resources utilization in Liaoning Province. Song et al. utilized the system dynamics and the mean square error weight method to evaluate the comprehensive benefits of marine resources utilization in coastal provinces and cities of China from 2006 to 2015 [14]. Based on the theory of resource intensity and economic growth convergence, Wang et al. made a comprehensive evaluation on the utilization efficiency of marine resources in coastal provinces and cities of China from 1996 to 2015 [15]. However, the economic benefits of marine resources development activities are evaluated from two aspects of input and output, and the economic benefits with and without the development of marine resources are compared and analyzed [16,17]. However, there is no in-depth analysis of the waste of resources caused by the unreasonable development and utilization of marine resources and the negative impact of ecological environment problems on the development of marine economy. Although the development and utilization of marine resources can stimulate social and economic development, it will inevitably affect the marine environment [18,19]. Nowadays, many studies are focusing on the role of marine resources development in promoting economic development, but the impact of marine environment was underestimated [20]. In short, the selection of evaluation indexes, calculation of weight, calculation of safety threshold and selection of evaluation methods for marine resources development need to be addressed, and no unified theory has been proposed [21,22]. The reasonable selection and construction of the indicator system is the premise and basis for scientific evaluation of the development of marine resources [23,24].

The objective of this research is to accurately assess the comprehensive benefits of various types of marine resource development and to provide a scientific basis for the reasonable selection and efficient allocation of marine resource development types in the region. Reveal key influencing factors and action paths, propose specific control measures and implementation plans, and provide decision-making references for promoting the rational development and utilization of marine resources and high-quality marine development. In this study, 15 sample projects of marine resources development are selected from five types of marine resources development, including marine reserve, mariculture, offshore wind power, sewage dumping, and reclamation. From the four aspects of social profit and loss, economic profit and loss, resource profit and loss, environmental profit and loss, the comprehensive benefit evaluation index system of marine resources development is constructed. By evaluating the comprehensive benefits of marine resources development, it provides a scientific basis

for the selection and management of marine resources development types, which is of great significance for timely adjusting marine resources development countermeasures, and benefits high-quality marine development [25]. The research results can provide reference for timely adjustment of marine resources development, along with the basis for reasonable selection of marine resources development types, and have great significance for promoting the coordinated development of marine resources, environment, and economy.

2 Methods

2.1 Study area and data sources

Jiangsu Province of China is located in 116°18'E–121°57'E, 30°45'N–35°20'N, west of the Pacific Ocean (Figure 1). The coastal area is about $3.5 \times 10^4 \text{ km}^2$. Jiangsu's per capita gross domestic product (GDP), regional development, and development and life index rank first in China. It is among the provinces with the highest comprehensive development level in China and has entered the level of “middle and upper” developed countries. As one of the most economically active provinces in China, Jiangsu's GDP is 10.27 trillion Yuan in 2020. Therefore, Jiangsu Province is selected as an example to evaluate the comprehensive benefits of marine resources development.

To compare the comprehensive benefits of different types of marine resources development, five typical types of marine resources development, including marine protected areas, mariculture, offshore wind power, sewage dumping, and land reclamation, are selected for comprehensive benefit evaluation in this study (Table 1). For each type of marine resources development, three marine resources development projects were selected, with a total of 15 projects. The selected marine resources development projects are representative, involving marine fishery resources, marine space resources, marine power resources, and tourism resources.

According to the construction results of marine resources development evaluation index system both domestically and internationally, this study consulted experts in related fields [26]. Based on comprehensive consideration of the profit and loss of various types of marine resources development, combined with the actual situation of China's marine resources development. The Delphi method is used to select the benefit and cost indicators [27], and the comprehensive benefit evaluation index system of marine resources development type

Figure 1: Regional map of China’s coastal provinces.

is constructed. The index system consists of three layers, of which the target layer is the comprehensive benefit of marine resources development. The criterion layer is the second layer. As the third layer, the factor layer is composed of 24 evaluation indexes. The range standardization method is used to make the index system dimensionless. Entropy weight method is used to quantify the weight of each index to eliminate the influence of human subjectivity. The projection pursuit clustering (PPC) model is established to objectively evaluate the projection value of comprehensive benefits of various types of marine resources development.

The relevant data mainly come from the regional sea use planning report, project feasibility study report, marine

environmental impact assessment report, sea area use demonstration report, enterprise financial statements, China marine statistical yearbook, environmental protection department’s monitoring data and pollution declaration data, project actual survey data, etc.

2.2 Entropy weight method

2.2.1 Standardization of evaluation indexes

To make the evaluation indexes of different unit values comparable, the influence of different unit data

Table 1: Main types and representative projects of marine resource development

Main types of marine resources development	Representative projects of marine resources development	Number
Marine protected areas	A national marine park in Lianyungang	A ₁
	A national marine park in Haimen	A ₂
	A national marine park in Yangkou	A ₃
Mariculture	A mariculture project in Ganyu	B ₄
	A mariculture project in Dongtai	B ₅
	A mariculture project in Rudong	B ₆
Offshore wind power	A coastal offshore wind power project	C ₇
	The first phase demonstration project of an intertidal wind farm in Rudong	C ₈
	Qidong wind farm project	C ₉
Sewage dumping	A sewage discharge project in Nantong	D ₁₀
	A tailwater discharge project in Binhai	D ₁₁
	One to four unit project of a nuclear power plant	D ₁₂
Land reclamation	A coastal power plant project	E ₁₃
	A heavy equipment manufacturing project	E ₁₄
	A petrochemical storage project in Rudong	E ₁₅

dimensions was eliminated and each index was made to have a comparable scale, and the range standardization method was used to render the index dimensionless by transforming the evaluation index data into the standardized value of 0–1 interval. The formula is as follows:

$$\text{For benefit indicators: } Y_{ij} = \frac{X_{ij} - \min X_{ij}}{\max X_{ij} - \min X_{ij}}, \quad (1)$$

$$\text{For cost indicators: } Y_{ij} = \frac{\max X_{ij} - X_{ij}}{\max X_{ij} - \min X_{ij}}. \quad (2)$$

In the formula, Y_{ij} is the evaluation value of the i -th index. X_{ij} is the normalization coefficient. $\max X_{ij}$ and $\min X_{ij}$ are the maximum and minimum values of the normalization coefficient, $i = 1, 2, \dots, n$; $j = 1, 2, \dots, n$.

2.2.2 Calculate the entropy weight

Based on the information entropy of the obtained evaluation indicators, the weight value of each evaluation index was further determined. The weight W_j was calculated as follows:

$$e_{ij} = \frac{y_{ij}}{\sum_{i=1}^n y_{ij}}; \quad h_j = \frac{1}{\ln(n)} \sum_{i=1}^n e_{ij} \ln e_{ij}; \quad w_j = \frac{1 - n_j}{m - \sum_{i=1}^m n_j}. \quad (3)$$

In the formula, e_{ij} is the proportion of the standard value of the j -th index standard value y_{ij} in the total value of the i -th sample year. h_{ij} is the information entropy value of the j -th index. w_j is the weight of the j -th index and $0 \leq w_j \leq 1$, $\sum w_j = 1$. n is the number of samples, and m is the number of evaluation indexes, $i = 1, 2, \dots, n$; $j = 1, 2, \dots, m$.

2.3 The projection pursuit cluster model

PPC model projects some combination of high-dimensional data to low-dimensional subspace. By analyzing the change characteristics of low-dimensional spatial data points, the characteristics of high-dimensional data are revealed [28]. The calculation process of the model is straightforward, and it can be used in the analysis and research of multifactor complex system. The comprehensive evaluation indexes reflecting the characteristics of many influencing factors can be found, and the calculated results can be displayed by images [29].

The specific calculation steps are as follows. The first step is index data standardization and linear projection. The m -dimensional standardized data x'_{ij} is synthesized into one-dimensional projection value z_i with a_j ($a_1, a_2, \dots, a_m$) as the projection direction. Then the classification is carried

out according to the one-dimensional scatter diagram of z_i . The table of projection eigenvalue z_i of sample i in one-dimensional linear space is as follows:

$$z_i = \sum_{j=1}^m a_j x_{ij}. \quad (4)$$

In the formula, z_i is the projection eigenvalue. a_j ($a_1, a_2, \dots, a_m$) is the unit vector of m -dimension, and x represents the influencing factors of comprehensive benefit.

The second step is to construct the projection index function. The projection value, z_i , should extract as much variation information as possible from x_{ij} . Therefore, the projection index function, Q_a , can be defined as the product of the standard deviation, S_z , of the projection value, z_i , and the within class density, d_z , of the projection value, z_i , that is, $Q_a = S_z \cdot d_z$.

$$S_z = \left[\sum_{i=1}^n (z_i - \bar{z}_a)^2 / (n - 1) \right]^{1/2} \\ = \left[\sum_{i=1}^n \left(\sum_{j=1}^m (a_j x_{ij} - \bar{z}_a)^2 / (n - 1) \right) \right]^{1/2}, \quad (5)$$

$$d_z = \sum_{i=1}^n \sum_{j=1}^m (R - r_{ij}) \cdot f_t(R - r_{ij}), \quad (6)$$

$$\bar{z}_a = \frac{1}{n} \sum_{i=1}^n z_i = \frac{1}{n} \sum_{i=1}^n \sum_{j=1}^m a_j x_{ij}. \quad (7)$$

In the formula, $\bar{z}_a$ is the average value of sequence z_i , and the larger S_z is, the more open the dispersion is. $r_{ij} = |z_i - z_j|$ represents the difference between the projection values of state i and j of environmental assessment. The larger r_{ij} is, the smaller the intra class density is. f_t is the first-order unit step function. When $t \geq 0$, its value is 1, and when $t < 0$, its value is 0, in this symbol, that is, when the value r_{ij} is less than or equal to R , it shall be calculated according to the category; otherwise, it shall be calculated according to different categories. The reasonable range of radius parameter R is $r_{\max} < R \leq 2m$, $r_{\max} = \max(r_{ij})$ ($i = 1, 2, \dots, n$; $j = 1, 2, \dots, m$).

In the third step, the projection index function is optimized. The best projection direction, a_j , is estimated, where a_j is the optimization variable:

$$\begin{cases} \max Q_a = S_z \cdot d_z \\ \text{s.t. } \sum_{j=1}^m a_j^2 = 1. \end{cases} \quad (8)$$

The fourth step is comprehensive evaluation and cluster analysis. According to the size of the projection value and the aggregation and dispersion of the distribution,

the value of the sparse distribution is taken as the division standard. The value and range of each evaluation grade can also be determined by bilinear fitting method. After substituting the estimated value, a^* , of the best projection direction into the projection value formula, the projection value, z_i^* , corresponding to each level of all sample values can be obtained.

3 Results

3.1 The comprehensive benefit evaluation index system

This study constructs a comprehensive benefit evaluation index system of marine resources development type, which includes target layer, criterion layer, and factor layer. The target layer is the comprehensive benefit of marine resources development type. The criterion layer includes social profit and loss, economic profit and loss, resource profit and loss, and environmental profit and loss. The factor layer contains 24 selected evaluation

indexes, involving the social, economic, resource, environmental, and other costs and benefits of each case in the process of marine resources development. In this study, the entropy weight of each index is calculated by *Matrix Laboratory (MATLAB)*, which is used as the weight value of the comprehensive benefit evaluation system index (Table 2).

3.2 Evaluation on comprehensive benefits of marine resources development

3.2.1 The order of projection direction of each evaluation index

PPC model was established for normalized 24 dimensional data. The initial population size of the selected parents was $N = 400$, the crossover probability $P_c = 0.8$, the mutation probability $P_m = 0.2$, the number of optimization variables $n = 24$, the random number of mutation direction $M = 10$, and the acceleration times $C_i = 20$. In this test, the bigger the better formula is used, so $ads = 1$.

Table 2: Evaluation index system and weight value of comprehensive benefit of marine resources development type

Criterion layer	Factor layer	Number	Entropy weight
Social profit and loss B_1 0.0111	Improvement rate of living standard (%)	X_1	0.0072
	Completion degree of residents' interest coordination (%)	X_2	0.0082
	New employment rate (%)	X_3	0.0072
	Annual change rate of tourists (%)	X_4	0.0186
	Contradiction between management and marine use	X_5	0.0212
	Negative impact on residents' lives	X_6	0.0199
Economic profit and loss B_2 0.3656	Economic net income per unit shoreline (10,000 yuan/km)	X_7	0.1101
	Annual tax payment (10,000 yuan/hm ²)	X_8	0.0317
	Economic net income per unit area (10,000 yuan/hm ²)	X_9	0.1640
	Expenses for prevention and control of environmental pollution (10,000 yuan/hm ² a)	X_{10}	0.0192
	Ocean utilization charges (10,000 yuan/hm ²)	X_{11}	0.0241
	Economic loss of marine disaster per unit coastline (10,000/km)	X_{12}	0.0185
Resource profit and loss B_3 0.1995	Space development rate of ocean (%)	X_{13}	0.0565
	Change rate of total output of aquatic products (%)	X_{14}	0.0194
	Biodiversity index	X_{15}	0.0269
	Change rate of shallow water wetland (%)	X_{16}	0.0263
	Loss value of marine tourism resources	X_{17}	0.0251
	Loss value of marine living resources per unit area (10,000 yuan/hm ²)	X_{18}	0.0170
Environmental profit and loss B_4 0.4238	Ecological environment bearing capacity	X_{19}	0.0275
	Ecological environment sensitivity	X_{20}	0.0352
	Water quality compliance rate (%)	X_{21}	0.0335
	Loss value of ecosystem services (10,000 yuan/hm ² a)	X_{22}	0.1739
	Coefficient of erosion and deposition (%)	X_{23}	0.0141
	Change rate of maximum velocity value of characteristic point (%)	X_{24}	0.0949

The maximum projection index is 2.0989 and the best projection direction is $a^* = (0.1106, 0.1699, 0.1074, 0.0717, 0.3407, 0.3139, 0.0957, 0.2038, 0.2009, 0.1197, 0.2149, 0.2501, 0.0346, 0.3516, 0.2134, 0.2816, 0.2393, 0.1312, 0.0648, 0.0802, 0.1795, 0.1965, 0.3126, 0.1001)$. The order of projection values of each evaluation index is shown in Figure 2.

According to the best projection direction, the influence degree of each evaluation index on the evaluation results can be further analyzed. As can be seen from Figure 2, the 24 evaluation indicators can be divided into three categories. X_{14} , X_5 , X_6 , X_{23} , X_{16} , and X_{12} belong to the first category, which has a great impact on the sample and is the key factor to be considered. X_{17} , X_{11} , X_{15} , X_8 , X_9 , X_{22} , X_{21} , and X_2 belong to the second category, and the influence degree of these evaluation indexes is general. X_{18} , X_{10} , X_1 , X_3 , X_{24} , X_7 , X_{20} , X_4 , X_{19} , and X_{13} belong to the third category, and the impact of this kind of evaluation index is insignificant.

3.2.2 Projection values of 15 samples of marine resources development projects

After substituting a^* into the formula, the projection value of each sample can be obtained, $z_{(j)}^* = (3.3617, 3.3870, 3.3740, 2.2168, 2.2015, 2.2044, 2.9743, 2.8275, 2.9790, 2.2012, 2.2093, 1.6987, 1.5330, 1.8434, 1.7203)$. According to the projection value $z_{(j)}^*$ from large to small, we can get the ranking of each marine resources development project sample (Figure 3). The serial number is as follows: $A_2 > A_3 > A_1 > C_9 > C_7 > C_8 > B_4 > D_{11} > B_6 > B_5 > D_{10} > E_{14} > E_{15} > D_{12} > E_{13}$.

As shown in Figure 3, 15 samples of marine resources development projects can be divided into three categories.

A_2 , A_3 , A_1 , C_9 , C_7 , and C_8 belong to the first category, and the comprehensive benefit value of this category is higher. B_4 , D_{11} , B_6 , B_5 , and D_{10} belong to the second category, and the comprehensive benefit value of this category is general. E_{14} , E_{15} , D_{12} , and E_{13} belong to the third category, and the comprehensive benefit value of this category is low.

3.2.3 Projection values of five types of marine resources development

According to the projection values of 15 marine resources development projects, the average value is calculated according to the project types as the projection values of five marine resources development types (Figure 4). It proves that the projection values of the five types of marine resources development from high to low are marine protected areas (3.3742) > offshore wind power (2.9269) > mariculture (2.2076) > sewage dumping (2.0364) > land reclamation (1.6989).

4 Discussion

The development and utilization of marine resources not only stimulate the coastal social and economic development and prosperity but also inevitably affect the marine ecological environment. At present, there is a lack of effective comprehensive benefit evaluation of marine resources development activities in China [30]. On the one hand, the economic benefit evaluation of China's marine resources development is often only from the perspective of financial

Figure 2: Projection direction sequence diagram of each evaluation index.

Figure 3: Projection value ranking scatter chart of 15 marine resources development projects.

Figure 4: Projection values of five types of marine resources development.

benefit evaluation, lack of comprehensive and effective national economic evaluation, ignoring the external dis-economy, and the loss of resources and environment is also underestimated [31]. It is urgent to develop marine resources scientifically, protect the marine ecological environment, and improve the quality and benefits of marine economic development [32]. However, many researchers often pay attention to the sustainability of marine resources, but ignore the value evaluation of marine power energy, seabed mineral resources, oil and gas and other resources. The evaluation of indirect use value and nonuse value of marine resources, such as the value of choice, the value of existence, and the value of heritage, is less involved [33]. Therefore, more attention should be paid to the sustainability of the complex system of marine economy, resources, and environment such as Avelino used data envelopment calculation to analyze the sustainability assessment index of marine protected areas in the Philippines [34]. Marine circular economy and marine ecological security are the subsystems

of the complex system of ecology, society, and economy. Marine resources are an important driving force for the sustainable development of marine economy [35]. Ma et al. proposed an overall conceptual model for evaluating the carrying capacity of marine ecosystem and evaluated the carrying capacity of marine ecosystem in Dongtou islands, China [36]. By using comprehensive index model and catastrophe series model, Gao et al. constructed a three-level evaluation index system of marine economic system vulnerability and dynamically evaluated and analyzed the vulnerability and main influencing factors of marine economic system in Jiangsu Province of China from 2008 to 2016 [37].

The development of marine resources involves many factors, such as society, economy, ecology, and so on, but the current evaluation of comprehensive benefits of marine resources development types is relatively vague. It is mainly reflected in the selection of evaluation methods, the selection of evaluation indicators, the determination of index weight, the construction of index framework, the determination of safety threshold, the uncertainty of evaluation standards and the simplification of evaluation types, etc., which need to be discussed and demonstrated. In the past, many decision-making methods used fuzzy comprehensive evaluation. Compared with the previous methods, the PPC model takes the best projection direction as the prediction result, which is more objective [38]. For example, Wang and Yang constructed driving forces, pressures, state, impacts, responses (DPSIR) four-dimensional indicator system from the four sustainability dimensions of energy, economy, society, and environment. The projection pursuit fuzzy clustering model based on real coding accelerated genetic algorithm focuses on evaluating and analyzing the sustainability and influencing factors of renewable energy in 27 EU countries [39]. Liao et al.

constructed the fuzzy projection pursuit clustering model, which was combined with the fuzzy clustering iterative model and the projection pursuit technique [40]. Kong et al. proposed a new combination of weight allocation method based on the decision maker's preference and PPC model [41]. Zhang et al. introduced an improved PPC model to find the best projection direction [42]. Zhang and Mao proposed a method based on projection clustering and fuzzy rule extraction [27]. In our previous research studies, combined with the Delphi method, entropy weight method, and rough set theory, we constructed the evaluation index system of marine resources development. The linear weighted sum model is used to evaluate the comprehensive benefits of various marine resources development, and the key influencing factors are analyzed [33]. The net economic benefit, ecosystem service function loss, fishery resource loss, and ecological profit and loss of various marine development projects are calculated, respectively. The evaluation, correlation, and driving force analysis of the comprehensive benefit value per unit area of marine development types are carried out [43].

With the rapid development of marine economy, it is of great significance to evaluate the comprehensive benefits of various types of marine resources development. On one hand, it can provide scientific basis for marine management departments to formulate marine development strategies and delimit marine functional areas. On the other hand, it can provide decision support for the rational development and utilization, scientific management, and protection of marine resources [37]. In this study, a variety of marine development types are selected as the research object for comprehensive benefit evaluation. Based on the comprehensive consideration of the social, economic, resource, and environmental benefits and costs in the process of marine development, the index values are calculated and the comprehensive benefit evaluation index system of marine development activities is constructed. By using the Delphi method and entropy weight method, the knowledge and experience of experts can potentially eliminate the negative impact of information entropy and reduce the subjective and random impact in weighting, so as to make the evaluation results more objective. The PPC model was used to evaluate the comprehensive benefits of marine resources development, and the comprehensive benefits of various types of marine resources development are objectively compared to reveal the state of marine resources development. It provides empirical reference for reasonable selection of efficient types of marine resources development and objective basis for marine resources development and management.

In the future research, we should expand the framework of index system, build complex models, and use a variety of methods to objectively evaluate the comprehensive benefits of marine resources development. We should use relevant factor analysis, principal component analysis, and other driving force analysis to locate the main influencing factors of the comprehensive benefits of various types of marine resources development. It provides a scientific basis for the selection and management of marine resources development types and offers empirical reference for reasonable evaluation of the comprehensive benefits of marine resources development activities, enrich relevant research cases, and enhance the reliability of empirical results. The type of marine resources development involved in this study is not fully covered due to lack of port and waterway resources. The coastal port resource development project is not included in the case study. Therefore, the development types of marine port and waterway resources need to be included in the follow-up study.

5 Conclusion

This study selects five typical types of marine resources development, including marine protected areas, mariculture, offshore wind power, sewage dumping, land reclamation, and 15 samples of marine resources development projects. From four aspects of social profit and loss, economic profit and loss, resource profit and loss, and environmental profit and loss, this study constructs a comprehensive benefit evaluation index system of marine resources development type, which includes target layer, criterion layer, and index layer. The entropy weight method and PPC model are used to measure the projection value, analyze the classification structure characteristics of high-dimensional data, and evaluate the comprehensive benefits of marine resources development types. The research results expand the application of relevant methods and empirical reference, which can provide decision-making basis for the reasonable selection of marine resources development types, provide reference for the adjustment of marine resources development direction, and alleviate the contradiction between marine resources development and ecological environment. The main conclusions are as follows.

First, among the 15 samples of marine resources development projects, A_2 , A_3 , and A_1 in marine protected areas and C_9 , C_7 , and C_8 in offshore wind power have higher comprehensive benefits, belong to the first category.

Second, among the five types of marine resources development, the comprehensive benefit projection values of marine protected areas and offshore wind power are higher, which are 3.3742 and 2.9269, respectively. The comprehensive benefits of mariculture and sewage dumping were generally 2.2076 and 2.0364, respectively. The comprehensive benefit of land reclamation is the lowest, only 1.6989.

Third, among the 24 evaluation indexes, the change rate of total output of aquatic products, contradiction between management and marine use, negative impact on residents' lives, coefficient of erosion and deposition, the change rate of shallow water wetland, economic loss of marine disaster per unit coastline are important factors, which have a great impact on the comprehensive benefits of marine resources development.

Finally, the development, management, distribution, and utilization of marine resources have always been the focus of China. In the future, we need to innovate the allocation and management mechanism of marine resources, strengthen the monitoring and regular evaluation of marine functional zoning, and promote the marketization of marine resources allocation. It is necessary to accelerate the development of marine ecological industry cluster, improve the efficiency of marine resources development, and reduce the emission rate of pollutants.

Acknowledgements: All authors have read and approved the final manuscript and thank the anonymous reviewers very much.

Funding information: This study is supported by the Jiangsu Social Science Fund (17GLB003, 19GLC013).

Conflict of interest: Authors state no conflict of interest.

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