Original Research Article

Research on the Coupling Relationship between Marine Rresources and Environmental Carrying Capacity and Marine Economy in Jiangsu Province

Abstract: This paper takes the coastal area of Jiangsu Province as the research area, collects the relevant statistical data of the coastal area from 2010 to 2020, and uses the coupling degree and coupling coordination degree model to analyze the degree of marine economy-marine environment coupling in Jiangsu Province in the past 10 years and its correlation. The coordination type is analyzed and evaluated. The research results show that the coupling index of marine resources and environmental carrying capacity and marine economy in Jiangsu Province fluctuates up and down in the interval of 2010-2020. trend. From 2010 to 2020, the coupling index of marine resources and environmental carrying capacity and economic development level in the coastal areas of Jiangsu Province showed an inverted "U"-shaped change, which is in line with the environmental Kuznets curve. The coupling coordination index fluctuates repeatedly, and the value is between 0.4 and 0.8. The coupling stage is from the antagonistic stage to the running-in stage. The coupling coordination type is mainly based on the coordinated development type, and the coupling level roughly develops from a mild imbalance to a low-level coordinated development to a well-coordinated development. It began to rise rapidly, and the coupling status is good. The coupling status of Lianyungang and Yancheng needs to be further improved.

Keywords: Jiangsu Province; C oastal economy; Marine resources and environmental carrying capacity; C oupling model; C coordinated development

1 Introduction

1.1 Research background and significance

International :

Due to the continuous development of the economy, the problems it faces, such as the environment, population and resources, are becoming more and more serious. Various problems are increasingly threatening the existence of human beings. At this time, finding a new living space has become an important issue for countries around the world. Therefore, the world has turned its attention to the ocean. As the ocean holds 96.5% of the earth's water and 70% of the earth's area, it has huge development potential for people. The ocean economy is increasingly becoming a measure of national comprehensiveness. important factor in ability.

At present, all coastal countries in the world regard marine resources as a key step in their national development. The ocean is a key part of human life and brings a huge treasure trove to human life. It provides channels for trade and habitat for resources. It also provides a cradle for people's lives. In today's world, the marine economy is the key to a country's prosperity and an indispensable key part of the national economy. Since the 1990s , the marine economy has attracted wide attention from all countries, and the strategy of becoming a powerful marine country has gradually become a common pursuit of all countries. With the development of the marine economy, both the marine high-tech industry and the traditional marine industry have been improved; however, it is inevitable that in the process of marine development and utilization, the marine ecological environment has also social and economic progress.

Since the first industrial revolution to the present, human beings have always competed in economic development and environmental governance. The blood and tears lessons of sacrificing the environment for economic development have always reminded us that when developing marine resources today , we must take the road of green development. At the same time of development, we should pay attention to protecting the marine environment, improve the carrying capacity of the marine environment, avoid the waste of marine resources, and realize sustainable marine development and utilization.

Domestic :

As the main part of the economy in the 21st century, the marine economy requires China to place the ocean in an important position and take the coordinated development of the marine economy and the marine environment as an important goal.

Ocean development cannot go back to the past model, regardless of whether the marine environment is damaged, but should be developed reasonably and in a limited way, and protection should not be left behind during development. At the 18th National Congress of the Communist Party of China, the party proposed that we should strengthen the country through the ocean , so as to determine that the marine economy is the key to the development of the national economy, and we must firmly grasp the balance between development and governance to achieve the best results . At the 19th National Congress of the Communist Party of China , the strategy of "going forward by sea and developing together" was put forward, placing the building of a maritime power in a strategic position, and taking the road of a maritime power in an all-round, multi-level, and unswerving manner .

In 2021, the State Council incorporated the concepts of "carbon peaking" and "carbon neutrality" into government reports for the first time , and formulated specific plans to achieve " carbon peaking " by 2030 and " carbon neutrality " by 2060 . " Carbon peaking" means that carbon dioxide emissions stop growing and start to decrease after reaching a peak, while " carbon neutrality" means that people's daily use of the gas reaches zero emissions . At the current level of human technology , there will still be emissions in both production and life CO_2. When we say " zero emissions " we don't mean no emissions, we mean energy efficiency through the use of renewable energy and recycled materials, as well as reforestation and carbon sequestration for uptake, so that the gas emitted is equivalent to being Absorption means zero emissions.

In recent years, China has attached great importance to the development of the marine economy . As of 2020, the gross value of China 's marine industry has reached 9.1 trillion yuan, accounting for 9.767 % of China's total domestic production . This means that the ocean is becoming an indispensable part of the economy. The missing component is an important force for national economic development. However, due to the development of the marine economy, the destruction of the marine environment and the depletion of marine resources have restricted the development of the marine economy and hindered the improvement of the social economy.

The coupling and coordination relationship between the marine economy and the marine environmental carrying capacity system is a topic of common concern to all countries . Historical experience tells us that only by taking the road of green ocean and realizing the balance and coordination of the two can we truly achieve a maritime power.

1.2 Coupling evaluation model

(1) Order parameter evaluation system and efficacy function

The most important order parameters in the study of the system coupling relationship are the regional economic system and the regional environmental system. These two systems contain various elements, and the development goal of the system is the utility of each system to the overall system, so the coupling and coordinated development of the regional economy and the regional environment need to consider many aspects, that is, it is a multi-objective object. Suppose there are n objects $M_i(X)$(1,2,...,n) in the system, the n_1 larger the better, n_2 the smaller the better, and then assign a certain utility coefficient to these objects $0 \le u_i \le 1$(i =1,2,...,n), when u_i=1 means the object is the most desirable, and when u_i=0 means the object is the least desirable. According to the above, we call the function used to describe u_i the $M_i(X)$ relationship between and the utility function. The function u_{ij} (i=1,2...;j=1,2...,n) is the utility value of the jth order parameter of the ith subsystem in the marine economy-marine environment system (u_{ij} 0≤≤1), whose values are x_{ij} (i=1,2...;j=1,2...,n), α_{ij} and β_{ij} are the upper and lower critical values of each order parameter in the system, respectively. The utility function of each order parameter in the marine economy-marine environment coupling system can be expressed as:

Has positive utility: $u_{ij} = (x_{ij} - \beta_{ij})/(\alpha_{ij} - \beta_{ij})$, that is, the higher the index value, the greater the positive contribution.

Has negative utility: $u_{ij} = (\alpha_{ij} - x_{ij})/(\alpha_{ij} - \beta_{ij})$, that is, the lower the indicator value, the greater the negative contribution.

（2）System Comprehensive Evaluation Model

SEDI (System Development Index) is used to evaluate the development status of the place, it is necessary to conduct a comprehensive assessment of the system, and select appropriate indicators in order to understand the system more comprehensively, and calculate a comprehensive system score, using a mathematical model Assess the level of development of the system. The Comprehensive Economic Development Index (CEEI) and the Comprehensive Environmental Development Index (CEDI) were used to assess the region's economic and environmental systems.

According to the corresponding weights of each index, the proportion of each index's impact on the marine economy-marine environment total system is calculated, which are expressed as $f'(a)$, $f'(b)$ and T.

$$f(a)=\sum_{i=1}^{n} W_i a_i$$

$$f(b)=\sum_{j=1}^{m} W_j b_j$$

$$T=\alpha f(a)+\beta f(b)$$

Among them: W_i is the weight of each index in the marine economic operation system, is the weight of each index in the W_j marine environment impact system, a_i and b_i is the specific value of each index in the marine economy and marine environment protection system, respectively , α and β is the marine economic operation and regional ecology. The weight of the environmental impact of system changes on the entire system.

（3）Coupling degree and coupling coordination degree model

The coupled model of marine economy and marine environment system in coastal areas of Jiangsu Province is expressed as follows:

$$C=\{[(f(a)\cdot f(b)]/[f(a)+f(b)][f(a)+f(b)]\}^{1/2}$$

(0≤C≤1, the larger the value, the higher the coupling degree of the system)

When the coupling degree model is used to measure the coupling degree level of the marine economy and the marine environment in Jiangsu Province, the degree of coupling coordination cannot be measured. Therefore, the coupling degree model is used to measure the degree of coordination. The function D represents the degree of coupling coordination: $D=(C*T)^{1/2}$ (0≤ D≤1, the value of the value represents the level of coupling coordination).

1.3 Innovation points

（1）From the research perspective, the coupling and coordination relationship between the two systems in Jiangsu Province is dynamically studied in a long time interval;

（2）In the research method, this paper adopts the entropy method, the order parameter method and the coupling degree and coordination degree model to jointly study the coupling and coordination relationship and types between the marine economy and the marine environment carrying capacity in Jiangsu Province.

2 Overview of the study area

Jiangsu Province is located in the Yangtze River Delta region, with the Yellow Sea to the east and Shanghai, Zhejiang, Anhui and Shandong provinces beside it. There are many rivers and lakes in Jiangsu Province, and it is also bordered by the ocean. The terrain is mostly plain. Plains, rivers and small hills together constitute the landform. It also contains two major water systems, namely the Yangtze River and the Huaihe River. The research object of this paper is the coastal cities of Jiangsu Province, namely Lianyungang, Yancheng and Nantong. The total length of the coastline is 954.32 kilometers, and the entire coastal water area is 37,580 square kilometers.

Figure 1   Geographical location of the study area

3 Evaluation and Analysis of Coupling Model

3.1 Build an evaluation model

3.1.1 Comprehensive evaluation model of marine economy

According to the weight of each index determined by the entropy value distribution method , the evaluation value of the system is calculated by the weighted sum formula , and the comprehensive economic evaluation function of the coastal areas of Jiangsu Province is constructed. The formula is as follows :

$$f(a)=\sum_{i=1}^{n} W_i' a_i'$$

Among them, $f(a)$ is the comprehensive economic evaluation value of the coastal area, that is, the economic sequence parameter, n is the number of indicators in the system, W_i' is the weight of the i-th indicator, a_i' is the normalized and shifted value of the i-th indicator . $f(a)$ The higher the value, the higher the overall economic level of the coastal area, and vice versa .

3.1.2 Comprehensive evaluation model of marine environment

The construction of the global evaluation function of the marine environment in Jiangsu Province is the same as the construction of the global economic evaluation model, and its formula is as follows :

$$f(b)=\sum_{j=1}^{m} W_j' b_j$$

In $f(b)$ is the global evaluation value of the marine environment, that is, the environmental sequence parameter, m is the number of indicators in the system, W_j' is the weight of index j, a_j is the standardized value of index j, $f(b)$ The higher the value , the higher the carrying capacity of the marine environment and the better the environment .

3.1.3 Coupling and even-sum coordination models

Coupling degree refers to the connection between systems or between indicators and indicators. In this paper, it refers to whether there is an internal connection between the two systems of marine economy and marine environmental carrying capacity, that is, the degree of interaction between each other. What is lacking is that it does not reflect how well they are coordinated. Therefore, this paper makes adjustments according to the lack of coupling degree, uses the coupling coordination degree model to make up for the deficiency of the coupling degree model, and calculates the harmony value between the two systems of marine economy and marine environment in coastal areas of Jiangsu Province. The formula for calculating the coupling degree C is:

$$C=\{[(f(a)\cdot f(b)]/[f(a)+f(b)][f(a)+f(b)]\}^{1/2}$$

In the above formula, $f^{'}(a)$ is the evaluation value of the marine economic system, and $f^{'}(b)$ is the evaluation value of the marine environment carrying capacity system.

Its coupling coordination degree D calculation formula is:

$$T=\alpha f^{'}(a)+\beta f^{'}(b)$$

$$D=\left(C^{*}T\right)^{1/2}$$

In the above formula, T is the overall coordination value of the marine economy-marine environment system, and α and β are undetermined coefficients. In this paper $\alpha=\beta=0.5$, the marine economy and the marine environment carrying capacity are equally important.

3.2 Design of Indicator System

3.2.1 Construction principles

Both the coastal economic and marine environmental carrying capacity systems are not intuitive systems, and their data indicators are complex, and the data are constantly changing, and there are more or less data and data or between indicators and indicators. connect. Therefore, in order to have a clear and detailed understanding of the development status and characteristics of the system, in addition to following basic principles, such as rigor, factuality and timing, when establishing the indicator system in this paper, the following four principles should also be followed:

(1) Comprehensiveness. The marine economy and marine environmental carrying capacity system covers many aspects, and the factors affecting the system should be comprehensively analyzed based on the actual situation of the study area, and the evaluation indicators that can objectively reflect the regional economic and environmental characteristics should be selected.

(2) Implementability. It requires available and applicable indicators, data obtained through simple surveys and calculations, while avoiding tediousness so that it can be easily quantified and synthesized to draw conclusions.

(3) Representative. The establishment of the indicator system should be as concise as possible, and representative and comprehensive indicators should be selected.

(4) Hierarchical structure. The index system of marine environmental carrying capacity and marine economy is relatively cumbersome, so when choosing a suitable index system, we should pay attention to whether there is a relationship between each index, whether it meets the needs of the article, and whether it can describe the system scientifically.

3.2.2 System Construction

Table 1 Index System of Marine Economy-Marine Environment Carrying Capacity System in Jiangsu Province

target layer	Criterion layer	Indicator layer
Coastal Area Economic System A1	Economic level B1	GDP per capita C1
		Gross product C2
		Financial revenue C3
		The proportion of fixed asset investment in the whole society C4
	Economic Structure B2	The proportion of primary industry C5
		The proportion of secondary industry C6
		The proportion of the tertiary industry C7
	Economic Vitality B3	GDP growth rateC8
		Talent Density Index C9
		Investment in science and technology education C10
	People's living standard B4	Per Capita Consumption Point C11
		Residents' per capita disposable income C12
		Average salary of on-the-job workers C13

	Environmental carrying capacity level B5	Area C14 not up to Class 1 level
		Contaminated sea area C15
		Cumulative sea area of red tide occurrence C16
Marine Environmental Carrying Capacity System A2	Ambient pressure B6	Major river pollutants enter massive amounts of C17
		COD into massive C18
		Excessive rate of sewage outfalls into the sea C19
		Ocean dumping of dredged material C20
	Environmental Protection B7	Industrial wastewater discharge compliance rate C21
		Comprehensive utilization rate of industrial solid waste C22
		Area of marine nature reserve C23

3.3 Data acquisition and processing

3.3.1 Data sources

The research period of the article is from 2010 to 2020, and the data mainly comes from "China Urban Statistical Yearbook", "China Ocean Statistical Yearbook", "Jiangsu Statistical Yearbook", "Yancheng Statistical Yearbook", "Nantong Statistical Yearbook", " Lianyungang Statistical Yearbook, "Jiangsu Provincial Marine Environmental Quality Statistical Bulletin", etc. Most of these data are obtained directly from yearbooks and bulletins, and a small portion is obtained after calculation and processing

3.3.2 Dimensionless Quantization Processing

Since the selected data spans the two major systems of economy and ocean, and there are great differences in units, it is impossible to directly compare objectively, so it is necessary to uniformly process the indicator data . The article chooses the method of first extremizing the data and then standardizing the data . The following is the calculation formula :

Has a positive effect: $u_{ij}=\left(x_{ij}-\beta_{ij}\right)/\left(\alpha_{ij}-\beta_{ij}\right)$

Has a negative effect: $u_{ij}=\left(\alpha_{ij}-x_{ij}\right)/\left(\alpha_{ij}-\beta_{ij}\right)$

In the above formula, u_{ij} is the standard value of the indicator, x_{ij} is the raw data of index i in year j, α_{ij} and are the β_{ij} upper and lower bounds of the index i in the time series . In this paper, all indicators of marine economy have positive efficacy , while all indicators of marine environmental carrying capacity system have negative efficacy. After unified and dimensionless processing, the data are as follows:

Table 2 Dimensionless Quantitative Results of Marine Economy-Marine Environmental Carrying Capacity System Indexes in Jiangsu Province

Index	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
C1	0.985	0.913	0.000	0.164	0.177	0.263	0.492	0.661	0.703	0.856	0.944
C2	0.998	0.930	0.000	0.366	0.402	0.468	0.688	0.731	0.812	0.941	0.916
C3	0.021	0.930	0.000	0.569	0.612	0.643	0.741	0.778	0.862	0.911	0.932
C4	0.875	0.866	0.000	0.650	0.693	0.708	0.644	0.792	0.823	0.876	0.923
C5	0.344	0.878	0.010	0.644	0.675	0.524	0.432	0.389	0.304	0.295	0.213
C6	0.734	0.779	0.444	0.668	0.372	0.422	0.496	0.394	0.402	0.367	0.391
C7	0.919	0.759	0.682	0.356	0.431	0.516	0.608	0.663	0.759	0.862	0.944
C8	1.000	0.855	0.767	0.921	0.425	0.511	0.672	0.714	0.768	0.812	0.931
C9	0.805	0.867	0.114	0.628	0.348	0.402	0.465	0.583	0.627	0.734	0.892
C10	0.590	0.642	0.205	0.205	0.416	0.533	0.627	0.691	0.763	0.841	0.887
C11	0.694	0.713	0.980	0.933	0.214	0.348	0.465	0.638	0.714	0.899	0.931
C12	0.669	0.706	0.971	0.916	0.261	0.401	0.596	0.633	0.731	0.842	0.872
C13	0.764	0.792	0.953	0.869	0.314	0.455	0.607	0.688	0.724	0.816	0.894

C14	0.595	0.539	0.868	0.730	0.675	0.691	0.602	0.598	0.572	0.514	0.507
C15	0.136	0.077	0.183	0.092	0.065	0.082	0.134	0.162	0.082	0.064	0.059
C16	0.748	0.999	0.827	0.949	0.837	0.814	0.799	0.712	0.610	0.635	0.594
C17	0.558	0.272	0.332	0.376	0.374	0.402	0.316	0.348	0.294	0.277	0.238
C18	0.836	0.636	0.238	0.341	0.357	0.361	0.397	0.327	0.304	0.286	0.000
C19	0.918	0.928	0.970	0.904	0.831	0.705	0.724	0.682	0.724	0.808	1.000
C20	0.599	0.716	0.938	0.824	0.653	0.728	0.706	0.830	0.839	0.746	1.000
C21	0.503	0.625	0.858	0.803	0.731	0.634	0.482	0.760	0.742	0.824	1.000
C22	0.550	0.673	0.724	0.792	0.813	0.847	0.899	0.912	0.933	0.975	1.000
C23	0.669	0.772	0.912	0.647	0.532	0.313	0.641	0.775	0.861	0.933	1.000

3.3.3 Indicator weight assignment

By assigning the weights to the indicators, the article uses the entropy weight method to assign the weights. This method is objective and can reduce the influence of other factors to a certain extent. By determining the entropy value, the specific indicators of the required indicators are determined. data. The empowerment is as follows:

（1）First, the data is standardized according to the formula; at the same time, in order to eliminate the result error caused by the 0 value, the standardized data results are shifted to the right. The smaller the offset, the smaller the impact on the results. Therefore, this paper shifts the standardized data to the right. 0.001 units.

（2）Calculate the indicator values for year i y_{ij} and build a data weight matrix:

$$y_{ij} = \frac{x'_{ij}}{\sum_{i=1}^{m} x'_{ij}} \left(0 \le y_{ij} \le 1\right)$$

（3）Calculate the entropy value of the j index:

$$e_j = -K\sum_{i=1}^{m} y_{ij} \ln y_{ij}$$

（4）Calculate the information utility value of the j index:

$$d_j = 1 - e_j$$

（5）Calculate the j index weight:

$$W_j = \frac{d_j}{\sum_{i=1}^{n} d_j}$$

In the above formula , m represents the year, and n represents the total number of indicators.

After calculation, the weights of each index of marine economy and marine environment carrying capacity in Jiangsu Province are shown in Table 3below:

Table 3 The weight of the evaluation index of the marine economy and marine environment carrying capacity in Jiangsu Province

target layer	first-level indicator	Weights	Secondary indicators	Weights
Coastal Area Economic System A1	Economic level B1	0.3803	GDP per capita C1	0.0726
			Gross product C2	0.0788
			Financial revenue C3	0.1076
			The proportion of fixed asset investment in the whole society C4	0.1213
	Economic Structure B2	0.1749	The proportion of primary industry C5	0.0105
			The proportion of secondary industry C6	0.0476
			The proportion of the tertiary industry C7	0.1168
	Economic Vitality B3	0.1826	GDP growth rateC8	0.0519
			Talent Density Index C9	0.0479

			Investment in science and technology education C10	0.0828
	People's living standard B4	0.2622	Per Capita Consumption Point C11	0.0940
			Residents' per capita disposable income C12	0.0953
			Average salary of on-the-job workers C13	0.0729
Marine Environmental Carrying Capacity System A2	Environmental carrying capacity level B5	0.3436	Area C14 not up to Class 1 level	0.1132
			Contaminated sea area C15	0.0840
			Cumulative sea area of red tide occurrence C16	0.1446
	Ambient pressure B6	0.4238	Major river pollutants enter massive amounts of C17	0.1126
			COD into massive C18	0.1199
			Excessive rate of sewage outfalls into the sea C19	0.0877
			Ocean dumping of dredged material C20	0.1036
	Environmental Protection B7	0.2303	Industrial wastewater discharge compliance rate C21	0.0278
			Comprehensive utilization rate of industrial solid waste C22	0.0646
			Area of marine nature reserve C23	0.1342

Table 4. Results of comprehensive economic analysis of coastal areas in Jiangsu Province

Years	The economic level of each region	overall economic level	regional economic structure	Regional economic vitality	per capita consumption level
2010	0.2905	0.1822	0.0335	0.1367	0.1073
2011	0.3482	0.2259	0.0667	0.1355	0.1276

2012	0.4014	0.2765	0.0505	0.1508	0.1795
2013	0.4859	0.3224	0.0326	0.1647	0.2235
2014	0.5619	0.365	0.0363	0.1952	0.2624
2015	0.624	0.4208	0.0461	0.2564	0.3422
2016	0.7162	0.4706	0.0597	0.3034	0.3954
2017	0.7705	0.5648	0.0624	0.3541	0.4221
2018	0.8428	0.6024	0.0638	0.3994	0.4632
2019	0.8947	0.6425	0.0721	0.4021	0.5301
2020	0.9364	0.7589	0.0699	0.4335	0.5944

3.4 Evaluation Results and Analysis

3.4.1 Evaluation of the coupling and coordination relationship between marine economy and marine environment

According to the comprehensive economic evaluation model formula of coastal areas, the comprehensive evaluation effect of the marine economy and marine environment carrying capacity system of coastal cities Table 4below:

Table 4Results of comprehensive economic analysis of coastal areas in Jiangsu Province

From the above table, the following figure is drawn, that is, the change trend of the economic level of each region over time. From **Error! Reference source not found.**, we can see that the overall economic level of coastal cities in Jiangsu Province has been on a steady upward trend in the ten years from 2010 to 2020. From 2010 to 2015, the overall economic level of the coastal areas of Jiangsu Province increased year by year, but the growth rate was lower than that from 2015 to 2020. During this period, under the guidance and influence of government policies, Jiangsu Province seized the "building a maritime power" It is necessary to build a strong marine province" concept, stimulate the economic growth of coastal areas in all aspects, build new vitality for economic growth in coastal areas, continuously develop high-tech enterprises, and at the same time take advantage of the unique coastal location to develop the marine economy, including port transportation, oil exploration. and coastal tourism, which to a certain extent accelerated the development of the land economy.

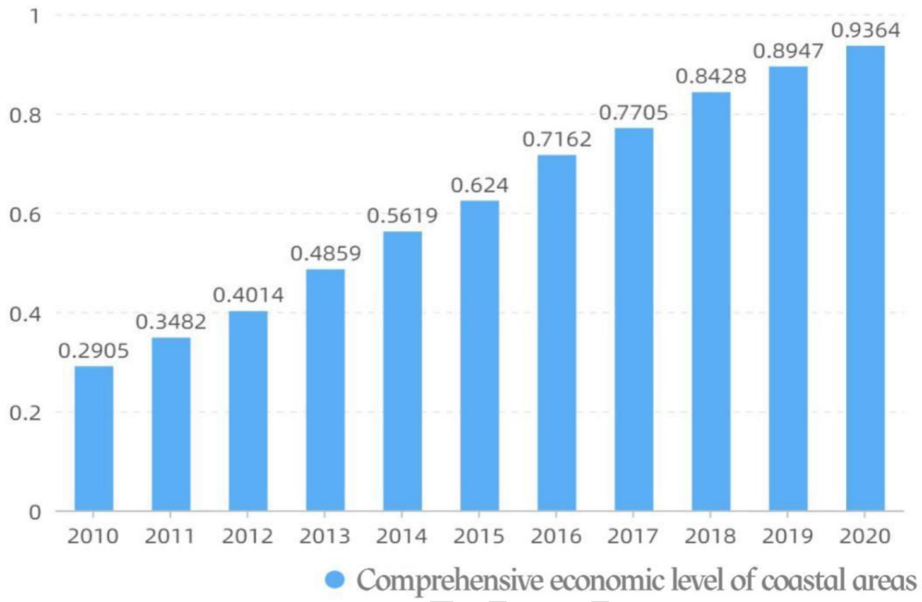

Figure 2 Trend map of economic comprehensive level in coastal areas of Jiangsu Province

The economic level, people's living standard and economic vitality of each sub-indicator shown in Figure below are consistent with the overall economic level of the coastal areas of Jiangsu Province, showing an upward trend year by year. The economic structure of the sub-indicators fluctuated slightly. From 2010 to 2013, the primary and secondary industries contributed greatly to the economic structure. At that time, the average proportion of the primary and secondary industries in GDP reached 13.94% and 34.59%, respectively. From 2014 to 2019 The economic structure is rising year by year, and both heavy and light industries are declining. In contrast, the high-tech industry has become the main driving force, and the industrial structure has been continuously optimized. On the whole, the economy of the coastal areas of Jiangsu Province has entered a stage of stable development.

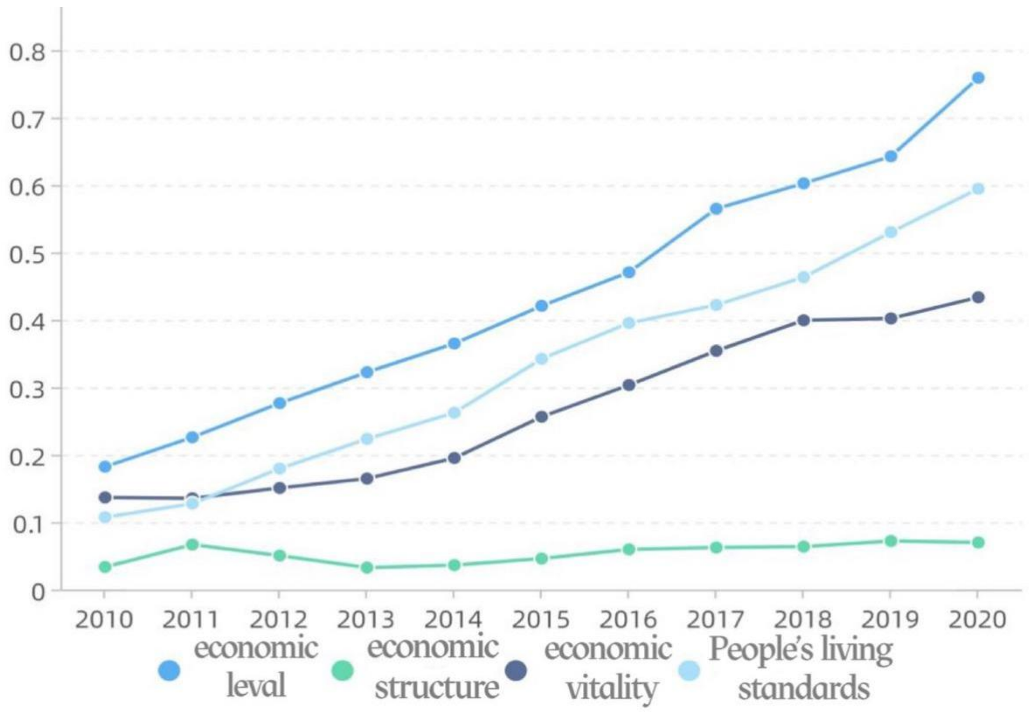

Figure 3 Time series changes of sub-indices levels of economic system in coastal areas of Jiangsu Province

According to the comprehensive evaluation model formula of the marine environment, the comprehensive state of the marine environment in Jiangsu Province in the past ten years can be obtained. The results are shown in Table 5below:

Table 5 Comprehensive evaluation results of sub-indicators of marine environment system in Jiangsu Province

years	Comprehensive level of marine environment	environmental level	Environmental pressure	environmental protection
2010	0.7715	0.2708	0.3567	0.1607
2011	0.6858	0.3101	0.3628	0.1905
2012	0.5602	0.3402	0.3772	0.1074
2013	0.4851	0.3315	0.3129	0.2197
2014	0.4802	0.2966	0.3502	0.1392
2015	0.6646	0.3476	0.2245	0.2002

2016	0.7481	0.3904	0.2043	0.2761
2017	0.7532	0.3962	0.1927	0.2994
2018	0.7874	0.4121	0.1168	0.3421
2019	0.8783	0.4359	0.1064	0.3668
2020	0.9105	0.5127	0.1002	0.4029

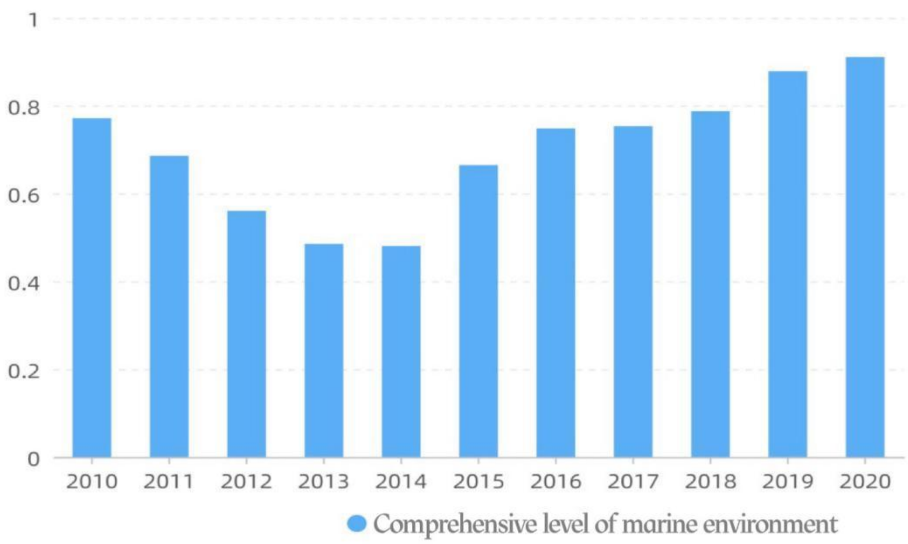

Figure 4 Trend map of comprehensive level of marine environment in Jiangsu Province

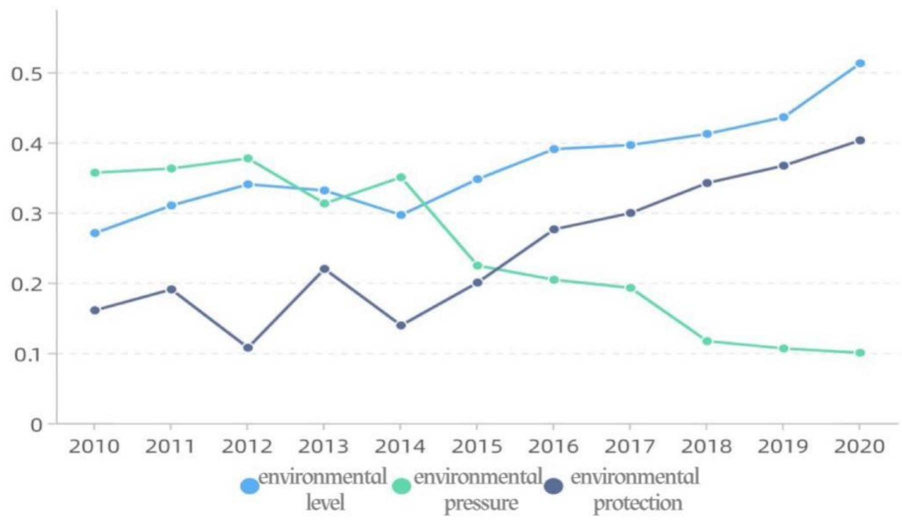

Figure 5 Time series changes of sub-indices of marine environmental system in Jiangsu Province

from Figure that from 2012 to 2019, the overall level of marine environment in Jiangsu Province showed a "V"-shaped fluctuation, and from 2010 to 2014, the overall level of marine environment showed a downward trend year by year. After the rise in 2014 and 2016, the overall level of the marine environment fluctuated within a small range from 2017 to 2018, and the marine environment remained relatively stable, but from 2018 to 2020, the level of the marine environment rose significantly, mainly because the epidemic was under control, The government pays more attention to the ocean, thus making the ocean economy progress steadily. Except for the traditional marine industries such as seaside tourism and sea salt industry, other marine high-tech industries have made a lot of progress, which indicates that the marine industry still has a large space for development in the future. In terms of the marine economy of the three cities in Jiangsu Province, as of 2020, the gross marine product of Jiangsu Province is 411.64 billion yuan, an increase of 0.9% over the gross marine product of Jiangsu Province in 2019, and it is a key component of the province's economy; overall; In terms of marine environment, the level of marine environment in coastal areas of Jiangsu has steadily improved.

Figure , the levels of the three sub-indicators of the overall marine environment in Jiangsu Province are volatile, and the fluctuations are uncertain. The magnitude of the marine environmental carrying capacity and the level of protection change in the same direction, fluctuated from 2010 to 2014, and began to show a steady upward trend in 2015. Is the fluctuation due to the influence of the industrial structure of coastal areas, heavy industry and The oil industry has caused pollution to coastal areas, and government policies have called for greater impact on marine protection; from 2011 to 2016, the level of environmental protection showed an "M"-shaped trend, the overall environmental level showed a "V"-shaped trend, and the level of environmental pressure generally Influenced by the adjustment of the coastal economic structure and the improvement of the level of economic development, the level of marine environmental protection and the comprehensive level have risen significantly. Therefore, on the whole, before 2015, the sub-indicators fluctuated greatly, but after 2015, the overall marine environment has been continuously optimized.

（1）Coupling stage and coordination type analysis

Through the above formula, the coupling degree and coordination degree of marine economy and marine environment in Jiangsu Province are calculated, and divided according to the model, so as to obtain the coupling stage and coupling coordination type. The analysis results are as follows:

Table 6 Coupling Evaluation Results of Economic-Marine Environment System in Coastal Areas of Jiangsu Province

years	size of f(a)-f(b)	Coupling in coastal areas	Coupling coordination degree in coastal areas	Coastal Coupling Phase	Types of Coupling Coordination in Coastal Areas
2010	f(a)-f(b)>0.1	0.3921	0.4228	antagonistic phase	Dissonance Decay
2011	f(a)-f(b)>0.1	0.3629	0.3901	antagonistic phase	Dissonance Decay
2012	f(a)-f(b)>0.1	0.3602	0.4031	antagonistic phase	Dissonance Decay
2013	f(a)-f(b)>0.1	0.5236	0.5086	antagonistic phase	Barely coordinated development
2014	f(a)-f(b)>0.1	0.5938	0.5453	run-in stage	Barely coordinated development
2015	f(a)-f(b)>0.1	0.6029	0.6164	run-in stage	Coordinated development
2016	f(a)-f(b)>0.1	0.6111	0.6299	run-in stage	Coordinated development
2017	f(a)-f(b)>0.1	0.6856	0.6534	run-in stage	Coordinated development
2018	f(a)-f(b)>0.1	0.6921	0.6871	run-in stage	Coordinated development
2019	f(a)-f(b)>0.1	0.6523	0.7022	run-in stage	Coordinated development
2020	f(a)-f(b)>0.1	0.7428	0.7638	run-in stage	Coordinated development

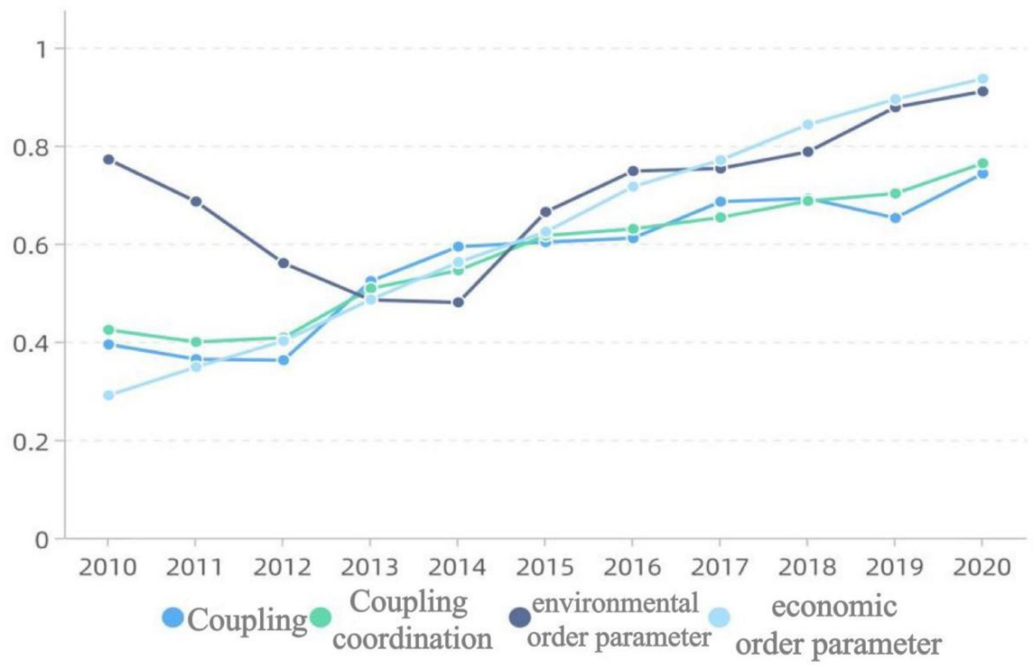

Figure 6 Time series change of coupling relationship between economy and marine environment system in coastal areas of Jiangsu Province

from Figure , from 2010 to 2020, the coupling degree fluctuated between 0.3 and 0.8, and from 2010 to 2012, the coupling degree showed a downward trend. The main reason is that the primary and secondary industries are in the main position in the economic structure. From 2012 to 2014, the degree of coupling has been greatly improved, which is mainly due to the appeal of government policies and the optimization of the economic structure, and the level of economic development has been improved; while from 2014 to 2020, the degree of coupling has undergone a small rise and fall movement, which is still in general. an upward trend. From the above chart analysis, it can be concluded that the coupling stage in this paper is the antagonistic stage and the running-in stage.

According to :

Table 6 Coupling Evaluation Results of Economic-Marine Environment System in Coastal Areas of Jiangsu Province

years	size of f(a)-f(b)	Coupling in coastal areas	Coupling coordination degree in coastal areas	Coastal Coupling Phase	Types of Coupling Coordination in Coastal Areas

2010	f(a)-f(b)>0.1	0.3921	0.4228	antagonistic phase	Dissonance Decay
2011	f(a)-f(b)>0.1	0.3629	0.3901	antagonistic phase	Dissonance Decay
2012	f(a)-f(b)>0.1	0.3602	0.4031	antagonistic phase	Dissonance Decay
2013	f(a)-f(b)>0.1	0.5236	0.5086	antagonistic phase	Barely coordinated development
2014	f(a)-f(b)>0.1	0.5938	0.5453	run-in stage	Barely coordinated development
2015	f(a)-f(b)>0.1	0.6029	0.6164	run-in stage	Coordinated development
2016	f(a)-f(b)>0.1	0.6111	0.6299	run-in stage	Coordinated development
2017	f(a)-f(b)>0.1	0.6856	0.6534	run-in stage	Coordinated development
2018	f(a)-f(b)>0.1	0.6921	0.6871	run-in stage	Coordinated development
2019	f(a)-f(b)>0.1	0.6523	0.7022	run-in stage	Coordinated development
2020	f(a)-f(b)>0.1	0.7428	0.7638	run-in stage	Coordinated development

, the period from 2010 to 2013 was in an antagonistic stage. With the continuous development of the coastal economy, the carrying capacity of the marine environment gradually decreased, and its self-purification capacity also decreased, unable to absorb the negative impact of economic development. From 2014 to 2020, it is in the running-in stage, and the changes in the stage have brought the experience to the society. Only when the environment is protected can the economy achieve a real leap; therefore, people have invested more funds and technologies to restore the marine environmental system and truly do When it comes to governance and development at the same time. After 2012, with the economic development and the continuous adjustment of government policies, the coupling stage has also transitioned to the running-in stage, and the marine economy has gradually moved on the right track.

At the same time, according to the above table and the above figure, the change process of the coupling coordination type is analyzed. From 2010 to 2012, it was in an imbalanced recession type. Due to the influence of economic and natural factors, the development level of the marine economy was higher than the level of the marine environment, and the system was in an uncoordinated stage, and there was a phenomenon of degradation; the coupling coordination type from 2013 to 2014 was reluctant Coordinated type, at this time, the environmental water is still slightly lower than the level of economic development, and the marine environmental carrying capacity fluctuates around the threshold, which belongs to the transitional stage type; 2015-2020 is the type of coordinated development, at which time the level of economic development is basically the same as the level of the marine environment , and the coupling coordination degree is generally on the rise, and the system tends to be optimized. Therefore, in the past ten years, the level of coupling and coordination between the marine environment and the marine economic system in Jiangsu Province has been continuously optimized.

3.4.2 Coupling and coordination analysis of marine economy and marine environment

According to the above models and methods, and after adjusting the indicators, the coupling and coordination relationship between the marine economy and the marine environment of the three coastal cities in Jiangsu Province (i.e. Lianyungang, Yancheng and Nantong) is analyzed. The results are as follows:

Table 6 Calculation results of coupling degree of economy-marine environment system in three coastal cities

years	Lianyungang		Yancheng		Nantong	
	Coupling	coupling phase	Coupling	coupling phase	Coupling	coupling phase
2010	0.4039	antagonistic phase	0.3394	antagonistic phase	0.4672	antagonistic phase
2011	0.4252	antagonistic phase	0.4203	antagonistic phase	0.4901	antagonistic phase
2012	0.4472	antagonistic phase	0.4406	antagonistic phase	0.5191	run-in stage
2013	0.4582	antagonistic phase	0.4963	antagonistic phase	0.5421	run-in stage
2014	0.5040	run-in stage	0.4997	antagonistic phase	0.5536	run-in stage
2015	0.5560	run-in stage	0.5306	run-in stage	0.6481	run-in stage
2016	0.5880	run-in stage	0.5824	run-in stage	0.6272	run-in stage
2017	0.5613	run-in stage	0.6411	run-in stage	0.6899	run-in stage
2018	0.5938	run-in stage	0.6743	run-in stage	0.7106	run-in stage

2019	0.6205	run-in stage	0.6912	run-in stage	0.7288	run-in stage
2020	0.6455	run-in stage	0.7003	run-in stage	0.7931	run-in stage

Table 6that from 2010 to 2020, the coupling degree of Lianyungang fluctuated between 0.4 and 0.7, and its coupling stage was in the stage of antagonism and running-in, of which 2010-2013 was the antagonistic stage, 2014-2020 was the running-in stage, and the coordination type From the brink of imbalance to reluctance to emphasize and to basic harmony; within the study interval, the change curve of the degree of coupling and coordination between the marine economy and the marine environment in Lianyungang City is relatively flat. It can be seen that the marine environment of Lianyungang City has been improved, and there is still much room for development.

Figure 7　Variation trend of coupling degree of economy-marine environment system in three coastal cities

from Figure that the coupling degree of Yancheng's marine economy-marine environmental carrying capacity system is between 0.3 and 0.8, in which 2010-2014 is the antagonistic stage, 2015-2020 is the running-in stage, and the coupling coordination type is in the 2010-2011 period. On the verge of dissonance, 2012 was a transitional stage, in a reluctantly stressed and harmonious type, and after that it was a basic harmonious type; within the study interval, the coupling and coordination of Yancheng's marine economy and the marine environment tended to be optimal and fluctuated on the whole. rising trend.

Table 7　Calculation results of coupling coordination degree of economy-marine environment system of three coastal cities

years	Lianyungang		Yancheng		Nantong	
	Degree of Coupling and Coordinated Development	Coupling and coordinated development type	Degree of Coupling and Coordinated Development	Coupling and coordinated development type	Degree of Coupling and Coordinated Development	Coupling and coordinated development type
2010	0.4442	on the verge of dysregulation	0.4953	on the verge of dysregulation	0.5112	reluctantly emphasize and
2011	0.4815	on the verge of dysregulation	0.4977	on the verge of dysregulation	0.5520	reluctantly emphasize and
2012	0.4923	on the verge of dysregulation	0.5065	reluctantly emphasize and	0.5640	reluctantly emphasize and
2013	0.5111	reluctantly emphasize and	0.6015	basic harmony	0.5467	reluctantly emphasize and
2014	0.5677	reluctantly emphasize and	0.6880	basic harmony	0.6592	basic harmony
2015	0.5930	reluctantly emphasize and	0.6554	basic harmony	0.6791	basic harmony
2016	0.6013	basic harmony	0.6753	basic harmony	0.7194	basic harmony
2017	0.5982	reluctantly emphasize and	0.6916	basic harmony	0.7729	basic harmony
2018	0.6491	basic harmony	0.7210	basic harmony	0.7952	basic harmony
2019	0.6883	basic harmony	0.7683	basic harmony	0.8204	well reconciled
2020	0.7210	basic harmony	0.7951	basic harmony	0.8625	well reconciled

According to the above Table 7, the coupling degree between the marine economy and the marine environment in Nantong City from 2010 to 2020 is between 0.4 and 0.8, and the coupling coordination degree is between 0.5 and 0.9. In the running-in stage, the coordinated development type from 2010 to 2013 is a reluctant and harmonious type, 2014-2018 is a basic harmonious type, and 2018-2020 is a good harmonious type; and it can be seen from Figure that Nantong's marine economy-marine environment coupling degree and The degree of coordination is generally high and continues to rise within the study range. It is not only the adjustment and optimization of the economic structure, but also the reasons for the continuous protection of the marine environment and the continuous enhancement of the carrying capacity. The system as a whole is a benign coupling.

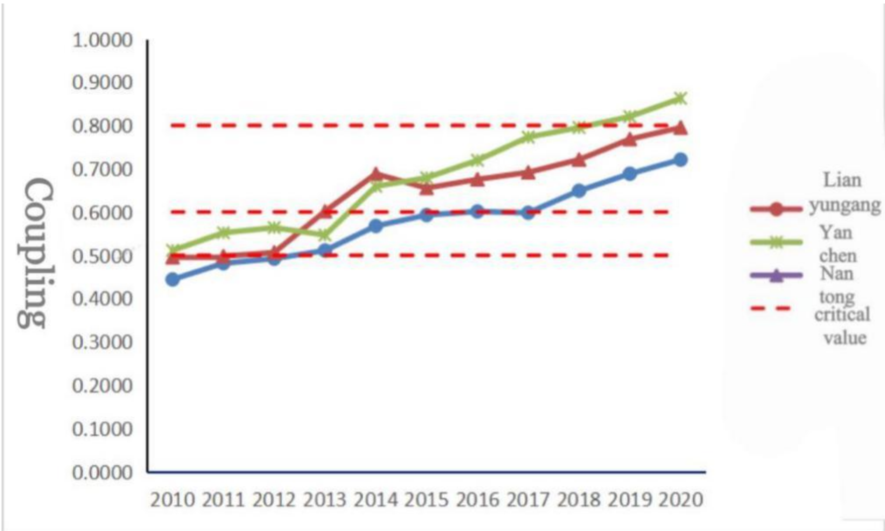

Figure 8 Time series change of coupling coordination degree of economy-marine environment system in three coastal cities

Through the above analysis, in the marine economy-marine environment coupling system of the three coastal cities, Nantong is the best, Lianyungang is the most unstable, and Yancheng has steadily improved the coupling degree after 2015, and the coupling relationship has been significantly optimized. In short, the marine economy-marine environment coupling coordination relationship in the three coastal cities in Jiangsu Province is on the rise, and the system as a whole tends to be well coupled.

4 Constraining factors and countermeasures

basis of the index evaluation of marine economy and marine environment of Jiangsu Province in the third chapter , it analyzes the factors that hinder the coordinated development of the two , and proposes to promote the coordination of marine economy and marine environment carrying capacity from three aspects of marine economy, marine environment and society. development strategies and measures.

4.1 Analysis of Constraining Factors

4.1.1 Problems of Ocean Economic System

There are many reasons for the lack of marine economy in Jiangsu Province, but they can be mainly summarized as four aspects: insufficient scientific and technological research and development, incomplete transformation of scientific and technological achievements, the need to optimize the marine industry structure, and lack of marine investment funds. In 2020, the proportion of the three major industrial structures in Jiangsu Province was 4.41%, 43.05% and 52.54% respectively, although the industrial structure has been greatly improved from 6.2%, 53.2% and 40.6% in 2010. However, the proportion of the tertiary industry that can bring more economic benefits still needs to be increased. Industries such as shipping and coastal tourism need to make progress in development, and high-tech industries should be paid more attention. Within the study interval, the marine industry in Jiangsu Province is not sufficiently funded, which is seriously disproportionate to the rapidly expanding population and rapid economic development. Since 2012, the scale of investment has expanded rapidly, but these investments are mainly used to make up for the deficiencies of previous investments or to strengthen the foundation. These funds are mainly used for traditional marine industries, which usually have a long investment return period, the effect is not obvious, and they cannot bring about an economic leap. To realize the rapid growth of the marine economy, it is necessary to realize the growth of marine investment. Investment is an important pillar of the economy and an inevitable requirement for coordinated progress.

The economy of Jiangsu Province as a whole presents a trapezoidal trend, that is, from southern Jiangsu to central Jiangsu to northern Jiangsu, the per capita consumption level gradually decreases. In terms of per capita GDP in 2020, Nantong is 129,900 yuan, Yancheng is 88,731 yuan, and Lianyungang is 71,303 yuan. Compared with the economy of southern Jiangsu, northern Jiangsu is still some distance away. At present, the funding for scientific and technological research in Jiangsu Province is basically provided by the government. Because the amount is large and the return time is long, it is unrealistic to ask enterprises to raise their own funds to support scientific and technological research and development, and because the funds held by enterprises are limited, It cannot fundamentally promote the development and progress of science and technology, so it has gradually become a key factor restricting the development of marine economy.

4.1.2 Marine environmental system issues

(1) Lack of marine resources

Since the "One Belt, One Road" initiative and the development strategy of the Yangtze River Economic Belt have been put forward, the marine economy of Jiangsu Province has begun to develop rapidly. Due to the predatory development and utilization of resources, especially the sharp reduction of marine fish resources, the problem of resource scarcity has been very obvious. As a result, the number of fish resources in marine fisheries is also decreasing. Years of fishing have greatly reduced fishery resources and marine water quality. Among them, the number of large yellow croaker is in danger, and the small yellow croaker, shad and saury are also on the verge of extinction. At the end of the fishing moratorium every year, a large number of fishing boats swarmed in, and the results of the fishing moratorium were seriously damaged. As a result, the fishing season has been very poor, fish production has declined, and economic benefits have continued to decline. At the same time, the hatchery resources in Jiangsu waters were also severely damaged, among which crabs and eels were the most serious. These behaviors have inevitably caused huge damage to marine fisheries. Although marine fry breeding has been protected since 2018, the scale of breeding and release is limited, so its role in resource recovery needs to be further improved.

(2) Marine environmental pollution

There are many sources of marine environmental pollution in Jiangsu Province, and the first is the sewage discharged from life, followed by the waste water from farmers and industries. According to statistics, in 2020, Jiangsu coastal areas discharged a total of 69,245.5 tons of domestic sewage and industrial processing wastewater into the ocean, accounting for 13.2% of the province's total discharge, and 57.9% of all sewage was for domestic use. wastewater, while the proportion of wastewater treated by industrial processing was 31.8%. It also includes marine environmental disasters. In 2020, there will be 1 storm surge process in Jiangsu Province, which is a typhoon storm surge process; 10 ocean wave processes will occur, causing 2 ocean wave disasters, economic losses of 19.1899 million yuan, and no one was injured; the sea area under the jurisdiction of Jiangsu From April to July, the green tide of prolifera was found, covering a wide area, up to 5 square kilometers, and the loss caused by it was as high as 19.1899 million yuan. Compared with the 2019 value, the overall decline is the lowest value in the past five years, but there is room for further improvement.

In 2020, the probability of acid rain in Jiangsu Province is about 14%. The pH value of precipitation in the province fluctuates around 5.71, and the pH value of acid rain fluctuates around 5.04. Eight cities in Jiangsu have encountered different levels of acid rain pollution. Lianyungang and Nantong are among the coastal cities. The overall probability of acid rain is 2%-34.1%. Compared with 2019, Jiangsu Province suffered from acid rain. The likelihood was reduced by 1.7%, compared to a decrease in the intensity and acidity of acid rain. The frequency of acid rain in Nantong is the highest at 36.25%, followed by Lianyungang with a value of 29.42%, and the acid rain rate in Yancheng is lower; the frequent occurrence of acid rain has brought serious negative impact on the economy and society in the coastal areas of Jiangsu.

4.1.3 Marine social system issues

The marine social system problems in Jiangsu Province are reflected in the following three aspects: (1) the lack of social awareness of ocean protection; (2) the lack of coastal urbanization; (3) the lack of marine scientific and technological research results. The three coastal cities have a limited level of urbanization, and their urban areas are relatively small. As of 2020, Lianyungang's population ranks the bottom three among the 13 cities in the province, and its urban area is also the bottom three; the urbanization level of Jiangsu's coastal areas is still 4.1 percentage points behind the inland areas. The low level of urbanization in the coastal areas of Jiangsu Province and the small scale of the cities have caused the development of cities in the coastal areas to be relatively low compared to other urban areas, thus limiting the ability to attract investment and expand funding sources, and lack of universities and research. Therefore, it cannot bring about the rapid development of coastal areas.

The lack of knowledge about the ocean is mainly reflected in the fact that people's cognition of the marine industry is still in the traditional marine industry in the past. Many high value-added and high-level marine resources have not been effectively developed and utilized, and they cannot promote the common development of the marine economy. growth, it will not be able to contribute to the social economy. Due to the lack of universities and marine research institutes, the marine high-tech industry cannot be developed, and the professional quality and skills of marine-related professionals need to be improved; at the same time, there is a shortage of marine-related professionals, and marine scientific research is weak, specializing in marine science and technology. There are few research institutes and institutions for research and development, and insufficient marine science and technology cannot provide support for the development of the marine economy.

The development of marine economy is inseparable from the support of marine science and technology, and it is necessary to strengthen the advancement of marine science and technology. In addition, because the coastal areas of Jiangsu are mostly lowland and plain areas, there is still great potential in absorbing population flow and concentration, but a large number of people gather in the coastal areas, which has brought a heavy burden to the already tense marine ecological environment.

To sum up, marine economy, marine environment and marine social issues have become the bottleneck restricting the coordinated development of marine economy and marine environment in Jiangsu Province, and it is also the bottleneck that this paper aims to solve.

4.2 Countermeasures and Adjustments

4.2.1 Adjust the industrial layout and realize the common progress of sea and land

The adjustment of the marine industry structure and the optimization of the layout are the top priorities of the current work. From the above analysis, it can be seen that the poor marine ecological environment in Jiangsu Province is an important reason for restricting economic development. Therefore, in the process of adjusting the industrial structure, we should focus on the development of environmentally friendly marine industries and take the road of coordinated development of marine economy and environment.

To pursue a sustainable marine industry, both quantity and quality must be guaranteed. While developing traditional marine industries such as marine fisheries and coastal tourism, focus on cultivating high-tech marine renewable energy, ecological agriculture, and biomedicine. industry. By adjusting the layout of the industry, realizing the transformation and upgrading of the industrial structure, and stimulating economic growth through high-tech enterprises, while enhancing the protection of the marine environment, the marine economy will be "doubled", and the joint development and common progress of the sea and land will be truly realized.

4.2.2 Increase scientific and technological efforts and strengthen economic development

The economic structure of the coastal areas of Jiangsu Province needs to be improved, and optimizing the economic structure is the only way to realize the coordinated development of marine economy and environment. First of all, it is necessary to increase investment in scientific research and development, promote technological innovation of enterprises, protect the environment and increase industrial output. Secondly, pay attention to protecting intellectual property rights and technology patents, achieve technological innovation, and improve the competitiveness of enterprises from the root. Third, we must attach importance to education and personnel training, and we must increase capital investment in education, so as to increase the proportion of education investment in total investment, and change the direction of personnel training to obtain high-level talents. In addition, we must attach importance to international exchanges and cooperation, attract foreign investment, learn advanced production and management methods, realize technology sharing, and truly realize that technology is the primary productive force,

4.2.3 Strengthen marine ecological construction and improve environmental carrying capacity

The discharge of polluted industrial and domestic waste water into the sea is a major source of pollution to the marine ecosystem. To prevent and reduce the pollution of the marine environment, we must first reduce the discharge of pollutants into the sea, and strive to adopt alternative methods, such as optimizing urban sewage treatment systems, Reduce waste water discharge. Second, we need to use advanced technologies to treat already heavily polluted waters to optimize water quality. This can use hydrogen dioxide and algicides for reduction, precipitation, and oxidation reactions to purify water, or microbes to absorb and break down pollutants.

Artificial breeding can be used to restore marine ecological resources, and banning fishing can help restore depleted waters to a certain extent. In addition, it is necessary to establish a marine biological reserve to conduct a comprehensive inspection of marine life, especially the scarce marine life, to increase the salt content of marine nutrients, improve water quality, and thus improve the level of the marine environment.

At the same time, increase investment in science and technology, combine big data with the marine environment, and conduct real-time monitoring and management of the marine environment through network systems and big data. This is mainly achieved by implementing the planning framework for marine ecological reserves. Government departments should pay more attention, increase financial support, and strengthen the staffing of reserves. For traditional marine protected areas, it is necessary to innovate and improve the management of protected areas from various aspects, and government departments must take the lead.

5 Conclusion and Outlook

5.1 Research conclusions

On the basis of collecting relevant data and materials, and synthesizing domestic and foreign research results, this paper combines the marine economy and environmental status of the coastal areas of Jiangsu Province . At the same time, based on relevant theoretical methods, a comprehensive evaluation index system for marine economy and marine environment is constructed. Finally, the entropy weight method is used to distribute the weights of each index, and the coupling model is used to analyze and evaluate the marine economy and marine environment in the coastal areas of Jiangsu Province from 2010 to 2020 . The conclusions reached are as follows :

(1) Judging from the evaluation results of the coastal economic system and the marine environment system, the economy of the coastal areas of Jiangsu Province has been greatly developed in the past 10 years, and the economic structure is more reasonable. The economic growth in the past has caused environmental damage to a certain extent. The level of marine environmental coupling fluctuates greatly, the order parameters of the marine environment lag behind the marine economic order parameters, and the overall pressure of the marine environment is relatively high.

(2) From the perspective of the coupling and coordination relationship, the coupling degree and coordination degree of the marine economy- marine environment system in the coastal areas of Jiangsu Province from 2010 to 2020 were both in the range of 0.3-0.8 , and showed a trend of up and down fluctuations . From 2010 to 2012, the coupling degree and coupling coordination degree of the marine environment in Jiangsu Province continued to decline, mainly because the economic structure has not been perfected, and the marine environment system is under great pressure ; With the improvement of the carrying capacity of the environmental system and the implementation of government policies, from 2013 to 2020, the coordinated development level of the marine economy and the marine environment in Jiangsu Province has been continuously optimized. Coupling between systems is improved. Looking at the type of development of coupling and coordination, the three coastal cities have all embarked on the type of coordinated development, and Nantong has achieved good coordination. In conclusion, within the research interval , the level of coupling and coordination of the system is generally developing in a positive and orderly direction.

(3) From the perspective of the coordinated development of the marine economy and the marine environment in the three coastal cities, the coupling degree and coupling coordination degree of the marine economy- marine environment system in the three coastal cities from 2010 to 2020 are increasing, and the coupling stage is also progressing . Among them , the coupling rate stability of Nantong's marine economy-marine environment system is better than that of Yancheng and Lianyungang.

(4) From the perspective of restrictive factors and solutions , the industrial structure of the three coastal cities in Jiangsu Province is not coordinated, and there is a lack of government and social support in the economy, resulting in a reduction in the carrying capacity of the marine environment . In response to the above situation ,

specific suggestions and solutions should be put forward from the three aspects of marine economy, marine environment and marine society : ① In marine economy, we should adjust the industrial structure, achieve common progress on land and sea , and speed up the transformation and upgrading of science and technology ; ② In the marine environment On the one hand, strengthen the governance of marine ecological civilization and improve the carrying capacity of the marine environment ; ③ On the marine society, it is necessary to improve the supervision system and call on everyone to protect the ocean .

5.2 There are deficiencies

Since the acquisition of data cannot be guaranteed to be completely accurate, there will be more or less errors, and the acquisition of information is not perfect, so this article has some flaws.

First, studying the degree of coupling between the marine economy and the marine environment system is subjective. Although the selection of indicators is based on existing research results, some statistical data are difficult to obtain , which will affect the accuracy of the results . , this paper uses the entropy weight method and the coupling model to focus on the coupling relationship between the marine economy and the marine environment carrying capacity in Jiangsu Province . These results are based on the index system and research method used in this paper , and thus lack comparison with other research methods .

Finally, the scope of this article is also flawed. On the one hand , although this paper evaluates the coupling degree of marine economy and marine environmental carrying capacity of the three coastal cities in Jiangsu Province , the spatial scope is still not detailed enough ; The coupling between the marine economy of the city and the carrying capacity of the marine environment is generally evaluated , but the future development trend is not predicted.

In response to the above problems, it is necessary to strengthen the understanding of the research content, improve the research depth, and strengthen the scientificity , accuracy and integrity of the research results , so as to better play its guiding significance in the future research work.

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