Journal of Coastal Research	SI	94	605–608	Coconut Creek, Florida	2019

Coupling and Coordinated Development of Marine High-end Human Resources and Marine Innovation Economic Development Capability

Ying Wei*

Nan yang Institute of Technology,
Henan 473004, China

www.cerf-jcr.org

www.JCRonline.org

ABSTRACT

Wei, Y., 2019. Coupling and coordinated development of marine high-end human resources and marine innovation economic development capability. *In*: Gong, D.; Zhu, H., and Liu, R. (eds.), *Selected Topics in Coastal Research: Engineering, Industry, Economy, and Sustainable Development*. *Journal of Coastal Research*, Special Issue No. 94, pp. 605–608. Coconut Creek (Florida), ISSN 0749-0208.

The coupling degree model and the coupling coordination degree model are used to measure the degree of coupling and coordination between the two, and the coefficient of variation method is used to analyze regional differences. Through the investigation, the author found that the coupling degree between Hebei Province and Liaoning Province is low, the fluctuation is large, and the regional difference is obvious. The coefficient of variation of the degree of coupling between regions is calculated, the coefficient of variation is gradually reduced, and the difference between regions is significantly reduced. The carrying capacity of marine resources and environment is positively correlated with the potential of marine economic development. The entropy method is used to measure the environmental carrying capacity of marine resources and the potential for economic development in the Bohai Sea. The results show that the coupling degree between marine economic development potential and marine resource environmental carrying capacity in the Bohai Rim region is generally higher than 0.8 and less than 0.8. This space shows the stable coupling and coordination of the coupling degree and coupling coordination degree between Tianjin and Shandong Province.

ADDITIONAL INDEX WORDS: *Resource and environment carrying capacity, economic development potential, entropy method, coupling degree, coefficient of variation.*

INTRODUCTION

At present, the main research on sustainable development is gradually exploring the general theoretical model and entering a new stage to solve the practical problems faced by mankind. The main task is to sustainable development of the region. The Sustainable Development Research Group of the Chinese Academy of Sciences believes that regional sustainable development capabilities are the sum of the capacity contributions of the "five major support systems" with strict logical relationships. Among them, the economic development system is the traction to achieve sustainable development, and the resource and environmental system is the limitation and constraint to achieve sustainable development. Regional development potential refers to the potential capacity of the regional composite system support system under the premise of sustainable development, and the resource environment carrying capacity is the support ability of the ecosystem to the development of human social system in terms of resources and environment (Di *et al*., 2018).

It can be seen that resource and environmental carrying capacity is not only an endogenous variable in regional economic development, but also an important factor affecting regional economic development (Gai *et al*., 2013). The sustainable development of the marine economy is the embodiment of the concept of sustainable development in the field of marine economy. The marine economy is based on the consumption of certain material resources and the emission of certain pollutants (Gao *et al*., 2015).

Gaime et al. used the variable fuzzy recognition model to measure the coordination degree of marine resources environment and economy in Liaoning Province, and obtained the trend of Liaoning Province from disharmony to initial coordinated development (Zhao.*et al*.,2018).The research on the relationship between marine economic development system and marine resource environmental carrying capacity system is still rare. Coupling is a common method to describe the synergy between two or more interactions. Many scholars use the coupling model to explore the coordinated development of ecological and economic systems, and have achieved satisfactory results. From the perspective of system coupling, the coupling degree model and the coupling coordination degree model are used to quantitatively measure the coupling relationship between marine resource environmental carrying capacity and marine economic development potential, and provide reference for the sustainable development of marine economy in the Bohai Rim region.

THEORETICAL BACKGROUND

Overview of the Study Area

The Bohai Rim region mainly refers to the Bohai Economic Belt with China's Liaodong Peninsula, Shandong Peninsula, and Beijing-Tianjin-Hebei region. It includes four provinces (municipalities) including Shandong, Hebei, Tianjin, and Liaoning, including 17 prefecture-level administrative regions.

DOI: 10.2112/SI94-121.1 received 2 February 2019; accepted in revision 5 April 2019.
*Corresponding author: 3367526796@qq.com
©Coastal Education and Research Foundation, Inc. 2019

www.manaraa.com

The coastline has a length of 6 924.2km, accounting for 38.47% of the length of the national ocean coastline. The Bohai Sea region is vast, with a sea area of 112,600 hm2, accounting for 60.55% of the country's confirmed sea area. It is rich in marine living resources, marine mineral resources, marine tourism resources and renewable marine energy, and the ocean. In 2012, the total marine production in the Bohai Rim region was 179.507 billion yuan, an increase of 9.7% over 2011, accounting for 35.8% of the national total marine production, accounting for 15.7 of the Bohai Rim. %, the contribution of the marine economy is obvious. However, it should also be noted that with the continuous development of the marine economy, many marine resources and environmental problems have been brought about, such as serious pollution of the seawater environment, certain damage to marine biological resources, and unstable coastal systems.

The indicators are quantified, and the proportion of the i-th area under the j-th index is calculated:

$$P_{ij} = \frac{X_{ij}}{\sum_i^n X_{ij}}(1) \quad (1)$$

Calculate the entropy of the jth indicator:

$$e_j = -k \bullet \sum_i^n p_{ij} \bullet \ln(p_{ij}) \quad (2)$$

Where k=1/(In(k)), where n is the actual number of years of statistics. The coefficient of variation is a variable used to describe the degree of dispersion of two sets of variables. In order to indicate the difference between the marine resource environmental carrying capacity (and the potential of marine economic development) among the provinces and cities in the Bohai Rim region, the variation coefficient method can be used for quantitative analysis. The formula is as follows:

$$\mathrm{M}L_t^{t+1} = \left[\frac{1 + D_0^t(x^t, y^t, b^t, g^t)}{1 + D_0^t(x^{t+1}, y^{t+1}, b^{t+1}, g^{t+1})}\right]^{1/2}(3) \quad (3)$$

where, xi represents the coupling value of marine resource environmental carrying capacity and marine economic development potential in area i; x represents the average coupling degree of marine resource environmental carrying capacity and marine economic development potential; n represents the number of units in the study area, this study n=4.

Coupling is a common method of describing the synergy between two or more systems that interact with each other. The article draws on the method of Huang Ruifen's scholars and introduces the coefficient of variation method to measure the coupling relationship between the marine resource environment and the potential of marine economic development.

In this study, according to the research needs, the evaluation index system of marine resources and environmental carrying capacity and the evaluation index system of marine economic development potential in the Bohai Rim region are constructed, each containing 15 and 13 indicators. The index values are directly through the 2007-2013 China Ocean Statistical Yearbook. Obtained or obtained through calculation.

METHODS

In this study, the entropy method is used to measure the environmental carrying capacity of marine resources and the potential of marine economic development in the Bohai Rim region. The coupling degree model and the coupling coordination degree model are used to measure the degree of coupling and coordination between the two and the variation coefficient method is used to analyze the interval difference and its evolution law. The entropy method is derived from physics and is widely used in sustainable development evaluation and social economy. At present, many scholars in China apply the entropy method to environmental management, energy utilization, and economic system quality growth. The basic steps are as follows.

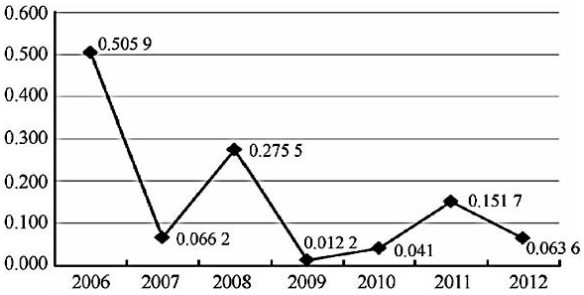

Figure 1. Development of high-end marine human resources and innovative economy.

Evaluation and Analysis of Marine Resources

From the perspective of resources and environment, the capacity of marine resources and environment to measure the ability of the ocean to support human economic activities in terms of ocean resource supply function and marine environment containment function is a specialized form of sea area carrying capacity.

The connotation of the carrying capacity of marine resources can be understood from two aspects: on the one hand, the resource supply capacity of the ocean, that is, the ocean to human activities. According to the connotation of bearing capacity and the practicability, comprehensiveness and availability principle of the index, the article constructs an index system consisting of marine resources and environmental carrying capacity as the target layer, marine resources and marine environment as the criterion layer and 15 indicators. The environmental carrying capacity of marine resources in various areas of the Bohai Sea is shown in Figure 1.

It can be seen from Figure 1 that the comprehensive bearing capacity of the Bohai Sea region (Tianjin, Hebei, Liaoning, Shandong) in 2006-2012 shows an upward trend, but the fluctuations in each region are different. The value of the coefficient of variation fluctuates between 0.1 and 0.5, and the maximum value of 0.463 2 is still lower than 0.5. The overall value is very small, indicating that the difference in marine environmental carrying capacity between the regions around the Bohai Sea is not big.

There are factors of production (including over-utilization and under-utilization), as well as the ability to generate sustainable economic development in the region that can be generated by the introduction of scarce production factors within the region. According to the connotation of the potential

www.manaraa.com

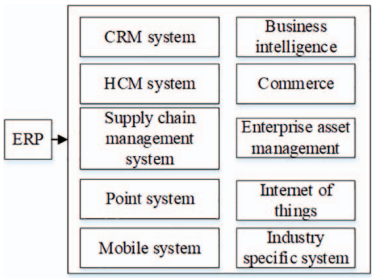

Figure 2. Evaluation Index System for Marine Economic Development Potential.

of marine economic development and the objectivity, availability, comprehensiveness and relevance of indicators, as shown in Figure 2 below:

As shown in Figure 2 above: the quality of marine scientific and technical personnel is the proportion of masters and doctors in marine science and technology activities. The output capacity of marine science and technology is that the number of invention patents owned by marine scientific research institutions in coastal areas accounts for the national total. The density of marine scientific research institutions is the coastal area. The number of scientific research institutions accounts for the total proportion of the country.

The results show that the marine economic development potential of the provinces in the Bohai Rim region between 2006 and 2012 is between 0 and 0.3, and the four provinces and cities are staggered, and the gap between the regions is not large. Through the calculation of the growth rate within the years, the faster growth was in Hebei and Liaoning, reaching 475% and 823% respectively, while the growth rates in Shandong and Tianjin were 151% and 118% respectively. The marine economy of Shandong and Tianjin started earlier and developed more maturely.

RESULTS AND DISCUSSION

Coupling mechanism of marine economic development and marine resources and environmental systems "Coupling" is derived from physics. Coupling analysis methods are often used to describe and explain the synergistic relationship between two or more systems or interactions between motion forms. The economic development system restricts the development of marine resources and environmental systems through waste discharge, and at the same time promotes the improvement of marine resources and environmental systems through scientific and technological progress, as shown in Figure 3 below. Shown as follows:

As shown in Figure 3 above, the coupling degree of the four provinces and cities in the Bohai Rim region shows an increasing trend. Shandong showed a high coupling state. The coupling value increased from 0.827 to 0.981 in 2006-2012. The value is high, the fluctuation range is small, and the coupling state is higher in Shandong Province. Combined with the coupling coordination degree, Shandong Province has a high degree of coupling degree and coupling coordination degree, and the marine resource environment carrying

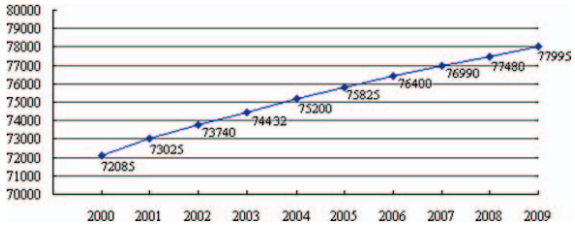

Figure 3. Coupling degree of 4 provinces and cities in the Bohai Rim region.

capacity and marine economic development potential develop synergistically. The growth of Tianjin's coupling degree is divided into two stages. The growth period of 2006-2009 is the decline stage from 2009 to the present. In 2012, the coupling degree value was 0.885 8, which was 2.9% higher than that in 2006. The increase was not large, but the annual coupling degree values were all greater than 0.8, and the Tianjin area was also in a high coupling state. Combined with the degree of coupling coordination, it has been above 0.35 since 2007. In recent years, Tianjin's marine resources and environmental carrying capacity and marine economic development potential are both on the rise, showing that the coupling coordination state is better, as shown in Figure 4.

In Figure 4, Hebei Province is in a state of rising volatility. In 2012, the coupling value was 0.973, an increase of 29.76% compared with 2006, and the increase was large. With the approach of the age, the fluctuation of the coupling degree became smaller and smaller, and the coupling coordination degree between 2006 and 2012. By 2007, the gap has been greatly reduced. In recent years, the coupling degree has remained basically at 0. Above 8.8, the coupling coordination degree also shows an upward trend, and the coupling state is basically improved.

As shown in Figure 5 above, the highest coupling area in 2006 was Tianjin, followed by Shandong, Hebei and Liaoning. In 2009, the highest coupling area was still in Tianjin, Hebei ranked second, and Shandong was the lowest. Shandong ranked first in 2012, followed by Hebei. Combined with the degree of coupling degree, the difference between Shandong and Tianjin is small, and the development is relatively stable. Hebei Province and Liaoning Province have large fluctuations

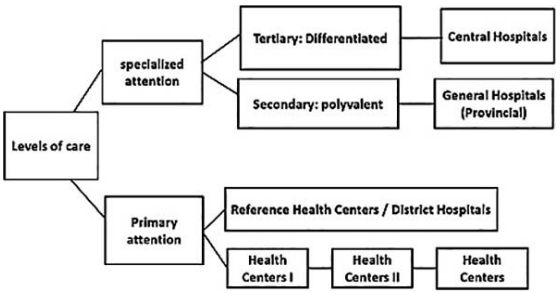

Figure 4. Marine high-end human resources and marine innovation economic development.

www.manaraa.com

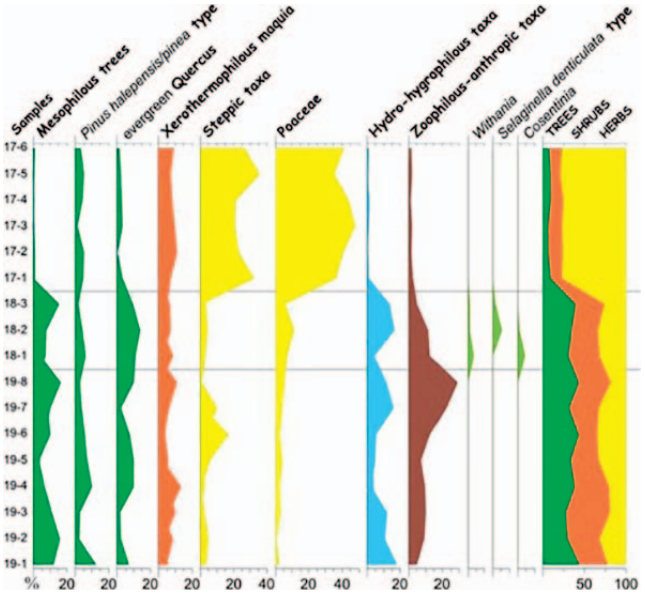

Figure 5. Innovative application statistics for high-end marine human resources.

and are in a low coupling state. The coupling degree of the development potential of the marine economy fluctuates greatly, and the overall tends to decline, and the fluctuation is gradually reduced with time. It can be seen that the coupling and coordination degree between the marine economic development potential and the marine resources and environmental carrying capacity is generally improved in the Bohai Rim region, and the degree of coordination between the regions is gradually decreasing, that is, it shows an increasingly coordinated state (Qianbin *et al*., 2008).

CONCLUSIONS

Through the MapInfo result graph, it is obvious that the coupling degree of the circle around the Bohai Sea is obviously different, but the coefficient of variation of the coupling degree can be calculated to show that the difference in the degree of coupling between regions has a significant downward trend. It is predicted that the future development of marine economy in the Bohai Rim region will have a more stable coupling and coordinated development model with the marine resources and environment. Coupling degree and coupling coordination degree are more mature methods to evaluate the coordination relationship between systems. This method is introduced into the relationship between the development potential of marine economy and the carrying capacity of marine resources, objectively reflecting the coupling between the development of marine economy and the carrying of resources and environment. The article focuses on the analysis of the coupling and coordination relationship between the marine economic system and the resource environment system in different regions. In the future, we should do research on the sustainable development of marine economy, and explore the coupling and coordination of marine economic development and resources and environment from the quantitative perspective.

LITERATURE CITED

Di, Q.B.; Yu, Z., and Wang, M., 2018. Coupling and coordination of marine high-end human resources and marine innovation economic developing capability. *Ocean Development and Management*, 12, 249-232.

Gai, M.; Wang, Y.F.; Ma, G.D., and Hao, H.J., 2013. Evaluation of the coupling coordination development between water use efficiency and economy in LiaoNing coastal economic belt. *Journal of Natural Resources*, 12, 25-32.

Gao, Y.; Han, Z.L.; Yang, J., and Guan, C., 2015. Spatial agglomeration of marine industries and region coordinated development in China. *Scientia GeographicaSinica*, 35(8), 946-951.

Zhao, C.; Ren, J.; Chen, Y., and Liu K. 2018.Coupling coordination and spatio-temporal differentiation of scientific and technological innovation and sustainable development in China. *Scientia GeographicaSinica*, 2, 214-222.

www.manaraa.com

Reproduced with permission of copyright owner. Further reproduction prohibited without permission.

www.manaraa.com