Circular Economy Development Mode of Coastal and Marine Areas in China and its Evaluation Index Research – The Example of Qingdao

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Abstract: Marine circular economy development and marine ecological security construction is the solution of seeking sustainable development when human beings are faced with marine ecological crisis in future period. Marine circular economy and ecological security is the subsystem of ecological, social and economic compound system. These two are mutually conditional and have been in collaborative development. Marine circular economy development is the premise and approach of securely constructing marine ecology. Constructing marine ecological security and building harmonious marine ecological environment is an important goal of developing circular economy. Circular economy is one of the important economic models for managing public resources under the principle of sustainable development, which is the guiding direction of future economic development in China. As important strategic resources, ocean is a crucial component of realizing economic sustainable development, which also needs to take the circular economy concept and basic principles as a guide for development.

Keywords: Marine circular economy, Layout, Development model.

Introduction

The development of 21st century would enjoy the great advantage of ocean [3]. The great undertaking of developing marine and protecting the ocean has attached wide attention and great importance to the countries around the world, especially the coastal countries, as the basic component of global life support system and the valuable wealth of human sustainable development, it has very important strategic value, which has got common recognition in the world. The development and utilization of ocean has become the strategic direction of easing current and future tense land resources conflicts. Marine economy is gaining increasingly important status in whole world [6]. However, traditional and extensive mode of economic development has caused problems of intense consumption of marine resource, too much waste emissions and overweight of ecological environment overload has become more and more outstanding. Therefore, we must merge the concept of marine circular economy with the economic development at the same time.

Marine circular economy and its complexity analysis
Marine circular economy
Congchun Xu [10] etc. points out that in the context of "*a brief analysis of developing circular economy*", this article indicates: marine circular economy is a kind of circular economy combining marine features and development, which is the organic component of circular economy and new development mode of marine economy. It refers to that through relying on the oceanside location advantage, taking high efficiency and recycling utilization

of marine resources as the core [7], depending on circular economy technology, integrating regional economy, society, environmental and technical resources, to realize the economy development mode of sea and land circulation, which is the integration strategy of giving consideration to the development of marine economy, saving marine resources and protecting marine environment [4].

Marine economy is the economic form which is constructed on the basis of natural ecological system of land and sea, its rapid growth should be established on the basis of sustainable use of resources and environment in the sea and marine sustainable development, which is taken as a resource saving and environmentally friendly development model. Circular economy precisely corresponds to the requirements of marine economy sustainable development, which is an effective way to realize the sustainable development of marine economy, under the guidance of overall strategy on land or sea, guide the development of marine economy with the concept of circular economy and build up the minor cycle of marine enterprise level. Middle circulation of marine industry level and the massive circulation of ocean and society as a whole forms the marine circular economy system. Thus it is advantageous to realize the organic coordination and unity of marine economy development, marine resources conservation and marine environmental protection [11]. Marine circular economy and the relationship between marine economy and circular economy are shown in Fig. 1.
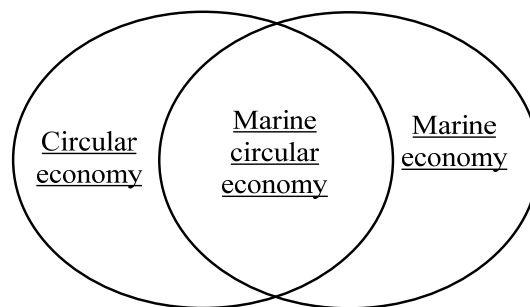

Fig. 1 Schematic diagram of marine circular economy and the relationship
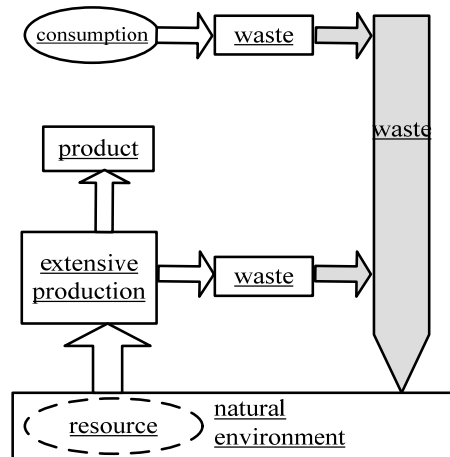between marine economy and circular economy

The comparison analysis for the process in traditional economy
and circular economy
Through observing the path of material flow, we could see that traditional economy is a kind of linear technology economy model, which operates as it is shown in Fig. 2a, "waste" is discharged into the environment directly or after terminal processing without recycling; while circular economy is a technically economic model as showed in Fig. 2b, and the "waste" is transformed into available resources in economic system.

Analysis for the present situation of marine economy development
in Shandong Qingdao
Qingdao is located in the south of Shandong Peninsula, facing the waters of the South China Sea and the Yellow Sea, 36° line of north latitude crosses the bay in the front of Huangdao and northern Xue Gudao, whose climate type belongs to warm temperate maritime monsoon climate. Land is hilly, shoreline twists and turns, cape bay alternate with each other, forming many natural harbor sites [9]. The sea area of Qingdao is on the verge of secondary water mass on the east, its central section follows Jiaozhou bay stretching into urban areas, its west is controlled by coast flow. Qingdao offshore become an important part of the famous

Lian-Qing-Shi Fisheries (Lianyungang, Qingdao, Shidao) because of its superior natural and geographical advantages, contributing to the inherent marine function of Qingdao, since ancient times it is flourishing and benefiting from fish and salt, crossing conveniently with ships, its main function is fisheries and salt industry, its secondary function is port and shipping [5].

(a) traditional economy
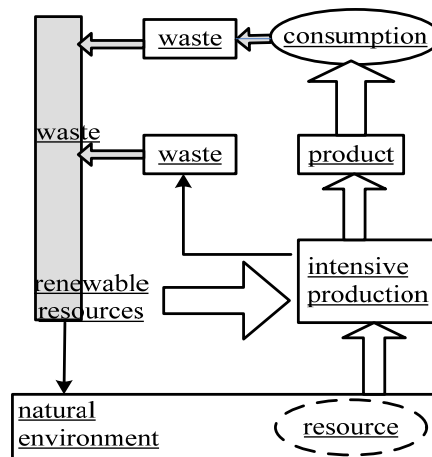
(b) circular economy

Fig. 2 Linear technology economy model

Present situation of marine fisheries development in Qingdao

Qingdao coastline is long and circuitous, coastline along the coast is 710.9 km long. The sea area within the baseline of territorial waters in jurisdiction is 8405.0 km^2, mud flat resources are rich, coastal intertidal zone covers an area of 278.9 km^2. There is vast mud flat and waters which is available for cultivation. The natural environment condition has provided a good foundation and development space for the development of Qingdao marine fisheries. Marine fishery occupies an important position in Qingdao marine economy. In 2003, while decreasing inshore fishing, aquaculture production increased, the offshore fishery resources could get protection, the total output of aquatic products was 1.3208 million tons, increasing by 1.16% compared with 2002, contributing to the total output value of fishery reaching 14.18 billion yuan, increasing by 15.86% since in 2002. In 2003, the fishing output was

443200 tons, 0.87% lower than in 2002, output value of ocean fishing was 3.27 billion yuan; aquaculture production was 877700 tons, increasing by 2.24% on year-on-year basis, the output value was 4.88 billion yuan, the ratio of raising in yield was close to 2:1 [1]. In 2004, the total output of aquatic products amounted to 1.3245 million tons, fishery output value reached 18.484 billion yuan, ranking the second in each marine industry. Compared with 2003, the total value of fishery output increased by 30.35% in 2004 under the premise that the total production was holding at the line, fishery economy structure was further optimized. Traditional fisheries speed up its pace of transforming into modern fishery, technology level of fishery, export for earning foreign exchange, utilization of foreign capital and fishery facility keep ahead in domestic cities. Marine GDP and the proportion in gross domestic product are shown in Fig. 3.
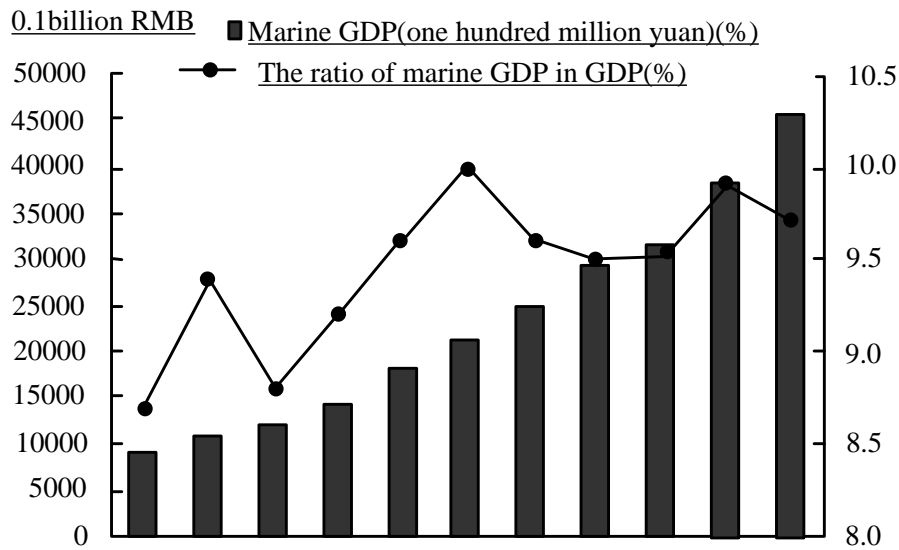

Fig. 3 GDP of marine proportion and its gross domestic product in 2003-2013

The main problems existing in Qingdao marine fisheries
With the implementation of the functional zoning for Qingdao marine, the pressure of industrial structure adjustment and development of space transferring that marine fishery faces is growing increasingly. At present, Qingdao marine fishery mainly has the following problems:

First, fishery resource decline seriously, fishery waters' space is narrowing, the amount of fishing effort is redundant, a lot of fishermen are facing transferring and changing civilian work; fishing equipment is poor, the development of pelagic fishery is restricted by capital and fishing equipment [8].

Second, the discharge of industrial wastewater and domestic sewage from coastal city and pollution from breeding has resulted into the eutrophication of offshore water, deterioration of ocean ecological environment and desertification of seabed vegetation, seriously affect the regeneration ability of the fishery resources and the development of seawater breed aquatics.

Third, the existing nursery farms mostly have backward facility and their size is smaller, the seedling ability cannot satisfy the needs of the development of production far from enough, the cost of going out to buy seedling is huge. In addition, the hybrid varieties, germplasm

degradation phenomenon is relatively serious, aquaculture lacks improved variety; fish' feed production lags behind the development of production, utilization rate of raw feed is low, which not only wastes resources, but also pollutes the environment.

Fourth, port shipping, coastal industry and marine tourism have become the leading industry of Qingdao marine economy development, the development space of inshore fisheries is narrowing gradually and facing transferring.

Development mode of Qingdao marine circulation economy and building evaluation system

Circulation economy and marine economic development
The complicated natural and economic ties between the land and sea indicate that there is close and endless correlation of matter and energy between ocean and land [2]. Science takes advantage of this correlation relationship, to establish a kind of economic development mode which is conducive to promote the economic integration development of land and sea, as well as keep the balance and coordination of ecological system on sea and land which correlate with the sustainable development of ocean and the long-term interests of human beings.

According to the differences between category of industrial carrier which supports circular economy, marine circular economy is divided into three categories, including land circulation economy (only containing land industry) and marine circular economy (containing both marine industry and terrestrial industry), and it believes that the circulation economy system of sea and land which is made up of these three kinds of circular economy (see Fig. 4) is the important guarantee of sustainable development of ocean.
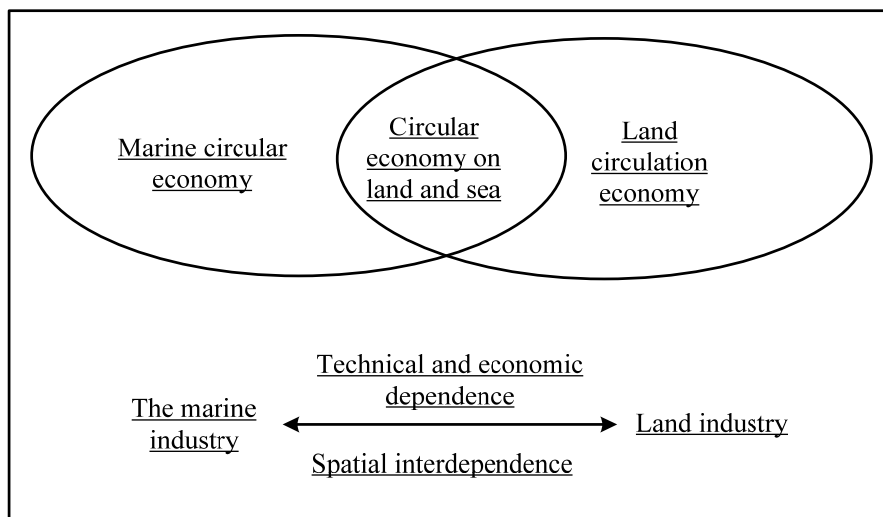
Fig. 4 Economy system diagram of sea-land circulation

The index set of economic evaluation index system in marine circulation economy
Economic aspects: the added value of marine oil-gas industry (X_1, one hundred million yuan), the added value of marine transportation (X_2, one hundred million yuan), the added value of marine fisheries (X_3, one hundred million yuan), the added value of ocean shipping industry (X_4, one hundred million yuan), the added value of coastal tourism (X_5, one hundred million

yuan). Through considering that the output value of related industries in marine economy has repeatedly calculated the transfer value in economic indicator many times, thus it can not exactly reflect the real situation of economic development, so this paper chooses the added value of related industries in marine economy as the evaluation indicator. Added value is the increased value from production activity, although it is smaller than output value, but it can reflect the size and speed of related industries in marine economy more accurately.

Marine science and technology development: the number of marine scientific research institutions (X_6, person), the number of employees in marine scientific research institution (X_7, person) the number of subjects in marine scientific research institution (X_8, person).

Sea environment protection: qualified rate of industrial wastewater discharge (X_9, ten thousand tons), disposal amount of industrial waste (X_{10}, ten thousand tons), the completion amount of wastewater treatment project in those years (X_{11}, ten thousand tons), the completion amount of waste treatment project in those years (X_{12}, ten thousand tons).

The analysis for evaluation index system of marine circular economy
We have performed standardized processing for obtained raw data, the results are shown as Table 1.

Table 1. Standardized data of evaluation index

Indicator	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
X_1	-1.14	-0.22	-1.05	-0.81	-0.72	-0.45	0.00	0.38	0.76	1.43	1.82
X_2	-1.07	-0.77	-0.93	-0.92	-0.63	-0.32	0.32	0.81	0.89	2.03	0.52
X_3	-0.91	-0.88	-0.73	-0.68	-0.59	-0.42	-0.17	0.17	0.72	1.35	2.14
X_4	-1.56	-1.52	-0.64	-0.46	-0.24	0.00	0.31	0.31	1.17	1.30	0.99
X_5	-1.63	-1.42	-0.83	-0.47	-0.81	-0.47	-0.10	-0.11	0.83	1.25	1.69
X_6	-0.56	-0.64	-0.70	-0.48	-0.50	-0.64	-0.70	-0.70	0.58	0.54	2.55
X_7	-0.88	-0.33	-0.41	-0.45	-0.47	-0.52	-0.62	0.25	0.31	0.39	2.77
X_8	-0.78	-0.69	-0.76	-0.71	-0.59	-0.52	-0.43	0.40	0.72	0.00	2.36
X_9	-2.57	-0.11	-0.73	-0.60	-0.02	0.58	0.99	0.00	0.00	0.86	1.03
X_{10}	-0.47	-0.63	-0.96	-0.96	0.09	-0.92	-0.92	0.86	1.16	1.30	1.47
X_{11}	1.15	2.04	-0.17	-0.79	-0.06	-1.01	-0.99	0.25	0,53	0.27	-0.23
X_{12}	-0.01	0.81	-1.41	-0.82	0.18	-0.92	-0.98	1.45	1.14	1.14	-0.55

Through using standardized data to perform factor analysis, thus we obtain the particular value, the variance contribution rate and cumulative variance contribution rate of correlation coefficient matrix, such as Table 2. We can see from Table 2, the eigenvalues of the first two factors were greater than 1, and the cumulative contribution rate has reached 85.803% of the total variance, which shows that the information contained by the two factors accounts for 85.803% of total information contained by original variable, it could be used to represent total information of 12 indicators in index system, therefore, choose the first two indicators as principal component of analysis, and get the load of original index in the main component, such as Table 3.

Table 2. Characteristic value of covariance matrix, contribution rate
of characteristic value and the cumulative contribution rate

Factor	Characteristic value	Variance contribution value	Cumulative contribution rate
1	8.014	67.918	67.918
2	2.145	17.886	85.803
3	0.977	8.146	93.951
4	0.495	4.135	98.065
5	0.171	1.436	99.522
6	0.026	0.222	99.746
7	0.018	0.142	99.888
8	0.007	0.065	99.952
9	0.006	0.042	99.993
10	0.002	0.007	100.100
11	1.471E-16	1.226E-15	100.100
12	-2.002E-16	-1.666E-15	100.100

Table 3. The load of indicators factor in the main components

Project	Index	Principal component 1	Principal component 2
X_1	The added value of marine fisheries	0.973	0.067
X_2	The added value of marine oil-gas industry	0.862	0.093
X_3	The added value of ocean shipping industry	0.981	-0.058
X_4	The added value of maritime transportation	0.881	-0.229
X_5	The added value of marine tourism	0.968	-0.194
X_6	The number of marine scientific research institution	0.916	0.037
X_7	The number of employees in marine scientific research institutions	0.868	-.0082
X_8	The number of subjects in marine scientific research institution	0.971	0.013
X_9	The completion amount of wastewater treatment engineering in those years	-0.009	0.941
X_{10}	The completion amount of waste treatment engineering in those years	0.401	0.812
X_{11}	Target rate of wastewater	0.508	-0.605
X_{12}	The disposal amount of waste	0.905	0.352

Countermeasures and suggestions of speeding up the marine economic development of Qingdao

Sparing no efforts to manage marine science and technology resources, marine science and technology is the most important resources of Qingdao, trying our best manage this strategic resource is the need to increase the competitiveness of the city; build policy environment which is conducive to the development of marine science and technology. Give play to the role of the government's macroeconomic regulation and control, in order to strengthen the system innovation and management mechanism innovation, effectively take advantage of the central and local financial resources, try every efforts to shape a policy environment which is conducive to marine science and technology innovation, as well as industrialization of high and new technology. It helps to establish and improve the marine science and technology service system. Marine economic development needs to go beyond the general supporting condition with the specific content of technology, namely the social service system or support structure; finance ocean development funds with multi-channels.

Conclusion

Throughout the historical process of circular economy development in China, generally speaking, time is short. China has not formed a system of typical model and thorough legal system. But there has been practice at different level, through the typical pilot work. It has gained some successful experience. It also has some breakthrough in the management and introducing the law system about circulation economic development. This is advantageous to build circular economy of typical models with Chinese characteristics, explore new ideas and new situation of economic development. The destruction of the marine ecological environment inevitably affects the development quality of marine economy. Therefore, in the process of developing marine economy, how to deal with the relationship between marine ecological environment and economic development is particularly prominent. So we should develop a more detailed and scientific marine ecological protection regulations and strictly enforce them. Strictly control land-source pollutant emissions and change industry development thought. The land economy promotes to develop high-tech industry with low land resources consumption and products with high added value. The related industry of serious pollution shall gradually be restricted and prohibited. It will strengthen urban districts planning and effectively deal with urban waste, try to avoid or diminish polluting the environment, and actively promote clean energy and treat both symptoms and root causes. The aim is to construct functional zoning system for marine resources, make the ocean transportation, fisheries, mining be in reasonable layout and realize the sustainable development of tourism, etc.

Now Qingdao has the advantages of marine science and technological power, which has provided strong technical force support for the development of Qingdao marine economy. But we should not blindly favor one side, for fundamental and applied science. We should go hand in hand and develop the practice theory in application, which in turn promote the development and innovation of theory and form a benign interaction of marine science and technology.

Qingdao, as an important economic trade port city along the east coasts of ocean. It could develop marine economy completely and conditionally through relying on its rich marine resources and the abundant technological strength, depending on the timely transformation of the urban development concept. It is certain that in the near future Qingdao could shift to be an international ocean city with marine economy as the leading industry.

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