Evaluation and Analysis on Carrying Capacity of Comprehensive Ecology in Cost Zone

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Abstract. this paper makes discussion on evaluation index system of constructing comprehensive carrying capacity of ecological environment in cost zone area; it also uses data such as economy, society, ecology, environment and culture of Tianjin Binhai from 2011 to 2014 to make evaluation on comprehensive carrying capacity of cost zone. The calculation result indicates that carrying index in cost zone presents decrease trend with development in new district of Binhai, the comprehensive carrying pressure in cost zone is becoming increasingly larger, while carrying capacity becomes worse. It proposes idea of sustainable development to optimize industrial structure and persists in coordination in land and ocean, optimize layout in cost zone, parallel measures of emphasizing economic development and improving ecological environment of ocean to improve ecological carrying capacity of this cost.

Introduction

Abundant resources in cost zone provides stronger material base for the sustainable development of costal area, while excessive exploration on natural resources has caused serious threat to ecological system in cost zone. Plenty of investigations and researches indicate that out-of-balance in ecological system, exaggeration in environment pollution, degeneration in ecological environment and frequent occurrence in natural disaster and damage in housing environment etc are all caused[1] by excessive expropriation and application on natural resources by human. For this, it has important meanings to effectively plan and manage development and application on resources in coast zone, control discharge of pollution, control economic activity within ecological carrying capacity of cost zone for sustainable development of costal areas. This paper constructs evaluation index system on comprehensive capacity of ecological environment in coast area; it also uses data such as economy, society, ecology, environment and culture of Tianjin Binhai from 2011 to 2014 to make evaluation on comprehensive carrying capacity of cost zone. This paper uses P-S-R concept model and combines with every method on evaluation on comprehnsive carrying capacity of coast area both in China and abroad to construct evaluation index system on comprehensive carrying capacity of ecological envionrment in coast area. This index system is compsoed of tarhet level, project level, factor level and index level, there are totally 14 indexes are used to evaluate pressure and carrying condition of carrying capacity.

Research area and index evaluation system of comprehensive carrying capacity

Data source

The social and economic data used in evaluation is from statistical yearbook of Chinese Ocean(2010-2014) and statistical yearbook of Binhai District in Tianjin(2010-2014), ecological

index and data source of ocean are from external investigation and other literatures of this research in 2014.(table 1)

Table 1 Nature and data on carrying capacity evaluation index of Binhai new district in Tianjin

Index	Index nature	Unit	2010	2011	2012	2013	2014
discharge of industrial wastewater	Pressure index	10000 tons	16027.10	11493.82	10726.80	9992.26	9728.99
discharge of solid waste	Pressure index	10000 tons	447.41	516.5592	524.1372	514.09	558.89
10000 Yuan GDP energy consumption	Pressure index	Ton standard coal	1.05	1	0.96	0.89	0.84
availability of coastline	Pressure index	%	66	100	100	100	100
Ocean square develped by per	carrying and perssure index	km2/one million people	2.58	2.21	1.94	1.66	1.46
per coastline length	perssure-bearing index	km/one million people	1.182	1.011	0.889	0.757	0.667
primary productivity of ocean	perssure-bearing index	mg/m^3	11.87	8.58	11.47	9.6	6.5
proportion of ocean pollution square	perssure-bearing index	%	45.9	64.8	69.1	59.4	57.8
index of biodiversity	perssure-bearing index	-	2.176	1.892	1.511	1.97	2.31
density of population	perssure-bearing index	per/ km2	483	496	504	512	522
per ocean economic output value	perssure-bearing index	10 millions/one million people	11.26	9.63	9.26	9.31	8.21
Annual average growth of GDP	perssure-bearing index	%	19.83	20.2	20.5	23.1	23.5
Input in science research and development	perssure-bearing index	10000 Yuan	63290	66708	98547	157590	188540
Expenditure in environmental protection	perssure-bearing index	10000 Yuan	449693	252687	421741	348253	368094

Evaluation index system

Evaluation on comprehensive carrying capacity in coast zone area is to make quantitative and qualitative analysis on costal population, economic scale supported by ecological environment in coast area and capacity of accepting pollution without exceeding flexible limitation conditions of ecological system in coast zone as well as confirm carrying level and carrying capacity of ecological environment in every coast zone area by system evaluation. This paper constructs evaluation index system on comprehensive carrying capacity in ecological environment in coast zone area of 4 levels by P-S-R model and combining with evaluation methods on comprehensive carrying capacity in coast zone area. (diagram 1)

Comprehensive carrying capacity in coast zone area mainly pays attention to ecological environment in designated coast zone area on supporting capacity of sea-related industry as well as carrying capacity of pollutant on ocean and land. In this research, evaluation system on

comprehensive carrying capacity established in this paper includes contents of 3 aspects: they are pressure indicator in coast zone area, state indicator and response indicator. The evaluation index system on comprehensive carrying capacity in coast zone are established in this paper is no exception. Therefore, we should choose proper index and establish corresponding evaluation index system according to analysis on influence factors on comprehensive carrying capacity in ecological environment in the designated coast zone area on making evaluation on carrying capacity of ecological environment in certain detailed coast zone area.
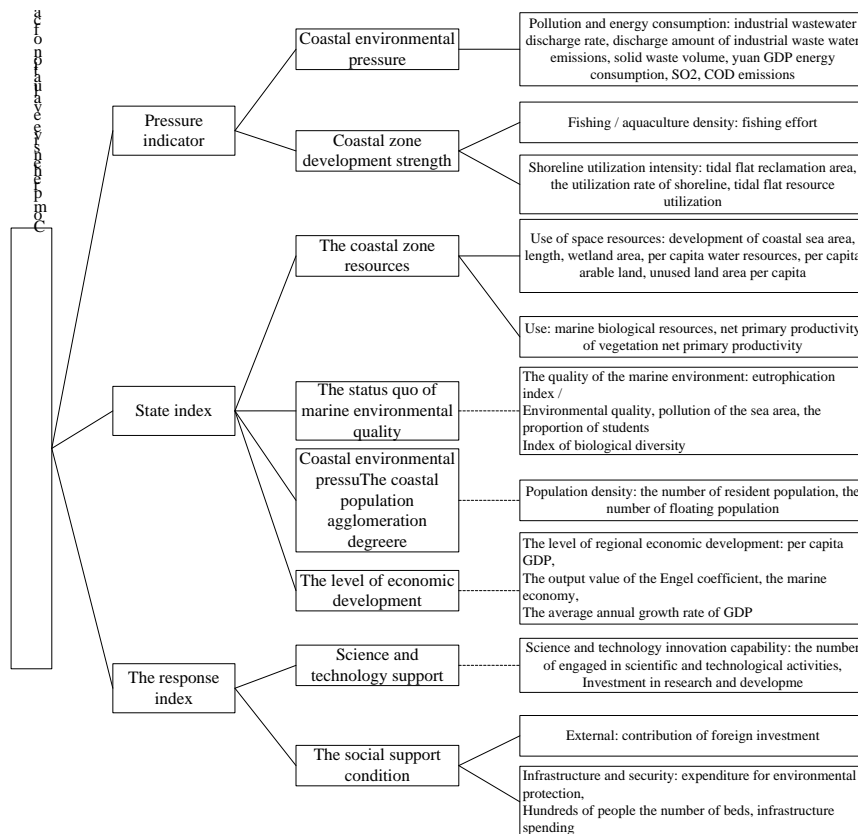

Diagram 1 Evaluation index system on comprehensive carrying capacity in coast zone area

Evaluation method on carrying capacity of comprehensive ecology in coast zone

Index procession

Every index in the index system generally has its own dimension and distribution range, the dimension of every index is different, so it can not directly make comparison and calculation. In order to eliminate difference influence of every index dimension and change range of uniform index, before using index system to make quantitative calculation, it should make procession and change without dimension for the original index in the system, the detailed calculation process is as follows:

Suppose there are n data sets $(X_{ij})_{n \times m}$ for m indexes, there is as follows:

$$Y_{ij} = \frac{X_{ij} - X_{j\min}}{X_{j\max} - X_{j\min}} \qquad (1)$$

As for cost index there is as follows:

$$Y_{ij} = \frac{X_{j\max} - X_j}{X_{j\max} - X_{j\min}} \qquad (2)$$

Of which, X_{jmax}, X_{jmin} respectively represents the maximum value and the minimum value for the j indexes, Y_{ij} is the value of index after regression, when $Y_{ij}=1$ when the project represented by index reaches optimal state, on the contrary, when $ijY_{ij}=0$, it reaches the optimal state.

Confirmation on weight of evaluation index

At the same time, by using application center to summarize information provided by multiple variant, the obtained main cause is influence ability, the reduction in several independent factors of reflected variable of changeable dimension needs to reach the target. It can pass space by rotation and flexibility, main factors analysis favorable for local expansion, which provides much more realistic and reasonable explanation for cause.

Its procedures are as follows:

（1） make normalization processing for matrix data

（2） solve the relevant coefficient matrix after normalization

（3） solve characteristic value of relevant matrix and then confirm the number of principal divisor

（4） solve feature vector of each feature and then confirm load matrix of each factor

（5） Solve score value of feature vector of principal factor. The detailed operation procedures can be analyzed in the SPSS software, choose the prior m principal factors can reflect most information (it usually larger than 85%).

This paper uses square of a_{ij} in factor load of factor (after rotation) as the contribution rate of each index to principal part.

（a） After square procession on factor load, it will not affect its meaning in the principal part. a_{ij} indicates relevant coefficient of the i index variable and the j variable of principal part, the bigger of absolute value($|a_{ij}|\leq1$)， which indicates the reliance degree of index variable on principal part is larger.

b） Because the commonness of variable is the square sum of the i element in factor load matrix A, it describes the contributions of all the principal part to index variable Xi, the closer to 1, it indicates that almost all the original information of this variable are described by the chosen principal part, if it is close to 0, which indicates the chosen principal part has little effect on index variable. Therefore, using the square of factor load in factor load matrix after rotation as contribution rate to principal part for each index only indicates the importance of index variable in the corresponding principal part, but also considers the ability of principal part to synthesize original index information to affect contribution rate.

In conclusion, it can get the confirmation method of index weight in this paper:

$$W_i = \sum_{j=1}^{m} \overline{W_j} C_{ij} = \sum_{j=1}^{m} \overline{W_j} a_{ij} \quad （3）$$

It makes further normalization for W I, it gets quantitative evaluation index weight of comprehensive carrying capacity in coast zone area of Binhai new district.

Evaluation result and analysis on comprehensive ecological carrying capacity in coast zone

Carrying capacity and pressure calculation

It uses the following formula to give index value of carrying index system and pressure index system.

$$F_K = \sum_{i=1}^{m} Z_i W_i \quad （4）$$

Of which, F_k is evaluation value, Z_i为is the index value after normalization, W_i is weight of each index.

Through calculation, it gets annual index standard value of pressure index and carrying index, it is indicated by diagram 2 and table 2.

Table 2 Evaluation result on carrying capacity from 2010 to 2014

Year	2010	2011	2012	2013	2014
carrying index	0.854168	0.5129943	0.4588841	0.3498719	0.2272198
Pressure indicator	0.487897	0.3095842	0.380096	0.4653713	0.5121032
Ratio of carrying and pressure	1.750714	1.657043	1.207285	0.751812	0.443699

In this result, the maximum value of carrying value and pressure value are 1, respectively represents 2 kinds of limit states, that is maximum carrying value and maximum pressure value, the minimum value is also 0, respectively represents 2 kinds of limit states, that is minimum carrying and minimum pressure.
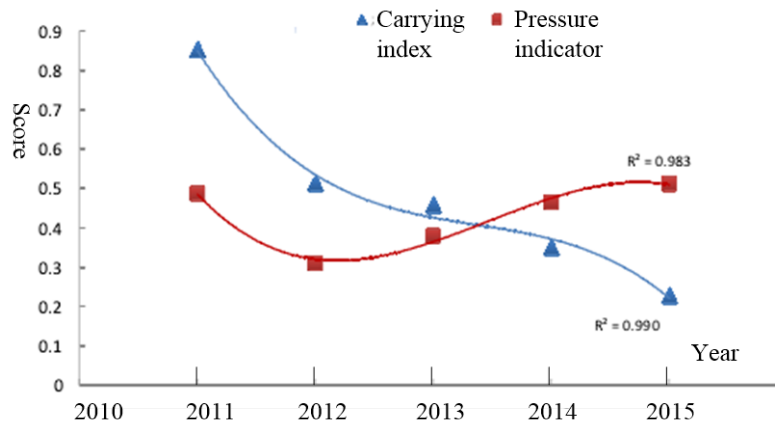

Diagram 2 Change trend of pressure index an d carrying index

Analysis and evaluation on carrying capacity

Overall change characteristics

From calculation result (table2 and diagram 2) we can see that with development in Binhai new district, the carrying index in coast zone presents obvious decrease trend while pressure index presents trend of slow increase. The carrying and pressure value reduces from 0.854 to 0.227 from 2010 to 2014, while pressure indicator increases from 0.488 to 0.512. Its change characteristic is as follows: the carrying and pressure index of comprehensive carrying capacity in coast zone of Binhai new district presents larger decrease from 2010 to 2011, and slow decrease from 2011 to 2013, while afterwards it presents obvious decrease from 2013 to 2014, while after decrease in pressure indicator in 2011 and 2012 starts from 2010, it reaches level of 2010 again and it continues to increase in 2014.

Grading evaluation

The carrying index of comprehensive carrying capacity is between 0 and 1, the higher value indicates stronger carrying capacity in coast zone area, while pressure index is also between 0 and 1, but higher value indicates larger pressure that coast zone area faces with.

By referring to relevant grading standard of carrying capacity, it uses 0.6 as standard value in this research to establish grading system (table 3) of grades on comprehensive carrying capacity in Binhai new district of Tianjin, the index above 0.6 indicates carrying capacity can meet requirement of economic and social development as well as sustainable development, the index below 0.6 indicates carrying capacity can not meet its demand. Likewise, it makes grade on pressure indicator, the index above 0.6 indicates coast zone faces with higher pressure, it is unfavorable for sustainable development in economy, society and ecology, while index below 0.6 indicates that pressure level is good. The detailed grading index range and meaning are indicated by table 3.

Table 3 Grade on carrying capacity evaluation

Grade	Index value	description of carrying index	description of presure index
I	Grade	<0.2	weak carrying level
II	Grade	0.2-0.4	low carrying level
III	Grade	0.4-0.6	carrying level of middle level
IV	Grade	0.6-0.8	higher carrying level
V	Grade	>0.8	highest carrying level

By using the above mentioned grade standard, the result after grading on carrying index and pressure index of Binhai new district of Tianjin is indicated by diagram 4, the result indicates intuition. We can obviously see carrying index reduces from the higher level in 2010 to the middle level in 2011 and 2012, and then to the lower level from 2013 to 2014, the quick decrease in comprehensive carrying capacity in Binhai new district should arouse high attention of management departments.

Table 4 Grading result on carrying capacity in Binhai new district of Tianjin from 2011 to 2014

Year	2010	2011	2012	2013	2014
Carrying index	Very high（V	grade）	medium（III	grade）	medium（III
Pressure index	medium（III	grade）	low（II	grade）	low（II
Year	2005	2006	2007	2008	2009

（3）Analysis on carrying capacity

Ratio application of carrying and pressure can reflect the serious situation confronted by comprehensive carrying capacity of coast zone in Binhai new district. Ratio of carrying and pressure is the ratio between carrying index and pressure index; it reflects response of ecological environment to economic activity to certain degree. From the calculation result on carrying and pressure in table 2, we can see that with development activity, economic activity and quick growth in population in Binhai new district, the ratio of carrying and pressure changes from 1.75 in 2010 to 1.20 in 2012, and then to 0.44 in 2014(diagram 4). This indicates that coastal pressure is becoming increasingly serious while carrying capacity is becoming worse, Binhai new district is faced with situation of much more population density, the per development ocean area and per coast zone length are becoming smaller, the ocean pollution square is gradually increase, index such as primary productivity of ocean is gradually decreasing.
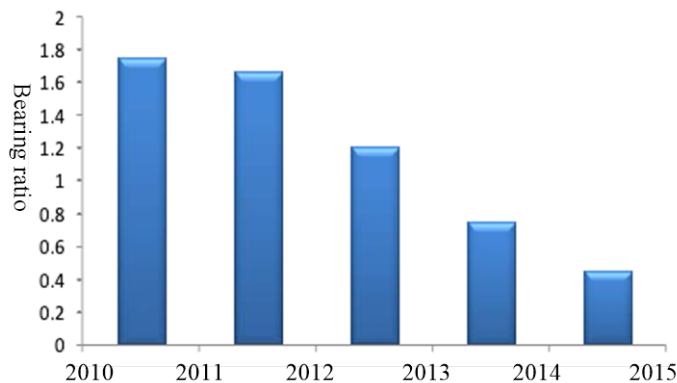

Diagram 3 Carrying pressure change from 2010 to 2014

Countermeasure and suggestion

Establish idea of sustainable development

Square increase in Binhai new district, population pressure, natural resources, excessive application, degeneration in ecological environment, so it must observe ecology rule and solve industrial structure and layout in city air, construction progress of city environment infrastructure,

improve comprehensive management of ecological environment in s coast area, introduce into sustainable development idea and development strategy, protect sustainable and equal development of social economy and ecological environment in Binhai new district from ability in implementation environment, determinative factor and city direction.

At present, the industry percentage in industrial structure of Binhai new districts is relatively larger (accounts for 72.4%), it is unfavorable for improvement on ecological environment in coast zone, nor favorable to relieve pressure faced by coast zone area. It should properly increase percentage of the third industry, coordinate relations between economic development and ecological environment improvement by optimizing industrial structure. It should greatly promote industrial transformation and reform.

Persist in coordination in land and ocean, optimize layout in coast zone

The water environment in coast zone area should make comprehensive consideration and complete arrangement, organically combine with sewage resources development, sewage treatment as well as ecological recovery and pollution management to maximally develop sewage treatment and increase procession efficiency, develop water quality improvement and management work. People should strictly control discharge total amount of pollution from the source, coordinating relation between land area and ocean area is the important factor for the whole ecological environment in Binhai new district. In addition, we should coordinate relations between protection and development in coastal beach resources, protect Binhai wet land with typical characteristics, recover halophytic vegetation in Binhai wet land by ecological engineering such as fresh water draw and storage as well as wet land recovery etc, and promote straight succession of halophytic vegetation. Reasonable arrange scale of sea reclamation, coordinate relation of protection and application in coast beach and offshore area.

Attention to simultaneous improvement in social development and ocean ecological environment

Strengthen protection awareness of ecological system in coast zone and establish a batch of ocean special protection area, promote estuary, wet land, spawing site, beach area with rich shellfish to get effective supervision and protection, ecological system with typical ocean get effective protection. Strengthening ecological environment management and restoration strength of coast zone, it makes comprehensive management and ecological restoration engineering for coast zone with serious damage, at the same time establishes a batch of ecological demonstration park with economic benefit, ecological benefit and social benefit. People should learn coordination to makes simultaneous plan. In the construction process of Binhai new district, we should strengthen exchange and communication between ocean department and other departments; achieve coordination design and simultaneous plan between land and ocean, which is the important method and measure for simultaneous improvement of ecological environment in coast zone in the process of guarantee economic construction and development.

Summary

This research makes comprehensive evaluation on ecological carrying capacity of Binhai new district by comparing with relations between yearly change rate of ecological carrying system and yearly change rate of ecological pressure system. The result indicates that ecological carrying system and pressure system in Binhai new district have already in the unbalanced state in recent years, with the gradual development in area and population increase as well as gradually increase of pressure in economic development and social living level enhancement, Binhai new district is faces with trend of degeneration in environment pollution and resources shortage day by day.

Under the background of pressure increase in population, excessive application of resources, gradually degeneration in ecological environment, drastic progress in industrialization and urbanization, Binhai new district should observe ecological rule and start from ecological carrying capacity, by increasing living quality of people as target , creating better housing environments as center, combining with development trend of urbanization, strengthening comprehensive management of regional ecological environment, effectively restraint degeneration trend in ecology,

making carrying capacity of coast zone have obvious improvement and realizing target of sustainable development.

Acknowledgement

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