# ASSESSMENT OF ENVIRONMENTAL CARRYING CAPACITY OF ECOTOURISM IN THE YELLOW RIVER ESTUARY

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## ABSTRACT

*Tourism environmental carrying capacity, a term born out of the booming development of the tourist industry and a basis for determining whether tourism activities negatively impact the environment, comes under the spotlight in the field of tourism research To preserve the exploitation of tourism resources in the Yellow River estuary, re-frame tourism structure and protect the environment, this paper dissected the current development and utilization of wetland tourism resources in the region and the corresponding resource advantages in virtue of SWOT and assessed the local ecotourism environmental carrying capacity by applying the evaluation model of ecotourism environmental carrying capacity. Years between 2017 and 2021 reported overweighted human social and economic activities in the Yellow River Estuary, proving the assessment outcomes. From 2017 to 2019, it dropped from 0.83 to 0.61, and then slowly and stabilized at this level. Fluctuations were found in the ecological and environmental assimilative capacity. The pollution-accepting capacity, between 2017 and 2018, increased from 1.3 to 1.8, dropped to some 0.61 from 2018 to 2019, and then rose to 1.35 by 2021. Judging from the economic growth in the area, these indicators were constantly rising. It follows that given ensuring ecological security, efforts should be doubled in studying the development of ecotourism in the Yellow River Estuary under the guidance of sustainable development theory, thereby carrying out tourism activities in phases and planned manner.*



## KEYWORDS

*Yellow River estuary; Wetland; Ecological environment; Ecotourism; Tourism environmental carrying capacity*




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# INDEX




https://doi.org/10.17993/3ctic.2023.122.342-358

# 1. INTRODUCTION

Wetlands, along with forests and oceans, are among the three major ecosystem types in the world and are unique and most productive ecosystems on the Earth's surface due to the interaction of land and water [1-2]. It is one of the most biodiverse ecosystems in nature and one of the most important environments for human survival [3-5]. It is known as the "cradle of life", "birthplace of civilization" and "gene pool of species" [6-10], with ecological and social service functions such as water conservation, climate regulation, environmental purification, provision of resources, and leisure and tourism sites.

With the northward shift of China's economic development center of gravity, the Bohai Rim region, with Binhai New Area and Caofeidian Industrial Zone as its core, has rapidly emerged as a new "growth pole" for China's economy [11-13]. This initiative has promoted the process of economic and tourism integration in the Bohai Rim region, which has brought the Yellow River Estuary closer to other cities and tourism areas in the Bohai Rim [14-15]. In the integrated development of tourism around the Bohai Sea, the Yellow River estuary and the Beijing-Tianjin region form a good complementary urban tourism, with good external conditions for rapid development and its foundation, which can be built into an important segment of tourism development in the Bohai Sea region [16-19].

In many places, tourism is no longer a "smoke-free industry". Destructive construction and tourism development activities destroy the landscape environment and biological habitats of tourism sites, making the conflict between humans and nature more intense, endangering the survival of biological species and even the safety of humans themselves [20-23]. In this situation, the protection of the natural ecological environment got more attention to realize the harmony between humans and nature, and ecotourism developed to protect the ecological environment is naturally favored by more and more travelers [24-25]. With the increasing awareness of environmental protection, wetland ecotourism has emerged as a "green tourism" that "returns to nature" [26].

Foreign experts have conducted systematic studies on wetland tourism resources, and experts focus on the development, utilization, and protection of wetland tourism resources. In the literature [27], the hyperspectral data of Zhuhai-1 was used as the research data. The wetland classification method for hyperspectral data was explored using these experiments. The literature [28] identified the spatial-geographic scope analyzed the cultural, sports, and tourism points of interest, and explored the spatial distribution characteristics and changing trends of mixed resources in the Yellow River Basin based on data analysis. This study also makes suggestions for the development of cultural, sports, and tourism resources in the basin from different perspectives based on the theoretical model of development, aiming to promote the high-quality development of the region. The literature [29] addresses the strong interest in these resources that have been generated over the past few years. Visitors interested in them were found to gain knowledge, opportunities, experiences, and


https://doi.org/10.17993/3ctic.2023.122.342-358

entertainment, while economic facilities (and the towns and regions in which they are located) can shape the image and brand and enhance their reputation. These benefits are important and are prerequisites to stimulate the development of these resources and link them to the destination's strategic plan for sustainable development. The literature [30] mainly studied the resources of the Yellow River estuary and Buzeen wetlands and proposed effective ways of managing the sustainable development of the resources. Through the management of tourist' activities and ecotourism awareness, the protection of wetland resources is enhanced, and the satisfaction of tourists and residents is effectively improved. From the research content, most of the studies focus on the development of wetland ecotourism resources and the planning of wetland ecotourism products. In particular, the research focuses on the coastal type and other lake and river-type wetland ecotourism sites, accounting for about 90% of the total number of studies. In terms of research methods, most of them adopt qualitative methods, lacking the support and depth of quantitative data, thus increasing the probability of the influence of human judgment factors. The study area is also mainly for different types of wetland ecotourism sites and mostly for wetland nature reserves. The Yellow River Delta is the last large river delta to be developed among the three major deltas in China, with obvious resource and location advantages and promising development prospects. Based on the study of the natural landscape pattern, the characteristics of the ecological resources and their tourism development potential should be analyzed to find out the effective ways and means suitable for the development of ecological tourism. The literature [31] takes the conservation and utilization of ecotourism as the development prospect. For the unstable structure and fragile ecological function, ecological restoration should be carried out according to local conditions to ensure water recharge and protect the native vegetation. It also carries out artificially assisted breeding and renewal, introduces and selects salt-tolerant plants, increases vegetation species, and improves vegetation coverage. The above literature shows that in accelerating the ecological tourism development of the Yellow River estuary, tourism resources are of great strategic importance in promoting economic and cultural construction and the coordinated development of the regional economy. The above research results fully recognize the special characteristics of ecological tourism development and focus on the goal of building an efficient ecological economic demonstration zone, developing protection and protection in development, and promoting the coordinated development of the regional economy and society.

The Yellow River estuary is the main body to promote regional economic development, location conditions, rich natural resources, and broad development prospects, the development of the Yellow River estuary ecotourism has important and far-reaching significance to the development of the entire province and city. To achieve good social and environmental benefits while better promoting the economic development of tourism, this paper conducts a SWOT analysis of ecotourism in the Yellow River estuary by assessing the environmental carrying capacity of the estuary. The advantages and disadvantages of ecotourism resources in the Yellow River estuary were obtained. The evaluation model of ecotourism environmental carrying


https://doi.org/10.17993/3ctic.2023.122.342-358

capacity is established based on the self-purification capacity of the ecological environment system.

## 2. SWOT ANALYSIS OF ECOTOURISM IN THE YELLOW RIVER ESTUARY

Huanghekou eco-tourism has many advantages and opportunities. The unique wetland ecotourism resources, convenient location, high-quality ecological environment, strong government support, the strategic opportunity of "Shandong on land and Shandong on the sea" and ecotourism gradually become the main direction of tourism consumption. SWOT analysis can make a study of the scenario in which the research object is located. Therefore, it has certain applicability to the ecotourism of the Yellow River Estuary. The SWOT matrix analyzes the situation of ecotourism from four aspects: strengths, weaknesses, opportunities, and threats, as shown in Figure 1. The analysis shows that the Yellow River estuary wetland ecotourism development has both advantages and disadvantages, and opportunities and challenges coexist. To make full use of these advantages and opportunities, to overcome the shortcomings and disadvantages, to meet the challenges, to create tourism products with characteristics, to establish their brand, and to improve the core competitiveness of the scenic area.

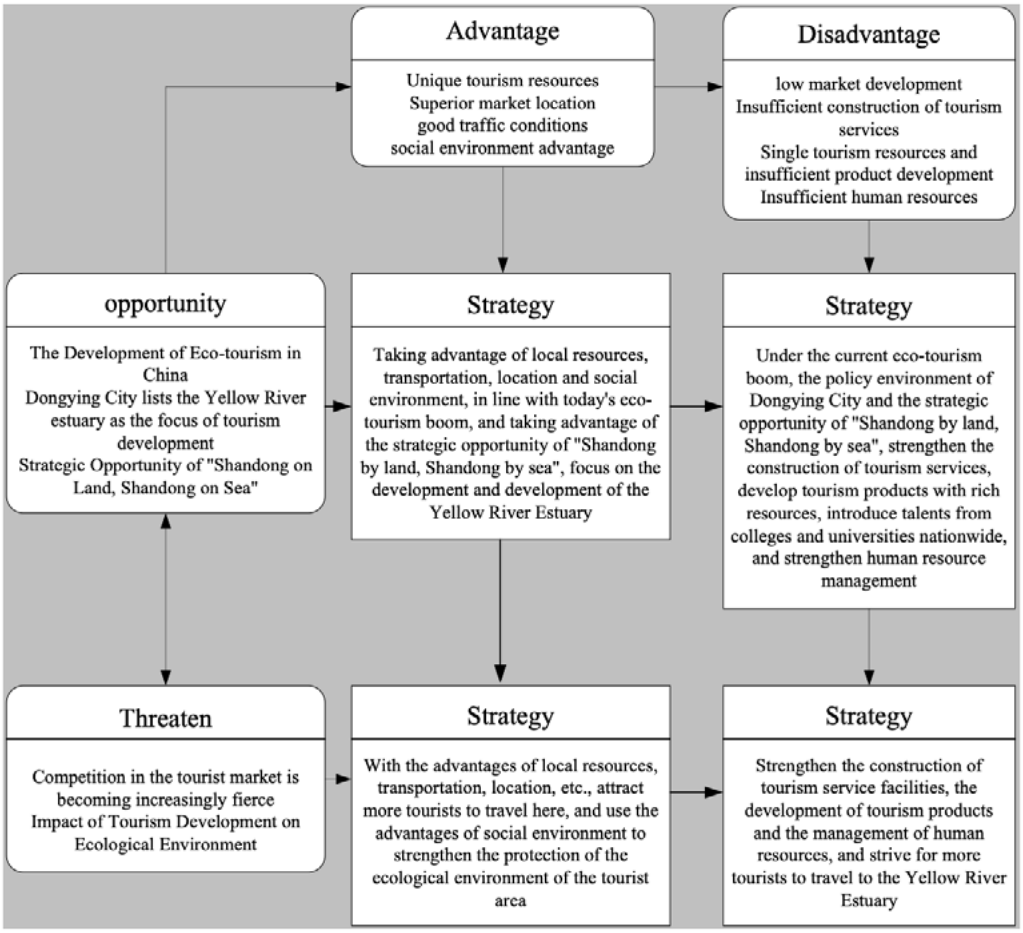


**Figure 1.** SWOT matrix analysis


https://doi.org/10.17993/3ctic.2023.122.342-358

## 2.1. ADVANTAGES

Unique tourism resources. Located at the mouth, the Yellow River Estuary Ecotourism Area is the most typical coastal estuarine wetland and the most important migratory bird habitat in China, with well-preserved natural resources, providing a good resource base for developing true ecotourism. The Yellow River estuary is also the second largest oil industry base in China, with the estuary's pristine landscape forming a strong contrast to the modern oil fields, giving a visual impact. Such tourism resource characteristics and resource combination forms can be considered national or even world-class for scientific examination, science education, tourism, and leisure vacation [32-34].

Superior market location. Huanghekou is in the center of China's Bohai Sea economic belt and the Yellow River economic belt, and the Liaodong Peninsula across the sea is the Jiaodong Peninsula north to Beijing, Tianjin, and Tang, the development of the hinterland including North China, Northeast China, the lower and middle Yangtze River provinces, the Pearl River Delta and the central and western regions.

Good transportation conditions. Based on the Shengli oilfield, the transportation infrastructure is good, and there are convenient transportation conditions between Huanghekou and domestic and foreign countries. At present, Huanghekou has convenient highway and railroad traffic access to all major cities in China, which is greatly improved. Small and medium-sized aircraft can land on the airport runway, so the Yellow River estuary has a multifunctional transportation network of roads, railroads, waterways, and airways [35-37].

Social environment advantage. The development of tourism as a breakthrough to promote local economic development, increased tourism development, and the formulation of relevant preferential policies, the development of tourism has become a social consensus.

## 2.2. DISADVANTAGES

Low degree of market development. The degree of development of the source market is low, the attractiveness to tourists is not enough, and the market-oriented operation method is not very mature.

Insufficient construction of tourism services. Modern tourism competition includes the promotion service to the source of tourists, tourism in the food, accommodation, travel, and other services to product after-sales service and other tourism service competition. Good tourism services need modern tourism service reception facilities but also need a high level and high quality of professional service management personnel, the Yellow River mouth is currently facing a shortage of talent problem.

Tourism resources single, and product development is insufficient. Huanghekou tourism resources, although unique, the current lack of boutiques and highlights, and


https://doi.org/10.17993/3ctic.2023.122.342-358

landscape quality seasonal differences are great, tourism off-peak season contradiction is prominent. Tourism product development is less and lack of boutique and personalized tourism products.

Insufficient human resources. The competition of the modern tourism industry with business training and human resources with higher education in tourism is an important element of competition and an important factor in the soft environment of tourism development, and Huanghekou is insufficient in this regard.

## 2.3. OPPORTUNITIES

The development of eco-tourism in China. The booming tourism industry provides a good opportunity for the development of the Yellow River Estuary. With modernization and economic and social development, tourism is gradually shifting to "green" ecotourism. The Yellow River Estuary is a real and original ecotourism area, which will be favored by domestic and foreign tourists.

The Yellow River estuary is the focus of tourism development. The Yellow River estuary occupies tourism resources including the natural landscape with the ecology of the Yellow River estuary wetlands, the modern industrial landscape with oil as the main theme, and the ancient Qi culture as the theme of historical and humanistic tourism resources in two of the three pieces, and want to make the Yellow River estuary to become the city's tourism development to drive the "frontrunner".

The development strategy of "Shandong on Land and Shandong on Sea" provides an opportunity for the development of tourism. To revitalize the development of tourism, the strategy of "Shandong on Land and Shandong on Sea" is proposed, and the Yellow River estuary is the center of gravity of "Shandong on Land" and Bohai Bay is the center of gravity of "Shandong on Sea". The Yellow River estuary is a combination of "Shandong on land and Shandong on the sea". This development strategy provides a good opportunity for the development of eco-tourism in Huanghekou.

## 2.4. THREATS

Increasing competition in the tourism source market. According to statistics, 24 out of 31 Chinese provinces and cities have made tourism a key development industry. The proximity of Huanghekou to the Dalian seaside and Qingdao seaside, and the many famous domestic attractions around, have affected the number of tourists visiting Huanghekou to some extent. However, if Huanghekou can be successful in tourism image planning, tourism product development, and tourism product promotion, borrowing the surrounding area tourist attractions will play a role in the formation and development of the Huanghekou source market.


https://doi.org/10.17993/3ctic.2023.122.342-358

Yellow River estuary's ecological environment is more sensitive and fragile, in the development of the slightest carelessness, it will cause the reverse environmental succession, directly affecting the quality and benefits of ecotourism. The breakage of the Yellow River, ice ribs, and storm surge hazards are all due to ecotourism and wetland ecosystem threats.

## 3. EVALUATION MODEL OF ECOTOURISM ENVIRONMENTAL CARRYING CAPACITY BASED ON THE SELF-PURIFICATION OF ECOSYSTEM

The ecotourism environment carrying capacity refers to the tourism intensity that the natural ecological environment of the tourism area can withstand without degradation within a certain period. Research shows that the ecological environment system itself has a certain regeneration capacity. The purpose of determining the environmental carrying capacity of ecotourism is to control the impact of tourism on the environment within the range of environmental regeneration capacity, that is, the environmental impact caused by tourism activities (such as the adverse impact of tourism activities on vegetation) shall not break through the regeneration capacity. At the same time, the self-cleaning capacity of the natural environment can completely absorb and purify the pollutants produced by tourists (e.g., pollution of the water bodies of tourist sites by tourism activities); around these two requirements, a series of assessment models for the carrying capacity of the tourism environment are established.

This type of model assumes that the environmental impacts caused by tourism activities can be controlled to a reasonable extent through strict management, and thus the ecological carrying capacity of the tourism environment depends on the ability of the natural ecosystem to purify and absorb tourism pollutants and the amount of pollutants produced by tourists per unit of time. Based on this assumption, some researchers have established the formula for measuring the carrying capacity of the tourism environment:

$$EEBC = \text{win}(WEC, AEC, SEC) \quad (1)$$

Where: $EEBC$ is the ecological environment carrying capacity, take the minimum value of the three components $WEC, AEC, SEC$. $WEC$ is the water environment carrying capacity (with the water surface as the main tourist resource, take = sewage port treatment capacity / per capita sewage generation, not with the water surface as a tourist attraction or does not constitute the main environmental factors, then take infinity). $AEC$ is the atmospheric carrying capacity (for tourism activities that do not generate atmospheric pollution, infinity is desirable. (When atmospheric pollution is generated, $AEC$ A = regional atmospheric environmental capacity / per capita exhaust gas generation). $SEC$ is the carrying capacity of solid waste generation ( $SEC$ = daily solid waste capacity / average daily solid waste generation per person).


https://doi.org/10.17993/3ctic.2023.122.342-358

Based on this concept, a more intuitive measurement model was developed as shown in Equation 2.

$$F_0 = \sum_{i=1}^{n} S_i T_i / \sum_{i=1}^{n} P_i \quad (2)$$

Where: $F_0$ is the ecological carrying capacity (daily carrying capacity), expressed as the maximum allowable amount of tourists received per day, $P_i$ is the amount of pollutant $i$ produced by each tourist per day, $S_i$ is the amount of the $i$th pollutant purified and absorbed by the natural ecological environment, $T_i$ is the self-purification time of various pollutants, $n$ is the number of tourism pollutant types. Considering that tourist attractions generally treat pollutants artificially, thus expanding the pollution absorption capacity of the natural environment. The above formula is amended to formula 3:

$$F = \left( \sum_{i=1}^{n} S_i T_i + \sum_{i=1}^{n} Q_i \right) / \sum_{i=1}^{n} P_i \quad (3)$$

Where $F$ is the extended ecological capacity; $Q_i$ is the amount of pollutant $i$ that is treated manually each day.

# 4. RESULTS AND ANALYSIS

## 4.1. ECOTOURISM ECONOMIC DEVELOPMENT BEARING STATUS

From 2017 to 2021 human socio-economic development is over-carrying, and its pressure mainly shows a trend of gradual increase and stabilization. The carrying capacity value of human socio-economic development calculated by the evaluation model of ecotourism environment carrying capacity, decreases from 0.83 to 0.61 from 2017 to 2019 and then shows a trend of slow stabilization at this level. It can be seen that the pressure of human socio-economic development on regional resources and ecological environment still exists and is likely to persist for a long time, although the rate is slowing down, the trend has not changed. To further analyze the pressure brought by human socio-economic development to the Yellow River estuary region, this paper analyzes the pollution elements according to the results of the evaluation model assigned to the ecotourism environmental carrying capacity of the ecological system self-cleaning, and the population, socio-economic and ecological environment in the category layer human socio-economic development as shown in Figure 2.


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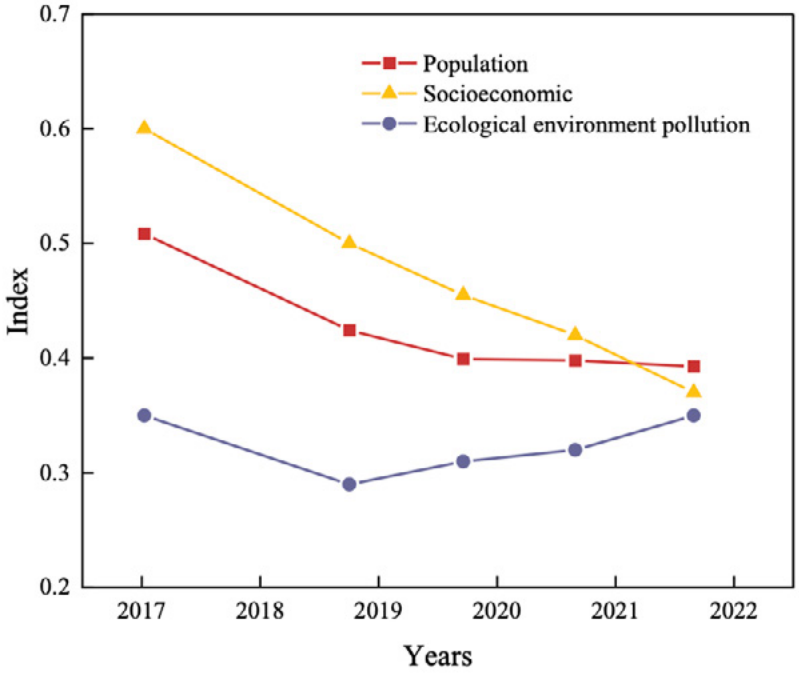


**Figure 2.** Changes in population, socio-economic, and ecological pollution

As can be seen from Figure 2, the three elements of population, social economy, and ecological environment pollution are in the overload state, and ecological environment pollution has been the dominant element of overload from 2017 to 2021, followed by economic development. The ecological and environmental carrying capacity has been at a low level between 0.25 and 0.35 since 2018, with the lowest value reaching 0.26. The indicators in the factor layer include population size, marine industry output value, wastewater discharge, mariculture area, and red tide occurrence area. With the rapid economic development, the average annual growth rate of the total industrial output value from 2017 to 2021 is 28.7%, which is higher than the national average of 12.1% during the 15th Five-Year Plan. The rapid development of population and rough industries inevitably brings a large increase of pollutants such as wastewater, COD, and ammonia nitrogen, leading to the deterioration of marine ecology and the expansion of the area where red tide occurs, etc. From the current economic development of the Yellow River Estuary region these indicators are expanding, and at the same time, with the Binhai New Area and the Yellow River Delta Efficient Ecological Zone rising as national strategies, this growth trend will be inevitable in a longer period, and at the same time, it will bring great challenges to the ecological and environmental carrying capacity of the Yellow River estuary.

## 4.2. ANALYSIS OF ECOLOGICAL POLLUTION ABSORPTION CAPACITY

The ecological and environmental pollution carrying capacity of the Yellow River estuary region shows a fluctuating trend, from 2017 to 2018, the ecological and


https://doi.org/10.17993/3ctic.2023.122.342-358

environmental pollution carrying capacity value increased from 1.3 to 1.8, decreased to about 0.61 in 2018-2019, and increased to 1.35 in 2021. the overall condition of the ecological and environmental pollution carrying capacity is good, and most of the time is within the bearable range. This is mainly because the carrying capacity of marine resources, ecology, and environment includes two aspects. On the one hand, is the ecological environment, and on the other hand is the human social support. Human social support plays a negative role in the economic development of human society, so it is considered in the overall pollution-carrying capacity. Human social support plays a leading role in the process of resource, ecological, and environmental carrying capacity of the Yellow River estuary. For further analysis, see Figure 3 for changes in ecological and environmental pollution carrying capacity of the Yellow River estuary region. From Figure 3, the carrying capacity of ecology and environmental pollution carrying capacity is mainly considered in three aspects, which are environmental pollution carrying capacity, ecological and environmental quality, and human society's support.

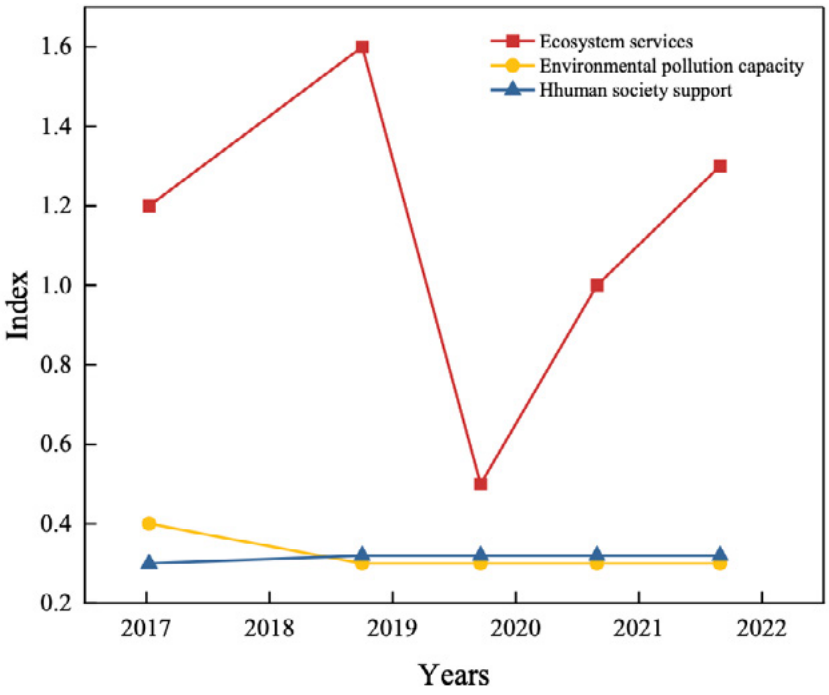


**Figure 3.** Changes in marine ecology and environmental pollution carrying capacity

The environmental pollution carrying capacity is over-carrying, showing a trend of first weakness and then strength. The main indicators considered for the environmental pollution carrying capacity are the environmental capacity of ammonia nitrogen and active phosphate. The upward trend is mainly due to the increase in wastewater and pollutant discharge compliance rates. In recent years, the investment in environmental protection infrastructure has been increased around the world, which has controlled the amount of wastewater and pollutants entering the sea at source, thus making the environmental pollution capacity of the Yellow River estuary effectively controlled. The ecological environment quality mainly includes two indicators: the ecosystem service function and the density of phytoplankton. From


https://doi.org/10.17993/3ctic.2023.122.342-358

Figure 3, we can see that the ecological environment quality is very volatile, and the carrying status fluctuates above and below the carrying capacity critical value, which is in a more dangerous alert state. The ecological environment quality is the only element in the critical and bearable state of carrying capacity, and the ecological environment quality reflects the integrity and health of the ecosystem. The health of the ecosystem is directly related to the strength of marine resources and ecological environment carrying capacity. If we do not pay attention to it, it will easily lead to the overload condition of the region as a whole. Therefore, the health of marine ecosystems should be closely monitored. The carrying status of human support elements is in an overload state. From this, we can see that human support still has great potential. For example, we can increase the investment in environmental protection and improve the rate of sewage treatment. By improving the level of scientific research and innovating science and technology, it will play a useful role in improving the carrying capacity of the resources, ecology, and environment.

The analysis of the results of resource, ecological, and environmental carrying capacity shows that the Yellow River Estuary is generally in a bearable condition for resources and ecological environment from 2017 to 2021. However, the overall carrying level is low and at the edge of a near-critical carrying state, which needs to be paid high attention. The Yellow River estuary region is currently carrying very limited remaining space, the region's population, rapid socio-economic development, and excessive exploitation of the resources, are super-bearing. This has brought tremendous pressure to the resources and ecological environment. At present, if the ecological environment did not have a strong pollution-absorbing capacity, the Yellow River estuary region as a whole would be over-carrying. The quality of the marine ecosystem plays a leading role in the pollution-carrying capacity of the Yellow River estuary ecosystem. Thus, it can be seen that the health of the ecosystem can effectively improve the overall carrying level of resources, ecology, and environment.

## 5. DISCUSSION

To better develop the ecological tourism environment, can be satisfied by providing tourists with a good tourism environment and ecological knowledge education. At the same time, it constrains the behavior of tourists, requiring them to make their contribution to nature conservation while enjoying nature and receiving nature knowledge education. Ecotourism is inevitably the best way to combine people and nature and thus becomes the highlight of tourism. On the one hand, caring about getting the best level of satisfaction. On the other hand, people have increased their sense of responsibility for the environment of human development, and have begun to pay attention to how to make the best use of existing resources to meet the needs of the present while considering how to keep the resources that will meet their needs for future generations unimpaired and undamaged. As a kind of tourism with a sense of responsibility that has a special feeling for ecology and culture, this sense of responsibility of ecotourism is a strong guarantee for its development.


https://doi.org/10.17993/3ctic.2023.122.342-358

# 6. CONCLUSION

Based on the results of the SWOT analysis of ecotourism, this paper assesses the current situation of the environmental carrying capacity of ecotourism by using the evaluation model of ecotourism environmental carrying capacity of ecological environmental system self-cleaning. Summarizing the whole paper, the following main research conclusions are drawn.

1. From the ecotourism economic development bearing status, human socio-economic development is in over-bearing status in 2017~2021. 2017~2019 decreases from 0.83 to 0.61, and then shows a trend of slow stabilization at this level. According to the ecological environment and socio-economic development, the development of ecotourism should be researched, which must be guided by the theory of sustainable development and carry out tourism activities in a systematic and planned manner under the premise of ensuring ecological safety.

2. The three elements of population, social economy, and ecological and environmental pollution are in the overload state, and ecological and environmental pollution has been the dominant element of overload from 2017 to 2021, followed by economic development. The ecological and environmental carrying capacity has been at a low level between 0.25 and 0.35 since 2018, with the lowest value reaching 0.26.

3. The ecological and environmental pollution-carrying capacity of the Yellow River estuary region shows a fluctuating trend, with the ecological and environmental pollution-carrying capacity value rising from 1.3 to 1.8 from 2017 to 2018, decreasing to about 0.61 from 2018 to 2019, and rising to 1.35 by 2021. Therefore, the management of ecotourism in the Yellow River estuary should be strengthened, mainly to maintain ecological balance, control ecological deterioration, environmental pollution, and artificial destruction of wetland landscape, and protect biodiversity. We establish scientific, perfect, reasonable, and effective management standards and measures in management, restrain and control relevant stakeholders, strengthen communication with local community residents, coordinate the interests between residents and ecotourism development, and promote the promotion of healthy and harmonious development of local tourism.

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