Scholar Publishing Group
Frontiers in Ocean Engineering
https://doi.org/10.38007/FOE.2022.030207
ISSN 2790-2706 Vol. 3, Issue 2: 59-66

Environmental Impact Assessment of Marine Engineering Coastal Landscape Based on AHP

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Keywords: Ocean Engineering, Coastal Landscape, Analytic Hierarchy Process, Evaluation Index

Abstract: Environmental protection has become the most concerned topic of human beings. The importance of environmental construction in marine engineering construction projects has gradually increased, and coastal landscape(CL) have received more and more attention. The large-scale construction of marine engineering has a great impact on the CL. Ocean engineering may cause some original landscape resources to disappear, and may also generate some things that damage the original landscape, and may also cause the impact of the landscape environment on the CL. In this regard, this paper takes the reclamation project as an example, and uses the analytic hierarchy process to screen out the evaluation indicators of the impact of the marine project on the CL environment, that is, the topographic landscape, reef island landscape, human landscape, and traffic landscape, and construct the evaluation index system. The evaluation experiment on the environmental impact of marine engineering on the CL shows that the reclamation project destroys the topographical landscape and reef island landscape, and its negative impact degree is 36.36% and 14.84% respectively, while the combined analysis of the human landscape and the traffic landscape results in the reclamation project. The positive impact of the construction of the sea project on the coastal human landscape and traffic landscape is 18.52%.

1. Introduction

As the environmental impact assessment of CL is quite difficult, and the evaluation content, methods and evaluation standards of various types of CL are different, it is difficult to reach a consensus evaluation method. However, according to a certain type of landscape and a certain type of construction project, a comprehensive landscape impact assessment method can be found [1]. In this paper, the evaluation method based on AHP is reasonable and feasible in the impact of marine engineering on CL environment.

At present, there are many domestic and foreign research results on CL evaluation. Foreign research on CL evaluation has a wide range, mainly through various elements of CL to evaluate its landscape quality, so as to put forward suggestions and measures for managers to manage CL [2]. For example, if someone artificially determines the sound and visual parameters that can explain a specific area of the coastal area, research and develop an artificial neural network to evaluate the relative importance of the input variables and compare with the linear regression model to better evaluate the soundscape quality of the CL[3]. Some scholars have also conducted a survey of hundreds of beach users on a beach on a certain coast, conducted a bottom-up assessment of the quality of coastal beaches, obtained the public's views and preferences on coastal beaches, and made policy recommendations for beach development [4]. Domestic scholars generally use analytic hierarchy process and fuzzy comprehensive evaluation method to study coastal tourism resources [5]. If some scholars use the AHP method to evaluate the tourism carrying capacity and development potential of all coastal cities in a province, or use the AHP method to evaluate the coastal sports tourism resources, starting from the resources, environment and infrastructure of the coastal sports tourism space, choose the coastal tourism environment. Other indicators such as transportation convenience are used to construct an evaluation system for the supporting conditions of coastal sports tourism [6-7]. Some scholars discussed how to strengthen the protection and sustainable development and utilization of coastal tourism resources, and pointed out that coastal tourism development brings coastal erosion, causing coastal tourism resources to gradually lose their value, and causing serious environmental pollution problems [8]. Although my country has formed a CL evaluation system, the impact of marine engineering on the landscape is often ignored in the environmental impact assessment of CL.

This paper first introduces the concepts of CL and AHP, and then takes a marine reclamation project as an example to analyze its impact on the CL environment, and selects four general evaluation indicators and 17 sub-indices, and evaluates the effect of each index through AHP calculation. Finally, the scores of each index before and after the reclamation project were compared to illustrate the degree of impact of the reclamation project on the CL environment.

2. Marina Landscape and AHP Approach

2.1. The Concept of CL

The area near the sea or between the sea and the land and has a certain landscape value is called the urban CL. The coastal road is usually used as the base line, the part facing the land includes the open area of the coastal road and some relevant characteristic blocks, and the part facing the sea covers the area between the coastal road and its coastline and some offshore islands [9- 10]. CL is to combine the limitedness of marine resources with the infinity of cultural wealth to generate new human resources.

2.2. AHP

Analytic Hierarchy Process (AHP) applies the principle of multi-level sorting. First, the problem should be hierarchical, and the complex problem should be divided into several levels composed of different indicators according to a certain logical relationship. From high to low, go down level by level and layer by layer; then invite experts to judge the importance of the indicators and assign corresponding values; then use mathematical operations to calculate the weight of each indicator at each layer, and sort them; finally, according to the results of the sorting To carry out planning analysis and decision-making [11-12]. AHP can simplify complex problems, combine qualitative description with a certain degree of quantitative calculation, and the calculation process is simple.

Rigorous scientific theoretical basis strengthens the reliability and validity of the evaluation process.

AHP has formed a three-level hierarchical structure model, which are:

The target layer (A), the highest layer. There is only one indicator in this layer, which is the predetermined target of the research problem.

The intermediate layer (B) is the intermediate link included in order to achieve the predetermined goal.

Indicator layer (C), the lowest layer. This layer contains various specific measures and decision-making programs to achieve the predetermined goals.

AHP needs to construct a judgment matrix A, and then obtain the weight of each index at the same level relative to the upper-level index to which it belongs, and then sort it. The expression of the judgment matrix A is as formula (1), and the calculation formula of the index weight is as formula (2).

$$A=(a_{ij})_{k\times k}, i=1,2,...,k; j=1,2,...,k \tag{1}$$

$$W_i=\sum_{j=1}^{N}\frac{a_{ij}}{N} \tag{2}$$

In the formula, a_{ij} is the value corresponding to each row element in the judgment matrix A, and W_i represents the weight of the element i.

3. Evaluation Indicators and System Establishment

3.1. Introduction to Ocean Engineering

This project is to backfill a sea area to form a land, the so-called reclamation project, mainly to build a cofferdam first and set a geotextile to the filter layer inside the cofferdam, and then backfill with earth and stone to prevent sand and gravel from entering the sea. In order to prevent the oil from polluting the seawater, the machinery and cars entering the construction site are strictly prohibited from revealing oil.

3.2. Construction Principles of Evaluation Index System

Scientific principle: The index system should be based on a full understanding of the CL, in-depth research, and can reflect the current situation of the CL more objectively and truly. The selected indicators should be accurately, rigorously and reasonably defined to avoid repetitive and one-sided indicators. , while ensuring that the relevant factors affecting the CL environment can be fully reflected, the data related to the indicator system must be based on rules and evidence[13-14].

Systematic principle: This principle runs through the whole process of constructing the CL environmental impact index system. In order to quantitatively analyze the environmental impact of marine engineering on CL, it is necessary to analyze the structure of the complex system in the process of establishing the index system, and divide it into multiple subsystems according to levels [15]. Each indicator layer is a subsystem; on the other hand, the indicator system consists of the target layer and the indicator layer. The evaluation factors contained in different levels can systematically and correctly reflect the basic characteristics of the CL environment at different levels.

The principle of combining qualitative and quantitative indicators: The indicator system should combine quantitative and qualitative indicators on the basis of quantitative indicators. However, because the index system covers a wide range and describes various phenomena, sometimes subjective indexes that cannot be directly quantified are required. Therefore, these subjective indexes can be indirectly allocated and quantified to improve the evaluation index system and better reflect the situation of the evaluation object [16].

The principle of typicality: the factors affecting the CL environment of marine engineering are numerous and complex, and the selection of each index should be typical, that is, the index should not be too many or too detailed, so as not to be too complicated, but it should not be too small or too simple to avoid omission. Indicator information, ensuring that the information is as comprehensive and concise as possible. Therefore, under the premise of reflecting the basic situation, typical indicators should be highlighted, and some other indicators that are not close or similar to the main characteristics should be excluded to make the indicator system representative [17-18].

3.3. Screening of Evaluation Index Factors Based on AHP

In the evaluation indicators of the impact of the marine reclamation project on the CL environment, this paper has determined four indicators, namely the topographic landscape (B1), the reef island landscape (B2), the human landscape (B3), and the traffic landscape (B4). Topography and landscape evaluation indicators include surface rock (C1), surface structure (C2), erosion rate (C3), landform composition (C4), tourist environmental capacity (C5), popularity (C6), etc.; the indicators for reef island landscape evaluation are: Reef ornamental value (C7), scientific value (C8), reef island scale (C9), sensitivity (C10), etc.; cultural landscape evaluation indicators include historical sites (C11), museums (C12), famous gardens (C13)), cliff stone carvings (C14), etc.; traffic landscape evaluation indicators include transportation facilities (C5), means of transportation (C16), and ship docks (C17).

Using the AHP method, the evaluation factors and weights of the environmental impact assessment of the marine engineering on the CL are calculated, as shown in Table 1, and the evaluation system is obtained as shown in Figure 1.

Table 1. Evaluation factors and weights of CL environmental impacts

Target layer	Middle layer	Indicator layer
A	B1 (0.27)	C1(0.044)
		C2(0.016)
		C3(0.032)
		C4(0.051)
		C5(0.082)
		C6(0.045)
	B2 (0.18)	C7(0.057)
		C8(0.021)
		C9(0.048)
		C10(0.054)
	B3 (0.34)	C11(0.104)
		C12(0.042)
		C13(0.109)
		C14(0.085)
	B4 (0.21)	C15(0.063)
		C16(0.053)
		C17(0.094)

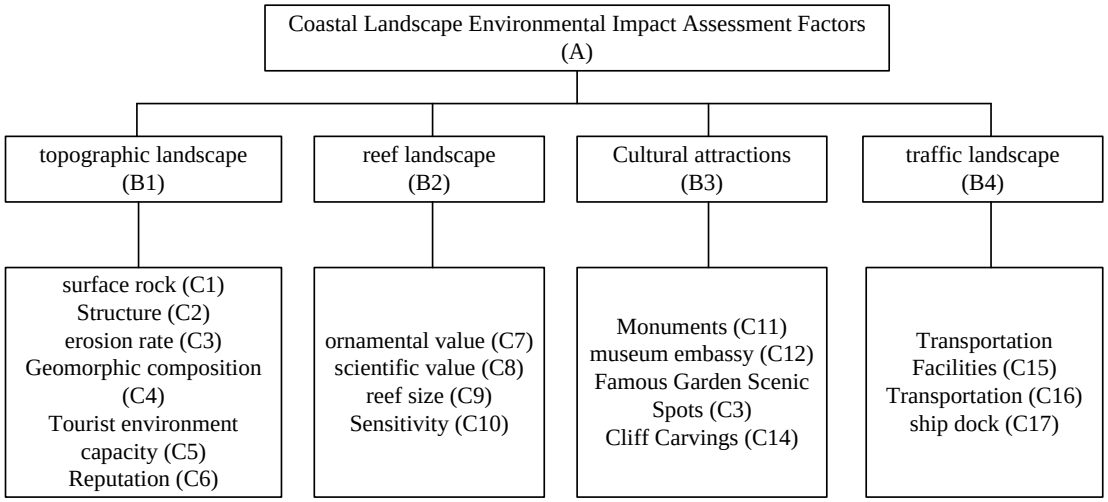

Figure 1. Evaluation system of CL environmental impact

4. Impact Assessment of Marine Engineering on CL Environment

4.1. Evaluation of Topography and Landform Landscape

Table 2. Results of topography and landscape evaluation

Project	Surface rock	Structure	Erosion rate	Geomorphic composition	Tourist environment capacity	Reputation	Total
Before	6	5	7	6	5	4	33
After	5	4	3	4	3	2	21

As shown in Table 1, it is calculated that the impact of the changes in the topography and landscape before and after the marine reclamation project in this area is: (21-33)/33=-36.36%. That is, after the end of the project, the topography and landscape will suffer a loss of 36.36%.

4.2. Evaluation of Reef Island Landscape

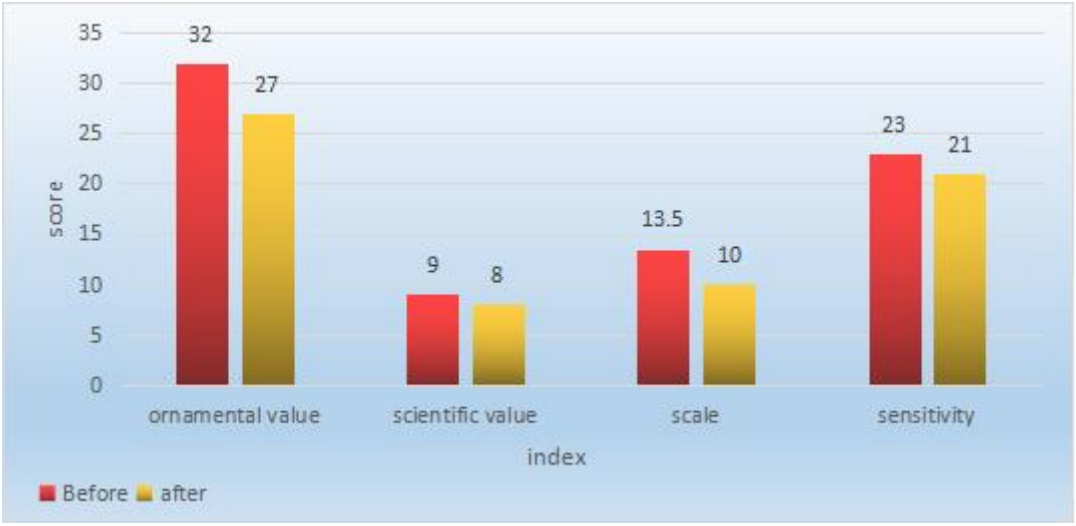

Figure 2. Results of the reef island landscape evaluation

The reef landscape in this area adopts the granite natural landscape evaluation method, in which

a score of 100 points is a special grade, a score of more than 80 points is a grade one, a score of more than 60 points is a grade two, and a score of more than 50 points is a grade three. As shown in Figure 2, the pre-engineering score is 75.35 points, which is between the first and second grades, and is relatively close to the first grade. This shows that the reef landscape in this sea area has great potential for development. The post-engineering score is graded, and it is at the second level. The impact before and after the project is: (66-77.5)/77.5=-14.84%. It shows that most of the reef landscape will be destroyed after the project, resulting in a negative impact of about 14.84%.

4.3. Impact on Coastal Human Landscape and Traffic

Table 3. Human landscape and traffic impact assessment results

	Before	After
Tourism area	Build roads	Marine entertainment
Opening hours	15 hours	11 hours
Dwell time	55 minutes	35 minutes

The reclamation project has an impact on the human landscape and the traffic environment, and the impact on the two is mutual. Therefore, when the impact analysis of the two is carried out, it is evaluated as a whole, and the evaluation content is determined as the area before and after the completion of the reclamation project. Changes in the capacity of the tourism environment. As shown in Table 3, the tourism area, opening time, and stay time before and after the reclamation project are compared. After the reclamation, the original tourist area of the area will be used to build roads, but the reclamation project will not be implemented. The reclamation area can be opened up as a marine entertainment area to increase the tourism area and provide people with places of leisure and entertainment. The average day before reclamation was 15 hours, compared to 11 hours after reclamation. The average stay time of tourists at a scenic spot before reclamation is about 55 minutes, and the stay time after reclamation is about 35 minutes. As the time spent by tourists in the scenic spot is shortened, the development time of the reclamation area may increase, so after the completion of the reclamation project, the tourism environment capacity will increase. According to the weight calculation of the evaluation factors of humanities and traffic landscapes, it is concluded that the positive impact of ocean engineering on coastal humanities and traffic landscapes is 18.52%, indicating that the construction of reclamation projects has a very large impact on the humanities and traffic landscapes in this area.

5. Conclusion

Due to different marine engineering projects and different landscape types, the methods of landscape environmental impact assessment are different. Now, the landscape environmental impact assessment method is striving to develop in the direction of quantification. The size of the landscape impact and the degree of change is expressed by the size of the number, and the characteristics of each component of the landscape and the pros and cons of the landscape are expressed by the number. This paper is based on the AHP. The evaluation method can also express the degree of impact of marine engineering on the CL environment through numbers. By establishing a corresponding evaluation system and determining the weight of evaluation indicators, the impact of marine engineering on the CL environment is analyzed from four perspectives. On the whole, the marine project is more destructive to the CL environment, and the construction of the project has brought a negative impact on the CL.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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