Scholar Publishing Group
Frontiers in Ocean Engineering
https://doi.org/10.38007/FOE.2021.020402
ISSN 2790-2706 Vol. 2, Issue 4: 9-16

Evaluation Method of the Impact of Intensive Sea Use on Marine Resources Based on Lyapunov Function Method

Kim Yeongmin*

University of Sulimanyah Univ Sulaimani, Iraq

**corresponding author*

Keywords: Lyapunov Function, Intensive Sea Use, Marine Resources, Marine Ecology

Abstract: The rational use of MR(MR) is a new concept to find cooperation and balance between marine development and protection, so as to ensure the sustainable use of coastal resources. Intensive sea use(ISE) maintains the balance of the marine ecosystem more scientifically, and is an efficient way to use the sea. However, under the influence of economic development, people's intensive exploitation of MR has destroyed the marine ecosystem, resulting in marine pollution and environmental degradation. Therefore, how to reduce the impact of marine development projects on marine ecology and scientific evaluation of the impact of ISE on MR is of great significance. This paper selects three evaluation indicators for the impact of ISE on MR, analyzes the current situation of marine resource utilization in coastal areas of G city from the perspective of these three indicators, and then uses the Lyapunov function to calculate the weight of each indicator, and analyzes the impact of the three indicators on MR. The results of resource impact, the study shows that the intensive utilization of MR in the city shows a fluctuating upward trend.

1. Introduction

As an emerging research field, ISE is in its infancy in all aspects. The theoretical research results and practical proofs of intensive use of sea areas can be used as the theoretical basis for the research on intensive use of sea areas [1]. Based on the research of marine intensive utilization, this paper analyzes its influence on MR, and excavates suggestions for effective development and utilization of MR from the research results, so as to realize the harmonious development of MR utilization and society, economy and ecology.

At present, the research on the evaluation method of the impact of ISE on MR has achieved good results. For example, there are few studies on evaluation criteria at home and abroad, and most of the studies classify the evaluation factors according to the evaluation level from a subjective point of view, which are generally divided into qualitative and quantitative [2]. Some researchers have

carried out research on the evaluation of the ecological environment effect of the reclamation and development activities, and put forward the evaluation standard of the evaluation index of the ecological environment effect of the reclamation and development activities. , indicating that the reclamation and development activities have a serious impact on the ecological environment, and the reclamation and development activities need to be controlled. When the ecological evaluation index is between 55 and 75, it means that the effect of the reclamation and development activities on the ecological environment is moderate, and the process of the reclamation and development activities needs further discussion. Affecting the ecological environment effect, reclamation and development activities can be carried out [3-4]. Some scholars have established an evaluation system for the effect of changes in the utilization of coastal MR, and used the SAWT model to evaluate the influencing factors of coastal water environment changes. In terms of evaluation research and spatial analysis of sea areas, single-factor index and comprehensive index evaluation methods are used to evaluate Evaluation of the marine ecological impact caused by ISE [5]. Although there are many evaluation methods for the impact of ISE on MR, this paper mainly uses the Lyapunov function to analyze the evaluation results.

This paper first puts forward the basic concept of Lyapunov function, and then analyzes the construction principles of the evaluation index of intensive use of sea area for marine resource utilization. And according to the index weight analysis and evaluation results obtained by the Lyapunov function, the suggestions for improving the intensive utilization of MR in the city are given at last.

2. Evaluation of the Impact of ISE on MR Based on the Lyapunov function Method

2.1. Lyapunov Function

The Lyapunov method is divided into a first method and a second method. Among them, the first method is also called the indirect method. Its main idea is to first linearize the nonlinear system with Taylor's formula, and then indirectly obtain the stability of the original system from the eigenvalues of the linear system [6]. The second Lyapunov method is the so-called direct method, whose concept is based on the idea of the power distribution of the energy field in the system stability in general mechanics, that is, the stability of the system. By analyzing the generalized energy function, the derivative of the Lyapunov function is determined to determine the stability of the system [7]. The basic concept of the Lyapunov function is a continuous-time nonlinear time-varying autonomous system considering the following general structure:

$$\hat{x} = f(x,t), x(t_0) = x_0, t \geq t_0 \tag{1}$$

where x is the state vector, and x $\in$ Rn, f(x, t) is a vector function with a certain time t. If f(x, t) has no time-varying t, the system becomes a time-invariant system, and when f(x, t) is a linear function, the system becomes a linear system.

Stability in the sense of Lyapunov: if for $\forall \varepsilon > 0$, there exists a real number $\delta(\varepsilon, t) > 0$ such that the disturbed motion starting from any x0 satisfying $\|x_0 - x_\varepsilon\| \leq \delta(\varepsilon, t_0)$ satisfies:

$$\|\phi(t, x_0, t_0) - x_e\| \leq \varepsilon, \forall t \geq t_0 \tag{2}$$

Then the equilibrium point xe=0 of equation (2) is said to be stable in the sense of Lyapunov at t0.

In this paper, the Lyapunov function is mainly used to calculate the weight of the index of the

impact of ISE on MR by using its stability analysis characteristics, so as to obtain the index with the greatest degree of influence, and from this index, we can focus on how to stabilize the marine ecology [8].

2.2. Principles for Constructing Evaluation Indicators for the Utilization of MR by ISE

The principle of pertinence: The establishment of the index system for the intensive utilization of MR should be pertinent, and the factors to be considered should include natural environment factors such as geographical location, social factors such as policies and regulations and economic development, and human factors affected by human activities [9].

Dynamic principle: The sea area will be in different stages of development with the progress of economic development and science and technology. Increase the investment of economic capital, improve management, give full play to the potential of marine utilization, and the efficiency of intensive utilization of MR will continue to improve [10] .

Feasibility principle: In the selection of evaluation indicators for the intensive utilization of MR, the availability and accuracy of index data should be considered in order to achieve an objective evaluation of the intensive utilization of MR [11-12].

3. The Utilization of MR in G city

3.1. Selection of Evaluation Indicators for Intensive Utilization of Sea Areas

Marine input intensity: the more capital investment, the greater the fixed asset investment per unit sea area; the greater the labor input, the greater the number of employees per unit sea area; the greater the sea area aquaculture resources investment, the greater the per capita mariculture area index [13-14]. From the perspective of marine fishery, this paper analyzes the output of aquaculture resources.

Marine economic benefits: This paper uses the ocean salt industry to measure the structural layout of the marine industry. The marine economic benefits are reflected through the added value of the marine salt industry [15].

Marine tourism ecology: In order to maintain marine productivity, tourism resources must be developed. This paper analyzes the potential of intensive utilization of MR from the number of port tourists.

3.2. Analysis of the Status Quo of Marine Resource Utilization

(1) Marine input intensity - marine fishery resources

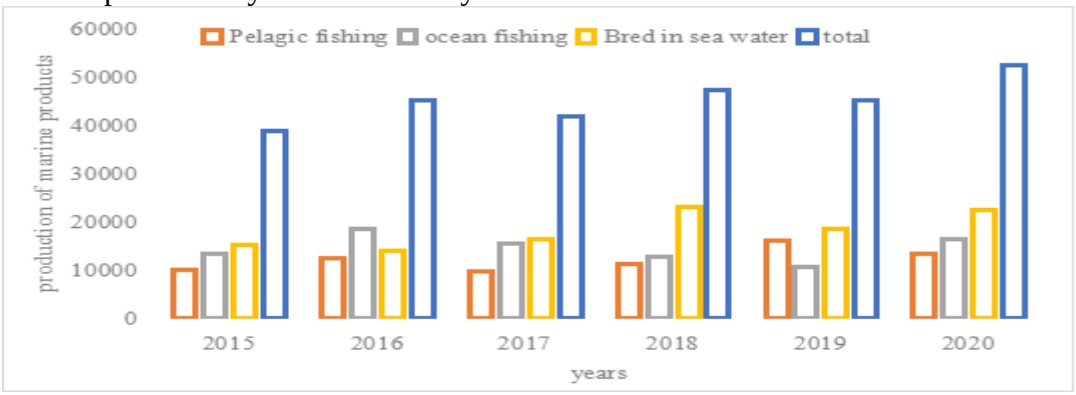

Figure 1. The city's seawater product output (tons)

As shown in Figure 1, in 2020, the city's total seawater products reached 52,486 tons, an increase of 39,105 tons compared with 2015. Among them, the output of mariculture was 22,563 tons. The output of marine fishing has reached 10,745 tons, a decrease of 20.18% compared with 2015; the output of ocean fishing has reached 13,381 tons, an increase of 30.08%.

Table 1. The city's annual output value of marine fishery (10,000 yuan)

	Ocean fishing	Bred in sea water	Total
2015	53468	24692	78160
2016	55173	23045	78218
2017	46354	37635	83989
2018	68720	53823	122543
2019	57492	64428	121920
2020	78935	71247	150182

As shown in Table 1 is the output value of marine fisheries. In 2020, the annual output value of the city's marine fishery increased to 1,501.82 million yuan, an increase of 92.15% compared with 2015; the annual output value of marine fishing was 789.35 million yuan, an increase of 47.63% compared with 2015, and the annual output value of marine aquaculture was 712.47 million yuan, an increase of 188.54% compared with 2015. Overall, the city's marine fisheries output value is increasing.

3.3. Marine Economic Benefits - Marine Salt Resources

Table 2. Added value of marine salt resources in the city

	2015	2016	2017	2018	2019	2020
Total area of salt pans (ha)	27634	25843	24961	24307	22718	21559
Total sea salt (10,000 tons)	237.5	218.7	205.3	172.9	166.4	158.2
Added value (100 million yuan)	8.1	8.0	7.8	7.3	6.7	6.4

As shown in Table 2, in recent years, with the gradual decline in the output of the sea salt industry in the city, the development of the marine salt industry has gradually slowed down, and the growth of the added value of the marine salt industry has also shown a downward trend. In 2020, the total area of salt fields will drop to 21,559 hectares, and the output of sea salt will drop to 1.582 million tons. Affected by this, the added value of the marine salt industry will also drop to 640 million yuan.

3.4. Marine Tourism Ecology - Marine Ports and Waterway Traffic Resources

Table 3. The city's marine transportation industry added value and port throughput

	2015	2016	2017	2018	2019	2020
Added value (100 million yuan)	341	286	322	395	367	408
Port cargo throughput (10,000 tons)	45962	48753	49284	52430	53725	54638
Port tourist throughput (10,000 people/times)	24	28	31	34	35	37

As shown in Table 3, the added value of the city's marine transportation industry and the throughput of marine ports. In 2020, the added value of the marine transportation industry will be 40.8 billion yuan, a slight increase of 19.65% compared with 2015. The port throughput continued

to increase, among which, the port cargo throughput reached 546.38 million tons, an increase of 18.88%; the port passenger throughput was 370,000 passengers, an increase of 54.17%.

4. Analysis and Suggestions on the Evaluation Results of the Intensive Utilization of MR in the City

4.1. Evaluation Index Weight Calculation Based on Lyapunov Function

Table 4. Calculation results of indicator weights

Index	Weights(%)
Marine input intensity	31.28
Ocean economic benefits	42.35
Marine tourism ecology	26.37

As shown in Table 4, the weights of the three evaluation indicators for the intensive utilization of MR calculated by using the Lyapunov function. It can be seen that the economic benefit index of marine gold has the largest weight, accounting for 42.35%; followed by the marine input intensity, which accounts for 31.28%; The last is the marine tourism ecological index, accounting for 26.37%. It can be seen that the marine economic benefits are the most critical factor affecting the intensive use of the sea.

4.2. Analysis of Evaluation Results

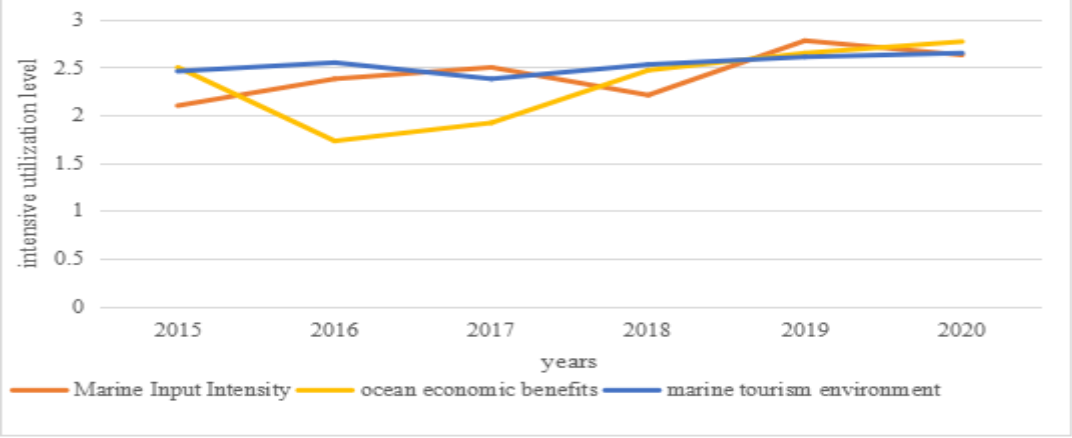

Figure 2. Changes in the intensive utilization of sea areas in the city

It can be seen from Figure 2 that the intensive utilization of the city's sea areas was relatively weak in 2015-2016. In 2017, it rose to a medium level, and in 2018-2020, it was in a state of fluctuating rise, but it was still a medium level. The marine input intensity is in a fluctuating and rising state, rising from a weak level to a medium level; the fluctuation of marine economic benefits is obvious, but the overall trend is on the rise; the level of intensive utilization of marine tourism environment is at a medium level, and the fluctuation changes have not improved significantly. The intensive utilization level of the two standard layers of marine input intensity and marine tourism environment is consistent with the trend of the city's comprehensive and intensive evaluation level. In general, the intensive utilization of MR in the coastal economic zone of the city has shown a fluctuating upward trend, the awareness of intensive utilization of MR has been enhanced, the comprehensive management level of sea areas has been improved, and the strengthening of marine

environmental protection has promoted the improvement of the city's intensive use of MR.

4.3. Suggestions for Improving the Intensive Utilization of MR

The unsatisfactory situation of the intensive use of sea areas in the coastal economic zone of the city has forced us to increase our attention to the intensive use of sea areas from all aspects. Here are some suggestions for improving the situation of intensive use of sea areas:

(1) Increase the investment in the sea area of the city's coastal economic zone. Government departments should invest more capital for the intensive use of sea areas; encourage employment and increase the number of people engaged in marine labor; increase investment in science and technology to improve marine aquaculture technology [16].

(2) Optimize the sea area utilization structure of the Liaoning coastal economic zone. Intensive utilization of sea areas in the city's coastal economic zone is unevenly distributed. All cities in the city's coastal economic belt should rationally plan the proportion of sea use for salt industry, increase the proportion of other sea use methods, and gradually guide and adjust the sea use that does not conform to functional zoning, especially to resolutely clean up unreasonable development activities in accordance with the law , to encourage the overseas development of aquaculture [17-18].

(3) In the future development, the city should combine the actual situation of the local area, promote the industrial structure and technological transformation, and promote the rationalization of the industrial structure; strengthen the construction of ecological civilization in the sea area, and develop the marine ecological economy[19]; Sea area resources; while developing the economy, strengthening the environmental protection of resources, adapting environmental pollution and control, realizing the orderly development of sea areas, and the continuous improvement of the intensive utilization of sea areas [20].

(4) Strengthen publicity and education on the value of MR. To optimize the development and utilization of MR and maintain the marine ecological environment, the first thing to do is to strengthen the publicity and education of the value of MR. The government should increase publicity and education on the management of sea area use and related systems and policies, so that the public can better understand the ownership of sea areas, the types of sea areas used, the methods of sea use, and the collection standards for sea area use fees. Management departments, industries, enterprises, and community members) have legal awareness of the use of the sea in accordance with the law and paid use of the sea, and earnestly safeguard the government's marine ownership interests and protect the marine ecological environment.

5. Conclusion

Abundant MR provide many necessities for people's production and survival. However, with the wanton exploitation of MR, the marine ecological environment has deteriorated seriously. ISE is a way to promote the rational use of MR. In this paper, based on the utilization of MR in city G, the Lyapunov function is used to calculate the weight of the evaluation index of the impact of ISE on the coastal areas of the city. The results show that the marine economic benefits The impact on the intensive utilization of MR has the greatest weight, and the city's marine intensive utilization can be improved from the perspective of improving the city's marine economic benefits.

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.

References

[1] Bayhan S , Seyedalipour S , Komurcugil H , et al. Lyapunov Energy Function Based Control Method for Three-Phase UPS Inverters With Output Voltage Feedback Loops. IEEE Access, 2019, PP(99):1-1. https://doi.org/10.1109/ACCESS.2019.2934404

[2] Giesl P , Mohammed N . Verification Estimates For The Construction Of Lyapunov Functions Using Meshfree Collocation. Discrete and continuous dynamical systems, 2019, 24(9):4955-4981.

[3] Martynyuk A A . 40 Years of the Direct Matrix-Valued Lyapunov Function Method (Review)*. International Applied Mechanics, 2020, 56(3):253-325. https://doi.org/10.1007/s10778-020-01013-x

[4] Nieto J J , Tun O . An application of Lyapunov–Razumikhin method to behaviors of Volterra integro-differential equations. Revista de la Real Academia de Ciencias Exactas, Físicas y Naturales. Serie A. Matemáticas, 2021, 115(4):1-21. https://doi.org/10.1007/s13398-021-01131-2

[5] Lisetskii F , Stolba V , Golyeva A , et al. Postantique Soils as a Source of Land Use Information: A Case Study of an Ancient Greek Agricultural Area on the Northern Black Sea Coast. Applied and Environmental Soil Science, 2020, 2020(3):1-15. https://doi.org/10.1155/2020/8698179

[6] Gumus S , Nver-Okan S , Hatay T Y . Analysis of work accidents in wood harvesting: a case study of the East Black Sea region. Forestist, 2020, 70(1):1-7. https://doi.org/10.5152/forestist.2020.19008

[7] Petton S , Pouvreau S , Dumas F . Intensive use of Lagrangian trajectories to quantify coastal area dispersion. Ocean Dynamics, 2020, 70(4):541-559. https://doi.org/10.1007/s10236-019-01343-6

[8] Bondur V G , Serebryany A N , Zamshin V V . Registering Fish Shoals Attracted by Solitary Intensive Internal Waves. Doklady Earth Sciences, 2020, 492(2):471-474. https://doi.org/10.1134/S1028334X20060033

[9] Bondur V G , Serebryany A N , Zamshin V V , et al. Intensive Internal Waves with Anomalous Heights in the Black Sea Shelf Area. Izvestiya, Atmospheric and Oceanic Physics, 2019, 55(1):99-109. https://doi.org/10.1134/S000143381901002X

[10] [Park J H , Grave S D , Park T . First record of the caridean shrimp family Chlorotocellidae (Crustacea: Decapoda) from Korea. Journal of the Marine Biological Association of the United Kingdom, 2021, 101(7):1029-1032. https://doi.org/10.1017/S0025315422000042

[11] Tladi D , Gupta J . An institutional framework for addressing marine genetic resources under the proposed treaty for marine biodiversity in areas beyond national jurisdiction. International environmental agreements: politics, law and economics, 2019, 19(4-5):485-495. https://doi.org/10.1007/s10784-019-09449-4

[12] Rozas-Serri M . Gill diseases in marine salmon aquaculture with an emphasis on amoebic gill disease. CAB Reviews Perspectives in Agriculture Veterinary Science Nutrition and Natural Resources, 2019, 14(32):1-15. https://doi.org/10.1079/PAVSNNR201914032

[13] Phankamolsil N , Sonsri K , Kheoruenromne I , et al. Spatial distribution characteristics and types of salt-affected soils spots developed on alluvial fan complex over old marine sediment, Thailand. Agriculture and Natural Resources, 2021, 55(2):229–236. https://doi.org/10.34044/j.anres.2021.55.2.10

[14] Carlucci R , Capezzuto F , Cipriano G , et al. Assessment of cetacean–fishery interactions in the marine food web of the Gulf of Taranto (Northern Ionian Sea, Central Mediterranean Sea). Reviews in Fish Biology and Fisheries, 2021, 31(1):135-156. https://doi.org/10.1007/s11160-020-09623-x

[15] Pollnac R B , Carothers C , Seara T , et al. Evaluating impacts of marine governance on human communities: Testing aspects of a human impact assessment model. Environmental Impact Assessment Review, 2019, 77(JUL.):174-181. https://doi.org/10.1016/j.eiar.2019.02.001

[16] Sangha K K , Stoeckl N , Crossman N , et al. A state-wide economic assessment of coastal and marine ecosystem services to inform sustainable development policies in the Northern Territory, Australia. Marine Policy, 2019, 107(SEP.):103595.1-103595.10. https://doi.org/10.1016/j.marpol.2019.103595

[17] Luttenberger L R , Mati J , Miheli D , et al. Environmental impact assessment procedures for projects in marine environment -evaluation analysis. Pomorstvo, 2020, 34(1):65-73. https://doi.org/10.31217/p.34.1.8

[18] B D áz L ópez, Methion S , Paradell O G . Living on the edge: Overlap between a marine predator's habitat use and fisheries in the Northeast Atlantic waters (NW Spain). Progress In Oceanography, 2019, 175(JUL.-AUG.):115-123. https://doi.org/10.1016/j.pocean.2019.04.004

[19] Raycraft J . Circumscribing communities: Marine conservation and territorialization in southeastern Tanzania. Geoforum, 2019, 100(MAR.):128-143. https://doi.org/10.1016/j.geoforum.2018.12.011

[20] Kyhn L A , Wisniewska D M , Beedholm K , et al. Basin-wide contributions to the underwater soundscape by multiple seismic surveys with implications for marine mammals in Baffin Bay, Greenland. Marine Pollution Bulletin, 2019, 138(JAN.):474-490. https://doi.org/10.1016/j.marpolbul.2018.11.038