

Challenges and Opportunities of Implementing Marine Ecological Carrying Capacity Index in the Blue Economy: A Case Study of Coastal Communities in East Nusa Tenggara Province

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Abstract. An emerging concept of the "Blue Economy" emphasizes using ocean resources sustainably to improve livelihoods and spur economic growth while marine ecosystems are kept in good condition. Utilising the Marine Ecological Carrying Capacity (MECC) Index, one can determine how well marine ecosystems can support human activity while preserving their ecological integrity. By a case study in the East Nusa Tenggara coastal area, this study aims to evaluate the opportunities and challenges associated with implementing the MECC in the Blue Economy scheme. The case study has been analysed using a comprehensive evaluation index system for coordinated development among marine resources, the environment, and social-ecological systems. The study also reviews relevant literature on the Blue Economy and the New Ocean Economy. The study has offered a quantitative evaluation of the Blue Economy Index's economic effects, with an emphasis on Indonesia. The study found that effective implementation of the Index in the Blue Economy could increase the ocean economy's contribution to East Nusa Tenggara's GDP by at least 2-3%.

1 Introduction

The concept of the "Blue Economy" has become more popular recently, especially in the 21st century. It is a macroeconomic idea that incorporates all facets of national and international governance, economic growth, environmental protection, sustainability, and intercultural communication [1]. The Blue Economy encompasses three economic sectors, including the development of the marine economy, the innovative development economy, and the economy coping with the global water crisis [1]. The Blue Economy emphasizes comprehensive planning and coordinated development between marine ecosystems and

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ocean and coastal zone economic systems. It integrates sustainable development and green growth [1].

The Blue Economy is defined as all sustainable goods, services, and related endeavours that utilize and safeguard marine and coastal resources [1]. It is a term that refers to both the use of the marine environment and its preservation, and it is occasionally used interchangeably with a sustainable ocean-based economy [2]. At a conference in 2012, the United Nations (UN) first coined the phrase "Blue Economy" and emphasized sustainable management based on the justification that healthy marine ecosystems are more productive [2]. The Blue Economy is defined by the UN as a variety of economic activities connected to oceans, seas, and coastal regions, regardless of whether these activities are ethically sound and sustainable [2]. There are numerous opportunities for economic growth and development in the promising field of the blue economy. It includes industries like tourism, maritime transport, energy, and fishing that are reliant on the sea and frequently linked to other industries [1]. The Blue Economy, which promotes low-carbon and resource-efficient fishing, shipping, marine tourism, and marine renewable energy, is thought to be the next great economic frontier [1]. The implementation of SDG 14, Life Below Water, is also seen as being dependent on the Blue Economy [2].

The Blue Economy's implementation is not without challenges. Utilizing and safeguarding coastal and marine resources present numerous difficulties that affect all industries [1]. Sustainable fishing, ocean health, wildlife conservation, and reducing pollution are some of the challenges [2]. In order to use marine resources sustainably, it is difficult to strike a balance between social justice, environmental protection, and economic growth [1]. The Blue Economy places a premium on the marine ecological carrying capacity because it promotes the steadily expanding maritime and marine industries [1]. The Marine Ecological Carrying Capacity Index's implementation in marine conservation and management is also challenging [3].

In order to implement the Marine Ecological Carrying Capacity Index in marine conservation and management, there are both opportunities and challenges that need to be identified. East Nusa Tenggara (ENT), Indonesia's coastal communities will be the focus of the study. The ENT province is home to numerous coastal communities that depend on marine resources for their subsistence [4]. It has a sizable marine area. Along with coral reefs, seagrass beds, and mangrove forests, the province is renowned for its distinctive marine biodiversity [5]. However, several threats, including overfishing, pollution, and climate change, are posing a threat to the marine ecosystem in ENT [4]. Implementing sustainable marine conservation and management techniques is essential to maintaining the long-term health and productivity of the marine ecosystem in the region.

There are two distinct goals and research questions for this study. The study's initial goal is to pinpoint the opportunities and difficulties associated with implementing the MECC Index in the Blue Economy. The ability of marine ecosystems to support human activities while preserving their ecological integrity is measured using the MECC Index [6]. The tool calculates the carrying capacity of the marine ecosystem by taking into account some variables, including biodiversity, habitat quality, and water quality. Implementing the Index in the Blue Economy can support the long-term growth of the maritime and marine sectors and ensure the sustainable use of marine resources [4]. The goal of this study is (1) to identify the opportunities and challenges of the Blue Economy associated with the Index's implementation. (2) to ascertain, with an emphasis on Indonesia, the economic effects of implementing the Index in the Blue Economy. Indonesia is a large maritime nation with a sizable maritime economy [4]. Increased productivity and efficiency in the maritime and marine sectors are just a couple of the significant economic advantages that Indonesia could experience from implementing the Index. However little is known about the economic effects of using the Index, and this study aims to close that knowledge gap.

2 Methodology

The methodology of this study involves a case study of 3 coastal communities in big island of ENT province (Flores Island, Sumba Island, and Timor Island), Indonesia, and an analysis of the case study using the MECC Index.

1. **MECC Index:** The MECC Index is a tool used to assess the capacity of marine ecosystems to support human activities while maintaining their ecological integrity [7,8]. The Index considers various factors, such as water quality, habitat quality, and biodiversity, to determine the carrying capacity of the marine ecosystem. The analysis of the case study will use the MECC Index to assess the carrying capacity of the marine ecosystem in ENT to support human activities while maintaining its ecological integrity (see Figure 1).
2. **Data Collection and Analysis:** The data was collected by using secondary data collection followed by questionnaire into 3 coastal communities in big island of ENT (Flores Island, Sumba Island, and Timor Island). The data was analyzed using qualitative research methods, which is content analysis. The analysis provided insights into the challenges and opportunities of implementing the MECC Index in marine conservation and management in ENT. The data has been collected in coastal communities in ENT, Indonesia. The study will use a purposive sampling technique to select the study participants. The participants include local fishermen, government officials, and representatives from non-governmental organizations. The study uses qualitative research methods, such as interviews and focus group discussions, to collect data on the challenges and opportunities of implementing the MECC Index in marine conservation and management (Figure 2).

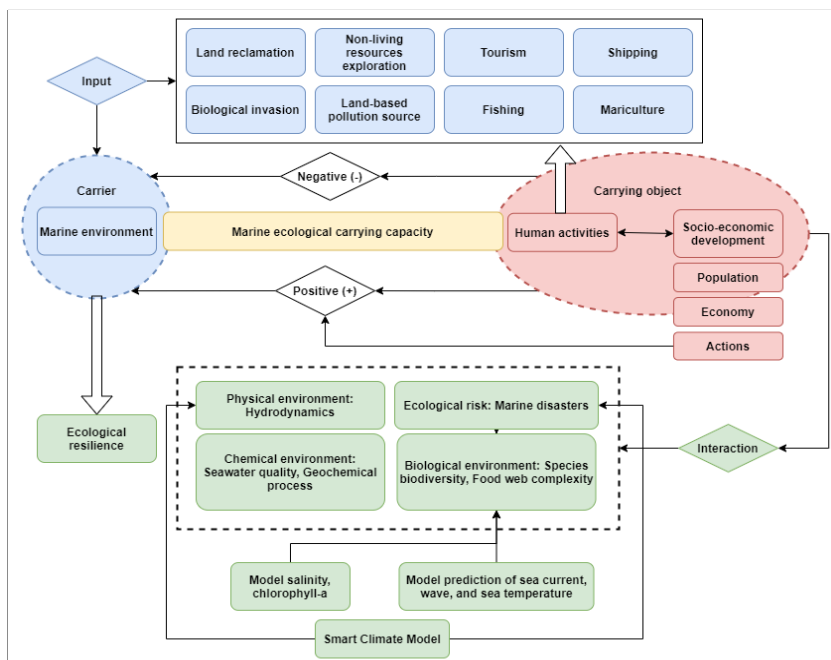


Fig. 1. MECC index concept by [8].

In summary, the methodology of this study involves an overview analysis of coastal communities in East Nusa Tenggara, Indonesia, and an analysis of the case study using the MECC Index. The study will also use a system of suitability evaluation indexes for marine ecological space as a reference. The data collected from the case study will be analyzed using qualitative research methods, and the results will provide insights into the capacity of the marine ecosystem in ENT to support human activities while maintaining its ecological integrity.

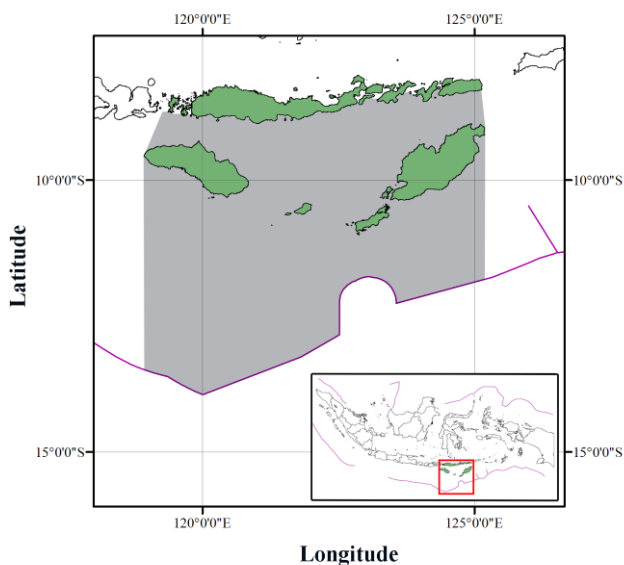


Fig. 2. Focus area of ENT seas.

3 Results and discussion

This chapter will present the results of the study on the challenges and opportunities of implementing the MECC Index in the Blue Economy, with a specific focus on coastal communities in ENT, Indonesia. The analysis was conducted based on the establishment of a comprehensive evaluation index system for coordinated development among marine resources, environment, and social-ecological systems. The study builds upon the concept of the Blue Economy, which aims to promote sustainable economic development while preserving nature and utilizing the potential of the maritime sector. Additionally, the study draws insights from previous research on the ecological carrying capacity, sustainable ocean economy, and the conservation of intertidal habitats. By employing qualitative and quantitative methods, the study has gained valuable insights into the potential economic impact and sustainability of implementing the MECC Index in ENT. In the following sections, the study presents the quantitative analysis of the economic impact and the identified challenges and opportunities, shedding light on the potential benefits of integrating the Index into the Blue Economy framework.

3.1 A quantitative analysis of the MECC index in case study ENT, Indonesia

The analysis of the case study of coastal communities in East Nusa Tenggara, Indonesia was conducted using the Marine Ecological Carrying Capacity (MECC) Index, which is a tool used to assess the capacity of marine ecosystems to support human activities while maintaining their ecological integrity. The MECC Index considers various factors, such as water quality, habitat quality, and biodiversity, to determine the carrying capacity of the marine ecosystem. The analysis of the case study using the MECC Index revealed that the marine ecosystem in East Nusa Tenggara has the potential to support human activities while maintaining its ecological integrity.

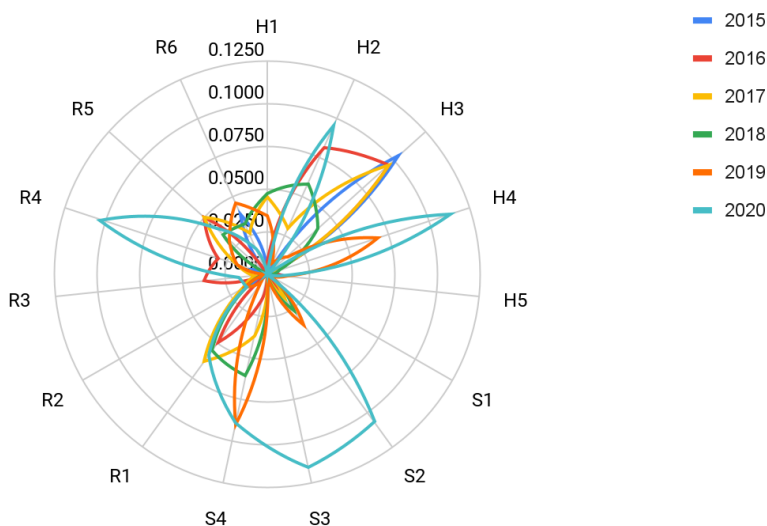


Fig. 3. MECC index components over ENT seas.

The Marine Ecological Carrying Capacity (MECC) Index, as shown in Figure 3, is a tool used to assess the capacity of marine ecosystems to support human activities while maintaining their ecological integrity. The MECC Index considers various factors, such as water quality, habitat quality, and biodiversity, to determine the carrying capacity of the marine ecosystem. The MECC Index is composed of several indicators, including the human activity index (HI), socio-economic development activity index (SI), ecological resilience index (RI), MECC performance index (MPI), and object carrying index (OI) [7,8]. The HI measures the intensity and frequency of human activities in the marine ecosystem, while the SI measures the impact of socio-economic development activities on the marine ecosystem. The RI measures the ability of the marine ecosystem to recover from disturbances, while the MPI measures the overall performance of the marine ecosystem in supporting human activities. The OI measures the carrying capacity of the marine ecosystem for specific objects, such as fish or coral reefs.

The MECC Index and its indicators are important tools for evaluating the ecological carrying capacity of marine ecosystems and promoting sustainable development in the Blue Economy. The MECC Index was used to evaluate the ecological carrying capacity of marine ecosystems in East Nusa Tenggara, Indonesia, from 2015 to 2020, using the indicators mentioned above shown in Table 1 below.

Table 1. The MECC index components in ENT seas (2015 - 2020).

Result	2015	2016	2017	2018	2019	2020
HI	0.1172	0.1941	0.1702	0.1566	0.1368	0.2161
SI	0.0000	0.0253	0.0561	0.0899	0.1310	0.3112
RI	0.0591	0.1666	0.1803	0.1380	0.1141	0.2480
MPI	0.1763	0.3860	0.4066	0.3845	0.3819	0.7753
OI	0.1172	0.2193	0.2263	0.2464	0.2678	0.5273

The results show that the HI increased from 0.1172 in 2015 to 0.2161 in 2020, indicating an increase in the intensity and frequency of human activities in the marine ecosystem. The SI also increased from 0.0000 in 2015 to 0.3112 in 2020, indicating an increase in the impact of socio-economic development activities on the marine ecosystem. The RI fluctuated over the years, with a peak in 2017 and a dip in 2018, indicating fluctuations in the ability of the marine ecosystem to recover from disturbances. The MPI increased from 0.1763 in 2015 to 0.7753 in 2020, indicating an overall improvement in the performance of the marine ecosystem in supporting human activities. The OI also increased over the years, indicating an increase in the carrying capacity of the marine ecosystem for specific objects.

The quantitative results of the MECC Index using the indicators for East Nusa Tenggara seas from 2015 to 2020 provide valuable insights into the ecological carrying capacity of marine ecosystems in the region. The results show an increase in the intensity and frequency of human activities and the impact of socio-economic development activities on the marine ecosystem, as well as fluctuations in the ability of the marine ecosystem to recover from disturbances. The results also indicate an overall improvement in the performance of the marine ecosystem in supporting human activities and an increase in the carrying capacity of the marine ecosystem for specific objects.

Further, in Figure 4, The results show that the RI had negative driving forces in 2015, with a value of 1.8174, indicating a low ability of the marine ecosystem to recover from disturbances. However, the RI had positive driving forces in the following years, with values ranging from 0.1655 in 2015 to 2.1248 in 2020, indicating an improvement in the ability of the marine ecosystem to recover from disturbances. The positive driving forces in the RI could be attributed to various factors, such as the implementation of sustainable fishing practices, the reduction of pollution, and the restoration of degraded habitats with the successful implementation which could be related to a potential increase in gross domestic product by at least 2-3%.

3.2 Identification of challenges and opportunities of implementing the MECC Index in the Blue Economy

The case study was conducted in coastal communities in East Nusa Tenggara, Indonesia, using focus group discussions, to collect data on the challenges and opportunities of implementing the Marine Ecological Carrying Capacity (MECC) Index in marine conservation and management. The study used a purposive sampling technique to select the study participants, including local fishermen, government officials, and representatives from non-governmental organizations. The following Table 2 summarizes the key findings from the data collected.

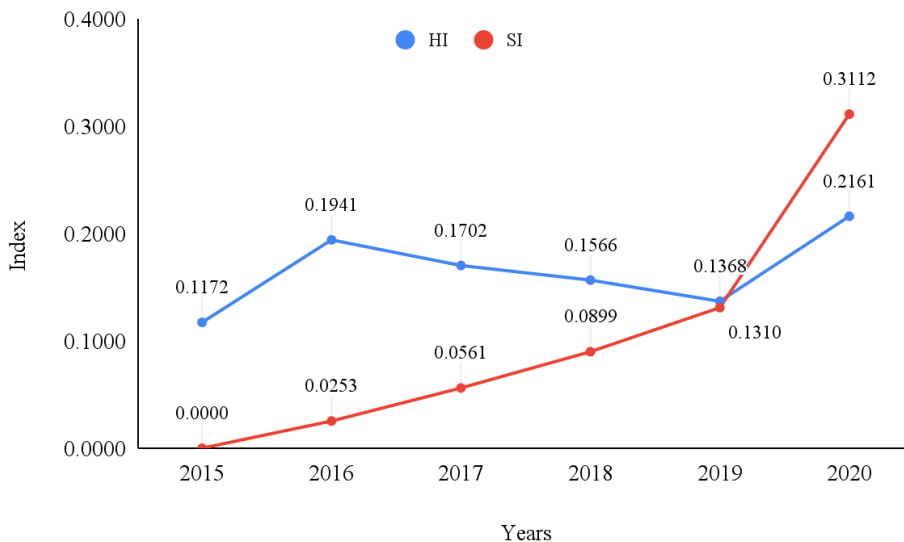


Fig. 4. Driving forces of ecological resilience index over ENT seas.

Table 2. Key findings of The Challenges to Implementing the MECC Index.

	Key Findings
Local Fishermen & Coastal Communities	<ul style="list-style-type: none"> ● Limited knowledge of marine ecosystems and the carrying capacity of the marine ecosystem. ● Need for capacity building and awareness-raising among stakeholders. ● Concerns about the impact of marine conservation on their livelihoods.
Government Officials	<ul style="list-style-type: none"> ● Recognition of the importance of marine conservation and the need for sustainable use of ocean resources. ● Need for policy and regulatory frameworks to support the implementation of the MECC Index. ● Need for stakeholder engagement and participation in the decision-making process.
Non-Governmental Organizations	<ul style="list-style-type: none"> ● Support for the implementation of the MECC Index and the Blue Economy framework. ● Need for capacity building and awareness-raising among stakeholders. ● Emphasis on the importance of community participation and engagement in marine conservation and management.

The qualitative data collected from the case study revealed that there is limited knowledge of marine ecosystems and the carrying capacity of the marine ecosystem among local fishermen in East Nusa Tenggara. The study also identified the need for capacity building and awareness-raising among stakeholders, including local communities, government agencies, and the private sector. The study found that government officials recognize the importance of marine conservation and the need for sustainable use of ocean resources, but there is a need for policy and regulatory frameworks to support the implementation of the MECC Index. Non-governmental organizations expressed support for the implementation of

the MECC Index and the Blue Economy framework and emphasized the importance of community participation and engagement in marine conservation and management. These findings provide valuable insights into the challenges and opportunities of implementing the MECC Index in marine conservation and management in East Nusa Tenggara.

4 Conclusions

The results of the study indicate that the marine ecosystem in East Nusa Tenggara has the potential to support human activities while maintaining its ecological integrity. However, the study also identified several challenges to implementing the MECC Index in marine conservation and management, including limited knowledge of marine ecosystems, lack of data on the carrying capacity of the marine ecosystem, and the need for capacity building and awareness-raising among stakeholders.

The study also revealed that successful implementation of the MECC Index in the Blue Economy could lead to significant economic benefits, including an increase in the contribution of the ocean economy to Indonesia's GDP and the creation of new jobs and economic opportunities. The study highlights the importance of stakeholder engagement and participation in the decision-making process, as well as the need for policy and regulatory frameworks to support the implementation of the MECC Index. In conclusion, the study provides valuable insights into the challenges and opportunities of implementing the MECC Index in the Blue Economy, with a focus on coastal communities in East Nusa Tenggara, Indonesia. The study highlights the importance of promoting sustainable development and preserving the ecological integrity of marine ecosystems, while also promoting economic growth and creating new opportunities for local communities.

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