Towards Sustainable Fisheries Through Marine Ecological Carrying Capacity Index

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Abstract. Overexploitation and unsustainable fisheries activities will have an impact on environmental quality degradation. In the 4.0 era, technology can assist in monitoring and managing sustainable fisheries resources. Research on sustainable fisheries management activities guided by the marine ecological carrying capacity (MECC) evaluation index has been carried out. The purpose of this study was to determine changes in fishery activity to MECC as an evaluation material for sustainable development in the fisheries sector in the form of a website. This can provide convenience and effectiveness and can be used as a basis by stakeholders in monitoring and making policies in the sustainable development of the fisheries sector. MECC is composed of two components, namely carrying object (OI) and carrier resilience (RI). OI is obtained from changes in the value of changes in human activity (RI) and socio-economic development (SI). Fishery activities are a component of RI in the Nunukan Regency, Indonesia. The HI value decreased during 2015 - 2019 and affected the decline in the MECC index as a whole. This decrease was caused by the increase in fish catches, the number of fishing households, and boat activity in the waters of the Nunukan Regency. Based on the evaluation of the decline in the value of HI, it can be used as an evaluation material in developing integrated and sustainable development in the fisheries sector by mitigating bycatch by regulating fishing gear and methodologies, as well as establishing protected area management and fishing. To make this happen, it is necessary to build partnerships between public authorities, business, civil society, academia, and the financial sector within the framework of the Penta-helix model.

Key Words: Fisheries Management, Sustainability, Marine Ecological Carrying Capacity (MECC), Information System

1 INTRODUCTION

Background

Fishery products make important contributions to the livelihoods, food and nutrition security, and well-being of international coastal groups. Fishery activities are vulnerable due to declining environmental health and climate change. Fisheries sustainability is challenged by several elements and techniques including overfishing and unprofitable fishing practices, improper shore repair, and land-based pollutants [1]. All of these can threaten the productivity of the useful resource base, poor fish handling, and abandoned harvesting practices, in addition to non-existent, or underdeveloped infrastructure, leading to high wastage, and loss of yields. Fisheries sustainability is also low with the cumulative impact of climate change, resulting in shifts in species abundance and variety, increased acidity and deoxygenation of the oceans, in addition to increasing climate turbulence, making sport fishing less certain and more unstable [1].

If climate change which decrease the biodiversity and increase the number of pollutants continue to emerge in the future, it will lead to more critical consequences. Consequently, to reduce the adverse impacts that arise, sustainable marine monetary improvement efforts are needed. Therefore, the idea of Integrated Ocean Management (IOM) techniques is vital. IOM is a sustainable concept that aims to improve the ability to use and sustainably manage marine resources and ensure that the health, productivity, and resilience of marine ecosystems can provide multiple benefits without reducing environmental quality due to human activities [2]. Consequently, it is imperative to effectively measure, monitor, and adaptively manipulate ocean space as a complex adaptive engine [3]. The Marine Ecological Carrying Capacity (MECC) can be used as a means to monitor IOM implementation. The regularly occurring characteristics of the affected MECC and the need for answers to address human activities and socio-economic improvements for marine and coastal management in Nunukan Regency is one of the unique contexts including local knowledge, environmental conditions, scale-up of the surrounding environment. movement, and the need for percentage facts and potential builds.

Strong resource control has been thwarted by the loss of information about how humans impact the ocean. There was an explosion in statistics and a new era for the ocean in the meantime and with it the vast potential for advances in knowledge and management of marine resources. Coordinated efforts by industry, researchers, and governments can create sophisticated sensor networks that provide anyone who wants them with a redundant, real-time record of the oceans, an "Internet of Things" for the oceans [4]. Era can take advantage of important improvements in control. Real-time statistics and automation can enable powerful and agile variations to change situations and create new accountability in authorities and across companies. An urgent priority is to ensure that the new capabilities are shared by all marine stakeholders. In the 4.0 era, technology can assist in monitoring and handling sustainable fisheries resources.

This research conducted a combination of MECC concept with the “4.0” approach. Calculation of MECC parameters was conducted inside a system with algorithm then it is depicted as simple as possible with cloud system. The simplicity of the information is important because it will be used by some of stakeholders including local government or even fisherman. Naturally, not all part of society could easily understand the MECC information, therefore, the visualization method plays an important role in order to transfer the information from MECC system to the stakeholders. The aim of this study is to map the potential of the coastal environment especially in Nunukan Regency with the approach of MECC concept that already integrated with cloud system.

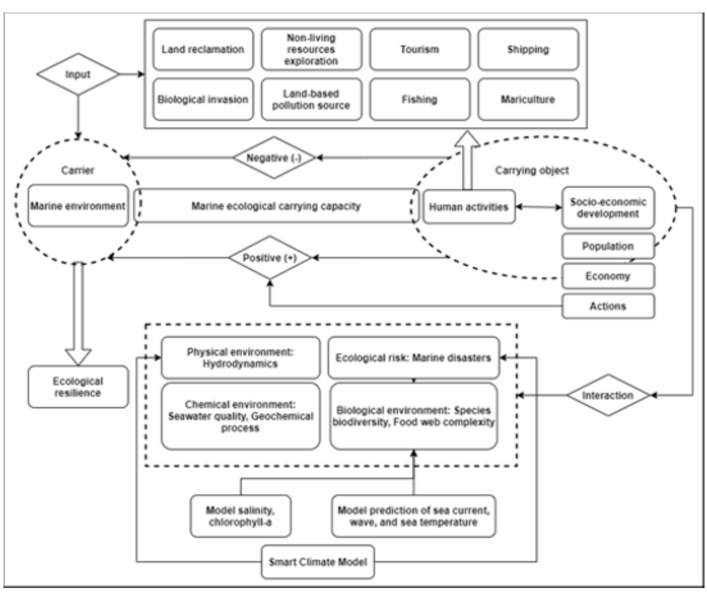

Figure 1. Marine Ecological Carrying Capacity (MECC) Modeling Concept Chart

2 METHODS

Marine Ecological Carrying Capacity (MECC) Monitoring System

Carrying capacity could be described as an ecological principle which states that a certain consumption value will accommodate a limited number of individuals as long as the surrounding ecosystem is not degraded. This concept is to describe the relationship between the community as a supporting entity (carrying object) and the environment as support (carrier) to ensure sustainability. The population carrying capacity is theoretically followed by the carrying capacity of resources, the carrying capacity of the environment, and finally the ecological carrying capacity (ECC). Many studies have been conducted with a focus on comprehensive regional carrying capacity because sustainable development policies have become the main guideline in regional socio-economic development. Compared to other ecosystem assessments used in sustainability research such as those used in health and climate risk studies, the results of this study are more promising [7], the ECC assessment looks at ocean-atmosphere climate, living things, and their relationships from a more holistic perspective. This metric is easier for the public and policymakers to understand because it offers a holistic understanding of the environmental impacts of sustainable economic and social change, and reveals capacity deficits and surpluses for specific ecosystem components [8]. The ECC has become a widely used index to create a sustainable regional ecological environment [8]. Human activities (such as fishing), coastal growth, and pollution have all changed and disrupted the capabilities of marine ecosystems as the marine economy developed [5].

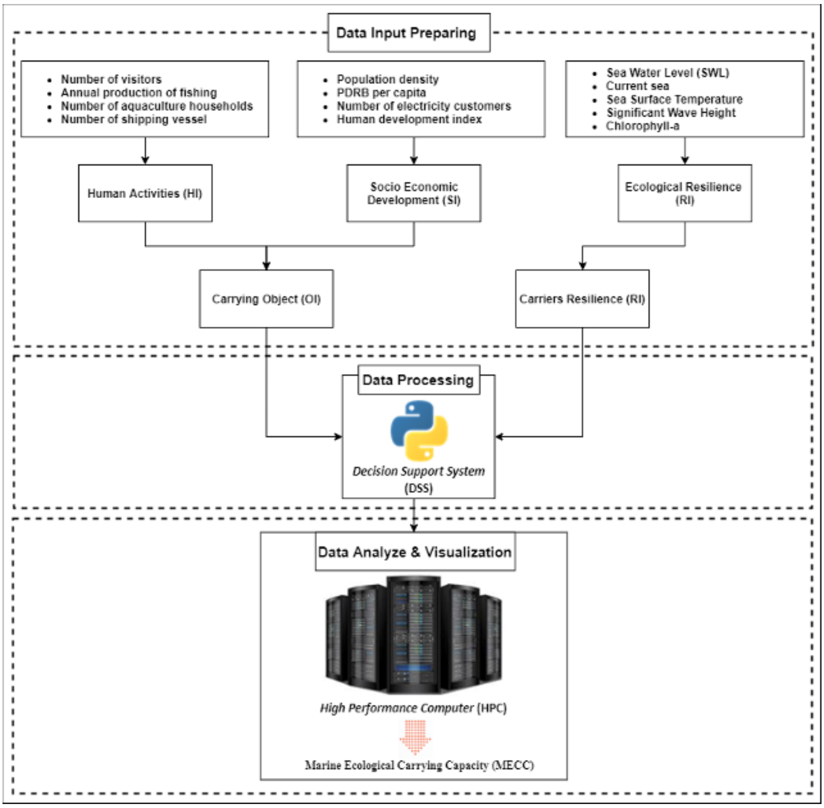

Figure 2. Design of the Marine Ecological Carrying Capacity (MECC) prediction calculation system.

There are three stages on forming the design system, namely data preparation, data processing, and data visualization (Figure 2). The MECC calculation to become An MPI consists of two components, namely the carrying object component (human activity and socio-economic growth) and the carrier resistance component (ecological resilience). Human activities include coastal and marine activities that directly suppress ecosystems (carriers), while socio-economic growth includes elements that represent the population and coastal economy, as well as actions to protect coastal areas. The carrier resilience component consists of elements that maintain or damage the structure and function of coastal and marine ecosystems.

Figure 3. Value of MECC indicators in Nunukan regency during 2015-2019

3 RESULTS AND DISCUSSION

Nunukan Regency is one of the Marine and Capture Fisheries Centers (SKPT) that has been established by the Ministry of Maritime Affairs and Fisheries (KKP) in Indonesia. MECC indicator data for Nunukan Regency for 2015-2019 was obtained from the Central Statistics Agency (BPS) of the Nunukan Regency, European Center for Medium-Range Weather Forecasts (ECMWF), Moderate Resolution Imaging Spectroradiometer (MODIS), and Visible Infrared Imaging Radiometer (VIIRS) as shown in Figure 3.

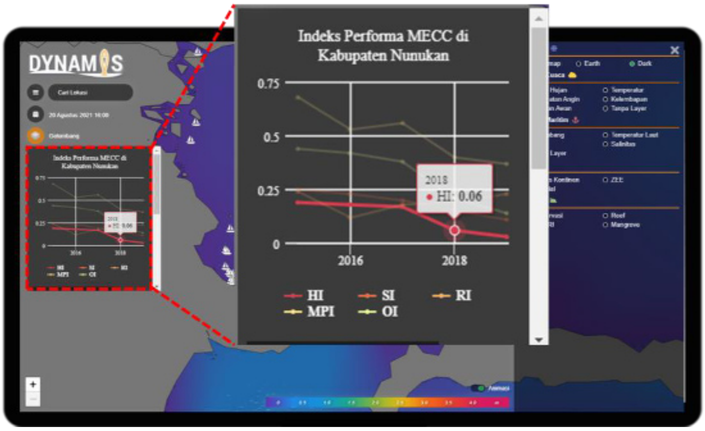

Figure 4. Graph of human activity carrying index (HI) in Nunukan Regency 2015-2019

The graph of the value of the innate human activity index (HI) in Nunukan Regency in 2015-2019 is shown in Figure 4 showing a decrease from 2015 to 2019. The value of HI has decreased by 82% from 0.19 in 2015 to 0.03 in 2019, which shows the effect of increasing human activities that continue to increase. This shows that the increase in the development of socio-economic activities is not proportional to the increase in the human development index in Nunukan Regency.

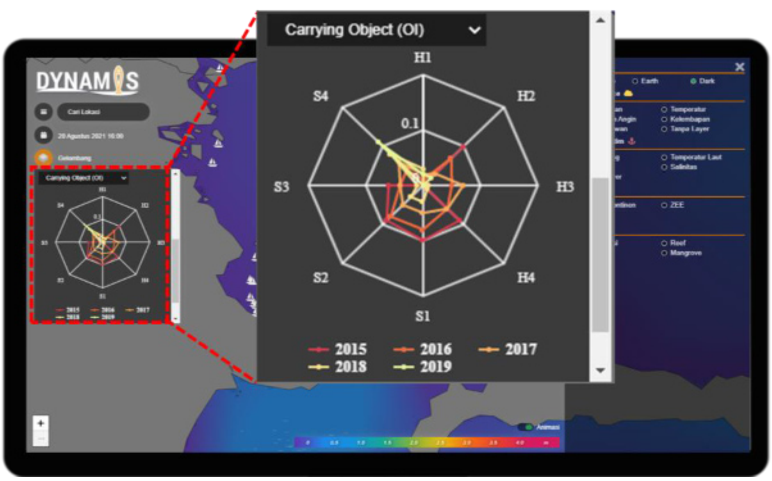

Figure 5. The value of 8 carrying indicators in Nunukan Regency during 2015- 2019

Figure 5 depicts the value of the bearer object indicators (HI and SI) during 2015-2019. In indicators of human activity (H1-H4), the production value of fish catches (H2) and the number of vessels (H4) in the waters of the Nunukan Regency was increased from 2015 to 2019. This shows that the fishing industry, both capture fisheries, and fisheries aquaculture and marine transportation in Nunukan Regency continued to increase from 2015 to 2019. This can be seen from the increase in the number of capture fisheries products (H2, average rate of increase of 6%) and the number of fishermen households (H3, 1% increase rate on average). In addition, sea transportation activities also experienced an increase as seen from the number of ships operating in Nunukan waters (H4, the average rate of increase increased by 4%) while the number of tourists decreased (H1, the average rate of increase decreased by 2%). The increase in activity in this area shows that there has been excessive exploitation in the coastal area so that which can lead to disruption of the stability of the coastal ecosystem in Nunukan Regency.

Based on the evaluation of the decline in the value of HI, it can be used as an evaluation material in developing integrated and sustainable development in the fisheries sector through by catch mitigation by regulating fishing tools and methodologies, as well as determining the management of protected areas and fishing. To achieve this, it is necessary to build partnerships between public authorities, business, civil society, academia, and the financial sector within the framework of the Penta-helix model.

4 CONCLUSION

Based on the MECC analysis, the value of HI has decreased during 2015 – 2019 and has an impact on the decline in the MECC index as a whole. This decrease was caused by an increase in fish catches, the number of fishing households, and boat activities in the waters of the Nunukan Regency. Based on the evaluation of the decline in the value of HI, it can be used as an evaluation material in developing integrated and sustainable development in the fisheries sector through bycatch mitigation by regulating fishing tools and methodologies, as well as determining the management of protected areas and fishing.

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