Development strategy for marine conservation area of Mare Island, Tidore Islands City

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Abstract. Mare Island is a strategic small island, both in its location and its natural resources. In the Regional Regulation of North Maluku Province Number 2 of 2018 concerning Zoning Plans for Coastal Areas and Small Islands of North Maluku Province for 2018-2038, Mare Island is designated as Coastal and Small Islands Conservation Areas. Furthermore, through the Decree of the Minister of Marine and Fisheries Affairs Number 66/KEPMEN-KP/2020, Mare Island has been designated as a Marine Conservation Area. The research aims to formulate a strategy for developing marine conservation areas on Mare Island. Field data collection was carried out in the form of observations, interviews and questionnaires, analysis of existing spatial conditions using the Geographic Information System (GIS), for strategy formulation using SWOT analysis tools after identifying various internal and external factors. The external strategy, while the alternative strategy is continued by determining the priority of the strategy using the Analytical Hierarchy Process (AHP). The results showed that there were 11 alternative formulations of strategies for development of Mare Island marine conservation areas in order of priority: Improved conservation area management, Capacity building for government and community organizations, Implementation of Zoning Plans and Preparation of Detailed Spatial Plans, Economic empowerment and development of alternative livelihoods, Partnership network improvement, Improvement of tourism facilities and infrastructure, Collaboration of programs among local government offices, Structuring residential areas, Limiting the use of SDKP, Law enforcement and Development of sea and land transportation facilities.

1. Introduction
Currently, potential natural resources of small islands have not been optimally utilized in North Maluku Province [1]. In fact, according to opinion of [2], resources of small islands can be utilized for various economic activities, such as tourism, capture fisheries, aquaculture, etc., simultaneously, or alternately according to natural conditions [3]. Even small islands, if successfully developed optimally and sustainably, will not only be a source of new growth but will also reducing development gap between regions and social groups in Indonesia [4].

Tidore Island City has 11 small islands, namely: Tidore Island, Mare, Maitara, Failonga, Sibu, Woda, Raja, Guratu, Shield, Joji and Taba Island. Of the eleven islands, three of them are inhabited islands, namely Tidore, Mare and Maitara, while the rest are uninhabited islands [5].
Mare Island is a strategic island, both in its location and its abundance of natural resources. In the Regional Regulation of North Maluku Province Number 2 of 2018 concerning Zoning Plans for Coastal Areas and Small Islands of North Maluku Province for 2018-2038, Mare Island surrounding sea is designated as Coastal and Small Islands Conservation Areas. Furthermore, through the Decree of the Minister of Fisheries and Marine Affairs number 66/KEPMEN-KP/2020, the waters of the island of Mare have been designated as a Marine Conservation Area. The basis for considering the waters of Mare Island as an aquatic conservation area is in the context of protecting, conserving, and utilizing fishery potential, the existence of important habitats and biota such as coral reefs, seagrass beds, mangroves, reef fish, small pelagic fish, black fin sharks, and other protected species like dolphin. Where these wild marine animals are considered to have their own uniqueness and have opportunity to support sustainable marine tourism activities [6].

In the ministry regulation, it is stated that the marine conservation area of Mare Island will be managed as an Aquatic Tourism Park which has a total area of 7,060.87 hectares and is divided into core zone with an area of 155.14 hectares and utilization zone in form of a marine nature tourism subzone with an area of 61.05 hectares. Other zones are sustainable fisheries zone with an area of 6,811.01 Ha and rehabilitation zone with an area of 33.67 Ha.

Figure 1. Map of prospective water conservation areas in Tidore Archipelago City, North Maluku

2. Research methods

2.1 Research location and time
This research was carried out on Mare Island, South Tidore Sub-district, Tidore Islands City, North Maluku Province, as shown in Figure 2.
2.2 Data and data sources
The data in this study included biophysical conditions of islands and se waters, socio-economic and cultural conditions, facilities and infrastructure conditions, policies, and organizational of local government. The data sources used were primary and secondary data [8].

2.3 Data collection technique
Field data collection was done in forms of observation, interview, and distribution of questionnaires.

2.4 Data analysis
2.4.1 Spatial analysis
Spatial analysis was carried out using Geographic Information System (GIS) with ArcGIS software. This spatial analysis focused on analyzing the existing condition of the land use of Mare Island.

2.4.2 Alternative strategy formulation and strategic priority determination
SWOT Analysis
Strategy formulation applied SWOT analysis tools after identifying various internal and external factors. This analysis was based on logic that could maximize Strengths and Opportunities, but simultaneously minimize Weaknesses and Threats [11].

Analytical Hierarchy Process (AHP)
The results of the SWOT analysis in the form of alternative strategies were followed by setting strategic priorities using the Analytical Hierarchy Process (AHP) [12]. The principles used were hierarchical arrangement, priority setting and assessing logical consistency. The focus in the preparation of the hierarchy was to determine priorities of the Mare Island conservation area development strategy at Level 1 of the hierarchy. The focus was then divided into four SWOT components (strengths, weaknesses, opportunities, and threats) at Level 2 which was result of the identification of external and internal factors. The hierarchical arrangement was still continuing at Level 3, namely alternative strategies from the results of the SWOT analysis.

3. Results
3.1 Tidore Islands City overview
The City of Tidore Islands is located between 0°47′21.18″N and 27°37′5.41″E to 0°127.56′S and 127°47′47.41″E, and between 0°34′21.85″N and 127°49′53.81″E to 0°43′59.78″N and 127°21′42.49″E.
The area of Tidore Islands City in the north is bordered by Ternate City and South Jailolo Sub-district, West Halmahera Regency; to the south with South Halmahera Regency and Ternate City; in the east with South Wasile Sub-district, East Halmahera Regency and Weda Sub-district, Central Halmahera Regency; and to the west with the Molucca Sea.

3.2 Coastal and aquatic ecosystem conditions

There are three types of important ecosystems on the coast of Mare Island, namely coral reefs, mangroves, and seagrasses. The distribution is shown in Figure 3

3.2.1 Coral reef ecosystem

Coral reefs can be found around Mare Island with a total area of 146.19 Ha [6]. According to the results of the study as quoted by the North Maluku Government [6], composition of coral reefs on Mare Island consists of hard corals, broken corals, soft corals, sand, sponges, and algae. Most rubble was found at a depth of 6-10 m with a percentage of 33%, while hard corals at a depth of <4 m had the largest percentage of 47% compared to hard coral cover in deep waters. The number of broken corals and the lack of hard coral cover at a depth of 6-10 m indicated the use of bombs and cyanide in the waters of Mare Island.

The percentage of hard coral cover in the waters of Mare Island ranges from 6% to 70% which indicated the coral reefs were in poor to moderately good condition. The area with the lowest percentage of hard coral cover was in front of Maregam Village, while Batu Nona in Marekofo area had the highest percentage of hard coral cover at 70%. The data referred to are shown in graphical form in Figure 4. Good coral reefs provide places for coral fish to live which can be a source of income for local fishermen and coastal communities, besides that it can also be an attraction for dive tourists to enjoy the beauty of coral reefs.
3.2.2 Mangrove ecosystem
Mangroves on Mare Island grow along Maregam Village in the Northeast of the island and Marekofo Village in the Southwest of the Island. According to the Tidore Islands City Bapelitbang report [5], the mangrove area on Mare Island is 43.56 Ha [5], mangroves on Mare Island consisted of five species from three mangrove families. The five species were *Rhizophora stylosa*, *R. apiculata*, *Bruguiera gymnorrhiza*, *Sonneratia alba* and *Avicennia alba*. Furthermore, [7] concluded that the mangrove species *Sonneratia alba* obtained the highest cover value on Mare Island because this species had a large stem circumference, which also affected coverage at each location. Meanwhile, based on the overall analysis, it shows that *Rhizophora apiculata* was most dominant vegetation in mangrove community on Mare Island. It was also concluded that from the calculation results, the diversity of mangrove species on Mare Island was in very low category.

3.2.3. Seagrass ecosystem
According to the report by [1] as quoted by the North Maluku Government [9] [10], it was stated that the area of seagrass ecosystem on Mare Island is ±9.68 Ha. Existence of this ecosystem was found in the west and the north of the island, in the south in front of Marekofo Village and in the east in front of Maregam Village. There were five species of seagrass found on Mare Island, namely *Cymodocea serrulata*, *C. rotundata*, *Syringodium isoetifolium*, *Enhalus acoroides* and *Thalassia hemprichii*.

3.3 Strategy formulation
Results of SWOT matrix analysis indicated links between internal and external factors (links between the components of strengths and opportunities, components of strengths and threats, components of weaknesses and opportunities, components of weaknesses and threats). The linkage of internal and external factors resulted in 11 alternative strategies, the explanations of which are as follows:

1. SO strategy, is an aggressive strategy because of the link between the factors of strength and opportunity. The alternative strategies formulated are:
   a. Improved management of conservation areas
   b. Improvement of tourism facilities and infrastructure
   c. Capacity building for government and community institutions

![Figure 4. Percentage of hard coral cover in several survey locations in the waters of Mare Island](image)
d. Improved partnership network

2. WO strategy is a turn-around strategy or updates from the results of the link between weakness factors by taking advantage of external opportunities. The alternative strategies formulated are:
   a. Collaboration of the SDKP fisheries resource monitoring program in an integrated manner
   b. Development of sea and land transportation facilities
   c. Economic empowerment and development of alternative livelihoods
   d. Settlement of residential areas

3. ST strategy is a strategy of diversification or diversification, which is the result of linking strength factors to overcome threats. The alternative strategies formulated are:
   a. Implementation of Management and Zoning Plans, and Preparation of Detailed Spatial Plans
   b. Law enforcement

4. The WT strategy is a defensive or defensive strategy because it is the result of a link between weakness factors (internal) and threats (external). The alternative strategies formulated are:
   a. Restrictions on the use of SDKP

3.4 Strategic priority determination

Strategic priorities determination uses AHP which was analyzed using expert choice software. The analysis is focused on determination of strategic priorities which was at level 1 in the hierarchy of strategic priorities for the development of marine conservation areas on Mare Island. The priority that will be obtained begins with giving weight to the components of the SO strategy, ST strategy, WO strategy and WT strategy which are in the hierarchy at level 2. At level 3, weight is given to each of the resulting alternative strategies, which are 11 alternative strategies.

The weighting is carried out using a comparative scale of 1 – 9 on the pairwise comparison scale matrix (pairwise comparison) as well as to obtain the priority of the SWOT component. Comparison matrix filling in pairs in the expert choice 11 application as can be seen in Figure 5.

Based on the results of the analysis of the components of the SO strategy, ST strategy, WO strategy and WT strategy, it is known that the value of the consistency ratio (CR) to the assessment carried out is 0.07. This means that the assessment carried out has met logical consistency, because according to [12] the value of this logical consistency must be 10% (0.1) or less, otherwise the assessment is considered random and needs to be corrected.

![Figure 5](image_url)

Figure 5. Input of Level 2 Pairwise Comparison Assessment in the Expert Choice 11 Application

The results of the assessment carried out show that the order of strategy components from the highest to the lowest is the SO strategy (strengths - opportunities) is 0.558, the ST strategy (strengths -
threats) is 0.303, the WO strategy (weaknesses - opportunities) is 0.095 and the WT strategy (weaknesses - threats) is 0.043. This means that the SO strategy is the most preferred over other strategy components.

Meanwhile, the input for giving assessment weights to the 11 alternative strategies produced in the expert choice 11 application is as shown in Figure 6. Based on the results of the analysis, it is known that the consistency ratio (CR) value for the assessment carried out is 0.08, which means this value still meets the consistency value logical because it is below 10%.

The results of the analysis showed that the highest value for priority management strategy was Improvement of Conservation Area Management with score of 0.174 and the lowest one was Development of Sea and Land Transportation Facilities with score of 0.029. All in all, resulted management strategies options in order was as follows: (1) Improvement of conservation area management; (2) Capacity building of government and community institutions; (3) Implementation of Zoning Plans and Preparation of Detailed Spatial Plans; (4) Economic empowerment, and development of alternative livelihoods; (5) Enhancement of partnership network; (6) Improvement of tourism facilities and infrastructure; (7) Integrated SDKP monitoring program collaboration; (8) Arrangement of residential areas; (9) Restrictions on the use of SDKP; (10) Law enforcement; (11) Development of sea and land transportation facilities.

![Figure 6. Input of Level 3 Pairwise Comparison Assessment in the Expert Choice 11 Application](image)

4. Conclusion
There were 11 management strategies for developing marine conservation areas of Mare Island with the following priority order: Improving conservation area management, Capacity building of government and community institutions, Implementation of Zoning Plans and Preparation of Detailed Spatial Plans, Economic empowerment and development of alternative livelihoods, Improved partnership network, Improvement of tourism facilities and infrastructure, Integrated SDKP monitoring program collaboration, Arrangement of residential areas, Restrictions on the use of SDKP, Law enforcement, Development of sea and land transportation facilities.

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