Mapping of spatial features model in developing marine ecotourism in Waerole and Nusa Telu, Maluku Province, Indonesia

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Abstract. In the formulation and designation of the ecotourism area, the use of spatial suitability indexes is usually employed. The social, economic, and cultural parameters have almost been ignored in the analysis. These parameters are essential to be included in the development of marine ecotourism to avoid the loss and the impact of these socio-cultural parameters in the development of marine ecotourism. The objective of this research was to construct a conceptual model and thinking perspective and to identify the connectivity of ecology, socio-economy features spatially in designing marine ecotourism areas. Data were collected through observation, participatory mapping, focus group discussion, and interview. Data obtained were then analyzed descriptively and displayed graphically. The conceptual model constructed shows that the marine ecotourism management plan of Waerole and Nusatelu Cape can be categorized into six spatial marine ecotourism explicitly coastal marine ecotourism, snorkeling ecotourism, diving ecotourism, in-shore angling ecotourism, open sea fishing ecotourism, and habitat rehabilitation. The conceptual model for a sustainable management plan for coastal and marine ecotourism suggested the need for holistic and integrated sustainable management comprise of 27 biophysics and socio-economy feature.

1. Introduction.
The area of Waerole and Nusatelu Cape in the coastal area of Asilulu Village is one of the regions that has marine and fish potency. The vast coral reef area is spotted along the intertidal coastline. The productive marine ecosystem in this area brings about many local fishermen with several fishing gears, mostly traditional ones. The village of Asilulu also one of the marine tourism destinations in Ambon, visited by local, regional, even international tourists. The international tourist mostly does snorkeling and diving, while the local one does beach recreation, swimming, and fishing. This area is one of the small-scale tuna fishery centers in Ambon, a few of the fishermen work together with MDPI, a partnership of Fair-Trade USA. This short information describes the potency of Asilulu Village that can be developed even more for the welfare of its community.

The coastal management plan is one of the vital instruments to identify coastal community dynamics connecting to various natural resource use and their appreciation towards marine and coastal resources [1]. According to Maluku Province Coastal Area and Small Islands Zoning Plan [2], this region is listed as one of the tourism development plans. The development of this area as one of the prime marine ecotourism destinations, therefore, should be carefully designed to enable sustainable tourism destinations.

Ecotourism is one of the most advocated concepts in tourism studies, yet there remains considerable debate on what the meaning is, or what it should be. Despite this lack of clarity, there is a broad set of ecotourism principles that are clear and widely promoted, including environmental conservation and education, cultural preservation and experience, and economic benefits [3, 4, 5, 6]. Several aspects should be bear in mind in the sustainable tourism management plan, specifically maintaining environmental sustainability, improving community welfare, satisfying tourist level of
satisfaction, and increase integrated management [4, 7, 8]. Ecotourism has been described as sustainable natural-based tourism with the focus on experience and nature, managed by a specific system, and produces the lowest negative impact on the environment [4, 6, 9].

The development of marine tourism has a double fold role, economically and environmentally. In the economical sphere, the development of marine tourism serves to increase the country's national exchange and immediate community income. In ecological scope, if the developers do not manage properly will negatively affect the environment. The development of marine tourism consequently should be directed through an ecotourism concept that seeking and maintaining natural (environmental) sustainability [10, 11, 12].

In the optimal development of ecotourism on the local scale, Hijriati and Madriana (2015) [13] argued that a strategy in the planning, utilization, controlling, institutional, and community empowerment is required. The social norms, economy, ecology, as well as the involvement of the policymakers, have to be of concern in the management plan. To establish a sustainable ecotourism region and to guarantee the local coastal community wellbeing, there is a necessity to inventory the kind of factors that interact with one another in a causal-effect relationship. The factors could be ecology, economy, socio-cultural, and bring it into the management process.

Research on the suitability of one area as a marine tourism object is mainly based on physical and environmental conditions like water clarity, species diversity, coral percent coverage, current, depth, etc. [14, 15, 16, 17]. The features like social, economic, cultural, behaves often ignored. The comprehend, holistic, and integrative incorporating socio-economy features and bio-ecology and physic is understood necessary to produce well manage marine ecotourism. This research was aimed to construct a conceptual model and perspective thinking in the identification of biophysical, environmental, socio-economy, and cultural and their interaction and put it as management plan of marine ecotourism development.

The conceptual model is a diagram of a set of relationships between certain factors that have an impact on a target condition. The relationship in the conceptual model is depicted with arrows, where each arrow will point in one direction. One factor leads to other factors that influence each other [18]. This conceptual model is expected to assist marine ecotourism management planning by modifying the spatial conservation area planning model.

2. Matherial and Method.
The research was conducted at Asilulu Village, Sub-district Leihitu, Maluku Province, Indonesia. Asilulu is bordered by Seram Island in the north, Buru Sea in the west, Ureng Village in the east, and Larike in the south. Astronomical the village situated at 1270 56’22,07” - 1270 55’ 19,95”EL and 30 40’30,04” - 30 41’ 40,61” SL (Figure 1). The village is situated close to three small islands viz. Ela, Hatala, and Lain Island, generally known as “Pulau Tiga”, that also part of the study site.

For the development of marine ecotourism, data required covers the aspect of bioecology, physical environment, socio-economy, cultural, institutional, and resource utilization. The marine tourism suitability index for the study site was assessed according to [14]. Parameters used in suitability index analysis were collected through field observation. Socio-economy, cultural, and institutional data was also collected through field observation, interviews, and focus group discussion. A close and structured list of questions was distributed to a sample of the community randomly selected. The analysis was done through descriptive statistics [19] and presented graphically and descriptively.
Figures 1. Map of Study Site

The conceptual model constructed was developed based on parameters observed, and presented by a figure explaining the relationship that exists between the parameters. This model is a qualitative model that can be applied to develop a conceptual model framework [20, 21]. A conceptual model is a model composed of a composition of concepts that helps to study, understand, describe, and explain the system represented based on the perspective of the modeler [22]. The conceptual model framework was then used to develop a sustainable management strategy for marine ecotourism at the study site. The analysis was then discussed descriptively covering the features of spatial components such as ecosystem conditions, coastal types, hydro-oceanographic parameters, resource uses activities, socio-cultural and historical conditions, and existing regional management policies, as well as other resource use activities. Based on this description, a conceptual model and the relationship between these spatial features were formed in the management of marine and coastal ecotourism areas.

3. Result and Discussion

3.1. General overview of study site

The width of Asilulu Village based on Central Maluku BPS data in 2019 is 19 km² with a population of 5,787 people, 49.82% are male whilst 50.18% are female. The island of Ela, Lain, and Hatala is considered a micro island and has been inhabited by a few individuals from Asilulu Village. From the total Asilulu Village population, 512 (8.85%) work as fishermen that are mostly considered as artisanal fishermen. The limited fishing gear technology, small fishing vessels, shortest of capital, and short distance fishing ground describes the fishermen[23, 24]. Fishing gears used are gill net, handline, fish trap, and tuna handline (dominant). Apart from fishermen, the people of Asilulu also work as a farmer, civil servant, and the private sector.
3.2. Physical and biological parameters of marine and coastal ecotourism suitability

The result of physical and biological parameters analyzed at the coastal area of Asilulu and Nusa Telu shows that the type of beach was dominated by white sand with a water depth of 10 m and more. The Nusa Telu area comprises three islands: Hatala, Ela, and Lain. These three islands have a beach with a width of more than 15 m, with the substrate dominated by coral and white sand. The current speed measured shows that the average current speed of these islands have a range from 0.07 to 0.25 m/s which was classified as slow speed. The percentage of beach slope of this location ranges from 0.13-29.27% with a water brightness value of 100% from the surface to the depth of 20 m. At the depth of 30-50 m, the water brightness ranges from 40-70%. The coastal land coverage locations consist of open land overgrown with coconut trees, shrubs, and savanna.

The width of the coral reef at the three locations of Nusa Telu ranges from 20-400 m with a depth of coral reef spreading from 1-40 m. The percentage of coral cover on Lain Island and Ela Island ranged from 50-75%, while Hatala Island ranged from 25-50% with more than 12 life form types. The number of reef fish found was more than 100 species. Table 1 shows the taxa number of coral reef fish found in the study site.

Table 1. Coral reef fish taxa composition

| Site  | Species | Genera | Family |
|-------|---------|--------|--------|
| Waerole | 153     | 77     | 30     |
| Hatala  | 244     | 84     | 30     |
| Ela     | 180     | 70     | 28     |
| Lain    | 207     | 76     | 30     |

From the total fish species found, some species classified as dangerous marine biota like Barracuda (*Sphyraena* sp.), Yellow Sea Anemone (*Sagartia troglodytes*), Stonefish (*Synanceia* sp.), Scorpionfish and Lion fish (*Scorpaena* sp. and *Pterois antennata*), Poisonous Sea Star/Mosaic Sea Star (*Plectaster decanus*), Sea Urchin (*Diadema* sp.), and Stingray (*Manta birostris*). The abundance and diversity of these 3 locations of the island of Hatala, Ela, and Lain and Nusa Telu of Asilulu, in general, is categorized as very high. The evidence of this abundance can be recognized from the variety of fishermen's catch, both demersal and pelagic fish. Fish that are the target fish include *Tylosurus* sp, *Epinephelus* pachycentru, *Caranx sexfasciatus*, *Istiophorus platypterus*, *Thunnus albacores*, *Acanthocybium solandri*, *Decapterus karroides*, *Rastrelliger brachysoma*, *R. kanagurta*, *Lutjanus malabaricus*, *Chlorurus sordidus*, *Monacanthidae*, *Lates calcarifer*, *Caesio caerulaureus*.

Even though tourism increases global water consumption, direct tourism-related water use is considerably less than 1% of global consumption, and will not become significant even if the sector continues to grow at anticipated rates of around 4% per year (international tourist arrivals). The situation differs at the regional level because tourism concentrates on traveler flows in time and space, and often in dry destinations where water resources are limited [25]. Water scarcity is recognized as a key factor in the development of the tourism industry. Water consumption in the tourism industry has received increasing attention from organizations such as the World Tourism Organization (WTO) [26, 27].

The availability of freshwater for tourism development programs in this area, particularly for these three islands is a limiting factor. The only freshwater available is in Asilulu Village. The freshwater supply for these three islands, therefore, should be brought from Asilulu through boat transportation. At the moment no water pipe available to connect to these islands.

In this study, the kind of marine tourism is divided into six categories viz. beach recreation, snorkeling, diving, in-shore fishing, off-shore fishing, and habitat rehabilitation. Based on the tourism suitability matrix according to [14, 16], the tourism suitability index for marine and coastal ecotourism in the research location is summarized in Table 1. The suitability index for marine and coastal tourism
in this area ranges from 44.05% which is considered not suitable to 100% which is considered very suitable. In general, these areas can be developed for marine and coastal ecotourism. The detail of the marine and coastal tourism suitability index can be seen in Table 2.

**Table 2. Suitability parameters for marine ecotourism in Ela Island, Hatala Island and Lain Islands**

| No. | Tourism type       | The Island | Tourism Suitability Index | Percentage Conformity (%) |
|-----|--------------------|------------|---------------------------|---------------------------|
| 1.  | Beach recreation   | Ela        | Very suitable             | 98.81                     |
| 2.  |                    | Hatala     | Not suitable              | 44.05                     |
| 3.  |                    | Lain       | Not suitable              | 44.05                     |
| 4.  |                    | Ela        | Very suitable             | 100.00                    |
| 5.  | Snorkeling         | Hatala     | Suitable                  | 82.46                     |
| 6.  |                    | Lain       | Very suitable             | 85.95                     |
| 7.  | Diving             | Ela        | Suitable                  | 79.63                     |
| 8.  |                    | Hatala     | Suitable                  | 70.37                     |
| 9.  |                    | Lain       | Suitable                  | 79.63                     |
| 10. |                    | Ela        | Suitable                  | 82.35                     |
| 11. | In-shore Fishing   | Hatala     | Very suitable             | 100.00                    |
| 12. |                    | Lain       | Very suitable             | 94.12                     |
| 13. |                    | Ela        | Very suitable             | 92.31                     |
| 14. | Off-shore Fishing  | Hatala     | Very suitable             | 100.00                    |
| 15. |                    | Lain       | Very suitable             | 94.44                     |

3.3. **Factors in conceptual model framework for marine ecotourism management plan**

Marine and coastal tourism are interconnected, both of them are dependent on the sea and the marine environment. Marine tourism mostly takes place at sea, for example, a cruise and sailing, while coastal tourism takes place in coastal areas that include beach-based tours and recreational activities, such as swimming and sunbathing, canoeing, coastal walks, etc. Marine and coastal tourism as one of the largest segments of the maritime economy sector, as well as the largest component of the tourism industry, often leads to a controversy over environmental impact and compatibility with other human activities [28].

Sustainable marine and coastal tourism are crucial in developing this sector. Many factors involve and interconnected within this sector. The management plan for developing marine and coastal tourism, therefore, should incorporate all factors in developing a management strategy for sustainable marine and coastal tourism. Table 3 shows the factors considered crucial in developing sustainable marine and coastal tourism in the study site.
Table 3. Parameters considered crucial in the development of sustainable management of marine and coastal ecotourism

| Parameter type | Parameter name | Code |
|----------------|----------------|------|
| Biophysical     | Coastal type   | P1   |
|                 | Water depth    | P2   |
|                 | Coastal width  | P3   |
|                 | Bottom substrate | P4 |
|                 | Current speed  | P5   |
|                 | Coastal slope  | P6   |
|                 | Water transparacy | P7 |
|                 | Land coverage  | P8   |
|                 | Dangerous organism | P9 |
|                 | Ground water availability | P10 |
|                 | Coral coverage | P11  |
|                 | Coral life form | P12 |
|                 | Coral reef fish | P13 |
|                 | Coral reef depth | P14 |
|                 | Coral reef width | P15 |
|                 | Coral reef flat width | P17 |
|                 | Fish abundance | P18  |
|                 | Catch composition | P19 |
| Socio-economy   | Existing tourism | PS-1A |
|                 | Fishing activities and positioning of fish aggregating device | PS-1B |
|                 | Inland and sea transportation | PS-1C |
|                 | Location of fishing boat mooring | PS-1D |
|                 | Domestic waste | PS-1E |
|                 | Conflict result from fishing gear use | PS-2 |
|                 | Investment activities | PS-3 |
|                 | Local wisdom | PS-4  |
|                 | Marine services | PS-5 |

3.3.1. Biophysical parameter. The number of biophysical parameters or factors used in the sustainable management plan for marine and coastal tourism in this study covers 18 parameters. Some of the parameters are standard parameters [14, 16], and some additional parameters. From marine tourism suitability index analysis, it was found that all the parameters suited except for beach recreation tourism category at the island of Hatala and Lain. Overall the study area suitable according to biophysics criterion.

3.3.2. Socio-Economic and Cultural Parameters. Most of the marine and coastal tourism development applies biophysics parameters as their basis for the developing tourism sector. In reality, socio-economic, include a cultural aspect, are also important since they are interconnected and affecting one another. Management strategy for sustainable tourism, therefore, should incorporate the biophysics parameter with the socio-economy parameter. Below are socio-economy and cultural parameters found in the study site and considered crucial to be included in the management strategy.
A. Activities that have economic value (PS-1)
All economic activities are targeted to give a benefit to the community. The activities are believed to increase community welfare. Some activities noted during the research as follows:

A.1. Existing tourism (PS-1A)
Tourism activities already exist in almost all areas of Tanjung Waerole and Nusa Telu both foreign and local tourists. Foreign tourists generally do diving activities located on Ela Island and between Ela Island and Hatala Island. From these three islands, only Ela Island has some tourism facilities such as lodging. This area is particular for coastal and diving tourism. From FGD it was found that there are other tourist activities in the coastal and marine area. In-shore fishing activity was done by visitors in the coastal area of west Tanjung Waerole, Lain island, and Hatala.

A.2. Commercial fishing activities and fish aggregating device (PS-1B)
The fishing activity parameter in this analysis is classified as commercial fishery which is different from fishing activity in tourism that is mainly related to leisure. The fishing activities in the research area consist of various kinds of fishing gear. The scoop net, drifting gill nets, bottom gill net, compressor, spear, fish trap, and hand lines are common fishing gear used. The fish aggregating device (FAD) locally called "rumpon," was also found in a quite large number. The fishing activity is conducted by Asilulu fishermen. The fishing took place generally around Tanjung Waerole and the west coast of Tanjung Waerole and Asilulu waters.

Commercial fishing activity is considered here since it affects economically to the fishermen. The fishermen can sell their harvest to the visitors (tourist), but at the same time can disturb tourist especially those doing diving or snorkeling. The gear might encounter by the divers and distract them.

A.3. Inland and sea transportation (PS-1C)
The Asilulu Village is also a place where a local seawater port exists and is used by individuals to travel to other areas outside Ambon Island like Kelang Manipa Village in Seram Island and visa versa. The traditional outboard boat made of wooden is usually used in this transportation. Inland transportation is also available that connects Asilulu to other areas in Ambon Island. This transportation is necessary for developing tourism destinations.

A.4. Fishing boat mooring site (PS-1D)
Some of the local community of Asilulu Village working as fishermen. The fishing boat used is considered a traditional one with a one-day fishing category. When the fishermen arrive from fishing, they will anchor their fishing boat at the coastal waters of Asilulu Village. After unloading their harvest, the fishermen always do some maintenance towards their fishing gear and boat. The side effect that could arrive from this activity could be an oil spill, plastic debris, etc. These at some point can disturb the coastal environment.

A.5. Domestic waste (PS-1E)
With a quite dense population, there is always a problem concerning domestic waste. From field observation some forms of domestic waste found in the coastal area are liquid detergent, organic waste in the form of leaves and tree branches, as well as inorganic waste in the form of plastic food wrapping, beverage can, etc. These wastes will have an impact on an organism such as shellfish alike, gastropods, and corals. The plastic waste will inhibit coral growth so that it will directly affect the species and abundance of fish.

The present status of domestic waste is considered to have a low-level impact. In the long run if not managed properly will affect both the coastal environment quality and the biota. Domestic waste also will distract the amenity of the area which will negatively have an impact on tourism [29].
B. Conflicts due to fishing gear use (PS-2)
There are sorts of fishing gear used by the local fishermen of Asilulu Village. Sometimes there is a conflict between the fisher regarding the gears operated. The bottom handline and bottom gill net sometimes entangle when encountering the bottom fishing trap, and will damage the hand line and gill net. This causes conflict but the occurrence is very scarce and can be resolved by the fishermen themselves.

C. Investment activities (PS-3).
The Asilulu Village Government has plans for infrastructure development in the field of transportation, the fisheries sector, and tourism. From the fisheries sector, the local government plan to establish a traditional fish trap called sero at Hatala Island. From the tourist sector, the local government plan to make a temporary homestay at Hatala Island that will accommodate the tourist. There are also plans to establish a jetty and marina at Hatala and Lain Island.

D. Local wisdom (PS-4)
The Asilulu people have some local wisdom regarding important locations that have historical, customary, and cultural values. There is an area in Asilulu Village that have their own local names and the meaning of these locations and names. In addition, the Asilulu community also has locations called Mamolin or Pamali (taboo) where these locations are considered sacred. Activities in that area are prohibited by the customs and culture of the Asilulu people.

Tourism involves a temporary and voluntary visit to a place away from home, it is a leisure activity. During this visit, a tourist has to interact with different people, who facilitate different means in the tourism process. These facilitating people are the host community, the Asilulu people. who share a common culture with others in the same geography or network. The effect of tourism has double facet on the culture, it could change the local culture of the host or the culture could be an asset that attracts tourists.

E. Maritime services (PS-5).
Maritime services can be seen as a service provided by the marine environment. The services can be in many different forms like productivity, fish production, medicine, (pharmaceutical), leisure, and many more. Some of these services could be an asset in the tourism sector like diving, sailing, sport fishing, etc.

Based on information from the fishermen community, there is a shipwreck around the waters of Asilulu. According to them, the shipwreck came from the Japanese era. This information needs to be explored in more detail to find that object. Shipwreck could be an asset as well in marine tourism. Shipwrecks containing antiques and historic objects, ordinary wrecks, and aircraft wrecks have high attractiveness and will be packaged into the best diving tourism centered [30].

F. Governance parameters.
In the management of coastal and marine areas, it is inseparable from the existence of policies or management rules set by the central or regional governments. One of the important factors that have been established by the provincial government in the context of coastal zone management is the Coastal and Small Islands Management Zone Plan of Maluku Province (PT-1) [2]. In this plan, the area of Asilulu, Tg Waerole, and Pulau Tiga has been designated as a tourism destination development plan.

3.4. Conceptual model in the management of Waerole and Nusa Telu.
The Tanjung Waerole and Nusatelu areas have a lot of potential resources such as tourism, marine fisheries, and maritime affairs. Apart from potential resources available, there are also quite high levels of resource utilization that potentially threaten those resources. To enable sustainable resources management, therefore, proper planning is required. Sustainable resource management will enhance the ecosystem, habitat, and the community itself. Under Maluku Province Coastal and Small Islands Zone
Planning, this area is designated as one of the tourist destination areas. The management of this marine and coastal zone should be conducted in a holistic and integrated way to achieve sustainability.

In this management plan for Waerole and Nusa Telu area, the conceptual model [18, 20] combined with tourism suitability index parameters [14, 18] and Marxan approach for the marine protected area is used to produce a management strategy for sustainable marine and coastal tourism. Marxan requires input in the form of ecological spatial data, utilization, and management patterns [31]. The input data is in the form of conservation features and cost features. The conservation features are ecological parameters in the form of ecosystems, particular species, or other biophysical diversity that are planned to be included in one of the objectives to be conserved. Whereas the cost feature is data on socio-economic conditions, where its presence in a planning unit will increase the cost of managing the area [31, 32].

Table 4 displays biophysics, socio-economy (cost), and governance parameters used as a feature in developing management plan strategy for coastal and marine ecotourism in Waerole and Nusa Telu region. The tourism type that proposed in this area is coastal tourism (beach recreation), snorkeling, diving, in-shore fishing, off-shore fishing, and habitat/ecosystem rehabilitation.

Table 4. Matrix of marine and coastal ecotourism spatial features

| Tourism type       | Suitability features   | CODE | Cost feature       | CODE |
|--------------------|------------------------|------|--------------------|------|
| Coastal recreation | Type of beach category | P-1  | Fishing area       | PS1-B|
|                    | Water depth            | P-2  | Domestic waste     | PS-1E|
|                    | Beach width            | P-3  | Investment activities | PS-3 |
|                    | Bottom substrate       | P-4  | Important Location | PS-4 |
|                    | Current speed          | P-5  |                    |      |
|                    | Beach slope            | P-6  |                    |      |
|                    | Water transparency     | P-7  |                    |      |
|                    | Coastal land coverage  | P-8  |                    |      |
|                    | Dangerous marine biota | P-9  |                    |      |
|                    | Availability of fresh water | P-15 |      |      |
| Snorkeling         | Current speed category | P-5  | Fishing activities | PS-1B|
|                    | Water transparency     | P-7  | The mooring location | PS-1D|
|                    | Coral coverage categories | P-10 | Household waste | PS-1E|
|                    | Types of coral life form | P-11 | Investment activities | PS-3 |
|                    | Reef fish diversity    | P-12 |                    |      |
|                    | Depth of coral reef    | P-13 |                    |      |
|                    | Reef flat width        | P-14 |                    |      |
| Diving             | Current speed          | P-5  | Fishing activities | PS-1B|
|                    | Water transparency     | P-7  | Inland and sea transportation | PS-1C|
|                    | Coral coverage         | P-10 | Domestic waste     | PS-1E|
|                    | Types of coral life form | P-11 | Investment activities | PS-3 |
|                    | Reef fish species diversity | P-12 |      |      |
|                    | Depth of coral reef    | P-13 |                    |      |
|                    | Existing tourism       | PS-1A|                    |      |
|                    | Marine services        | PS-5 |                    |      |
|                  | P   |                                          | PS   |
|------------------|-----|-----------------------------------------|------|
| Type of beach    | P-1 | The mooring location                    | PS-1D|
| Water depth      | P-2 | Domestic waste                          | PS-1E|
| Current speed    | P-5 | Investment activities                    | PS-3 |
| Fish species caught | P-16 | Important Location                      | PS-4 |
| Fish abundance   | P-17|                                          |      |
| Existing tourism | PS-1A|                                          |      |

**Off-shore fishing**

|                      | P   |                                      | PS   |
|----------------------|-----|--------------------------------------|------|
| Water depth          | P-2 | Fishing activities                    | PS-1B|
| Current speed        | P-5 | Inland and sea transportation        | PS-1C|
| Fish species caught  | P-16| Household waste                      | PS-1E|
| Fish abundance       | P-17| Fishing gear utilization conflict    | PS-2 |
|                      |     |                                       |      |
|                      |     | Investment activities                | PS-3 |

**Habitat rehabilitation**

|                              | P   |                                                | PS   |
|------------------------------|-----|-------------------------------------------------|------|
| Coral coverage category      | P-10| Fishing activities                              | PS-1B|
| Type of coral life form      | P-11| Inland and sea transportation                  | PS-1C|
| Depth of coral reef          | P-13| The mooring location                           | PS-1D|
| Reef flat width              | P-14| Domestic waste                                 | PS-1E|
|                              |     | Investment activities                          | PS-3 |

Based on biophysical parameters (features), socio-economy, and governance features, the connectivity that links all the features is connected to produce the conceptual model. This conceptual model describes the management strategy model for sustainable marine and ecotourism in Waerole and Nusa Telu region as shown in Figure 2.

This conceptual model is a spatial model for the design of marine ecotourism management in the Tanjung Waerole and Nusa Telu of Tiga Island. This model shows the abstraction of real marine and ecotourism system exists in this area, the interconnection and complexity of that system. The sustainable management of this area should incorporate all the features and costs within the system. The diving sector, for example, will be affected by fishing gear such as the bottom gill net when encounter by the diver. Domestic waste will also negatively affect the amenity of the diving spot, coastal recreation, snorkeling, fishing activity either coastal (in-shore) or off-shore. The detail interconnected between all features and cost can be seen in Figure 2.
Figure 2. Conceptual model of the management strategy plan for marine and coastal ecotourism in Waerole and Nusat Telu

4. Conclusions.
In planning the management of marine and coastal ecotourism in Asilulu and Nusa Telu, six tourism sectors suitable to be developed. A total of 27 biophysics and socio-economy spatial features are applied to establish the conceptual model for a sustainable management plan for coastal and marine ecotourism. The conceptual model shows that many interconnected features exist and should be incorporated into the sustainable management of this area.

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