

Zoning Model on Conservation in the Ecosystem Islands Southeast Aru

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Abstract

Southeast Aru was a conservation area in Indonesia. This area was preserved based on the survey result of biophysical and socio-economical potentials. It signaled that this area must be retained because it had endemic resources that should be protected, including turtle, dugong, crocodile, and its ecosystem diversity. Some problems were found, such as (a) ineffective management of conservation area, (b) lack of planning for management and area zoning, and (c) less community empowerment in this area. Taking these into account, the

objective of research was to develop a zoning model of islands ecosystem to give input for the management, government and community to be used in the preparation, determination and implementation of policy, program and activity of the management of Southeast Aru Conservation Area. Result of this current research indicated that: (1) islands ecosystem in Southeast Aru Conservation Area was important to be protected, while Enu Island and Karang Island were recognized as the core zone; (2) the ecosystems of Jeh, Mar, Jeudin, Marjinjin, and South Kultubai Islands were acknowledged as the utilization zone, especially their coastal eco-tourism sub-zone; and (3) the ecosystems of Jeh, Mar, Jeudin, Marjinjin, and South Kultubai Islands were, beside for tourism interest, also used as other zone, which was protective zone for these five islands, with Jeh Island and South Kultubai Island as rehabilitation zone.

Keywords: zoning Model, Islands ecosystem, conservation area, Southeast Aru

1. Introduction

Ecosystem conservation was an effort to protect, to preserve, and to utilize the ecosystem function as the supporting habitat for the living of fish resources either for recent or future days (Adams et al, 2004). Indeed, ecosystem conservation was realized through the protection of habitat and population of the fish, the research and development, the utilization of fish resource and environmental service, the development of community socio-economic, the supervision and control, and/or the monitoring and evaluation. Community-based conservation and its development became a new paradigm either for the government or non-government organization with great engagement within conservation activity (Browder, 2002; Gjertsen, 2005). Great complexity was apparent when the question whether the conservation had achieved the expectation should be answered because the achievement was always related to the utilization rate of human (Jackson and Sala, 2001; Stachowitsch, 2003; Halpern et al, 2008). Human resource has very big effect in the coastal ecosystem. The conflict of human activities only gave simultaneous pressure and exploitation against coastal natural resources (Crain et al., 2008; Darling and Côté 2008; Doak et al., 2008; Halpern et al., 2008).

A method for effective management of coast and sea resources was by developing Waters Conservation Area (KKP). This method involved allocating some proportions of coast and sea areas to be used as the protection site for important resource, such as for good site for spawning and breeding. The zoning plan of Waters Conservation Area was aligned with Act No.31 of 2004 but revised by Act No. 45 of 2009 about Fishery, and also complying with Government Regulation No. 60 of 2007 about Fish Resource Conservation. Both laws explained that KKP zoning consisted of core zone, sustainable fishery zone, utilization zone, and other zone. For specific cases, there were sub-zones which remained as part of these four main zones but its determination was always based on potential, characteristic and socio-economical consideration of immediate community.

Southeast Aru Area represented a conservation area in Indonesia. This area was stated as conservation area based on the survey result of biophysical and socio-economical potentials. This survey showed that this area must be retained because it had endemic resources that should be protected, including turtle, dugong, crocodile, and its ecosystem diversity. To understand the relationship between human pressure and ecosystem status in the area, it was very important to develop spatial and zoning plans (Douvere, 2008). It seemed difficult to understand the relationship between human activity and ecosystem status because (1) pressure rate against ecosystem (Shears dan Ross, 2010) and (2) limited fundamental information about ecosystem, related with its status and impact potential (Halpern et al, 2008; Fraschetti et al, 2009).

Result of preliminary research in this area indicated that there were a lot of things that should be managed. Some findings were: (a) ineffective management of conservation area, (b) lack of planning for management and area zoning, and (c) less community empowerment in this area. Considering these findings, the objective of research was to develop a zoning model of islands ecosystem to give input for the management, government and community to be used

in the preparation, determination and implementation of policy, program and activity of the management of Southeast Aru Conservation Area.

2. Material and Method

Data of islands ecosystem were involving island width, coastline length, land vegetation width, mangrove vegetation width, coast sand, dry land forest, turtle spawning site, swamp, and lake. The data were analyzed by image interpretation analysis over the image from 2010 Landsat ETM-7 Satellite which had been adjusted with the result of field review. Lamun ecosystem width, coral reef ecosystem width and open waters ecosystem width (for the fishing site of pelagic and demersal) were also considered.

Criteria to determine space and zoning orders had been stated by The Regulation of The Minister of Marine and Fishery for Republic of Indonesia No.02/Men/2009 about the Method to Determine Waters Conservation Area, as explained in Chapter II Article 4 Verse (1) about the criteria and type of waters conservation area. The criteria included ecological, social, cultural and economical aspects. One component of criteria was added into the model, which called as area management component. This component was added by considering that the conservation area had been established and managed for long term. The criteria to use in determining the zoning of Southeast Aru Conservation Area were:

- 1) The diversity: population rate, density rate, ecosystem distribution, and species.
- 2) Distinctive marker: form and size.
- 3) Rarity: population rate, density rate, ecosystem distribution, and species.
- 4) Representativeness: form, size and distribution.
- 5) Originality: form, color, size and distribution.
- 6) Susceptibility: status, characteristic and history of island.
- 7) Demographic: the utilization rate, education rate, and income rate.
- 8) Tourist: population rate, destination, perception, education rate, and income rate.
- 9) Structure and infrastructure: population and distribution.

Area development, which related to the preparation of human resource, institution, regulation and area development.

Management that was aligning with the protection policy and/or the custom that regulated the ecological processes, the life supporting system, natural resource conservation, and sustainable utilization.

Any considerations used to determine the zoning of islands ecosystem were as followed. If the criteria of being as the island protection area were met, the area must become the island protection area. However, if the criteria were not met, the area would become the island cultivation area. If the island cultivation area was meeting the criteria of island tourism zone, it was then developed as island tourism zone. If it did not meet the criteria of island tourism

zone, it can become island protection zone.

Island cultivation area might be assessed for its potential. If it met the criteria of island production forest zone, it was then becoming island production forest zone. If it did not meet the criteria of island production forest zone, this area could be reserved for other usage. If this reserved area could meet the criteria of agriculture zone, it was then used as agriculture zone. If it met the criteria of settlement zone, it was then classified as settlement zone.

These criteria were used as guide in determining the criteria of space or zone determination at Southeast Aru Conservation Area. Based on the area characteristic and to facilitate the determination of area, therefore, Southeast Aru Conservation Area was divided into five ecosystems, including islands ecosystem area, mangrove ecosystem area, lamun ecosystem area, coral reef ecosystem area, and open waters ecosystem area. However, discussion in this writing was only focused on islands ecosystem area. Regarding to these criteria, the analysis of data was using mathematic model (Steel and Torrie, 1993) which became the base of arranging the space order and the area zoning. This mathematic model, in general, involved the following equation:

$$A = \left[\frac{B_{ij}}{\sum C_{ij}} \right] \times 100$$

Where:

A = A value of area or zone

B_{ij} = The score of every criterion of area or zone

C_{ij} = Maximum score for all criteria

100 = Constant

This model was then detailed based on the criteria:

a. Island Protection Zone

$$NKKLP = \left[\frac{(\sum N_k) + N_{kh} + N_1 + N_w + (\sum N_a) + N_r + NPel + NPes + NPem}{\sum B_{ki}} \right] \times 100$$

Where:

NKKLP = Score of the criteria of island protection area

$\sum N_k$ = Score of biodiversity criterion

N_{kh} = Score of distinctive marker

N₁ = Score of rarity

N_w = Score of representativeness

$\sum N_a$ = Score of originality criterion

N_r = Score of susceptibility

NP_{el} = Score of species protection

NP_{es} = Score of species preservation

NP_{em} = Score of species utilization

$\sum B_{ki}$ = Maximum score of all criteria

ki = Criterion i-th

Criteria that were used were as following:

If $NKKLP \geq 80$, area was suitable for island protection area.

$NKKLP < 80$, area was not suitable for protection area, but matched for island cultivation area.

b. Island Tourism Zone

$$NZWP = \left[\frac{(\sum N_k) + N_{leg} + N_{cp} + N_{ak} + N_{pw}}{\sum B_{ki}} \right] \times 100$$

Where:

$NZWP$ = Score of the criteria of island tourism zone

$(\sum N_k)$ = Score of diversity criterion

N_{leg} = Score of legality criterion

N_{cp} = Score of island characteristic criterion

N_{ak} = Score of accessibility criterion

N_{pw} = Score of tourism request

$\sum B_{ki}$ = Maximum score of all criteria

k_i = Criterion i-th

Criteria that were used were as following:

If $NZWP \geq 80$, area was suitable for island tourism zone.

$NZWP < 80$, area was not suitable for island tourism zone.

Island Production Forest Zone

$$NZHPP = \left[\frac{(\sum N_k) + N_{leg} + N_f + N_p}{\sum B_{ki}} \right] \times 100$$

Where:

$NZHPP$ = Score of the criteria of island production forest zone

$(\sum N_k)$ = Score of diversity criterion

N_{leg} = Score of legality criterion

N_f = Score of island function criterion

N_p = Score of island management norm

$\sum B_{ki}$ = Maximum score of all criteria

k_i = Criterion i-th

Criteria that were used were as following:

If $NZHPP \geq 80$, area was suitable for island production area.

$NZHPP < 80$, area was not suitable for island production area.

c. *Island Agriculture Zone*

$$NZPer = \left[\frac{N_e + N_{sk} + N_k}{\sum B_{ki}} \right] \times 100$$

Where:

$NZPer$ = Score of the criteria of agriculture zone

N_e = Score of ecology criterion

N_{sk} = Score of socio-economic criterion

N_k = Score of security criterion

$\sum B_{ki}$ = Maximum score of all criteria

ki = Criterion i-th

Criteria that were used were as following:

If $NZPer \geq 80$, area was suitable for island production area.

$NZPer < 80$, area was not suitable for island production area.

Island Settlement Zone

$$NZPm = \left[\frac{N_{sp} + N_{at} + N_{id} + N_e}{\sum P_{pi}} \right] \times 100$$

Where:

$NZPm$ = Score of the criteria of settlement zone

N_{sp} = Score of the parameter of transport structure and infrastructure

N_{at} = Score of the parameter of easiness to get fresh water

N_{id} = Score of the parameter of land compatibility

N_e = Score of the parameter of economic development

Criteria that were used were as following:

If $NZPem \geq 80$, area was suitable for settlement zone.

$NZPem < 80$, area was not suitable for settlement zone.

3. Result and Discussion

3.1 The Potential and Problem of Islands Ecosystem

Southeast Aru Conservation Area was 114,000 ha width covering within it 7 small islands such as Enu Island, Karang Island, South Kultubai Island, Jeh Island, Mar Island, Jeudin Island and Marjinjin Island (Figure 1). Among these, three islands were the outermost small islands (at the boundary). These islands were also along with other eight border islands belonging to Aru Islands District, precisely remaining at administrative area of South Central Aru Subdistrict and East South Aru Subdistrict.

Border and characteristic of small islands at Southeast Aru Conservation Area were explained as following:

- 1) The width of islands was less than or equaled to 2,000 km². It could be possible that these islands had very small size because the greatest island in this area was Jeudin Island with its width only 16.18 km² or 0.81 % and still, it classified into the definition of a small island.
- 2) Ecologically, these islands at Southeast Aru Conservation Area were separated from mainland island, with clear physical border, and isolated from the habitat of insular-natured mainland island.
- 3) These islands were the habitat of endemic, typical and highly valued diversity including turtle, dugong, crocodile, pouched kus-kus, kima, and other endemic animals.
- 4) Catchment area was relatively small and therefore, surface water flow and sediment flow were always coming to the sea.
- 5) These islands were rarely occupied and only accessed by the community who mostly settled within the mainland island, and therefore, the character of these islands was relatively similar to the community.

The distribution of these islands was very close to each other, except for Enu Island and Karang Island that were relatively far away from the population settlement. Geographic site, island width and coastline length were shown in detail in Table 1. Total width of seven islands in the conservation area was 48.94 km² with coastline length of 138.37 km². The greatest island was Jeudin Island with 16.18 km² width and coastline length of 42.28 km², while the smallest island was South Kultubai Island with 0.82 km² and coastline length of 6.67 km².

Some community activities were found in this island ecosystem, involving the agriculture-based activity at Jeh Island, the utilization of forest land for housing or charcoal, and the capture of land fauna such as kus-kus and birds at South Kultubai Island, Jeudin Island and Marjinjin Island. The collection of coast sand and coral reef for the development of settlement was obvious at Jeh Island, Mar Island, Jeudin Island, Marjinjin Island, and South Kultubai Island. Other activity was the capture and the collection of turtle egg during spawning season, and this activity was apparent at Enu Island and Karang Island (Table 2).

Jeh Island was the only island with the highest utilization activity, which were 6 activities (100 %), while lowest activity was found at Enu Island and Karang Island with only 4 activities (66.67 %). Other small islands at Southeast Aru Conservation Area had some sub-systems such as economic, community, demography, culture and ecology (Lin, 2005).

The use of land in these small islands at Southeast Aru Conservation Area consisted of eight (8) modifier components which were dominated by dry land forest of 22.37 km² (46.72 %). It was followed by mangrove ecosystem of 19.24 km² (39.30%) and the smallest was open land with 0.06 km² width (0.12 %). Table 3 indicated that the open land had the smallest width compared to whole components that were making up the vegetative coverage, meaning that small islands at Southeast Aru Conservation Area were not greatly utilized by immediate community. It was then understandable if land contained the abundant resources of wood.

Other component to review was that spawning site of turtle had 1.58 km² land (3.23 %) of the total width (Figure 2). After subjected to external pressure, the ecosystem, economic or community had exceeded the capacity of islands, and therefore, sub-system reaction was deprived. The ecosystem of small islands were very sensitive, and therefore, good sustainable treatment was always needed (Bengen, 2002).

The islands in this area had great potential to be visited by turtles for spawning and breeding. Result of interview with the local showed that the spawning site of turtle had been abandoned, especially the spawning site at 5 other islands nearby the mainland island. In other words, these islands were started to be accessed by the nearby community. Enu Island and Karang Island were suitable spawning sites for turtles although many turtles were slaughtered in these islands. Some results of research indicated that the development activity often caused a damage or degradation against ecosystem or endemic resource in small islands, either from development activity of the land or the waters area due to the environmental unfriendly technology (Gutzwiller and Barrow, 2003; Kuitunen et al., 1998; Reijnen et al., 1995).

A continuing supervision to both islands and the effort to recover the function of the spawning site abandoned by turtles were always important for the interest of turtles breeding. To preserve these islands, the awareness of community should be improved to ensure that small islands were suitable site for ecological, social, and economical interest, as well as for defense and security of the nation.

Most lands of these small islands were grown with vegetation of dry land forest, mangrove forest, and bush vegetation, while the remaining was water plant vegetation. Mangrove forest dominated the central part of the island, while the bush surrounded the coast. Some species of coastal vegetation included *kangkung laut* (*Ipomea pescapre*), *Kasuari* (*Casuarina* sp), *Ketapang* (*Terminalia catapa*), *Bintanggor* (*Canophyllum inophyllum*), and other follower mangroves.

Total density of terrestrial vegetation in this island reached 0.964 standing/m² or around 9,640 standings/ha. Vegetative density for tree category was 0.265 standing/m² (2,653 standings/ha), while for wean category was 0.145 standing/m² (1,453 standings/ha) and for seedling category was 0.553 tegakan/m² or attaining 5,533 standings/ha.

Vegetation species with the smallest tree diameter was Madawaldan, while the biggest was Kasuari. A species with smallest wean diameter was Jindan, while the biggest one was Kayu Susu. Data of terrestrial vegetation indicated that any disturbances against terrestrial ecosystem would take relatively longer time for recovery because the number of standings for wean category was lower (15.06 %) than tree category (27.52 %), and the number standings for seedling category was greater than tree and wean categories (57.40 %).

For tree category, the recovery of *Madawal* type might be faster because the number of wean standings was 4.82 times more than tree standings. Rather faster vegetative recovery was found at *Semarah* species, where the number of standing of the weaned was 72.55 % from the standing of tree category. Because of the number of vegetative standing of the seedling was greater, thereby the terrestrial community of the islands were always developing if it was well

managed. Fauna species in the islands was mostly birds (including sea birds). A reptile species in the protection category was Maluku endemic lizard (*Varanus indicus*).

Eight main components were characterizing small islands at Southeast Aru Conservation Area. These were: (a) land width; (b) open land; (c) coast sand; (d) island diversity; (e) water body; (f) swamp; (g) dry land forest; and (h) spawning site of turtles. These components had changed with the change of the islands, such as in the number of species, area width, and coverage percentage, and the end point was ecosystem damage. The similar condition also occurred in flora and fauna resources which had been disturbed, thus causing the lack or the loss of resources in the islands. Activities that were eliminating resources were the collection of turtle egg and the capture of the prime, the mining of sand, the capture of land animals such as pouched kus-kus, and the logging of trees for housing. All of these decreased ecosystem width, lowered resource diversity, and degraded islands ecosystem.

Further analysis indicated that these exploitative activities were emanated from the limited activity of community in their life space. The pursuing for problem solving alternative, including technological shift or subsistence alternative, was far beyond consideration. A problematic occurred, called as *maladaptive*. This unfavorable real fact of islands ecosystem was also occurred in other ecosystem. Therefore, the anticipated change in the community was not determined by which island was a real winner with superior resources, but by the stealing of resources by individuals to meet their demand, thus causing less sustainable utilization patterns (Adger, 2006; O'Brien and Leichenko, 2000).

If it was let happening, it might exceed the social, economical and ecological thresholds of the islands ecosystem (Folke et al, 2004; Kinzig et al, 2006; Reyers et al, 2009), such that the community were trapped in the poverty and rigidity because they had to make their welfare with limited subsistence (Allison and Hobbs, 2004; Anderies et al, 2006) or because of the degradation of the life aspect of the community (Hegmon et al, 2008).

A method to produce better condition in the future was through a dynamic process to improve the susceptibility rate in the future. Adaptive strategy must be developed through a process where internal dynamic of a system was assumed as relatively stable. It meant that the conversion of a certain area into a protection area must consider the rejuvenation of environmental preservation without disregarding the demand of community. Therefore, any steps toward change should be stable either in ecological, social or economical aspects. Adaptive management was a dynamic solution where the response to a change might cause further change (Smit and Wandel, 2006; Marshall et al, 2010). A process toward evaluation could be sustainable to identify the components causing instability. It might be carried out through adaptive management process, and therefore, it needed new touch to management.

3.2 Zoning Model in the Islands Ecosystem

Southeast Aru Conservation Area with 114,000 ha width had seven (7) islands, such as Enu Island, Karang Island, South Kultubai Island, Jeh Island, Mar Island, Jeudin Island, and Marjinjin Island. The result of assessment of island protection area based on ecological value (NE) indicated that diversity, distinctive marker, comprehensiveness and representativeness

had similar rate which remained in the high category (score 5). Originality or intactness and susceptibility rate had different rate, with Enu Island and Karang Island had score 4, while five other islands had score 3. The difference of the rate was caused by some factors such as natural succession, land vegetation coverage, damage rate, and moderate vegetative structure. Mainly, the access to utilize Enu Island and Karang Island was lower than five other islands (Table 1).

Table 1. Geographic Position, Island Width and Coast Length of Seven (7) Islands in Southeast Aru Conservation Area

Island	Position		area of the island (Km ²)	Coastal line (Km ²)
	Latitude	Longitude		
Enu Island	07° 06 ' 14" S	134° 11' 38" T	14,38	26,39
Karang Island	07° 01' 08" S	134° 41' 26" T	3,30	7,78
South Kultubai Island	06° 49' 54" S	134° 47' 14" T	0,82	6,61
Jeh Island	06° 51' 16" S	134° 45' 18" T	6,77	18,67
Mar Island	06° 55' 19" S	134° 33' 50" T	1,79	10,97
Jeudin Island	06° 49' 56" S	134° 47' 16" T	16,18	42,28
Marjinjin Island	06° 49' 55" S	134° 47' 15" T	5,69	25,68
Total			48,94	138,37

Result of assessment of island protection area with social value (NS) approach showed that there was a difference between Enu Island and Karang Island from other five islands. Related to the protection of species with regulation approach, it seemed that Enu Island and Karang Island had higher value because both had strong legal base as the protection islands and as conservation area. These two islands also had other value, which being as the border islands and as the historical islands to the community in Aru Islands District, in general and to the community of the conservation area, in particular. In relative with the resource preservation activity, all seven islands in the area only showed two (2) facts. These were (1) the community had been aware of the importance of islands preservation due to the historical value of islands, and (2) there was lack of greening activity for the forest in these seven islands.

Regarding to the utilization rate of islands resource, the greatest utilization rate was found in five islands other than Enu Island and Karang Island because these five islands were nearby and close. To get into Enu Island and Karang Island, the community must spend higher energy to afford these islands. In certain season, both islands were subjected to great wave from east and west, and therefore, it was difficult for the community to access these islands. Concerning with transportation, the local fisher only relied on not-machined boat and

ketinting-machined boat. However, traders in this area used greater boat with higher machine capacity and therefore, they could afford the remote area. Enu Island and Karang Island had highest rate for transportation criterion, while other islands had moderate rate.

Based on the decision criterion of zoning analysis, if *island protection area criteria rate* (NKKLP) was ≥ 80 , the area with suitability for island protection area was Enu Island and Karang Island. Other islands would need further analysis to determine its utilization. Result of this analysis showed that other five islands were suitable for eco-tourism sub-zone (Table 2) and other zone such as protection sub-zone and island rehabilitation zone (Figure 1).

Table 2. The Activity of Utilization in Islands Ecosystem in Southeast Aru Conservation Area

No	Utilization Activities	Island							Total	%
		1	2	3	4	5	6	7		
1	Agriculture /				V				1	
2	Horticulture logging	V	V		V	V		V	5	
3	Taking Sand				V	V	V	V	5	
4	Pengakapan Turtle	V	V	V	V	V	V	V	7	
5	Turtle egg collection	V	V	V	V	V	V	V	7	
6	Arrest terrestrial fauna	V	V	V	V	V	V	V	7	
	Total	4	4	4	6	5	4	5		6
	Percent (%)	66.67	66.67	66.67	100.0	83.33	66.67	83.33	7	76.19

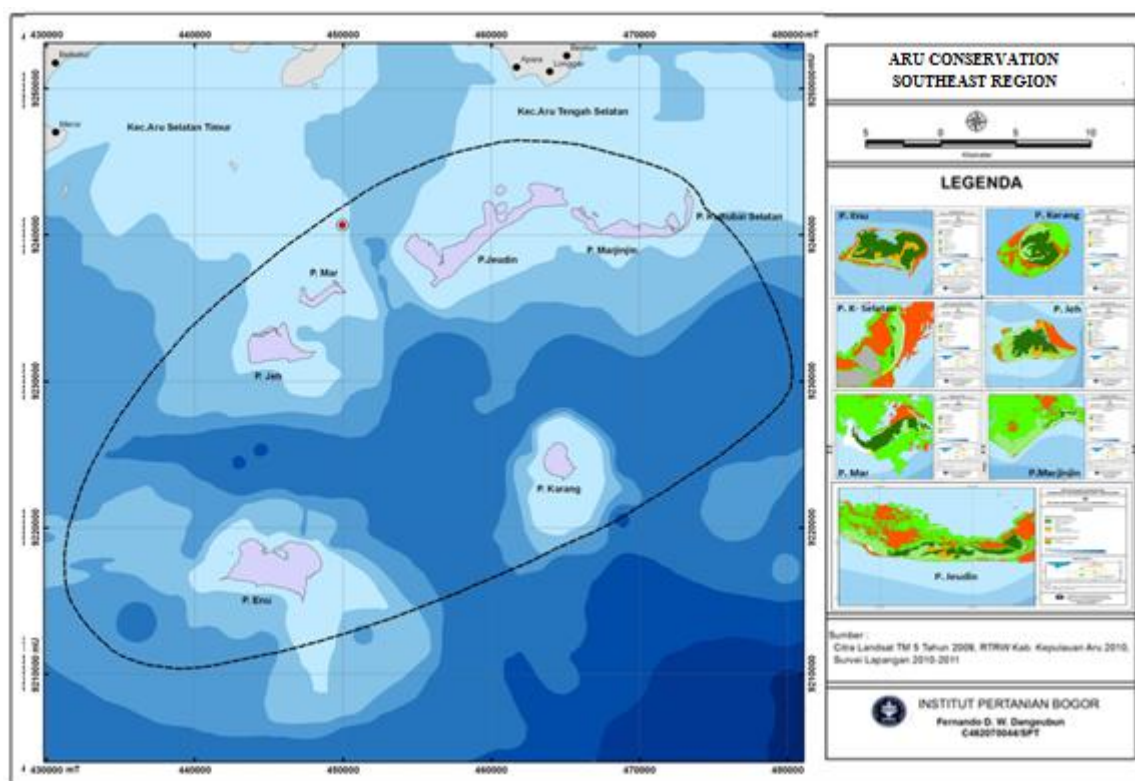


Figure 1. The Ecosystem Zoning Map of Islands in Southeast Aru Conservation Area

3.3 Determination of Zone

The Decree of The Minister of Marine and Fishery of Republic of Indonesia No. Per. 30/Men/2010 about The Management Plan and The Zoning of Waters Conservation Area, especially Article 9 Verse (1), had determined the zoning of waters conservation area. This zoning included:

- 1) Core Zone;
- 2) Sustainable Fishery Zone;
- 3) Utilization Zone; and/or
- 4) Other Zone.

Waters conservation area zone, as explained in verse (1), was arranged based on the function by considering the resource potential, supporting capacity, and ecological processes. Core Zone, as explained in verse (1) letter (a), must be available in the waters conservation area with at least 2 % width of area width. Every waters conservation area must have one core zone or more based on the width of physical, bio-ecological, social, economical and cultural characters.

3.3.1 Core Zone

Core zone, as illustrated in Article 9 verse (1) letter (a), was determined by criteria as following:

- a. it referred to the spawning area, caring area and/or fish breeding;
- b. it became a habitat of certain waters biota which was a priority, endemic (distinctive), rare and/or charismatic;
- c. it had diversity for waters biota and ecosystems;
- d. it had distinctive marker of natural ecosystem and represented certain original biota existence;
- e. It had relatively original waters condition, with less or lack of human disturbance;
- f. It had sufficient width to support fish survival, effective fishery management, and natural bi-ecological process;
- g. It had distinctive marker as the embryonic plasma source for Waters Conservation Area.

In relative with the decision of zone determination, the utilization was established based on the criteria. Based Article 9 Verse (1) Letter (a), not all islands in the area could meet the requirement as the core zone. Islands which suitable to the criteria of ecosystem core zone were Enu Island and Karang Island at Southeast Aru Conservation area. Both could be core zone with total width of 17.68 km² or 1,768.39 ha.

Core zone would be important to provide support to system in the other area. Therefore, serious attention should be given to this matter by the managing organization or the

immediate community, mainly by supervising the utilization of core zone.

3.3.2 Sustainable Fishery Zone

Sustainable Fishery Zone was explained in Article 9 Verse (1) Letter (b) and it proposed the following criteria:

- a. It had conservation value but could still tolerate the environmental friendly utilization of natural resource and fishery;
- b. It had ecosystem that supported the environmental friendly utilization and sustainable fishery;
- c. it had diversity for waters biota and ecosystems;
- d. It had relatively favorable waters condition, with the capacity of multi-functions and without destroying its original ecosystem;
- e. It had sufficient width to support environmental friendly cultivation, sustainable fishery, and social, economical, and cultural activities of the community;
- f. It had characteristic of potential and representativeness of highly economic waters biota.

Based on these criteria, the ecosystem of islands was not suitable to be sustainable fishery zone.

3.3.3 Utilization Zone

Utilization Zone was regulated through Article 9 Verse (1) Letter © with the following criteria:

- a. It had tourism attractiveness including waters biota and beautifully distinctive waters ecosystem;
- b. It had sufficient width to guarantee potential preservation and attraction for tourism and recreation;
- c. It had characters of research and education which would support conservation interest;
- d. It had relatively favorable waters condition for many utilization activities without destroying its original ecosystem;

Result of decision of tourism zone determination indicated that all islands had tourism value below the threshold for being waters tourism zone. This low value was caused by lower rate of tourism criteria such as low number of visitors and poor access to the structure and infrastructure. However, the diversity of resources and the distinctive marker of ecosystem might be great potentials to develop the islands into tourist resort based on environmental preservation.

Islands ecosystem in the conservation area had the beauty of white sand, spawning site of turtles, and endemic land flora and fauna. All of them might be good offering for the special interest of tourism. Eco-tourism represented an integration of many interests concerning with

the susceptibility of environment, economic and social. Eco-tourism of the coast and marine areas might be categorized into coast eco-tourism and marine eco-tourism. For coast eco-tourism, some tourism activities were considered such as coast recreation, sunbathing, coast traveling, and other utilization of coast resources. Therefore, based on the utilization zone for islands ecosystem, some islands were used for utilization zone such as Jeh Island, Mar Island, Jeudin Island, Marjinjin Island, and South Kultubai Island.

3.3. 4 Other Zone

Article 9 Verse (1) Letter (d) explained that other zone involved protection zone and rehabilitation zone. Jeh Island, Mar Island, Jeudin Island, Marjinjin Island, and South Kultubai Island were suitable to be classified as other zone. Jeh Island and South Kultubai Island were also determined as the rehabilitation zone.

4. Conclusion

Based on the result and discussion, the following conclusions were formulated:

- 1) The ecosystems of islands in the Southeast Aru Conservation Area should be protected, but Enu Island and Karang Island must be stated as core zone.
- 2) The ecosystems of Jeh Island, Mar Island, Jeudin Island, Marjinjin Island, and South Kultubai Island were determined as utilization zone, especially related to the presence of coast tourism sub-zone.
- 3) The ecosystems of Jeh Island, Mar Island, Jeudin Island, Marjinjin Island, and South Kultubai Island were also useful for tourism interest, and therefore, these islands were included into other zone category, with the rehabilitation zone for Jeh Island and South Kultubai Island, while protection zone for other islands.

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