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ROLE OF GOVERNMENT AND PRIVATE SECTOR IN MARINE ECOTOURISM RELATED TO CONSERVATION OF BIODIVERSITY IN SERIBU ISLANDS

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ABSTRACT: Ecotourism has relation with conservation of biodiversity which recently shows bad condition on the marine ecosystem. This research analyzed how the role of government compared to the private sector was conducted in Pramuka and Air Island based on the type of ecological zone and further conformity of ecotourism was assessed based on biodiversity of living organisms in both islands. Line intercept transect method was used in this study stretched along the parallel 85 m into the coastline with three replications over 25 m. Combination of 100 m Line intercept transect method and 20 m diameter of circular transect method inside were used to measure identify plants. Bird species was observed by the distance sampling point count method. Interview with local people surrounding islands was also conducted to get the information on anthropogenic activities. The study showed that coral diversity in Pramuka and Air Island were in moderate level (1.00 <H '<3.00), nevertheless live coral coverage in Pramuka Island was 29.17% of 73.44% total coral coverage lower than Air Island (49% of 55.62%). Seagrass species found in Pramuka Island were 6 species and only 3 species were found in Air Island whereas mangrove species was lower in Pramuka Island than Air Island. For ecotourism conformity, Pramuka Island was confirmed for recreation and seagrass ecotourism category whereas all tourism categories were confirmed in Air Island. Despite ecotourism in both islands likely destroyed the environment, conservation of biodiversity on marine ecosystem seemed ineffectively managed or even ignored by government neither private sector. Recovery by nature seems to play a greater role in biodiversity conservation in both islands.

Keywords: Biodiversity, Marine Ecotourism, Conformity Index, Seribu Islands

1. INTRODUCTION

Indonesia is the largest archipelago country with more than 17,000 small islands which is called Seribu Islands. The Seribu Islands have the unique natural resources, both in terrestrial and marine areas providing environmental services for local people to support economic and social development sustainably [1], [2].

The richness of biodiversity in Seribu Islands provides ecotourism activities which serve an interesting tourism destination, including white sandy beach, the beauty of underwater, and unique culture. Nevertheless, such ecotourism activities are conducted so far in Seribu Islands has some negative impacts on the conservation of biodiversity, including the use of coral for building, destruction of coral as water sports activities, exploitation sands for the building. Many studies have reported the degradation marine diversity, including corals in Seribu Island [3-6] and seagrass [7].

Most of the management of the small islands in Seribu Islands is run by the government and some of them are by private. There are 12 islands managed by the government of DKI Jakarta which is in the primary zone and 11 islands in inhabitant zone, while 34 islands managed by private for tourism destination and no inhabitants in those islands. Unfortunately, less study is conducted regarding evaluate the role of government and the private sector in conserving biodiversity related to tourism activities and other anthropogenic activities in the mainland. Therefore, this study was conducted at Pramuka and Air Island representing government and private sector management in order to analyze the role of both management in marine diversity conservation and evaluated the impact of ecotourism activities to biodiversity in the islands. The ecological data was collected and analyzed as the important information in determined type of ecological zone and further ecotourism conformity can be assessed for future sustainable ecological tourism development in Pramuka and Air Island.

2. MATERIALS AND METHODS

This research used the qualitative and quantitative methods, including collecting data through field survey methods, interviews and observations in Pramuka and Air Islands, Seribu Islands, Indonesia. The diversity of marine biota was collected including coral and seagrass, and the analysis was conducted at the Laboratory of Biology, Center for Integrated Laboratory, State Islamic

University (UIN) Syarif Hidayatullah Jakarta. The sampling point at Pramuka Island was at North, South, and West (Pier) sites, while Northern sites of Air Island which coral ecosystem found. Interview with local people was also conducted to get more information about the contribution given by government and private sector for conservation program in both islands.

Furthermore, the data of diversity index of various marine species is determined using the formula of Shannon-Wiener index [8].

$$\mathbf{H}' = -\sum_{n=1}^{\infty}\left(\frac{ni}{N} + \ln\frac{ni}{N}\right)$$

Description:
H '= Shannon-Wiener diversity index
ni = Number of individuals of a species to-i
N = Total number of individuals of all species

The value of Shannon Wiener Diversity Index has a range of categories is defined as follows:
H '<1.00: Diversity of species is low.
1.00≤H' ≤3.00: Diversity of species is moderate.
H '>3.00 : Diversity of species is high

For coral reef monitoring, it was used LIT (Line Intercept Transect) method to collect data which was made of 3 transects. The length of transect was each 25 m with 5 m interval between each transect, so it was about 85 meters length of the line toward the sea. The observation was conducted at two depths, which were at 3 and 10 meters depth, with 3 replications. The depth of 3 m represented shallow waters while the 10 m depth for a relatively deepest water, assuming two conditions represent the depth of the reef where coral can grow well [9]. The observation was conducted in the morning or during the day depending on the condition of weather [10].

Installation of transect was parallel to the shoreline and follow the contours of corals. The transect is placed on top of the coral colony and recorded the coral form, live and dead coral, abiotic form, coral cover, and the form of the substrate (sand, mud, and rocks), along 85 m length.

These measurements were performed with an accuracy approach which always considered the colony form as a single individual. If a colony of the same type is separated by one or several parts of the dead corals, the living part of each regarded as a separate individual. If two or more colonies are growing on top of the other colonies, then each colony was still counted as a colony separately [11]. The length of overlapping colonies was recorded and used to analyze the species richness.

The percentage of coral cover was used to estimate the condition of coral reefs in an environment which was obtained from the measurement of life form of corals using the formula [12] below:

$$\boldsymbol{L = \frac{Li}{N}\ x\ 100\%}$$

Description:
L = The percentage of coral cover (%)
Li = Length of life form (intercept colony) categories to-i
N = Length of transect (m)

Percentage of coral coverage is the area covered by growing corals which was developed by Gomez and Yap [13] the criteria as follow:

Table 1 Percentage of live coral coverage

Coverage (%)	Category
75 – 100	Very good
50 – 74.9	Good
25 – 49.9	Moderate
0 – 24.9	Bad

Measurement of physical parameters at each station of each transect was also considered. The physical parameters of water measured were pH, temperature, and clarity. The observation was also conducted for upper and lower level of plants species which used 100 m LIT method and combined with 20 m diameter on Circular Line Method (CLM) for sampling plots of upper-level plants and 5 m diameter for lower level plants sampling plots.

Observation of bird species was conducted using the distance sampling point count method from 06:00-13:00 am [14], [15]. It was established 40 point count stations that were at least 100 m apart throughout the area. Each point count station was surveyed 5 times for 10 minutes at each point count station. Birds were recorded and counted at a certain point based on visual and bird voice [16].

2.1. Data Analysis

The data of this study is the qualitative and quantitative data. Data obtained from this study was analyzed quantitatively descriptively using simple mathematic formula, so it can provide an overview of the ecological condition of Pramuka and Air Island. Furthermore, ecological data from both study sites were analyzed to evaluate the conformity index of ecotourism, including the type of ecotourism for recreation, snorkeling, diving, and seagrass tourism.

Assessment for conformity of ecotourism was adapted from Yulianda [17] and Baksir [18]. Based on the results obtained, it can be further evaluated the role of government and the private sector in managing the region-based biodiversity conservation and for a future recommendation in sustainable ecological tourism development.

3. RESULT AND DISCUSSION

Management in Seribu Islands is the important factor in determining the condition of biodiversity in this area. Based on ecological data, there were differences between Pramuka Island which was managed by local governments and Air Island which was managed by the private company (Table 2). The differences were very closely related to conservation activities carried out by the stakeholders.

Table 2 Comparison of Pramuka and Air Island profile

Parameter	Management	
	Pramuka Island	Air Island
Management	Government	Private
Residential	Yes	No
Wastes	Many domestic wastes and without treatment	Less domestic wastes and with treatment
Environmental awareness	- Cleanliness bad - Low awareness of government - Low Awareness of people	- Cleanliness keep well - Low awareness of management
Transportation	Ships dock every day	Ships dock only weekend, prefer big private ships
Exploitation of natural resources	Corals for building materials	Corals for water front development on large scale
Research	Many studies were done by universities, government, and NGO's	Less research is done

The quality of the environment and the level of diversity in Air Island as the resort's island which was run by the private company were relatively better than Pramuka Island. There was not found people living on this island resulted in little waste produced which in the further lead to better environmental quality of the surrounding waters. However, less waste production in the island did not significantly impact to the quality of the environment in Air Island. This assumes that lack of contribution was given by the management in marine conservation leading to disruption in the diversity of marine and terrestrial organisms which should have in a good condition because of no residential in this island.

3.1 Terrestrial Biodiversity in Pramuka and Air Island

Biodiversity in Pramuka and Air Island is very diverse, both on the terrestrial and marine ecosystem. There were 13 species of upper-level plants found in both islands (Table 3), but the diversity index was same in moderate level (H'=2.29, H'=1.26). Compared to lower level plant, diversity index in Air Island was low compared to Pramuka Island was in moderate level (H=1.85, H'=0.58) and the number of species was also less than the upper-level plants (Table 4).

The moderate level of upper plant diversity was confirmed with 18 species of birds from 14 families in Pramuka Island. The types of birds come to the island for food from the vegetation growing in the air (*Apus affinis, Artamus leucorhynchus, Collocalia linchi,* and *Hirundo tahitica),* trees *(Corvus macrorhynhos, Dicaeum trochileum, Pycnonotus aurigaster, Pycnonotus goiavier, Rhipidura javaniica, Zosterops chloris,* and *Zosterops palpebrosus),* or mangrove shoreline *(Todirhamphus chloris* and *Todirhamphus sanctus),* surface soil *(Passer montanus, Streptopelia*

Table 3 Diversity index of high-level plants at Pramuka and Air Island

No	Species	Amount	H'
	Pramuka Island		
1	*Acacia mangium*	7	0.242
2	*Artocarpus altilis*	9	0.276
3	*Barringtonia asiatica*	3	0.144
4	*Casuarina equisetifolia*	13	0.324
5	*Citrus sp.*	2	0.108
6	*Cocos nucifera*	1	0.065
7	*Hibiscus tiliaceus*	5	0.199
8	*Leucaena leucocephala*	10	0.290
9	*Morinda citrifolia*	1	0.065
10	*Pongamia pinnata*	2	0.108
11	*Sauropus androgynus*	6	0.222
12	*Scaevola taccada*	2	0.108
13	*Terminalia catappa*	3	0.144
	Total	64	2.295
	Air Island		
1	*Acacia mangium*	5	0.211
2	*Barringtonia asiatica*	1	0.070
3	*Casuarina equisetifolia*	37	0.287
4	*Hibiscus tiliaceus*	2	0.116
5	*Morinda citrifolia*	3	0.153
6	*Pongamia pinnata*	5	0.211
7	*Syzigium sp*	5	0.211
	Total	58	1.26

Table 4 Diversity index of lower level plants at Pramuka and Air Island

No	Species	Amount	H'
	Pramuka Island		
1	*Borreria laevis*	9	0.059
2	*Catharanthus roseus*	74	0.246
3	*Imperata cylindrica*	218	0.366
4	*Lantana camara*	18	0.099
5	*Piper caninum*	11	0.068
6	*Porophyllum ruderale*	35	0.156
7	*Rhoe discolor*	170	0.35
8	*Sauropus androgynus*	3	0.025
9	*Sida rhombifolii*	23	0.117
10	*Stachytarpheta jamaicensis*	22	0.114
11	*Turnera ulmifolia*	74	0.246
	Total	657	1.85
	Air Island		
1	*Ipomoea pescapre*	4	0.104
2	*Pandanus tectorius*	3	0.085
3	*Stachytarpheta jamaicensis*	15	0.244
4	*Wedelia biflora*	113	0.149
	Total	64	0.58

chinensis, and *Rhipidura javaniica), and lower plants* (*Dicaeum trochileum*, *Gerygone sulphurea, Nectarinia jugularis, Rhipidura javaniica, Zosterops chloris*, and *Zosterops palpebrosus*).

Being compared to Air Island, there were fewer bird species found, only 6 species of 5 families. They also searched food from many sources including from form vegetation (*Corvus macrorhynchos* and *Oriolus chinensis*), stony coral (*Ardea cinerea* dan *Egretta sacra*), lower level plants (*Gerygone sulphurea*), and form water surface (*Tordirhamphus chloris*, *Ardea cinerea*, and *Egretta sacra*).

It means that the vegetation was not the main source of food and wood for local people. They also did not want to plant fruit plants as it was not found any fruit plants in all islands. It was experienced that the existence of these birds was very difficult to find. The birds need food and fruits are the sources of food for birds. If the plant diversity was significantly low, moreover the very small number of birds was not even there to see. It showed that management of Air Island was not paid attention to conservation regarding to plantation of various vegetation for food and shelter of birds.

3.2 Marine Biodiversity in Pramuka and Air Island

Regarding to the marine diversity, diversity index of corals decreased to 1.38 in the recent study compared to the study conducted by Efrinawati in 2012 [3] that found diversity index of coral was 2.07-2.82. This was so bad and it can be assumed that all activities done did not give significantly impact to the marine environment, such as coral transplantation. Rifqi [4] observed that coral transplantation had already conducted in Pramuka Island since 2005, but live coral coverage was only 23-50% in 2016 due to water pollution come from mainland and diesel spill from ships. This condition was almost the same as reported by Mujiyanto et al [19] in 2009 that live coral coverage was 30-50%. More attention to corals conservation is needed for environmental sustainability in the future.

The low diversity index in Pramuka Island was also strengthened by the low coverage of live corals was 29.17%. The coral coverage in Pramuka Island was 73.44% however 44.27% was dominated by dead coral algae (DCA) (Fig. 1). In Air Island, 49.22% of 55.62 % live coral-dominated coral coverage and only 6.4% of dead corals found. Nevertheless, there was not any contribution given by the resort management for marine conservation. Thus, the good condition of live coral coverage was sole because of the dynamics of nature. This was proved by the study conducted by Subhan et al [6] in 2008 and Yosephine et al [5] in 2010 found that live coral coverage in Air Island was 27.18%-37.88% and 43.16% lower than the recent study.

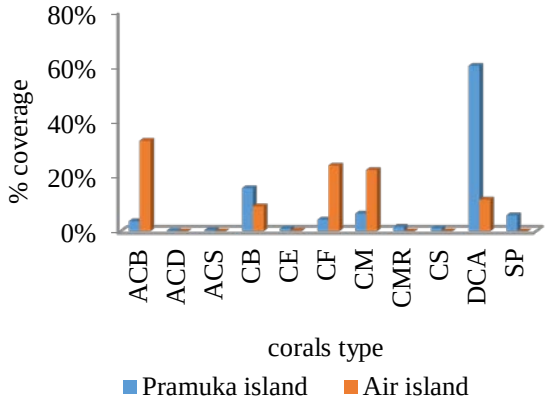

Fig. 1 Percentage of coral coverage at Pramuka and Air Island. Note: ACB (Acropora Branching), ACD (Acropora Digitate), ACS (Acropora Submassive), CB (Branching Coral), CE (Encrusting Coral), CF (Foliose Coral), CM (Massive Coral), CMR (Mushroom Coral), CS (Submassive Coral), DCA (Dead Coral Algae), SP (Sponge)

The diversity index of seagrass ecosystems in Pramuka Island compared to Air Island was better. There were 6 species of seagrass found in Pramuka Island, including *Cymodoceae rotundata, Cymodoceae serrulata, Enhalus acoroides, Halodule uninervis, Halophilia ovalis,* dan *Thalassia hemprichii*, whereas 3 species in Air Island, *Cymodoceae rotundata, Enhalus acoroides,* and *Thalassia hemprichii*. *Enhalus acoroides* (37%-

43%) and *Cymodoceae rotundatais* (31%-58%) were the most dominant species grown in both islands (Fig. 2). Both species are a hardy species and it is adaptable to marginal conditions. Just like other intertidal species, *Enhalus acoroides* and *Cymodoceae rotundatais* are common and widespread, especially in embayments. Based on criteria of ecology developed by Salm et al. [20] and Soselisa [21], diversity of seagrass was high (>5 species) in Pramuka Island, but it was categorized low (1-3 species) in Air Island.

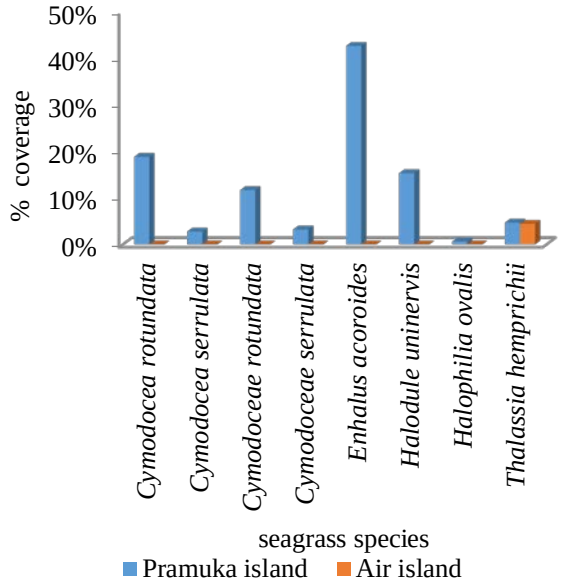

Fig. 2 Percentage of seagrass coverage at Pramuka and Air Island

Macroalgae were also found in Pramuka and Air Island, they were *Padina* sp., *Sargassum* sp., and only *Halimeda* sp. was in Air Island, but in small quantities due to anthropogenic wastes that have an impact on water quality degradation. Very low clarity was observed in both islands that were only 1.5 m in Pramuka Island and 2 m in Air Island. This resulted in interference of marine biota including corals, seagrass, and macroalgae diversity. Based on criteria of ecology [20], [21], diversity of macroalgae was low (<10 species) in both islands.

3.3 Conformity of Ecotourism

In general, the condition of Pramuka and Air Island was not in good condition, however, with high awareness and efforts form all stakeholders especially government, resort management, and the local community, ecotourism in both islands still have good potential to be developed because of the underwater uniqueness in both islands. This factor is very important to attract tourists visiting the islands.

In order to analyze the conformity of Pramuka and Air Island as an ecotourism destination, it is necessary to use the matrix of conformity [17], [18]. The conformity of ecotourism category is divided into recreation, snorkeling, diving and seagrass tourism. The value of matrix is defined as 3 categories: value 1 means not conform (NC), value 2 means conform (C) and value 3 means high conform (HC). Those data were supported by the ecological zone assessment, both in the terrestrial and marine ecosystem as well (Table 6).

Table 6 Assessment of ecological zone at Pramuka and Air Island

Parameter	Amount	Category
	Pramuka Island	
Terrestrial :		
Plant	24 species	High
Animal (bird)	14 species	High
Marine:		
Ecosystem	4 types	High
Coral life form	9 types	Moderate
% Coral cover	29.17%	Low
Spesies of coral fish	<61 types	Low
Species of algae	2 types	Low
Species of seagrass	6 types	Low
	Air Island	
Terrestrial :		
Plant	11 species	Moderate
Animal (bird)	6 species	Moderate
Marine:		
Ecosystem	3 types	Moderate
Coral life form	11 types	High
% Coral cover	49.22%	Low
Spesies of coral fish	<61 types	Low
Species of algae	3 types	Low
Species of seagrass	3 types	Low

Low category of those parameters needs more attention by government and also private sector to fix the condition of the ecosystem in both islands through education and research. This assessment can be used as the basis for determination on tourism conformity.

The result of the analysis of ecotourism conformity on Pramuka and Air Island was shown in Fig. 3-6. The value of each parameter was multiplied by the weight of parameter based on Baksir [18] and Yulianda [17]. Finally, conformity value of ecotourism could be determined (Table 7).

It showed that none of the sampling sites had very high ecotourism conformity value. Low to moderate biodiversity in both islands was as the main cause of low conformity. Most of ecotourism conformity value for snorkeling and diving in Pramuka Island was 1 meaning not suitable for these categories. However, recreation and seagrass tourism were suitable in Pramuka Island as more value 2 obtained and some of that was value 3. However, the presence of sea urchins and lepu fish in the shallow water has to be warned to all tourists as it can

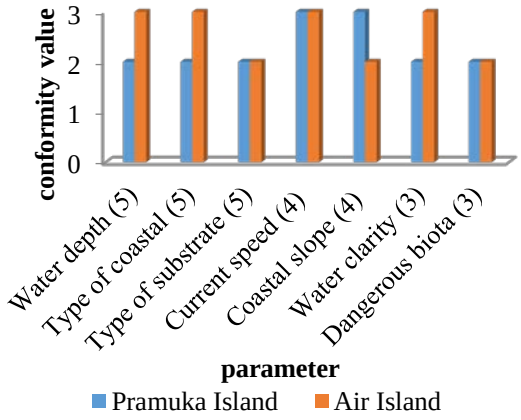

Fig. 3 Ecotourism conformity for recreation tourism category

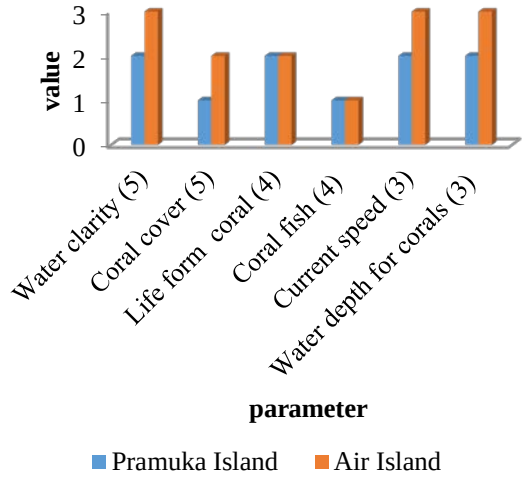

Fig. 4 Ecotourism conformity for snorkeling tourism category

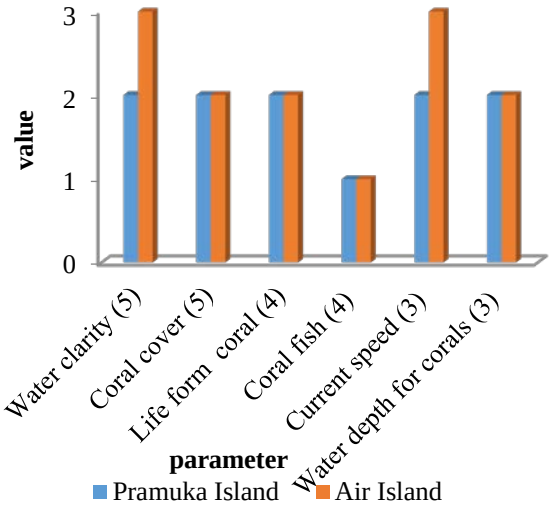

Fig. 5 Ecotourism conformity for diving tourism category

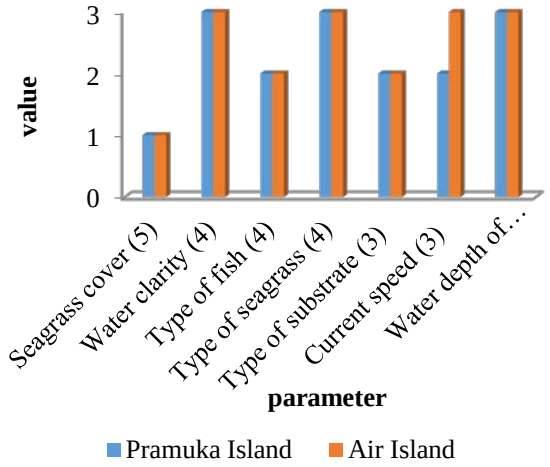

Fig. 6 Ecotourism conformity for seagrass tourism category

Table 7 The conformity of ecotourism at Pramuka and Air Island

No	Parameter	Pramuka Island	Air Island
1	Recreation	2.28 (C)	2.17 (C)
2	Snorkling	1.65 (NC)	2.31 (C)
3	Diving	1.85(NC)	2.19 (C)
4	Seagrass	2.26 (C)	2.39 (C)

endangered them while swimming or playing in shallow water.

On contrary, all ecotourism categories were confirmed in Air Island, although it was not highly recommended. Percentage of substrate type and the coastal slope was the cause of low value obtained in recreation category. For snorkeling and diving categories, low percentage of coral cover and life form coral and also less number of coral fish were the main cause of the conformity was not in the high category. Whereas, low percentage of seagrass cover did not affect the conformity for seagrass tourism category as other parameters were in value 2 and 3.

The presence of coral fish in the seagrass ecosystems was such an attractively scenery for tourist in shallow water activities as the main habitat for seagrass. Various types of seagrass can be found in Pramuka and Air Island at depths between 50-100 cm at low tide and 2 m at high tide.

For Air Island, snorkeling and diving tourism were more suitable to be developed. This was supported by higher live coral coverage in Air Island than Pramuka Island. Deep depth water was also considered which can dive until 18 m deep in Air Island. Although the diversity of coral fish was low based on Salm et al. [20] and Soselisa [21], the living coral coverage still attract tourist to dive or snorkel. The diversity of fish is closely related to the quality of the waters and the presence of the inhabitants of Island. Waste production in Air Island

as a Resort Island with no inhabitants was not so many as Pramuka Island with large residents which could pollute the water if it was disposed of directly to water without treatment.

In general, most of the ecotourism parameters have to be enhanced in Pramuka and Air Island to meet high conformity of ecotourism criteria that is to get environmental conservation and biodiversity goals. Developing ecotourism in the islands, the authorities should focus on consultation and participation between all stakeholders involved in ecotourism to ensure the economic and socio-cultural benefits are shared between government, the private sector, tourists and local communities. Voon et al [22] proved that social and environmental aspects of well-managed approach will benefit the multi-stakeholders including local people. With regard to informational, financial, technical and motivational supports, protection and restore the environment could be achieved [23].

This study has already shown that it is quite difficult to expect local communities with low awareness to support and implement conservation. Hence, it is up to the political will of the government to develop and implement policies that strike a balance between economic gains and environmental conservation. Clifton [24] suggested that if the activities do not reflect the needs of local communities and the environment, local people will not participate in conservation activities which finally will not result in environmental benefits.

The efforts in scientific research activities, conservation and management, environmental education, awareness, and community action have done successfully in Tamar project at Brazil [25], in Brunei Darussalam [26] and also in South Korea [27]. The high level of interaction develops awareness about the importance of field research and the importance of conservation and research in the islands.

4. CONCLUSION

The role of the private sector and government is still limited in the conservation of biodiversity in Pramuka and Air Island. However, if they make good collaboration with other parties including university, research center and NGO's, and have open minded to others, in future, both Islands will be getting a better environment as habitats for marine organisms.

Meanwhile, the government needs to give serious attention to population growth in Pramuka Island which tends to enhance waste production resulted in water quality declined. Bad water quality is related to the low-moderate level of marine diversity in Pramuka and Air Island. This also results in less conformity of ecotourism.

Moreover, Air Island as an uninhabited island, it was not even meet the high criteria of ecotourism conformity. With regard to this situation, the very loud reprimands should be given to the management of Air Islands by the government. They should conserve biodiversity and environment better than other inhabited islands, and further, it should be developed as one of the beautiful ecotourism sites.

With good efforts and collaboration among all stakeholders, ecotourism activities will further provide positive impacts in economic, socio-culture and environmental benefits in Seribu Islands. Research and education are the first steps concerned in order to develop the ecotourism in small islands, like Seribu Island. Finally, the quality of marine environment will increase in between with biodiversity conservation activities, so environmental sustainability will be achieved in the future. Recovery by nature will simultaneously enhance biodiversity in the islands as well.

5. ACKNOWLEDGEMENTS

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