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The Ecological Adaptive Capacity in the Group Of Guraici Island in Kayoa District, South Halmahera Regency, North Moluccas Provinces, Indonesia

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ABSTRACT
Coral reef, mangrove and sea grass are the important ecosystems in coastal areas and small islands that play an essential role in protecting the coastline and the mainland of small islands. These ecosystems are quite effective as the protectors for the security of mainland of small islands. This research was designed to calculate, assess and determine the status of ecological adaptive capacity of small islands in the group of Guraici Island. This research was conducted in 17 islands located in the group of Guraici Island by calculating the adaptive capacity of coral reef ecosystem, mangrove ecosystem and seagrass ecosystem. The value of adaptive capacity in each ecosystem was in the range of 0.0 to1. 0; while, the adaptive value of island ecology was in the range of 0.0 - 3.0. The result of this research showed that all coastal ecosystems examined in the islands located in the group of Guraici Island were grouped into three categories of adaptive capacity: "*medium*,*low* and *very low*". The value of the adaptive capacity of coral reef ecosystem was in the range of 0.0–0.58. Meanwhile, the mangrove ecosystem and the seagrass ecosystem had the values of adaptive capacity between 0.0–0.51, and between 0.0-0.59, respectively. Similarly, the result of analysis showed that the adaptive capacity of the ecology of islands in the group on Guraici Island was categorized into three: medium, low and very low with the value of the adaptive capacity of ecology in the range of 0.37-1.64.

Keywords: Adaptive Capacity of Ecology, Coral Reef, Mangrove and Seagrass, Guraici Island

INTRODUCTION

Climate change and global warming bring an impact on both the increase of extreme climate frequency and sea level rise. In the last few years, they have given a contribution to the increase of pressure and vulnerability of small islands; leading to quality decline of the environment of coastal areas and small islands (Mimura, 1999; Ghina, 2003; Lewis, 2009). The small islands have a vulnerable environment and come to be the most prone areas (Briguglio, 1995; Mimura, 1999). Julca and Paddison (2009) stated that the small islands, especially in small island countries, basically have one similarity; that is, being susceptible to disaster with the high level of susceptibility towards natural disaster due to the low level of physical, social, economic and environmental sustainability.

Coral reef, mangrove and seagrass are the important ecosystems in the coastal area and small islands, and play an important role in protecting the coastline and mainland of small islands, particularly related to recent global issues and climate change. Those ecosystems are quite effective as the protector towards the safety of mainland of small islands and have a relation to protect the small islands. Physically, the roles of those three ecosystems include preventing erosion, trapping sediments and hindering the waves, flow and storms (Moberg and Folk, 1999). The presence of those ecosystems in coastal areas and small islands is very critical in improving the adaptive capacity of an island towards natural disasters since they act as a natural dam or barriers (Mimura, 1999).

As stated by Gallopin (2006), adaptive capacity refers to the capability of a system to adapt to a disturbance or damage potential. Fusel and Klien (2006) added that adaptive capacity is the capability

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of a system to adapt to any change that can cause potential of more moderate impact, and to benefit from or to cope with the effect of the change.

The adaptive capacity of a system, such as small islands, is a system formed among the small islands themselves with other ecosystem nearby playing a role important in reducing the external effect on the small islands. For the coastal ecosystem such as coral reef, mangrove and seagrass, the adaptive capacity has an important value in facing the change and external pressure. With the high adaptive capacity, ecosystem can maintain itself from any disturbance or pressure. Luers (2005) stated that the adaptive capacity has the potential to shift the position of the system on the high vulnerability surface to the lower level of vulnerability by reducing sensitivity and exposure; thus, if the adaptive capacity of a system is low, the system tends to have a high vulnerability. The range of vulnerability range of value 0.0 – 1.0. (Very Low (0.0≤Kp≤0.2)", "Low (0.2<Kp≤0. 4)", "medium (0,4<Kp≤0, 6)". "High (0.6<Kp≤0. 8)". "Very High (0.8<Kp≤1. 0).

The islands in the group of Guraici Island are those categorized as the very small and basically vulnerable islands. Nevertheless, the coastal areas of the islands have the main coastal ecosystems such as coral reef, mangrove and seagrass. The presence of those three ecosystems, as previously explained, can enhance the adaptive capacity of a small island; thus, a vulnerability which is one of the main features of small islands can be minimized. By calculating and identifying the adaptive capacity of a small island, it is expected to give any significant contribution to the sustainability of management of the small islands. Based on the discussion above, this research was conducted to calculate, assess and determine the status of adaptive capacity of ecology of islands located in the group of Guraici Island based on the components of coastal ecosystems consisting of coral reef, mangrove and seagrass.

MATERIALS AND METHODS

Time and research site

This research was conducted in small islands in the group of Guraici Island. This group is administratively located in Kayoa District, South Halmahera Regency in North Moluccas Provinces. Geographically, it is found at 127°9'-127°16' longitude at 0°0'-0°8' latitude. This research was conducted in 17 islands, including Temo Island, Guraici Island, Ubo-Ubo big Island, Ubo-Ubo small Island, Popaco Island, Daramafala Island, Sohomao Island, Joronga Island, Lelei Island, Sonyiha Island, Salo Island, Rajawali Island, Talimau Island, Kelo Island, Sapang Island, Tapaya Island and Igo Island. This research was conducted within 6 months started from December 2010 to May 2011.

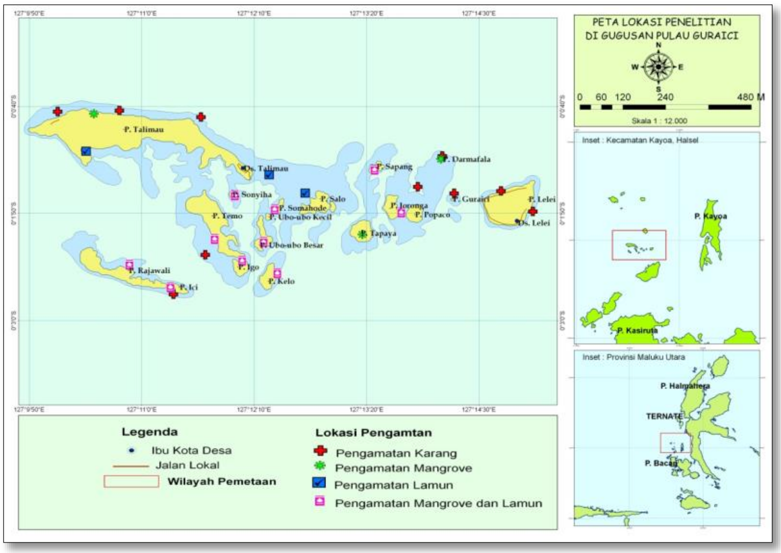

Figure1. Map of Research Site

Method of data collection

The determination of the ecological adaptive capacity of small islands in the group on Guraici Island was conducted by calculating the adaptive capacity of three components of coastal ecosystem:

ecosystem of a coral reef, an ecosystem of mangrove and the ecosystem of seagrass. Of total 19 (nineteen) parameters calculated to identify the ecological adaptive capacity of islands located in the group of Guraici Island, 7 (seven) parameters were calculated in the coral reef ecosystem, 6 (six) in each of mangrove and seagrass.

Parameters calculated in the ecosystem of coral reef included (1) index of dimension of coral reef (locally abbreviated as IDTK); (2) percentage of coral coverage (%); (3) dominant *life form*, (4) Number of life form types; (5) Number of species of coral fish; (6) the depth of coral reef; and (7) the distance of ecosystem from the activities of the citizen settlement (km) (Table 1). In the ecosystem of mangrove, 6 (six) parameters were involved, including (1) Value of Mangrove Dimensional Index (locally abbreviated as IDMg); (2) dominant species; (3) density of tree (tree/ha); (4) number of genera; (5) type of substrate; and (6) distance of mangrove ecosystem from citizen settlement (km) (Table 2). Meanwhile, in the ecosystem of seagrass, the data was collected in 6 (six) parameters: (1) value of Dimensional Index of Seagrass (IDLn); (2) types of dominant seagrass; (3) percentage of tutupan lamun (%); (4) number of species; (5) type of substrate; (6) distance of seagrass ecosystem from the citizen's settlement (km) (Table 3).

Table 1. Assessment criteria of capacity of coral reef ecosystem

Parameter	**Weight**	**Scale/Score**				
		1	**2**	**3**	**4**	**5**
		Very Low	Low	Medium	High	Very High
Dimensional Index of Coral Reef (*IDTK*)	5	0,0≤IDTK≤0,4	0,4<IDTK≤0,8	0,8<IDTK≤1,2	0,2<IDTK≤0,6	1,6<IDTK≤2,0
Coral Coverage (%)	5	0-20	21-40	41-60	61-80	81-100
Domination of *Lifeform*	5	SC,Ot	BC	ACT,ACD	CE	CM,CS
Number of Types of *lifeform*	3	<4	4 – 7	7 – 12	12 – 15	>15
Number of spesies of coral fish	3	<10	10-<30	30-50	50-80	>80
Depth of Coral Reef (m)	1	<1	>1 - 5	>5 - 10	>10 - 15	> 15
Distance from Citizen's Settlement (km)	1	<0,5	>0,5-1	>1-4	>4-5	>5

Remark: CM= Coral Massive; CS=Coral Submassive; CE=Coral Encrusting; SC=Soft Coral; Ot: Other; ACT=Acropora tubular; ACD=Acropora digitate. * Dimensional Index (0-5). Maximum Value: 115. Sources: English *et al*., 1997; Bengen, 2003; Dahuri, 2003; Yulianda. 2007; Bakosurtanal, 2011; Subur *et al*., 2011; Subur *et al*., 2012; Subur, 2012.

Table 2. Assessment criteria of Mangrove capacity

Parameter	**Weight**	**Skala/ Skor**				
		1	**2**	**3**	**4**	**5**
		Very Low	Low	Medium	High	Very High
Dimensional Index of Mangrove (IDMg)	5	0,0≤IDMg≤0,4	0,4<IDMg≤0,8	0,8<IDMg≤1,2	0,2<IDMg≤0,6	1,6<IDMg≤2,0
Dominant Spesies	5	*Ceriops / Nypa*	*Bruguieria*	*Rhizopora*	*Soneratia*	*Avicenia*
Density (tree/ha)	3	<110	110≤330	330≤660	660≤880	≥880
Number of Genera	3	1 – 2	3 – 5	6 – 7	8 – 10	11 – 12
Type of Substrate	1	Coral Sand	Sand	Muddy Sand	Sandy Mud	Muddy
Distance form citizen's settlement (km)	1	<0,5	>0,5-1	>1-4	>4-5	>5

Maximum Value: 90. Source: Bengen, 2003; Dahuri, 2003; Yulianda, 2007; Bakosurtanal, 2011; Subur *et al*., 2011; Subur *et al*., 2012; Subur, 2012.

Table 3. Assessment criteria of Seagrass capacity

Parameter	Weight	Scale / Score				
		1	2	3	4	5
		Very Low	Low	Medium	High	Very High
Dimensional Indexof Seagrass (IDLn)	5	0,0≤IDLn≤0,4	0,4<IDLn≤0,8	0,8<IDLn≤1,2	0,2<IDLn≤0,6	1,6<IDLn≤2,0
Seagrass Species	5	*Halophila,*	*Halodule, Sryngodium*	*Cymodocea, Thalassodendron*	*Thalassia*	*Enhalus*
Coverage (%)	3	<10	10-29,9	30-59,9	60-79,9	>80
Number of Species	3	1–2	3–5	6– 7	8 – 10	11–12
Type of substrate	1	Sand	Coral Sand	Muddy Sand	Sandy Mud	Muddy
Distance from Settlement (km)	1	<0,5	>0,5 –	>1–4	>4–5	>5

Maximum Value: 90. Sources: (English *et al,*. 1997; Yulianda, 2007; Subur *et al*., 2011; Subur *et al*., 2012; Subur, 2012).

One of procedures in calculating the ecological adaptive capacity of the islands in the group of Guraici Island was by calculating the dimensional index of each ecosystem, including IDTL for coral reef ecosystem, IDMg for mangrove ecosystem, and IDLn for seagrass ecosystem. To calculate those indexes; it began by calculating the width dimension and length dimension from each ecosystem found in an island area. The calculation was divided into some segments covering certain dimension of width and length. In this research, what is meant by width dimension is the width calculated from the point where an ecosystem was found at sea direction. While, length, dimension is the length calculated parallel with the coast line. Further, the term "segment" refers to categorization of each ecosystem based on the size of width and length dimension to a certain size.

In the ecosystem of each coral reef and mangrove, each of increase of width dimension of 10 meters would be followed by the increase of value at 0.01 in which it would reach the maximum value of 1.0 when the width dimension ≥1000 meter evenly spread in one island area. In contrast, in the seagrass ecosystem, each increase of width dimension of 5 meters would be followed by the increase of value by 0.01 and would reach the maximum value of 1.0 when the width dimension ≥ 500 meters was evenly spread to an island area. Furthermore, for all of those ecosystems, each increase of the length dimension of 120 meters in the equal width dimension, the value of length dimension would also increase in 0.01 and would reach the maximum value of 1.0 when the length of the spread of all ecosystems reached ≥12. 000 m (Subur *et al*., 2011; Subur *et al*., 2012; Subur, 2012).

The calculation of the value of dimensional index to both three coastal ecosystems (coral reef, mangrove and seagrass) covering the calculation of length dimension and width dimension of each ecosystem was directly conducted in the field with the support of the Geographic Information System (GIS) analysis. The result of the calculation, subsequently, was converted into the value forms as the value of each segment with the range of 0.0-1.0, for each ecosystem (Subur *et al*. 2011; Subur *et al*., 2012).

The calculation of other parameters in ecosystem of the coral reef was conducted using the method of *line Intercept Transec* (*LIT*) and *Underwater Visual Census* (*UVC*). Other parameter in the mangrove ecosystem was conducted using the method of transect/quadrat of 10m x 10 m. It was then followed by observing, calculating and recording all data required. Meanwhile, in the ecosystem of seagrass, the sampling was conducted by means of transect/quadrat of 0.5 m^2, and followed by observing, calculating and recording all data required (English *et al.*, 1997; Bengen, 2003).

Once data collection of parameters in three coastal ecosystems was completed, the result of the analysis would be included in the criteria that consisted of the weight of each parameter multiplied by the score / scale and classified into five categories: "very low, low, high and very high" in accordance with the instruction of Doukakis (2005). Furthermore, the capacity value of each component of coastal ecosystem and the adaptive capacity of ecology of each island in the group of Guraici Island were analyzed.

Data analysis

The calculation of adaptive capacity of island ecology was conducted by calculating the main components of the ecosystem in the coastal area and in the small islands including ecosystem of a coral reef, mangrove and seagrass. The calculation of capacity value of each component of coastal ecosystem was conducted using the equation that has been modified by Yulianda, (2007) Subur *et al.* (2011), Subur *et al*. (2011), Subur, (2012) as follows:

$$Kp_i = \sum \left[\frac{Ni}{N_{maks}}\right] \text{ x } 100\%$$

Where: Kp_i = First Adaptive Capacity of Ecosystem Component, N_i: Total value of parameter from the result of the first ecosystem calculation (weight Multiplied with score), N_{maks}: maximum value. Value of "Kp" was in the range of 0.0-1.0, with five categories: "very Low ($0.0 \leq Kp \leq 0.2$)", "Low ($0.2 < Kp \leq 0.4$)", "medium ($0.4 < Kp \leq 0.6$)". "High ($0.6 < Kp \leq 0.8$)". "Very High ($0.8 < Kp \leq 1.0$)" (Subur *et al*. 2011; Subur *et al*., 2012; Subur, 2012).

Having conducted calculation and capacity analysis for each component of the coastal ecosystem, the calculation was done to identify the adaptive capacity of ecology (KAE) of the island. The calculation used the following equation (Subur, 2012):

$$KAE_i = KpTK + KpMg + KpLn$$

Where: KAE_i = Adaptive Capacity of Island Ecology-i
KpTK = Capacity of Coral Reef
KpMg = Capacity of Mangrove
KpLn = Capacity of Seagrass
The value "KAE" was in the range of 0.0– 3.0with five categories: "Very Low ($0.0 \leq KAE \leq 0.6$)". "Low ($0.6 < KAE \leq 1.2$)". "Medium ($1.2 < KAE \leq 1.8$)". "High ($1.8 < KAE \leq 2.4$)". "Very High ($2.4 < KAE \leq 3.0$)".

RESULTS AND DISCUSSION

Adaptive capacity of coral reef ecosystem

The result of analysis on the adaptive capacity of coral reef ecosystem showed that the islands in the group of Guraici Island were categorized into three: "medium, low, and very low" with the value ranging from 0.0 to 0.58.There were 10 islands with "medium" capacity including Rajawali Island, Talimau Island, Temo Island, Igo Island, Joronga Island, Popaco Island, Tapaya Island, Daramafala Island, Lelei Island, andKelo Island with the value in the range of 0.54-0.58.Other three islands were categorized as the islands with low adaptive capacity including Salo Island, Guraici Island and Sapang Island with the value in the range of 0.33-0.38.The adaptive capacity of coral reef ecosystem with 'Low" category was found in four islands including Ubo-Ubo small Island, Ubo-Ubo big Island, Sonyiha Island, and Sohomao Island with the value of 0,0. This was in view of the coral reef ecosystem that was not found in the waters of those islands because of the muddy sea bed, high and shallow turbidity of waters, making the coral larva could not grow and blossom.

Meanwhile, the coral reef ecosystem with high adaptive capacity would indicate that the ecosystem had a quite wide spread with high quality. The quality of coral reef can be seen from the covering percentage (%), number of life form type, domination of life form, species of coral fish and other parameters. In contrast, the coral reef capacity would be lower in the coral reef ecosystem with low quality and narrow spread of area. The wider the area spread of coral reef, the higher the role of it to protect the coast line and small islands. The comparison of capacity values of coral reef ecosystem located in the islands in the group of Guraici Island and other is presented in Figure 3.

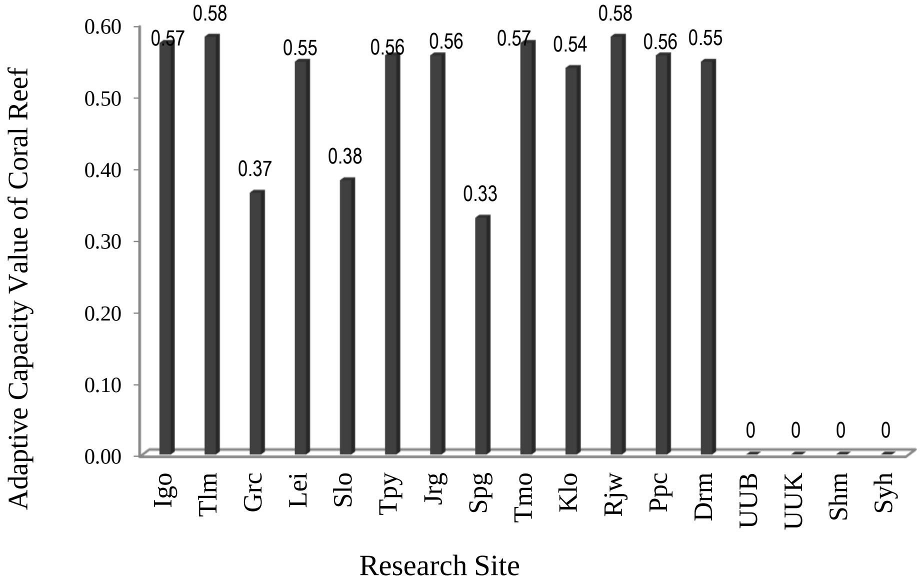

Figure 2. Comparison of Capacity Value of Coral Reef Ecosystem
Key: Tlm=Talimau. Grc=Guraici. Drm=Daramafala. Lei=Lelei. Ppc=Popaco. Jrg=Joronga. Spg=Sapang. Slo=Salo. Tpy=Tapaya. Rjw=Rajawali. Tmo=Temo. Igo=Igo. Klo=Kelo.

The capacity of coral reef ecosystem in the waters of the Rajawali Island in the category of "medium" and with the highest capacity value was influenced by the dominating factor of *lifeform* commonly dominated by coral, massive at 43.14 %, based on the findings of many relatively small corals, indicating the progress of the recovering and recruiting process. Van Moorsel (1985); Golbuu *et al.*, (2007), stated that conventionally the recruitment of coral in natural habitat can be monitored based on the number of juveniles identified as the colony of coral sized in ≥ 5 cm. Meanwhile, Miller *et al*., (2000) stated that the size is 2 and 5 cm; Mc Clanahan *et al*., (2005) stated that it is in the size of 0.5-5.0 cm, and Edmunds et al. (2004) stated that it is in the size of 2-40 mm. This condition is also supported by the condition of the high coral coverage that is around 79.72 %. The combination of these two parameters can give a high contribution in addition to the parameter of the number of the species of coral fish, number of species of *life form*, distance from human activities and the depth of coral reef. Again, though the index of dimension of coral reef ecosystem describing the width and the spread of the coral reef in this area is categorized very low, the ecosystem of the coral reef in this area is relatively rarely touchable since it is supported by other factors such as the distance from the settlement area or human activities that is relatively distant around 2-6 km. Alger *et al*,. (2002) explained that the closer a resource with human activities, the more susceptible it will be. Conversely, the more distant or the more isolated a resource from human activities, the more sustainable it will be. In addition, the area of this island is one of the outermost islands among other island in the group of Guraici Island.

In addition, there are three islands with the category of "low" adaptive capacity of coral reef; those are Salo Island; Sapang Island and Guraici Island. This is determined by the role of important parameters that are categorized very low such as the parameter of dimension index indicating the width and the spread of coral reef ecosystem and the parameter of the dominating *lifeform* dominated by *coral branching*and other parameters categorized into medium and low level; thus, it can give a significant contribution to the high or low level of adaptive capacity of coral reef ecosystem in the waters around those islands.

Ubo-Ubo Small Island, Ubo-Ubo big Island, Sohomao Island, and Sonyiha Island are the four islands with the adaptive capacity of coral reef ecosystem in the "very low" category. This condition is determined by the absence of the coral reef ecosystem in the waters nearby; thus, the role of coral reef as the protector of coastline and the land of an island to enhance the adaptive capacity of an island does not work in those islands.

Adaptive capacity of mangrove ecosystem

The analysis result of adaptive capacity showed that the mangrove ecosystem in the islands in the group on Guraici Island was in three categories: "*medium*, *low* and *very low*" with the value in the range of 0.0-0.51 of 17 islands studied, 13 islands were categorized to have "medium" adaptive capacity with the value in the range of 0.40-0.51 including Joronga Island (0.51), Daramafala Island, Rajawali Island,Popaco Island, Sohomao Island, Temo Island, Igo Island, Tapaya Island, Salo Island, Sapang Island, Ubo-Ubo small Island, Ubo-Ubo big Island and Talimau Island.Also, there were two islands categorized as the islands with "low" adaptive capacity of mangrove ecosystem with the value in the range of 0.33-0. 38. Meanwhile, the islands with the "very low" category of adaptive capacity of mangrove ecosystem with the value of 0.0 were Guraici Island and Lelei Island. This was in view of the absence of mangrove ecosystem in those two islands.

Mangrove ecosystem commonly grows and blossoms well in an area that is relatively protected by islands (i.e., sheltered coastaline). In contrast, in Lelei Island and Guraici Island, it was found that the area was relatively open for the wave motion and the current of sea water. This then has caused the fruits of mangrove that come to the areas of those two islands.

The high values of mangrove capacity will indicate that the ecosystem has a high capability in protecting the coastal areas and the lands of small islands. Conversely, if the capacity value of the ecosystem is lower, it can make its role to protect the coastal area and the land of a small island lower as well. The ratio of the values of capacity of the mangrove ecosystem in each island in the group of Guraici Island is presented in Figure 3.

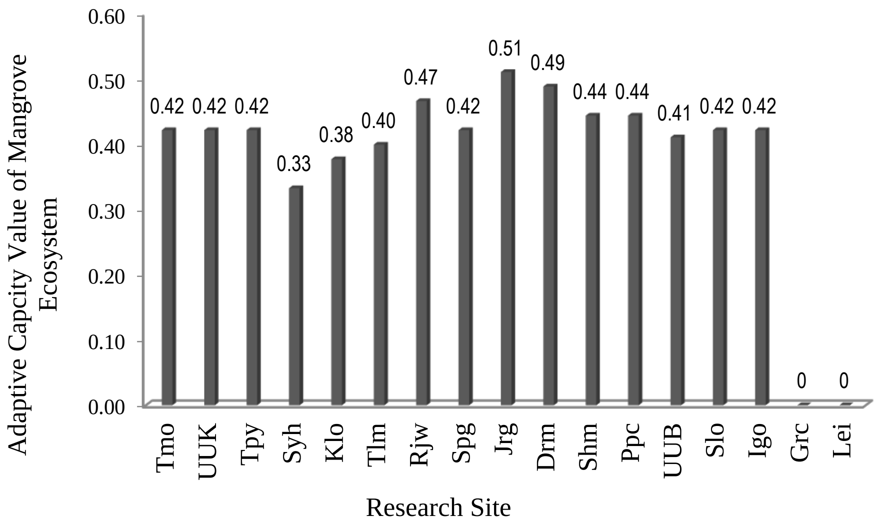

Figure 3. Comparison of Adaptive Capacity Value of Mangrove Ecosystem

Key: Tlm=Talimau. Grc=Guraici. Drm=Daramafala. Lei=Lelei. Ppc=Popaco. Jrg=Joronga. Spg=Sapang. Slo=Salo. Tpy=Tapaya. Rjw=Rajawali. Tmo=Temo. Igo=Igo. Klo=Kelo.

The ecological adaptive capacity of mangrove ecosystem found in most of islands in the group of Guraici Island with the "medium" category was highly determined by each parameter found in the ecosystem. Most of the islands in the group of Guraici Island have the dimension index with the "very low" category. This then indicates that the mangrove ecosystem found in each island has a limited spread. This can take place since the mangrove ecosystem has a high dependence on the suitable substrate for optimally growing and blossoming that commonly are found in the ecosystem in big islands (Nybakken, 1992). Meanwhile, in small islands as in the islands in the group of Guraici Island, they have a limited space; thus, the spread of mangrove come to be limited as well in certain areas that are suitable for growing. This is also supported by the number of trees/hectare that commonly is in the *low* and *very low* category; except in Rajawali Island, Popaco Island, Joronga Island and Sohomao Island that have a number of tree/hectare with "medium" category.

The uniformity of the habitat type commonly found in each island then causes the resemblance of mangrove species and dominant species that has a resemblance with most of mangrove ecosystems in the group of Guraici Island that is *Rhizopohora* sp. In addition, the number of mangrove genera found in each island was only around 2 – 4 genera with the number consisting of 3-5 mangrove species. Krebs (1989) explained that the variety will be high in the decline of environmental pressure. In general, all parameters examined in the mangrove ecosystem in each island was in the low to very low category; except in some islands with medium and high category.

Lelei Island and Guraici Island are two islands with the "*very low"*category of mangrove capacity (0.0). It then means that those two islands do not have any mangrove ecosystem in their coastal areas. Thus, the role of mangrove ecosystem as one of the ecosystem components in coastal area, enabling to enhance the adaptive capacity of an island does not work in those islands. As in its nature, mangrove will grow well in an area with a stable, protected substrate, and silent waters. In contrast, these two islands are relatively open for both the wave motion and the current of sea water (Nybakken, 1992; Bengen, 2002; Dahuri, 2003). Besides, the vegetation of mangrove also develops the adaptation pattern morphologically and physiologically for living in intertidal areas. The well-known pattern developed by the vegetation of mangrove towards the intertidal area is an aerial root system. The core function of it is for gas exchange, strengthening the stem in muddy area and for the nutrient absorption such as aerial root in Avicennia spp, sampling root in Sonneratia spp, knee rootin Bruguiera spp, plank rootin Xylocarpus spp and prop rootin Rhizophora spp (Tomlinson, 1986).

The value of the capacity of mangrove ecosystem can indicate its role towards the protection to an island in which the lower the value of mangrove capacity, the lower its role will be. Thus, conversely, the higher the value of the capacity it belongs to, the more significant its role in enhancing the adaptive capacity of an island. Othman (1994) stated that mangrove ecosystem with high capacity plays an important role in reducing the wave energy, sediment trap and in hindering the process of beach erosion. It is then added by Mazda *et al.*, (2007) that mangrove with high density is able to protect the land of an island and acts as a natural protector from tsunami.

Adaptive capacity of seagrass ecosystem

Based on the result of the research and analysis conducted towards the parameters in the seagrass ecosystem, it was found that the adaptive capacity of the seagrass ecosystem found in the areas of the islands in the group of Guraici Island was positioned in three categories: "medium, low and very low" with the values in the range of 0.0 – 0.59. 13 islands were categorized as the islands with the "medium: adaptive capacity including Talimau Island, Temo Island, Salo Island, Rajawali Island, Popaco Island, Sohomao Island, Ubo-Ubo small Island, Ubo-Ubo big Island, Sonyiha Island, Igo Island, Kelo Island, Joronga Island and Tapaya Island with the values of adaptive capacity in the range of 0.46-0.59. Of those islands, three of them; those are Daramafala Island, Sapang Island and Lelei Island were in the "low" category for the adaptive capacity of seagrass ecosystems with the values of adaptive capacity of 0.28 to 0.39. Meanwhile, the island with the "very low" category of the capacity of a seagrass ecosystem was found on the Guraici Island with the value of 0.0. The very low value of the adaptive capacity of seagrass ecosystems in the waters around Guraici Island was due to the absence of turf of seagrass ecosystem in the waters nearby. It was because the island was relatively open for the wave or the current of sea water; thus, the unstable substrate of seabed makes this plant hard to grow or blossom.

The lower the value of the adaptive capacity of seagrass ecosystem are, the less significant the role of the ecosystem for both the protection of a coastal area and a land of island will be. Conversely, the higher the value of adaptive capacity is, the more significant the role of ecosystem to protect the coastline and the land area of each small island.

Thirteen (13) islands in the group of Gracie Island (76.47%) have the adaptive capacity of seagrass ecosystems with "medium" category with the average value of 0.46-0.59. Those islands include Rajawali Island, Talimau Island, Temo Island, Salo Island, Sohomao Island, Ubo-Ubo small Island, Ubo-Ubo big Island, Sonyiha Island, Igo Island, Kelo Island, Joronga Island, Popaco Island, and Tapaya Island. Other three islands–Daramafala Island, Lelei Island and Sapang Island - were in the "low" capacity with the capacity value of 0.28 to 0.39 or around 17.64 %. Meanwhile, the island with the value of seagrass capacity categorized "low" was Guraici Island with value of 0.0 (zero). The distribution of the value of the adaptive capacity of seagrass ecosystem is presented in Figure 4.

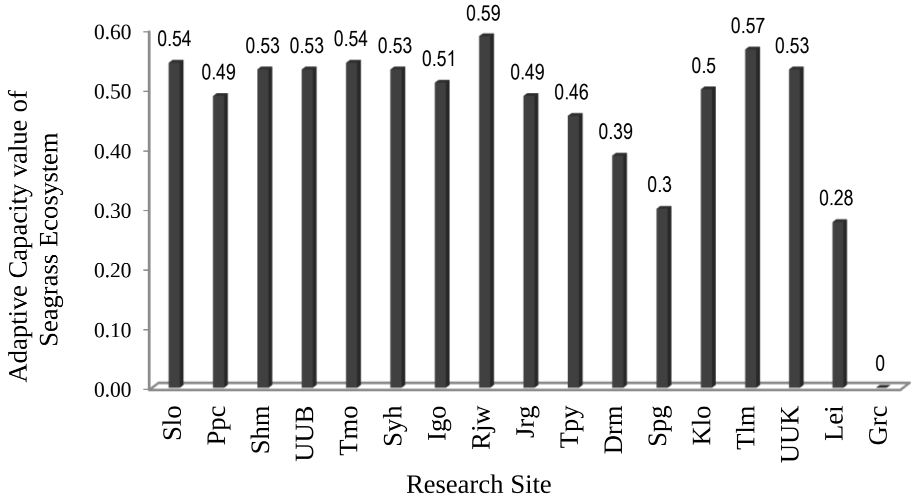

Figure 4. Comparison of Capacity Value of Seagrass Capacity

Key: Tlm=Talimau. Grc=Guraici. Drm=Daramafala. Lei=Lelei. Ppc=Popaco. Jrg=Joronga. Spg=Sapang. Slo=Salo. Tpy=Tapaya. Rjw=Rajawali. Tmo=Temo. Igo=Igo. Klo=Kelo.

Similar to the ecosystems of coral reef and mangrove, the existence of the seagrass ecosystem in the waters of the coastal areas of small islands also plays an important role in maintaining the stability of coastal area and the land of islands. Thus, the lower the value of the capacity is, the less significant the role will be. In opposition, if the value of the capacity of the seagrass is higher, it can make the role of the ecosystem more significant towards the protection of the coastline and the land of the island. In addition, the seagrass ecosystem also comes to be one of the parameters from the natural system of small islands playing an important role in enhancing the adaptive capacity of small islands. With high adaptive capacity, the ecosystem can function as the stabilizer and sediment trap (NOAA, 2004). According to EPA (2009), seagrass has a capability to trap the sediments around 1 cm per 100 years. The sediments importantly, act as the protector of the coast line from wave attack.

The adaptive capacity value of seagrass ecosystem was very low in Guraici Island. It is because of the absence of the spread of seagrass ecosystem in the waters nearby the island. This condition is caused by the condition of the island surrounding that is relatively open for the wave or the current of the sea water; thus, the substrate of the seabed that is unstable can make the plant hard to grow and blossom.

The adaptive capacity of the ecology of Islands located in the group of Guraici Island

Based on the result of the analysis conducted to three core components of coastal ecosystem and small islands; including coral reef ecosystem, mangrove ecosystem and seagrass ecosystem, it has been found that the adaptive capacity of the ecology from 17 islands studied is positioned in three categories: "medium, low, and very low" with the value in the range of 0.37-1.64.The ratio of the values of adaptive capacity of the ecology in each island in the group of Guraici Island is presented in Figure 5.

The result of the research showed that 10 islands have adaptive capacity of ecology in the "medium" category with the value in the range of 0.35-1.64. Those islands include Joronga Island, Temo Island, Popaco Island, Talimau Island, Daramafala Island, Rajawali Island, Igo Island, Tapaya Island, Salo Island, and Kelo Island. Commonly, in the area of islands with the medium category of adaptive capacity of ecology, the coral reef ecosystem, mangrove ecosystem, and seagrass ecosystem were found spread variously. Other 6 islands have the adaptive capacity of ecology with low category with the values ranging 0.37-1.05. Those islands include Sapang Island, Sohomao Island, Ubo-Ubo Small Island, Ubo-Ubo big Island, Sonyiha Islandand Lelei Island. Meanwhile, the island with the "very low" category for the adaptive capacity of ecology with the values of 0.37 was found at Guraici Island.

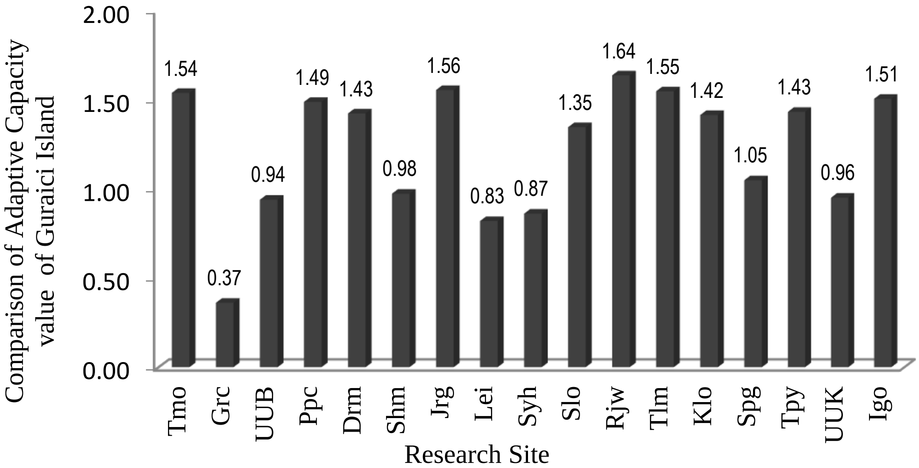

Figure 5. Comparison of Value of Adaptive Capacity of Ecology in each Island

Key: Tlm=Talimau. Grc=Guraici. Drm=Daramafala. Lei=Lelei. Ppc=Popaco. Jrg=Joronga. Spg=Sapang. Slo=Salo. Tpy=Tapaya. Rjw=Rajawali. Tmo=Temo. Igo=Igo. Klo=Kelo.

The low level of the adaptive capacity of ecology in Guraici Island brings a significant impact on the reduction of the land area of the island. At the moment, the area of Guraici Island has drastically declined in view of abrasion. The result of the analysis of this research in 2011 showed that the area of Guraici Island now Hasil still exists around 0.4 hectares (ha) in comparison to the result of the previous research conducted by the Department of Marine and Fishery of North Moluccas Province in 2004 in which the area of the Guraici Island was still at 1.6 ha. Thus, during the period of 2004-2011 or around 7 years, there has been a land reduction of the Guraici Island by 1.2 ha. This was because it was only coral reef ecosystem found on the island in the narrow spread; thus, it never gives any significant impact on the increase of the adaptive capacity of ecology of the Guraici Island in facing the threats of the wave and the current sea water towards the coastal area or the land of the island. The mangrove ecosystem and seagrass ecosystem that ecological function to protect the beach and the land of the island from the abrasion, to stabilize the sediments, reduce the acceleration of the wave and the current sea water coming to the coast line and the land of the island, in fact, were not found to grow around Guraici Island. This condition then significantly contributed to the low level of ecological adaptive of the island. The capability to adapt to a disturbance or pressure and the potential of damage is too low; thus, it can be said that Guraici Island is the very vulnerable island among 17 islands in the group of Guraici Island as a result of the low ecological adaptive capacity.

The range of the value of the ecological adaptive capacity of the islands in the group on the island nowadays is the range of 0.37-1.64. It indicates that commonly the islands in the group of Guraici Island have the ecological adaptive capacity with “medium” category. Thus, the existence of the coral reef ecosystem, mangrove ecosystem, and seagrass ecosystem commonly found in each area of the islands in the group of Guraici Island now should be sustained in natural way or through the rehabilitation towards the ecosystem that has experienced degradation to enhance the capacity of each ecosystem that in turn can enhance the ecological adaptive capacity of each island. Considering the condition of the islands in the group of Guraici Island as the very small islands, the reduction of the ecological adaptive capacity of each island can bring a negative implication towards them.

This research also showed that the higher capacity of each coastal ecosystem can give a significant contribution to the high ecological adaptive capacity of an island. Conversely, if the capacity of each ecosystem in an island is low, it can make the ecological adaptive capacity of the island lower.

Conclusion

Based on the result of the research conducted in small islands in the group on Guraici Island, some conclusions are then drawn as follows:

1) The value of ecological adaptive capacity of small islands in the group of Guraici Island is in the range of 0.37-1.64or with 3 categories of capacity; those are "medium, low, and very low".

2) Guraici is an island with a very low adaptive capacity as a result of the low capacity of the main coastal ecosystems (Coral reef, Mangrove and Seagrass)

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