

Socio Ecological System (SES) Assessment for Tourism at Sapeken Archipelago, Sumenep, Indonesia

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Abstract Tourism, has been observed as a complex ecology, social and economic phenomenon, which also been considered to unprecedented levels of development and prosperity worldwide. This study is aimed to analyse the social-ecological system of tourism in a small island entity using Sapeken Islands of Madura as a case study. We use an socio-ecological system (SES) approach suggested by Burkhard *et al* (2012) which consists of three Likert Scale-Matrix : 1) capacity of ecosystem services (supply), 2) request ecosystem services (demand), and 3) balance status (budgets) of the ecosystem services. The results are: 1) the largest usage of ecosystem service's demand by communities at Sapeken archipelago is the sea, with the exception for Sepanjang Island where the largest is mangrove's cover, 2) planning of tourism activities (ecotourism) in Sapeken archipelago by looking at balance status (budgets) ecosystem services, it is possible to do. Conditions of some natural capital assets are still able to provide a number of ecosystem services that can be used as the attraction of tourism.

Keywords Sapeken Archipelago, Socio-ecological System, Capacity of Ecosystem Services, Request of Ecosystem Services, Balance Status of Ecosystem Services

1. Introduction

Sapeken archipelago is a 201,887 km² area formed by a series of small islands located in 6° 46' - 7° 06' S dan 115° 10' - 115° 44' E. Sapeken archipelago has around 36 genera of corals (FDC-INNR, 2006), 36 species of mangrove (Suharjono and Rugayah, 2007), white sandy beaches and diversity of the local culture. These conditions make Sapeken archipelago has competitive advantages as well as the potential to increase the economic bargaining power and sustainable development of the islands.

As small island, Sapeken archipelago has some limitation, such as smallness (size), limited resources, scare of water, insufficient productivity, competences and infrastructure, geographic isolation, and ecological fragility lead to their vulnerability (Howarth, 2002). This vulnerability, together with their exposure to natural catastrophes (Roper, 2005) turn islands into particularly interesting cases to be studied; especially when intense tourism activity makes it more and more difficult for islands to obtain a sustainable character (Frangialli, 2006)

Taking into account the development efforts of small

islands in a sustainable manner, Robertico (2004); Bengen and Retraubun (2006), state that the strategy needs to be done is in the form of sustainable tourism activities (sustainable tourism). For Sapeken archipelago the highly applicable sustainable tourism strategy is an effort to protect the existing potential. Tourism activities are a complex process in which there is interaction between tourists, people and resources (Farrell and Twining-Ward, 2004).

One of the possible impacts of tourism activities as resources use activity at Sapeken archipelago ecosystems is changes in land use and land cover as natural capital assets. Furthermore, like any resource use activity, tourism risks becoming unsustainable if local ecological and socio - cultural capacities are not respected (Wall, 1997). Conversely, properly planned and implemented tourism can contribute towards conservation and sustainable use of marine and terrestrial resources at the host destination (White and Rosales, 2001).

Such interactions can be better understood in the context of complex adaptive socio-ecological system approach, where there are strong interactions between ecosystems and society (Gunderson and Holling, 2002).

In accordance to sustainable tourism strategies, the understanding of ecology, economy and social condition of the islands through SES (*socio ecological system*) is needed as a preliminary assessment of the Sapeken archipelago's potential for the development of tourism activities.

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Notes :

- | | | | |
|----|--------------|----|--------------|
| a. | Aesthetic | e. | Life sustain |
| b. | Biodiversity | f. | Leaming |
| c. | Cultural | g. | Recreation |
| d. | Economic | h. | Spirituality |

c. Ecosystem Service's Equilibrium

Assessment of the ecosystem services equilibrium status, is obtained by subtracting the value or score on the matrix ecosystem capacity (supply) with the matrix request (demand) services ecosystem. The scale ranges from - 3 to 3. Sign (-) indicates a request (demand) exceeds supply (supply); 0 = neutral balance, and to sign (+) indicates the supply exceeds demand. The matrix used is as follows:

Natural Capital Asset	Ecosystem service of small island							
	a	b	c	d	e	f	g	h
1 Coral reef								
2 Mangrove								
3 Arable land								
4 Building area								
5 Grazing land								
6 Vegetation								
7 Sea								



Notes :

- | | | | |
|----|--------------|----|--------------|
| a. | Aesthetic | e. | Life sustain |
| b. | Biodiversity | f. | Leaming |
| c. | Cultural | g. | Recreation |
| d. | Economic | h. | Spirituality |

3. Results and Discussion

Results of analysis *socio-ecological system* (SES) related to development of tourism activities in Sapeken archipelago area as follows:

Table 1. Ecosystem service capacity (*supply*) at Pagerungan Besar Island

Natural Capital Asset	Ecosystem service of small island							
	a	b	c	d	e	f	g	h
1 Coral reef	3	3	1	3	2	3	2	1
2 Mangrove	2	3	1	1	2	3	2	0
3 Arable land	1	1	0	1	2	0	0	0
4 Building area	1	0	1	0	0	1	0	0
5 Grazing land	1	0	0	0	0	0	0	0
6 Vegetation	1	2	1	1	1	1	1	2
7 Sea	3	3	2	3	3	2	1	2

Analyze result (2012)



3.1. Assessment of Ecosystem Service Capacity

The ecosystems capacity to provide ecosystem services can be used for various needs strongly associated with (a) natural conditions, such as natural land cover (vegetation), hydrology, soils, fauna, elevation, slope and climate, and (b) the human impact, especially land use emissions, pollution and other (Burkhard *et al.*, 2012). Assessment of ecosystem service capacity result are presented in Table 1 - 7 below.

Table 2. Ecosystem service capacity (*supply*) at Pagerungan Kecil Island

Natural Capital Asset	Ecosystem service of small island							
	a	b	c	d	e	f	g	h
1 Coral reef	3	3	1	3	2	3	2	1
2 Arable land	1	1	0	1	2	0	0	0
3 Building area	1	0	1	0	0	0	0	0
4 Grazing land	1	0	0	0	0	0	1	0
5 Vegetation	1	2	1	1	1	1	1	0
6 Sea	3	3	2	2	3	2	1	2

Analyze result (2012)



Table 3. Ecosystem service capacity (*supply*) at Paliat Island

Natural Capital Asset	Ecosystem service of small island							
	a	b	c	d	e	f	g	h
1 Coral reef	1	2	1	2	2	1	1	1
2 Mangrove	3	3	3	2	3	3	3	2
3 Arable land	1	1	0	1	1	0	0	0
4 Building area	1	0	0	0	0	0	0	0
5 Grazing land	1	1	0	0	0	0	1	0
6 Vegetation	2	2	1	1	1	1	1	1
7 Sea	3	3	2	3	3	2	1	1

Analyze result (2012)



Table 4. Ecosystem service capacity (*supply*) at Sapangkur Island

Natural Capital Asset	Ecosystem service of small island							
	a	b	c	d	e	f	g	h
1 Coral reef	2	3	1	2	2	1	1	1
2 Mangrove	2	3	1	2	2	1	1	1
3 Arable land	1	1	0	1	1	0	0	0
4 Building area	1	0	0	0	0	0	0	0
5 Grazing land	1	1	0	0	0	0	0	0
6 Vegetation	1	1	1	1	1	1	1	0
7 Sea	3	3	2	3	3	3	3	2

Analyze result (2012)

0	Not relevance
1	Weak relevance
2	Relevance
3	Strong relevance

Table 5. Ecosystem service capacity (*supply*) at Sapeken Island

Natural Capital Asset		Ecosystem service of small island							
		a	b	c	d	e	f	g	h
1	Coral reef	2	2	1	1	2	1	1	2
2	Arable land	0	1	0	1	1	0	0	0
3	Building area	0	0	0	0	0	1	0	0
4	Grazing land	0	1	0	0	0	0	1	0
5	Vegetation	1	1	0	1	1	1	0	0
6	Sea	3	3	2	3	3	2	1	2

Analyze result (2012)

0	Not relevance
1	Weak relevance
2	Relevance
3	Strong relevance

Table 6. Ecosystem service capacity (*supply*) at Saor Island

Natural Capital Asset		Ecosystem service of small island							
		a	b	c	d	e	f	g	h
1	Coral reef	2	1	1	1	1	1	1	1
2	Arable land	1	1	2	3	1	1	1	2
3	Building area	1	0	0	0	0	0	0	0
4	Grazing land	0	0	0	0	0	0	0	0
5	Vegetation	1	2	1	1	1	1	0	0
6	Sea	2	2	2	3	2	2	1	2

Analyze result (2012)

0	Not relevance
1	Weak relevance
2	Relevance
3	Strong relevance

Table 7. Ecosystem service capacity (*supply*) at Sepanjang Island

Natural Capital Asset		Ecosystem service of small island							
		a	b	c	d	e	f	g	h
1	Coral reef	3	3	2	3	3	3	3	3
2	Mangrove	3	3	3	3	3	3	3	3
3	Arable land	0	1	0	1	1	0	0	0
4	Building area	1	1	1	1	0	1	1	0
5	Grazing land	1	0	1	1	0	0	0	0
6	Vegetation	3	1	2	2	2	1	2	0
7	Sea	3	3	3	2	2	2	3	3

Analyze result (2012)

0	Not relevance
1	Weak relevance
2	Relevance
3	Strong relevance

Notes :

a.	Aesthetic	e.	Life sustain
b.	Biodiversity	f.	Learning
c.	Cultural	g.	Recreation
d.	Economic	h.	Spirituality

From Table 1 and Table 7, we can reveal that provision (*supply*) of ecosystem services at Sapeken archipelago is considered large in the context of sea natural capital assets, except for Sepanjang Island which has a large capacity (*supply*) of ecosystem services in the form of mangrove cover types. It can be also revealed that the lowest capacity of supply in the context of ecosystems services in Sapeken archipelago is cover types such as arable land, grazing land and building area as founded at the Sapeken Island for example.

For a small island, marine ecosystems are very influential in supporting human well-being. This condition is very possible considering the vast ocean larger than land area; small islands surrounded by water (marine ecosystems); providers and fisheries; connection between small islands and mainland. Presence services - marine ecosystem services (provisioning service) related owned social conditions that exist in the Sapeken archipelago. Livelihoods of Sapeken archipelago community, engaged in fishing. Specific to the field of fisheries, Sapeken archipelago has potentials like sea fishing, aquaculture, trading and processing. Fishing production in the Sapeken archipelago are include reef fish, ornamental fish, crabs and clams. Efforts are supported by fleet of fishing gear that consist of 2399 units of motorized boats in all the villages and 1214 units of vehicles boats (Bappeda Kab Sumenep, 2010).

Furthermore, in the planning of ecotourism activities, marine ecosystems at Sapeken archipelago have high cultural capacity. Unfortunately, there is no activities were developed to support some of cultural service activities like diving, snorkeling and beach recreation. Whereas based on the results of a scientific expedition reports (Zooxanthellae VIII, by FDC-IPB), Sapeken archipelago's area has a number of tourist attractions i.e. : coral reefs which are dominated by *Acroporidae* families, genera *Acropora* and *Montipora* inside reefs, which about 342 species of fish belonging to 96 genera and 33 family.

The lowest ecosystems capacity (*supply*) at Sapeken archipelago are arable land, grazing land and building area. Three types of ecosystems cover that have lowest ecosystems capacity (*supply*) were much influenced by the limitation of small islands in Sapeken archipelago.

The need for space (arable land and grazing land) for the people in Sapeken archipelago also required a number of activities in order to fulfil the basic necessities of life (food), such as farming and gardening. This condition will increase the pressure on the ecosystem service in Sapeken archipelago. The impact of human activities on ecosystem services are part of the socio-ecological system that needs to be considered in environmental management (Folke, 2006).

The considerations are needed, given the small islands is a

very unique ecosystem and vulnerable and supporting cultural and landscape characteristics. Anywhere the size limitations of small islands will take effect to development, life choices and to society and environment, particularly for ecosystem services (*ecosystem services*). This condition explains, except that capital nature (*ecology*) required in economic development (Gomez-Baggethun et al., 2010), social capital has also been considered a potential source (Roseta-Palma et al., 2010), because it affects social capital efficiency in the use of community resources (*human well-being*).

3.2. Ecosystem Service's Demand

Ecosystem service's demand is the number of all items and ecosystem's service which have been consumed or used in a certain location on a definite period of time. Based on that approach, ecosystem's service for the development of eco-tourism in Sapeken archipelago include esthetical values, biodiversity, culture, life sustain, learning, recreation and spiritually. Moreover, assessment's results of the ecosystem's service demand showed that the natural pattern of land use covers have a significant influence to the ecosystem's service demand. Assessment results of ecosystem service demand is displayed on Table 8 – 14.

Table 8. Ecosystem service demand at Pagerungan Besar Island

Natural Capital Asset		<i>Ecosystem service of small island</i>							
		a	b	c	d	e	f	g	h
1	Coral reef	1	1	1	1	2	1	0	1
2	Mangrove	1	1	1	1	2	1	0	0
3	Arable land	1	1	1	1	2	0	0	0
4	Building area	2	0	2	0	0	1	0	0
5	Grazing land	1	0	0	0	0	0	0	0
6	Vegetation	1	1	2	1	1	1	0	2
7	Sea	1	1	2	2	2	1	1	2

Analyze result (2012)

0	Not relevance
1	Weak relevance
2	Relevance
3	Strong relevance

Table 9. Ecosystem service demand at Pagerungan Kecil Island

Natural Capital Asset		<i>Ecosystem service of small island</i>							
		a	b	c	d	e	f	g	h
1	Coral reef	1	1	1	1	2	1	0	1
3	Mangrove	1	0	1	1	2	0	0	0
4	Arable land	2	0	2	0	0	1	0	0
5	Building area	1	0	0	0	0	0	0	0
6	Grazing land	1	1	2	1	1	1	0	2
7	Vegetation	1	1	1	1	2	1	1	2

Analyze result (2012)

0	Not relevance
1	Weak relevance
2	Relevance
3	Strong relevance

Table 10. Ecosystem service demand at Paliat Island

Natural Capital Asset		<i>Ecosystem service of small island</i>							
		a	b	c	d	e	f	g	h
1	Coral reef	1	1	1	2	2	1	1	0
2	Mangrove	1	1	1	1	1	1	1	2
3	Arable land	1	1	0	1	1	0	0	0
4	Building area	1	0	0	0	0	0	0	0
5	Grazing land	1	1	0	0	0	0	0	0
6	Vegetation	1	1	1	1	1	1	1	1
7	Sea	1	2	1	2	2	1	1	1

Analyze result (2012)

0	Not relevance
1	Weak relevance
2	Relevance
3	Strong relevance

Table 11. Ecosystem service demand at Sapangkur Island

Natural Capital Asset		<i>Ecosystem service of small island</i>							
		a	b	c	d	e	f	g	h
1	Coral reef	1	1	1	1	2	1	1	1
2	Mangrove	2	1	1	1	2	0	1	0
3	Arable land	1	0	0	1	1	0	0	0
4	Building area	1	0	0	1	0	0	0	0
5	Grazing land	1	0	0	0	0	0	0	0
6	Vegetation	1	1	1	1	1	0	1	0
7	Sea	1	1	2	2	2	2	2	1

Analyze result (2012)

0	Not relevance
1	Weak relevance
2	Relevance
3	Strong relevance

Table 12. Ecosystem service demand at Sapeken Island

Natural Capital Asset		<i>Ecosystem service of small island</i>							
		a	b	c	d	e	f	g	h
1	Coral reef	2	2	1	2	2	1	1	1
2	Arable land	1	1	0	0	1	0	0	0
3	Building area	2	0	0	2	0	1	0	0
4	Grazing land	1	1	0	1	0	0	0	0
5	Vegetation	1	1	0	2	2	1	1	0
6	Sea	2	2	2	2	3	3	2	2

Analyze result (2012)

0	Not relevance
1	Weak relevance
2	Relevance
3	Strong relevance

Table 13. Ecosystem service demand at Saor Island

Natural Capital Asset	<i>Ecosystem service of small island</i>							
	a	b	c	d	e	f	g	h
1 Coral reef	2	1	1	1	1	1	1	1
2 Arable land	0	1	2	2	1	1	1	1
3 Building area	1	0	0	0	0	0	0	0
4 Grazing land	0	0	0	0	0	0	0	0
5 Vegetation	1	1	1	1	1	1	1	0
6 Sea	2	2	2	2	2	2	2	2

Analyze result (2012)

0	Not relevance
1	Weak relevance
2	Relevance
3	Strong relevance

Table 14. Ecosystem service demand at Sepanjang Island

Natural Capital Asset	<i>Ecosystem service of small island</i>							
	a	b	c	d	e	f	g	h
1 Coral reef	2	2	2	2	3	3	2	1
2 Mangrove	2	2	2	2	3	3	3	2
3 Arable land	0	0	0	1	1	0	0	0
4 Building area	1	0	1	1	0	1	0	0
5 Grazing land	1	0	0	1	0	0	0	0
6 Vegetation	1	1	1	1	1	1	0	0
7 Sea	2	2	2	2	2	2	2	2

Analyze result (2012)

0	Not relevance
1	Weak relevance
2	Relevance
3	Strong relevance

Note

a.	Aesthetic	e.	Life sustain
b.	Biodiversity	f.	Leaming
c.	Cultural	g.	Recreation
d.	Economic	h.	Spirituality

The largest usage of ecosystem service's demand by communities at Sapeken archipelago is the sea, with the exception for Sepanjang Island where the largest is mangrove's cover. While the lowest of ecosystem service's demand are three types of land cover i.e. in the form of grazing land, building area and arable land (Table 8 – 14).

The diversity of resources on marine ecosystems at Sapeken archipelago affects social and cultural life of society. Socio-cultural developments are directly and indirectly are

affected by natural factors. The subsequent developments will characterize human activities to manage and exploit fishery resources, although there are also people in Sapeken Island who are not exploiting fishery resources. Similarly, islander in exploiting the sea for living shows a different pattern and character of the waters of the island to the other islands. Furthermore, there is also a diversity on the culture (mixture between Bajo and Madura) of the people settled in the Sapeken archipelago.

The lowest usage of ecosystem service's demand of Sapeken archipelago that consist of three types of land covers (arable land, building area and grazing land) are related to human need for space. Availability of space is one of the problems in a small island development. These limitations make a small island particularly vulnerable to the changes in landscape or land use activities. Changes in landscape or land use activities directly affects the biogeochemical and hydrological cycles (Metzger *et al*, 2006).

Limitations of land at Sapeken archipelago will effect on food demand. Food requirements of communities in the Sapeken Islands are fulfilled from surrounding mainland such as Sumenep, Banyuwangi, Probolinggo and Bali. Dependence for food from surrounding mainland is the characteristic of socio-economic condition of communities at Sapeken archipelago.

3.3. Availability Status of Ecosystem Service

Availability status of ecosystem service (budget) is measured by comparing ecosystem capacity (*supply*) and ecosystem service demand. The results describe ecosystem service's equality dynamic in Sapeken archipelago. The availability status of ecosystem service at Sapeken archipelago is explained in the following results.

Table 15. Availability status of ecosystem service (budgets) at Pagerungan Besar Island

Natural Capital Asset	<i>Ecosystem service of small island</i>							
	a	b	c	d	e	f	g	h
1 Coral reef	2	2	0	2	0	2	2	0
2 Mangrove	1	2	0	0	0	2	2	0
3 Arable land	0	0	-1	0	0	0	0	0
4 Building area	-1	0	-1	0	0	0	0	0
5 Grazing land	0	0	0	0	0	0	0	0
6 Vegetation	0	1	-1	0	0	0	1	0
7 Sea	2	2	0	1	1	1	0	0

Analyze result (2012)

-3	
-2	demand exceeds supply
-1	
0	neutral balance
1	
2	supply exceeds demand
3	

The results showed (Table 15 – 21) that in general,

ecosystem service demand is under ecosystem service capacity especially in Paliat Island, Sapangkur Island, Saor Island and Sepanjang Island (value from 1 to 3). Availability status showed that ecosystem service include aesthetic, biodiversity, culture, economic, live sustain, learning, recreation and spirituality can be fulfilled by natural capital assets such as coral reef, mangrove, building area, grazing land, vegetation and sea. This condition showed that beside high potency of utilization (especially in Paliat Island, Sapangkur Island, Saor Island and Sepanjang Island), the status of capital asset are fairly conserved. Therefore it can still provide goods and services to support the community. The fairly conserved of natural capital assets in Sapeken archipelago indicates that there is a good connectivity between social and ecology condition at Paliat Island, Sapangkur Island, Saor Island and Sepanjang Island.

Table 16. Availability status of ecosystem service (budgets) at Pagerungan Kecil Island

Natural Capital Asset	<i>Ecosystem service of small island</i>							
	a	b	c	d	e	f	g	h
1 Coral reef	2	2	0	2	0	2	2	0
2 Arable land	0	1	-1	0	0	0	0	0
3 Building area	-1	0	-1	0	0	-1	0	0
4 Grazing land	0	0	0	0	0	0	1	0
5 Vegetation	0	1	-1	0	0	0	1	-2
6 Sea	2	2	1	1	1	1	0	0

Analyze result (2012)

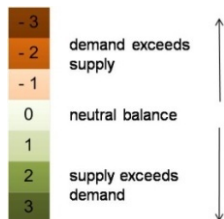


Table 17. Availability status of ecosystem service (budgets) at Paliat Island

Natural Capital Asset	<i>Ecosystem service of small island</i>							
	a	b	c	d	e	f	g	h
1 Coral reef	0	1	0	0	0	0	0	1
2 Mangrove	2	2	2	1	2	2	2	0
3 Arable land	0	0	0	0	0	0	0	0
4 Building area	0	0	0	0	0	0	0	0
5 Grazing land	0	0	0	0	0	0	1	0
6 Vegetation	1	1	0	0	0	0	0	0
7 Sea	2	1	1	1	1	1	0	0

Analyze result (2012)

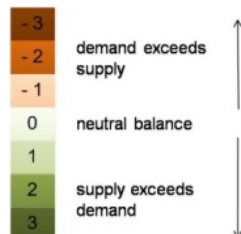


Table 18. Availability status of ecosystem service (budgets) at Sapangkur Island

Natural Capital Asset	<i>Ecosystem service of small island</i>							
	a	b	c	d	e	f	g	h
1 Coral reef	1	2	0	1	0	0	0	0
2 Mangrove	0	2	0	1	0	1	0	1
3 Arable land	0	1	0	0	0	0	0	0
4 Building area	0	0	0	-1	0	0	0	0
5 Grazing land	0	1	0	0	0	0	0	0
6 Vegetation	0	0	0	0	0	1	0	0
7 Sea	2	2	0	1	1	1	1	1

Analyze result (2012)

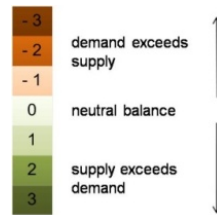


Table 19. Availability status of ecosystem service (budgets) at Sapeken Island

Natural Capital Asset	<i>Ecosystem service of small island</i>							
	a	b	c	d	e	f	g	h
1 Terumbu Karang	0	0	0	-1	0	0	0	1
2 Tegalam	-1	0	0	1	0	0	0	0
3 Pemukiman	-2	0	0	-2	0	0	0	0
4 Tanah Terbuka	-1	0	0	-1	0	0	1	0
5 Vegetasi	0	0	0	-1	-1	0	-1	0
6 Laut	1	1	0	1	0	-1	-1	0

Analyze result (2012)

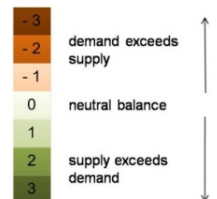


Table 20. Availability status of ecosystem service (budgets) at Saor Island

Natural Capital Asset	<i>Ecosystem service of small island</i>							
	a	b	c	d	e	f	g	h
1 Terumbu Karang	0	0	0	0	0	0	0	0
2 Tegalan	1	0	0	1	0	0	0	1
3 Pemukiman	0	0	0	0	0	0	0	0
4 Tanah Terbuka	0	0	0	0	0	0	0	0
5 Vegetasi	0	1	0	0	0	0	-1	0
6 Laut	0	0	0	1	0	0	-1	0

Analyze result (2012)

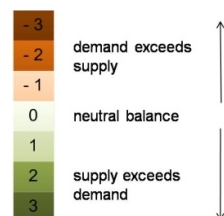
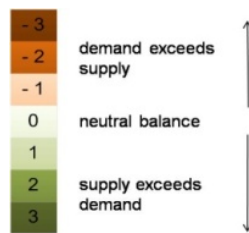


Table 21. Availability status of ecosystem service (budgets) at. Sepanjang Island

Natural Capital Asset		Ecosystem service of small island							
		a	b	c	d	e	f	g	h
1	Coral reef	1	1	0	1	0	0	1	2
2	Mangrove	1	1	1	1	0	0	0	1
3	Arable land	0	1	0	0	0	0	0	0
4	Building area	0	1	0	0	0	0	1	0
5	Grazing land	0	0	1	0	0	0	0	0
6	Vegetation	2	0	1	1	1	0	2	0
7	Sea	1	1	1	0	0	0	1	1

Analyze result (2012)



Note

a.	Aesthetic	e.	Life sustain
b.	Biodiversity	f.	Learning
c.	Cultural	g.	Recreation
d.	Economic	h.	Spirituality

The condition of natural capital assets at Sapeken archipelago increases possibility of other ecosystem services beside biodiversity such as culture, economics, life sustainability, learning, recreation and spirituality to grow. Ecosystem services refer to intangible benefits which are accepted from ecosystem in immaterial spiritual experiences, religion, inspiration and education.

Based on the existing connectivity between social and ecological system, it can be explained that small islands consist of several sub system, such as economy, community, demographi, culture, environment and ecology. The existing sub-systems are creating interaction and depending on each other. Sub-system interactions according to Bass and Dalal-Clayton (1995) are defined as the behaviour and sustainability of an island in facing the external influence and internal adjustment. A sustainable equality can be reached if the existing sub system is able to accept the influence, increase the revenue, health, culture, island's otonomy, biodiversity and support the ecology.

The damage potential due to excessive pressure beyond an island's capacity will disturb goods and services supply by ecosystem. The highest damage potential can be explained based on the availability of ecosystem service in natural capital assets such as land cover types, building area, grazing land and vegetation at Pagerungan Besar island, Sapeken and Pagerungan Kecil Island (Table 15,16,19). Damage potential in three islands might be caused by several factors related to high population. To create a sustainable ecosystem services, residents of the area should ensure that they live within the existing ecological limits. Thus, the sustainability of socio-ecological system depends on the health and functioning of the ecosystems. The influence of

human activities on the ecosystem known as the anthropogenic and damage their ability to provide ecosystem services (Kochtcheeva and Singh, 2000). In a broader scale, human activities affect ecosystem services by changing patterns of land use, hydrological and biogeochemical cycles (Foley *et al*, 2005).

Related to the planning of ecotourism activities (ecotourism) at Sapeken archipelago by looking at the status of availability (*budgets*) and ecosystem services, it is possible to developed. The conditions of some natural capital assets are still able to provide a number of ecosystem services that can be used as an eco-tourism attraction. Although ecotourism is a form of tourism that is very dependent on the quality of the environment, however according to Hunter and Green (1995) ecotourism has a complex impact on the environment, society, and economy. The planning of ecotourism activities (*ecotourism*) at Sapeken archipelago requires active management and control as other resource exploitation activities. This effort is necessary given the amount of exploited resources that are important parameters for ecotourism must be met to maintain quality and integrity of ecological resources, so that it remains attractive to tourists and residents (*islander*). In addition, to maintain the recreational experience quality that is not only based on the ecological quality, tourist interaction (user group) and the population should remain well maintained (Mihalic, 2000).

In order to achieve ecotourism planning at Sapeken archipelago, adaptive management policies in the socio-ecology based system is required. According Gunderson and Holling (2002), planning of ecotourism based on socio ecology system aims to create resilience and adaptive capacity through learning and provide a new experience to the user's resources, the best way to use and manage resources.

4. Conclusions

Based on results and discussions that has been described, the conclusions are as follows:

1. Condition of socio-ecological system at Sapeken archipelago through the availability status (budget) of ecosystem services showed different results on capacity (*supply*) and demand for ecosystem services (*demand*). The highest availability status (budget) ecosystem services is at Sepanjang island and the lowest is at Sapeken island. The higher value of the availability status (budget) shows natural capital of ecosystem services such as coral reefs, mangroves, arable land, building area, grazing land, vegetation and sea is sparse and well maintained so it can still provide services and goods in the form of aesthetics, biodiversity, culture, economy, sustainability, learning, recreation and spiritual life of the community at Sapeken archipelago.

2. Availability status of ecosystem services (budget) has been linked to ecosystems utilization by community. It is seen from differences characteristics of community activity

to manage the resources in each small island, be adapted to availability of ecosystem services (budget) in Sapeken archipelago.

3. Related to the planning of ecotourism activities (ecotourism) in Sapeken archipelago by looking at the of availability status of ecosystem services (budgets), it is possible to be developed. Conditions of some natural capital assets that is still able to provide a number of ecosystem services that can be used as an tourism attraction.

Lastly, assessment of socio-ecological system (SES) should be integrated in the planning of tourism activities, in order to provide existing condition in-depth overview related to ecosystem status as well as to support the existing social status.

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