

MARINE PROTECTED AREA AND ITS SOCIO-ECONOMIC IMPACTS ON THE COASTAL COMMUNITIES OF SERIBU ISLAND, INDONESIA

Suzy Anna

Padjadjaran University, suzyanna@indo.net.id

ABSTRACT

Over fishing is one of the obstacles faced in managing sustainable fishery resources. Even though various management instruments to control fishery resources have been in place, most of the time these instruments are not effective to curb over fishing especially in developing countries where poverty in coastal communities is still a major problem. Marine protected area or MPA is considered an alternative way to control such an over fishing. This paper addresses the socio economic impacts of marine protected area at Seribu island marine park in Indonesia using simple bio economic and economic valuation models. The paper also addresses policy implication the complex issue associated with other marine based activities such as tourism and capture fishery.

Keywords: *over fishing, marine protected area, social impacts, bio economic model, economic valuation, Seribu island.*

INTRODUCTION

Marine protected area or MPA for short, has been acknowledged as a powerful alternative instrument for managing fisheries. The policy of *Marine Protected Area* (MPA) itself was echoed for first time in the early nineties, even though actually this instrument has been implementing since 1800 in Finland (Sanchirico, 2000). The implementation of this management is very promising. It was reported that until the end of 2000, the MPA has been built in more than 1000 coastal areas around the world, and it is expected that it will cover 10 % from the total area of the ocean in the world. The proposal for using MPA as a fisheries instrument has grown rapidly due to failure of other alternative measures such as biological based using Maximum Sustainable Yield (MSY) or economic instrument based, well known as rationalization such as quota, limited entry as well as buy-back programs. Study by Dupont (1999) for example shows that even under controlled fishery, capital stuffing still occurred in the fisheries when rationalization program was implemented.

The growing acceptance of MPA has also captured the attention of fishery policy makers in Indonesia, where since 1980s the government has been exercising with variety of policy instruments to curb over fishing and rent dissipation. However, it was deemed to fail due to various reasons. Even though conventional measures currently are still in place, Indonesia's Department of Fisheries and ocean (DFO), has embraced Marine Protected Areas as complementary policy instrument for managing its complex tropical fisheries. Recently, the DFO has established about 5,597,282 ha of MPA (1% from the sea area) all over Indonesia. It is expected that it will cover about 10 million ha in the year of 2010, and 20 million ha in 2020.

The nature of conservation of the MPA is considered to be appropriate for some coastal areas in Indonesia where they have been experiencing degradation and over fishing, due to illegal and destructive fishing practices such as bombing, and poisoning. Nevertheless, the implementation of this policy is still subject to scrutiny between stakeholders, since there is still no convincing evidence yet of its socio-economic impact to the people especially to the fishermen. Most fishermen believe that establishment of MPA will cause some areas of their fishing grounds will be closed, and it will turn to the declining of their fish catch, which lead to the declining of their welfare. Lack of research in socioeconomic impact of MPA complicates the issue. That is why some local governments are still reluctant to implement such a policy. Central government in one side strongly recommended MPA policy for some coastal area, on the other hand, coastal community and also local government strongly refused this policy. Such a diametrical situation has happened in some coastal regencies such as Lembah Strait, and also Seribu Islands in their early development.

Research justification for socioeconomic impact of the MPA to the coastal society, especially assessment the MPA as a fisheries management tool, is sorely needed for decision makers. Sumaila (1998), for example, has addressed the gains and losses in economic rent, catches, and standing biomass of the Barents Sea cod fishery resulting from the establishment of the MPA. Furthermore, Arnason (1991) has also studied the economic justification of MPA instrument. Other studies from Gell and Roberts (2002) state that, no take zone instrument will cause an acceleration and dramatic change in population and stock habitat. Scientific judgment for establishing an MPA could be used to justify the government's decision to implement the policy. It can also be used as means of bridging the gap on misunderstanding of the MPA among stakeholders, i.e., coastal communities and policy makers. It is in this regards that bio-socio-economic justification of MPA is critically important. This paper analyzes all those aspects, through economic valuation and bio economic modeling, with Seribu Islands' MPA as a study area.

BRIEF DESCRIPTION OF SERIBU ISLAND MARINE PARK

Marine Park or Marine Protected Area of Seribu Islands located in the northern coast of the Jakarta, is an area with approximately 107,487 Ha, covering 44 small islands. It was established under the Law of Forestry Minister No. 162/Kpts-II/1995 and No. 6310/Kpts-II/2002, and is managed by the office of Marine Park Seribu Island, under the auspices of ministry of Forestry.

Seribu Island (literally means thousand islands) is a chain of hundreds of small islands located in the north coast of Java, close to the capital city of Jakarta. Seribu Island was weaned from the North Jakarta Regency and was established as an autonomous regency in 2001. The marine park is now becoming the major economic engine growth, generating income to local government from marine based tourism activities. Similarly, ninety percent of local population who works as fishermen is very much dependent upon fishing as the major source of their income (Fauzi, 2008). Even though the existence of Seribu island MPA has been acknowledged both by coastal communities and policy makers, effective management of the MPA for managing fisheries in the islands is still in doubt. Fauzi and Buchary (2001) noted that coastal communities were little affected in terms of their well being amid the existence of MPA. In addition study on bio economic aspects of MPA is relatively lacking which could give guidance to the policy makers on the impact of MPA.

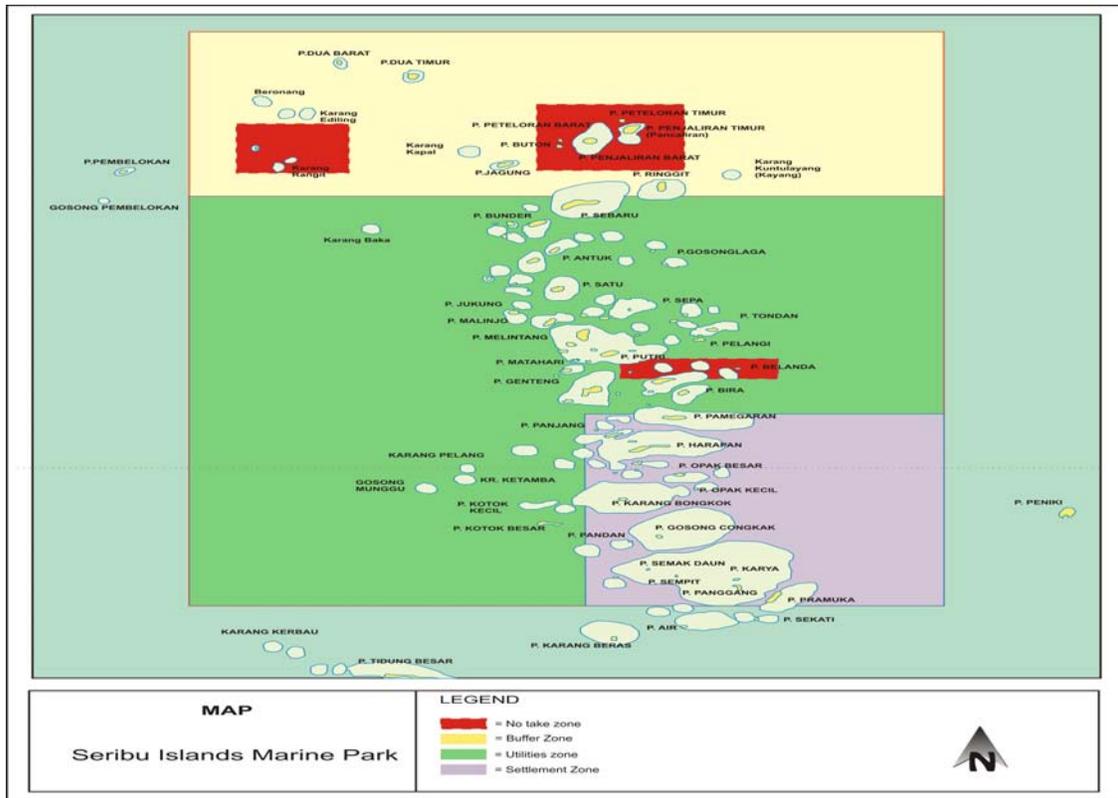


Figure 1. Map of Seribu islands Marine Park

THE MODEL

To analyze the socioeconomic impact of MPA to the demersal fisheries, a bioeconomic optimization model was proposed. The model was built using standard model where the dynamic of fish stock in the established of MPA area is assumed to follow Gompertz function:

$$\frac{dx}{dt} = rx \ln(K/x) \quad (\text{Eq.1})$$

where x is the fish stock measured in ton, r is intrinsic growth rate and K is carrying capacity. Fish production is assumed to followed Cobb-Douglass production function, that is,

$$h = qx E \quad (\text{Eq.2})$$

Where q is catchability coefficient and E is the level of effort exerted to the fishery measured in number of trip per year. In incorporating MPA, the production function is then modified into:

$$h = (1 - \gamma)qx E \quad (\text{Eq.3})$$

where γ = percentage size of MPA to total area. Using (Eq. 3) to describe harvesting under the MPA regime, stock dynamic in (Eq. 1) can then be written as:

$$\frac{dx}{dt} = rx \ln(K/x) - (1-\gamma)qxE \quad (\text{Eq.4})$$

Assuming that the system is in equilibrium condition, (Eq. 4) can then be solved for x variable as a function of bio physical parameters and effort level (E). This solution can be substituted back into (Eq. 3) and get the following yield-effort function.

$$h = \frac{(1-\gamma)qEK}{\exp\left(\frac{-(qE(1-\gamma))}{r}\right)} \quad (\text{Eq.5})$$

And from the above equation, we can then describe profit due to production in sustainable condition:

$$\pi = \frac{p(1-\gamma)qEK}{\exp\left(\frac{-(q(1-\gamma)E)}{r}\right)} - cE \quad (\text{Eq.6})$$

where p = fish price and c = cost of catch.

Optimum level of effort can be determined by deriving the profit function with respect to effort. This operational is rather complex, due to non linearity in effort function. A solution by MAPLE algorithm using Lambert function, yield the following equation:

$$E^* = \frac{\left(\text{LambertW}\left(\frac{\exp c}{p(1-\gamma)qK}\right) - 1 \right) r}{-q(1-\gamma)} \quad (\text{Eq.7})$$

The level of biomass under open access in the presence of MPA, is calculated as:

$$x_{\infty}^m = \frac{c}{p(1-\gamma)q} \quad (\text{Eq.8})$$

while level of harvest and effort under open access is calculates as:

$$h_{\infty}^M = \frac{rc}{p(1-\gamma)q} \ln\left(\frac{Kp(1-\gamma)q}{c}\right) \quad (\text{Eq.9})$$

$$E_{\infty}^M = r \ln\left(\frac{Kp(1-\gamma)q}{c}\right) \quad (\text{Eq.10})$$

respectively.

To determine the socio economic impact of establishing the MPA, a simulation was carried out using Vensim simulation software. The socio-economic impact was measured as fishermen's forgone benefits of establishing MPA. A simple iconic model was developed as can be seen in the following figure.

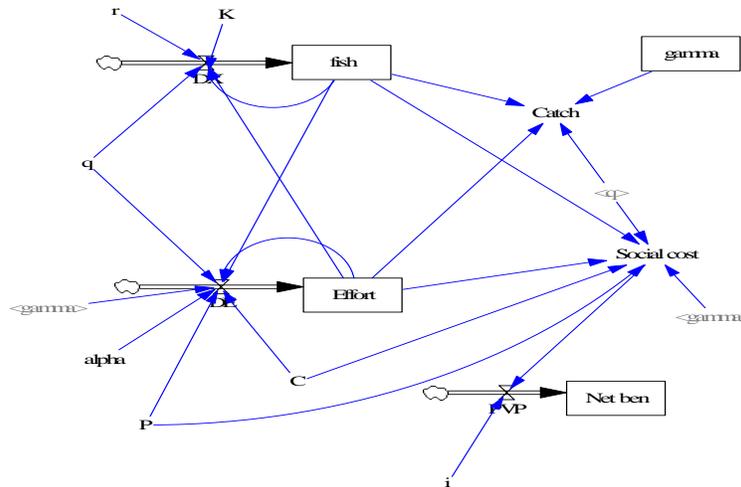


Figure 2. Simulation model using software Vensim

A couple of notes worth mentioning in order to run the model. First it was assumed that the basic standard bioeconomic model did not incorporate interaction among species within MPA (such as Lotka-Volterra effect). It is also assumed that price of fish and cost of fishing per unit of effort is constant. In addition, the model also assumed that technological differences among fleets operating in the area are not taken into account.

As mentioned earlier, Seribu Islands Marine Park is also a popular tourist destination, generating income for local government as well as local people in addition to fishing. The value of marine park from tourism and the socio economic impacts of MPA on society was also measured using direct expenditure from tourism.

A method of economic valuation was used to determine the economic value of Seribu Islands MPA. This approach was used due to the fact that currently there is lack of information on the importance of the MPA to society in terms of its economic value. By knowing this value, it is expected that society's appreciation toward the marine park will rise and the community will benefit from the existence of the MPA. Economic valuation methods conducted in this study, include productivity approach (market price) for use value, option value and Contingent Valuation Method (CVM) for non-use value. Productivity approach was applied for fisheries and tourism activities, while option value was applied for the fisheries, and CVM for other resources such as coral reef, mangrove and sea grass.

RESULTS AND DISCUSSION

The implementation of the model was carried out by first estimating the parameters required for the model. All biological and economic parameters were taken from Anna (2003) and Fauzi and Anna (2005) who estimated parameter r , q and K using Clark, Yoshimoto and Pooley (1992) technique. The estimated parameters are the following, $r=0.3672$ (% per year), $q=0.016687$ (per unit standardized effort), $K= 1325.83$ ton, $p=27.7$ (million rupiah/ton), $c= 0.27$ (million/trip). Parameter γ which measures percentage of MPA size was chosen arbitrarily and later was simulated in the range between 0.15 to 0.75 (15% to 75% closure).

Figure 3 depicts a comparison of the impact of increasing in size of MPA with respect to effort level under two different regimes, i.e., open access regime and Maximum Economic Yield Regime (MEY). As can be seen from Figure 3, if the area was left unmanaged ($\gamma=0$), effort level at open access regime is excessively higher (86000 trip) than that of MEY regime which is around 22000 trip.

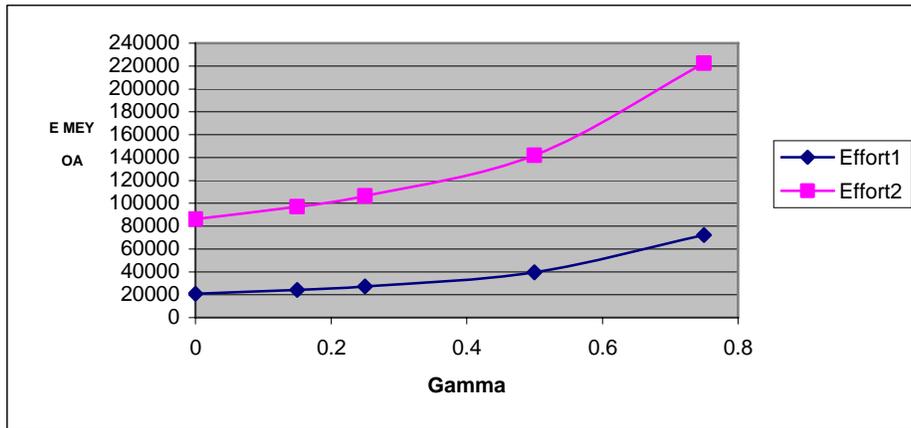


Figure 3. Effort Level in MPA scenario (MEY and Open Access Regime)

Varying the size of MPA from 15% to 75% reveals that level of effort at both regimes, increase but at different rate. It increases faster under open access than that of MEY. These results are in line with those of Arnason (2001) and Li (2000), which indicates that as the size of closed area increases, fishermen find it is more difficult to catch fish, as a result, they expand their effort to compensate the possible loss in catch.

If we look at both catch and stock levels under two different regimes, it shows that stock levels are increasing gradually under MEY regime while under open access regime, it marginally increases up to higher area closure (more than 50% MPA size). Similarly catch level under MEY regime, shows a little bit steady with respect to variation of MPA size, while it shows very responsive under open access regime. Figure 4 and Figure 5 depict the responsiveness of those variables with respect to the size of the MPA. The overall bioeconomic results for both open access and MEY regimes are displayed in Table 1.

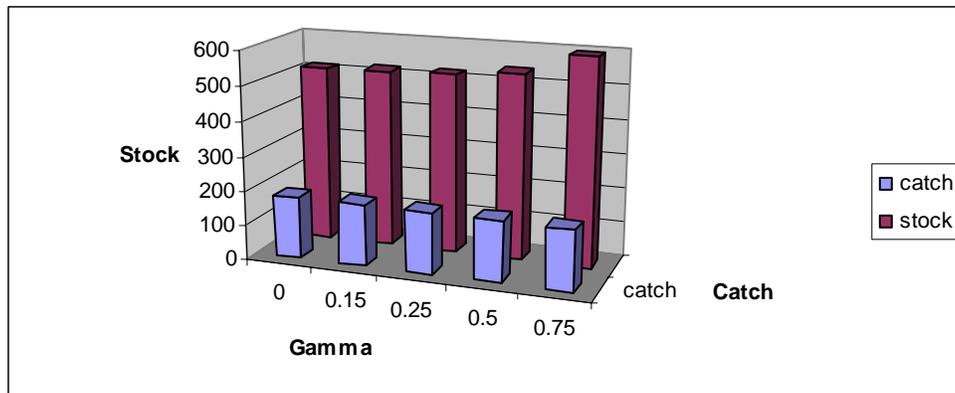


Figure 4. Catch and Stock Level in different size MPA scenario and MEY Regime

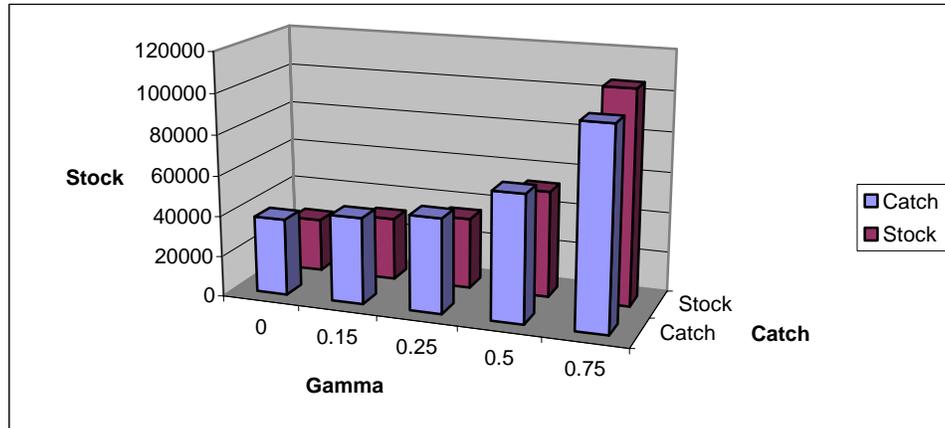


Figure 5. Catch and Stock Level in different size MPA and *Open Access* Regime

Table 1. Bioeconomic analysis result

Gamma	MEY Regime				Open Access Regime			
	Catch	Effort	Stock	Rent	Catch	Effort	Stock	Rent
0	178.758	20.86	513.475	3849.2	37.942	86.128	26.396	0
0.15	178.668	24.32	517.888	3812.55	42.785	97.123	31.055	0
0.25	178.577	27.343	521.78	3780.26	46.873	106.402	35.196	0
0.5	178.082	39.666	538.032	3645.81	62.454	141.771	52.793	0
0.75	175.703	72.069	598.658	3267.78	98.049	222.57	105.586	0

Figure 6 shows how economic rent (in rupiah) varies with respect to size of MPA. As can be seen from Figure 5, the rent declines as the size increases, indicating that the closure affects the fishermen in terms of its increase in cost due to increase in effort level.

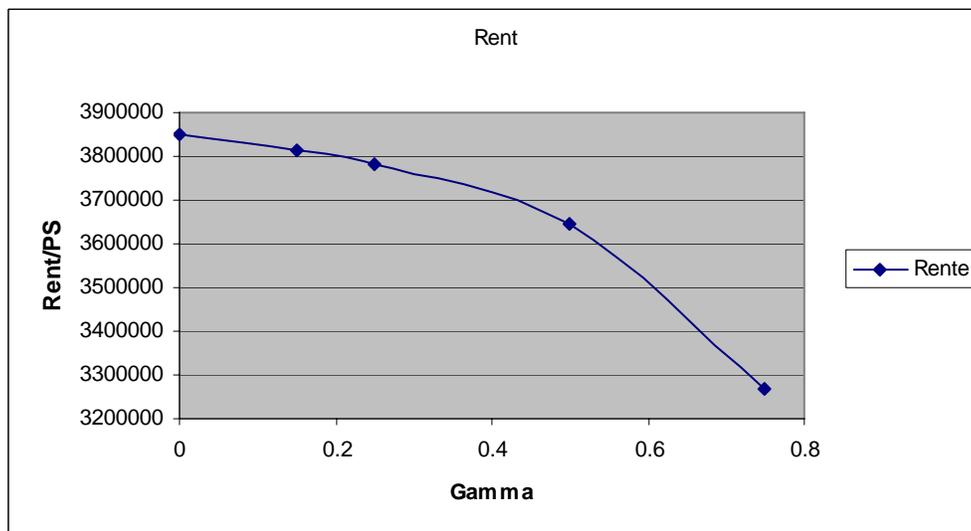


Figure 6. Rent in different size scenario MPA and MEY Regimes

As mentioned earlier in this paper, the critical question was that how the establishment of the MPA will impact on socio-economic of communities. To answer this question, two measures were carried out. The first one deals with the economic cost to fishermen due to the presence of the MPA. A forgone benefit, i.e., the benefit that could have been secured if no restriction of fishing ground were imposed, was employed as a proxy.

Figure 7 reveals how forgone benefits response to the size of the MPA. As can be seen from figure 7, there is a huge differences in forgone benefit at initial period between MPA closure at 25% and 50%. The difference could reach a maximum of Rp. 8 Million at year 3. After ten years period, however this difference is fading out and fishermen enjoy a marginal surplus of around 1 million rupiah per year. This might be explained as the following. As the time progressing, fishermen realize the benefit of the MPA as indicated by the increase in their catch levels and increase stock due to spill over effect. Combination of those effects will reduce their social costs and eventually emerge as social surplus to community.

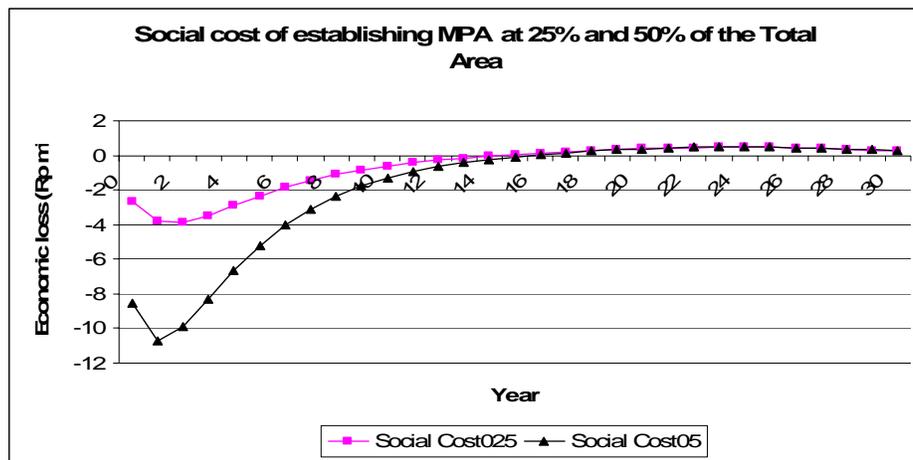


Figure 7. MPA social cost along the time

The second measure of social economic impacts was measured from economic contribution of the MPA to local government and community for tourism activity. Using data from various sources such as Fauzi (2008), as well as from direct survey conducted in 2007, the economic contribution of Seribu island Marine Park to the well being of society in general, is listed in Table 2.

Table 2. Economic contribution of Seribu island Marine Park

Contribution of PA	Value per year
Gross Value of tourism	\$9,580,915.41
Gross revenue from entry fee	\$2,367,825.59
Government revenue from taxation	\$1,194,874.10
Gross value of fisheries	\$647,591.45
Government benefits from fisheries	\$32,379.57
Indirect Impact	
Wage	\$65,789.47
Foods	\$479,045.77

As can be seen from Table 2, the gross value generated from tourism is more than US\$ 9 million per year. This is an average value of ten years gross revenue generating from average spending by tourists visiting Seribu Island resorts. The gross value is fluctuating, during more than ten years period due to the declining trend in the number of tourist visiting the island

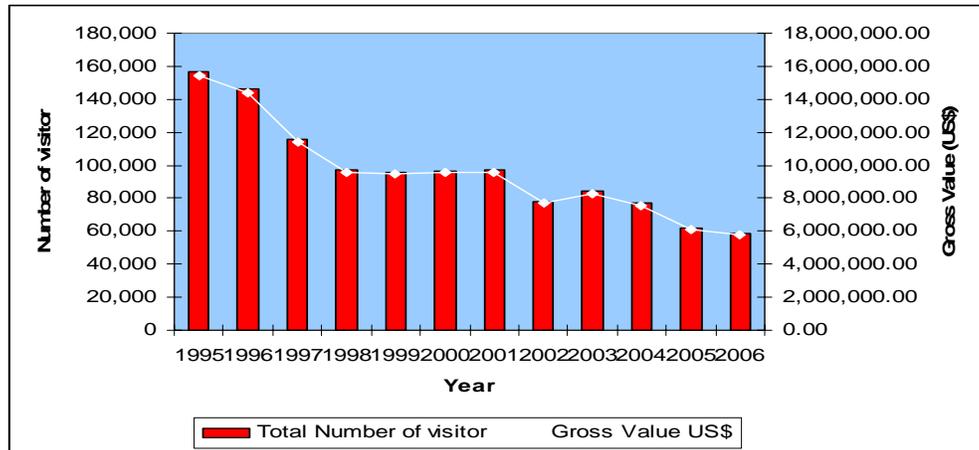


Figure 8. Gross value of tourism from Kepulauan Seribu (1995-2006)

The existence of MPA Seribu islands to some extent does not affect significantly on the policy effectiveness of the authority. This is due to the fact that the view of MPA is still very much distorted. Similarly, misperception on the importance of the MPA to society is still very much exist. There is currently an information gap on the notion of economic value of the protected area both at policy maker and community levels. One factor that drives this misperception is lack of information on economic values of the MPA. These values which include use value and non use value have to be conveyed to all stakeholders, so that they will appreciate the benefits of having MPA in Seribu island. To assess those values, a joint survey with the ministry of environment was conducted to assess the total value of marine park. To measure use value of MPA from fisheries and tourism, productivity approach and direct expenditure approach were used respectively. The non use value was estimated from the willingness to pay (WTP) of community for protecting the protected area. The option value was calculated using technique developed by Smith (1987) and also by Meir and Randall (1991) in which, option value was calculated as the difference between option price and the expected surplus.

By employing the expected utility theory of Von-Neuman Morgensten (V-M), option price is basically the value or price faced by community (i.e fishermen) in the presence of contingency. In this case it is assumed that the fishermen are facing two states of events, high season when catch is relatively abundant and low season when catch is relatively low at monsoon. These states of events were then confronted with two policy scenarios, one with MPA in place and the other is without MPA. Table 3 describes the state of nature and policy intervention. Expected surplus, on the other hand, is equivalent to expected value in V-M Theory, whereas in this case the outcome is the difference of production in two different states of nature.

Table 3. Production contingency

Contingency	With MPA*	Without MPA*	Probability (π)
High season	327360	278256	0.5
Low season	20460	17391	0.5
Expected Value	173910	147823.5	

* In Million Kg

Following expected utility theory and by assuming fishermen are risk-averse, the option value of MPA was calculated to be US\$ 33 million. The following Table describes the total value of marine park Seribu island.

Table 4 . Use and non use Value of Seribu Island MPA

Value		Technique	Value per year
Use Value	Non use value		
Fisheries		Productivity	US\$ 647,591.45
Tourism		Surplus	US\$ 9,580,915.41
	MPA's Protection	CVM	US\$ 78,751.03 WTP US\$ 15.42/cap/th
	Option Value	VNM	US\$ 33,295,274.64

CONCLUDING REMARKS

Implementing marine protected area as a device for fishery management, especially in developing country, is indeed a challenging exercise. Until recently there are few studies of such a kind in Indonesia, where the bio-socio-economic aspects of MPA are assessed. This study attempts to show that even though MPA is biologically superior in terms of securing stock size through its closure, its impact on coastal community is very much mixed. Using Seribu island Marine park as a case study it shows that the community actually benefited from the existence of MPA through indirect transfer from government from direct and indirect expenditures from tourism. The community, especially the fishermen, also benefited from an increase in fish productivity. Nevertheless, some parts of these surpluses are intangible in the form of non-use value of the MPA. It is, therefore, imperative for policy makers to convince the community about the long term benefit of the MPA through intense communication, or "repeated game" so that the community will appreciate the existence of the MPA, and will act to protect the area accordingly.

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