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Economic Value of Mangrove Ecosystem as Base of Coastal Area Planning

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Abstract: Mangrove is a coastal ecosystem that provides valuable ecosystem services, including coastal land stabilization, groundwater protection, fisheries and storm protection. Human utilization of coastal areas include economic activities such as settlement, brackish water aquaculture, industrial and infrastructure development. This study reports on economic modeling of these ecosystem services in planning the future development of coastal areas. This modeling include: the economic value of the mangrove ecosystem; Shrimp farming performance also economic activities alternative in the coastal area and optimal coastal area planning. This study analyzed the value of mangrove ecosystem services using Total Economic Valuation (TEV). To analyze the profitability and feasibility of shrimp farming; The writer used benefit tabulation, Net Present Value (NPV), Internal Rate of Return (IRR) and net Benefit Cost ratio (net B/C). For optimize of area planning the author used Multiple Objective Goals Programming (MOGP). The principal outcomes of these analysis was that mangrove ecosystem provide significant economic value also recommend at looks after the mangrove.

Key words: Mangrove ecosystem, economic value, shrimp farming, goal programming, planning area, out comes

INTRODUCTION

Mangroves are a coastal resource that support a diversity at life, especially on biological functions, chemistry, physical and economical functions. Moreover, coastal area becomes very important part for economic development. As predicted (Dahuri, 1993; 1996, 1997; Dahuri *et al*., 2001; Dietriech, 2005; De Groot *et al*., 2002) that any inclined rare land resources, make coastal resources will become new growth resources and hopes, for Indonesia economic development.

The mangrove forest in research site is good mangrove forest with a various vegetation. The dominated kinds of mangrove are *Rhizopora mucronata, Sonneratia alba and Avicennia alba.* Mostly the mangroves come from the reforestation in 1980's beside some mangroves that originally and naturally grow there. The area of mangrove forest in research site covers 146.0 ha. At present, the reforestation for 50 ha area is being carried on by "Bentar Indah" and "Curah Mulya" groups funded by OISCA-international foundation (OISCA = Organization for Industrial, Spiritual and Cultural Advancement) for program TMMP (Tokyo Marine Mangrove Project). The cooperation has been established, since, 5 years ago starting in 2004 until 2009.

Normally, coastal area resources are managed by government in order to their citizen welfare (UUD 1945, Section 33). Also, must be managed properly to give benefit for generation wealth (Decree of Environment Management No. 23, 1997 in this study). Indonesia President Decree No. 32/1990 for forest management had decided that green belt is 130 times of differences between high tide and low tide or 140 m from coastal line into land. Forestry Minister Decree No. P.03/MENHUT/V/2004 told that mangrove is coastal green belt has ecological and social economic. However, that decree have not implemented properly as many mangrove area were converted into another purposes. High demand of land on coastal area for many purposes (settlement, brackish water aquaculture, industrial and infrastructure development) and low coordination and integration of mangrove ecosystem in area development were made many conversion of mangrove area.

Coastal area utilization has many purposes and economic activities. Impact of one economic activity into another has bring inflict a financial loss if there are no rules to conduct. Another side of economic activity is maximizing benefit by utilizing their resources. Moreover, management integrity with some purposes and priorities must be determined well by maintain environmental balance. So, analysis of economic benefit and ecological ecosystem must be main point in determining policy and role model.

Economic use as economical value of resources utilization of mangrove is Direct Use Value (DUV). Ecological value related with their function and environmental services. Ecological value is classified as

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Indirect Use Value (IUV) in mangrove ecosystem. Classification of some benefit and function of mangrove ecosystem based on some versions that specific on economic and ecological benefit (De Groot *et al*., 2002; Dixon, 1989; Arief, 2003; Gunarto, 2004; Pagoray, 2004, Hudspeth *et al*., 2005). As assessment of natural resources were explained by Maynard *et al*. (1987), Pearce and Turner (1990), Pomeroy (1992), Munasinghe (1993), Pearce and Moran (1994) and Fauzi (2004).

Physic-chemical and biological data of mangrove forest water area around the research site shows supporting values for water biota life. The analysis result of Mahmudi *et al*. (2007) shows that the planktons primary productivity reaches 2.65-3.57g C/m^2/h and the chlorophyll content moves to 11.2-18.07 mg/L. The biology parameter value of the water area shows that the mangrove water area is fertile area and has abundant supply of plankton. The supportive role of mangrove forest for water biota is carried out through the nutrient release from mangrove leaves. From 704.45 g/m^2/year mangrove leaves production, after being processed by using grazing, export and decomposition techniques, the leaves can produce nutrient of 0.064 g/m^2/year (N = 0.061 and p = 0.003) into water environment before the primary productivity value of the leaves is attained. The primary productivity will finally determine the fish stock in the area. Besides the primary productivity of leaves waste in the water area there is primary productivity of phytoplankton found in the area. Based on both primary productivity values, the herbivore fish in mangrove area can be estimated and the result shows 1196.3 kg/ha/year. By using 10% conversion in energy flow, the production of carnivore fish is estimated to reach 119.63 kg/ha/year. It means that the mangrove ecosystem in the water area contributes 1315.93 kg/ha/year per hectare of mangrove per year. If the supportive role is used to value the expanse of mangrove area, the result is 146 ha and the fish production from the mangrove ecosystem is 192.2 ton/year.

The importance of mangrove forest ecosystem toward the coastal fishery can be witnessed from the site exploration in which the existence of mangrove forest can support the fishery activities either for catching or culturing fish. The fishermen activity of catching fish, shrimp or other sea creatures will be enhanced due to the better improved amngrove forest along with the laty water culture (embankment for shrimps).

Economic valuation is economical value given on all benefits and services of resources. Total Economic Valuation (TEV) is very important to obtain and integrated into area planning. In other word, coastal area planning with many activities of land utilization must be counted the economic value of ecosystem services by mangrove. Generally, purposes of the research are to get option in some alternative of coastal area management.

MATERIALS AND METHODS

Site study description: The research was carried out in coastal area in Curahsawo, Probolinggo Regency (East Java Indonesia). The area is chosen because the following aspects. First, the condition of the mangrove in this area is good. Furthermore, in this area there is silvofishery embankment. The area has the widest expanse of the coast in Probolinggo Regency (559 h). Besides, the area is low land area with slope level of 5% and near the shore area there is crowded inhabitant settlement (963 people/km^2) and with its small scale of fishery activity.

Creating the sample: Data needed for the research includes primary data and secondary data. Primary data was acquired from observation activities and respondents interview. Meanwhile, the secondary data was collected from document data of Forestry and Plantation Department, Fishery and Oceanic Source Department and Statistics Centre in Probolinggo Regency. Sample for this research was gathered by using purposive technique sample. The chosen respondents are: Fishermen, crab seeker, shrimp seeker, oyster seeker, bird egg seekers, embankment workers, stakeholders (Local government and NGO).

Operational framework: The first step the research took was carrying out the initial study in order to understand the area in terms of research material by doing Rapid Rural Appraisal approach (RRA). The second step of this research comprises the usefulness identification survey, the function of mangrove forest ecosystem and monetation. The third step includes the cost computation of economy activity benefit as the scenario (if all coastal area turns into shrimp intensive embankment; Silvofishery embankment that covers 40% area for pond and 60% area for mangrove forest; The whole area for mangrove forest that can supply the wood need for charcoal production; The entire area for conservation of mangrove forest). The nest step is the optimizing analyze to get optimal solution in relation to the management of coastal area.

Data analyses technique: The applied research method is descriptive quantitative method. Both descriptive quantitative analyses and qualitative explanation will describe the characteristic of ecosystem of mangrove forest and its supportive role in fishery business. Meanwhile, the quantitative analyses based on the number data will explain: business performance, total value of mangrove ecosystem and optimizing the management of coastal area. In detail explanation, the analysis technique mentioned can be described as followed:

Business performance analysis includes the estimation of business profitability value, rentability, Net Present Value (NPV), Net Benefit-Cost ratio (Net B/C) and Internal Rate of Return (IRR).

The estimation of mangrove forest ecosystem economy value. The estimation technique in assessing the any resource economy value refers to the Total Economic Valuation (TEV) as explained by Dixon (1989) in Pomeroy (1992). Mathematically, it can be represented in following formula:

$$TEV = UV + NUV = (DUV + IUV + OV) + (BV + EV)$$

Where:

TEV = Total Economic Value
UV = Use Value
NUV = Non Use Value
DUV = Direct Use Value
IUV = Inderect Use Value
OV = Option Value
EV = Excistence Value
BV = Beguest Value

Area planning optimization model: Analysis model that can be formulated for more than one goal is Goal Programming or Multiple Objective Goal Programming (MOGP). The model is mathematical procedure in determining activities as alternative plan by minimizing the aggregate deviation of any quantitative goal in order to reach optimal solution of any goal. By implementing more than one goal related to goal function in form of deviation variable, the multiple goals program model can be formulated as follows:

$$\text{Determine } X_j = X_1, X_2, X_3, X_4$$

Where:

X_1 = Activities for intensive embankment
X_2 = Activities for silvofishery embankment
X_3 = Activities for mangrove plantation and charcoal
X_4 = Aactivities for mangrove forest conservation

The formulation of mathematic goal function is:

$$\text{Minimized}: \quad Z = \sum_{j=1}^{n} P_i W_i \left(d_i^+ + d_i^-\right)$$

That is:

$$\text{Minimized: } Z = P_i W_i (d1^- + d2^- + d3^1 + d4^- + d5^1 + d6^- + d7^1 + d8^- d9^1 + d10 + d11^+ + d12^- + d13^- + d14^- + d15^- + d16^-)$$

Where:

P_i = The priority of goal barrier attainment
W_i = The weight as risk value from management of goal barrier
d_i^+ = Positive deviation of goal barrier for minimum target
d_i^- = Negative deviation of goal barrier for maximum target

The problems that is informed in the formula has purpose to solve the problem if all goals have same significance priority rank. If the decision making has several characteristic goals characterized by priority according to each goal significance, the solution procedure must be accomplished by giving the weight into goal significance as the need implies.

Suppose there are some goals that have some ranks based on their significance, the priority factor is P_i (I = 1, 2, 3, 4, ..., n). Notation of Pi means that P1 is given higher priority than P2 and so on, so, the priority factors are connected as follows: (P1>P2>P3>P4>Pi+1). The connection of priorities shows that even if factor Wi is multiplied n times (n>0), the prioritized factor still remains at the top. For research objective, the priorities will be treated in relation to the management scenario. The supporting software used in this analysis is QM, 3.2.

RESULTS AND DISCUSSION

Total economic value of mangrove ecosystem: The research result shows the function and the benefit of mangrove forest in research location. The direct benefit shows the fact that he shrimp production reaches 29.472 kg/year, the crab production is 93.000 kg/year, oyster production is 120.960 kg/year and as the site of birds nesting and hatching their eggs there (Usually during rainy season heron birds in the mangrove forest can produce 64.680 eggs/year). From the indirect benefit, we have the fact that the area functions as groundwater protection (giving benefit for the 133.401 inhabitants covering 9.097 families as wave absorber, abrasion prevention, sediment trap, wind resistance, nursery habitat for various water biota, especially, fish or as the supportive aspect for fishery production)

The research method in getting Total Economic Value (TEV) of mangrove ecosystem refers to the method developed by Dixon (1989) and Pomeroy (1992) by applying some methods that fit to site condition.

Tabel 1: The result of the calculation of mangrove ecosystem in gending

	Land area	
Uraian	146 ha (US$/year)	1ha (US$/year)
Direct use value:		
Shrimp production 29.472 (kg/year)	818.800	5,608.2
Crab production 93.000 (kg/year)	1,131.000	7,746.5
Bird egg production 64.680 (egg/year)	7.770	53.2
Oyster production 120.960 (kg/year)	850.200	5,823.2
Indirect use value:		
Groundwater protection	9,961.215	68,227
Storm protection	472.440	3,235.8
Support a diversity at life (fish)	678.802	4,649.3
Obtion value	21.656	148
Value	13,941.885	95,492

Furthermore, the benefit and the function of the mangrove ecosystem can be categorized into direct use value and indirect use value; Choice value; Existence value and bequest value. The result of the calculation of mangrove ecosystem TEV is shown in Table 1.

Business performance under scenario: The scenario of area exploitation for the 559 ha coast area that covers in research location offers some options. They are that the entire area becomes vanname shrimps intensive embankment cultivation, the entire area becomes silvofishery embankment cultivation, the entire area become mangrove plantation and charcoal production site and the entire area becomes mangrove forest conservation area. The analysis result of the option shows following performance.

The entire area for vanname shrimp intensive embankment cultivation: The shrimp cultivation using embankment technique needs high cost and huge investment. The investment for area and the equipment could reach $US 189.200 and the total operational coast could reach $US 264.460 ha/year including the need of seed that could comes to 6.000 kg/ha/cycle. The high production input makes the area and environment suffer much from the pollutant. Such condition will deteriorate the environment quality in fast way because the process of cleansing the pollutant can't be done completely. Finally, it will reduce the shrimp life expectation and increase the frequency of disease threat because of the bad water quality.

The empiric data shows that the development of embankment technique fishery along the Java coast line and other islands coast line in Indonesia shows failure after 5 years time from the beginning of production period. It means that there is no continuity after 5 year operation or the productivity always declines while at the same time, the investment need or other costs continue to increase. Such condition is caused by the damaged environment

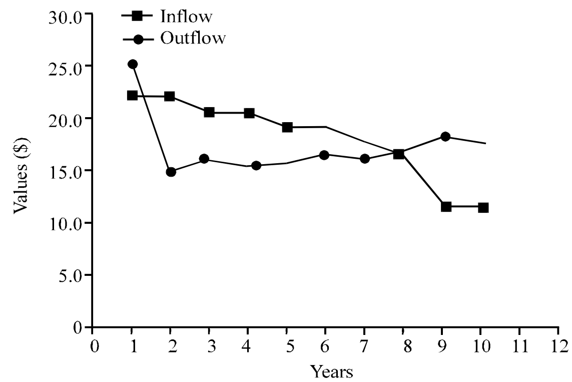

Fig. 1: Prediction inflow-outflow intensive embankment cultivation

and the reduced or lost mangrove area because the mangrove area is converted into intensive embankment cultivation. Some Asian countries experience the same condition (Barbier and Strand, 1997; Samina, 1999).

The income-cost prediction for next 10 years time follows the trend that can be witnessed in some areas. It shows that the production always declines when the years pass by and the drop is so, drastic after the 5th year. The drop of production is caused by the lower shrimp survival rate. Meanwhile, the production and investment cost tend to increase steadily. The result of calculation is shown in diagram of Fig. 1 while the business performance is shown by NPV value of 57.858.162; IRR 51%; Net B/C 1.4.

Silvofishery embankment cultivation: Some of research result shows that the combination between mangrove forest and embankment cultivation is 50-50% (Inoue *et al*.,1999). The technical guidance of silvofishery cultivation from Forest Department decides that the ideal area comparison between mangrove and embankment is 8:2. According to Hikmawati (2000) the ideal comparison between mangrove and the embankment cultivation is 70:30%. In Philippine the comparison between mangrove and embankment cultivation is 80: 20% in Vietnam the comparison is 70% for mangrove and 20% for settlement (Primavera, 2000).

Based on the research result in scenario of ecosystem area for mangrove forest in this research it is decided that 40% is for embankment cultivation and 60% is for mangrove. As a result the option for silvofishery embankment cultivation in 559 ha area, the combination will be 224 ha for embankment cultivation area and 335 ha for mangrove area.

The prediction of yearly inflow-outflow from silvofishery embankment cultivation is shown in diagram in Fig. 2. The business performance is shown by value of NPV 40.318.720; IRR 94%; Net B/C 8.6.

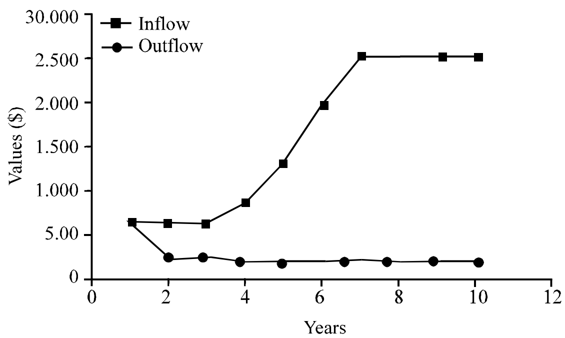

Fig. 2: Prediction inflow-outflow silvofishery embankment cultivation

The mangrove plantation and charcoal production: The management of mangrove forest area and charcoal production is expected as an good alternative. The mangrove from Rhizoporaceae family like *Rhizopora apiculata* and *Rhizopora* mucronata has good characteristic as the raw material of charcoal. The charcoal made from those plants has quality like Bincho charcoal from Japan in relation to its specific weight, the hardness and the burn traits (It is easy to burn).

The assumption used in the management scenario refers to the research result of Inoue *et al.* (1999) and then is formulated as follows. The charcoal production and the plantation of mangrove are done in a area by using well managed logging and reforestation. The decided rotation is 15 years and the logged or planted area is managed in such a way, so, it meets the requirement of 15 years rotation. The capacity of oven for charcoal production is 60 m^3. The rendement is expected 25%.

The yielded production is 15 ton/cycle. The frequency of burning is 8 time/year. The forest area needed for one burning oven by using selective logging and reforestation is: Wood consumption per year = the oven capacity×the burning cycle per year = 60 m^3×8 times burning = 480 m^3. The consumption for the 15 years rotation = the per year consumption × 15 years = 480 m^3×15 = 7.200 m^3. Based on the vertical volume table and the level of mangrove growth, the rotation and needed forest area can be determined. The effective vertical volume for 15 years is 97.34 m^3/ha. The need of wood consumption for 15 years rotation is 7.200 m^3, so, the area of mangrove forest needed for 15 years for one oven is (7.200/97.34) = 73.96 ha, rounded into 74 ha. So, the yearly need is 5 ha. The logging regulation still refers to Presidential Regulation No. 32/1992. It regulates the management of conserved area; The green area of mangrove with 130 times of the difference in the highest and the lowest tide. So, the area of mangrove forest is 559 ha with 6 burning oven units.

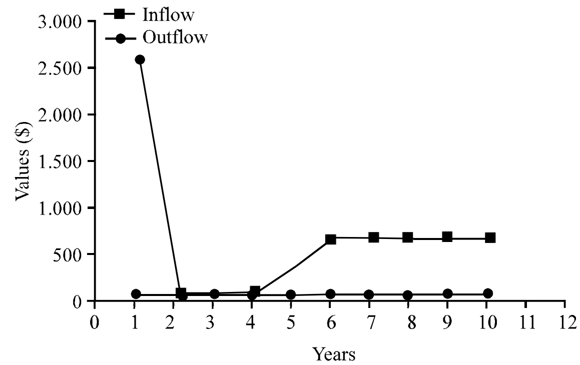

Fig. 3: Prediction inflow-outflow charcoal production and mangrove

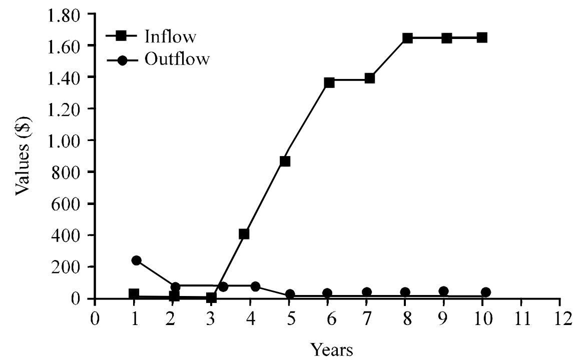

Fig. 4: Prediction inflow-outflow mangrove conservation

The inflow-outflow prediction for charcoal production for next 10 year time is shown in diagram in Fig. 3. While the business performance is shown by value of NPV 7.785.677; IRR 44%; Net B/C 4.1.

The entire area for mangrove forest conservation: If because of some particular considerations the entire area becomes the conservation area, the use of forest ecosystem is limited to the use of items and service the ecosystem produces but the plants can not be cut down. The prediction of income-cost in the next 10 years follows the fact in site. The income and benefit are expected to increase as the time goes by with assumption that the forest condition doesn't suffer from any damage. The prediction result of inflow-outflow can be seen in diagram in Fig. 4 whereas the business performance is seen in NPV value 22,878,117; IRR 65%; Net B/C 6.9.

The objective function shows the function from business activity whose optimal solution is searched. To ease the analysis and interpretation of the analysis result, the objective function of business activity is analyzed by using ha scale. There are some optimal solutions from many alternative business activities such as

Table 2: The net income from the use of 599 ha coastal area under the scenario

Detail	Intensive embankment cultivation (×1)	Silvofishery embankment cultivation (×2)	Charcoal production and mangrove (×3)	Mangrove conservation (×4)
Production				
Shrimp cultivation	86,868.600	4,905.600	-	-
Shrimp mangrov	(818,800)	1,878.753	611,295.9	1,878,753.4
Charcoal production	-	-	540,000	-
Milkfish	-	1,612.800	-	-
Crab	(1,131.000)	2,595.102	844,376.7	2,595,102.7
Bird egg	(7,770)	17,828	5,800,9	17,828.4
Oyster	(850,200)	1,950.801	643,738	1,950.801
Environment service				
Groundwater protection	(9,961.215)	9,961.215	7,436,797.5	9,961.215
Storm protection	(472,440.9)	472,440	352,712.7	472,440.9
Support a diversity at life (fish)	(678,802.5)	1,557.526	506,777	2,598,976.6
Biodiversity	(21,656.9)	49,692	16,168.5	49,692.2
Cost				
Investation	105,762.800	5,239.902	2,434.950	2,254.950
Operational cost	147,911.400	2,175.790	144,528	726,700
Cash flow				
NPV	57,858.162	40,318.720	7,785.677	22,878,117.6
IRR	51%	94 %	44 %	65 %
Net B/C	1.4	8.6	4.1	6.9

intensive embankment cultivation, silvofishery embankment cultivation, charcoal production and the use of environment role of mangrove area. It means that some ha of the area must be available for those activities. In this research, the objective function coefficient is the net income from each activity meaning that it is the net income from shrimp, milkfish, charcoal, crab, bird eggs, oyster, coast protection, biota supportive power, biological diversity. Whereas the limit function or problems function is form of mathematical representation from the limitation of resource availability that will be allocated optimally to some business activities.

The analysis result for four activities under scenario (they are X_1: intensive embankment cultivation; X_2: silvofishery embankment cultivation; X_3: charcoal production; X_4: the mangrove plantation) can present net income information for each activity (Table 2).

Deciding the objective function is a base of the research in determining the target applied to the research. As aresult this objective function will be used as the base for the researcher or decision maker in making the decision. The MOGP mathematical model is as follows:

Targeting:

- Shrimp profit, 155400 X1+8776 X2+1094 X3+ 3361 X4+d1++d1- = 4905600
- Charcoal profit, 966 X3+d2++d2- = 650000
- Milkfish profit, 2885 X2+d3++d3- = 1500000
- Crab profit, 4642 X2+1511 X3+4642 X4+d4++d4- = 2500000
- Bird eggs profit, 32 X2+10 X3+32 X4+d5++d5- = 5800
- Oyster profit, 3490 X2+1152 X3 +3490 X4+d6++d6- = 1950801
- Ground water protection, 17820 X2+13304 X3+17820 X4+d7++d7- = 9961217
- Storm protection, 845 X2+631 X3+845 X4+d8++d8- = 472442
- Support at fish life, 2786 X2+907 X3+282 X4+d9++d9- = 2598976
- Biodivercity, 89 X2+29 X3+89 X4+d10++d10- = 49698
- Cost, 264600 X1+3892 X2+1559 X3+1300 X4+d11++d11- <= 3047018
- Sustainability, 6 X1+25 X2+15 X3+50 X4+d12++d12- = 6
- IRR, 51 X1+94 X2+44 X3+65 X4+d13++d13- = 20
- Eficiensi financial (B/C), 1,4 X1+8,6 X2+4,1 X3+6,9 X4+d14++d14- = 2
- Labour, 945 X1+315 X2+773 X3+1560 X4+d15++d15- = 65498
- Land area, X1+X2+X3+X4+d16++d16- <= 559

Based on the analysis result, the optimization for area planning using MOG can be arranged in a matrix like in Table 3. The chosen management option depends on the objective of the management. For example, if the expected management objective is to realize all objectives (the production profit, environment service, the continuity and the efficiency), so, the chosen option is the use of area in this composition, 4.96 ha for intensive embankment fishery cultivation and 554.1 ha for silvofishery embankment cultivation.

The process of choosing the management option will be based on some valuations about how possible the management option can be done technically, economically and politically. In this study, choosing option doesn't consider the political problem. As a result the specification of management objective must be defined

Table 3: The Matrix of the Analysis Result of Optimization with Some Scenarios

Scenario/Priority	Activities: Intensive Embankment cultivation (×1)	Silvofishery embankment cultivation (×2)	Charcoal production and mangrove (×3)	Mangrove conservation (×4)
The same priority to all objectives				
Profit from shrimp, crab, milkfish, bird egg, oyster; environment service, the continuity and efficiency	4.96 ha	554.16 ha	0	0
The main priority of continuity	0	559.0 ha	0	0
The main priority of the continuity and environment service	0	0	0.03 ha	558.9 ha
The main priority of shrimp profit	4.8 ha	554.1 ha	0	0
The main priority of work chance and efficiency	12.29 ha	0	0	549.04 ha
Without target				

again, so that, the final objective is to guarantee the continuity of economy, ecology and social aspects. Therefore, the objectives related to economy dimension (the increase of welfare, the creation of job availability, and the maximization of total income) must prioritize the continuity values that fit to ecological and social system. According to Ruitenbeek, from management option in managing the mangrove area, none of the management options fits to every area as a result, any adopted procedure must enable the designers to identify and choose the most appropriate and the best strategy.

Based on the Table 3, the planning of the area use has to concern some available scenarios. Is the planner wants to create job availability as the main priority, so, the optimal solution is a choice in 5th scenario where the area use for X_1 intensive embankment fishery cultivation for 12.29 ha and for mangrove forest for 549 ha is available. However, the choice doesn't pay its attention to the efficiency, so, the economy efficiency objective in any business is not put into consideration. In such concept, the continuity of development is not present whereas in fact there must be three continuities; economy, ecology and social continuities. If the social and ecological continuities area guaranteed but there is no economy continuity, the ecological system is under the threat. The incentive economy must be present and is expected to be high without losing the ecological system and the social interest.

The research gives an insight that during the planning of area use, the choice of first and scenarios could be the most appropriate ones. From those scenarios, the main target of shrimp profit is reasonable because the shrimp commodity market both in local and international levels remains satisfying. Another consideration is that the scenarios can answer the economy, ecology and social problems right now and in the future. The current social problem is primarily dominated by the job opportunity, appreciation and community respect to the environment. Therefore, the choice is considered as the right choice to meet the need in order to prevent social conflict. Because the right proportion of area use for intensive embankment cultivation and silvofishery is able to create job opportunity and environment balance, the local community will not lose their jobs and have more job opportunity because the expanding mangrove area will diversify the fishery activities both for gathering or cultivating.

CONCLUSION

Mangrove ecosystem has a high carrying capacity for the economy and the aquatic life around it. The condition is shown by the benefits and economic value they contain. Economic-ecological value of mangrove ecosystems covering 146 ha in the Gending Sub district, Probolinggo was $US 13.941.885 per year for the Total Economic Value (TEV). 79% from those values was Indirect Use Value (IUV) of the ecology and a value that is often ignored. The use of coastal zone with mangrove ecosystem should maintain this ecosystem as an ecological processes keeper and buffer zone for the life support. Then, the existence of mangrove ecosystem through its ability in carrying capacity both in ecological and economic should be an important part in the planning of coastal zone management. Therefore, it was highly recommended to keep the sustainability of mangrove ecosystem.

REFERENCES

Arief, M.P.I.A., 2003. [Mangrove Forest: Functions and Benefits (In Indonesian)]. Penerbit Kanisius, Yogyakarta, Depok, Indonesia, ISBN:979-21-0558-1,.

Barbier, E.B and I. Strand, 1997. Valuing mangrove-fishery: A case study of Campeche, Mexico. Proceedings of the 8th International Annual Conference on European Association of Environmental and Resource Economics (EAERE), June 26-28, 1997, Tilburg University, Tilburg, Netherlands, pp: 1-29.

Dahuri, R., 1993. [Model development source power fishery in sustainability (In Indonesian)]. Proc. Indonesian Fish. Symp., 1: 297-316.

Dahuri, R., 1996. [Development of multiple utilization management plans for mangrove ecosystems in Sumatra]. Pusat Penelitian Lingkungan Hidup (PPLH) IPB, Bogor, Indonesia. (In Indonesian)

Dahuri, R., 1997. [Integrated management of marine and coastal areas in Indonesia, papers on coastal and marine area management courses]. Pusat Penelitian Kependudukan Dan Lingkungan Hidup, LP-ITS, PPPSL, Surabaya, Indonesia. (In Indonesian)

Dahuri, R., J. Rais, S.P. Ginting and M.J. Sitepu, 2001. [Integrated Management of Coastal and Oceanic Resources]. PT Pradnya Paramita, Jakarta, Indonesia, Pages: 326 (In Indonesian).

De Groot, R.S., M.A. Wilson and R.M. Boumans, 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecol. Econ., 41: 393-408.

Dietriech, G.B., 2005. [Towards Regional-based Integrated Coastal Areas Management River Flow (DAS), Land Interaction and Ocean Effect on Resources and Environment]. Indonesian Knowledge Institute, LIPI Press, Jakarta, Indonesia, (In Indonesian).

Dixon, J., 1989. Valuation of mangroves: Tropical coastal area management. Metro Manila Philipines, 4: 1-6.

Fauzi, A., 2004. [Natural Resource and Environmental Economics: Theory and Application]. PT. Gramedia Pustaka Utama, Jakarta, Indonesia, ISBN:9789792210422, Pages: 259 (In Indonesian).

Gunarto, 2004. [Mangrove conservation as a support of biological fishery fisheries (Indonesian)]. J. Litbang Pertanian, 23: 15-21.

Hikmawati, D.C., 2000. Sustainable ponds. Japan International Cooperation Agency, Japan.

Hudspeth, T., J. Farley and R. Boumans, 2005. Valuing Philippines mangrove forest via ecological economics. University of Vermon Environmental Program and Rubenstein Shool of Environmental and Natural Resources, Burlington, Vermont.

Inoue, Y.I., O. Hadiyati, H.M.A. Affendi, K.R. Sudarma and I.N. Budiana, 1999. Sustainable management models for mangrove forests. Japan International Cooperation Agency, Japan.

Mahmudi, M., H. Nuddin and A. Diana, 2007. [Supporting the ecology and economy of mangrove ecosystems on fisheries production as a basis for mangrove resource management in coastal areas]. Research and Technology, State Ministry of Research and Technology of the Republic of Indonesia, Jakarta, Indonesia. (In Indonesian)

Maynard, H.M. D.E. James, A.D. Meister, B.T. Bower and J.A. Dixon, 1987. Environmental Natural System and Development an Economic Valuation Guide. Gadjah Mada University Press, Jogyakarta, Indonesia,

Munasinghe, M., 1993. Environmental Economics and Sustainable Development. The World Bank, Washington, D.C., USA., ISBN:9780821323526, Pages: 112.

Pagoray, H., 2003. [Environment coastal and the problem as waste disposal area]. Master Thesis, Bogor Agricultural University, Bogor, Indonesia.

Pearce, D.W. and D. Moran, 1994. The Economic Value of Biodiversity. Earthscan, London, England, ISBN:1-85383-195-6, Pages: 167.

Pearce, D.W. and R.K. Turner, 1990. Economics of Natural Resources and the Environment. Johns Hopkins University Press, Baltimore.

Pomeroy, R.S., 1992. Economic Valuation Available Methode. In: Integrative Framwork and Methodes for Coastal Area Managemant, Chua, T.E. and L.F. Scura (Eds.). World Fish, Penang, Malaysia, ISBN:9789718709320, pp: 149-162.

Primavera, J.H., 2000. Integrated mangrove-aquaculture systems in Asia. Integr. Coastal Zone Manag., 1: 121-130.

Ruitenbeek, H.J., 1992. Mangrove Management: An Economic Analysis of Management Options with a Focus on Bintuni Bay, Irian Jaya. Dalhousie University, Halifax, Canada,.

Samina, K., 1999. The Economic Value of the Environment: Cases from South Asia. IUNC Publisher, Charlotte, North Caroli,