Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 7, No. 4, p. 34-42, 2015
http://www.innspub.net

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RESEARCH PAPER
OPEN ACCESS

Building strategy priority of blood cockle aquaculture development for conservation and welfare in Sub-districtof Central Kupang, West Timor, Indonesia

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Article published on October 22, 2015

Key words: Priority, Blood Cockle, Aquaculture, Conservation, Welfare.

Abstract

Blood cockle (*Anadara granosa* L., 1758) production in Sub-District of Central Kupang, West Timor, Indonesia, is the result of blood cockles catching business on an industrial scale household. Over-fishing of blood cockle has led to a drastic drop in blood cockles and encourage the catching of juvenile blood cockle, thus threatening blood cockle resource conservation and livelihood of fishermen community. This study aims to determine the priority of blood cockle aquaculture development strategy for the conservation and welfare. The research method applied is a survey method with the population is a blood cockle fishermen community. Data collection was used in depth-interview method with a guide questionnaire. Data was analyzed by SWOT–AHP combination (strengths, weaknesses, opportunities and threats combined with analytic hierarchy process). Results of SWOT-AHP combination analysis show that the global value of the strategies, i.e. development of cockle aquaculture blood with a participatory approach (3.856); building partnerships for the development of cockle aquaculture blood (3.712); and development of blood cockle aquaculture business integrated with its fishery business (3.693). This study has determined the priority of blood cockle aquaculture development strategy for the conservation and welfare is development of blood cockle aquaculture business integrated with its fishery business.

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Introduction

Blood cockle (*Anadara granosa* L., 1758) has an important role in the coastal ecosystem both economically and ecologically. The economic role of blood cockles is as a source of income coastal communities and a source of foreign exchange. Data from the Ministry of Maritime Affairs and Fisheries of Indonesia (2015) showed that the production volume of blood cockles Indonesia in the last decade the average reached 39,051.8 tons/year with an average value IDR 402.97 billion/year. The ecological role of blood cockles is reducing the turbidity of the water through filtration activity, enrichment through bio-deposition of benthic habitat, induces de-nitrification, overcoming some of the adverse effects of eutrophication in shallow water, sequester carbon, provide structural habitat for other marine organisms, and stabilize habitat and shoreline (Peterson *et al.*, 2010).

Sub-district of Central Kupang, West Timor is one of the areas which are producing the blood cockle in Indonesia. Drastic decrease in blood cockle production has occurred in the last decade in this area.The highest production of blood cockles is 3.18 tons in 2007 down into 0.79 tons in 2013 or a decrease of 73.67% (Statistics Central Bureau of Kupang Regency, 2014). This production decline has been aggravated by the exploitation to meet the needs of fishermen. Preliminary study results in this study showed that approximately 48% of the total catches of blood cockle were juveniles. The products of blood cockle juvenile were received in the local market with price IDR 15,000 per kg, or equivalent to the price of adult blood cockles, that has been triggered the exploitation of blood cockle juveniles. This phenomenon will hinder the regeneration of blood cockles and in the long term would threaten the conservation of blood cockle resources in Sub-District of Central Kupang.

The development of cockle blood aquaculture is a potential strategy for restocking blood cockle population in this area. Business of blood cockle aquaculture can be combined with business of blood cocklefishery, for rearing blood cockle juveniles as the catch for fishermen. Juvenile of reared blood cockle is expected breeding in wild for restocking, furthermore, it can provide economic benefits to the fishermen; both aquaculture and fishery business. Thus, this strategy is beneficial for conservation of blood cockle resources and simultaneously improving the welfare of fishermen.

The early stage study in a series phase of this research has determined the type of aggressive strategy based on the results of the evaluation on internal and external factors for the development of blood cockle aquaculture to the conservation and welfare. In addition, it has been formulated alternative strategies through mechanisms focus group discussion (FGD) together with blood cockle fishermen community (the respondents), i.e. development of blood cockle aquaculture business integrated with its fishery business; and development of cockle aquaculture blood with a participatory approach; and building partnerships for the development of cockle aquaculture blood.

The research was conducted as a continuation of the previous research stage, with the aim of establishing priorities of blood cockle aquaculture development strategy for the conservation and welfare of fishermen community in the Sub-District of Central Kupang, West Timor, Indonesia. The Priority of strategy recommended in this research is contributing to policy-makers (governments and other stakeholders), and is expected to be applied globally as an alternative strategy in sustainable management of blood cockles.

Materials and methods

Study site and data collection

The study was conducted in Sub-District of Central Kupang, Kupang Regency, East Nusa Tenggara Province, Indonesia, from November 2014 until February 2015. The population in this study was blood cockle fishermen in Sub-District of Central

Kupang. The numbers of respondents who are involved are 35 fishermen who were taken as a sample from the total population of 49 fishermen. Data were collectedusing purposive sampling method. Data were collected through interviews indepth-interview with a guide questionnaire consist of two patterns of the question. First, a rating scale to determine the rank of the SWOT factor group and strategies based on the perception of respondents. Second, the pattern of questions with the Likert scale for the assessment on the level of efficiency for each strategy in taking advantage of each SWOT factors.

SWOT-AHP analysis

Collected questionnaire data have been analyzed with SWOT-AHP technique. Analysis of SWOT-AHP were arranged in structured four levels. The first level is a goal to be achieved from the decision. The second level is a group of four SWOT factors, namely strength (S), weaknesses (W), opportunities (O) and threats (T). The third level is the factors of each group of SWOT. The final level is the strategies that evaluated their priorities (Fig. 1) (Osuna and Aranda, 2007).The global value of strategy is calculated using the following formula:

$$V_j = W_S \sum_{i=1}^{i=nS} W_{Si} U_{Si,j} + W_W \sum_{i=1}^{i=nW} W_{Wi} U_{Wi,j} + W_O \sum_{i=1}^{i=nO} W_{Oi} U_{Oi,j} + W_T \sum_{i=1}^{i=nT} W_{Ti} U_{Ti,j}$$

Specification:

(W_S, W_W, W_O, W_T) =the relative importance of each factor group (S, W, O and T) for the achievement of development and growth of blood cockle business;

(W_{S1}, W_{S2}, ...,W_{Sms}) =the relative importance of the strength factors (S1, S2, ..., SMS) in its group (S);

(W_{W1}, W_{W2}, ...,W_{Sms}) =the relative importance of weakness factors (W1, W2, ..., WMS) in its group (W);

(W_{O1}, W_{O2}, ...,W_{Oms}) =the relative of importance opportunity factors (O1, O2, ..., Oms) in its group (O);

(W_{T1}, W_{T2}, ...,W_{Tms}) =the relative importance of threat factors (T1, T2, ..., Tms) in its group (T);

$U_{Si,j}$ =Efficiency of strategy j in taking advantage of the strength factors;

$U_{Wi,j}$ =Efficiency of strategy j to mitigate the effects of the weakness factors;

$U_{Oi,j}$ =Efficiency of strategy j in taking advantage of opportunities factors;

$U_{Ti,j}$ =Efficiency of strategy j in the face of threat factors.

The strategy chosen as a priority in the analysis of SWOT-AHP is a strategy that results in global value (Vj) highest (Osuna and Aranda, 2007). The analysis of SWOT-AHP performed using software of Expert Choice.

Results

This study has chosen the priority of strategy in blood cockle aquaculture development for the conservation and welfare, which is generated through the process of decision making based on the global value of strategies using SWOT-AHP technique. Analysis of SWOT-AHP conducted in three stages, i.e. analysis of the relative importance on the SWOT factors; analysis of the relative importance in the group of SWOT factors; and evaluation of global strategies.

Table 1. Relative Importance of SWOT Factors.

SWOT Factors	Relative Importance (W_S, W_W, W_O, W_T)
Strengths	0.616
Weaknesses	0.091
Opportunities	0.243
Threats	0.049

Relative Importance of SWOT Factors

The relative importance of the SWOT factors is obtained from the calculation of the geometric mean of SWOT factors based on the respondents' assessment. The highest relative importance value is the strength factor, and followed by opportunity

factor (Table 1). This condition indicates that the fishermen in the Sub-District of Central Kupang have the number of strengths and opportunities that can be explored for the development of blood cockle aquaculture.

These results are consistent with the results of previous stages of research to determine the type of aggressive strategy for the development of cockle aquaculture blood to the conservation and welfare of fishermen. This strategy is a combination of the strength factor (internal) and opportunities factors (external). Rangkuti(2011) states that aggressive strategy is a strategy that utilizing the strength for taking advantage of opportunities or known as growth-oriented strategy.

Table 2. Relative Importance in group of Strength Factors.

Strength Factors	Relative Importance (W_{Si})
Suitability of intertidal waters for blood cockle aquaculture	0.036
Infrastructure for blood cockle aquaculture is available in local market	0.103
Technique of blood cockle aquaculture is easy and inexpensive	0.086
Local labor is available	0.026
Motivation to sustainable management	0.386
Motivation to improve income and welfare	0.294
Support of public infrastructure	0.070

Relative Importance in group of SWOT Factors

The relative importance of the factors in a group of SWOT is the result of calculation on the geometric mean of each factor in the group of SWOT factor based on the assessment of respondents. The highest value of relative importance in each group of SWOT factors are motivation for sustainable management (group of strength); no participatory planning in the management of blood cockles (groups of weakness); motivation to increase revenue (group opportunities); and decreased production of blood cockles in nature (group threat) (Table 2 to 5).

Table 3. Relative Importance in group of Weakness Factors.

Weakness Factors	Relative Importance (W_{Wi})
There has been no effort to empower fishermen	0.031
Fishermen less innovative	0.023
Fishermen have not had experience blood cockle aquaculture	0.129
There are no participatory planning in management of blood cockles	0.392
role of fishermen in sustainable management is still less	0.230
There are no institutional of fishermen	0.195

This condition illustrates that blood cockle fishermen in the Sub-District of Central Kupang have the motivation to carry out the sustainable management of blood cockles resources and motivation to support local government development program to increase local revenue. On the other hand the fishermen are faced with the threat of decreased production of blood cockles and the fact that these fishermen have never been involved in participatory planning related with sustainable management of blood cockles.

Strategy Efficiency on Each SWOT factors

Results of strategy efficiency assessment on each SWOT factors from respondents are evaluated further to get the global value on the strategic priority in the development of blood cockle aquaculture. Calculation of strategic global value using the following formula:

$$V_j = w_S \sum_{i=1}^{i=n_S} w_{Si} U_{Si,j} + w_W \sum_{i=1}^{i=n_W} w_{Wi} U_{Wi,j} + w_O \sum_{i=1}^{i=n_O} w_{Oi} U_{Oi,j} + w_T \sum_{i=1}^{i=n_T} w_{Ti} U_{Ti,j}$$

$$= 0.616 \sum_{i=1}^{i=7} w_{Si} U_{Si,j} + 0.091 \sum_{i=1}^{i=6} w_{Wi} U_{Wi,j} + 0.243 \sum_{i=1}^{i=5} w_{Oi} U_{Oi,j} - 0.049 \sum_{i=1}^{i=5} w_{Ti} U_{Ti,j}$$

The global final value for each strategy is obtained by calculating the mean arithmetic of global value in each strategy that obtained from all respondents. The result of Global value calculation are development of blood cockle aquaculture business integrated with its fishery business: 3.693, development of cockle aquaculture blood with a participatory approach: 3.856, and building partnerships for the development of cockle aquaculture blood: 3.712 (Table 6).

Table 4. Relative Importance in group of Opportunity Factors.

Opportunity Factors	Relative Importance (W_{Oi})
Product requirements is convenient	0.049
Local market demand is still widespread	0.183
Access to information and technology	0.028
Support of government policy	0.292
Employment recruitment	0.124
Motivation to increase local-generated revenue	0.323

Discussion

The global value of each strategy in this study has small differencevalue. This condition indicated that the third of strategies is important for the development of cockle aquaculture blood. However, according to the provisions of Osuna and Aranda (2007),chosen strategy as a priority in the analysis of SWOT-AHP combination is a strategy that generates the highest global value. Thus, priority strategy in the development of blood cockle aquaculture for the conservation and welfare that chosen in this study was development of blood cockle aquaculture with a participatory approach.

Table 5. Relative Importance in group of Threat Factors.

Treath Factors	Relative Importance (W_{Ti})
Blood cockle fishing is not selective	0.031
Decreased of natural blood cockle production	0.361
Conflicts of land use for blood cockle aquaculture	0.164
Living cost is high	0.294
Degradation of coastal ecosystems	0.150

Development of blood cockle aquaculture with a participatory approach is according to the policy of sustainable management of fisheries resources. Murdiyanto (2004) revealed that the success of a strategy of sustainable management of fisheries resources can be measured by the commitment and active participation of fishermen community. Top-down strategies in development are often failure in its application because there are rejection or ignored by fishermen who are more concerned with economic benefits or pressing necessities of life. Mussadun *et al.* (2011) states that public participation is an important approach for the success of the sustainable management of fisheries resources.

The success on a strategy of sustainable management of fisheries resources can be measured by the commitment and active participation of the fishermen community. Top-down strategies in development are often failure in its application because there were rejected or ignored by fishermen who are more concerned with economic benefits or needs (Murdiyanto, 2004). Although policy of development is a government authority, but it does not mean people do not have the contribution and participation in building public policy. With the contribution and

participation, a policy that is formulated was more touching the real issue and not harms the public interest (Syahra, 2012).

Community participation is a complex process and poses challenges for all involved parties. However, participatory initiatives also generate benefits by reduction of apathy and psychological burden of the community, as well as development and disseminate information in the community (Chifamba, 2013). Community participation will be most effective when integrated from the beginning of the planning process together with the active involvement of government institutions; for efficiency of implementation time and the success in building of management planning (Shofwan *et al.*, 2008). Public participation in the decision-making process is a key element, while the government plays an important role in the creation of an enabling environment for community participation (Njaya, 2007).

Table 6. Global Evaluation of Strategies.

Strategy	Global Evaluation Value
Development of blood cockle aquaculture business integrated with its fishery business.	3.693
Development of cockle aquaculture blood with a participatory approach.	3.856
Building partnerships for the development of cockle aquaculture blood.	3.712

Strategy of blood cockle aquaculture development in Sub-District of Central Kupang is intended not only to improve the welfare of fishermen but also for conservation of blood cockle resources. Aquaculture (rearing) blood cockle is expected to allow blood cockle juveniles breeding in the wild during the cultivation period. Gimin *et al.* (2014) stated that at this location first spawning of blood cockle occurred at size 24.6 mm in males and 24.3 mm in females. Thus, juveniles of blood cockle that reared until reaching market size can spawn more than once in wild nature. Rao and Somayajulu (2006) stated that the market size of blood cockle is 3.2 to 4.0 cm.

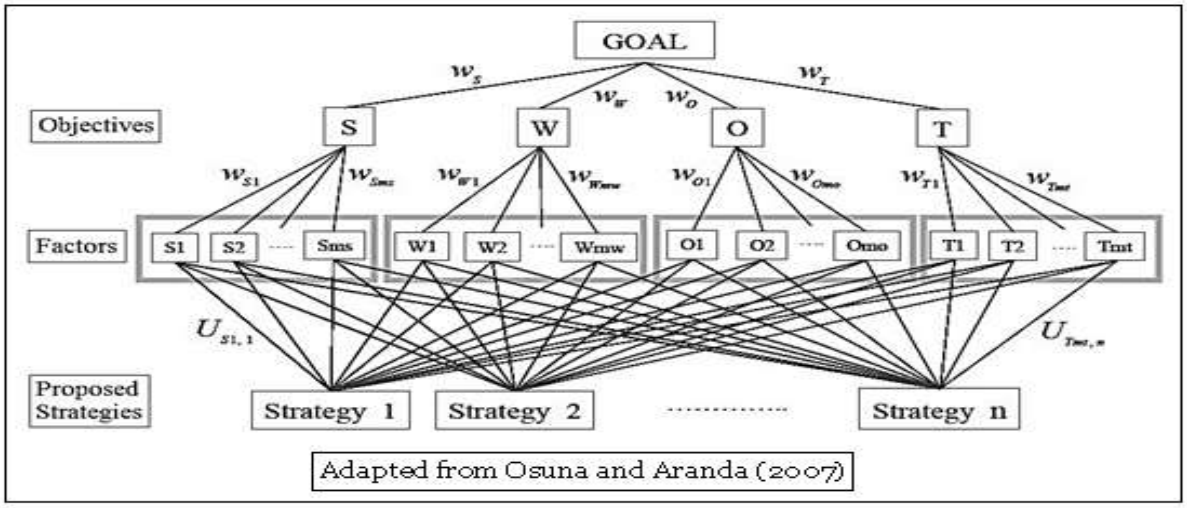

Fig. 1. Relations between hierarchical levels in the analysis SWOT-AHP.

The participatory is the right approach for the achievement of blood cockle resource conservation strategies in Sub-District Central Kupang. Berkes (2004) stated that conservation should be participatory because the nature of global and complex environmental problems requires a different approach. According to Lakitan *et al.* (2013) Community participation should provide incentives, i.e. recovery and utilization of sustainability of fishery resources and improvement of the livelihood of

fishermen community. Efforts for the welfare of society must necessarily be included, i.e. providing an opportunity for local communities to participate in the process and luxuriate the results.

Development of participation is particularly important considering the community as a stakeholder, who is directly carrying out and utilizing the results of the development program implementation (Tamba and Cipta, 2011). Participation of fishermen community will be realized based on understanding, realities and awareness about the importance on the conservation of fishery resources for welfare. Increased understanding and awareness of fishermen, with the condition of education level was relatively low, requires effort and continuous learning process (Lakitan *et al.*, 2013). The level of education is very influential on the fisherman community understanding about the importance of fishery resources for their livelihood. Understanding and awareness of fishermen community will improve their participation in efforts to protect the ecosystem of the fishery resource. The purpose of community participation in resource management is to engage the community actively to accelerate the achievement of management objectives effectively and efficiently through improvement of empowerment, understanding and awareness (Murdiyanto, 2004). Revenue will also affect the ability of the fishermen to create better participation in the management of natural resources. The higher income levels are tending to increase support to the implementation of sustainable development (Tamba and Cipta, 2011).

Community involvement in decision-making processes and enhancement of community participation in management can ensure the sustainability of the management process (Armah *et al.*, 2010). Participatory process that aims to reach a deal can fortify the differences and contradictions. Participation at an early stage in the decision-making is very important because participation loses its meaning if people are not involved in planning (Pieraccini, 2015). Community participation plays an important role in the development of capacity for the management and utilization of sustainable resources. Community participation is a form of self-awareness, confidence, and independence in the community structure (Shrestha, 2011). Community participation could be optimized if they understand and feel the benefits of innovative technologies for improving the welfare of their life (Syahra, 2012).

The search of strategies for the implementation of sustainable development is continuing to be done in many countries. Management strategies should be developed to overcome the shortcomings of previous strategies and contribute to improve the environmental integrity (Plummer, 2005). Development program that puts people as objects is the cause for the lack of active participation of fishermen community in managing their own potential and environment (Retnowati, 2011). Participatory management or also called community-based management is a learning medium for communities to think globally in the planning and implementation of sustainable management of local resources. Wiber *et al.* (2004) suggested that community-based management must go beyond local interests and utilize the relationship mechanisms that allow fishermen to participate in the management globally. Community-based management must find a balance between distribution of fisheries benefits widely to sustain communities in the long term and encourage individual investment for further commercial development. According to Plummer (2005), the acts locally from the perspective of the ecosystem are the basis for the implementation of sustainable development. Advantages of acts locally are enhancing the ability to access information, capacity building for implementation, and community education in sustainable development.

Acknowledgements

The authors gratefully acknowledge the support and generosity of Prof. Ricky Gimin, Dr. Sunadji, Dr. IsmawanTallo and Evelyn DewiLusiana for their

contribution in this research. We also thank Max Olla, Alauddin Al Ayyubi and Samuel Modok for their help during observation, interviews and discussion with fishermen community in Sub-District of Central Kupang, West Timor, Indonesia.

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