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The Management of Mangrove Ecosystem Based on Mitigation: Case Study in Mangrove Area of Tongke-Tongke, South Sulawesi

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Abstract

Mangrove ecosystems have ecological function and one of which is coastal protection. The implication of this ecological function is that mangroves need to be managed properly. Located in the village of Tongke Tongke, Sinjai, the study was conducted with the aim of:

(1) determining the problem structure of mangrove management
(2) formulating the direction of mangrove management based on mitigation, and
(3) assessing the benefit values of mangrove ecosystems.

The methods of analysis used are:

(1) DPSIR analysis;
(2) analysis of AHP, and
(3) analysis of use values.

The results showed:

(1) the problem structure of mangrove management is influenced primarily by the opening of the ponds and;
(2) the direction of mangrove management, respectively, are mangrove rehabilitation (0.3), institutional reinforcement (0.2), mangrove ecotourism (0.20), refined products of mangrove (0:15) and people empowerment (0:15), and
(3) the use values comprise: direct use value with Rp. 48.3009 million ha-1th-1, indirect use value with Rp.23.338-.650 ha-1 yr-1, the

alternative use value with Rp.19-588.750 ha-1th-1, and the existence value with Rp.2.917. 722 ha-1th-1.

Keywords: mangrove structure, problems, use value

INTRODUCTION

Background

In coastal areas both tropics and subtropics, mangrove ecosystem undergoes a transformation. Overall, the mangrove ecosystem changes between 2 to 8% (Miththapala, 2008). The main cause behind this condition is the conversion of mangroves into fishponds, prawn farms and other unsustainable mangrove utilizations (Duke et al., 2007). Later, many countries are aware of the importance of mangrove ecosystems (Walters et al., 2008). This realization spurred mangrove conservation efforts in most of development activities (Ronnback, 1999). Moreover, an increase in awareness of the importance of mangrove ecosystems to support human life and to bring welfare (human well-being) into reality at the same time, including the important function of mangroves in providing a nursery service for a number of important organisms, crustaceans and mollusk, natural coastal protection, nutrient and organic matter processing or sediment control (Polidoro et al., 2010). Furthermore, the existence of mangrove ecosystems provides an important role for the local and national economy in coastal areas in the tropics (Warren-Rhodes et al., 2011).

Based on these backgrounds, it is deemed necessary to apply integrated management in mangrove ecosystem, located in Tongke Tongke. Given as a tourist area, mangrove ecosystem in Tongke Tongke is already under threat from the existence of a number of such farms and residential use. Errors, imprecision or inaccuracies in planning and implementing the ecosystem management system, providing a significant negative impact on the declining quality of the environment and the creatures living in there (including local communities) that have a direct dependency on the natural resources. When this condition is maintained, then the degradation rate of natural resources will be more rapid. Thus, it is necessary to implement the management of the mangrove ecosystem based on mitigation to save the ecological functions and at the same time to give benefits for the surrounding society.

OBJECTIVE OF THE STUDY

The objective of this study were to

(1) Determine the problem structures of mangrove management in Tongke Tongke
(2) Formulate mangrove management based on mitigation in Tongke Tongke and
(3) Assess the use values of mangrove ecosystems in Tongke Tongke

METHODOLOGY

Time and place

This research was conducted from March to August 2015 in the village of Tongke-Tongke, East Sinjai district, Sinjai regency, South Sulawesi, which is geographically located at 20 19 '50 "-50 36' 47" latitude and 1190 48 '30 "-1200 10' 00 "BT

Instruments

The Implementation of this study used a number of instruments. The instruments used in this study is shown in Table 1.

Table 1: Research Instruments

No	Data Type	Tools/Analysis Method	Source
Primary Data			
1	Sampling point	Map and GPS	Sampling
2	Economic data	interview	Sampling
3	Social and institutional data	interview	Sampling
Secondary Data			
1	Citra landsat ETM 7 year 2006	Er Mapper 6.0 and Arc View 3.3	Biotrop and BPPT
2	Map		
	Earth map	Arc View 3.3	Bakosutanal, BPN, BPPT,Puslitanak, BMG, Bappeda
	○ Coastal map of Indonesia (LPI)		
	Bathymetry map		
	Administration map		

DPSIR Analysis

DPSIR is a method to analyze the system for observing environmental problem and the way people view the problem (EEA, 2006). DPSIR terminology is a way of evaluating economic and social development (Driving Forces / D) in controlling the pressure (pressures / P) on environment and, and the consequence is the state (State / S) of environmental change. This will cause the impact (Impact / I) on ecosystems, public health, which can cause the response (Response / R) form society as feedback to the (Driving Forces / D), (State / S) or (Impact / I). The steps in the DPSIR analysis consist of identifying the DPSIR components; constructing DPSIR linkage matrix; formulating plans and policies:

a. Identifying Driving Forces (D); Pressures (P); State (S); Impact (I); Response (R) in the form of a matrix. Matrix form used is as follows:

b. Developing matrix linkages of Driving Forces (D); Pressures (P); State (S); Impact (I); Response (R). Matrix form used is as follows:

Table 2. Identification of the DPSIR Components

No	Components				
	Driving Forces (D)	*Pressures* (P)	*State* (S)	*Impact* (I)	*Response* (R)

Table 3: Linkages of DPSIR Components

No	Components		No	Components	
	Driving Forces (D)	Pressures (P)		Pressures (P)	State (S)

No	Components		No	Components	
	State (S)	Impact (I)		Impact (I)	Response (R)

No	Components		No	Components	
	Response (R)	Pressures (P)		Response (R)	State (S)

Analytical Hierarchy Process (AHP)

DPSIR analysis result is then to be used to make priorities for alternative strategies through AHP (Analytical Hierarchy Process) using Expert Choice. AHP is used to analyze the weighting or priority based on the relative importance between levels. The tool used to collect the data values is in the form of a questionnaire. The purpose of using AHP in this research is to give weight or priority to each indicator based on the relative importance between levels in a hierarchical problem structure. The result of AHP analysis shows that inconsistency ratio (IR) of 0.0 or below the permissible value or inconsistencies ratio of 0.1. It can be concluded that the weight of the value given by the respondents have qualified the condition of consistency

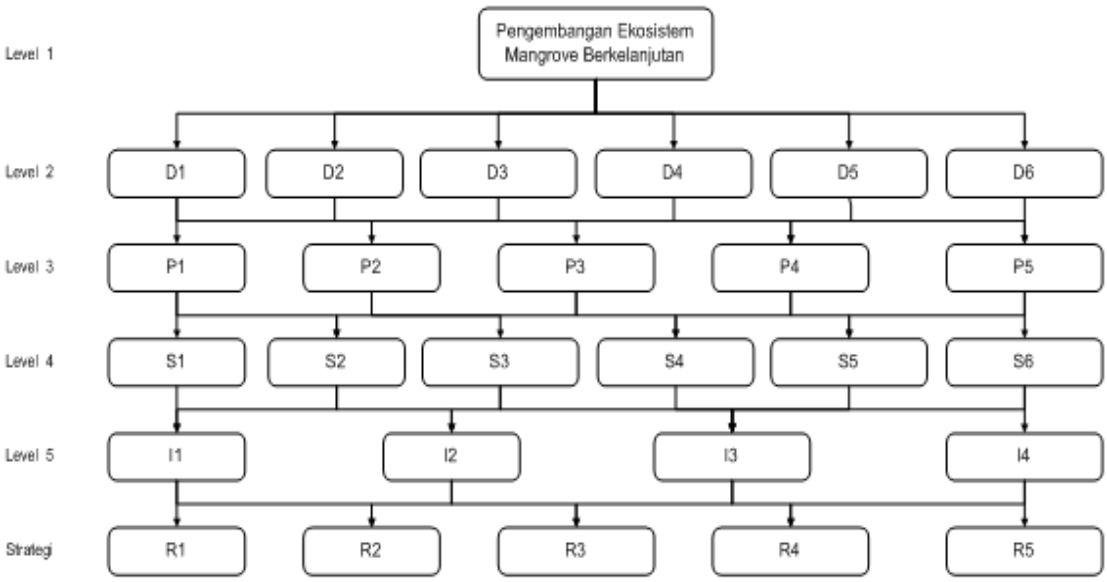

Figure 2: The structure of priority assessment of mangrove management strategy in Sinjai regency

RESULTS AND DISCUSSION

Mangrove ecosystem management in the village of Tongke-Tongke has a goal to increase the role and the function of mangrove ecosystems and its ecosystem services, and increase the participation of local societies in the conservation of mangrove ecosystems. With regard to this, an analysis of the conditions and also the society's perception towards the mangrove ecosystem management in Tongke Tongke.

Identifying the DPSIR Component

Driving Force (D)

Driving force (D) represents a change in the social, economic and institutional system, and the relationship which triggering the direct and indirect pressures. The Potential of ecosystem services is part of a social system as well as economic system. Based on observations and surveys conducted, the Driving Force (D) for the management of sustainable mangrove ecosystems is presented as follows:

Table 4: Driving Force (D) Mangrove Ecosystem Management

No	Driving Forces (D)	
1.	The existence of the pond	(D 1)
2.	The expansion of new settlements	(D 2)
3.	The opening of new farm land	(D 3)
4.	The need for firewood and fodder	(D 4)
5.	Expansion of agricultural land	(D 5)
6.	Society’s lack of knowledge about mangrove	(D 6)

The extent of mangrove ecosystems in Tongke-Tongke indicates some changes caused by both the presence of ponds and the settlement expansion. It is recorded that a reduction in mangrove land area is almost as big as 2 ha. This condition is aggravated by the public ignorance of the important role of mangrove ecosystems. The surrounding society by far only considers mangrove as fodder, whereas the mangrove ecosystem has many functions such as providers of ecosystem services. Furthermore, any change in the management or the use of environmental services will affect a number of other services produced by ecosystems (de Groot et al., 2010).

Pressures (P)

Pressures (P) are consequence of human activities (eg disposal of chemical waste; physical and biological materials; extraction and use of resources, land use change) that have the potential to cause changes to the environment and environmental services (impact). Table 5 below shows the results of the pressures (P) identification in the management of mangrove ecosystems.

Table 5: Pressures (P) Mangrove Ecosystem Management

No	Pressures (P)	
1.	Conversion of mangrove	(P 1)
2.	Reclamation of beach	(P 2)
3.	Opening of mangrove	(P 3)
4.	felling of mangrove	(P 4)
5.	Under value mangrove	(P 5)

Conversion of mangrove ecosystems in coastal areas of Tongke-Tongke is the cause of the decline of mangrove land area. Conversion was done by cutting and clearing the mangrove land and subsequently was turned into farms and settlements. Furthermore, the lack of society's knowledge of the role of mangrove ecosystems makes them only valuing mangrove from its direct use value.

State (E)

State (E) of the environment is the quantity of the biological, physical, and chemical condition of ecosystems and function of ecosystem, vulnerability and ecosystem function in a particular area. Here are the results of the changes identification of state (S) in the management of mangrove ecosystems.

Table 5: State (E) Mangrove Ecosystem Management

No	State (S)	
1.	The reduced density of mangrove	(S 1)
2.	The decline in mangrove area	(S 2)
3.	Damage to the mangrove ecosystem	(S 3)
4.	Changes in flow patterns	(S 4)
5.	The decline in water quality	(S 5)

The quantity of mangrove ecosystems in the coastal area of Tongke-Tongke is indicated by a decrease in mangrove area and a reduction in the density of the mangrove. The density of tree determines the extent of mangrove ecosystems damage as stated in the decree LH No. 201 in 2004. The results of the study in the coastal area of Tongke-Tongke show that more than 50% of mangrove ecosystems are in medium category. Furthermore, changes in the condition of mangrove affect a change in flow patterns and a decrease in water quality (Barbier 2006).

Impact (I)

Impacts (I) represents a change in ecosystem function, having a negative impact on the health of environment, and having an effect on changes in ecosystem services, both socially and economically. Impact (I) caused by changes in the State (s) is shown in Table 6.

Table 6: Impact (I) Mangrove Ecosystem Management

No	Impacts (I)	
1.	Sedimentation	(I 1)
2.	Trash increase	(I 2)
3.	Abrasion of beach	(I 3)
4.	Contamination of water and soil	(I 4)

Coastal abrasion is the negative impact caused by the damage of mangrove ecosystem in Tongke-Tongke. People in coastal areas should make a wall to protect the house from abrasion. It need not be the case if the mangrove ecosystem is well maintained. Protection from abrasion by the mangrove ecosystem is the result of the ability to stabilize the beach through the mangrove roots and one of the functions of ecosystems as wind and wave breaker. Mangrove ecosystem services, furthermore, are strongly affected by the use and the management (de Groot et al., 2010).

Response (R)

Response (R) is a policy, initiated by agencies or groups (stakeholders) that directly or indirectly underlie the social perceptions of the impact to maintain, eliminate, mitigate, or adapt. As for the response (R) in the management of mangrove ecosystems, is shown in Table 7

Table 7: Response (R) Mangrove Ecosystem Management

No	Response (R)	
1.	Rehabilitation of mangrove ecosystem	(R1)
2.	Home industry for processed products	(R2)
3.	Mangrove Ecotourism	(R3)
4.	Silvofishery	(R4)
5.	Grouping	(R5)

VALUE ANALYSIS

Direct Use Value

The direct use value of mangrove ecosystems associated with coastal waters fishery production both aquaculture and capture fisheries. The direct use value of mangrove ecosystems is in the form of coastal waters fishery production by area of mangrove ecosystems in the management of Silvofishery ponds amounting Rp.48.300.900. ha-1 yr-1. (Sambu, 2013)

The result analysis of the direct use value of the mangrove ecosystem in the form of coastal waters fishery production shows a positive correlation between the ratio percentage of mangroves and ponds on Silvofishery management, the greater the ratio of mangrove the greater the coastal waters fishery products. Results of this study strengthen the results of Niartiningsih (1996) which stated that young milkfish and fry in coastal waters Sinjai increased with increased extent of mangrove ecosystems.

Indirect Use Value

Indirect use value of mangrove ecosystems divided into two, namely: (1) indirect use value in the form of physical like barrier abrasion, interusi sea water, protection from tornados and (2) the breeding place, place to grow, food and shelter as well as providers of organic materials for shrimp, fish and other biota living in the mangrove ecosystem and its surroundings.

According Naamin (1990) the indirect use value of mangrove ecosystems as providers of organic feed with the regression of the mangrove area and production of shrimp produced shrimp with 51.97 kg ha-1 yr-1. Indirect use value is the sum of the multiplication of shrimp production with the mangrove ecosystem extent multiplied by the average price of shrimp per kilogram, so the indirect use value of mangrove ecosystems, especially shrimp, not including other biota, is Rp 2.33865 million ha-1 yr-1.

Alternative Use Value

The alternative use value of mangrove ecosystems is calculated based on the exchange rate between U $$ with the value of Indonesia currency (Rupiah) at the time of Rp 9,500,-/ U $$-1. The alternative use value of mangrove ecosystem is Rp 142 500,-ha-1th-1. The total area of the mangrove ecosystems in Sinjai is 1351.50 ha. Therefore, the alternative use value in Sinjai is Rp 19.58875 million,-.

Existence Value

The existence value of mangrove ecosystem in Sinjai can be known using Contingent Value Method (CVM). According Asbar (2007) The existence value of mangrove ecosystem gained Rp 2,917,722,-ha-1th-1, so that the total of existence value of mangrove ecosystem in Sinjai with the total area of 1351.50 ha is equal to Rp.3.943.30.

Mangrove Ecosystem Management Planning

The concept of mangrove management in coastal areas in Tongke-Tongke, prioritizes the system of sustainable development. Sustainable development is defined as development that considers the needs of the present generations without ignoring the needs future generations (IISD, 2012). Furthermore, the European Commission (2012) describes that sustainable development guarantee the needs of the present generation without compromising the ability of future generations to meet their own needs-namely, a better quality of life for everyone, now and for future generations. To achieve this goal it is necessary to integrate the immediate and long-term objectives, local and global actions, and to consider issues of social, economic and environment as an integral component and interdependency of human progression (Zacharoula et al, 2014). Thus, this management planning was to be adopted in the planning in coastal areas of mangrove in Tongke-Tongke.

Departing from the analysis of the condition (Table 3 to Table 7), the ecosystem management planning in Tongke-Tongke is conducted by assessing the priority of the management planning. The priority assessment results are shown in Figure 3.

The result of the priority assessment of management planning based on stakeholder perception indicates the main priority is done sequentially as follows: 1) the formation of community groups / R5 (0.33); 2) rehabilitation of mangrove / R1 (0:27); 3) Silvofishery / R4 (0.20); 4) mangrove ecotourism / R3 (0:13); and 5) home industry of mangrove refined products / R2 (0:07).

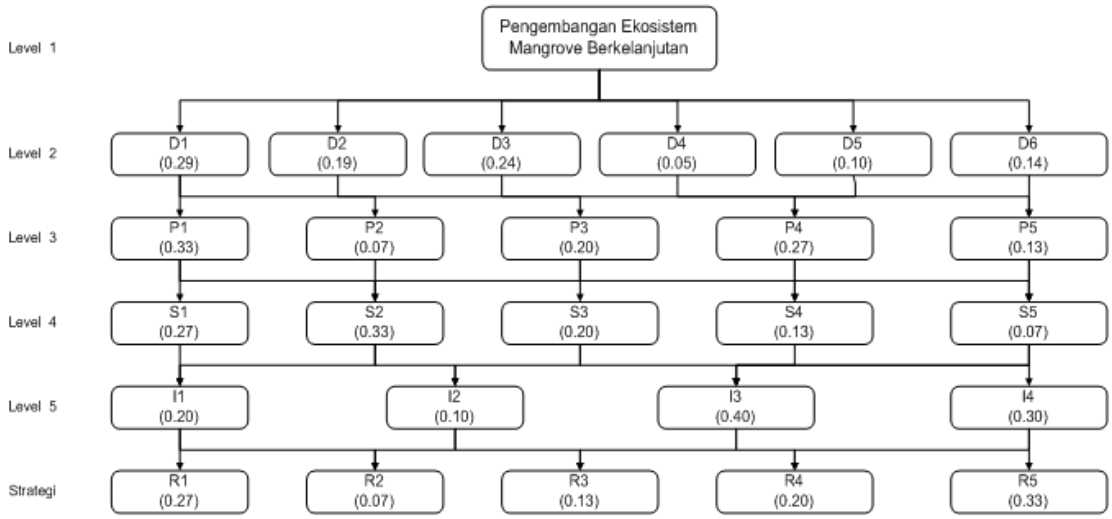

Figure 3: Priority assessment of mangrove management planning in tongke-tongke

The formation of community groups in the management of mangrove ecosystems in coastal areas in Tongke-Tongke is necessary to increase the participation of the community as well as their capacity at to preserve the mangrove ecosystem. Capacity building will open access to the local population on the distribution of values, both directly and indirectly. The opening of this access would make the population aware of the importance of resources management and in turn will ensure the preservation of these resources.

Rehabilitation and conservation of mangrove require supervision and maintenance on an ongoing basis. The likelihood of rehabilitation success is very small without supervision. The success of rehabilitation and conservation of mangroves is also determined by several factors, including the participation of residents of the region itself (the local population), because the local population has a direct interest, both of as a resource and as an ecosystem with its ecological functions with the rehabilitation and conservation area.

Rehabilitation is an activity / effort, including habitat recovery and habitat creation by changing the damaged system becomes more stable. Recovery is an activity to create an ecosystem or renew it to return its natural function. Nevertheless, mangrove rehabilitation is often interpreted as simple as planting or germinating mangrove and growing it in the absence of adequate assessment and evaluation of the success of planting and ecosystem level. In addition, to economic reasons, the recovery of mangrove ecosystems is often limited to certain species of mangrove (2 or 3 species).

This causes changes to the habitat and the decline of ecological functions of the mangrove ecosystem because its homogeneity compared to its natural (heterogeneous and many species), which is a biodiversity in relation to the variety of genetic (Macintosh et al., 2002 in Haikal, 2008).

CONCLUSION

Results of the study are concluded as follows:

(1) the structure of mangrove management problems is mainly influenced by the opening of the ponds and society's lack of value;
(2) the directions of mangrove management, subsequently, are mangrove rehabilitation (0.3), institutional reinforcement (0.2), ecotourism mangrove (0.20), mangrove refined products (0:15) and people empowerment (0:15), and
(3) the total of use value of mangrove ecosystem consisting of direct use value, indirect use value, alternative use value and existence value forming equation Y =-0347 + 0.20X or in other words, each 1% increase in mangrove area will increase the use value equal to Rp.520.000,-m-1 yr-1.

SUGGESTION

To make the mangrove ecosystem in Tongketongke preserved as part of disaster mitigation, we can do three things:

(1) The involvement of all stakeholders in the management of mangrove,
(2) The formation of the management group and the authority of unit area, and
(3) Empowering coastal societies either as managers or as sympathizers.

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