

Sustainable Mangrove Forest Management Analysis (a case study from Dusun Taman Jaya, West Seram Regency, Maluku)

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Abstract

Sustainability value of mangrove forest management in Dusun Taman Jaya, West Seram Regency Maluku. The aims of this study were determining the indicators of sustainable mangrove forest ecosystems and analyzing the sustainability index of mangrove forest management. The study was conducted in three sequential stages, i.e., first: determining the indicators of sustainable mangrove forest ecosystems based on literature studies and field observation, second, evaluating once indicator in ordinal scale based sustainability criteria and ordination analysis based on multidimensional scalling (MDS) methods; third: analyzing the sustainability index value of mangrove forest management system using Rap – Mforest Method. Based on Rap – Mforest analysis, multi-dimension index of mangrove forest management system was 36.08% (less sustainable), ecological dimension, the highest index value, was 79,95% (sustainable) and the lowest, social dimensions index was 22.96%(not sustainable).

Keywords: mangrove, sustainability index, Rap-Mforest analysis.

INTRODUCTION

Mangrove forest are one of important component ecosystems for coastal areas. The mangrove forest is a type of tropical forest growing along the coastal areas or estuaries. They are influenced by tides. Mangrove grew on coastal areas that have large estuaries and deltas. These areas are flowed by muddy water. The coastal areas have no estuary, the growth of mangrove forest is not optimal (Kusmana, 2003).

The Indonesia mangrove forests today are facing heavy destruction. Kusmana (2003) stated that the mangrove ecosystem destruction occurred because of the influence of natural factors and human factors. Natural mangrove destruction is due to sedimentation and sea level rise. While human factors such as uncontrolled mangrove exploitation, land conversion to other usage and pollution of estuaries and the mangrove. In addition, according to Dahuri (2001), the threaten factors of mangrove preservation are the rise and sinking land, socioeconomic issues and public awareness.

Mangrove ecosystems also interact with a variety of community activities, especially coastal communities dependent on these ecosystems for their livelihoods (Postenjak, F and Postenjak, K, 2014; Pattimahu, 2016). Mangrove ecosystem conditions located adjacent to residential communities are also increasingly threatened by the increasing demands of mangrove ecosystem uses. Aside from factors of urban expansion indicated above, there is also as growing incidence of overfishing, extraction of wood for fuel and other uses. As this paper will examine, changing ecosystem dynamics are taking place due to multiple stresses that include in coastal residential expansion and community pressures, especially in Dusun Taman Jaya, West Seram Regency.

Environmental conditions due to high human activities in some coastal areas in Dusun Taman Jaya, caused high pressure to mangrove communities. Mangrove communities cannot be survived or tend to decrease in number and finally will be extinct. The problem was a lack of awareness of most people to the role of mangrove communities to the environment, including human life. The mangrove cutting was still occurred, especially in coastal areas close to residential areas. This resulted in a pressure to growth of mangrove communities which affected mangrove forest ecosystem balance. This was characterized by the decreasing density of vegetation and mangrove area.

In optimizing the utilization of mangrove forests, the mangrove forest management needs to meet the criteria of sustainable development that integrates economic and environmental sustainability. Dahuri *et al.* (2001) said that criteria of sustainable development can be grouped into four dimensions namely ecological, social economy, politic and institution. But in this study, the author used only three dimensions i.e. ecological, economic and sosial.

The aim of this study was to determine the sustainability indicators of mangrove forest ecosystem management and to analyze the value of mangrove forest management sustainability in Dusun Taman Jaya, West Seram Regency.

METHODOLOGY

The valuation of the sustainability of existing mangrove forest management system was conducted by Rap-Mforest approach through several stages, namely:

1. Determination of indicator of sustainable mangrove forest ecosystem for each dimension (ecological, economic and social) and multi dimension.
2. Valuation of each indicator in ordinal scale based on sustainability criteria for each factor and ordination analysis based on multidimensional scaling (MDS) method.
3. Synthesizing of the index and the sustainability status of sustainable mangrove forests management in Dusun Taman Jaya, West Seram Regency.

The sensitivity analysis was conducted to identify sensitive indicators in giving contribution to Mforest at the sites. The influence of each indicator was shown in the form change of root mean square (RMS) ordination, especially at the X axis or sustainability scale. To evaluate the error effect in estimating process of ordination value of mangrove forests management used Monte Carlo analysis (Kavanagh and Pitcher, 2004).

In general, the method of Rap – Mforest will begin by reviewing indicators of mangrove forest ecosystem sustainability through literature studies and field observations. The next stage is scoring based on the defined provisions in the Rap-Mforest. After obtaining scores, each indicator was analyzed using multidimensional Scaling (MDS) to determine the relative position of mangrove forests management in good and bad ordinations.

The next step was to analyze the value of stress by using ALSCAL logarithm. From the ordination results of MDS and the value of stress through ALSCAL logarithm, rotation was conducted to determine the position of the mangrove forest ecosystem management in bad and good ordinations. The next step was to determine uncertainty aspects by applying Monte Carlo analysis and to determine the anomalous aspects of analyzed indicators by using leverage analysis.

RESULTS

Sustainability Status of mangrove Forest Management.

Valuation of the sustainability status of mangrove forest management in Dusun Taman Jaya, was performed by Rapid Appraisal Analysis of status for Forestry Mangrove (Rap-Mforest). This analysis will result an index value of the sustainability status of mangrove forest management in each dimension of ecological, economic and social. Each dimension has a sustainability indicator that reflects the status of the relevant dimension. The index value includes the index value of each dimension and multi-dimension sustainability

status which reflected existing mangrove forest ecosystem management in Dusun Taman Jaya.

By Rap-Mforest analysis, the value of sustainability index for multi-dimension was 36.08, classified into less sustainable status, ecological dimension was 79.95, sustainable status; economic dimensions was 33,56, less sustainable status and social dimensions was 22.96, unsustainable status. To increasing these index values until reaching sustainable status, the some efforts are needed to improve sensitive indicators those affected index value of economic and social indices. Indicators are valued by experts based on the existing condition of mangrove forests.

Multi-Dimension Sustainability Stastus

Rap-Mforest analysis results of multi-dimension sustainability of mangrove forest ecosystem management in Dusun Taman Jaya, showed sustainability index value was 36.08, categorized into less sustainable status. This value was obtained based on the valuing of 22 indicators of three dimensions of sustainable development. Multi-dimension analysis results by Rap-Mforests showed in Figure 1.

Sensitive indicators which contributed to index value of multi-dimension sustainability based on leverage analysis were 7 indicators, namely: (1) community niche structure, (2) habitat diversity change, (3) mangrove utilization inventory, (4) mangrove land use zonation, (5) stakeholders participatory, (6) forets resources destruction by people and (7) access of local community to mangrove forest. These indicators were needed to be improved in the future to improve the sustainability status of mangrove forest ecosystem management. Related improvement efforts were needed to increase the indicator capacity which has positive impact in improving the sustainability index values and vice reducing possibly potential indicators which decreased the value of sustainability index.

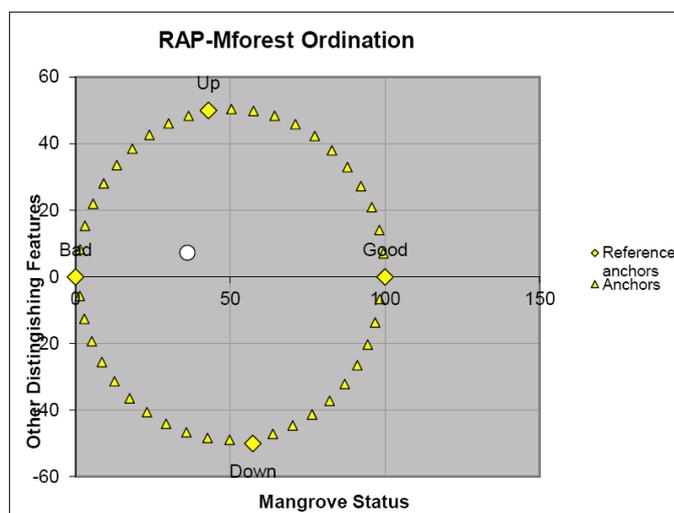


Figure 1: Rap-Mforest Analysis of value of mangrove forest Management Sustainaibility Index.

Some statistical parameters were obtained from Rap-Mforest analysis by MDS method functioned as a standard method to determine the feasibility of the study results in the study area table 1 showed the stress values and determination coefficient (R²) for each dimension and multi – dimension.

Table 1: Rap-Mforest Analysis Results for Statistical Parameter

Statistic value	Multi-dimension	Ecological	Economic	Social
Stress	0,13	0,14	0,13	0.14
R ²	0.95	0,95	0,95	0.93
Iteration number	2	2	2	2

Monte Carlo analysis results did not change index value of multi-dimension and each dimension. The result of Monte Carlo analysis showed the value of sustainability index of mangrove forest ecosystem management in Dusun Taman Jaya in Table 2. Difference of sustainability index values of Rap-Mforest analysis and Monte Carlo showed in table 2 below.

Table 2: Difference of sustainability index values of Monte Carlo and Rap-Mforest analysis

Dimension	Rap-Mforest analysis (%)	Monte Carlo analysis (%)	Difference (%)
Ecological	79.95	77.83	2.12
Economic	33.56	33.18	0.38
Social	22.96	25.01	2.05
Multi-dimension	36.08	37.97	1.89

Sustainability status of ecological dimension

Based on figure 2, the value of sustainability index of ecological dimension was 79.95 % categorized into sustainable status. Indicators affected the ecological dimension consisted of six indicators, namely: (1) food chain and ecosystem, (2) water quality change, (3) population size and demographic structure, (4) mangrove forest diversity level, (5) communities niche structure and (6) habitat diversity change.

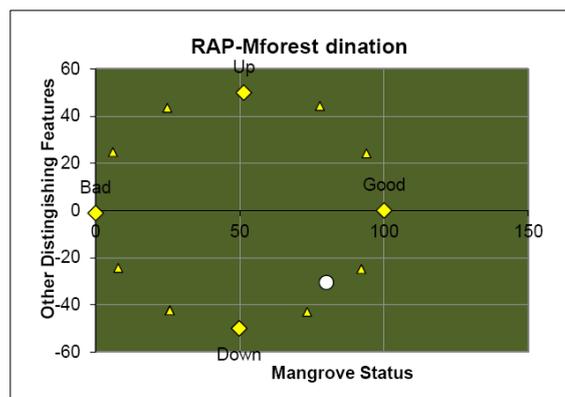


Figure 2: Rap-Mforest Analysis of Value of Sustainability Index of Ecological Dimension

Leverage analysis was to evaluate sensitive indicator contributed to values of ecological dimension sustainability index. Figure 2 showed all indicators of ecological dimension have relatively similar sensitivity in their role towards sustainability index values. Based on leverage analysis obtained two sensitive indicators to values of ecological dimension sustainability index, namely, (1) communities niche structure, and (2) habitat diversity change.

Community niche structure showed the changing can be seen from the change of relative abundance on seedlings and saplings of canopy-forming trees of mangrove forests in comparison with undisturbed mangrove forests by human activity. Besides, the abundance of certain bird groups only is partially maintained within their natural variation.

Another indicator to be considered is habitat diversity change. The occurrence of habitat diversity change in the mangrove forest was characterized by wide openness of tree canopy due to human activities. Various human activities conducted in the mangrove forest areas to meet their daily needs, such as illegal logging for firewood and other needs. People also did conversion of mangrove land to other usage. Population growth rate increased from 0.62 % in 2016 to 0.80 % in 2017 followed by the increasing human needs caused increasing human activities to utilize the mangrove forest to meet their needs. This contributed to forest damage.

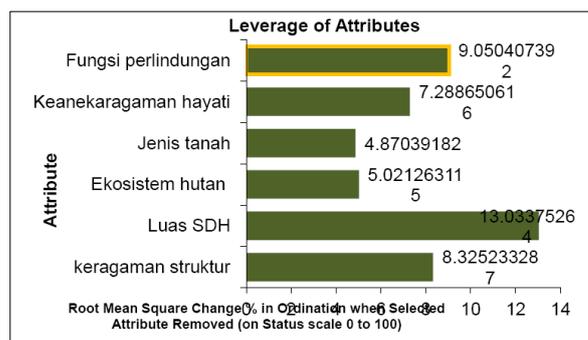


Figure 3: Sensitivity analysis result of Ecological dimension of mangrove forest management

Sustainability Status of Economic Dimension.

Based on figure 4, the value of sustainability index of economic dimension was 33.56 %, categorized into less sustainable. Indicators were expected will affect the degree of sustainable economic dimension consisted of seven indicators: (1) the role of mangrove to regional development, (2) results of mangrove forest utilization inventory (3) mangrove forest rehabilitation, (4) mangrove land use zonation, (5) stakeholder participation, (6) mangrove forest management planning, (7) mangrove utilization by people.

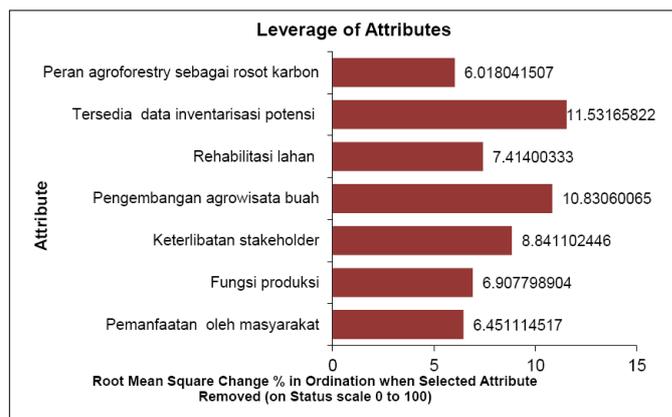


Figure 5: Sensitivity Analysis Result of Economic Dimension of Mangrove Forest Management.

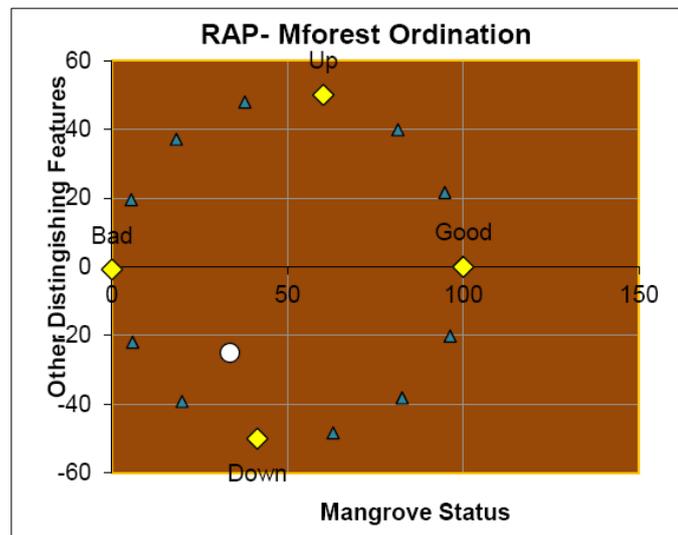


Figure 4: Rap-Mforest Analysis of Value of Sustainability Index of Economic Dimension.

Based on leverage analysis results in figure 5, there are three sensitive indicators to economic dimension of sustainability index, namely: (1) mangrove utilization inventory, (2) mangrove land use zonation and (3) stakeholders participatory. Indicator needed to be considered was not available at the sites. The absence of local regulation about management of mangrove forests in Dusun Taman Jaya caused illegal utilization of mangrove by people to fulfill their needs. However, in the framework of sustainable mangrove forests management, the local government especially authorized offices should prepare mangrove utilization inventory data.

The unavailability of mangrove land use zonation in the study site was one of the considered indicators. This was important in avoiding land use conflicts. Therefore, to more enhance the sustainability status, zonation was needed for various purposes of mangrove forest management. Other sensitive indicator was stakeholder participatory. The result showed that generally only people acted in utilizing mangroves for their benefits.

The government role was not significant in the utilization of mangrove at the sites. To enhance sustainability status, improvement efforts needed to be applied to the sensitive indicators to give effect to the economic dimension of sustainability index. But, other insensitive indicators based on leverage analysis also needed serious consideration to be managed. Effort needed to do was to improve or to maintain the indicators which have positive impact on improving the sustainability of the economic dimension. The indicators needed to be maintained were (1) the role of mangrove for regional development and (2) mangrove utilization by people. In accordance with the results of economic analysis, the value of direct benefit of mangrove to people, the usage of mangrove for fishery sectors can improve people's income so that it also influence the level of welfare.

Sustainability Status of Social Dimension

Figure 6 showed value of sustainability index of social dimension was 22.96 %. It was classified into not sustainable. Indicators affected the level of social dimension sustainability were (1) public participation in the management to mangrove forest, (2) people knowledge about the mangrove forest, (3) the relationship patterns among stakeholders, (4) forest resources destruction caused by people, (5) public education levels, (6) public awareness about the importance of mangrove forests, (7) access of local people to mangrove forest, (8) coordination among government agencies, (9) policy and forest management planning.

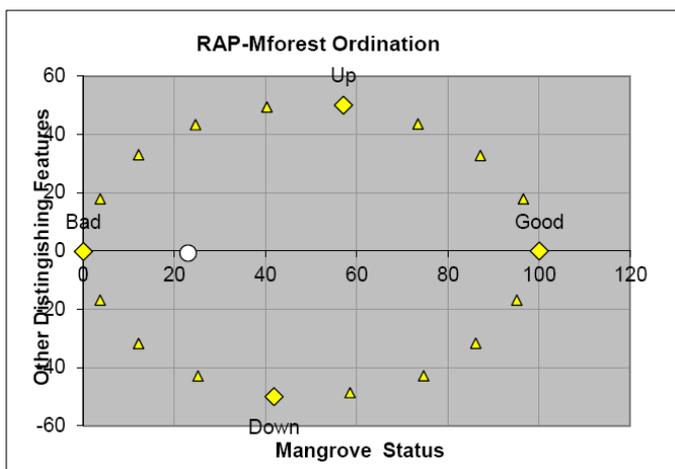


Figure 6: Rap-Mforest Analysis of Value of Sustainability Index of Social Dimension

Based on Leverage Analysis, two sensitive indicators of sustainability index of social dimension, namely : (1) forest resources damage caused by local community and (2) access of local people to mangrove forest. Leverage analysis result in figure 7.

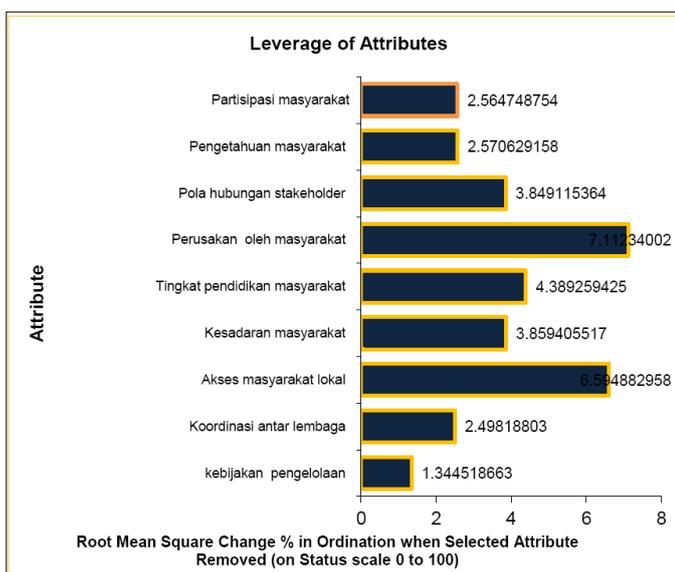


Figure 7: Sensitivity Analysis Result of Social Dimensions of Mangrove Forest Management.

Pattimahu (2016) stated that forest resources destruction by local community due to trees logging for firewood and other needs. This logging caused opening forest. Local people's access to mangrove resources was high. This was indicated by the high mangrove forest usage by the people for getting timber forest products and fishery products, such as : fish, crabs and shrimps.

CONCLUSION AND SUGGESTION

Conclusion

Based on Rap-Mforest analysis, value of multi-dimension index of mangrove forest ecosystem management was 36.08% (less sustainability scale of 0-100. Ecological dimension, the highest index value, was 79.95% (sustainable), economic dimension was 33.56% (less sustainable) and the social dimension, lowest value, was 22.96% (unsustainable). Thus, the RapM-forest method, modified from Rapfish, could be applied in formulating the sustainable management policy of mangrove forests in Dusun Taman Jaya.

Suggestions

1. In order to get the detailed sustainability value of mangrove forest resources, data and information including a more detailed valuation of mangrove forest resources are needed.
2. The detailed and systematic economic valuation of mangrove forest resources are needed so that it can be used as reference in making decisions regarding mangrove forests management in Dusun Taman Jaya, West Seram Regency , Maluku.

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