THE SUSTAINABILITY STATUS OF THE MANGROVE ECOSYSTEM MANAGEMENT IN THE COASTAL AREA OF BOALEMO GORONTALO

Yulinda Antu[1)], Ramli Utina[2)], Abdul Hafidz Olii[3)]
[1)]Postgraduate Program of Fisheries and Marine Science Gorontalo State University
[2)]Faculty of Mathematics and Natural Sciences Gorontalo State University
[3)]Faculty of Fisheries and Marine Science Gorontalo State University

ABSTRACT

This study aims to analyze the sustainability status of the mangrove ecosystem management in the coastal areas of Boalemo Gorontalo. The methods used are surveys and interviews. The data analysis used in this study is Rap-MpForest. There are 11 types of mangrove in Boalemo i.e. Rhizophora mucronata, Rhizophora apiculata, Rhizophora stylosa, Sonneratia alba, Sonneratia casseolaris, Ceriops decandra, Ceriops Tagal, Avicennia Lanata, Xylocarpus granatum, Excoecaria agalocha, *and* Brugiera Gymnoriza. *The sustainability status of the mangrove ecosystem management in Boalemo is based on the attributes of the following dimensions: the ecology dimension with a category of "fairly sustainable", the social dimension with a category of "highly sustainable", the economic dimension with a category of "less sustainable", and the institution dimension with a category of "less sustainable".*

Keywords*:* *Mangrove Ecosystem Management, Rap-MpForest, Sustainability Status*

INTRODUCTION

Mangrove is an important chain managing the biological cycle balance in water due to its functions as the spawning ground, nursery ground, and feeding ground of various highly profitable aquatic animals. Besides, mangrove builds an area functional to humans both now and in the future (Kordi, 2012). Due to the important functions of mangrove, management to retain the coastal ecosystem balance is thus needed.

Mangrove ecosystem is one of the highly used coastal resources. The coastal community, in the attempt to fulfill their daily needs, relies on the mangrove ecosystem. However, the potency of the mangrove ecosystem continues to decrease due to mangrove forest transfer into fishponds, settlement, and industries and excessive logging.

Gorontalo has a mangrove forest area of ± 12.74 Ha (Department of Forestry and Plantation in Gorontalo Utara, 2005 in Usman, 2013). One of the potential coastal areas in terms of the mangrove ecosystem is in Boalemo. BP-DAS Bone Bolango (2007) in Sahami (2008) reports that the area of mangrove ecosystem in Boalemo was 2,762.60 Ha. Meanwhile, based on BPS data 2016, the area of the mangrove ecosystem in Boalemo was ±1,706.02 Ha. Based on an interpreting study of land cover and changes in the area of mangrove forest in the coastal area of the Gulf of Tomini, the area of mangrove forest in Boalemo continues to decrease year by year due to the developing strategies to coastal areas that do not refer to the local regulation.

Furthermore, the stakeholders and the surrounding community have some different arguments on the status of the mangrove area. Despite many efforts made by the government and community in terms of mangrove ecosystem management, the output of the efforts is insignificant. The study of mangrove ecosystem management sustainability in Boalemo is thus crucial.

RESEARCH METHODOLOGY

The study is conducted in the mangrove area that covers five sub-districts in Boalemo Gorontalo. The study was started in August 2019 and finished in January 2020. Figure 1 indicates the map of the study location.

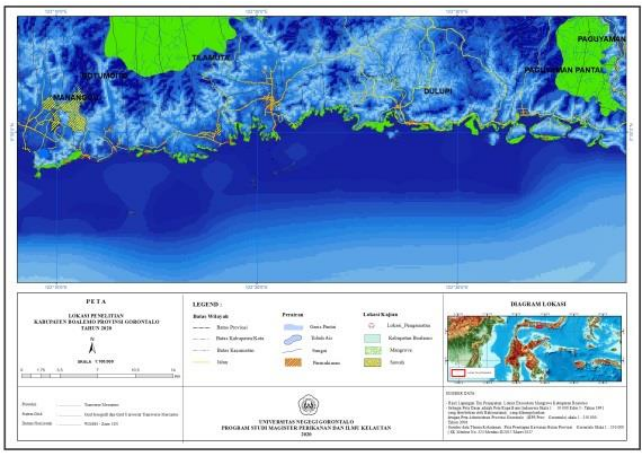

Figure 1. Map of Study Location

The ecologic characteristics observed are the types of mangrove, the number of mangrove stands, and environmental parameters. The observation uses a line transect by determining a quadrant at the respective observation station and drawing a line transect from the sea to the land (perpendicular to the coastline) (Figure 2). Three square plots at the size of 10×10 m are systematically put along the line transect (Hartoko *et al*., 2014).

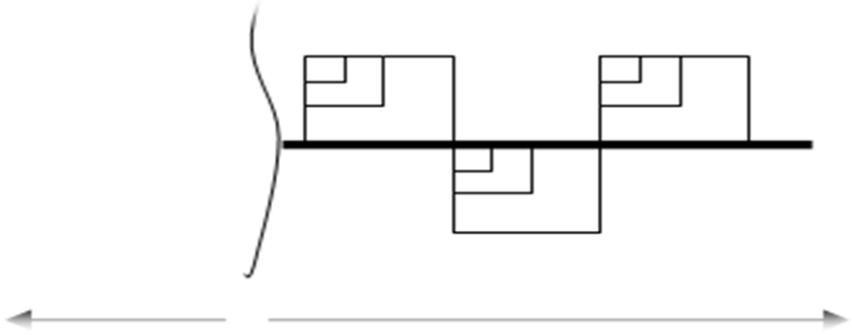

Figure 2. Design of Transect

Sampling to acquire information and knowledge (the acquisition of experts' arguments) is conducted purposively (purposive sampling). Experts selected to be respondents have to meet these following criteria:

1. The expert should be present and willing to act as a respondent.
2. The expert has some reputation, position/status, and credibility as an expert in the field being studied.
3. The expert has relevant experience.
4. The expert has relevant experience with the expertise required.
5. The expert has good knowledge of the condition and the sustainability issue regarding the mangrove ecosystem in Boalemo.

Table 1. The Number of Respondents/Experts in Rap-MpForest

No.	Respondent/Expert	Number
1	Department of Forestry and Plantation in Boalemo	1
2	Department of Marine Affairs and Fisheries	1
2	Fisheries extention services	4
3	Public figures	3

The data analysis technique used to evaluate the sustainability of mangrove ecosystem management in Boalemo is Rap-MPforest (Rapid Appraisal of the Status for Mangrove Protection Forest) (Karlina *et al*., 2016). Rap-MPforest is an adjusted RAPFISH (Rapid Appraisal of Fisheries) method. This analysis is one of the analyses to evaluate the sustainability status of the capture fisheries developed by Fisheries Center, University of British Colombia (Kavanagh, 2001; Pitcher & Preikshot, 2001; Cisse *et al*., 2014). It comprises Multidimensional Scaling (MDS) analysis, Monte Carlo analysis, and Leverage analysis. RAPFISH is a statistic method to show the sustainability status accurately and quickly. It simplifies multidimensional attributes (Hasan *et al*., 2011).

The steps taken to examine sustainability using Rap-MPforest are:

1. Determining attributes of the sustainability dimensions through literature study, discussion, and field research.
2. Evaluating the attributes/criteria of the sustainability dimensions using questionnaires.
3. Evaluating the sustainability status through an ordination/anomaly analysis (Monte Carlo analysis) (Schaduw, 2015) (Figure 3).

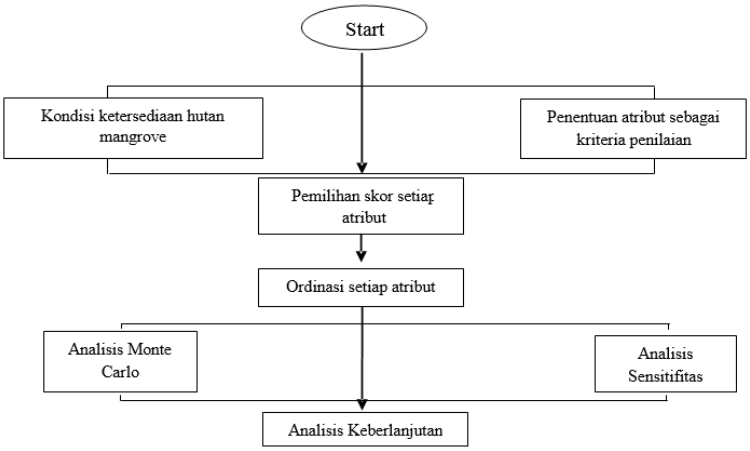

Figure 3. Rap-MPforest

(Source: Theresia, 2016)

The index scores of mangrove ecosystem management sustainability are grouped into the four levels of sustainability status (Table 3). The index score of the respective dimension is indicated in the form of a kite diagram. A leverage analysis is used to investigate the score of the attributes that sensitively affect the score of mangrove ecosystem management sustainability. Changes in the Root Mean Square (RMS) scores are the scores found in the final leverage analysis. The higher the changes in RMS score, the more sensitive the attribute in elevating the sustainability status of mangrove forest management. The leverage factors are the attributes that reach the highest score-the mid score (Karlina *et al*., 2016).

Table 2. Index Score of Mangrove Ecosystem Management Sustainability

Index Score	Category
0 – 25 %	Poor
25 – 50 %	Less
50 – 75 %	Fair
75 – 100 %	Good

(*Source: Theresia, 2016)*

FINDINGS AND DISCUSSION

Based on the study in Boalemo, there are 11 types of mangrove found i.e. *Rhizophora mucronata, Rhizophora apiculata, Rhizophora stylosa, Sonneratia alba, Sonneratia casseolaris, Ceriops decandra, Ceriops Tagal, Avicennia Lanata, Xylocarpus granatum, Excoecaria agalocha, Brugiera Gymnoriza* spread in five sub-districts. The types of mangrove found at the respective station are listed in Table 3.

Table 3. Types of Mangrove in Boalemo

No.	Type of Mangrove	Paguyaman Pantai	Dulupi	Tilamuta	Botumoito	Mananggu
1	*Rhizophora mucronata*	+	+	+	+	+
2	*Rhizophora apiculata*	+	+	+	+	+
3	*Rhizophora stylosa*	+	+	-	+	+
4	*Sonneratia alba*	+	+	+	+	+
5	*Sonneratia casseolaris*	-	-	-	-	+
6	*Ceriops decandra*	+	+	-	-	+
7	*Ceriops Tagal*	+	+	+	+	+
8	*Avicennia Lanata*	+	+	+	-	+
9	*Xylocarpus granatum*	-	+	-	-	-

10	*Excoecaria agalocha*	-	-	-	-	+
11	*Brugiera Gymnoriza*	-	+	-	-	-
Total		**7**	**9**	**5**	**5**	**9**

(Source: Processed data of this study, 2019)

Sustainability of the Mangrove Ecosystem Management in Boalemo

The sustainability status of the mangrove management in Boalemo is based on several attributes of the respective dimension. The sustainability score of the respective dimension is 52 (ecology), 81.24 (social), 25.78 (economy), and 49.12 (institution), as depicted in Figure 4.

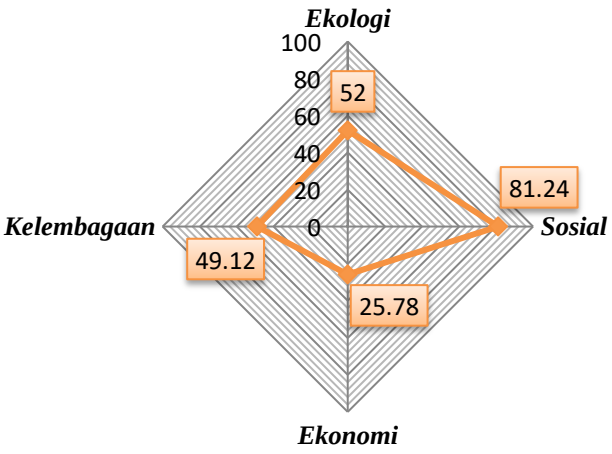

Figure 4. Sustainability Status of Mangrove Management in Boalemo

Based on the sustainability criteria, the ecology, social, economy, and institution dimension is categorized as "fairly sustainable", "sustainable", "less sustainable", and "less sustainable" respectively (Theresia, 2016). It indicates that the social dimension is the only sustainable dimension in Boalemo. The sustainability score reflects that the community of Boalemo gives the best support to mangrove management. It is in line with Parawansa (2007) that in mangrove forest management, the local community engagement should be retained. The community's access to the distribution of the benefits of mangrove, either direct or indirect, should also be maintained to increase the community welfare. It will raise community awareness of the urgency of mangrove management.

1. Ecology Dimension

Based on Rap-MPforest of the ecology dimension, we acquire an index score of sustainability of 52%, clarifying that the sustainability status in terms of the ecology dimension is "fairly sustainable". The indicators of the ecology dimension in the strategy for the mangrove ecosystem management in Boalemo are the vegetation type of mangrove, mangrove density, the diversity of mangrove species, the quality of waters, mangrove planting activities, and the number of mangrove fauna (Figure 5).

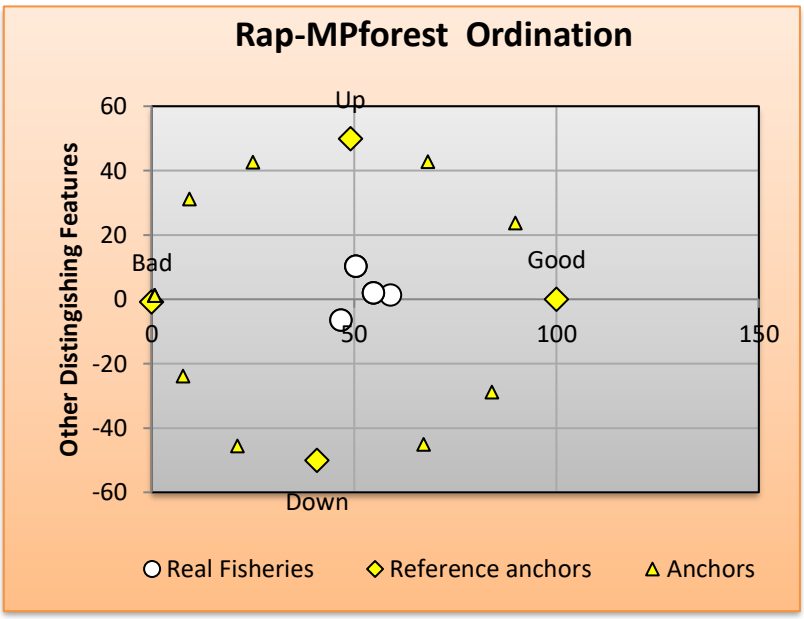

Figure 5. Rap-MPforest and the Leverage Analysis of Sustainability Status in Terms of the Ecology Dimension

Referring to the leverage analysis illustrated in Figure 5, the most sensitive attributes that affect the sustainability score in terms of the ecology dimension are the quality of waters (5.9155) and mangrove planting activities (5.6258). Despite their "fairly sustainable" status, the two attributes should be improved to retain or increase the sustainability score of the mangrove management in Boalemo. Furthermore, the mangrove planting activity is one of the leverage attributes of the sustainability of the ecology dimension. According to the survey on and the interview with the community of Boalemo, mangrove planting activities have been implemented by the government, non-government organizations, and the community itself. Nevertheless, the sustainability of mangrove maintenance and improvement is still considered insufficient. Evidently, in some mangrove rehabilitation areas, we can see abnormally grown mangroves. That condition should be paid more attention to retain the sustainability of mangrove management in Boalemo. Theresia (2016) argues that the rehabilitation activities are aimed to earn profits in the form of a fee paid for mangrove planting activities although the community has a good understanding of the urgency of mangrove in humans' life.

2. Social Dimension

Based on Rap-MPforest of the social dimension, we acquire an index score of sustainability of 81.24%, clarifying that the sustainability status in terms of the ecology dimension is "sustainable". The indicators of the social dimension in the strategy for the mangrove ecosystem management in Boalemo are the educational level, livelihoods, perception of mangrove, community engagement in mangrove management, the community's elevated knowledge of mangrove, and conflicts in mangrove utilization (Figure 6).

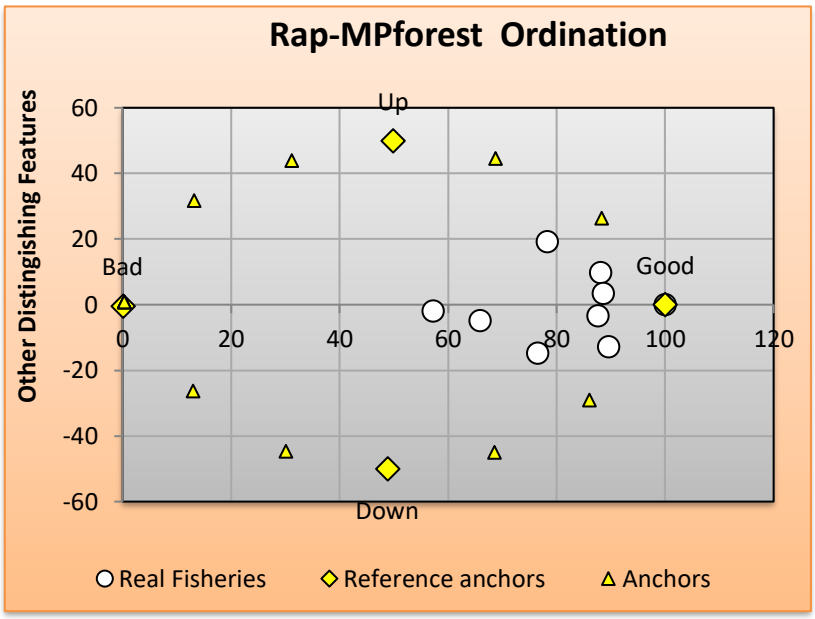

Figure 6. Rap-MPforest and the Leverage Analysis of Sustainability Status in Terms of Social Dimension

Based on Rap-MPforest, the social dimension has a good sustainability score and is thus categorized as "sustainable". Despite its good score, the dimension should be maintained. Referring to the leverage analysis illustrated in Figure 6, the most sensitive attributes that affect the sustainability score in terms of ecology dimension are the perception of mangrove (6.3911) and the community's elevated knowledge of mangrove (6.1818). The community's perception and knowledge are two important aspects contributing to mangrove preservation. Muhsimin *et al*. (2018) argue that direct community engagement in development activities constitutes a crucial social interaction in determining success. Meanwhile, community engagement in mangrove forest management is affected by the community's awareness of the urgency of preservation. Besides, the community empowerment is not merely the developed object anymore but also a subject to the community-based mangrove management. In other words, the community's perception and knowledge are important for sustainable mangrove management.

3. Economy Dimension

Based on the Rap-MPforest of the economy dimension, the index score of sustainability is 25.78%. The score clarifies that the sustainability status in terms of the economy dimension is categorized as "less sustainable". The indicators of the economy dimension in the strategies to mangrove ecosystem development in Boalemo are the surrounding community's average income, the types of the direct usability of mangrove to the community, the economic value of mangrove ecosystem to the community, the job opportunity in the zone of mangrove usability, the amount of production at the mangrove forest area, and other incomes (Figure 7).

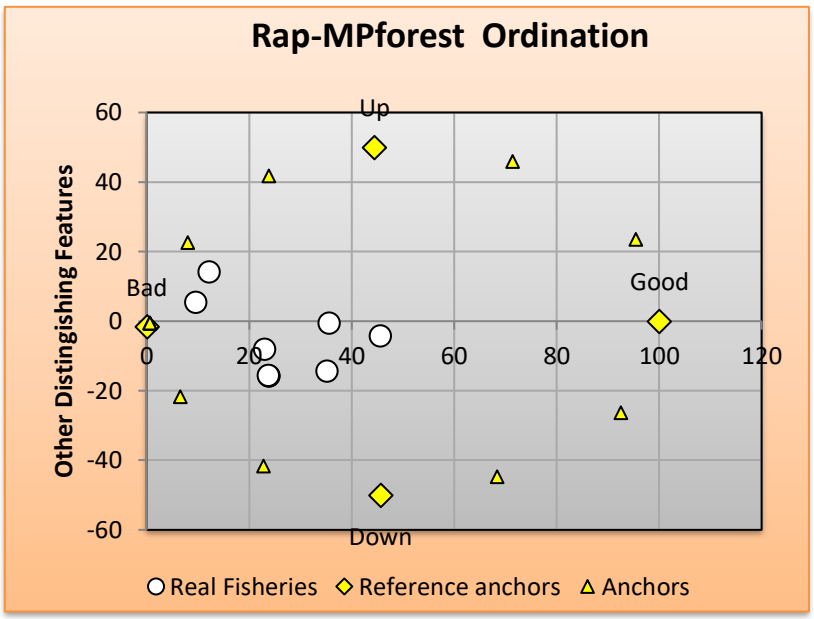

Figure 7. RAPFISH and the Leverage Analysis of Sustainability Status in Terms of Economy Dimension

Referring to Rap-MPforest, the economy dimension is the only dimension with a "less sustainable" mangrove management status. It implies that the dimension should be improved. Based on the leverage analysis indicated in Figure 7, there are two most sensitive attributes that affect the sustainability score in terms of the economy dimension are the economic value of the mangrove ecosystem to the community (7.4827) and the amount of production at the mangrove area (7.4296). The two attributes are thus should be more prioritized to realize sustainable mangrove management. The economic value of mangrove ecosystem to the community characterize to what extent the community uses mangrove ecosystem in their life; while the amount of production at mangrove areas is an increase in the production of the cultivated variants of mangrove. Based on the field survey, the majority of the community has not understood how to use mangrove ecosystems well and only a few people cultivate the variants of mangrove.

4. Institution Dimension

Based on the Rap-MPforest of the institution dimension, we acquire an index score of sustainability of 49.12%. The index score confirms that the sustainability status in terms of the institution dimension is categorized as "less sustainable". The indicators of the institution dimension in terms of the strategy for mangrove ecosystem management in Boalemo the compliance with the management, thorough management regulations, mechanisms in decision-making, management plan, the level of synergism and institution in management, and the capacity of stakeholders (Figure 8).

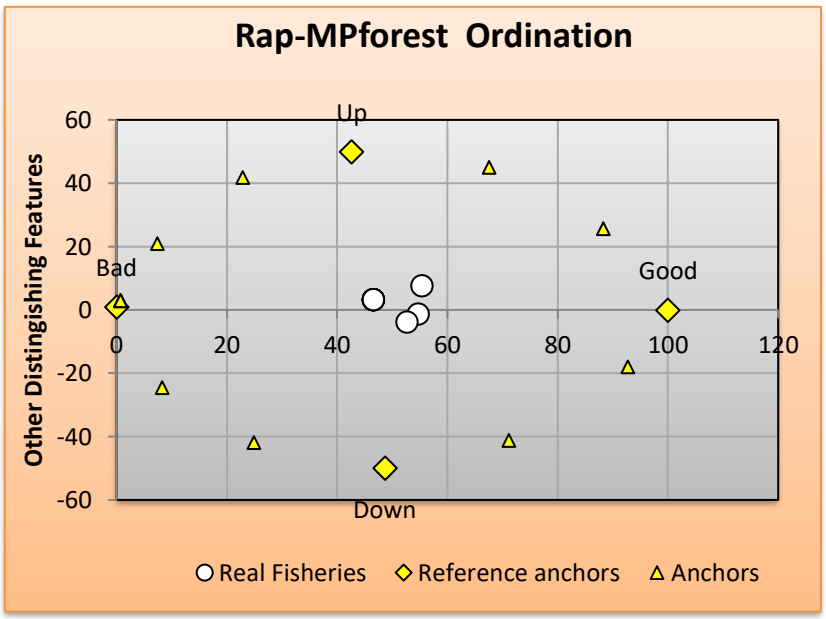

Figure 8. RAPFISH and the Leverage Analysis of the Sustainability Status in Terms of Institution Dimension

Based on the leverage analysis as shown in Figure 8, there are two most sensitive attributes that affect the sustainability score in terms of the institution dimension i.e. the mechanism of decision making (3.2553) and the level of synergism and institution in management (2.9307). Therefore, the two attributes should be improved. Muhsimin *et al*. (2018) conclude that a sustainable mangrove ecosystem management is a complex effort now that it is very accommodative and demands a synergized cooperative mechanism between stakeholders representing their organization to run a sustainable mangrove management activity well.

REFERENCES

Cisse, A.A., Blancvhard, F., and Guyader, O. 2014.Sustainability of tropical small –scale Fisheries: Integreted assessment in French Guina. Marine Poliy, 44, 397-405.

Hartoko A., Siska C., Dewati A. F., Dafit A.S. 2014. *Carbon Biomass Algorithms Development for Mangrove Vegetation in Kemujan, Parang Island Karimunjawa National Park and Demak Coastal Area–Indonesia*. Journal Procedia Environmental Sciences 23 (2015) 39– 47.

Hasan. M, SaPei A, Purwanto J., and Sukardi 2011. Kajian Kebijakan Pengelolaan Sumberdaya Air pada Daerah Aliran Sungai Citarum. Jurnal Sumber Daya Air, 7(2), 105-118.

Karlina, Kusmana, Marimin and Bismark 2016. Analisis Keberlanjutan Pengolahan Hutan Lindung Mangrove di Batu Ampar Kabupaten Kubu Raya Provinsi Kalimantan Barat. Jurnal Analisis Kebijakan, Vol. 13 No. 3 December 2016: 201-219 ISSN 0216-0897.

Kavanagh P. 2001 RAPFISH Sofware Description (for Microsoft Excel). Rapid Apprasial of Fisheries Project. Fisheries Centre University of British Columbia.

Kordi, K.M.G.H, 2012, *Ekosistem Mangrove: Potensi, Fungsi, dan Pengelolaan.* Rineka Cipta: Jakarta.

Muhsimin, Nyoto S. and Hariyadi 2018. Muhsimin Status Keberlanjutan Pengelolaan Ekosistem Mangrove di Wilayah Pesisir Desa Akuni Kecamatan Tinanggea Kabupaten Konawe Selatan. Jurnal Silvikultur Tropika Vol. 09 No. 1, April 2018, pp. 44-52.

Parawansa, I. 2007. Pengembangan Kebijakan Pembangunan Daerah dalam Pengelolaan Hutan Mangrove di Teluk Jakarta secara Berkelanjutan. Dissertation. Bogor (ID): Institut Pertanian Bogor.

Pitcher, T.J., and Preikshot, D. (2001). RAPFISH: A rapid appraisal technique to evaluate the sustainability status of fisheries. *Fisheries Research, 49*(3), 255-270.

Sahami, 2008. *Assesment Mangrove di Kabupaten Boalemo dan Kabupaten Pohuwato Provinsi Gorontalo.* Laporan Penelitian. Sustanable Coastal Livelihoods, and Management (SUSCLAM). Gorontalo.

Theresia, Boer M., Pratiwi N.T.M, 2015. *Status keberlanjutan pengelolaan ekosistem mangrove di Taman Nasional Sembilang Kabupaten Banyuasam*. Provinsi Sumatera. Jurnal Ilmu dan Teknologi Kelautan Tropis. Vol. 7 No. 2 December 2015. Faculty of Fisheries and Marine Science, IPB University, Bogor

Usman, 2013 *Analisis Vegetasi Mangrove di Pulau Dudepo Kecamatan Anggrek Kabupaten Boalemo*. *Undergraduate thesis*. Gorontalo: Aquatic Resources Management Program. Department of Fisheries Technology. Gorontalo State University.