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Species composition and utilization patterns of mangrove in the district of jailolo west halmahera province of north mollucas, indonesia

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ABSTRACT

The purpose of this study was to determine the species composition of mangrove forest and the pattern of mangrove wood utilization by fishermen communities in the coastal areas of Jailolo District, West Halmahera. The data collection had been carried out by observation and interviews. Data analysis of the interview technique had been carried out by the percentage technique, while data analysis of mangrove forest observation had been carried out based on the parameter of vegetation density, dominance, frequency, and importance value index (IVI).

Research result showed that composition of mangrove forest of this area consists of: *Rhizophora apiculata* (IVI = 7.9), *Bruguiera gymnorrhiza* (IVI= 5,2), *Xylocarpus moluccensis* (IVI = 1,9), *Osbornia octodonta* (IVI = 3,7), *Sonneratia caseolaris* (IVI = 24.5), *Avicennia lanata* (IVI = 36.4), and *Finlaysonia maritime* (IVI = 20.4). The utilization patterns of those species will be described further. The species of mangrove forest most widely used as firewood are *R. apiculata*, while used as a building and house materials, and as poles at the ports are *B. gymnorrhiza*, as well as being used for boat constructing are *X. moluccensis* and *O. octodonta*. Based on IVI above, it is necessary to conduct conservation of the mangrove forest soonly.

KEYWORDS

Mangrove forest;
Vegetation parameters;
Coastal ecosystem;
Xylocarpus moluccensis;
Osbornia octodonta;
Bruguiera gymnorrhiza.

INTRODUCTION

Jailolo is one district area located in Western Halmahera of North Mollucas Province. The total area of North Mollucas is 2,755 km^2, while its sea area is 11623.42 km^2; this region faces directly to the Mollucas Sea in the north direction and the Pacific Ocean in the south direction. Jailolo is the capital of West Halmahera regency; the total population of this regency is 94,645 people, consisting of 48.979 men and 45.666 women (BPS District Halmahera 2011).

Most people of West Halmahera regency live in coastal areas and some live in inland areas. Therefore the coastal zone is more widely utilized than the in the land zone. The people who live in the coastal areas are fishermen, and who live in inland areas are generally peasands (Halbar 2010).

The coastal area of West Halmahera regency has great potency of mangrove. Data of the mangrove forest area had been obtained from *Landsat 7 ETM* + in

2010 conducted by the Center for Watershed Management (BP DAS) Ake Malamo. Based on the data mangrove forest area amount to 12-20% of the total areas of mangrove forest in the Province of North Mollucas. It is estimated that mangrove forest in the District of Jailolo area is approximately 625 hectares[2].

Interview results conducted on some families who live as fishermen about the utilization patterns of mangrove wood, showed that mangrove woods had been utilized as firewood, house construction materials, boat body, as well as other parts of it, and poles supporting the harbor bridges. Such mangrove wood utilization had significantly reduced the density of mangrove vegetation in this area.

Conversion of mangrove forests to other functions along the coastal area in the Province of North Mollucas had been occurent long time ago. Based on the results of direct field observation, there were indications that the pressure on other mangrove areas in The Province of North Mollucas would increase. There are some indications related to the pressure increase is the increase of society growth around this area, and the rate increase of urban development as well as housing; the other factors such as high price of fuel will also increase the utilization of firewood by the people, as well as there are low concern of the local government and people to the sustainability of mangrove forest.

Based on survey conducted in 2012 in the District of Jailolo, it had been uncovered that mangrove forests area had decreased to 533 hectares only. It is clearly seen that during the 2 years, the mangrove forest area in this district had decreased up to 92 hectares. The reduction is caused by various factors especially by the increase of people activities around the mangrove forest area.

Fishermen people utilize mangrove wood of various species, as well as of various age, height of the trees and even of the tree trunk circles. Because of continuous use of this forest, there is certain type of mangrove such as *X. moluccensis* formerly found abundantly in this area, and also known as a typical mangrove species in Mollucas, right now was going to decrease in density and someday will run out.

MATERIALS & METHODS

The method used in this study was survey supported by observation and interview techniques. The survey supported by observation had been conducted to determine the species composition of mangrove forest based on reference of the Handbook of Introduction to Mangrove in Indonesia[10], as well as to obtain data of vegetation parameters such as density, dominance, frequency, and Importance Value Index (IVI) of each mangrove species. The survey supported by interviews had been conducted to obtain the pattern of mangrove wood utilization by the local fishermen people.

Target population of this interviews was 116 families. Of these families, only about 40 families were active fishermen, while the others were farmers and entrepreneur. This study then used 40 families of active fishermen as the samples. Several questions asked in the interviews including occupation, education level and utilization patterns of mangrove forest.

Data analysis related to vegetation parameters such as density, dominance, frequency, and Importance Value Index (IVI) refer to the formula of Krebs[9], will be indicated further.

Relative density

$$= \frac{number\ individuals\ of\ a\ species}{total\ individuals\ of\ all\ species} x\ 100$$

Relative frequency

$$= \frac{frequency\ of\ a\ species}{sum\ of\ frequency\ values\ for\ all\ species} x\ 100$$

Relative dominance

$$= \frac{basal\ area\ of\ a\ species}{total\ basal\ area\ of\ all\ species} x\ 100$$

Importance Value Index of a species (x) = relative density + relative frequency + relative dominance of species x

Data analysis related to the patterns of mangrove wood utilization had been conducted by percentage.

RESULTS & DISCUSSIONS

Determination of species and parameter measurement of mangrove vegetation in the district of jailolo, west halmahera

There are 7 species of mangrove that grow in mangrove forests in this coastal area, as presented on TABLE 1. Results of data analysis of mangrove vegetation parameters are presented in TABLE 2.

TABLE 1 : The 7 species of mangrove in district of jailolo, west halmahera

Kingdom	Class	Order	Family	Genus	Species	Local name
Plantae	*Angiospermae*	*Malpighiales*	*Rhizophoraceae*	*Rhizophora*	*Rhizophora apiculata Blume.*	*Soki*
	Angiospermae	*Malpighiales*	*Rhizophoraceae*	*Bruguiera*	*Bruguiera gymnorrhiza (L.) Lam.*	*Dao*
	Angiospermae	*Sapindales*	*Meliaceae*	*Xylocarpus*	*Xylocarpus moluccensis (Lam.) M.Roem.*	*Buah Kira-Kira*
	Angiospermae	*Myrtales*	*Myrtaceae*	*Osbornia*	*Osbornia octodonta F.v.M.*	*Baru-Baru*
	Angiospermae	*Myrtales*	*Lythraceae*	*Sonneratia*	*Sonneratia caseolaris (L.) Engl.*	*Posi-Posi*
	Angiospermae	*Lamiales*	*Acanthacea*	*Avicennia*	*Avicennia lanata (Ridley)*	*Sia-Sia*
	Angiospermae	*Asclepiadales*	*Asclepiadaceae*	*Finlaysonia*	*Finlaysonia maritima Backer ex Heyne*	*Rurum*

Source: Tolangara 2011

TABLE 2 : Analysis results of mangrove parameters in the district of jailolo, west halmahera

No.	Species	Relative density	Relative dominance	Relative frequency	Important Value Index (IVI)
1.	*Rhizophora apiculata*	5.3	14.4	9.7	7.9
2.	*Bruguiera gymnorrhyza*	8.5	5.1	3.2	5.2
3.	*Xylocarpus moluccensis*	3.6	2.8	3.2	1.9
4.	*Osbornia octodonta*	3.4	4.1	12.9	3.7
5.	*Sonneratia caseolaris*	21.7	17.5	19.4	24.5
6.	*Avicennia lanata*	45.0	46.1	35.5	36.4
7.	*Finlaysonia maritima*	12.5	10.0	16.1	20.4

Source: Tolangara 2011

Based on the mangrove parameter analysis in TABLE 2 it is seen that the Importance IVI of *A. lanata* was the highest one (36.4), while IVI of *X. moluccensis* was the lowest (1.9). IVI is an accumulation of all three parameters measured. In this case, the Importance Value Index describes the relative contribution of each plant species to the community. Hardjosuwarno[7] stated that if there were several species in a community having different IVI, it could be said that the plant species having the highest IVI would have the largest relative contribution to the environment, and vice versa.

The utilization patterns of mangrove wood by fishermen people in the district of jailolo, west halmahera

Based on the interview result regarding the utilization patterns of mangrove wood, it is uncovered that people tend to utilize 4 main mangrove species: *R. apiculata* Blume. (*Soki*), *B. gymnorrhiza* (L.) Lam. (*Dao*), *X. moluccensis* (Lam.) M. Roem.(*Buah Kira-Kira*), and *O. octodonta* F.v.M.(*Baru-Baru*). The percentage of respondents related to the utilization of the mangrove woods is presented in TABLE 3.

(a) The utilization of *Rhizophora apiculata* blume (soki)

R. apiculata Blume. (Soki) tree having a trunk diameter up to 50 cm reaches a height of 30 feet. The wood of *R. apiculata* used as firewood for self-need or to be sold, are cut into pieces about 50-60 cm long, tied up and then sold at a price of 15,000 IDR per bundle.

TABLE 3 : The utilization patterns percentage of the mangrove woods by the fishermen people

Species of mangrove	Utilization patterns	Percentage (%)
R. apiculata Blume. (soki)	Firewood	100
	Charcoal	5
B. gymnorrhiza (L.) Lam. (dao)	Making the fence of houses	87.5
	Making the poles of houses	87.5
	Making the poles of wharf	100
	Making the boat mast	100
	Making of poles of boats	100
X. moluccensis (Lam.) M.Roem. (Buah kira-kira)	Making the boat floor	92.5
	Making the wall of boats	92.5
O. octodonta F.v.M. (Baru-baru)	Furniture materials	5
	Manufacture of keels	92.5

Source: Tolangara and Sundari 2012

The wood of *R. apiculata* categorized into solid and sturdy wood can be utilized as building materials, firewood, and charcoal materials; among others, this wood is also used as a high quality paper materials. Mangrove wood is usually cut by a cutting machine to produce wood chips; the paper made from mangrove wood is known as paper of high quality[10].

FAO research results in Sierra Leone (1984) concluded that *R. apiculata was* used as firewood for smoking fish. *R. apiculata* firewood will produce a very high heat energy which is equal to 5,017 cal/GW, because of the amount of firewood needed for this process is approximately equal to the weight of the fish's body, then it is not surprised if the "harvesting" of mangroves for firewood had become the main job of fishermen people.

It had been also described by Inoue et al.[8], that the wood of *R. apiculata* had good quality due to durability and because it produced high heat. The mangrove firewoods are very efficient, because of using the woods of 8 cm diameter and of 50 cm length, one can cook for 5 people. The mangrove firewood is very important for poor people, especially at the time when fuel prices soared.

(b) The utilization of *Bruguiera gymnorrhiza* (L.) Lam. (dao)

The height of the tree *B. gymnorrhiza* sometimes reaches 15-30 meters. This tree often dominates the mangrove forests that are old and marks the final stage of the littoral zone development, as well as marks the transition to the drier land[10].

All respondents (100%) said that they always utilized the woods of *B. gymnorrhiza* for fencing, pillars of the house, harbor, boat mast and pole at the boat itself. People prefer this type of wood because the wood is quite strong and sturdy if it is embedded in the soil or mud. The people preference is in accordance with Noor et al.[10] saying that the wood of *B. gymnorrhiza* is classified as heavy, hard, strong, as well as durable wood when used as a pillar in the foundation of the house at swampy land. This wood is even more durable when used under the roof.

(c) The Utilization of *Xylocarpus moluccensis* (Lam.) M.Roem. (Buah kira-kira)

The tree height of *X. moluccensis* is approximately 5-20 meters, and has board roots. *X. moluccensis* fruits are green, and have round shape like guajava. Inside the fruit, there are usually 4 to 10 pieces of seed of tetrahedral shape arranged in the fruit confusing like a puzzle. These fruits, are called as *fruit puzzle,* and have diameter of 8 - 15 cm; these fruits will shatter when dry[10].

92.5% of respondents said that they utilized *X. moluccensis* wood as materials for constructing walls and floor of their boat. In order to use the wood of this tree, the tree is cut and processed to be such a board, and then dried for approximately 1 to 2 months. Furthermore the dried boards are used to build a boat of 9 meters in length and 1 meter in width and 80 cm in tall. The boat is used for personal need or to be sold in the prices of 3,000,000 IDR per boat.

This information also agrees with the reports of the FAO (1984) in Sierra Leone saying that many *X. moluccensis* woods were used as firewood, and for smoking fish. The woods of *X. moluccensis* tree would produce energy calories by 3,899 cal/GW.

(d) The utilization of *Osbornia octodonta* F.v.M. (Baru-baru)

The tree of *O. octodonta* has a height of 7 feet and has a breath root as well as has brown or gray, and fibrous bark. The twigs of *O. octodonta* are subtle pale gray, and rectangular when the tree is at young age. The tree trunk has a hole in its middle region when the tree is at old age[10].

Based on the data presented in Table 3, it is explained that 92.5 % of respondents confirmed that they use the wood of *O. octodonta* as a part of the boat keel because the wood is classified as strong and resistant to the attack of destroying sea animals. The bark of *O. octodonta* can be used to patch up the boat walls. On the other and only 5 % of the total respondents interviewed utilized this wood as their furniture material.

Information from the people agrees with Dahuri (2001) saying that the main problem related to the pressure on the mangrove was caused by the human desire converting the mangrove forest area to be residential area, as well as commercial industrial and agricultural areas. The damage was also caused by the increasing demand for mangrove wood production causing ex-

cessive exploitation of mangrove forest.

Mangrove forests damage is also closely related to the educational level of the people residing in the near by area. Based on interview result, the average education level of people in the area is only elementary school and junior high School. Tampubolon (2002) said that the traditional fishermen also play a major role in the destruction of the mangrove forest ecosystems. Furthermore it was stated too that the fishermen understood the important role of mangrove forests and the dangers if it was declined, but they had no choice due to the high economic pressure. This opinion agrees with Bengen studies[1] who reported that the occurrence of various damage of coastal ecosystems including harvesting of mangroves, beach sand mining and fishing using explosives, were caused by poverty and lack of knowledge of the people.

Bengen[1] also had said that the rapid increase of population growth and coastal development activities for a various purposes (resident, fisheries or farms, ports, etc.), would cause ecological pressures on ecosystems in coastal areas, especially the mangrove forest ecosystem. The increasing pressure will cause direct damage (for example, logging and land conversion) and indirect damage (such as waste pollution by construction activities). Saparinto[11] said too that the activities which had greatest contribution to the destruction of mangrove forests in Indonesia are the exploitation of the mangrove woods for commercial purposes, as well as the conversion of forest areas to be fishery farm areas and agricultural areas.

The damage of mangrove forests in District of Jailolo West Halmahera due to excessive utilization of mangrove woods will affect on the decline of fish catch and the income loss of the fishermen in this area. On the other hand, the damage will cause the loss of certain species of mangrove such as: *X. moluccensis*, as the characteristic species of Mollucas mangrove. In this connection, it is very important to carry out conservation of mangrove forest in this area soonly.

CONCLUSIONS

There are some conclusions based on the study results that will be described further:

1) There are seven species of mangrove found on the coastal areas of Jailolo District namely: *R. apiculata, B. gymnorrhyza, X. moluccensis, O. octodonta, S. caseolaris, A. lanata,* and *F. maritima*.
2) Important Value Index (IVI) of *A. lanata* is 36.4 (the highest), and of *X. moluccensis* is 1.9 (the lowest). It can be said that there is a great destruction of mangrove forests in this area so that its conservation must be carried out soonly.
3) The mangrove woods are utilized as firewood, house construction, as well as boat and furniture materials. The mangrove species most widely used as firewood is *R. apiculata*. While the species widely used as house building material and boat mast is *B. gymnorrhiza*, but the species used for boat constructing are *X. moluccensis* and *O. octodonta*.

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