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Destruction to Mangrove Forests in East Luwuk, Banggai Regency, Central Sulawesi

Ummu Kalsum[1]*, Ris Hadi Purwanto[2], Lies Rahayu Wijayanti Faida[2], Sumardi[2]

[1]Doctoral Program in Forestry Science, Faculty of Forestry, Gadjah Mada University Jl. Agro 1, Bulaksumur, 55281, Yogyakarta, Indonesia
[2]Faculty of Forestry, Gadjah Mada University. Jl. Agro 1, Bulaksumur, 55281, Yogyakarta, Indonesia

Abstract. According to the results of interactions between humans and mangrove forests, the causes of mangrove forest destruction are developing very dynamically. In the sub-district of East Luwuk, Banggai Regency, this study aims to determine the causes of mangrove forest damage. With descriptive analysis, this study utilizes qualitative methods. To determine the factors causing damage to mangroves was done by purposive sampling through interviews. The results showed that the damage to mangrove forests was caused by the conversion of mangrove forests into ponds, rice fields, and settlements. By carrying out restoration, rehabilitation, and restoration of damaged areas and recommending pond management by implementing a silvofishery pattern that can meet community welfare and maintain the survival of the mangrove ecosystem.

Keyword: Land Conversion, Mangrove Ecosystem, Qualitative Methods, Rehabilitation, Silvofishery Pattern,

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1 Introduction

With an area of 3.5 million hectares, Indonesia's mangrove forests are the world's largest and have the most varied biodiversity and structures [1]–[3]. In the estuary region, the mangrove forest is an ecological system that obtains nutrients and sediments from the terrestrial environment and has a very complex interaction with the environment [4]–[6]. As part of the coastal forest community, mangrove forests have a major role in the sustainability of the coastal forest ecosystem [2]–[4]. Mangrove forests have many functions and the actors create different interests in the mangrove forest [3]–[5]. The survival of the coastal forest ecosystem can be guaranteed if humans can maintain and maintain the life cycle of the coastal environment with the knowledge they have [6]–[8]. In meeting the daily needs of the community by managing

*Corresponding author at: Faculty of Forestry, Gadjah Mada University. Jl. Agro 1, Bulaksumur, 55281, Yogyakarta, Indonesia
E-mail address: ummujurnal16@gmail.com

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existing resources based on traditional knowledge and local wisdom [9]–[11]. Mangrove forests have an important role in maintaining environmental balance in coastal areas, especially in protecting coastal damage from abrasion; a place where various types of fish, crab, shrimp, and sea birds live; source of food commodity for human life [12]–[14].

Ecological and economic benefits can be provided by mangrove forests as tropical natural resources. The ecological role of mangroves in human life can be seen from their physical, chemical, and biological aspects [15]–[17]. In the meantime the economic role of mangrove forests is related to the use of commercially available mangrove forest products, both wood (firewood, building materials, charcoal, pulp, and tannins) and non-wood (medicines and fish), recreational use (nature tourism) and education [18]–[20]. The use of mangrove forests that do not comply with carrying capacity and adaptability causes harm to the mangrove forest itself and as a mangrove habitat, harm to the coast [21]–[23]. Pollution, conversion of mangrove forests that do not pay attention to environmental factors, and excessive logging are the main factors that cause mangrove damage, and conversion into ponds and colonies [24]–[26]. Mangrove conversion and loss are caused by human activities as a range of activities, either directly or indirectly. Overexploitation of mangrove forests is used for wood, firewood, paper, charcoal, agricultural land, aquaculture, mining, and settlement [27]–[29].

The loss of various types of coastal flora and coastal fauna, such as fish, crabs, shrimp, and shorebirds, has resulted in damage to mangrove forests that have occurred so far as a result of human activities and natural events [30]–[32]. Without human intervention, the existence of mangrove forests causes mangrove forests to regenerate themselves as a guarantee of mangrove forest preservation [33]–[35]. When human interaction with mangrove forests is very high, metamorphosis leads to damage and even extinction in the mangrove forest [36]–[38]. The community existence go into the forest area to access natural forest resources has caused degradation and deforestation in many forest areas [39]–[41]. Damage caused by humans, i.e. the existence of illegal logging activities used for timber construction, paddling, firewood, pond production, and port activities [42]–[44]. Coastal abrasion has also resulted from damage to mangrove forests, causing losses to the surrounding community [45]–[47]. In general, because of the pressure from the prolonged economic crisis faced by the community and industry, the condition of mangrove forests is under high pressure (encroachment and change in land use) [42]–[44].

In general, the mangrove area in Banggai Regency has experienced a decline in quality in terms of mangrove land cover, species diversity, and the number of individual mangroves. The level of damage to mangroves reached 100.475 ha due to land conversion activities into ponds, rice fields, and settlements. Mangrove forest in Banggai Regency has 25 pure mangrove species and 25 associated mangrove species spread throughout Banggai Regency. In the mangrove ecosystem of East Luwuk, Uwedikan, and Tingki-Tingki villages, there are mangrove

vegetation types that are categorized as endangered, namely *Scyphipora hydrophyllacea* and in Lambangan village, the species *Sonneratia ovata* (Popat). Both of them are vulnerable statuses and in their management need more special attention, so the sustainability of these species is needed to maintain in the future. As a result of human actions/actions that utilize the mangrove forest area and natural resources within the mangrove forest itself, the mangrove forest in East Luwuk is currently experiencing very high pressure. This initial research aims to identify the causes of damage in mangrove forests caused by human activities.

2 Research Method

This research was conducted in the mangrove forest area of Luwuk Timur District, Banggai Regency, Central Sulawesi Province for 6 months from October 2018 to March 2019. The East Luwuk sub-district (Hunduhon Village, Kayutanyo Village, Bantayan Village, and Uwedikan Village) has been chosen as the research location (Figure 1) with the following considerations: (1) it is one of the largest mangrove areas with different dynamics of human activity, and (2) they have several rare types of mangroves in the world. In this study, the instruments and materials used are as follows: voice recorder, GPS, camera, writing tools, questionnaires (which include questions including utilization of mangrove ecosystems, understanding of mangrove ecosystems and community, interactions with mangrove forests), and statistical data. Techniques to obtain data using in-depth interviews and observation (Figure 2).

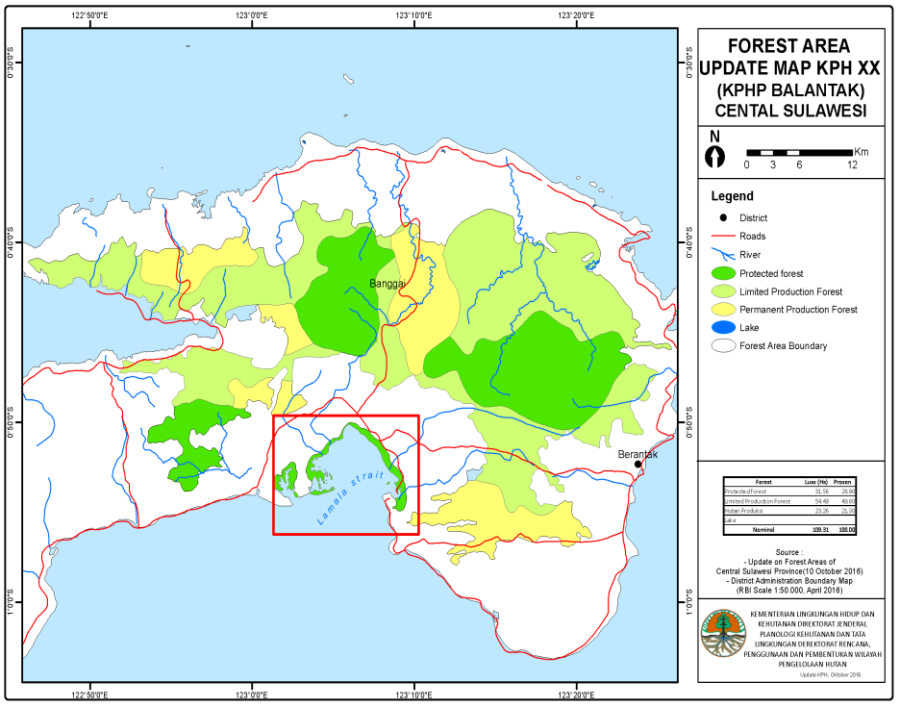

Figure 1 Research Site Map (Ummu Kalsum, March 16, 2017)

This study utilizes qualitative methods with descriptive analysis. This study used the techniques of purposeful sampling and snowball sampling. The head of the Forest Management Unit (FMU), the Forest Police Staff (Polhut), the Head of the Environmental Service of the Banggai

Regency, the Head of the Division, and the Head of the Section responsible for mangroves and village heads have directly involved in mangrove activities were selected for purposeful sampling. The snowball sampling starts from the head of the village and then evolves to other sources (community leaders) to obtain data on damage to the mangrove forest. When the data/responses of several figures receive the same answer or are saturated, the search for information will stop. It is analyzed using interactive methods after the data was obtained, which include the stages of data identification, presentation of data, and conclusion.

3 Results and Discussion

The inhabitants of East Luwuk use mangrove forests to sustain their everyday life, according to the findings of interviews conducted using the snowball sampling approach with four village chiefs, including the village heads of Kayutanyo, Hunduhon, Bantayan, and Uwedikan as the initial resource persons. The interview then moved on to the second resource person, which included community leaders from Kayutanyo village, Hunduhon village traditional leaders, Bantayan village religious leaders, and Uwedikan village community leaders. According to the information gathered, the majority of the population, including immigrants and indigenous people, have shrimp and milkfish ponds that are still productive and give excellent returns, particularly in Hunduhon and Uwedikan villages. Furthermore, fishermen who were indigenous people from each of the villages that became the research location stated that the damage to mangroves that occurred in the East Luwuk area was more due to the opening of large-scale ponds that did not consider environmental sustainability, in other words, converting mangrove forest to be a pond area.

3.1 Potential types and uses/advantages

As a community of plants, mangroves have multifunctional benefits for human life in terms of economic, ecological, and socio-cultural sustainability. Mangroves can be utilized to produce commercially available products such as wood (firewood, building materials, charcoal, pulp, and tannins) and non-wood products for economic gain (medicines and fish). Mangroves can maintain environmental stability and equilibrium to prevent and protect the environment from coastal abrasion due to the intrusion of seawater. Mangroves can provide socio-cultural benefits for recreation (natural tourism) and education.

3.2 Firewood collection by the community

Increased ecological pressure on different ecosystems has resulted in population growth and rapid development in mangrove forest areas, which will threaten the existence and sustainability of the surrounding ecosystem [39]–[41]. Generally, the mangrove forest area tends to be reduced because much of it is cut down and converted into arable land [36]–[38]. There is always a negative impact on the forest when the community interacts with the forest [33]–[35]. With their knowledge of the use of forest products, the relatively simple idea of public

knowledge causes forest objects to become damaged [30]–[32]. In the East Luwuk sub-district, the mangrove forest is a mangrove community with a very high value for diversity. There are 27 species of mangroves in the village of Uwedikan Pulau Supply, Luwuk Timur Subdistrict, comprising 17 types of true mangroves and 10 types of associated mangroves. The highest importance of *Bruguiera gymnorrhiza* at the location of Supply Island was 93.09. This high diversity of species allows the community to use the existing mangrove forest resources to meet their daily needs and one of them is the fulfillment of the fuelwood requirements [27]–[29]. Fulfilling the community's need for firewood originating from mangrove forests is not in line with the available carrying capacity that causes damage to the mangrove forest [24]–[26].

The interview results showed that firewood is made from mangrove species such as *Avicennia* sp. *Rhizophora* sp. It happened continuously because firewood is one of the community's principal fuels used for cooking. In ancient times, the extraction of firewood began along with the arrival of several residents from one community to settle in the region. Community activities in the mangrove forest are looking for firewood for 2 to 4 hours per day per head of a family with 2 bunches of firewood each day. Firewood harvesting is not carried out on dry trees/branches/twigs, but rather on living trees/branches/twigs that are cut down. The next step is to tie the tree trunks into a bundle to bring them to the house after the community cuts down the mangrove trees. The activity of extracting firewood from mangrove forests takes place every day on an ongoing basis and alternates between groups.

The informants acknowledged that because only firewood from mangrove forests was available in that area, there was no other choice for them not to use mangroves as firewood. The results of the field identification show that the continuous extraction of firewood can cause damage to the mangrove forest because the community also aims to harvest mangrove branches and twigs that should be preserved for the mangrove growth process. The impact caused by the continuous extraction of firewood causes the opening of mangrove forests, starting from the nypa zone near the outer boundary of the coast to the land to the outer Avicennia zone to the sea. Coastal abrasion causes the reduction of mangrove vegetation.

3.3 Conversion of mangrove forests became into traditional ponds

Besides gathering firewood, the community interaction with the forest drives to another practical level to fulfill the family's daily needs. The living communities around the mangrove forest meet their daily needs by looking for marine products such as fish, shrimp, and crab. They are used for consumption and seafood selling to meet their needs for food, shelter, and clothing. The results obtained from the sea are not sufficient to fulfill their daily needs and it is found that most of the people are below the poverty line. Poverty is an impact due to the income inequality of the people living around the forest. Structural poverty is a natural condition that because of limited resources available, has been passed down from generation to generation. In meeting their daily needs, limited resources require people to meet their daily needs by

maximizing the use of the resources around them based on their knowledge. As a community, which is mostly dominated by a very low level of education, the utilization of resources exceeds the existing carrying capacity of the area. Economically, in addition to the benefits of environmental services, mangrove forests and coastal forests are a source of non-wood forest for the local community and play a physical role in protecting coastal lands because they are capable of breaking the kinetic energy of sea waves [21]–[23].

The economic condition of people below the poverty line demands they meet their daily needs by annexing the surrounding mangrove forests by clearing mangrove forest land for traditional aquaculture purposes [18]–[20]. The mangrove forest area decreased because the community clear the forest and did not replant it in a location that can still be planted, then the existing mangrove stands has been suffered enormous damage [15]–[17].

Figure 2 Mangrove forest clearance by the community in Hundohon Village (source: field documentation)

In Figure 2, the mangrove forest has converted into traditional pond land. The conversion of mangrove forests into traditional ponds with shrimp and milkfish commodities is carried out by immigrant communities, while the indigenous people (the Saluan Tribe) are mostly fishermen. The results of shrimp obtained from ponds, usually people sell to middlemen for Rp. 50,000 to Rp. 85,000/kg depending on the size of the shrimp, while the price of milkfish reaches Rp. 20,000/kg. From the results of community interviews, the opening of the mangrove forest was carried out by immigrant communities who had been clearing mangrove forests since 2013 in Hunduhon village with an area of ± 30 ha. Generally, the migrants come from the South Sulawesi Bugis tribe. The community will take the products from the mangrove forest as wood to be used as firewood before the community opens a pond in the mangrove forest area. Community activities such as fisheries, settlements, food locations, and natural tourism sites result in a decrease in the area of mangrove forests and a decrease in the functioning and benefits of mangroves for residents and the environment [12]–[14].

3.4 Mangrove forest conversion into company-owned ponds

Increasing the number of industries and settlements requires the opening of new land, in particular coastal mangrove forest areas. Some have converted into residential and industrial areas. It can directly cause ecological impacts that threaten the sustainability of different coastal biota that make habitat for mangrove forests and can physically eliminate the role of mangrove forests in preventing coastal abrasion [10], [11], [48]. A special attraction for investors to do different businesses is the conversion of mangrove forest land to become land for the aquaculture industry and one of them is shrimp commodities.

Figure 3 Clearance of pond land by companies in Uwedikan Village (source: field documentation)

Compared to other commodities, the potential for shrimp commodities with a sufficiently high price provides pond companies with fresh air to open shrimp ponds. The business utilizes a large number of mangrove resources located at the pond location to build a pond (Figure 3). Destructive mangrove forest exploitation causes damage to the ecosystem of the mangrove forest and has an impact on the loss of surviving mangrove species in the village of Uwedikan. It is also involved in the destruction of mangrove forests, namely PT. Lautan Gunung Mas, is the private sector on the village of Uwedikan. The application by a company covering an area of ± 45 ha for processing permits caused the world's rare mangrove species, *Schypiphora hydropalaceae*, to decline in this village. The shrimp pond permit (UKL/UPL) is not yet owned by the company, but it has cleared the mangrove forest. Activities carried out by PT. The Gunung Mas Ocean threatens other areas in the village of Uwedikan and is extended to Balean Island where the *Schypiphora hydropalaceae* species grow so that it can threaten the extinction of this species. The community dismissed the presence of PT Lautan Gunung Mas because the waste was channeled into the sea through culverts in the company's planning. The existence of the shrimp pond company PT. Lautan Gunung Mas to invest in the area has the support and support of the Regional Government of Banggai Regency because it contributes to increasing local revenue (PAD).

The efforts of the local government of Banggai Regency to increase PAD greatly assist the government in implementing poverty alleviation programs, especially community empowerment activities. It can threaten the existence of mangrove forests, on the other hand. There must be resources sacrificed when investing, particularly the resources that are available at this time and are in the place where the investor is going to invest. Mangrove forest areas are resources currently available at the research site and are strategic locations for aquaculture companies, particularly shrimp. Massive destructive exploitation of mangrove forests causes damage to mangrove forests and threaten habitat extinction for several types of mangroves and other commodities, such as fish, crabs, and other microbenthos, and global warming. The causes of global warming are the increasing content of carbon dioxide (CO_2) and the decrease of forest areas as a CO_2 absorbers in the atmosphere [6], [9], [49]. Mangrove forests, through the photosynthesis process, are considered to absorb carbon quite well. In mangrove management, community participation has an important role because the community is at the forefront of mangrove preservation. With the support of different parties, increasing community participation from planning to implementation can be done.

3.5 Conversion of mangrove forests to fields of rice

Poverty is a source of inspiration with different strategic programs for various organizations, such as community social organizations, and government, to overcome poverty issues. The existence of resources would be sacrificed at the place where the program is applied to realize the strategic programs carried out by the government. Mangrove forests are one of the sacrificed resources in Luwuk Timur, Banggai Regency. Currently, the government has launched a labor-intensive program to meet the needs of the people for rice, by converting mangrove forests to rice fields.

Figure 4 Mangrove forest damaged due to paddy field clearing in Hunduhon Village (source: field documentation)

As the location was not suitable for rice fields due to the very high salinity levels, the conversion of mangrove forest land to paddy fields was not continued (Figure 4). The paddy field program's unsustainability has had a severe impact because it eliminates or completely clears mangrove forests that are turned into rice fields. This condition indirectly leads to the extinction of endangered mangrove species and species of mangroves. The mangrove forest clearing activity was also carried out by the local government, namely, the agricultural office, designated as paddy field printing in the Bantayan village covering an area of ± 35 ha, the Hunduhon village, and the Kayutanyo village covering an area of ± 84 ha, in collaboration with the Indonesian Army.

The results of community interviews obtained information that the cooperation carried out by the government to open rice fields only involved the head of the village of Hunduhon. While the village government apparatus and the village community of Kayutanyo strictly prohibited the operation of paddy fields in mangrove forests. The mangrove forest clearing activity caused a lot of mangrove stands to disappear and the dominant one was *Rhizophora* sp.

The existence of mangrove forest exploitation to meet human needs tends to be excessive and does not respect the principles of conservation [5], [7], [8]. It causes the mangrove forest ecosystem to degrade and lose its function directly, as a place to find food for various high commercial valuable fish and shrimp, and as a refuge for other living things in the surrounding coastal waters. Mangrove forests have multiple functions and cannot be replaced by other ecosystems and function physically as land stabilizers, which play a role in mangrove roots accumulating mud substrate so that they can withstand coastal abrasion and block the intrusion into the mainland of seawater. Therefore, for the preservation of mangrove forests, community and government participation is needed [2]–[4]. The existence of the mangrove forest must be retained by all actors who have an interest in it. Because they obey mangrove forests are a place for different types of fish and shrimp to live, which can promote and support the quantity of fish caught by fishermen and pond farmers [1], [50], [51].

4 Conclusion

As a result of interactions between humans and forests, the phenomenon of mangrove forest destruction is developing very dynamically. There are positive and negative impacts on the outcomes of the interaction process. The positive impact of mangrove forests remains sustainable and the adverse effects of mangrove forests are being damaged and threatened with extinction. The damage to the mangrove forest depends on the phenomena that interact with the mangrove forests in the community. In East Luwuk sub-district, Banggai Regency, the phenomenon of damage to mangrove forests is caused by the collection of trees / trunks / branches / mangrove chains for firewood energy, the conversion of mangrove forests into ponds owned by communities and businesses, and the conversion of mangrove forests into rice fields,

resulting in the discontinuation of rice field activities. The above phenomena have caused damage to mangrove forests, threatening the extinction of mangrove forest ecosystems and affecting global warming. This phenomenon can be overcome by restoring, rehabilitating, and reclaiming damaged areas and recommending that the company implement a pattern of silvofishery that is capable of meeting community welfare and maintaining the mangrove ecosystem's survival.

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