Evaluation of Ecosystem Services Mangrove Restoration Area in South Malang

Nur Aini[*], Luchman Hakim[**], Catur Retnaningdyah[**]

[*] Magister Study Program, Biology Departement, faculty of Mathematics and Natural Sciences, University of Brawijaya, East Java
[**] Department of Biology, Faculty of Mathematics and Natural Sciences, University of Brawijaya, East Java

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Abstract- Mangrove ecosystems are providers of ecosystem services in the surrounding environment, but have decreased in area throughout the tropics. To reduce the impact of damage, restoration is one of the mangrove conservation efforts, but the restoration program that is carried out is rarely evaluated.This study aims to evaluate the success of restoration by measuring its ecosystem services. The measurement of ecosystem services includes 4 aspects namely regulating, supporting, provisioning and cultural. There are 3 research sites namely Bajulmati and Clungup (restoration area) and Kondang Buntung (reference site). The results show shows the length of the restoration affects the quality of mangrove vegetation. The longer the restoration time the higher the mangrove density. In the 10-year Bajulmati restoration, mangrove density has the lowest value because the station is located near residential areas so human activity can affect the growth of mangroves.The service in supporting the mangrove ecosystem of South Malang is able to store carbon and absorb CO_2 well. The biggest carbon storage and CO_2 uptake is in the famous butts of natural mangroves. The ability to store carbon and absorb CO_2depends on the diameter of the tree and the density of the mangrove. Regulating services for the mangrove ecosystem in Malang, South, have met the established standards, although there are some parameters that exceed sea water quality standards but can still be tolerated by mangrove vegetation. South Malang mangrove ecosystem provisioning and cultural services make use of firewood and fisheries. While cultural services are maximized in mangrove education tourism activities, so that they contribute greatly to the preservation of mangroves and can improve the economy of the surrounding community.

Index Terms : Mangrove, Ecosystem services, South Malang

I. INTRODUCTION

Mangrove forests play an important role in maintaining the balance of global ecosystems that provide a variety of important ecosystem services to humans and the biota that lives around them[1] such as food, fish habitat, and tourism [2]. Mangrove ecosystems also play a role in climate change [3]. Among them can store the biggest carbon and protect the coast from abrasion and storms [4].However, anthropogenic factors cause a large impact on the decline in mangrove ecosystems by 30-50% globally [5]. With losses of 0.16-0.39% per year [6].Decreasing area causes mangrove ecosystems to be degraded [7]. Thus, reducing limitations in providing ecosystem services [2], [8].

To reduce the risk of continued decline in mangrove ecosystems, restoration is an important program that must be implemented [9], [10]. Currently, many restoration programs have begun in coastal areas [11]. The government also recognizes the importance of protecting the mangrove ecosystem. mangrove restoration activities that are replanting in degraded ecosystems [12], and are expected to restore the functioning of ecosystem services properly. Services available in the mangrove ecosystem are supply services (food and wood), regulatory services (water quality), support services (carbon storage and CO_2 absorption) and cultural services (aesthetics and tourism) [13].

II RESEARCH METHODOLOGY

Study area

This research was conducted in January 2020 in the mangrove restoration area of South Malang beach, namely Bajulmati and Clungup and Kondang Buntung (Reference site). Data analysis was performed in the Ecology Laboratory of the Faculty of Mipa, Universitas Brawijaya. The map can be seen in Figure 1

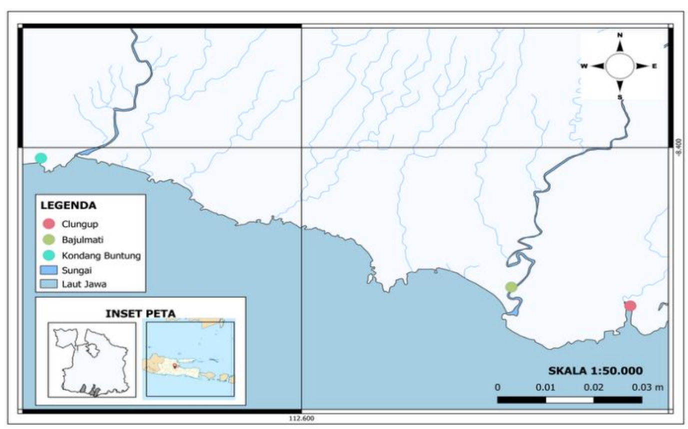


Figure 1. Study area

Sample Collection

The sampling method uses the transect line method with the quadrant sampling technique [14]. Sampling was carried out at 3 research sites in the restoration area (Bajulmati and Clungup) and Kondang Buntung (reference site). each location is determined by 3 stations based on the difference in mangrove planting time. Each station has 3 transects, each with 2 research plots. Determination of the plot size of each study plot is 10 x 10 m for trees, 5x5 m for saplings and 1x1 m for seedlings with 50 m transect distance. Determination of stations is marked using GPS, coordinate data are analyzed and mapped using google earth. The measurement methods for regulating ecosystem services using water quality parameters include, temperature, pH, DO, salinity, conductivity, and turbidity are presented in table 1.

Table 1. water physics chemical were measured in this research

Parameters	Unit	Methods
Suhu	^{0}C	Termometer
pH	-	pH meter
DO	Mg/l	DO meter
Salinitas	‰	Refraktometer
Turbiditas	NTU	Turbidymeter
Konduktivitas	µS.cm^{-1}	Konduktivitimeter

Supporting services are measured by analyzing biomass, carbon storage and CO2 uptake by the allometric equation method for each type of mangrove [15]. Provisioning and Cultural services are analyzed descriptively by interviewing managers and the public on aspects of direct use and tourism activities.

III RESULT AND DISCUSSION

Mangrove Vegetation Structure

The condition of mangrove vegetation can be described in terms of the density of the number of trees per unit area. Mangrove density can be used as an indicator of the level of damage in a mangrove area [16]. The highest total density observed was at Clungup station.

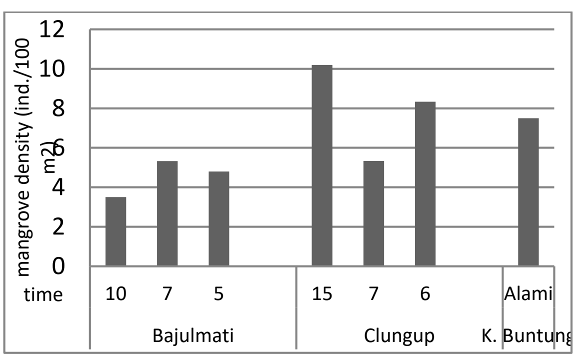


Figure 2. mangrove Density

In total there were 9 types of mangroves found at the study site, namely *Rhizophora apiculata, Soneratia alba, Ceriop tagal, Ceriop decandra, Aegiceras corniculatum, Exoecaria agallocha, Bruguiera gymnorhiza, Avicennia marina sand Rhizophora mucronata*. The type that dominates the station average is *Rhizophora sp*. This is related to the ability of the mangrove type compared to other types in adapting to environmental factors [17].besides suitable habitat, Rhizophora mangroves have an even distribution because these mangroves are generally viviparous, ie seeds / propagules are able to germinate while the fruit is still attached to the parent tree, so the growth success rate becomes greater [18]. Besides Rhizophora sp. has a much larger form of propagules with far more food reserves, so that mangrove species Rhizophora sp. have a higher chance of life and can be spread by sea currents more broadly. Presented in Figure 3:

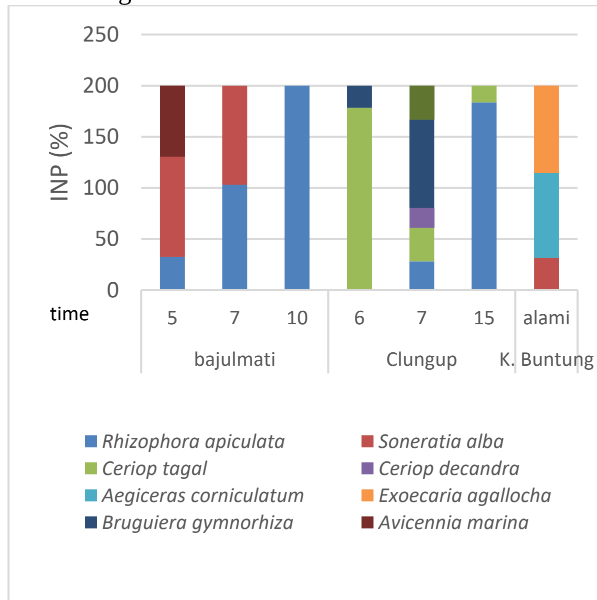


Figure 3. Measurement importance Value Index of Mangrove in each station

Regulating ecosystem services

Measurement of regulatory services is carried out by measuring water quality, including temperature, pH, DO, traffic, conductivity and turbidity. Temperature is an important factor to see water quality [19]. Mangroves can grow well in tropical regions with temperatures above (20^{0}C) [20]. Water temperature at the study site in South Malang ranged from 27-380 C (figure 4).

The lowest temperature (27^{0}C) is at the Kondang Buntung location and the highest temperature value (38^{0}C) is at the Clungup station. The highest value exceeds the sea water quality standard based on the Minister of Environment Decree No. 51/2004. But the temperature results are still in the normal range for the mangrove ecosystem and associated biota therein. Some marine plants can tolerate high sea water temperatures [21]. water temperature also affects other water quality such as conductivity, pH, dissolved oxygen and others [22]

pH (degree of acidity) is one of the parameters in monitoring water stability [23]. The results of pH measurements at the study site showed a value of 7.2 - 8.13. The pH value of water does not have a significant difference in each area, but there is a decrease in pH at several stations. A decrease in pH indicates an increase in acidity of the water. One factor that affects the pH value is temperature.

According to [24] high temperatures cause changes in water to become acidic. The ideal pH value for sea water ranges from 7-8.5 [25]. At the research location, the pH value is still within the range of the standard quality of sea water based on the Minister of Environment Decree No. 51/2004, so that it is safe for mangrove growth and aquatic fauna. Mangroves grow and develop well in the pH range of 6.2 - 8 [26]

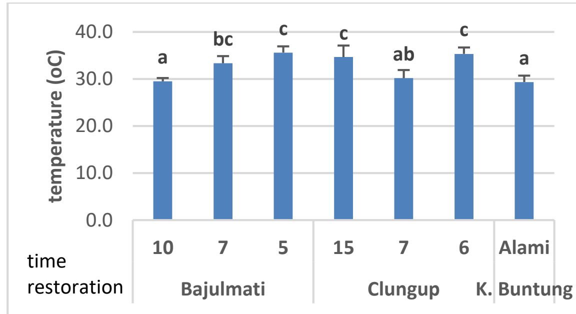
DO (Dissolved Oxygen) increases or decreases due to mixing, water mass movement, photosynthetic activity, respiration and waste and fluctuations can occur seasonally. Oxygen in waters originates from photosynthesis and direct diffusion from the air. Oxygen loss is caused by biota respiration, oxidation of organic matter both in waters and in sediments [27], [28]

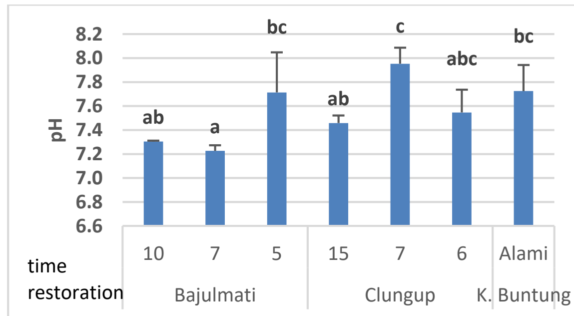
Oxygen is needed by all creatures that live around mangroves such as fish, shrimp, shellfish including microorganisms. DO acts as a regulator of the body's metabolism of organisms to grow and multiply. DO values at the study site ranged from 0.74 to 4.79 mg / l based on Minister of Environment Decree No. 51/2004, DO values are recommended> 5 mg / l, so DO values at the study site indicate that it does not meet sea water quality standards increasing organic waste in the waters and the high decomposition process by decomposers is likely to cause a decrease in DO in the aquatic environment [29].

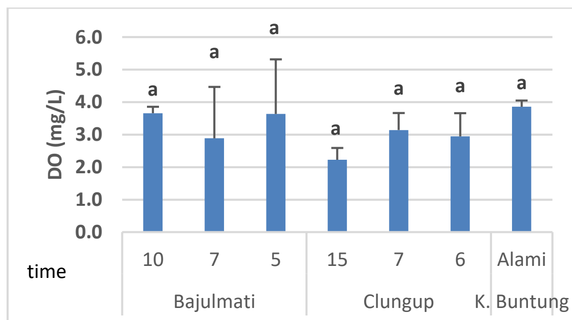
Salinity is the level of salt in a water that can affect the life and growth of mangroves. Salinity at the study site ranged from 0.1 to 40 o/oo. Based on the Minister of Environment Decree No. 51 (2004), the salinity standard is 33-34 o/oo. the highest salinity is found in the restoration area of the 2014 Clungup station with a value of 40 o / oo, so that it exceeds the threshold, but some types of mangroves can adapt to extreme salinity. Macnae (1968) states that the optimum salinity level for Bruguiera gymnorhiza is 10-40 o / oo.Exoecaria agallocha also adapts to salinity levels of up to 40 o / oo [30] The high salinity levels in Clungup 2014 are due to the closest proximity to the sea so that it influences the tides. Meanwhile, the lowest value is found in the natural station, (Kondang Buntung) with a value of 0.1 this is due to mangroves living in estuary areas (estuaries). Eustaria is an estuary where seawater and freshwater meet so that the salinity level is reduced due to the supply of fresh water from rivers and rainwater [31]

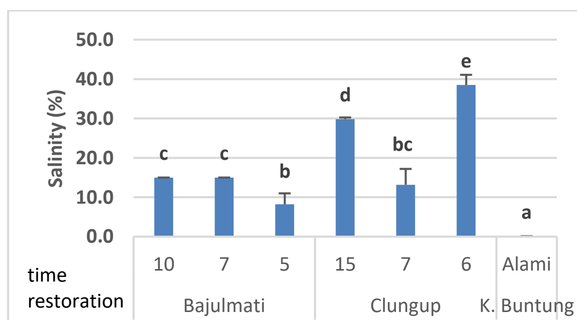
The turbidity of the water at the study site ranged from 1.29-98.3 NTU. Turbidity values show significant differences. The lowest turbidity value is found in the famous natural mangrove area butts, which are in the estuary region and are not affected by tides.While the highest value is found in the Clungup mangrove restoration station. This difference can be caused by differences in the number of organic and inorganic particles dissolved in water. Particles can be divided into three types of particles namely soil particles, organic particles and fibrous or fibrous particles the size and type of particles that vary causes different levels of water turbidity.

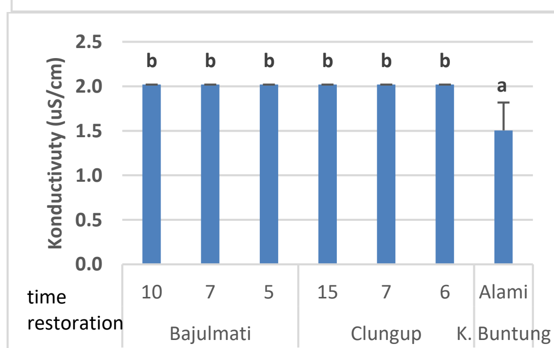
Conductivity contains ions from natural substances and pollutants produced by humans [33]. Ions contained in water have an electric charge. According to [32] conductivity can come from chloride ions nitrates, phosphates, sulfates, sodium, magnesium, calcium, iron and aluminum.The ions are contained in domestic waste, garbage, and agricultural residues. The large conductivity value causes disruption of aquatic organisms. Aquatic organisms are very susceptible to the ion content of salts dissolved in water [34]. The results of conductivity measurements at the study site showed no significant difference in the restoration area, and were lower in natural mangroves.











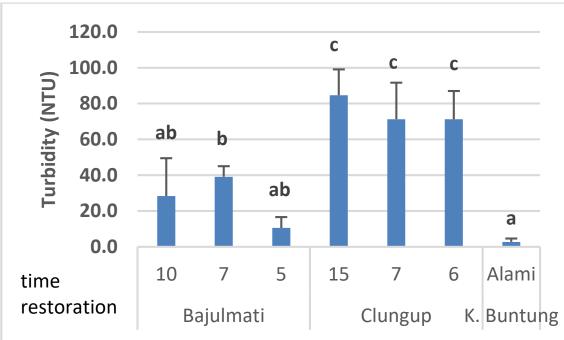
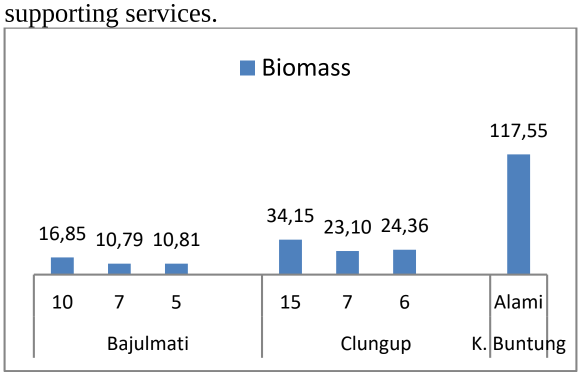
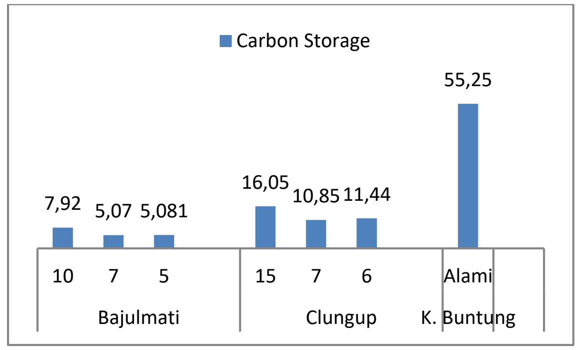


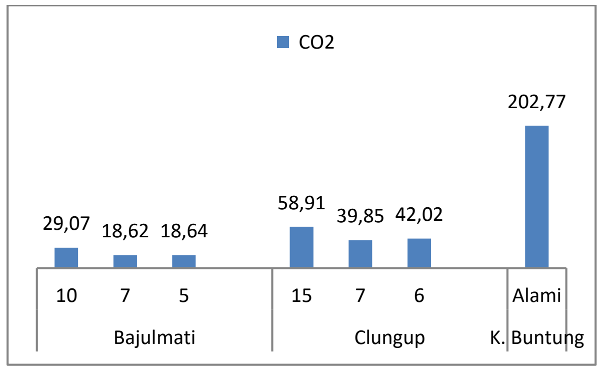
Figure 4. Physical and chemical quality of water in the Bajulmati and Clungup, Kondang Buntung restoration areas (Reference site)

Supporting ecosystem services

Observation of Supporting services is measured using parameters of biomass, carbon storage and CO_2 absorption. Tree biomass is calculated using allometric equations by measuring the DBH (Diameter as breast height) at each mangrove tree species found at each restoration and natural location. Based on the calculation results, there is a significant difference in the amount of biomass content between stations. The natural mangrove biomass (famous stump) is higher when compared to mangrove restoration. The content of natural mangrove biomass Kondang Buntung with a total of 117,556 tons / ha, with a total carbon storage of 55,251 tons / ha and CO_2 uptake of 202.7723 tons / ha.Whereas in the 2 restoration areas, the highest amount was found in the Clungup beach, biomass contained in the 15-year restoration with an average value of 30.42565 tons / ha, carbon storage of 14.48158 tons / ha and co2 uptake of 53.14741 tons / ha . While the lowest value is at Bajulmati station with an average biomass of 7.487486 tons / ha. Differences in biomass content occur due to differences in planting years, mangrove density, diameter of trees at each station and the quality of the environment. The greater the density of mangroves and the diameter of a tree, the greater the value of biomass. However, the diameter of the tree is more influential compared to density. [35] argues that there is a close relationship between tree diameter and biomass value. The longer the restoration year, the better the supporting services.







Provisioning and Cultural Services

One of the environmental services produced by the mangrove ecosystem is the provision of services [36]. Provisioning services in this study were taken by interviewing the surrounding community regarding the direct use of mangrove ecosystems. At Bajulmati Station, the results

of interviews conducted by some of the community use the land around the mangrove to become an annual plantation, such as oil palm. In addition, the community uses mangroves as firewood

Provisioning services also act as providers of fauna habitat. The surrounding community usually, fishing for crabs and clams that live around the mangrove. in contrast to Clungup, utilization is not done directly, this is because Clungup is an area of rehabilitation and conservation of mangroves, management is carried out in principle based on preservation.

Cultural services are defined as cultural, spiritual / religious means, educational values, aesthetics, social relations, cultural heritage values, recreation and ecotourism [37]. From the results of cultural services interviews, the results show that the mangrove clungup ecosystem is used as an ecotourism for mangrove conservation, namely the CMC (Clungup Mangrove Concervation). Besides traveling, it also builds public awareness of the importance of nature conservation.

In the Bajulmati mangrove restoration cultural services are utilized in terms of tourism. The results of interviews that have been conducted to managers, the natural potential that is now being developed by Bajulmati community groups is the river, cave, and beach. All three of these ecotourism have emerged a long time ago but began to be explored directly and utilized are starting in 2011.Lepen Adventure along the river by utilizing the river flow along Bajulmati to the estuary using a canoe and accompanied by a guide. while planting mangrove seeds that have been provided by the manager, in addition to traveling visitors take part directly in protecting and preserving nature. Aside from preserving mangroves, ecotourism activities also contribute to the economy of the surrounding communities by renting homestays, public toilets and food stalls. Thus, the Clungup and Bajulmati restoration areas have made good use of provisioning and cultural services

IV CONCLUSION

This study shows the length of the restoration affects the quality of mangrove vegetation. The longer the restoration time the higher the mangrove density. In the 10-year Bajulmati restoration, mangrove density has the lowest value because the station is located near residential areas so human activity can affect the growth of mangroves.The service in supporting the mangrove ecosystem of South Malang is able to store carbon and absorb CO_2 well. The biggest carbon storage and CO_2 uptake is in the famous butts of natural mangroves. The ability to store carbon and absorb CO_2 depends on the diameter of the tree and the density of the mangrove.Regulating services for the mangrove ecosystem in Malang, South, have met the established standards, although there are some parameters that exceed sea water quality standards but can still be tolerated by mangrove vegetation. South Malang mangrove ecosystem provisioning and cultural services make use of firewood and fisheries. While cultural services are maximized in mangrove education tourism activities, so that they contribute greatly to the preservation of mangroves and can improve the economy of the surrounding community.

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Authors

First Author – Nur Aini S.Si, Magister Study Program, Biology Departement, faculty of Mathematics and Natural Sciences, University of Brawijaya, East Java. Indonesia, Gmail. Aininuraini62@gmail.com
Second Author – Prof. Luchman Hakim. S.Si..M.Agr.Sc.,Ph.D, Department of Biology, Faculty of Mathematics and Natural Sciences, University of Brawijaya, East Java, Luchman@ub.ac.id

Third Author – Dr. CaturRetnanigdyah,M.Si, Department of Biology, Faculty of Mathematics and Natural Sciences, University of Brawijaya, East Java, Catur@ub.ac.id

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