Mangrove Health Index and Carbon Potential of Mangrove Vegetation in Marine Tourism Area of Nusantara Dian Center, Molas Village, Bunaken District, North Sulawesi Province

by Joshian Schaduw 25

Submission date: 23-Feb-2022 12:37PM (UTC+0700)
Submission ID: 1768944126
File name: 22._Spasial_Vol_21_No_2_2021_MHI_NDC_Nico.pdf (181.53K)
Word count: 4820
Character count: 25805

Mangrove Health Index and Carbon Potential of Mangrove Vegetation in Marine Tourism Area of Nusantara Dian Center, Molas Village, Bunaken District, North Sulawesi Province

Joshian Nicolas William Schaduw[a,1*], Fihri Bachmid[a], Gosal Reinhart Paat[b], Elisa M. Lengkong[b], Devira C. Maleke[b], Udin Upara[a], Henry E. Lasut[c], Jimmy Mamesah[c], Tri Alamsyah Azis[d], Yusuf L.Tamarol[d], Heni Sulastri[e], Stella M. A. Puteri[e], Jimmi D. Saladi[f],Robin J. Dambudjai[g], Fenly Derek[h], Utary Dwi Pratiwi[i], Oki Pratama[j], Muzani[k], I Wayan Eka Dharmawan[l]

[a] Marine Science Study Program, Faculty of Fisheries and Marine Sciences, University of Sam Ratulangi
[b] Wildlife Conservation Society (WCS), North Sulawesi Province
[c] Dinas Kelautan dan Perikanan, North Sulawesi Province
[d] Balai Konservasi Sumberdaya Alam, North Sulawesi Province
[e] Balai Taman Nasional Bunaken, North Sulawesi Province
[f] Relawan Konservasi, North Sulawesi Province
[g] Perkumpulan Manengkel Solidarity
[h] Chaetodon Manado, North Sulawesi Province
[i] Seasoldier North Sulawesi Province
[j] Center for Coastal and Marine Resources Management (BPSPL), Makassar
[k] Faculty of Social Science, State University of Jakarta
[l] Research Centre for Oceanography, Indonesian Institute of Sciences

[1*] schaduw@unsrat.ac.id

Informasi artikel

Sejarah artikel
Diterima : 11 Agst 2021
Revisi : 11 Sept 2021
Dipublikasikan : 30 Sept 2021

Kata kunci:
Indeks Kesehatan Mangrove
Karbon Vegetasi
Mangrove
Bunaken

ABSTRAK

Tujuan dari penelitian ini untuk mengetahui kondisi kesehatan mangrove di Nusantara Dian Centre (NDC) Kelurahan Molas, Kecamatan Bunaken, Kota Manado, Provinsi Sulawesi Utara. Metode yang digunakan dalam kegiatan penelitian ini yaitu menggunakan metode garis transek petak/plot untuk mengambil data struktur komunitas dan metode hemisperichal photography untuk mengambil data persentase tutupan kanopi. Data yang didapat semuanya di input dan kemudian dianalisismenggunakan aplikasi MonManguntuk mengetahui mangrove healthy indeks (MHI). Dari hasil analisis menunjukan rata-rata kondisi kesehatan mangrove pada tiap stasiun masuk dalam kategori moderate/Sedang, serta kondisi tutupan kanopi mangrove masih masuk dalam kategori baik dengan nilai kerapatan dalam kategori sedang dan jarang berdasarkan Kepmen LH No 201 Tahun 2004 tentang kriteria kerusakan mangrove. Untuk potensi simpanan karbon vegetasi mangrove didapatkan total nilai rata-rata sebesar 32,91 ton C/ha atau 120,80 ton CO2/ha.

Keywords:
Mangrove Health Index
Vegetation Carbon
Mangroves
Bunaken

ABSTRACT

The research aims at determining the health condition of mangroves in the Nusantara Dian Center (NDC) in Molas Village, Bunaken District, Manado City, North Sulawesi Province. The research method used the line transect plot method to collect community structure data and the hemisperichal photography method to collect canopy cover percentage data. The obtained data were entirely inputted and analyzed using the MonMang application to determine the mangrove healthy index (MHI). The analysis results showed that average health condition of the mangroves at each station was in the moderate category, and the condition of the mangrove canopy cover remained in the good category with the density value of medium and rare category based on the Minister of Environment Decree Number 201 of 2004 concerning the criteria for mangrove damage. For the potential carbon storage of mangrove vegetation, total average value reaches 32.91 tons C/ha or 120.80 tons CO2/ha.

Introduction

The potential of Indonesia's forest resources is very abundant, one of which is the mangrove forest. Mangrove forest is a type of forests that has a characteristic because it grows and develops along the coast or river estuaries due to tide influence (Kusmana, 2010 in Bachmid et al., 2020). Mangrove plant communities flourish in tropical areas and are able to adapt to extreme environmental conditions such as high temperatures, high salinity, extreme tides, high sedimentation, and substrate conditions with lack of oxygen or without any oxygen (Alongi, 2009 in Schaduw, 2018).

Indonesia's mangrove forest areas are the highest of totally 3,112,989 ha or 22.6% of the world's total mangrove areas if compared to other countries that have mangrove forests (Giri et al., 2011). However, unfortunately more than 30% of the mangrove forest areas in Indonesia has lost in the period of 1980 – 2005 (FAO, 2007). The degradation of mangrove forests in Indonesia is due to various factors, i.e. the conversion of mangrove forests into various development activities, such as residential growth areas, dock buildings and canals; agricultural and plantation areas as well as for oil and gas exploration activities. Myers & Patz (2009) have stated that the increasing need for and dependence on natural resources in coastal areas is a pressure for the sustainability of coastal ecosystems.

The decline quality and quantity of mangrove forests can affect the economic life of coastal communities, such as lower fish catches and fishermen's income (Mumby et al., 2004). Moreover, it can deteriorate the balance of ecosystems and habitats as well as the extinction of fish species, marine biota and coastal abrasion (Polidoro et al., 2010). High mangrove degradation is also due to the lack of strict law enforcement in Indonesia (Kathiresan & Bingham, 2001).

The overall health condition of the mangrove ecosystem can affect the condition of two other ecosystems in coastal areas, i.e. seagrass and coral reefs. The typical mangrove root system physically provides protection for seagrass and coral reefs from the dangers of sedimentation. Mangrove roots function to filter out large materials carried by rivers into the sea. This effort prevents the waters from becoming cloudy and therefore, there is no buildup and accumulation on the surface of seagrass and coral. Mangrove forests are ecologically a habitat for the growth of coral biota at certain phases of their lives. When the mangrove ecosystem is maintained, there are more choices for coastal communities in meeting the economic needs in an area. The research purpose was to determine the mangrove health condition and to estimate the potential vegetation carbon in the marine tourism area of Nusantara Dian Center (NDC).

Method

The research method used herein is the survey method of direct field observation to know the mangrove condition. The field observations will know the structure of the mangrove community with the line transect method by making a perpendicular line from the coast to the land in a kind of a map or plot (Cox in 1969 in Abrat et al., 2014). Taking pictures to determine the percentage of mangrove canopy coverage uses the hemisperichal photography method or techniques for canopy characteristics by using photographs to estimate solar radiation and plant characteristics through a remote viewing lens (Anderson, 1964). Moreover, the two parts are inputted and processed using the MonMang application.

Data collecting were carried out at 3 research stations with the station codes, i.e. M01, M02 and M03 (M = Mangrove – 01 = serial number of the stations). At each station, 3 plots measuring 10x10 m2 were made (Figure 2). All individuals contained in the plot/plot are inputted for the number, type, and diameter of the tree trunk, as well as other supporting data such as number of seedling and sapling, tree height, amount of marine debris, tree felling, substrate types, and photos of canopy coverage are taken for further analysis to determine Mangrove Health Index / MHI (Mangrove Health Index) using the MonMang application.

Results and discussion

Based on the monitoring of mangrove forest condition in Nusantara Dian Center (NDC)

presented in Table 3, it shows that Avicennia marina species dominates the dominant substrate type at each station, i.e. muddy sand because it is in accordance with the types of substrate located on Batanta and Salawati Islands, Raja Ampat Islands District, West Papua Province, where the types of substrate that dominates the Avicennia marina zoning is mud and muddy sand (Schaduw, 2019 and Schaduw, 2020c).

Table 1. Research Location and Subtrate Types

No	Stations	Coordinate		Substrate Types	Coverage Notes
		Longitude	Latitude		
1.	M01	124.837	1.52939	Muddy Sand	Good
2.	M02	124.838	1.52902	Muddy Sand	Good
3.	M03	124.838	1.52863	Muddy Sand	Good

Individuals and Types of Mangroves

The number of individuals and species of mangroves found at each research station is presented in Table 4 and Figure 4. These shows the number of species in M02 and M03. There are 3 types, i.e. Avicennia marina, Avicennia alba, and Sonneratia alba despite the number of the individuals different, in M01 there are only 2 types, i.e. Avicennia marina and Sonneratia alba. The highest number of the individuals is in M01 as many as 36 ind/300 m2, while the lowest M02 is only 21 ind/300 m2. It is almost the same as the species found in Tongkaina Village, the mangrove species found here were R. Apiculata, Avicenia officinalis, and S. Alba (Sasauw et al, 2016; Tuwongkesong et al, 2018). Different from the case with Mantehage Island, the types of mangroves found at the two stations on Mantehage Island consist of 8 (eight) mangrove species, i.e. : R. mucronata, R. apiculata, R. stylosa, B. gymnorrhiza, B. cylindrical, C. tagal , S. alba, and L. littorea from 3 (three) families, i.e. : Rhizophoraceae, Sonneratiaceae, and Combretaceae (Lahabu et al, 2015; Schaduw 2015b)). In the protected marine area of Blongko Village, the mangrove vegetation consists of four families, with seven species. The mangrove families are Avicenniaceae, Meliaceae, Rhizophoraceae, and Sonneratiaceae. Meanwhile, 16 mangrove species in this village are Xylocarpus granatum, Avicennia lanata, Avicennia marina, Avicennia officinalis, Bruguiera gymnorrhiza, Rhizophora apiculata, and Sonneratia alba (Schaduw, 2015a and Schaduw, 2016a). In contrast to the species in Bunaken Island with five types of mangroves, i.e. Soneratia alba, Avicennia marina, Xylocarpus granatum, Rhizophora apiculata, and Bruguiera gymnorrhiza, which are divided into four families, i.e. Sonneratiaceae, Avicenniaceae, Meliaceae, and Rhizophoraceae (Schaduw, 2016b; Schaduw 2020). Nain Island located in Bunaken National Park has two types of mangroves, i.e. Rhizophora apiculata and Avicennia marinna from the Avicenniaceae and Rhizophoraceae families, respectively, with a mangrove area of 4.40 ha, and an average distance between trees of 1.02 m (Schaduw, 2018). A research in Kupang Bay Nature Park from six stations where vegetation sampling was conducted, 16 species of mangrove were found: Acanthus ilicifolius, Aegialitis annullata, Avicenia alba, A. lanata, A. marina, Bruguiera cyndrica, B. parvifflora, Ceriops tagal, Excoecaria agallocha, Lumnitzera racemosa, Osbornia octodonta, Rhyzophora apiculata, R. mucronata, R. stylosa, Sonneratia alba, and Xylocarpus granatum. These species come from 9 families, i.e.: Acanthaceae, Avicenniaceae, Combretaceae, Euphorbiaceae, Meliaceae, Myrtaceae, Plumbaginaceae, Rhizopho-raceae and Sonneratiaceae (Bessie et al, 2013). It differs from the types of mangroves found on Morowali coast, from the three types of mangroves there were Rhizophora apiculata, Sonneratia alba and Rhizophora stylosa (Schaduw, 2020b). The difference in the number of mangrove species depends on the types of substrate, the input of fresh water, the duration of standing water at high tide, the topography, and the geographical and climatic conditions of each region.

Table 2. Types of Mangrove at Each Research Station

No	TYPES OF MANGROVES	M01	M02	M03
1.	*Avicennia marina*	✓	✓	✓
2.	*Avicennia alba*	-	✓	✓
3.	*Sonneratia alba*	✓	✓	✓

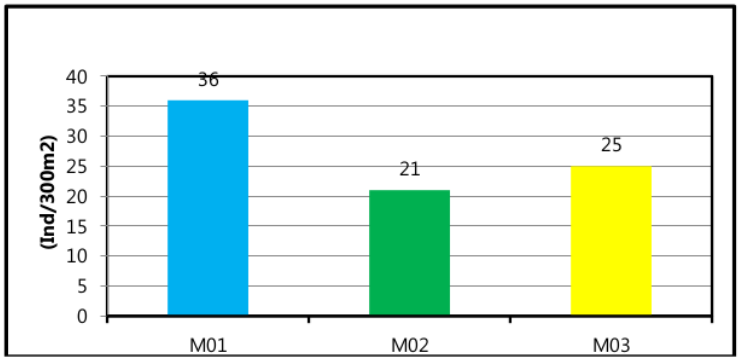

Figure 1. Diagram of total individuals per station

Percentage of Canopy Coverage and Mangrove Density

From the analysis results (Table 5), it can be shown that average percentage of mangrove canopy cover at each station is different. The highest percentage of the coverage is in M01 totaling 78.90 ± 1.47% and the lowest percentage is at M03 with 57.61 ± 4, 71%. From the analysis results when considered from Minister of Environment Decree No. 201 of 2004 concerning the criteria for mangrove damage, M01 is in the good category with a canopy coverage value of >75% and M03 is in the damaged category because it only has a canopy coverage value of <50% . For the density value, it can be shown that M01 has the highest density value of 1200 ind/ha which is in the medium category, while the lowest is M02 which is only 700 ind/ha which is in the rare category. This research is in line with the previous researches where the value of mangrove canopy coverage in Meras Village amounts to 82.78% and Molas Village 61.24%. However, if it is viewed from Minister of Environment Decree No. 201 of 2004 concerning the criteria for mangrove damage, it includes the very dense category with medium/moderate canopy coverage. The highest species density value was seen in Tiwoho Village for R. mucronata species totaling 0.133 ind/m2 and the relative density value was 76.92%, while the lowest value was in Tongkaian/Bahowo Village for B.gymnorrhiza and R.mucronata species totaling 0.003 ind/m2. and the relative density value was 3.333%. Furthermore, the highest species diversity index value was in Tongkaian Village with a value of 1.203 and the lowest value in Molas Village was 0.562, while the highest evenness index value was in Tongkaina Bahowo Village with a value of 11.14 and the lowest value in Molas Village was 3.474 (Anthoni et al, 2017).

Mangrove Health Index

Based on the analysis results using the MonMang application presented in Table 5, it can be shown that the mangrove health condition based on the Mangrove Health Index (MHI) shows M02 with average highest MHI percentage value of 69.79%, and M03 as the lowest of only 48 ,66%. From these results, there are several indicators that determine the good or bad condition of mangrove health, such as garbage. It can be shown due to the high amount or percentage of waste coverage on M03 and therefore, the MHI percentage value at this station is low. Marine debris is one of the most influential indicators. It can interfere the growth and regeneration and death of mangroves. This is in line with the response of Hartoni and Agusalim, 2013 in Djohar et al., 2020, that waster entering the mangrove

ecosystem will have a negative impact on mangroves and the associated bi[31] therein. Djaguna et al, (2019) have stated that the types of marine debris commonly found at the research sites at Tongkaina Beach and Talawaan Bajo, such as plastic, rubber, metal, glass, and wood debris. However, the most common ty[2]e of debris is plastic debris. The total amount of macro-debris [2]nd meso-debris collected on the twelve observation transects was 481 species/items with [2]total weight of 1433, 38 gr/m2. A research on marine debris on the coast has been carried in the research of Schaduw et al (2021). The research results show that on the mainland there are 9 types of debris groups from 14 types of debris groups, i.e. glass; aluminum; paper, cardboard and wood; medical/personal device; paper plastic; foam plastic; plastic sheet and foam; rubber; ropes and wires are not for fishing. On the other hand, marine debris includes 7 types of glass debris groups; aluminum; paper, cardboard and wood; medical/personal device; paper plastic; foam plastic; plastic sheet and foam. Land debris has a higher total weight than that from marine debris. The debrus source definitely comes from from waste or human activities that are not processed or not disposed of in its place. The researcg of Kahar et al, (2020) have found that the density of inorganic debris in the Talawaan Bajo coastal mangrove ecosystem as a whole reaches 162 pots/900m2 (1,800 Pots/Ha) with a weight of 4392.11 grams/m2 (48,801.2 grams/ha). Moreover, the most dominating types of [2]arine debris is plastic debris with total number of 132 pots/900m2 (1,466 Pots/Ha) and total weight of 3131.55 grams/900m2 (34,795 grams.ha) and the highest waste. It is found at station 3, i.e. 62 pots/ha with a weight of 1608.73 grams/m2 (17.874.7 grams/ha).

Table 3. Table of Mangrove Health Index

St	Spec	%cover	Tre (m)	Diam eter (cm)	Density (ind/ha)	Important Value Index (IVI)		NuM of Seedl ing (ind/ m2)	Cut-Wood Occur ence (%)	Garba ge Cover age (%)	Mangrove Healthy Indeks (%)
						Min	Max				
M01	2 (Sa;Am)	78,90 ± 1,47	12.5	17.14	1200 ± 346,41	Sa: 132,02	Am: 300,00	7	0	25	63,93 (MODERATE)
M02	3 (Aa; Am; Sa)	75,94 ± 4,85	10.3	21.39	700 ± 200	Aa: 62,83	Am: 200,58	4	0	25	69,79 (MODERATE)
M03	3 (Aa; Am; Sa)	57,61 ± 4,71	10.8	18.72	833,33 ± 115,47	Aa: 60,28	Sa: 213,38	8	0	33	48,66 (MODERATE)

Potential Carbon

From the analysis results of the potential carbon presented in Table 6 and Figure 5, it can be shown that average highest carbon storage of mangrove tree stands is in M01, which is 59.28 tons C/ha, while the lowest is M03, which is 15.52 tons C. /Ha. The obtained results are higher if com[35]ed to those from Bachmid et al,. 2020 for the mangrove forest in Sarawet Village, East Likupang Sub-District, North Minahasa District totaling 52.90 tons C/ha. However, it is lower than the research results of Restuhadi et al., (2013) in Indragiri Hilir District totaling 159.46 tons C/ha. Moreover, mangrove sediments also have the potential to store carbon. The research of Verisandria et al (2018) has stated that average value of carbon content per depth in mangrove ecosystem sediments in the North Coast of Bunaken National Park differs. At the front and middle points of the mangrove forest, average highest carb[27] content in a depth layer of 60-100 cm reaches 160.37 Mg ha-1 and 178.26 Mg ha-1 respectively. Average carbon content value at the back point has the highest value in the 0-30 cm depth layer totaling 124.21 Mg ha-1.

The carbon stock is directly proportional to the biomass content. The greater the biomass content, the greater the carbon stock. [9]herefore, the amount of carbon storage in a vegetation depends on the amount of biomass contained in trees, soil fertility and the absorption capacity of the vegetation. Moreover, the value of tree

biomass is directly proportional to its carbon value. It is because the carbon content of an organic material amounts to 47% of the total biomass (IPCC, 2006 in Bachmid et al., 2020).

The carbon content in plants describes how much the plants can bind CO2 from the air. Some of the carbon will be used as energy for plant physiological processes and some will enter the plant structure and become part of the plant, for example cellulose stored in stems, roots, twigs and leaves (Bismark, et al. 2008 in Bachmid et al., 2020).

Table 4. Results of Estimated Potential Carbon in Mangrove Trees

Station	Biomassa (ton/ha)	Carbon (ton/ha)	Absorption CO2 (ton/ha)
M01	126.14	59.28	217.57
M02	50.94	23.94	87.87
M03	33.01	15.52	56.94

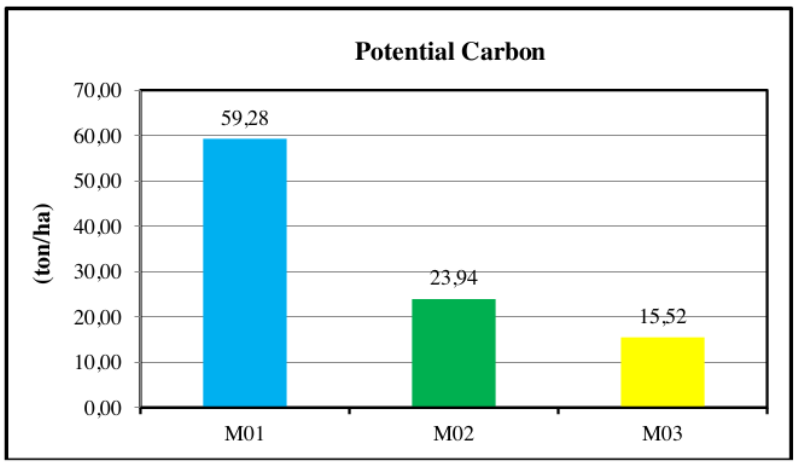

Figure 2. Diagram of Average Potential Carbon Storage Value at Each Station

Conclusion

From the analysis results of the Mangrove Health Index (MHI) it shows that average mangrove health condition at each station is in the moderate category, and the mangrove canopy coverage is in the good category with the mangrove density value of medium and rare category. It bases on the Minister of Environment Decree Number 201 Year 2004 regarding the criteria for mangrove damage. For the potential carbon storage of mangrove vegetation, moreover, average total value amounts to 32.91 tons C/ha or 120.80 tons CO2/ha.

Acknowledgment

Our thanks are due to the Wildlife Conservation Society (WCS); University of Sam Ratulangi; Faculty of Fisheries and Marine Science; North Sulawesi Province Department of Marine and Fisheries; Bunaken National Marine Park; BPSPL Manado; Manengkel Solidarity; Seasoldier Manado; and Manado's Nusantara Dian Center (NDC).

Reference

Abrar, M., Giyanto., Siringoringo, R.M., Edrus, I.N., Arbi, U.Y., Sihaloho, H.F., Salatalohi, AdanSutiadi. 2014. Monitoring Report (Baseline) on the Health of Coral Reef Ecosystems and Other Related Ecosystems. Pieh Island Marine Tourism Park and the surrounding Sea, West Sumatra Province (*Laporan Monitoring (Baseline) Kesehatan Ekosistem Terumbu Karang dan Ekosistem Terkait Lainnya. Taman Wisata Perairan Pulau Pieh dan Laut di sekitarnya, Provinsi*

Sumatera Barat). Oceanographic Research Center. Indonesian Institute of Science. 57 pp.

Anthoni, A, J.N.W. Schaduw., C. Sondakh. 2017. Percentage of mangrove coverage and community structure along the northern coast of Bunaken National Park (*Persentase tutupan dan struktur komunitas mangrove di sepanjang pesisir Taman Nasional Bunaken bagian utara*). Tropical Coasts And Seas Journal (*Jurnal pesisir dan laut tropis*). 2 (1), 13-21

Anderson, M.C. 1964. Studies of the wood-land light climate I. The photographiccomputation of light condition. Journal of Ecology 52: 27-41.

Bachmid, F.,J. N. W. Schaduw., C. F. A. Sondak., U. N. W. J. Rembet., S. V. Mandagi., D. A. Sumilat., dan A. Luasunaung. 2020. Potential Carbon Sequestration of Mangrove Forest in Sarawet Village, Dusun Kuala Batu, East Likupang Sub-District, North Minahasa District (*Potensi Penyerapan Karbon Hutan Mangrove Di Desa Sarawet Dusun Kuala Batu Kecamatan Likupang Timur Kabupaten Minahasa Utara*). Platax Scientific Journal (*Jurnal Ilmiah Platax*), 8 (2) : 152-158.

Bessie, D., J.N.W. Schaduw., M.T. Lasut. 2013. Community structure of mangrove at Marine Tourism Park of Kupang Bay, East Nusa Tenggara. Aquatic Science & Management. Special Edition May 2013 : 3-9

Dharmawan, I.W.E. & Pramudji. 2014. Guidelines for Monitoring The Mangrove Ecosystem Status (*Panduan Monitoring Status Ekosistem Mangrove*). COREMAP-CTI. Oceanographic Research Center. Indonesian Institute of Sciences. 46 pp.

Dharmawan, I.W.E., Suyarso; Ulumuddin, Y.I., Prayudha, B., Pramudji. 2020. Guide for Mangrove Community Structure Monitoring (*Panduan Monitoring Struktur Komunitas Mangrove*). PT. National Science Media (*Media Sains Nasional*). Bogor. 90pp

Djaguna, A., W. E. Pelle., J. N.W. Schaduw., H.W.K. Manengkey., Natalie D.C. Rumampuk1 , Erwin L.A. Ngangi2 . 2019. Identification of Marine Debris at Tongkaina Beach and Talawaan Bajo (*Identifikasi Sampah Laut Di Pantai Tongkaina Dan Talawaan Bajo*). Tropical Coasts and Seas Journal (*Jurnal pesisir dan laut tropis*). Vol 7. No. 3 (174-182)

FAO. 2007. The World's Mangroves 1980-2005. FAO Publisher. Rome. Italy

Giri, C., E. Ochieng, L. L. Tieszen, Z. Zhu, A. Singh, T. Loveland, J. Masek & N. Duke. 2011. Statusand distribution of mangrove forests of the world using earth observation satellite data. Global Ecology and Biogeography. 20: 154–159.

Djohar, M. A., F. B. Boneka., F., J. N. W. Schaduw., S. V. Mandagi., K. A. Roeroe., dan D. A.Sumilat. 2020. Analysis of Marine Debris and Gastropod Abundance in the Tongkaina Mangrove Ecosystem, North Sulawesi Province (*Analisis Sampah Laut Dan Kelimpahan Gastropoda Di Ekosistem Mangrove Tongkaina, Sulawesi Utara*). Platax Scientific Journal (*Jurnal Ilmiah Platax*), 8 (1) : 15-23.

Kahar M.G., J.N.W.Schaduw., N. D.C. Rumampuk., W. E. Pelle., C. Sondakh., J. F. Pangemanan. 2020. Identification of Inorganic Waste in the Mangrove Ecosystem of Talawaan Bajo Village, Wori Sub-District, North Minahasa District (*Identifikasi Sampah Anorganik Pada Ekosistem Mangrove Desa Talawaan Bajo Kecamatan Wori Kabupaten Minahasa Utara*). Tropical Coasts and Seas Journal (*Jurnal Pesisir dan Laut Tropis*). Vol. 8 No. 1 (1-6)

Kathiresan, L and B.L. Bingham. 2001. Biology of Mangroves and Mangrove Ecosystems. Advances in Marine Biology, 40: 81-251.

Decree of Republic of Indonesia's State Minister of Environment Number 201 of 2004 concerning Standard Criteria and Guidelines for Determining Mangrove Damage (*Keputusan Menteri Negara Lingkungan Hidup No. 201 tahun 2004 tentang Kriteria Baku dan Pedoman Penentuan Kerusakan Mangrove*).

Lahabu, Y., J.N.W. Schaduw., A.B. Windarto. 2015. Mangrove Ecological Conditions on Mantehage Island, Wori Sub-District, North Minahasa District, North Sulawesi Province (*Kondisi Ekologi Mangrove Di Pulau Mantehage Kecamatan Wori Kabupaten Minahasa Utara Provinsi Sulawesi Utara*), Tropical Coasts and Seas Journal (*Jurnal Pesisir dan Laut Tropis*). 2 (1) : 41-52

Mumby, P.J., A.J. Edwards, J.E. Arias-Gonzalez, K.C. Lindeman, P.G. Blackwell, A. Gall, M.I. Gorczynska, A.R.Harborne, C.L. Pescod, H. Renken, C.C.C. Wabnitz & G. Llewellyn. 2004. Mangroves enhance the biomass of coral reef fish communities in the Caribbean. Nature, 427(6974): 533-536.

Polidoro BA, Carpenter KE, Collins L, Duke NC, Ellison AM, *et al.* 2010. The Loss of Species: Mangrove extinction risk and geographic areas of global concern. PLoS ONE 5(4): e10095.

Restuhadi, F., A. Sandhyavitri., R. Sulaeman., D. Kurnia., I. Suryawan. 2013. Estimated Potential of Mangrove Forest Carbon Stock in Indragiri Hilir District, Riau Province (*Estimasi Potensi Cadangan Karbon Hutan Mangrove Di Kabupaten Indragiri Hilir Provinsi Riau*). Research and Development Center of Coastal & Marine Resources, University of Riau (*Pusat Penelitian dan Pengembangan Sumberdaya Pesisir & Laut, Universitas Riau*). 215 pp.

Sasauw, J., J.D. Kusen., J.N.W. Schaduw. 2016. Mangrove Community Structure in Tongkaina Village, Manado (*Struktur Komunitas Mangrove di Kelurahan Tongkaina Manado*). Tropical Coasts and Seas Journal (*Jurnal Pesisir Dan Laut Tropis*). 2 (1) : 17-22

Schaduw, J.N.W. 2015a. Mangrove Bioecology of Community-Based Protected Marine Areas, Blongko Village, Sinonsayang District, Minsel Regency, North Sulawesi Province (*Bioekologi Mangrove Daerah Perlindungan Laut Berbasis Masyarakat Desa Blongko Kecamatan Sinonsayang Kabupaten Minsel Provinsi Sulut*). LPPM UNSRAT Journal in the Field of Sciences and Technology (*Jurnal LPPM UNSRAT bidang Sains dan Teknologi*). 2 (1) 89-102

Schaduw, J.N.W. 2015b. Sustainability of Mangrove Ecosystem Management on Mantehage Island, Wori Sub-District, North Minahasa District, North Sulawesi Province (*Keberlanjutan Pengelolaan Ekosistem Mangrove Pulau Mantehage, Kecamatan Wori, Kabupaten Minahasa Utara, Provinsi Sulawesi Utara*). LPPM UNSRAT Journal in the Field of Sciences and Technology (*Jurnal LPPM UNSRAT bidang Sains dan Teknologi*), 2 (2) : 60-70

Schaduw, J.N.W. 2016a. Evaluation of Mangrove Ecosystem Management in Protected Marine Areas, Blongko Village, Sinonsayang Sub-District, South Minahasa District, North Sulawesi Province (*Evaluasi Pengelolaan Ekosistem Mangrove Pada Daerah Perlindungan Laut Desa Blongko Kecamatan Sinonsayang Kabupaten Minahasa Selatan Provinsi Sulawesi Utara*). SPATIAL Journal of Geographic Information and Communication Media (*Jurnal SPATIAL Wahana Komunikasi Dan Informasi Geografi*). 16 (2) : 27-38

Schaduw, J. N. W. 2016b. Kondisi Ekologi Mangrove Pulau Bunaken Kota Manado Provinsi Sulawesi Utara. LPPM UNSRAT Journal in the Field of Sciences and Technology (*Jurnal LPPM UNSRAT bidang Sains dan Teknologi*) 3 (2) : 64-74

Schaduw, J. N.W. 2018. Distribution and Water Quality Characteristics of the Small Island Mangrove Ecosystem, Bunaken National Park (*Distribusi Dan Karakteristik Kualitas Perairan Ekosistem Mangrove Pulau Kecil Taman Nasional Bunaken*). Indonesian Geographic Magazine (*Majalah Geografi Indonesia*). 32 (1) : 40-49

Schaduw, J.N.W. 2018. Community Structure and Sustainability of Mangrove Ecosystem Management on Small Islands (Case in Nain Island, North Minahasa District, North Sulawesi Province) (*Struktur Komunitas Dan Keberlanjutan Pengelolaan Ekosistem Mangrove Pulau-Pulau Kecil (Kasus Pada Pulau Nain Kabupaten Minahasa Utara Provinsi Sulawesi Utara)*). Environmental Science Journal (*Jurnal Ilmu Lingkungan*). 16 (2) : 120-129

Schaduw, J.N.W. 2019. Community Structure and Percentage of Mangrove Canopy Closure on Salawati Island, Raja Ampat Islands District, West Papua Province (*Struktur Komunitas dan Persentase Penutupan Kanopi Mangrove Pulau Salawati Kabupaten Kepulauan Raja Ampat Provinsi Papua Barat*). Indonesian Geographic Magazine (*Majalah Geografi Indonesia*) 33 (1): 26-34

Schaduw, J. N. W. (2020a). Management Strategy Mangrove Ecosystem Base On Multy Criteria Decision Making Analysis (Case In

Bunaken Island, Manado City, Indonesia). Platax. 8 (1) : 77-88

Schaduw, J.N.W. (2020b). Mangrove Community Structure Morowali District, Central Sulawesi Province, Case In Maratape Village, Lafeu Village, And Labota Village. Platax 8 (2), 264-273.

Schaduw, J.N.W. (2020c). Percentage Of Mangrove Canopy Coverage And Community Structure In Batanta Island And Salawati Island, Raja Ampat Islands District, West Papua Province. Journal Aquatic Science and Management 8 (1), 28-34.

Schaduw J.N.W., F. Bachmid., S. Ronoko., K. Legi., D Oroh., V. Gedoan., H.F.V. Kainde., T. Pantouw., A. Tungka. 2021. Characteristics of Marine Debris in Malalayang Coastal Area, Manado City, North Sulawesi Province. Platax 9 (1) : 89-99

Tuwongkesong, H., S.V. Mandagi., J.N.W. Schaduw. 2018. Ecological study of mangrove ecosystems for ecotourism in Bahowo, Manado city (*Kajian ekologis ekosistem mangrove untuk ekowisata di Bahowo kota Manado*). Indonesian Geographic Magazine (*Majalah Geografi Indonesia*). 32 (2) 177-183

Verisandria, R.J., J.N.W. Schaduw., C.F.A. Sondak, M. Ompi., A. Rumengan., J. Rangan. 2018. Estimated Potential Carbon Potential in Mangrove Ecosystem Sediments in the Northern Coast of Bunaken National Park (*Estimasi Potensi Karbon Pada Sedimen Ekosistem Mangrove Di Pesisir Taman Nasional Bunaken Bagian Utara*). Tropical Coasts and Seas Journal (*Jurnal Pesisir dan Laut Tropis*). 1 (1) 81-97

Mangrove Health Index and Carbon Potential of Mangrove Vegetation in Marine Tourism Area of Nusantara Dian Center, Molas Village, Bunaken District, North Sulawesi Province

ORIGINALITY REPORT

18%	10%	16%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Universitas Sam Ratulangi Student Paper	2%
2	www.scilit.net Internet Source	1%
3	Submitted to Universitas Negeri Jakarta Student Paper	1%
4	I Dewiyanti, Syamsiaturrofiah, S A ElRahimi, A Damora, M Ulfah. "Mangrove litter production in correlation to environmental properties of water in Pusong Cium, Seruway, Aceh Tamiang", IOP Conference Series: Earth and Environmental Science, 2021 Publication	1%
5	Joshian Nicolas William Schaduw. "Mangrove Community Structure Morowali District, Central Sulawesi Province, Case In Maratape Village, Lafeu Village, And Labota Village", Jurnal Ilmiah PLATAX, 2020 Publication	1%

6	journal.ugm.ac.id Internet Source	1 %
7	anzdoc.com Internet Source	1 %
8	ojs3.unpatti.ac.id Internet Source	1 %
9	E Kezia, B Nurkin, B Bachtiar, S Millang, Muh. Restu, S H Larekeng. "Potential of mangrove stands carbon deposits in the north part Pannikang islands, Barru Regency, South Sulawesi province", IOP Conference Series: Earth and Environmental Science, 2019 Publication	1 %
10	Submitted to Universitas Andalas Student Paper	1 %
11	Sodikin, S R P Sitorus, L B Prasetyo, C Kusmana. "Spatial Analysis of Land Adjustment as a Rehabilitation Base of Mangrove in Indramayu Regency", IOP Conference Series: Earth and Environmental Science, 2018 Publication	<1 %
12	Joshian N.W. Schaduw. "Percentage of mangrove canopy coverage and community structure in Batanta Island and Salawati Island, Raja Ampat District, West Papua	<1 %

Province", AQUATIC SCIENCE & MANAGEMENT, 2020
Publication

13	Joshian Nicolas William Schaduw. "Estimation of Carbon Stored Mangrove Vegetation in Small Islands Bunaken National Park", Jurnal Ilmiah PLATAX, 2021 Publication	<1 %
14	Yostan Lahabu, Joshian N. W. Schaduw, Agung B. Windarto. "Kondisi Ekologi Mangrove Di Pulau Mantehage Kecamatan Wori Kabupaten Minahasa Utara Provinsi Sulawesi Utara", JURNAL PESISIR DAN LAUT TROPIS, 2015 Publication	<1 %
15	media.neliti.com Internet Source	<1 %
16	ejournal.undip.ac.id Internet Source	<1 %
17	D Yoswaty, B Amin, Nursyirwani, A Diharmi, M A Wibowo, A Hendrizal. "Analysis of marine debris and mangrove forest density in Purnama village, Dumai city, Riau province", IOP Conference Series: Earth and Environmental Science, 2021 Publication	<1 %
18	ojs.uajy.ac.id Internet Source	<1 %

19	Juwari -, Daddy Ruhiyat, Marlon Ivanhoe Aipassa. "Growth Analysis of Rhizophora Mucronata Mangrove in Ngurah Rai Forest Park (Sanur) Bali Province, Indonesia", Energy and Environment Research, 2020 Publication	<1 %
20	Mangrove Ecosystems of Asia, 2014. Publication	<1 %
21	I Tahir, R C Kepel, R Jamaluddin. "Assessment of mangrove condition of Mare Island, North Maluku, Indonesia", IOP Conference Series: Earth and Environmental Science, 2021 Publication	<1 %
22	Nafiri C. Patuwo, Wilmy E. Pelle E Pelle, Hermanto W.K. Manengkey, Joshian N.W. Schaduw, Indri Manembu, Edwin L.A. Ngangi. "KARAKTERISTIK SAMPAH LAUT DI PANTAI TUMPAAN DESA TATELI DUA KECAMATAN MANDOLANG KABUPATEN MINAHASA", JURNAL PESISIR DAN LAUT TROPIS, 2020 Publication	<1 %
23	www.researchgate.net Internet Source	<1 %
24	www.scriptiebank.be Internet Source	<1 %
25	Dena Indriawan, Ankiq Taofiqurrohman, Indah Riyantini, Ibnu Faizal. "Assessment of Risk	<1 %

Levels of Mangrove Forest Due to Oil Spill in Muara Gembong, Bekasi Regency", E3S Web of Conferences, 2021
Publication

---

26 Donny M Bessie, Joshian N Schaduw, Emil Reppie, Markus T Lasut. "Community structure of mangrove at Marine Tourism Park of Kupang Bay, East Nusa Tenggara", AQUATIC SCIENCE & MANAGEMENT, 2013
Publication

<1 %

---

27 Rio Verisandria, Joshian Schaduw, Calvyn Sondak, Medy Ompi, Antonius Rumengan, Jety Rangan. "Estimasi potensi karbon pada sedimen ekosistem mangrove di pesisir Taman Nasional Bunaken bagian utara", JURNAL PESISIR DAN LAUT TROPIS, 2018
Publication

<1 %

---

28 backoffice.neonatologia.it
Internet Source

<1 %

---

29 journal.ipb.ac.id
Internet Source

<1 %

---

30 Frian Patra, Ridwan Lasabuda, Adnan S. Wantasen. "Structure Of Mangrove Communities In Baturapa Village, Lolak District, Bolaang Mongondow Regency", JURNAL PERIKANAN DAN KELAUTAN TROPIS, 2019
Publication

<1 %

31	Geraldo Thimoty Sundah, Joshian N. W. Schaduw, Veibe Warouw, Deislie R.H. Kumampung et al. "Waste Inventorization Inorganic In The Mangrove Ecosystem Bunaken Island For The East Part", Jurnal Ilmiah PLATAX, 2021 Publication	<1 %
32	mafiadoc.com Internet Source	<1 %
33	www.neliti.com Internet Source	<1 %
34	C. Giri. "Status and distribution of mangrove forests of the world using earth observation satellite data : Status and distributions of global mangroves", Global Ecology and Biogeography, 01/2011 Publication	<1 %
35	H M Jelita, R Ginting, S F Ayu. "Economic valuation of mangrove forests at Secanggang, Langkat", IOP Conference Series: Earth and Environmental Science, 2019 Publication	<1 %
36	Hasanuddin, Irma Sribianti, M Daud, Saharuddin. "The level of damage and estimation of rehabilitation value in the Lantebung Mangrove Ecotourism, Makassar	<1 %

City", IOP Conference Series: Earth and Environmental Science, 2021
Publication

37	I Akhrianti, A Gustomi. "Important value aspect of mangrove community at coastal area of Pangkalpinang City, Bangka Island", IOP Conference Series: Earth and Environmental Science, 2020 Publication	<1 %
38	I Wayan Eka Dharmawan. "Mangrove health index distribution on the restored post-tsunami mangrove area in Biak Island, Indonesia", IOP Conference Series: Earth and Environmental Science, 2021 Publication	<1 %
39	Joshian Nicolas William Schaduw, Fihri Bachmid, Stephen Ronoko, Kunio Legi et al. "Characteristics of Marine Debris in Malalayang Coastal Area, Manado City, North Sulawesi Province", Jurnal Ilmiah PLATAX, 2021 Publication	<1 %
40	R Haryanti, A Fahrudin, H A Susanto. "Analysis degradation of mangrove vegetation in Tangerang District, Banten Province", IOP Conference Series: Earth and Environmental Science, 2020 Publication	<1 %

41	www.aensiweb.net Internet Source	<1%

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		