

Participation of community in mangrove conservation in coastal area of the Valentine Strait, West Seram, Maluku, Indonesia

MARLON I. AIPASSA^{1,2,*}, MARTHA E. SIAHAYA^{3,**}, HENDRIK S.E.S. APONNO⁴, YOSEP RUSLIM^{1,***}, ROCHADI KRISTININGRUM¹

¹Faculty of Forestry, Universitas Mulawarman. Jl. Penajam, Kampus Gunung Kelua, Samarinda 75123, East Kalimantan, Indonesia.
Tel.: +62-541-735089, Fax.: +62-541-735379, *email: marlon.ivanhoe@gmail.com, ***email: yruslim@gmail.com

²Graduate Program of Environmental Sciences, Universitas Mulawarman. Jl. Sambaliung, Kampus Gunung Kelua, Sempaja Selatan, Samarinda 75123, East Kalimantan, Indonesia

³Politeknik Pertanian Negeri Samarinda. Jl. Samratulangi, Kampus Gunung Panjang, Samarinda 75131, East Kalimantan, Indonesia.
Tel.: +62-541-260421, Fax.: +62-541-260680, **email: marthasiahaya@gmail.com

⁴Faculty of Agriculture, Universitas Pattimura. Jl. Ir. M. Putuhena, Kampus Poka, Ambon 97233, Maluku, Indonesia

Manuscript received: 6 January 2023. Revision accepted: 30 April 2023.

Abstract. Aipassa MI, Siahaya ME, Aponno HSES, Ruslim Y, Kristiningrum R. 2023. Participation of community in mangrove conservation in coastal area of the Valentine Strait, West Seram, Maluku, Indonesia. *Biodiversitas* 24: 2467-2474. A mangrove forest is composed of mangrove plants and constitutes a crucial ecosystem in coastal areas. It is a vital source for maintaining aquatic ecosystems between the sea, coast, and land. Additionally, it provides benefits to humans, such as contributing to a more comfortable climate and weather conditions that can prevent natural disasters. However, the mangrove in the Valentine Strait area (West Seram, Maluku, Indonesia) is threatened by land conversion, leading to damage and loss. Some people are trying to preserve and maintain mangrove in their area. Therefore, the aim of this research was to describe the actions of the local community in the area, using the concept of cultural capital. A combination of qualitative and quantitative methods was used, and both primary and secondary data were collected. Primary data were gathered directly from the research location, while secondary data were obtained through local community information, various websites, and documents related to the management of natural resources. Additionally, key informants, including local community leaders, Kewang, and LPPM Maluku (NGO), were interviewed to collect relevant data on the cultural capital possessed by the community. The data for identifying mangrove species were calculated and tabulated to determine the species density in the Valentine Strait area. Furthermore, the collected community data were analyzed using cultural capital theory. The results indicate that community has started to reapply the concept of cultural capital of the Sasi tradition as ecological knowledge to maintain and preserve mangrove; hence, ensuring conservation in the Valentine Strait area. Mangrove forests have become home to fish, shrimp, and crabs and are also important for birds, primates, and reptiles.

Keywords: Community, cultural capital, mangrove, *sasi*, Valentine Strait

INTRODUCTION

Forests possess significant economic, ecological, and social values, commonly called ecosystem services, that sustain countless livelihoods (Björstig and Sténs 2018; Baciú et al. 2021). Over 350 million people worldwide rely on forests and derive their livelihoods from their resources (Chao 2012; Langat et al. 2016). Conservation and sustainable use of forests play an important role in global environmental sustainability (Haji et al. 2021).

One forest ecosystem type is mangrove coastal, which has many functions, such as a coastal defense against natural disasters (Unnikrishnan et al. 2013; Spalding et al. 2014; Lestyningrum et al. 2017). Mangroves are coastal areas' main woody habitats and carbon sinks (Shedage et al. 2019). These forests consist of various marine biota, food producers, drink, medicine, firewood, building materials, and a source of income for residents (Castellanos-Galindo et al. 2017; Islamy and Hasan 2020). Moreover, they are also conservation, educational area, and cultural identity (Kissinger et al. 2020; Kristiningrum et al. 2020; Siahaya et al. 2021). Spalding and Parrett (2019)

stated that the importance of mangrove for cultural services, especially their use in recreation and tourism, has received little attention despite frequently being mentioned in reviews.

The Buano people use the forests for customary activities because of their sacred places. For instance, sacred places are prohibited from being used to prevent forests destruction. According to Mulyadi et al. (2022), this also occurs in several areas in Indonesia, such as Nagari Sungai Buluh, Mollo, Kampung Naga, Manggarai, and Dayak Kanayatn where indigenous people regard forests as clean and sacred places.

In addition to the population growth and the expansion of economies and industries, the demand for natural resources is increasing, which in turn is putting greater pressure on these resources. This phenomenon is evidenced by several facts, one of which is the steady increase in the exploitation of mangrove each year. This was also stated by Cahyaningsih et al. (2022), where Indonesia has the largest area of mangrove globally. However, as the human population increases, the area and quality of mangrove decrease. Population growth is consistent with increased

human activities that lead to deforestation and the degradation of mangrove forests.

Buano indigenous people are still faithful to the implementation of various traditions, and customs passed down from their ancestors since ancient times to protect and preserve the natural environment. Pratiwi et al. (2019) also stated that indigenous peoples know how to sustain and use forest resources. The involvement of local community in managing forests is an important aspect of sustainable development. This is the opinion of Hong and Saizen (2019) that local and community-based forest management is a multi-dimensional approach where different stakeholders play a role in achieving common goals.

Local communities are part of the forest ecosystem (Shishany et al. 2022). Ngo et al. (2021) stated that the culture of the people in the forest interacts with the ecosystems, forming and adapting to the natural environment. Based on the preceding, this research aims to explain community's cultural capital in preserving the Valentine Strait mangrove on Buano Island, West Seram District, Maluku, Indonesia.

MATERIALS AND METHODS

Research area

This research was conducted between June to August 2022 in the Valentine's Strait in coastal zone of Buano Island, West Seram, Maluku (Moluccas), Indonesia. The materials used were Landsat 8 imagery, administrative boundary maps, and topographical maps of Indonesia

(Figure 1. Map of the research locations at the Valentine Strait, West Seram, Maluku, Indonesia).

Procedures

This research used a combination of qualitative and quantitative methods. The quantitative and qualitative data were intermingled to produce a complete result. However, more emphasis was placed on qualitative aspects in further data operation.

The data collected in this research were primary and secondary. Primary data were collected directly at the research location, while secondary data were obtained through local community information, various website, and documents on the management of natural resources in coastal area of the Valentine Strait. Furthermore, the key informants consisted of the village leader, *Kewang*, and LPPM Maluku (NGO).

The vegetation data were collected using the Point Centered Quarter method (Mitchell 2010) at each station. The measured mangrove trees were located at the point-centered quarter in 2 area, namely, mangrove area far from the settlements (natural) and near community settlements, where each area has 4 stations. The population observed was trees with a diameter at breast height ≥ 20 cm, which were in the plot area from quadrats 1 to 4. Furthermore, the samples were taken from 4 quadrats, and the selected trees were the closest in each quarter (Mitchell 2010).

The animal data collection was carried out through direct observation and indirectly through footprints, excrement, sounds, and information from local people. In contrast, the research site is under the characteristics of animals that always change location.

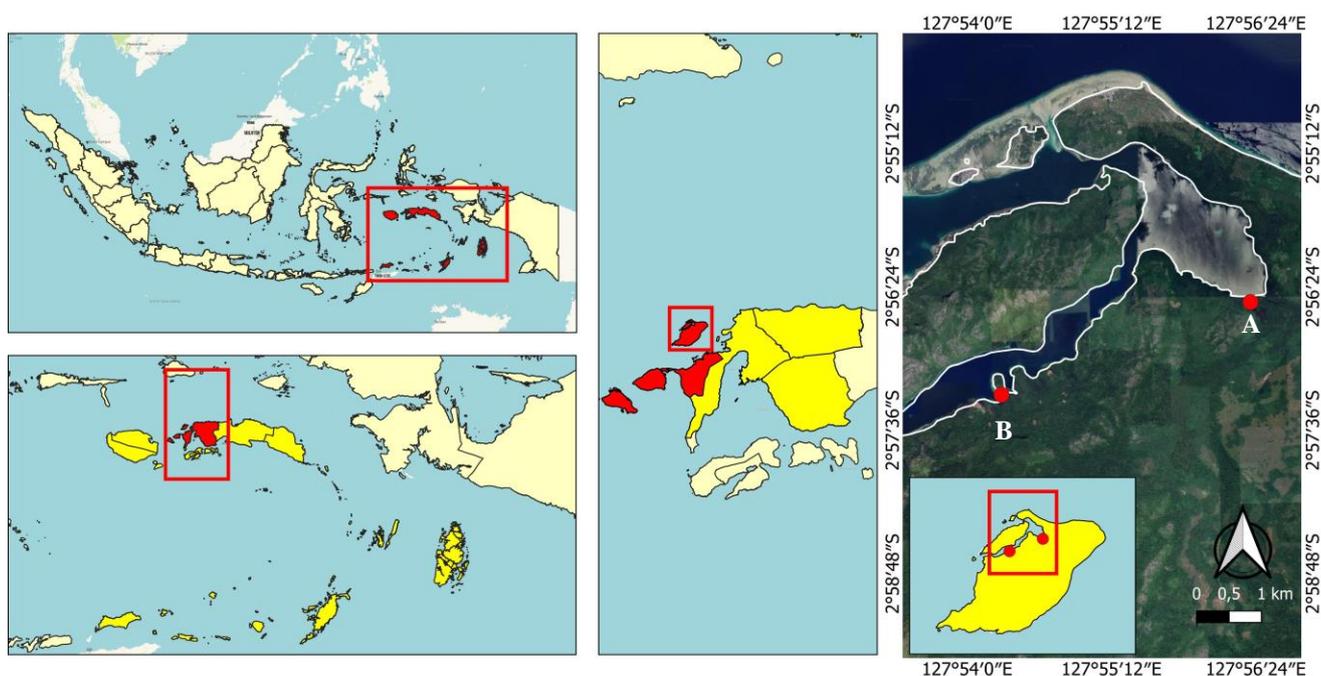


Figure 1. Map of the research locations at the Valentine Strait, West Seram, Maluku, Indonesia. A. 127° 56' 21.432" E . 2° 56' 31.479" S; B. 127° 54' 17.174" E . 2° 57' 18.026" S

Data analysis

Data for identifying mangrove species were calculated and tabulated to determine the species density in the Valentine Strait Area using Cottam and Curtis (1956) method. The standard criteria for damage to mangrove forests established by the Ministry of Environment RI No. 201 in 2004 can be seen in Table 1.

To calculate the quantitative values of mangrove parameters was as follows:

The average distance of individual trees to the measurement point from Cottam and Curtis (1956):

$$d = \frac{d_1 + d_2 + d_3 \dots\dots\dots + d_n}{n}$$

Where:

d : Distance of individual trees to measurement points in each plot

n : The large number of trees

(d)2 : Average area/individual, namely the average surface area of land occupied by one individual plant

Species density from Cottam and Curtis (1956)

$$d_i = \frac{n_i}{A}$$

Where:

di : Species density

ni : Total number individual of species

A : Total area of measurements plots

The collected data from community were analyzed using cultural capital theory (Berkes and Folke 1994) by examining traditional ecological knowledge and local institutions in the local community.

Table 1. Standard criteria for damage to mangrove forests

Condition	Criteria	Density (tree ha ⁻¹)
Good	Very dense	>1,500
	Medium	≥1,000 - <1,500
Damage	Rare	<1,000

RESULTS AND DISCUSSION

Mangrove ecosystem in the Valentine Strait coastal area

The research location covered an area of 25,000 square meters divided into two separate mangrove area. Area A, spanning 12,000 square meters, was situated at the coordinates 127° 56' 21.432" E, 2° 56' 31.479" S, and was located a considerable distance from community settlements. Furthermore, Area B was situated near the settlements, covering 13,000 square meters and at the coordinates 127° 54' 17.174" E, 2° 57' 18.026" S. Table 2 presents mangrove conditions at both locations in the Valentine Strait.

Based on the results, the highest density value in mangrove natural area (A) was found at stations I, II, III, and IV, namely *Rhizophora mucronata*, *R. apiculata*, *Avicennia alba*, and *Sonneratia alba* at 1,550, 1,600, 825,

and 575 individuals/m², respectively. The highest species density value in the rehabilitation mangrove area (B) for the dense category was at stations I, III, and IV, namely *R. apiculata*, *R. mucronata*, and *Xylocarpus molucensis* at 2,050, 1,600, and 1,500 individuals m⁻², while the medium category was station II, namely *Bruguiera gymnorhiza* at 1,250 individuals m⁻². The predominated species were *R. apiculata* in both area and *R. mucronata*, while *X. molucensis* was found in mangrove rehabilitation area, as shown in Figure 2. In Pangempang Beach, one species that dominated mangrove ecosystem was *R. apiculata* (Aipassa et al. 2022). The research conducted by Kristiningrum et al. (2019) in the Mentawir Village and Rafiq et al. (2020) in Mandeh Bay of West Sumatra stated that *R. apiculata* and *R. mucronata* dominate in the area.

In the natural mangrove area (A) at each observation station, the density of mangrove species in the very dense category was only found at stations I and II, while III and IV were rare because the natural mangrove area is in the front zone directly facing the sea.

The comparison of mangrove species in the natural (A) and rehabilitation area (B) showed that location (B) was denser, reaching 2,050 individuals m⁻². At this location, it was deliberately planted, hence, the density of mangrove species was higher (denser). It is hoped that the people living around mangrove forests will always maintain and protect the rehabilitation area. Therefore, community must participate in rehabilitating mangrove area that have been damaged.

The Valentine Strait mangrove in the bay is one of the ecosystems with an important role in coastal community of Buano Island, both ecologically and economically. Firdaus et al. (2021) also stated that mangrove provide benefits and services to local community along the coast, particularly fishing community in Lampung Bay. Furthermore, coastal ecosystem of Valentin's Strait also includes karst reefs, seagrasses, coral reefs, and coastal forests, as shown in Figure 2. These ecosystems provide productive natural resources as a source of food and leisure for tourist area. As part of coastal ecosystem, the mangrove ecosystem along the coast of the Valentine's Strait makes a significant contribution. These benefits include physical protection against waves, wind, and storms (McIvor et al. 2012; del Valle et al. 2020).

Table 2. Mangrove condition in the Valentine Strait, West Seram, Maluku, Indonesia at two locations

Station	Species	Species density	Criteria
(A) Natural area (far from community settlement)			
I	<i>Rhizophora mucronata</i> Lam.	1550	Very dense
II	<i>Rhizophora apiculata</i> Blume	1,600	Very dense
III	<i>Avicennia alba</i> Blume	825	Rare
IV	<i>Sonneratia alba</i> Sm.	575	Rare
(B) Rehabilitation area (near community settlement)			
I	<i>Rhizophora apiculata</i> Blume	2,050	Very dense
II	<i>Bruguiera gymnorhiza</i> (L.) Lam.	1,250	Medium
III	<i>Rhizophora mucronata</i> Lam.	1,600	Very dense
IV	<i>Xylocarpus molucensis</i> (Lam.) M.Roem.	1,500	Very dense

Mangrove can protect settlements, buildings, and agriculture against strong winds and seawater intrusion. The forests also play an important role in coastal protection against storms. The capacity to develop their territory in the sea's direction is important in forming new lands. Mangrove serves as a barrier to natural abrasion of seawater and reduces the impact of tsunami waves. Besides having beautiful beaches and rich underwater charm, the Valentine Strait has mangrove tourist destinations with cool nature. Some wildlife (Figure 3) can also be found in the Valentine Strait Mangrove area, such as various birds, i.e., Gosong Maluku (*Eulipoa*

wallacei G.R.Gray 1861), *elang-laut perut-putih* (*Haliaeetus leucogaster* Gmelin 1788), *mandar besar* (*Porphyrio porphyrio* Linnaeus 1758), *sikatan kelabu* (*Myiagra galeata* G.R.Gray 1861), *perling ungu* (*Aplonis metallica* Temminck 1824), reptiles such as *biawak maluku* (*Varanus indicus* Daudin 1802), *soa-soa* (*Hydrosaurus amboinensis* Schlosser 1768), mammals such as *kuskus* (*Phalanger sp.*), and crustaceans such as *kepiting bakau* (*Scylla serrata* Forskål 1775), *udang windu* (*Penaeus sp.*), and mermaids (*Dugong dugon* Müller 1776).



Figure 2. Some mangrove species from Valentine Strait, West Seram, Maluku, Indonesia. A. *Rhizophora mucronata*; B. *Rhizophora apiculata*; C. *Xylocarpus molucensis*; D. Corals were overgrown by mangrove

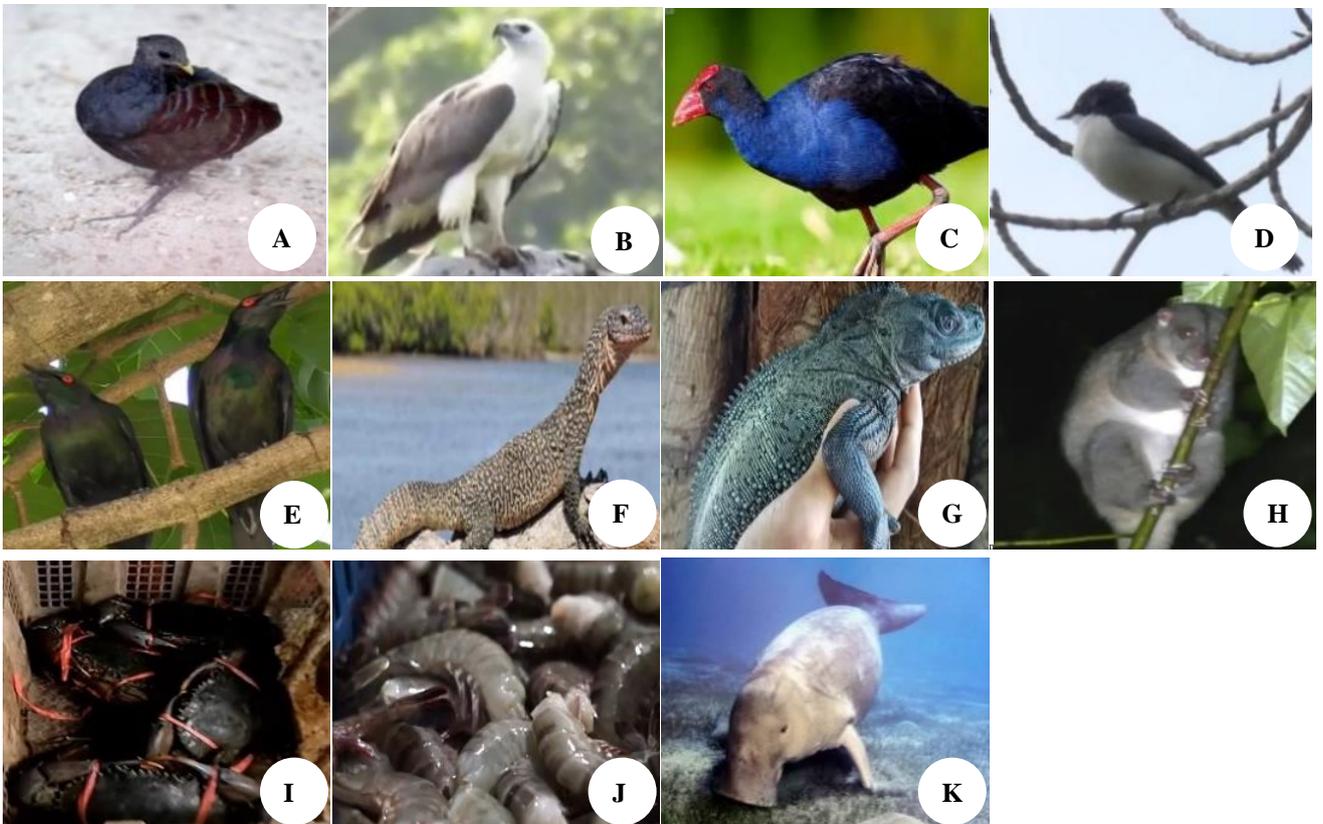


Figure 3. Fauna found in mangrove area of the Valentine Strait, West Seram, Maluku, Indonesia: A. *E. wallacei*; B. *H. leucogaster*; C. *P. porphyria*; D. *M. galeata*; E. *A. metallica*; F. *V. indicus*; G. *H. amboinensis*; H. *Phalanger sp*; I. *S. serrata*; J. *Penaeus sp.*; K. *D. dugon*

Socio-culture

Buano people occupy two main villages in the island's coastal area, divided into North and South Buano. In addition, there are also immigrant community from the Buton tribe from Southeast Sulawesi, who was thought to have migrated to this island 300 years before Indonesia's independence. Migrant community occupy several villages called Petuanan. They were located on the west coast to the north of the island of Buano and have been formed administratively in hamlets.

Socio-economic

The distribution of educational attainment for Buano graduates from junior high school was higher than elementary and high school. Community education is one factor influencing the understanding of mangrove conservation, and the results show that people's education varies greatly. The number of uneducated people was 22.46%, who did not finish elementary school 12.46%, graduated from elementary school 11.98%, junior high school 33.65%, high school 12.66%, undergraduate level 4.36%, and diploma level 1.06%. Meanwhile, for undergraduate level graduates, it was 1.30%, postgraduate 0.05%, and doctoral degrees 0.02%.

Livelihood

Concerning livelihood, 80% of individuals in the Buano island community are fishermen and farmers. Fishermen catch demersal and pelagic fish and only a small proportion practice aquaculture. Fishery production from Buano Island was sold to Seram and Ambon Island. Marine catches were purchased directly by fish traders from the hamlets of Kawa, Pelita Jaya, and Masika and their surroundings on the Seram and Ambon islands. Many people on the island of Buano, especially men, also work as loggers using chainsaws.

Mangrove wood such as *R. Apiculata*, *S. alba*, and *A. alba* was mostly used to burn cajuputi oil refining furnaces. This was also the cause of the reduced density of mangrove species in area near and far from settlements. Logging for firewood has become the main occupation of fishing

community. Firewood was also very important for community, especially for the poor, when the price of fuel oil increased. Since mangrove wood can generate higher heat energy when compared to others, the destruction of the forests continues to occur. According to Sathe et al. (2013), in the Konkan area of India, the residents nearby utilize mangrove as a source of energy. This condition makes the people around the forests always cut down mangrove wood to fulfill their daily needs.

The head of the community institute for the participation in development (LPPM) Maluku, Mr. Piet Wairisal, stated that before the counseling from NGOs (LPPM Maluku) in 2017, mangrove encroachment occurred along the coast of Huhua hamlet, as shown in Figure 4. However, there was biodiversity in this area that needed to be protected, such as Buano Kehicap/Black-headed Monarch (*Symposiachrus boanensis* Bemmell 1939). The environmental impact would be very small because mangrove forests can renew themselves when the logging activities are conducted correctly and only take a small portion each year.

The efforts to prevent mangrove degradation in Huhua Hamlet were performed by increasing the local community's understanding of the functions and roles. The preservation or maintenance of the ecosystems as habitats will impact the maintenance of marine life to support the Buano people's economy and future generations.

Coastal abrasion has resulted in several losses that have predominantly impacted the residents living along the coast due to erosion caused by tidal waves. The environmental quality of fisheries resources has been adversely affected because of the damage inflicted upon the ecosystems and coral reefs, leading to a decline in production. Furthermore, the cutting down mangrove for firewood has led to seawater intrusion into the mainland.

Numerous studies in the past have emphasized the significance of mangrove restoration and the need for effective conservation management with varied perspectives and goals. Ellison et al. (2020) argued that rehabilitated and restored mangrove ecosystems have important ecological, economic, and social values for coastal community.



Figure 4. A. Residential community around mangrove; B. Mangrove timber exploitation around mangrove in the hamlet of Huhua (Photo source: LPPM Maluku 2018)

The people of Buano, individually and in groups, have been motivated to plant the forests by Community Development Participation Institute (LPPM Maluku) since 2017. Community awareness has emerged after counseling by the LPPM Maluku and the desire to obtain better fish catches. Berkes and Folke (1992) stated that community's ability to return the natural environment to its original status after being damaged by exploitation was a cultural capital. In natural resource management, cultural capital refers to factors that provide the means and adaptations for human community to deal with the natural environment. Understanding a society's cultural capital could be an important lesson in conserving natural resources such as mangrove forests.

TEK and local institutions in mangrove conservation

Fundamentally, the culture of the Buano people provides diverse cultural institutions and local wisdom. This wisdom can become an important social capital in the responsible management of natural resources when properly used. The natural resources were sensitive to the value of local knowledge, cultural customs, and belief values.

From a conceptual perspective, there were three categories of local wisdom and their function in community, namely (i) the human relationship with God, or supernatural powers which were thought to have power over life, (ii) human relations with others as a means of solidarity, closeness, and fraternity, (iii) the relationship between the natural environment and humans to live in harmony and sustainability.

Acknowledging the local wisdom deeply rooted in the Buano community is crucial as it encompasses noble values that community has upheld throughout their lives. One of these values is the sustainable protection and management of the environment and natural resources. Berkes (2018) defined local ecological knowledge as a cumulative collection of practices and beliefs developed by adaptive processes and passed down through cultural transmission.

According to interviews and direct observations conducted in the field with the *Kewang*, the *Sasi* tradition has started to fade from memory. However, activities to revive *Sasi* values managed by LPPM Maluku in damaged mangrove area were able to control forests destruction. The utilization of mangrove wood has been significantly limited since mid-2017 due to the prohibition of mangrove logging imposed by the village government and the local community leaders.

Sasi is a limitation against consuming specific resources at a particular period in order to manage sustainable resources. It regulates how community manage forests and marine resources in applying customary punishments to violators of *Sasi* laws. *Sasi* could be a social capital in maintaining the balance between humans and nature. During the implementation, community was prohibited from picking certain fruits and products from the land and sea for a period determined by the customary leader. The role allows increasingly limited natural resources to grow and develop. In other words, biological and vegetable natural resources can be continuously conserved within a

certain period, allowing nature to restore its growth and development to achieve satisfactory results.

Based on interviews with the local community, mangrove are the food source for fish, shrimp, crabs, and clams. Therefore, the mangrove must be properly maintained when marine products are in abundance. For this reason, community voluntarily seeks to preserve mangrove area. Marine products were harvested with the aim of selling or as family consumption to fulfill the family economy. The sea and coast yield may substantially decline when mangrove are absent. In addition, community believed that the mangrove is important in protecting coastal area, especially their settlements, from abrasion and strong winds.

Furthermore, the local community received support through provision of seeds from the Maluku Watershed Management Center (BPDAS) and environmental conservation training as a form of concern for the government and community. During the training, participants consisting of elementary/junior high school/senior high school students who represented the training planted several tree species together. As an organization accountable for forests conservation, the Ministry of Forestry and Environment provides assistance and training to young students as environmental cadres to promote their love and concern for the environment. This training aimed to impart comprehension, motivation, and awareness among young individuals and to instill in them the realization that protecting the environment and planting trees is the responsibility of every virtuous human being.

From discussions with key village community leaders, training on environmental conservation was also provided by NGOs from LPPM Maluku for leaders of traditional institutions.

The methods of local community engagement in mangrove conservation comprise the following: (i) Educating community, who are the beneficiaries of mangrove resources, about the regulations governing life in the village and the use of natural resources. The village's custom was *Sasi*, namely sea (beach) *Sasi*, river *Sasi*, and land (forest) *Sasi*. Various linked parties continue to preserve the mangrove forests. Supervision was carried out by community, such as village institutions (Saniri Negeri and *Kewang*) and families with rights. Saniri Negeri is a custom forum for meetings of various social and customary institutions in Buano, while *Kewang* is a normal position for a traditional leader tasked with overseeing the village's natural resources. According to Uphoff (1986), institutions and organizations can exist simultaneously. Institutions are an organization that forms community groups with good rules to regulate relations between people and the management of the surrounding forest resources. (ii) Community whose source of livelihood is fishermen have the initiative and awareness to plant mangrove. (ii) Community collect organic and inorganic wastes lodged in mangrove roots during floods and high tides. Rubber shoes and plastic mineral water bottles were recycled as a float for seaweed farming.

This description highlights how environmental factors have influenced the integration of community awareness

regarding mangrove in the Valentine Strait. Cultural perception of mangrove as a “tree of life” has significant implications for conservation and emphasizes the importance of promoting community involvement in protecting the environment. This was also pointed out by Salampessy et al. (2015) that community understands cultural capital as an effort to preserve natural resources, especially mangrove. The important role of traditional ecological knowledge of community has strongly influenced conservation of mangrove in Ambon Dalam Bay.

Efforts to manage mangrove forests by community and local government were considered inadequate to maintain and increase the viability of the ecosystem in the Valentine Strait around Huhua, hamlet. For this reason, community should implement management recommendations by collaborating with relevant agencies such as the Agriculture, Forestry, and Fisheries Extension Coordinating Agency and the Maritime Affairs and Fisheries Office of Maluku Province to conduct counseling about the functions and roles of mangrove ecosystems. Furthermore, these institutions should draft village regulations regarding managing mangrove ecosystems, such as prohibiting logging and other activities that negatively impact mangrove area. Rehabilitation and conservation activities are also necessary for mangrove species that grow quickly. The surrounding community must maintain mangrove and increase community participation in managing and utilizing the resources.

ACKNOWLEDGEMENTS

The authors are grateful to Piet Wairisal from LPPM Maluku NGOs (community institute for participation in development) and community of Buano, Maluku, Indonesia, who guided data analysis, provided photos that support the research, and reviewers who provided suggestions. The authors also thank anonymous reviewers for their constructive feedback to improve the manuscript.

REFERENCES

- Aipassa MI, Emil SJ, Erwiantono E, Kristiningrum R, Ruslim Y. 2022. Strategic design for sustainable tourism management on Pangempang Beach. *Proceed Intl Conf Trop Agrifood, Feed Fuel (ICTAFF 2021)* 17: 251-262. DOI: 10.2991/abstr.k.220102.038. [Indonesian]
- Baciu GE, Dobrotă CE, Apostol EN. 2021. Valuing forest ecosystem services. Why is an integrative approach needed? *Forests* 12 (6): 1-17. DOI: 10.3390/f12060677.
- Berkes F, Folke C. 1992. A systems perspective on the interrelations between natural, human-made and cultural capital. *Ecol Econ* 5 (1): 1-8. DOI: 10.1016/0921-8009(92)90017-M.
- Berkes F, Folke C. 1994. Investing in cultural capital for sustainable use of natural capital. In Jansson AM, Hammer M, Folke C, Constanza R (Eds.). *Investing in Natural Capital: The Ecological Economics Approach to Sustainability*. ISEE/Island Press, Washington, DC.
- Berkes F. 2018. *Sacred Ecology* (4th ed.). Routledge Taylor and Francis Group, New York. DOI: 10.4324/9781315114644.
- Björstig T, Sténs A. 2018. Social values of forests and production of new goods and services: The views of Swedish family forest owners. *Small-Scale For* 17 (1): 125-146. DOI: 10.1007/s11842-017-9379-9.
- Cahyaningsih AP, Deanova AK, Pristiawati CM, Ulumuddin YI, Kusumawati LIA, Setyawan ADWI. 2022. Review: Causes and impacts of anthropogenic activities on mangrove deforestation and degradation in Indonesia. *Intl J Bonorowo Wetl* 12 (1): 12-22. DOI: 10.13057/bonorowo/w120102.
- Castellanos-Galindo GA, Cantera J, Valencia N, Giraldo S, Peña E, Kluger LC, Wolff M. 2017. Modeling trophic flows in the wettest mangrove of the world: The case of Bahía Málaga in the Colombian Pacific coast. *Hydrobiol* 803 (1): 13-27. DOI: 10.1007/s10750-017-3300-6.
- Chao S. 2012. *Forest Peoples: Numbers Across the World*. Forest Peoples Programme, Moreton-in-Marsh, UK.
- Cottam G, Curtis JT. 1956. The use of distance measurements in phytosociological sampling. *Ecology* 37: 451-460. DOI: 10.2307/1930167.
- del Valle A, Eriksson M, Ishizawa OA, Miranda JJ. 2020. Mangrove protect coastal economic activity from hurricanes. *Proc Natl Acad Sci U S A* 117 (1): 265-270. DOI: 10.1073/pnas.1911617116.
- Ellison AM, Felson AJ, Friess D.A. 2020. Mangrove rehabilitation and restoration as experimental adaptive management. *Front Mar Sci* 7: 1-19. DOI: 10.3389/fmars.2020.00327.
- Firdaus M, Hatanaka K, Saville R. 2021. Mangrove forest restoration by fisheries communities in Lampung bay: A study based on perceptions, willingness to pay, and management strategy. *For Soc* 5 (2): 224-244. DOI: 10.24259/fs.v5i2.12008.
- Haji L, Valizadeh N, Hayati D. 2021. The role of local communities in sustainable land and forest management. In: *Spatial Modeling In Forest Resources Management*. Springer, New York. DOI: 10.1007/978-3-030-56542-8_20.
- Hong NT, Saizen I. 2019. Forest ecosystem services and local communities: Towards a possible solution to reduce forest dependence in Bach Ma National Park, Vietnam. *Hum Ecol* 47 (3): 465-476. DOI: 10.1007/s10745-019-00083-x.
- Islamy AR, Hasan V. 2020. Checklist of mangrove snails (Mollusca: Gastropoda) in south coast of Pamekasan, Madura Island, East Java, Indonesia. *Biodiversitas* 21 (7): 3127-3134. DOI: 10.13057/biodiv/d210733. [Indonesian]
- Kissinger, Syahrin NA, Muhayah NPR, Violet. 2020. The potential of mangrove forest as natural tourism area based on the flora-fauna characteristics and social aspect case study: mangrove forest in Angsana Village. *BIO Web of Conf* 20: 02004. DOI: 10.1051/bioconf/20202002004.
- Kristiningrum R, Lahjie AM, Masjaya, Yusuf S, Ruslim Y, Ma'rif A. 2020. Fauna diversity, production potential and total economic value of mangrove ecosystem in Mentawir Village, East Kalimantan, Indonesia. *Biodiversitas* 21 (5): 1940-1953. DOI: 10.13057/biodiv/d210522. [Indonesian]
- Kristiningrum R, Lahjie AM, Masjaya, Yusuf S, Ruslim Y. 2019. Species diversity, stand productivity, aboveground biomass, and economic value of mangrove ecosystem in Mentawir Village, East Kalimantan, Indonesia. *Biodiversitas* 20 (10): 2848-2857. DOI: 10.13057/biodiv/d201010. [Indonesian]
- Langat, DK, Maranga EK, Aboud AA, Cheboiwo JK. 2016. Role of forest resources to local livelihoods: The case of East Mau Forest Ecosystem, Kenya. *Intl J For Res* 2016: 1-10. DOI: 10.1155/2016/4537354.
- Lestyningrum RA, Mahmudi M, Harahab N. 2017. The biodeversity of mangrove in Ngantep Coastal, Malang District. *J Sustain Dev Nat* 8 (1): 13-18. [Indonesian]
- LPPM (Lembaga Penelitian dan Pengabdian kepada Masyarakat) Maluku. 2018. Hasil pemetaan partisipatif. Program revitalisasi, kearifan lokal dalam pengelolaan sumberdaya alam di Pulau Buano. Lembaga Partisipasi Pembangunan Masyarakat (LPPM), Maluku. [Indonesian]
- McIvor AL, Spencer T, Möller I, Spalding M. 2012. Storm surge reduction by mangrove. *The Nature Conservancy and Wetlands International. Natural Coastal Protection Series: Report 2. The Nature Conservancy and Wetlands International*. <https://www.nacionmulticultural.unam.mx/mezinal/docs/3151.pdf>
- Mitchell K. 2010. Quantitative Analysis by the Point-Centered Quarter Method. *ArXiv, Cornell*. DOI: 10.48550/arXiv.1010.3303
- Mulyadi A, Dede M, Widiawaty MA. 2022. The role of traditional belief and local wisdom in forest conservation. *J Geo Gea* 22 (1): 55-66. DOI: 10.17509/gea.v22i1.43702. [Indonesian]
- Ngo TTH, Nguyen TPM, Duong TH, Ly TH. 2021. Forest-related culture and contribution to sustainable development in the northern mountain region in Vietnam. *For Soc* 5 (1): 32-47. DOI: 10.24259/fs.v5i1.9834.

- Pratiwi R, Nitibaskara TU, Salampessy ML. 2019. Kelembagaan masyarakat dalam pengelolaan hutan adat (Studi kasus di Kasepuhan Pasir Eurih, Desa Sindanglaya, Kecamatan Sobang, Kabupaten Lebak, Provinsi Banten). *Jurnal Belantara* 2 (1): 62-69. DOI: 10.29303/jbl.v2i1.131 [Indonesian]
- Rafiq M, Chairul, Muchtar E. 2020. The vegetation of mangrove forest in Mandeh Bay, West Sumatera-Indonesia. *Intl J Soc Sci World* 2 (1): 95-102. DOI: 10.5281/zenodo.3964175 [Indonesian]
- Salampessy ML, Febryano IG, Martin E, Siahaya ME, Papilaya R. 2015. Cultural capital of the communities in the mangrove conservation in the coastal area of Ambon Dalam Bay, Moluccas, Indonesia. *Proced Environ Sci* 23 (Ictcred 2014): 222-229. DOI: 10.1016/j.proenv.2015.01.034.
- Sathe SS, Lavate R, Bhosale LJ, Vasantraodada PD. 2013. Mangrove as source of energy for rural development with special references to Ratnagiri Shindudarg district MS0 India. *Biosci Discov* 4 (2): 198-201.
- Shedage S, Shrivastava PK, Behara LK. 2019. Carbon rich mangrove forests: An overview for strategic management and climate change mitigation. *Adv Res* 18 (2): 1-9. DOI: 10.9734/air/2019/v18i230084.
- Shishany S, Al-Assaf AA, Majdalawi M, Tabieh M, Tadros M. 2022. Factors influencing local communities relational values to forest protected area in Jordan. *J Sustain For* 41 (8): 659-677. DOI: 10.1080/10549811.2020.1847665.
- Siahaya ME, Matius P, Aipassa MI, Rayadin Y, Ruslim Y, Aponno HSES. 2021. Potential analysis of location, socio-culture and biodiversity as ecotourism attraction in Valentine Bay on Buano Island, West Seram, Maluku, Indonesia. *Biodiversitas* 22 (1): 438-448. DOI: 10.13057/biodiv/d220154. [Indonesian]
- Spalding M, McIvor A, Tonneijck F, Tol S, Eijk P. van. 2014. Mangroves for Coastal Defence. Guidelines for Coastal Managers & PolicyMakers. https://www.researchgate.net/publication/272791554_Mangroves_for_Coastal_Defence_Guidelines_for_Coastal_Managers_Policy_Maker
- Spalding M, Parrett CL. 2019. Global patterns in mangrove recreation and tourism. *Mar Policy* 110: 103540. DOI: 10.1016/j.marpol.2019.103540.
- Unnikrishnan, Singh A, Kharat M. 2013. The role of mangrove in disaster mitigation: A review. *Intl J Environ Sustain Dev* 11 (2): 164-179. DOI: 10.1007/978-3-642-31110-9_16.
- Uphoff NT. 1986. *Local Institutional Development: An Analytical Source Book With Cases*. Kumarian Press, West Hartford, Connecticut.