

CASE STUDY

The influence of legal compliance in farmer group on the growth and development of sustainable mangrove ecosystemE.K. Purwendah^{1,2}, N.A. Sasongko^{2,3}, H. Susanto², R. Mawardi², T. Cahyono², H.L. Susilawati^{2,*}, T. Wahyuni², D. Juhandi⁵, T. Rahman², A. Gustina⁴, I.D.S. Triana⁴, E. Pudyastiyi¹, O. Kusumaningsih⁶, T. Martini²¹ Faculty of Law, Wijayakusuma University, Purwokerto, Central Java, Indonesia² Research Center for Sustainable Production Systems and Life Cycle Assessment, National Research and Innovation Agency, Indonesia³ Indonesia Defense University, Indonesia Peace and Security Center, Bogor 16810, Indonesia⁴ Legal Research Center, National Research and Innovation Agency, Indonesia⁵ Horticultural Agribusiness, Polytechnic of Wilmar Business Indonesia, Deli Serdang, North Sumatra, 20371 Indonesia⁶ Faculty of Social Science and Political Science, Wijayakusuma University, Purwokerto, Central Java, Indonesia

ARTICLE INFO

Article History:

Received 26 November 2023

Revised 01 March 2024

Accepted 05 April 2024

Keywords:

Community participation

Farmer group

Legal compliance

Mangrove

Preparators

Sanctions

Sustainability

ABSTRACT

BACKGROUND AND OBJECTIVES: The limited role of law enforcement agencies in the vast area provides opportunities for local community to contribute to mangrove ecosystem protection. This study emphasizes the importance of sustainable legal adherence by mangrove farmer groups in protecting the ecosystem through self-defence or community policing. It is essential for farmer groups to work together with legal institutions in order to defend the mangrove ecosystem from potential harm. This study seeks to resolve legal uncertainties related to the regulation of natural resources. Legal protection is crucial to ensure sustainability of mangrove ecosystem.**METHODS:** This study used multi-aspect sustainability analysis and normative-empirical legal methods. Primary data were collected by administering questionnaires and engaging in discussions with the Krida Wana Lestari Farmer Group community in Ujung Alang, Cilacap, Central Java. The data obtained from questionnaire was assessed for its sustainability through the application of Multi-Aspect Sustainability Analysis. The analysis of sustainability value, which significantly impacts legal compliance in the future, was conducted using secondary data in the form of legal materials. This enabled the identification of priority areas for improvement.**FINDINGS:** Legal ambiguities in the protection and supervision of mangrove ecosystem require the participation of the Krida Wana Lestari Farmer Group community. Mangrove management involves the planting of seedlings and their subsequent utilization. Ecosystem protection is ensured through monitoring efforts within the Segara Anakan mangrove area, as well as through informal sanctions imposed by the local community in collaboration with the Nature Conservation Agency and the Village Trustee Non-Commissioned Officer.**CONCLUSION:** The limited role of law enforcement agencies provides opportunities for community to contribute to the protection. The role in conducting Jagawana Swakarsa (Community-based self-funded Forest Rangers) or community policing is crucial for sustainable mangrove ecosystem management. The engagement of farmer groups exemplifies the application of indigenous wisdom in preserving the environment, which is presently not regulated by the prevailing legal framework. The mangrove ecosystem provides farmers with economic benefits that contribute to their livelihoods. Not only do farmers have a strong social connection to the mangroves as their place of residence, but they also hold a political stake in ensuring the survival of these valuable ecosystems. Benefits, management, and monitoring aspects scored 100, 94.5, and 100, respectively. Sanctions aspect is sustainable with a score of 65 because forest guards and the authorities enforce forest destruction laws. Through their collaboration with the forestry police, they initiated community-driven endeavors. This united community plays a crucial role in enabling law enforcement to independently safeguard mangroves. The organizational significance lies in prioritizing regional law enforcement and fostering inclusive and comprehensive communication with the community.DOI: [10.22034/gjesm.2024.03.***](https://doi.org/10.22034/gjesm.2024.03.***)This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

NUMBER OF REFERENCES

70



NUMBER OF FIGURES

5



NUMBER OF TABLES

3

*Corresponding Author:

Email: hele007@brin.go.id

Phone: +6281325178040

ORCID: [0000-0002-2636-4422](https://orcid.org/0000-0002-2636-4422)

Note: Discussion period for this manuscript open until October 1, 2024 on GJESM website at the "Show Article".

INTRODUCTION

Indonesia stands out as the primary mangrove producer, contributing around 26 percent (%) and 29% to the global stock (Hamilton and Casey, 2016). Deforestation in the Indonesia occurs at a rate ranging from 0.26% to 0.66% annually (Goldberg et al., 2020). Blue carbon (C) mangrove ecosystems can absorb natural C (Uddin et al., 2023). The ecosystem is recognized as one of the top C storage systems worldwide, demonstrating production rates that rival those of tropical forests and coral reefs (Alongi, 2022). The presence of forest areas is of utmost importance in shielding coastal areas and preserving the natural habitats of wildlife. Additionally, these areas act as a valuable means to regulate the effects of global warming. The services are crucial for the environment, economy (Friess et al., 2020) and well-being of community living (Macreadie et al., 2019) in forest areas (Sumarga et al., 2023). The significance of mangrove ecosystems lies in their ecological, economic, and social advantages. At a local scale, these forests play a crucial role in providing ecosystem services, including food resources and sustainable livelihoods for communities in the vicinity (Wintah et al., 2023). Indonesia prioritizes the well-being of communities living around mangrove forests (Christie and Rayment, 2012) as a source of livelihood (Thuy et al., 2024). Intertidal forests in tropical-subtropical coastal areas demonstrate adaptability by providing essential coastline protection, supporting biodiversity, sustaining ecosystem functions, and contributing to human well-being (Giri et al., 2011). Mangrove wetlands protect shoreline biodiversity, ecosystem functions, and human well-being (Murray et al., 2022). Achieving the targets for reducing greenhouse gas emissions heavily relies on the significant contribution of the ecosystem (Chatting et al., 2022). Indonesia's coastal area management encountered a range of issues, including: 1) the biophysical degradation of coastal environments, such as coral reefs, population of fish, shoreline erosion, contamination, and sedimentation, 2) Conflicts concerning the exploitation and governance of coastal zones pose obstacles to achieving sustainable coastal management, and 3) Legal ambiguities arise due to the unclear ownership and management of maritime resources. Indonesia, recognized for its substantial mangrove C stocks, plays a pivotal role in global climate mitigation efforts (Murdiyarto et al.,

2023). At the national level, approximately 331.65 (\pm 222.26) square kilometre (km²) of forest are deforested annually (Fries and Webb, 2014; Zeng et al., 2021). According to Hamilton and Casey (2016), there has been a decline in deforestation on a global scale, with an annual rate of decrease ranging from 0.16% to 0.39%. This is because legal uncertainty issues are closely related to environmental degradation. The management of mangrove ecosystems is the state's obligation (Article 28H Paragraph (1) of the Indonesian Constitution) and the obligation of the community to actively participate in protecting the environment (Article 67), Environmental and Management Law, 2009. Indonesia has the world's largest mangrove forest, covering more than 24% of the total global area (PDASRH, 2021), which is approximately 3.36 million hectares (Mha) (Murdiyarto et al., 2023). Around 19,26% or 637,624 hectares (ha) of Indonesian (Winanti et al., 2023) total mangrove forests are in critical condition (Cameron et al., 2019), with very sparse vegetation cover (Murdiyarto et al., 2023). Myanmar, Malaysia, Cambodia, Indonesia, and Guatemala are facing a pressing challenge of mangrove loss. These countries are witnessing alarming rates of depletion in their mangrove forests, posing a serious threat to their coastal ecosystems. Over the course of the past 50 years, around half of the planet's mangrove forests have been decimated as a result of habitat loss stemming from the rapid expansion of the human population and the encroachment of invasive species into coastal regions (Friess et al., 2019), and rising sea levels attributed to climate change. Mangrove wetlands are highly threatened by rising sea levels (Murray et al., 2022). From 1990 to 2020, approximately 1.04 Mha of mangrove forests were destroyed (Long et al., 2022). Countries can increase mangrove restoration and the blue C ecosystem by aligning national commitments and plans with international policy frameworks. The dedication to reducing carbon emissions and achieving carbon equilibrium is crucial in order to fulfill both domestic and global decarbonization goals, as well as to reach the net zero target (Hashim et al., 2022). By 2023, mangroves are explicitly included in the national regulations of around 97 jurisdictions (Global Mangrove Alliance, 2023). Indonesia has officially ratified the Convention on Wetlands of International Importance, demonstrating

its commitment to preserving waterfowl habitats through Presidential Decree Number 48 of 1991, which also encompasses mangrove ecosystems. The government has been instructed to carry out comprehensive management initiatives for the betterment of the global community. Regulations on the management of coastal areas and small islands are outlined in Law Number 27 of 2007, which was amended by Law Number 1 of 2014. These regulations aim to efficiently regulate logging activities in fishing zones and encourage the adoption of sustainable management methods. However, it should be noted that this legislation does not offer direct safeguards for the conservation of mangrove ecosystems. Presidential Regulation Number 73 of 2012 recognises forests as life sustaining resources. Through National Strategy for Mangrove Ecosystem Management (SNPEM), community well-being requires conservation, preservation, and usage. Presidential Regulation of Indonesia Number 120 of 2020 focuses on mangrove restoration in degraded or critical areas by increasing rehabilitation through the Peat Restoration Agency. The decrease in mangrove forest land cover in Segara Anakan Cilacap from 1987-2016 was caused by increased rice fields and population density (Supriatna, 2023). Every year, plant species in the Kampung Laut region of Cilacap, Indonesia face the threat of extinction. Approximately 26 out of 35 species have disappeared due to various factors, including illegal logging for timber and forest conversion into shrimp ponds. These ponds are abandoned due to massive looting, declining productivity, and a lack of capital. The modifications in the condition and purpose of mangrove forests have the potential to influence the environmental support available to the surrounding areas. The Krida Wana Lestari Farmer Group community initially focused on restoring mangrove forests damaged by large-scale logging and shrimp pond development in 1994 and 1998, respectively. The mangrove land area in Segara Anakan covers 6,696.4 ha, with a high density of 41.3% on 2,7226 ha located at the Krida Wana Lestari farming community in Ujung Alang Village, Kampung Laut subdistrict (Ati, 2023). Investors from various areas, including Sulawesi, Lampung, East Java, West Java, and Pengandaran, acquired mining land by clearing thousands of ha to create shrimp ponds until 1999. The practice was short-lived, resulting in desolate land, with some

areas now converted into ponds. By 1999, numerous individuals experienced financial setbacks, prompting the farmer group community to repurpose abandoned shrimp ponds and deforested areas into profitable mangrove zones. Farming group contributes to mitigate greenhouse gas emissions and tackle climate change narrative (Kamyab, 2024). The participation of local communities, particularly farmer groups, has emerged as a crucial factor in guaranteeing the enduring conservation of mangrove ecosystems. The active involvement of farmer groups in the conservation, revitalization, and responsible utilization of mangrove ecosystems highlights their successful integration of traditional knowledge and modern conservation practices. The impact of adhering to legal requirements within the farmer groups on the expansion and progress of sustainable mangrove ecosystems continues to be a subject of significant investigation. The demand for increased expertise in legal compliance, community empowerment, and ecosystem resilience is evident, highlighting farmer groups as pivotal contributors to advancing the global goals for mangrove conservation and sustainable development. This study introduces an innovative strategy for resolving legal uncertainties related to the safeguarding and preservation of mangrove ecosystems. By combining normative-empirical legal techniques with Multi-Aspect Sustainability Analysis (MSA), this study uncovers the intricate connections between economic, social, and environmental factors, as well as the adherence of local communities to legal regulations. The innovation lies in the comprehensive assessment methodology used to identify priority areas for improvement, significantly impacting legal compliance in the future. The study highlights the pioneering role of the Krida Wana Lestari Farmer Group community in contributing to mangrove ecosystem protection through community-based initiatives such as *Jagawana Swakarsa* (Community-based self-funded Forest Rangers) or community policing. The assessment criteria for measuring sustainability revolves around the benefits and supervision of farmer groups that utilize mangroves as agricultural resources. This includes activities such as seeding, planting, harvesting, and utilization. Monitoring and guarding, along with implementing sanctions, are crucial activities for preserving and safeguarding the agricultural ecosystem, specifically the mangrove

ecosystems. In line with [Saberikamarposhti, \(2024\)](#). The findings of this study have the capacity to shape government policies by emphasizing the significant role of mangrove farming in climate change mitigation. The results of the analysis are projected to address existing limitations in sustainability values and legal adherence in the coming years. As outlined in Article 67 of Law Number 32 of 2009 on Environmental Protection and Management, legal ambiguities regarding the prevention of the destruction of mangrove ecosystems are mitigated through community participation in the fulfilment of obligations. The study's hypothesis suggests that combining government regulations with the involvement of local communities has the potential to enhance the sustainability of mangrove ecosystem management. The study aims to assess the legal compliance of community mangrove ecosystem management and supervision. This study was carried out at Kampung Laut, Segara Anakan, Cilacap Regency, Central Java, in 2023.

MATERIALS AND METHODS

Study area

The mangrove ecosystem area located in Segara Anakan, on the southern coast of Cilacap Regency, Central Java, Indonesia, is a lagoon connected to the Indian Ocean through a western outlet called Plawangan, and a tidal channel serving as the eastern outlet towards Cilacap. The geographical boundaries of the administrative area of Kampung Laut District lie between 108.8 - 109.0 East Longitude and 7.6 - 7.8 South Latitude, with an area of 146.14 km², a maximum temperature 33.9 degrees Celsius (°C), height of 100 meters (m) above sea level. Segara Anakan Lagoon is dominated by mangrove forests, with constitute most of the ecosystem. Another important area is Kolak Sekancil, an arboretum covering 6 ha and consisting of mangrove trees owned by the Krida Wana Lestari Farmer Group community as the driving force for conservation. Within Arboretum Kolak Sekancil, the farming community undertakes the conversion of mangroves into a range of commodities including food, beverages, batik dyes, tea, and coffee. Furthermore, they actively propagate forests for the purpose of selling. The protective barrier island, Nusakambangan, acts as a shield, safeguarding this area from direct exposure to the open sea. The dominant ecological feature in the

area is the presence of mangrove forests which form a large part of the ecosystem in Segara Anakan Lagoon. Cilacap Mangrove Forest lies in the western region of the regency, covering an area of approximately 51 ha ([Fig. 1](#)). The Krida Wana Lestari farmer group is known for being at the forefront of mangrove cultivation. Unlike most farmer groups in the area, they are primarily composed of fishermen and rice field farmers. The Krida Wana Lestari consists of 95 individuals, as it is composed of various sub-groups from different villages. Klaces Village has a population of 25, Ujung Gagak Village has 20 residents, and Ujung Alang Village is home to 50 people. Collaborating with law enforcement, a team of fifteen farmer group members participated in patrolling and monitoring the mangroves.

Data collection and analysis

Utilizing empirical normative legal analysis, this study is classified as an applied research. Its primary aim was to scrutinize the practical execution of positive legal provisions in relation to specific social events, with a notable emphasis on accomplishing predetermined objectives. The study began by analyzing applicable legal regulations that pertain to positive events within society. The process was carried out in two stages, namely examining normative law, including a deeper study of applicable normative law, such as basic principles with related theories, and the empirical application of legal provisions to specific events. A thorough examination of cases and legal documents was undertaken to elucidate the implementation of normative legal regulations. Evaluation of the sustainability of community legal compliance in mangrove management was performed through the utilization of multi-faceted sustainability analysis (MSA). The sustainability status measured was a combination of each aspect, namely mangrove use, sustainable mangrove management, supervision by the community, and the imposition of sanctions against destruction perpetrators. Sustainability assessment was determined by establishing an index value of 75-100 (highly sustainable), 50-75 (sustainable), 25-50 (low sustainable), and 0-25 (not sustainable). The data used consists of secondary and primary data. Secondary data sources contribute to understanding the basic principles of law, while primary legal materials consist of hierarchal regulations ([Muttolib,](#)

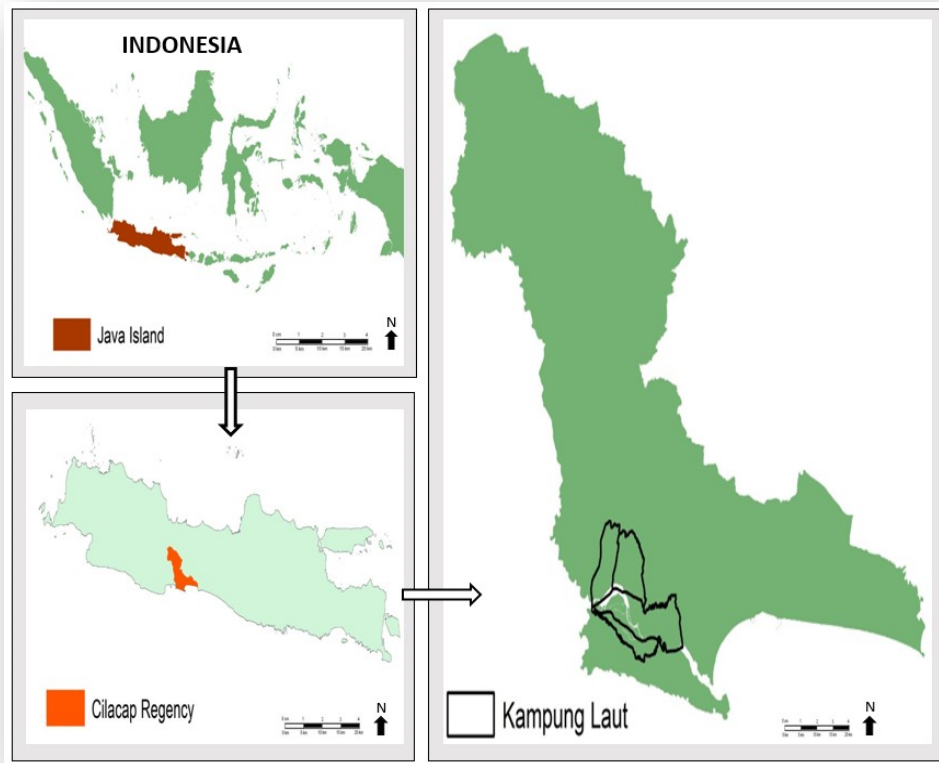


Fig. 1: Geographic location of the study area in the mangrove forest area of Ujung Alang, Kampung Laut, Cilacap, Central Java, Indonesia

2024). Essential legal resources are required to assess both direct and indirect incentives related to current regulations, ensuring adherence or facing potential penalties for non-compliance, offering rewards, or avoiding the risk of being unfairly treated as a driving force for behavior. The concept of reward and punishment serves as a fundamental mechanism for redistributing resources within society. It operates by assigning specific consequences, referred to as sanctions, to various behaviors, thereby offering either advantageous or disadvantageous outcomes (Hasan, 2023). Tertiary legal resources encompass materials that offer direction or explanation regarding primary legal sources. Primary sources of data pertain to information gathered through empirical research, such as firsthand investigation within the community (Kurniasih, 2023). This data was collected through pre-study observation techniques such as field observation, and an initial exploration of everything related to the required study. The field study includes

data collection activities in the area and interviews (Leeuw, 2016) with key informants from the Krida Wana Lestari Farmer Group community. This study fills a void in existing literature by investigating the long-term viability of adhering to legal regulations within the mangrove ecosystem management sector. Table 1 presents a comparison between this study and previous studies.

RESULTS AND DISCUSSION

Analysis of legal compliance sustainability by the Krida Wana Lestari community

MSA method was used to determine the sustainability value of legal compliance by the community in the aspects of mangrove use, sustainable mangrove management, supervision of mangrove management by the community, and sanctions against perpetrators. Table 2 illustrates the sustainability framework for legal compliance aspects utilizing MSA. The utilization and

Table 1: A comparison between this study and previous studies

Previous studies	Sources
<p>Mangrove forests serve important ecological, economic, and social functions. There is a lack of public awareness regarding these functions. It is essential for the government to intervene and bolster the local economy of communities living in close proximity to these forests. Moreover, challenges like forest conversion, illegal logging, and pond construction need to be addressed promptly.</p> <p>Methods: descriptive qualitative with interview data instruments.</p> <p>The rehabilitation of degraded mangrove ecosystems in Indonesia started in the 1960s. Over the years, there have been major improvements in the management approaches and understanding of the impact of mangrove rehabilitation on macro invertebrate diversity. The results emphasize the crucial elements that play a role in the achievement of mangrove restoration, aiming to preserve biodiversity. Various elements contribute to the evaluation of performance. These encompass sustained funding and upkeep, a greater willingness to adopt protective measures, heightened community backing, the utilization of a broader range of mangrove species, more extensive mangrove restoration initiatives, and the enforcement of supplementary strategies to mitigate wave impact in areas prone to erosion.</p> <p>The Climate Village program is dedicated to empowering communities in safeguarding mangrove ecosystems. The community's active role in preserving the mangrove ecosystem is motivated by the concept of empowerment, backed by government and stakeholders. This strategy seeks to improve the community's perspective and advocate for a socio-ecological approach.</p> <p>Methods: using both quantitative and qualitative approaches through in-depth interviews and observation</p> <p>Structural equation models and community involvement to enhance mangrove forest restoration. It is essential to involve community leaders, farmer groups, government support, and non-governmental organizations in order to improve community participation and restore mangrove forests.</p> <p>Methods: survey, qualitative descriptive analysis, and structural equation models analysis.</p>	<p>The role of communities in conserving mangrove forest to achieve sustainable development (Hardin, 2019)</p> <p>Effectiveness of community-based mangrove management for biodiversity conservation: A case study from Central Java, Indonesia (Damastuti, 2022)</p> <p>Community-based mangrove protection to mitigate climate change: A socio-ecological approach (Sarkamen, 2023)</p> <p>Enhancing coastal community participation in mangrove rehabilitation through structural equation modelling (Listiana, 2024)</p>
The current study	
<p>Farmer groups have successfully dealt with legal ambiguity by ensuring legal compliance in their cultivation of mangroves. These valuable resources are effectively utilized for economic endeavors such as seeding, planting, and social welfare. By establishing collaborations with legal frameworks, they have successfully cultivated a culture of adhering to legal regulations, even in the absence of government mandates.</p> <p>Methods: MSA and empirical normative legal methods. The evaluation and examination rely on diverse dimensions of economic and social environmental factors, along with adherence to community legal regulations. The information can be categorized into two groups: secondary data and primary data. Secondary data consists of legal regulations that pertain to farming communities, while primary data is gathered through observations, interviews, and questionnaires.</p>	<p>The influence of legal compliance in farmer group on the growth and development of sustainable mangrove ecosystem</p>

characteristics of mangrove wood demonstrate its significant advantages for the local community and meet the demands for exports overseas. The fruits serve as a source of food and sweets, whereas the mangrove waters support the local fisheries industry. The significance of community management in mangrove management is evident through various factors. These factors include the management of seedlings, replanting efforts, and the suitability

of planting in accordance with spatial planning concepts. Additionally, community empowerment in processing and utilizing mangroves, as well as the leadership role of community figures in driving management and empowerment, further contribute to the overall success. Furthermore, the participation of stakeholders in providing support adds to the effectiveness of mangrove management. The findings of this study are in line with the findings of [Pudji et](#)

Table 2: Aspects of legal compliance sustainability in mangrove management by the Krida Wana Lestari Farmer Group community

Aspect	Factor					
Mangrove use	Wood for export, houses and bridges construction	Leaves for culinary and beverage	Fruits for food and candy	Waters for community fisheries	Root for <i>Batik</i> (cloth) coloring	-
Mangrove management	Mangrove seedling by community	Replanting of mangrove by community	Planting mangrove according to the spatial planning of mangrove areas	Empowerment of the farming community	Role of community leaders in mangrove management	Stakeholder involvement in mangrove management
Mangrove management supervision by community	Community Supervision of Mangrove Ecosystem Areas	Mangrove monitoring areas	Community funding sources for mangrove ecosystem supervision	Community legal compliance in mangrove ecosystem areas	Involvement of law enforcement in mangrove monitoring	-
Sanctions against perpetrators	Awareness of sanctions by mangrove destroyers	Deterrent influence on mangrove destroyers	Involvement of law enforcement agencies in imposing sanctions	-	-	-

al. (2018), who indicated that human resources are the valuable assets in the management of mangrove ecosystem. The aspect of management supervision is conducted in the mangrove ecosystem area of Kampung Laut, Segara Anakan, Cilacap, Central Java with community facilities and infrastructure. Community legal compliance is very high and always coordinated with law enforcement agencies. Working as mangrove farmers has a substantial influence on the landscape of mangrove mitigation concerns.

Farmer associations can play a crucial role in improving social, economic, and political conditions. The approach to mangrove conservation has evolved from a top-down model to a more community-driven strategy. This strategy is founded on the principles of efficient and community-focused conservation, along with acknowledging rights to the environment (Petriello, 2022). As a result, the sustainability of the mangrove ecosystem is effectively maintained. The lack of understanding regarding sanctions for mangrove ecosystem destruction is evident through the ineffective enforcement of laws and inadequate socialization efforts. According to Astuti and Sulistyawati (2019), despite the important role village heads play as local leaders, the effectiveness of law enforcement officials in protecting mangrove forests is not yet at its peak. There is no deterrent influence on perpetrators and law enforcement agencies are required to enforce strict sanctions for the

sustainability of mangrove ecosystem management. The feature serves as a key element in identifying the actions needed to protect against degradation of the mangrove ecosystem, as outlined in Table 3.

Fig. 2 illustrates that the implementation of sanctions on those responsible for mangrove destruction is considered the least sustainable criteria, with a reported figure of 16.5. In scenarios 1 and 2, the figure can be increased to 66.5 with the assistance of community partnerships with law enforcement authorities in imposing legal sanctions to create a deterrent influence for destroyers. Table 3 illustrates a contrast of the existing legal compliance status of the Krida Wana Lestari farmer group community under three different scenarios. As mangrove utilization and its sustainability have received the highest score, there is no necessity for further improvement in this aspect. The aspect of supervision and sanctions needs concern due to its low score. The first scenario focuses on the financial benefits of using mangrove resources for the community, with a maximum score of 100; nevertheless, the average score overall is 64.68, with a sustainability level that is moderate. The second scenario demonstrates how the community's supervision or control element was able to raise its score to 85.25 with the assistance of law enforcement, nearing the maximum sustainability figure and earning a high sustainability score. Legal issues in mangrove ecosystem protection and

Community policing for sustainable mangrove management

Table 3. Sustainability status of legal compliance of the Krida Wana Lestari Farmer Group community

Row Aspect	Existing	Scenario 1 Economy aspect improvement	Scenario 2 sanction aspect improvement	Scenario 3 Sanction aspect improvement	Sustainability Criteria
1 Use of mangrove by community	100	100	100	100	0 – 25 Not sustainable
2 Sustainable mangrove management by community	89	94.5	94.5	94.5	25 – 50 Low sustainable
3 Supervision of mangrove management by community	53.2	60	80	100	50 – 75 Sustainable
4 Sanctions against mangrove destruction perpetrators	16.5	33.25	66.5	66.5	75 – 100 Highly sustainable
Average total	64.68	71.94	85.25	91.63	
Sustainability status	Sustainable	Sustainable	Highly sustainable	Highly sustainable	

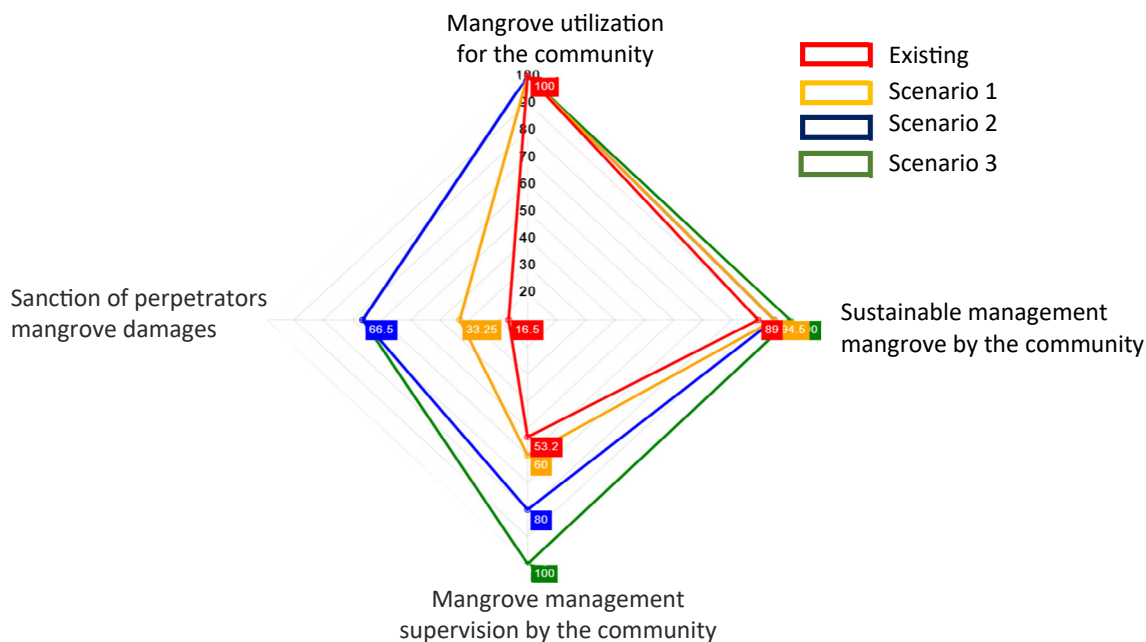


Fig. 2: Sustainability status of legal compliance in the Krida Wana Lestari Farmer Group community

supervision require the Krida Wana Lestari Farmer Group participation. By eliminating these legal uncertainties and clarifying mangrove conservation laws, farmer groups are more inclined to conserve. Enhanced regulations and legal assistance can help farmer groups grasp the importance of mangrove protection. Collaboration between legal entities

and farmers can foster a sense of community responsibility and improve conservation efforts. Engaging in mangrove conservation not only helps preserve the ecosystem, but also boosts the economic well-being of farmer communities, strengthens their social connection to the mangroves, and enhances their political investment in the preservation of

these vital habitats. This multifaceted engagement demonstrates that adherence to laws and regulations can motivate farmer groups to take a more active role in conservation efforts. Legal compliance is exemplified by farmer groups' assistance to the government in preserving the mangrove environment. Implementing environmental laws can be difficult, but it is increasingly crucial to ensure compliance with environmental standards. Despite the existence of well-established environmental regulations, law enforcement officials face a significant amount of work in effectively enforcing them (Purdy, 2010). The third scenario demonstrates an emphasis on working with law enforcement to increase sanctions to a maximum value of 66.5. The value of scenario three is low due to the illegitimacy of the sanctions imposed. Enforcing environmental laws may pose challenges, yet it is becoming more and more essential to guarantee adherence to environmental regulations. Despite the presence of established environmental laws, authorities responsible for enforcement encounter a substantial workload in ensuring their effective implementation. There is a recognised need for more effective management, incentive mechanisms, and regulations to drive and explore improvements in this area (Ogus, 2002). The objective of law enforcement is to ensure that appropriate measures are taken to safeguard the environment and ensure adherence to established regulations. It is expected that there will be a positive response to this legal proposal, with an emphasis on voluntary cooperation. The efficiency of law enforcement hinges on four essential principles: equitable and impartial enforcement of laws, uniformity in approach, focused initiatives, and openness in carrying out law enforcement operations (Ogus, 2002). The farmer groups and legal institutions, acting as partners in mangrove monitoring patrols, impose social sanctions, such as confiscation of mangrove wood, rather than legal sanctions. It is important to contemplate the adoption of more robust measures to effectively tackle the impact on the sustainability of ecosystems. Implementing legal consequences to discourage wrongdoers can enhance adherence to the law in the future, ultimately benefiting the mangrove ecosystem. This necessitates the involvement of community leaders and collaboration with law enforcement agencies.

Sustainable protection of mangrove ecosystem by Jagawana Swakarsa or community policing

According to Article 1 Number 30 (Law Number 32 of 2009, on Environmental Protection and Management), indigenous knowledge is a noble value that helps communities successfully conserve and manage the environment. Preservation of the environment is a key responsibility of the customary law community in specific regions, shaped by ancestral heritage, profound environmental ties, and value systems that govern economic, political, social, and legal frameworks. Community participation in environmental protection may include encouraging social involvement, seeking input, listening to opinions, considering suggestions, addressing concerns, and sharing information and reports. The community has a vital role in promoting awareness of environmental protection and management. Additionally, it aims to promote collaboration and build partnerships within the community, all while enhancing their skills and leadership abilities. The community works towards building resilience in conducting social oversight and preserving indigenous knowledge and culture for environmental conservation (Article 70 Paragraph 1, 2, 3, Law Number 32 of 2009, concerning Environmental Protection and Management). Law compliance is an obligation that must be fulfilled, and failure to comply will result in legal sanctions and consequences. In social compliance, sanctions are only carried out when the law is not adhered to and society acts as the judge. Therefore, law compliance tends to be coercive and can be categorized into 3 types, namely obedience due to fear of sanctions, which requires continuous monitoring, identification of compliance. The adherence to rules is primarily driven by the apprehension of jeopardizing interpersonal connections and the internalized commitment to uphold cherished principles. The conformity to societal norms does not transpire instantaneously but rather evolves gradually over time. These stages include the pre-conventional and conventional stages (Domie, 2023), where individuals obey the law stating the consequences when not followed and emphasize the recognition of the law containing the rules of the game in an upheld community (Valentini, 2023). The principle of legal compliance lies in the belief that individuals have a responsibility to uphold fairness, promote mutual benefit, and contribute to the overall social cooperation within a given system. The need for

this obligation arises when a party has already gained advantages from the system and aims to preserve those advantages. To ensure citizens' adherence to the law, they must fulfill their responsibilities, which encompass abiding by the law. The requirement to conform to rules and regulations stems from an individual's receipt of social benefits (Gremmen et al., 2018). Law enforcement does not necessarily have to be carried out by agencies. Community policing serves as an alternative form of law enforcement to manifest social compliance. Adherence to the law by individuals or communities enhances the legal culture, leading to internalized compliance. Furthermore, the law serves as a behavioral guide for residents, shaping community life patterns. Legal consciousness focuses on the orientation towards legality as a condition for legal mobilization, claiming rights to access the environment (Hoddy et al., 2023), and proving legal consciousness. In the subsequent stage, the law functions as a means of control for the community (Febbrajo, 2019). Legal awareness serves as a reference to protect areas, as performed by Forest Rangers or *Jagawana*. Forest Rangers in India are responsible for enforcing field-level regulations as outlined in the Indian Forest Act of 1927 and the Wildlife (Protection) Act (Vasan, 2002). Local villagers who become Forest Rangers are essential links between the community and the forestry department. They help in formulating conservation strategies and carrying out prevention initiatives. In the United States (US), Forest Rangers are described as officials responsible for protecting forests, parks, plantations, and nature reserves, as well as safeguarding parks, or places (Oxford Learner's Dictionary, 2005). In Indonesia, forest guarding or *Jagawana* originates from the Javanese language, where *jaga* and *wana* mean guard and forest, respectively. The process includes the activity of protecting forests as a legal culture derived from local wisdom (Oikonomakis, 2024). The modifications made to the institutions exert a profound influence on the social fabric, influencing aspects such as beliefs, perspectives, and behavioral patterns. Moreover, the structure brings about alterations in the functions, roles, mindsets, and attitudes of society. Community-based Forest Rangers (Hyunh et al., 2016), known as *Jagawana Swakarsa*, are recognized in various forms as embodying local wisdom. Lifuleo Mangrove Forest Community Surveillance Group (*Kelompok*

Masyarakat Pengawas/POKMASWAS) is in Timor Island, Kupang; Wana Tirta Group Community is in Temon, Kulonprogo; Greef Leaf POKMAWAS is in Daun, Sangkapura, Bawean Island, Gresik (IBRD-IDA, 2015); and the guardian of the mangrove forest conservation area is in Torosiaje, Gorontalo (Baruadi et al., 2017). In Bali, there are *pecalang* who specifically guard the Rindeng forest with the concept of *Tri Hita Karana* regulating the obligation of residents to preserve and secure forest (UNESCO, 2015). *Jagawana Swakarsa* differs from official forest rangers regarding institutional governance. Ministry of Environment and Forestry (MoEF) has law enforcement officers tasked with protecting forests in Indonesia (Fig. 3).

The official Forest Rangers at MoEF are civil servants who hold functional responsibilities dedicated to forest protection. The salaries are determined based on their positions. The Functional Position Allowances of the rangers are regulated by the Presidential Decree of Indonesia Number 16 of 2000, as per the governing guidelines. Official Forest Rangers are stationed in the Ministry, Regional Forestry Agencies, and State-Owned Forestry Enterprises, appointed by the Ministry as forestry officials with special police authority (Fatwansyah, 2019).

Building awareness and community participation in collective security with Jagawana Swakarsa or community policing

Jagawana Swakarsa of the Krida Wana Lestari Farmer Group resembles community policing in form and purpose. This group monitors and protects forests out of awareness with funding. Community policing has gained global popularity over the past few decades (Oliver, 2000). The origins can be traced back to the United Kingdom during the early 19th century. Subsequently, it expanded its reach to the United States in the 1970s, followed by Canada, Europe, Latin America, Africa, and Asia (Denney and Jenkins, 2013). Community policing is carried out by officers who patrol and operate from different locations, collaborating closely with residents to address and resolve issues in a proactive manner (Blair et al., 2021). Increased accessibility of police to citizens, with problem-oriented approaches, aggressive order maintenance strategies, a necessity for intervention, enhanced contacts between police and community organizations, strengthened

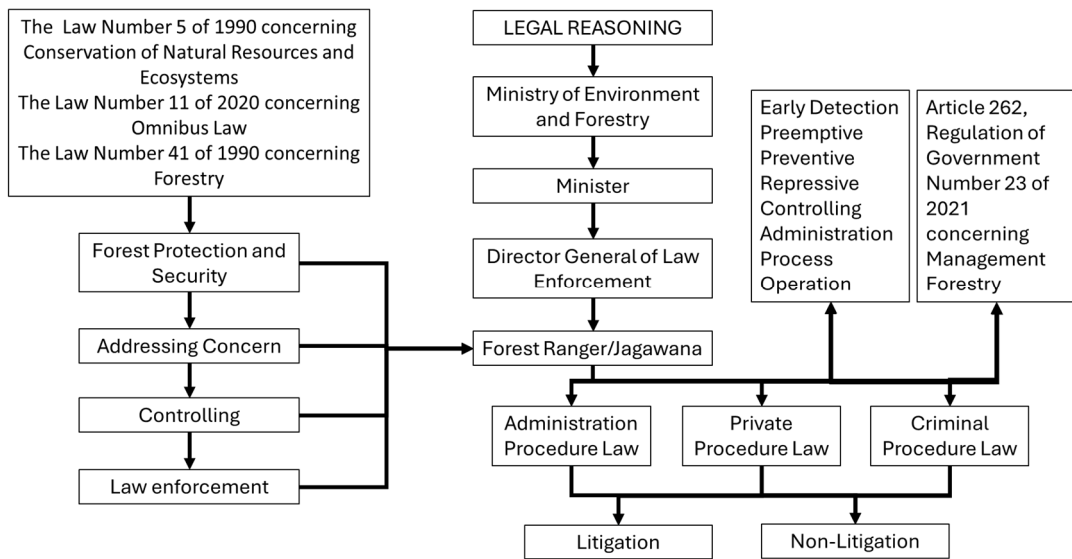


Fig. 3: Scope of duties and authorities of Forest Rangers Officials at MoEF

community cohesion, and sponsored crime prevention activities (Santana, 2021). According to Ziembo-Vogl and Meško (2000), the four elements of community policing are police-community reciprocity, real command decentralization, patrol reorientation, and civilianization. Asserted that the concept had four meanings such as 1) ideological, including the restoration of the sense of community found in the past when the residents were more united and the police received assistance and support (Manning, 1984), 2) programmed, which included a series of programs to restore police-community closeness, even though the programs had no relation to crime, 3) pragmatic, meaning the police were less bureaucratic, impersonal and more crime-focused and localized, 4) organizational, which emphasized local policing or team as well as extensive and intensive communication with community groups. Community policing is not formally structured since the form is an initiative to protect the environment from internal and external threats. This is different from community policing, which is defined as “wise and service-oriented to improve the quality of life...” (Moose, 1993). The implementation of public policing in Indonesia is governed by the Chief of Police Decree Number Skep/737/X/2005. This decree outlines the policies and strategies for effective implementation of *Perpolisian Masyarakat* (Polmas) as a model of

public policing. The police and public partnership forum is a model that involves the Indonesian police working together with the community to utilize the increasing power of the community in fulfilling their duties. Both the police and the community play crucial roles in Polmas, each bringing unique qualifications to the table (Apriliyanti, 2023). The quality can be determined by factors such as ethnic similarity, religion, geographic area, or shared interests. In terms of objectives, both community and public policing share similarities. One common goal is to establish a police partnership forum that fosters and sustains mutual trust, which is a key component (Wischmeyer, 2016). The objective of the partnership is to collectively tackle security issues in the community. The following phases may be used to solve problems through Community Police Partnership Forum (*Forum Kemitraan Polisi dan Masyarakat/FKPM*) (COPS, 2014): 1) scanning, stakeholders should gather information related to the problem, data, background and demography, surveys, and individual influences; 2) assessing of non-criminal issues; 3) responses, the team collaborates to improve ideas and establish clear strategies with specific assignments and defined boundaries, and; 4) assessment, the team creates a method to track the strategy and establish its impact (Gill et al., 2014). Community-level government services are

transformed by public or community policing (Biellejewaki, 2021). The Chief of Police Regulation Number 1 of 2021 states that the objectives of public policing are to: a) create a mutually beneficial police-community partnership to solve problems that treat public security and to create stabilization, and b) promote legal knowledge and community attention to environmental security and order threats. Community participation will be effective when groups and organizations actively fulfil the obligation to protect the environment. The participation in environmental management is closely connected to the entitlement of having a healthy environment, as stated in Article 2, letter k, of the participatory principle in the Indonesian Constitution of Law. According to Principle 10 of the Rio Declaration of 1992, all concerned persons should participate in the protection of the environment at the appropriate level (Handl, 2012). Community involvement plays a pivotal role in making environmentally responsible and democratically valid decisions. It is imperative to guarantee that all parties involved have an opportunity to express their opinions and concerns when addressing environmental matters. Law Number 32 of 2009 on Environmental Protection and Management describes that every community has equal chances and rights to preserve and manage the environment (Article 70 (1). Community participation aims to increase awareness, enhance self-reliance, empower communities, improve partnerships, as well as develop community capacity and innovation (Article 70 (3) a, b, and c). The activities of *Jagawana Swakarsa* as community policing performed by the Krida Wana Lestari Farmer Group community are carried out in collaboration with law enforcement officers. The farmer group works in community-based sustainable environmental management as a Forestry Police Community Partner (*Masyarakat Mitra Polisi Kehutanan/MMP*) (Ministry of Forestry Regulation of Indonesia Number P.56/Menhut-II/2014), the Nature Conservation Agency (Balai Konservasi Sumber Daya Alam/BKSDA) of Cilacap Regency, and Village Trustee Non-Commissioned Officer (Bintara Pembina Desa/BABINSA). The activities exemplify the state's power in coordinating the sustainable management of mangrove ecosystems. Presidential Regulation Number 73 of 2012 governs the SNPEM as part of coastal area management and coordinates, integrates, synchronizes, and synergizes across

sectors, institutions, and agencies. In Northeast Austin, Texas, community participation in law enforcement is referred to as community Policing Program (Stickels, 1999). In Texas, participation includes feedback from locals and problem-solving strategies leading to messengers of information. The initiative is seen by the community as being focused on addressing issues, with involvement from a range of community members and chances for participation (Goldstein, 1979). Community policing was first depicted as an alternative to incident-based policing by Herman Goldstein. Goldstein responded to the call to provide services that should only be the first stage in the policy process. Goldstein's community policing approach is centered on addressing underlying problems to offer long-lasting solutions for law enforcement, rather than just addressing recurring grievances (Goldstein, 2003). Dealing with legal uncertainty in coastal resource management is a key focus of public policing efforts. Meanwhile, *Jagawana Swakarsa* is essential to support the state's duty in protecting and managing mangrove ecosystem resources. This is a community obligation to actively participate in natural resource management. The ideal model consists of three main components (Brogden and Nijhar, 2013), as shown in Fig. 4, namely 1) community partnerships are law enforcement agencies working with individuals as well as organizations to solve problems and build trust in the police, 2) organizational transformation, comprising management clarification, structure, people, and information systems to facilitate community collaboration and develop proactive problem-solving, and 3) problem-solving is the methodical and proactive investigation of recognized difficulties in order to design and assess appropriate answers.

Ad.1. Community partnership

The law enforcement authorities frequently face challenges in managing public safety, thus requiring active partnerships with pertinent stakeholders. Collaborative partnerships are formed between law enforcement agencies and a range of stakeholders, such as individuals, groups, and governmental bodies, to address issues and build confidence in the police. These partnerships involve communities, nonprofit organizations, service providers, commercial corporations, and media. The ongoing partnership between the Krida Wana Lestari Farmer Group and

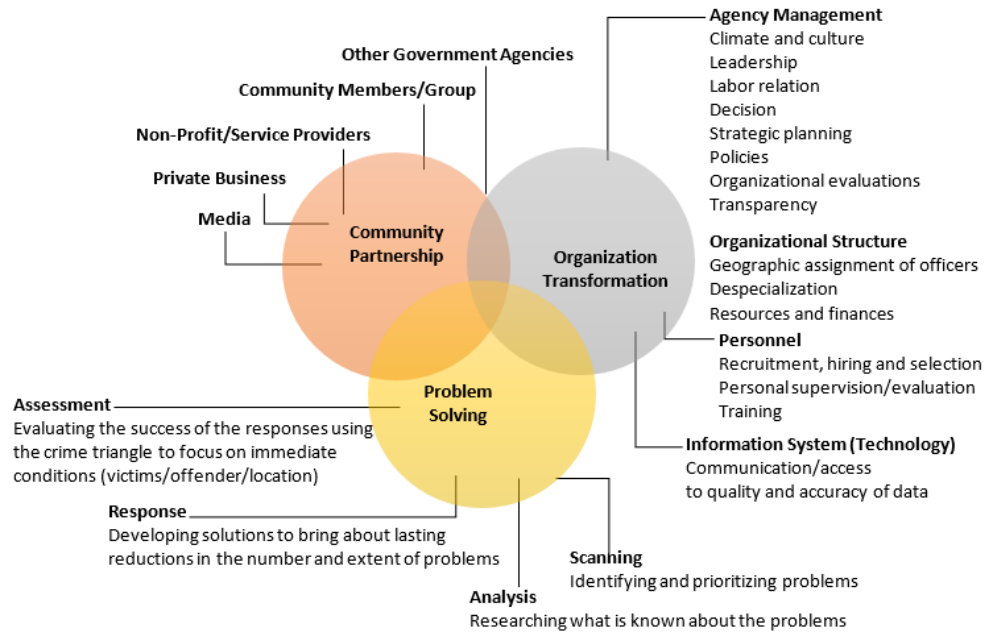


Fig. 4: The three main components of *Jagawana Swakarsa* or Community Policing of the Krida Wana Lestari Farmer Group community

the government is coincidental and lacks organization and integration into a cohesive plan. Legal provisions mandate the significance of community-government partnerships in forest protection through the implementation of MMP (according to regulation of Ministry of Forestry of the Republic of Indonesia Number P.56/Menhut-II/2014), the activities are not routinely scheduled. Collaborations between legal institutions and agricultural communities are essential, as the individuals or groups living in the mangrove ecosystem are best positioned to lead monitoring efforts.

Ad.2. Organizational transformation

Establishing effective organizational management, structure, personnel, and information systems is vital in order to encourage community partnerships and support proactive problem-solving. These elements play a crucial role in supporting the overall objectives of the organisation, such as; 1) Agency management, by implementing adjustments to organisational assessment, climate and culture, leadership, working relationships, decision making, strategic planning, and policies. 2) Transparency, community policing involves more transparent decision-making than conventional policing. 3) Organizational structure, to

allocate decision-making authority and accountability for the acts, geographic deployment of officers, establish specialized roles, and manage resources and finances effectively. 4) Personnel recruitment, community policing agencies thoroughly evaluate their recruitment, personnel supervision/evaluation, and performance procedures to meet the highest standards. Developing the skills to recognize and address underlying issues can help prevent criminal activity, raise public consciousness, and involve the community in problem-solving. 5) Information systems, technology, and enhancements in information are essential for ensuring quality access to crime and community conditions, communication/data access, data accuracy, and reliability. They help in systematically collecting, centralizing, and interconnecting information from different sources, ensuring its accuracy for effective utilization. The Krida Wana Lestari Farmer Group has provided valuable benefits to the government by actively assisting in mangrove conservation efforts through patrols using essential equipment. Partnerships create valuable opportunities for farmer groups to enhance their skills and knowledge through training programmes, workshops, and knowledge-sharing sessions. The guidance and support offered by legal institutions are

invaluable for farmer groups seeking to understand laws, regulations, and compliance mechanisms. By leveraging the expertise of these institutions, farmers can navigate complex legal frameworks with greater ease and effectiveness. Collaborations facilitate farmer groups in closely working with legal authorities and enforcement agencies to effectively monitor and enforce compliance with environmental regulations. The detection and prevention of illegal activities in mangrove areas heavily rely on the involvement of farmer groups through joint patrols, surveillance systems, and reporting mechanisms.

Ad.3. Problem solving

One of the key tools that officers can use to enhance their problem-solving skills is SARA (Scanning, Analysis, Response, and Assessment). It provides a structured and disciplined approach to address various challenges. It is imperative to identify issues, ascertain their characteristics, evaluate their magnitude, establish fundamental phases, gain insight into the dynamics, and comprehend the boundaries of response. This endeavour employs strategic approaches to address the identified problem through comprehensive and strategic interventions. The efficacy of these intervention strategies is evaluated by discerning reductions in the problem's prevalence and assessing the extent to

which the implemented responses have contributed to the reductions. The crime triangle relationship between victim, offender, and area focuses on factors within. Active collaborations between community policing, government agencies, private enterprises, and the media can effectively ensure adherence to legal requirements in the management of sustainable mangrove ecosystems. The questionnaire data indicates the participation of stakeholders, including the government and state-owned corporations, who contribute partnership assistance, funds, and resources to facilitate mangrove mitigation efforts. The mangrove ecology is continuously monitored by the government, as depicted in Fig. 5.

There are approximately three main components of community policing that need improvement to ensure sustainability of compliance in mangrove management. The partnership aspect involves working together with government agencies or law enforcement authorities to enforce sanctions, collaborating with private businesses to grant access to corporate responsibility funds for supporting self-guardians or community police, and allowing media access to comprehend the impact of sanctions and deterrence on offenders. The organizational transformation component empowers the community to conduct *Jagawana Swakarsa* or community policing. In contrast, the problem-solving component

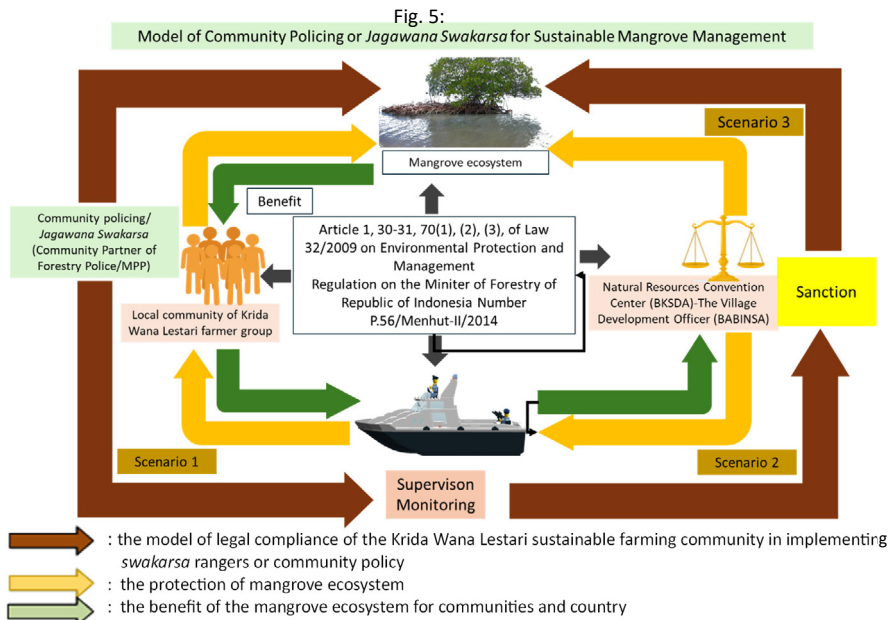


Fig. 5: Legal compliance in sustainable mangrove management by *Jagawana Swakarsa* or Community Policing

provides structured training through scanning, analysis, response, assessment, and the crime triangle. The collaboration between legal authorities and farmer groups in the management of mangroves exemplifies a partnership based on shared interests, promoting adherence to legal regulations. Farmer groups assume a pivotal role in upholding laws within the mangrove ecosystem. The adherence to this legislation is firmly embedded within society, acting as a potent instrument for societal manipulation. Farmer groups willingly conform to this regulation owing to their extensive comprehension of the pivotal function fulfilled by the mangrove ecosystem in upholding their economic sustenance.

CONCLUSION

The MSA analysis reveals that the utilization aspect demonstrates highly sustainable criteria, with a current value of 100. This indicates that mangroves provide significant economic benefits to the community. The leaves are used in a variety of culinary and beverage preparations. The fruit is harvested for both sustenance and confectionery uses, and the mangrove waters are an important resource for the local community's fishing activities. The management team's dedication to sustainability is evident with a significant value of 89. In both scenarios two and three, this dedication is even more pronounced with a value of 94.5. This highlights the essential role stakeholders' play in assisting the community in their efforts to preserve and manage mangroves. The criteria for the sanctions aspect is currently at an unsustainable level of 16.5. The increase in the value of 66.5 in scenarios two and three represents an increase in sanctions for perpetrators of destroying mangrove ecosystems. Empirical normative legal analysis is conducted to enhance sanctions through community pioneering activity includes the deployment of community policing or *jagawana swakarsa* to safeguard the mangrove ecosystem areas from both internal and external threats. Community policing, as an innovative approach, serves as a prime model in effectively managing mangrove ecosystems while ensuring compliance with legal obligations. This proactive measure is carried out by a farmer group, which actively fosters social harmony and upholds the rule of law. Implementing community policing can address the issue of legal uncertainty in coastal resource

management. There are three important components of community policing: partnership, collaboration and strong partnerships between communities and law enforcement agencies. Organizational transformation involves aligning management, structure, staff, and information systems to effectively facilitate community partnerships. Addressing issues proactively necessitates a methodical approach to identifying and solving problems in order to develop and assess effective solutions. The Krida Wana Lestari as community policing has taken on the responsibility to protect the environment, as stated in the Environmental Protection and Management Law Number 32 of 2009, Article 70 Paragraphs 1, 2, and 3. The Krida Wana Lestari collaborates with various organizations including the Forestry Police, the Nature Conservation Agency of Cilacap Regency, and an Indonesian Territorial Army non-commissioned officer. Management of mangrove ecosystems is governed by the National Strategy for Mangrove Ecosystem Management as outlined in Presidential Regulation Number 73 of 2012. The focal point of this strategy is to stress the importance of synchronizing efforts and consolidating actions across sectors and institutions for the effective management of coastal areas (Presidential Decree Number 73 of 2012 concerning SPNEM). The Krida Wana Lestari Farmer Group exemplifies a successful strategy that maximises the use of mangroves while ensuring their sustainability, without relying on official support. In addition, it collaborates effectively with government efforts to combat climate change and advance towards a low-carbon Indonesia.

AUTHOR CONTRIBUTIONS

E.K. Purwendah conceptualized the concept, supervised the experiment, and prepared the article. N.A. Sasongko critically analysed the article, H. Susanto conducted data recognition and participated in data validation. R. Mawardi conceptualized the concept and operated the field study; T. Cahyono operated the field study and participated in data validation. H.L. Susilawati participated in drafting, and editing the article. T. Wahyuni performed administrative tasks and supported data collection. D. Juhandy supported data interpretation and drafted the article. T. Rahman participated in data validation and edited the article, A. Gustina participated in data validation, performed the literature review. I.D.S.

Triana performed the literature review and operated the field study. E. Pudyastwi handed material and operational support, O. Kusumaningsih performed administrative tasks and operated the field study. T. Martini supervised the experiment and supported the article preparation.

ACKNOWLEDGEMENT

The authors express the gratitude to the Chairman of the Krida Wana Lestari Farmer Group, Ujung Alang Village, Cilacap Regency, and the Regent of Cilacap Regency for obtaining approval to conduct this study. Furthermore, the first author is grateful to Wijayakusuma University Purwokerto for the Research Grant [No.: SK 045/F.H. UNWIKU/C.06/VII/2023] and the Post-Doctoral Programme at the Research Center for Sustainable Production Systems and Life Cycle Assessment, National Research and Innovation Agency (BRIN), Indonesia 2023-2024 for supporting the study [No.: 86/II/HK/2023].

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy, were observed by the authors.

OPEN ACCESS

©2024 The author(s). This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution, and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third-party material in this article are included in the article's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit: <http://creativecommons.org/licenses/by/4.0/>

PUBLISHER'S NOTE

GJESM Publisher remains neutral with regard to jurisdictional claims with regard to published maps and institutional affiliations.

ABBREVIATIONS

%	Percent
°C	Degree Celsius
BABINSA	<i>Bintara Pembina Desa</i> (Village Trustee Non-Commissioned Officer)
BKSDA	<i>Balai Konservasi Sumber Daya Alam</i> (Nature Conservation Agency)
C	Carbon
COPS	Community Oriented Policing Services
FKPM	<i>Forum Kemitraan Polisi dan Masyarakat</i> (Community Police Partnership Forum)
Ha	Hectare
IBRD-IDA	International Bank for Reconstruction and Development- International Development Association
ICOMOS/ICCROM	International Council on on Monuments and Sites/ International Center for the Study of the Preservation and Restoration of Cultural Property
Km ²	Square kilometre
m	Metre
N	North
Mha	Million hectares
MMP	<i>Masyarakat Mitra Polisi Hutan</i> (Forest Police Partner Communities)
MoEF	Ministry of Environment and Forestry
MSA	Multi-aspect sustainability analysis
PDASRH	<i>Pengendalian Daerah Aliran Sungai dan Rehabilitasi Hutan</i> (Watershed Management and Forest Rehabilitation)

POKMASWAS	<i>Kelompok Masyarakat Pengawas (Mangrove Forest Community Surveillance Group)</i>
Polmas	<i>Perpolisian Masyarakat (Public policing)</i>
SARA	Scanning, analysis, response, and assessment
UNESCO	United Nations Educational, Scientific and Cultural Organization
SPNEM	<i>Strategi Nasional Pengelolaan Ekosistem Mangrove (National Strategy for Mangrove Ecosystem Management)</i>
US	United States

REFERENCES

- Alongi, D.M., (2022). Impacts of climate change on blue carbon stocks and fluxes in mangrove forests. *Forests*, 13(2): 1-15 (15 pages).
- Apriliyanti, K., (2023). Implementation of tri hita karana in community policing to achieve regional resilience in desa Tangguh Dewata during the covid-19 pandemic. *Proceeding: International Graduate and Scholar's Conference in Indonesia (IGSSCI)*. 71-87 (17 pages).
- Astuti, P., Sulistyowati, E., (2019). Factors that influence the effectiveness of sanctions in mangrove forest preservation efforts. In *3rd International Conference on Globalization of Law and Local Wisdom (ICGLOW 2019)* (pp. 189-192). Atlantis Press.
- Ati, R.N.A.; Kusumaningtyas, M.A.; Sudirman, N.; Salim, H.L.; Suryono, D.D.; Rustam, A.; Trenggono, M.; Hidayat, R.R.; Prasetyawan, N.R., (2023). Ecological status of threatened mangroves *Ceriops decandra* and *Meropse angulata* in mangrove ecosystem Segara Anakan Laon, Central Java, Indonesia. *Bio Web Conf*, 1-11 (11 pages).
- Baruadi, A.S.; Utina, R.; Katili, A.S., (2017). The implementation of local wisdom intervention by Bajo people in eco-friendly artisanal fishery in Torosiaje Gorontalo, Indonesia. *Aust. J. Basic Appl. Sci.*, 11(12): 57-60 (4 pages).
- Bielejewaki, A., (2021). *Holding Down the Fort*. Springer. 1-421 (421 pages).
- Blair, G.; Weinstein, J.M.; Christia, F.; Arias, E.; Badran, E.; Blair, R.A.; Cheema, A.; Farooqui, A.; Fetzer, T.; Grossman, G.; Haim, D.; Hameed, Z.; Hanson, R.; Hasanain, A.; Kronick, D.; Morse, B.S.; Muggah, R.; Nadeem, F.; Tsai, L.L.; Nanes, M.; Slough, T.; Ravanilla, N.; Shapiro, J.N.; Silva, B.; Souza, P.C.L.; Wilke, A.M., (2021). Community policing does not build citizen trust in police or reduce crime in the Global South. *Science*. 374(6571).
- Brogden, M.; Nijhar, P., (2005). *Community Policing, National and International Models and Approaches*. Cullompton: Willan Publishing. U.S.A.
- Cameron, C.; Hutley, L.B.; Friess, D.A.; Brown, B., (2019). Community structure dynamics and carbon stock change of rehabilitated mangrove forests in Sulawesi, Indonesia. *Bull. Ecol. Soc. Am.*, 100(1): 1-5 (5 pages).
- Chatting, M.; Al-Maslamani, I.; Walton, M.; Skov, M. W.; Kennedy, H.; Husrevoglu, Y. S.; Le Vay, L., (2022). Future mangrove carbon storage under climate change and deforestation. *Front. Mar. Sci.*, 9: 1-14 (14 pages).
- Christie, M.; Rayment, M., (2012). An economic assessment of the ecosystem service benefits derived from the SSSI biodiversity conservation policy in England and Wales. *Ecosyst. Serv.*, 1(1): 70-84 (15 pages).
- COPS, (2014). *Community policing defined*. U.S. Department of Justice, U.S. 1-17 (17 pages).
- Damastuti, E.; de Groot, R.; Debrot, A.O.; Silvius, M.J., (2022). Effectiveness of community-based mangrove management for biodiversity conservation: A case study from Central Java, Indonesia. *Trees For People*. 7: 1-13 (13 pages).
- Denney, L.; Jenkins, S., (2013). *Securing communities: The what and the how of community policing*. Overseas Development Institute Background Paper PhD thesis. Dept. of Economics. Adelaide University (48 pages).
- Domie, G.; Dodzi, S.; Gawu, P.S., (2023). Morality an offshoot of philosophy and psychology: A theoretical exploration. *Open J. Social Sci.*, 11(11): 41-74 (34 pages).
- Fatwansyah, S., (2019). Environmental conservation through law enforcement in Sulawesi Barat. *Indonesia Prime*, 4(1): 58-68 (11 pages).
- Febbrajo, A., (2019). *Law, Legal Culture and Society, Mirrored Identities of the Legal Order*. Routledge. (213 pages).
- Friess, D.A.; Rogers, K.; Lovelock, C.E.; Krauss, K.W.; Hamilton, S.E.; Lee, S.Y.; Lucas, R.; Primavera, J.; Rajkaran, A.; Shi, S., (2019). The state of the world's mangrove forest: Past, present, and future. *Annu. Rev. Environ. Resour.*, 44: 89-115 (27 pages).
- Friess, D.A.; Web, E.L., (2014). Variability in mangrove change estimates and implications for the assessment of ecosystem service provision. *Global Ecol. Biogeogr.*, 23(7): 715-725 (11 pages).
- Friess, D.A.; Yando, E.S.; Alemu, I.; Jahson, B.; Wong, L.W.; Soto, S.D.; Hatia, N., (2020). Ecosystem service and disservices of mangrove forests and salt marshes. *Oceanogr. Mar. Biol.*, 58: 107-142 (36 pages).
- Gill, C., Weisburd, D., Telep, C. W., Vitter, Z., Bennett, T., (2014). Community-oriented policing to reduce crime, disorder and fear and increase satisfaction and legitimacy among citizens: A systematic review. *J. Exp. Criminol.*, 10: 399-428 (30 pages).
- Giri, C.; Ochieng, E.; Tieszen, L.L.; Zhu, Z.; Loveland, T.; Masek, J.; Duke, N., (2011). Status and distribution of mangrove forests of the world using earth observation satellite data. *Global Ecol. Biogeogr.*, 20 (1): 154-159 (6 pages).
- Global Mangrove Alliance, (2023). *Mangrove law and policy, November 2023, legal and policy framework that enable mangrove conservation, restoration and sustainable use, support of global goals for climate, Biodiversity and Sustainable Development*.
- Goldberg, L., Lagomasino, D., Thomas, N., Fatoyinbo, T., (2020). Global declines in human-driven mangrove loss. *Global Change Biol.*, 26(10): 5844-5855 (12 pages).
- Goldstein, H. (2003). On further developing problem-oriented policing: The most critical need, the major impediments, and a proposal. *Crime Prev. Stud.*, 15, 13-48 (35 pages).
- Goldstein, H., (1979). *Improving policing: A problem-oriented approach*. *Crime Delinquency*. 236-258 (23 pages).
- Gremmen, K.J.M.; Ossewaarde, M.R.R.; van Gerven@Haanpää, M.M., (2018). The discourse of the social benefit system in The Netherlands. *Public Administration* (74 pages).
- Hamilton, S.E.; Casey, D., (2016). Creation of a high spatio-temporal resolution global database of continuous mangrove forest cover the 21st century (CGMFC-21). *Global Ecol. Biogeogr.*, 25(6): 729-738 (10 pages).
- Handl, G. (2012). *Declaration of the United Nations conference on*

- the human environment (Stockholm Declaration), 1972 and the Rio Declaration on Environment and Development, 1992. UN Audiovisual Library of International Law, 11(6), 1-11.
- Hardin, Dewi, I.K.; Alzarliani, W.O.D.; Azaludin, Andara, D.; Ramadhan, F.M.; Huda, A.M., (2019). The role of communities in conserving mangrove forest to achieve sustainable development. IOP Conf. Ser., 343:1-8 **(8 pages)**.
- Hasan, R.; Watson, B.; Haworth, N.; Oviedo-Trespacios, O., (2023). The self-reported psychosocial and legal factors contributing to drink and drug driving. Transportation Research Part F: Traffic Psychology and Behaviour, 98: 186-204 **(19 pages)**.
- Hashim, H., Zubir, M.A., Kamyab, H., Zahran, M.F.I., (2022). Decarbonisation of the industrial sector through greenhouse gas mitigation, offset, and emission trading schemes. Chem. Eng. Trans., 97: 511-516 **(6 pages)**.
- Hilmi, E.; Sari, L.K.; Amron; Cahyo, T.N.; Siregar, A.S., (2020). Mangrove cluster as adaptation pattern of mangrove ecosystem in Segara Anakan Lagoon. IOP Conf. Ser.: Earth Environ. Sci., 746:1-11 **(11 pages)**.
- Hoddy, E.; Halliday, H.; Ensor, J.; Wamsler, C.; Boyd, E., (2022). Legal culture and climate change adaptation: An agenda for research. Wiley Interdiscip. Rev. Clim. Change. 14(3): 1-15 **(15 pages)**.
- Hyunh, H.T.N.; de Bruyn, L.L.; Prior, J.; Kristiansen. (2016). Community participation and harvesting of non-timber forest product in benefit-sharing pilot scheme in Bach Ma National Park, Centra Vietnam. Trop. Conserv. Sci., 9(2):877-902 **(16 pages)**.
- IBRD-IDA, (2015). Providing Rural Youth in Aceh with an Alternative to Forest Crime: Lessons from the Community Rangers Program. World Bank Group: 1-6 **(6 pages)**.
- Kamyab, H.; Saberikamarposhti, M.; Hashim, H.; Yusuf, M., (2024). Carbon dynamics in agricultural greenhouse gas emissions and removals: A comprehensive review. Springer Link. 34:265-289 **(25 pages)**.
- Kurniasih, I.; Setiawan, R.A.; Dharmawan, R.D.; Dewi, A.A.P.; Wulandari, T., (2023). Enforcement of Supreme Court regulations of the Republic of Indonesia in the administration of justice. Balt. J. Law Polit., 16(3): 3203-3219 **(17 pages)**.
- Leeuw, F.L.; Schmeets, H., (2016). Empirical Legal Research, A Guidance Book for Lawyer, Legislators and Regulators. Edward Elgar Publishing, Cheltenham, UK. Northampton, MA, USA.
- Listiania, I.; Priyanto, D., (2024). Enhancing coastal community participation in mangrove rehabilitation through structural equation modeling. Global J. Environ. Sci. Manage., 10(2):873-890 **(18 pages)**.
- Long, C.; Dai, Z.; Wang, R.; Lou, Y.; Zhou, X.; Li, S.; Nie, Y., (2022). Dynamic changes in mangroves of the largest delta in northern Beibu Gulf, China: Reasons and causes. For. Ecol. Manage., 504: 1-12 **(12 pages)**.
- Macreadie, P.I.; Anton, A.; Raven, J.A.; Beaumont, N.; Connoly, R.M.; Friess, D.A.; Kelleway, J.J.; Kennedy, H.; Kuwae, T.; Lavery, P.S.; Lovebock, C.E.; Smale, D.A.; Apostolaki, E.T.; Atwood, T.B.; Baldock, J.; Bianchi, T.S.; Chmura, G.L.; Eyre, B.D.; Fourqurean, J.W.; Hall-Spencer, J.M.; Huxham, M.; Hendriks, I.E.; Krause-Jensen, D.; Laffoley, D.; Luisetti, T.; Marbà, N.; Masque, P.; McGlathery, K.J.; Megonigal, J.P.; Murdiyarso, D.; Russel, B.D.; Santos, R.; Serrano, O.; Siliman, B.R.; Watanabe, K.; Duarte, C.M., (2019). The future of blue carbon science. Nat. Commun., 10(3998): 1-13 **(13 pages)**.
- Maning, P.K., (1984). Review of Working the Street: Police Discretion and the Dilemmas of Reform, by Michael Brown. Sage Publ. 29(1): 158-161 **(5 pages)**.
- Moose, C., (1993). The theory and practice of community policing: An Evaluation of the Irish court demonstration project. Dissertations and Theses. Portland State University.
- Murdiyarso, D.; Krisnawati, H.; Adinugroho, W.C.; Sasmito, S.D., (2023). Deriving emission factors for mangrove blue carbon ecosystem in Indonesia. Carbon Balance Manage., 18(12): 1-12 **(12 pages)**.
- Murray, N.J.; Worthington, T.A.; Bunting, P.; Duce, S.; Hagger, V.; Lovelock, C.E.; Lucas, R.; Saunders, M.I.; Sheaves, M.; Spalding, M.; Waltham, N.J.; Lyons, M.B., (2022). High-resolution mapping of losses and gains of Earth's tidal wetlands. Sci., 376(744): 1-44 **(44 pages)**.
- Muttolib, A.; Yonariza, Y.; Rahmat, A., (2024). Abnormality in optimal forest management by indigenous people in deforestation. Global J. Environ. Sci. Manage., 10(1): 405-418 **(24 pages)**.
- Ogus, A.; Abbot, C., (2002). Sanctions for pollution: Do we have the right regime? 14(3):283-298 **(16 pages)**.
- Oikonomakis, L., (2024). Protecting the forest being that protect us: The Cosmo-political challenge Kawsak Sacha poses to Ecuador's extraction-based development. Bull. Latin Am. Res. J. Soc. Lat. Am. Stud., 1-14 **(14 pages)**.
- Oliver, W.M., (2000). The third generation of community policing: Moving through innovation, diffusion, and institutionalization. Police Quarterly, 3(4): 367-388 **(22 pages)**.
- Oxford Learner's Dictionary, (2005). 7th edition, (2005). Oxford University Press.
- PDASRH, (2021). National Mangrove Map, 2021. Directorate General of PDASRH. Jakarta.
- Petriello, M.; Redmore, L.; Sene, A.L.; Katju, D.; Barraclough, L.; Boyd, S.; Madge, C.; Papadopoulos, A.; Yalamala, R.S., (2023). The scope of empowerment for conservation and communities. Conserv. Biol., 1-22 **(22 pages)**.
- Pudji, P., Erlinda, I., Mochammad, F., (2018). The analysis of mangrove forest management sustainability in Damas Beach, Trenggalek. Russ. j. agric. soc.-econ. sci., 84(12): 252-259 **(8 pages)**.
- Purdy, R., (2010). Using earth observation technologies for better regulatory compliance and enforcement of environmental laws. J. Environ. Law, 22(1):59-87 **(29 pages)**.
- Santana, F., (2021). Community Oriented Policing (COP), Community Economic Development (CED) and Law Enforcement Legitimacy: A Qualitative Study of St. Johns County CED and COP Synchronization. Doctoral dissertation, Northeastern University **(136 Pages)**.
- Saberikamarposhti, M.; Ng, K-W.; Yadollahi, M.; Kamyab, H.; Cheng, J.; Khorami, M., (2024). Calculating a sustainable future in the artificial intelligence era: A comprehensive assessment of greenhouse gas emissions and removals in agriculture. 250:1-17 **(17 pages)**.
- Sarkamen, A.; Mubarak; Chairilisyah, D.; Yoswati, D.; Hamidy, R., (2023). Community-based mangrove protection to mitigate climate change: A socio-ecological approach. 18(8): 2473-2480 **(8 pages)**.
- Stickels, J.W., (1999). What happens after the lone ranger rides away? J. Police Crim. Psychol., 14: 48-59 **(12 pages)**.
- Sumarga, E.; Sholihah, A.; Srigati, F.A.E.; Nabila, S.; Azzahra, P.R.; Rabbani, N.P., (2023). Quantification of ecosystem services from urban mangrove forest: A case study in Angke Kapuk Jakarta. Forests, 14(9): 1-13 **(13 pages)**.
- Supriatna, S.; Purwadhi, S.H.; Purwanto, A.D., (2023). The spatial dynamics model of mangrove forest changes in Segara Anakan, Cilacap. AIP Conf. Proc. 1-7 **(7 pages)**.
- Thuy, P.T.; Hue, N.T.; Dat, L.Q., (2024). Households' willingness-to-pay for mangrove environmental services: Evidence from Phu Long, Northeast Vietnam. Trees, Forests and People, 15: 1-11 **(11 pages)**.
- Uddin, M.M.; Aziz, A.A.; Lovelock, C.E., (2023). Importance of mangrove plantations for climate change mitigation in Bangladesh. Global Change Biol., 29(12): 3331-3346 **(16 pages)**.
- UNESCO, (2015). Report on the ICOMOS/ICCROM Advisory Mission Cultural Landscape of Bali Province: the Subak System as a Manifestation of the Tri Hita Karana Philosophy (Indonesia) (C

- 1194rev). (73 pages)
- Valentini, L., (2023). *Morality and Socially Constructed Norms*. Oxford University Press. United Kingdom. (247 pages).
- Vasan, S., (2002). Ethnography of the forest guard: Contrasting discourses, conflicting roles and policy implementation. *Economic and Political Weekly*, 37(40): 4125-4133 (9 pages).
- Winanti, W.S.; Sudinda, T.W.; Oktivia, R.; Ihsan, I.M.; Ikhwanuddin, M.; Amru, K.; Anjani, R., Aryantie, M.H., (2023). Barrier analysis to leverage the climate change mitigation-adaptation implementation action in mangrove forest and its surrounding community villages. *IOP Conference Series*, 1201 (1): p. 012062 (16 pages).
- Wintah; Kiswanto; Hilmi, E.; Sastranegara, M.H., (2023). Mangrove chocolate food be observed from the nutritional values found in the coast of Southwest Aceh. *E3S Web Conference*, 448: 1-8 (8 Pages)
- Wischmeyer, T., (2016). Generating trust through law? Judicial cooperation in the European Union and the "Principle of mutual trust". *German Law J.*, 17(3): 339-382 (44 pages).
- Zeng, Y.; Friess, D.A.; Sarira, T.V.; Siman, K.; Koh, L.P., (2021). Global potential and limits of mangrove blue carbon for climate change mitigation. *Curr. Biol.*, 31(8): 1737-1743 (7 pages).
- Ziembo-Vogl, J.; Meško, G., (2000). Conceptualizing the ethical aspects of community policing inception and practice. *Policing in Central and Eastern Europe: Ethics, integrity, and human rights*, 523-536 (15 pages).

AUTHOR (S) BIOSKETCHES

Purwendah, E. K., Ph.D., Assistant Professor, ¹ Faculty of Law, Wijayakusuma University, Purwokerto, Central Java, Indonesia; ² Post-doctoral Researcher, Research Center for Sustainable Production System and Life Cycle Assessment, National Research and Innovation Agency, Indonesia.

- Email: ellykpurwendah@gmail.com
- ORCID: 0000-0003-2583-205X
- Web of Science Researcher ID: AAE-8009-2021
- Scopus Author ID: 57203912837
- Homepage: <https://fhunwiku.ac.id/>

Sasongko, N.A., Ph.D., Researcher and Director, Research Center for Sustainable Production System and Life Cycle Assessment, National Research and Innovation Agency, Indonesia.

- Email: nugroho.adi.sasongko@brin.go.id
- ORCID: 0000-0002-6546-1348
- Web of Science Researcher ID: IUM-2301-2023
- Scopus Author ID: 56709544200
- Homepage: <https://www.linkedin.com/in/nugroho-adi-sasongko-94558ab9/>

Susanto, H., M.Sc., Researcher, Research Center for Sustainable Production System and Life Cycle Assessment, National Research and Innovation Agency, Indonesia.

- Email: heru031@brin.go.id
- ORCID: 0000-0001-6498-3606
- Web of Science Researcher ID: NA
- Scopus Author ID: NA
- Homepage: <https://brin.go.id/>

Mawardi, R., M.Sc., Researcher, Research Center for Sustainable Production System and Life Cycle Assessment, National Research and Innovation Agency, Indonesia.

- Email: raha016@brin.go.id
- ORCID: 0000-0001-7850-8929
- Web of Science Researcher ID: -
- Scopus Author ID: 58040644400
- Homepage: <https://brin.go.id/>

Cahyono, T., M.Sc., Researcher, Research Center for Sustainable Production System and Life Cycle Assessment, National Research and Innovation Agency, Indonesia.

- Email: tric002@brin.go.id
- ORCID: 0000-0001-6498-3606
- Web of Science Researcher ID: KEV-8217-2024
- Scopus Author ID: 58694188300
- Homepage: <https://brin.go.id/>

Susilawati, H.L., Ph.D., Researcher, Research Center for Sustainable Production System and Life Cycle Assessment, National Research and Innovation Agency, Indonesia.

- Email: hele007@brin.go.id
- ORCID: 0000-0002-2636-4422
- Web of Science Researcher ID: 8098-2024
- Scopus Author ID: 56642735200
- Homepage: <https://brin.go.id/>

Wahyuni, T., S.P., Researcher, Research Center for Sustainable Production System and Life Cycle Assessment, National Research and Innovation Agency, Indonesia.

- Email: triw022@brin.go.id
- ORCID: 0009-0002-8400-5804
- Web of Science Researcher ID: NA
- Scopus Author ID: 58665424400
- Homepage: <https://brin.go.id/>

AUTHOR (S) BIOSKETCHES

Juhandi, D., Ph.D. Candidate, Agribusiness of Horticulture, Polytechnic Wilmar Business Indonesia, Deli Serdang, North Sumatra, 20371.

- Email: dany.juhandi@wbi.ac.id
- ORCID: 0000-0001-2956-2707
- Web of Science Researcher ID: NA
- Scopus Author ID: 57216509097
- Homepage: <https://wbi.ac.id/program-studi/agribisnis-hortikultura/dosen/dany-juhandi>

Rahman, T., M.Sc., Researcher, Research Center for Sustainable Production System and Life Cycle Assessment, National Research and Innovation Agency, Indonesia.

- Email: Taufik_06011@yahoo.co.id
- ORCID: 0000-0003-4765-7467
- Web of Science Researcher ID: KER-0868-2024
- Scopus Author ID: 57698488800
- Homepage: <https://brin.go.id/>

Gustina, A., M.H., Researcher, Legal Research Center, National Research and Innovation Agency (BRIN), Indonesia.

- Email: amel004@brin.go.id
- ORCID: 0000-0002-9839-8074
- Web of Science Researcher ID: AGX-8077-2022
- Scopus Author ID: 57211600835
- Homepage: <https://brin.go.id/>

Triana, I.D.S., Ph.D., Assistant Professor, Faculty of Law, Wijayakusuma University, Purwokerto, Central Java, Indonesia.

- Email: ikamadewisetiatriana@unwiku.ac.id
- ORCID: 0000-0003-0816-6710
- Web of Science Researcher ID: GPS-6317-2022
- Scopus Author ID: 57764171300
- Homepage: <https://fhunwiku.ac.id/>

Pudyastwi, E., M.H., Assistant Professor, Faculty of Law, Wijayakusuma University, Purwokerto, Central Java, Indonesia.

- Email: elisabethpudyastwi@unwiku.ac.id
- ORCID: 0009-0004-5734-1110
- Web of Science Researcher ID: GPK-0924-2022
- Scopus Author ID: NA
- Homepage: <https://fhunwiku.ac.id/>

Kusumaningsih, O., M.Sc., Assistant Professor, Faculty of Social Science and Political Science, Wijayakusuma University, Purwokerto, Central Java, Indonesia.

- Email: otikusumaningsihfisp@gmail.com
- ORCID: 0009-0004-2297-1964
- Web of Science Researcher ID: -
- Scopus Author ID: NA
- Homepage: <https://isip.unwiku.ac.id/>

Martini, T., Ph.D., Researcher, Research Center for Sustainable Production System and Life Cycle Assessment, National Research and Innovation Agency, Indonesia.

- Email: tri.martini@brin.go.id
- ORCID: 0000-0002-2316-6033
- Web of Science Researcher ID: JUV-2948-2023
- Scopus Author ID: 57674319100
- Homepage: <https://brin.go.id/>

HOW TO CITE THIS ARTICLE

Purwendah, E. K., Sasongko, N.A., Susanto, H., Mawardi, R., Cahyono, T., Susilawati, H.L., Wahyuni, T., Juhandi, D., Rahman, T., Gustina, A., Triana, I.D.S., Pudyastwi, E., Kusumaningsih, O., Martini, T., (2024). The influence of legal compliance in farmer groups on the growth and development of sustainable mangrove ecosystem. *Global J. Environ. Sci. Manage.*, 10(3): 1-20.

DOI: 10.22034/gjesm.2024.03.***

URL: ***

