Community-Based Mangrove Forest Management as Ecosystem Services Provider for Reducing CO\textsubscript{2} Emissions with Carbon Credit System in Bengkalis District, Riau, Indonesia

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Abstract. The rapid economic development in Bengkalis District has reported disrupted environmental balance. Such as mangrove forest damage, due to the intensification of wetland conversion, which is based on the emergence of industrialization. Implementing community-based mangrove forest management (CBMFM) with a carbon credit system is potential way to reduce the degradation. This management model also inline to support the achievement of sustainable development goals (SDGs). This study objective is aims to formulate a CBMFM strategy for CO\textsubscript{2} emission reduction which registered as carbon offset project. The research design was descriptive qualitative, focusing to identify current and best management aspect of mangrove ecosystem which meet carbon project standard. The information used was secondary data that collected from relevant literatures. The formulation of sustainable CBMFM strategy was established based on the gap analysis between existing management versus expected sustainable ones. The analysis results showed that the current management was yet optimal, due to the lack of sustainable management dimensional practices, include: human, natural, and financial resources. The strategy to reduce current management gap as follows: (1) Increasing the capacity of human resources for managers and institutions; (2) Application of collaborative management; (3) Accountable budgeting; (4) Preparation of an integrated management plan; and (5) Technology management. The research result recommended as one of a reference for policymakers, in order to formulate sustainable mangrove forest management.

1. Introduction
In 2020, Riau is one of the provinces in Indonesia that effectively contributes to CO\textsubscript{2} emissions, which was found to reach 12,422,996 occurrences due to forest and land fires (KHL) incidences, and was the highest producer compared to other regions [1]. KHL in this province is also caused by the implementation of economic development to support industrialization, which is not environmentally friendly.
Bengkalis District is one of the contributors to KHL in Riau Province, and in 2016, 32,248 hotspots were reported, which was found to be the highest [2]. Furthermore, one of the damaged forest areas in the Bengkalis District is the mangrove. According to Murdiyarso et al, the causes of these damages were illegal logging, land clearing and conversion, as well as charcoal wood production [3]. This is because the forest area has an ecosystem with the highest carbon stock. The high assimilation capacity causes this area to have the potential in supporting the reduction of CO$_2$ emissions [4]. Mangroves are also one of the most productive marine ecosystems on earth, which provides unique habitat opportunities for several species, as well as primary goods and services for humans [5]. They further provide important habitats and services for many creatures and human communities, respectively. However, these mangroves are decreasing due to the rise of sea levels. The main factors responsible for these losses are land clearing for aquaculture, rice production, and oil palm plantations [6].

The mangrove forest area in Bukit Batu Sub-district is one of the locations in Bengkalis District, which is preserved to support tourism development. This development is carried out on a community-based management, in the framework of preserving the site and local knowledge of Malay culture. According to [7], the potential of an area was observed as a source of income when properly managed, with effective focus on the environmental balance. Furthermore, a sustainable economy is based on the concept of legality and business management, environmental monitoring, worker and social responsibility, as well as community empowerment programs [8].

Beside only for tourism development purposes, CBMFM in Bukit Batu Sub-district potentially to be registered as a CO$_2$ emission reduction project for carbon credit. This step is observed as one of ways to improve the community’s economy, through the ecosystem services management. Economic development which only relies on tourism development has higher vulnerability risk. Pritanto et al., in their research results explains that the Covid-19 pandemic had an impact on the decline in local people’s economic income due to a decrease in the number of tourist visits [9]. One of the ways to mitigate the pandemic is to prepare a social safety fund [10]. The carbon project is one of efforts to prepare a social safety fund. The development and credits funding has been generated can be used as a stimulus for achieving the SDGs [11].

Several factors that support the carbon project program in the mangrove forest area within Bukit Batu Sub-district, are the existence of large private companies as carbon markets, and government policies that promote the development of alternative sectors. These companies contribute to facilitating carbon credit programs in mangrove forests, starting from the planning, implementation, and marketing stages, respectively. This is essential towards certification or eco-labelling standards, in order to achieve sustainable development goals (SDGs), which are required by the global market. Furthermore, the management of natural resources including mangrove forests, was closely related to the economy, where the use of these materials requires and provide economic costs and benefits, respectively. The use of natural resources should also be planned by considering ecological conditions, as well as not neglecting economic and social values, in order to improve environmental quality [12]. Additionally, forests strengthen community relations, increases management participation, create jobs, as well as maintain local and institutional knowledge [13].

This research is initiated due to the following objectives: (1) Analyzing the existing condition of mangrove forest management based on local knowledge within Bukit Batu Sub-district, Bengkalis District. This is conducted in order to support the reduction of CO$_2$ emissions and the local economy improvement, through the use of carbon credits; (2) Review of best practice of community-based mangrove forest area and other forest area which certified as carbon offset project and it carbon market standard; (3) Analyzing the gap of existing CBMFM implementation, compared to the other developed locations; (4) Formulating a CBMFM strategy in order to support sustainable development. This research is expected to be one of the inputs for the government, in setting sustainable development policies.
2. Materials and Methods
Research design was used descriptive qualitative, focusing on management aspect which meet requirements to establish carbon offset projects refers to sustainable and integrated mangrove management framework [14] and available carbon offset project standards. The data used in this study was secondary data was collected from various sources and literatures which related to mangrove forest management in Bukit Batu Sub-district, Bengkalis District, Riau Province. The secondary data also refers to community-based forest management and private concession forest that have been certified and received carbon credit funding in the World and Indonesia. Furthermore, gap analysis refers [15] was carry out to identify the gap between current mangrove management with sustainable mangrove forest management practice as expected in the established area. Based on this gap analysis result, the formulation of CBMFM strategy was carried out to meet sustainable mangrove forest management goals.

3. Results and Discussion

3.1 The existing condition of mangrove forest management in Bukit Batu Sub-district
Based on the spatial analysis of forest area data provided by the Ministry of Environment and Forestry 2021 [16] and Bengkalis District Government Administration 2018 Maps [2], the mangrove forest area in Bukit Batu Sub-district was 1,449 Ha or 2.74% of the total area. Bukit Batu, Buruk Bakul, and Sukajadi were three villages with the largest mangroves area, which more than 200 Ha. Meanwhile, the largest proportion of this region is in Sungaiselari, with 11.97% of the village area covered by mangrove (Table 1 and Figure 1).

Efforts to prevent mangrove forest damage in Bukit Batu Sub-district were carried out by making the area become a tourist destination. This program was initiated by the Bengkalis District Government, collaborated with Pertamina and the community. Furthermore, the tourism program was developed in the four settlements, namely Pangkalan Jambi (Mangrove Education Centre), Sukajadi (Pangkalan Laksamana Mangrove Tourism Forest), Sungai Pakning (Gawar-Gawar Mangrove Education Park), and Bukit Batu Village (Bukit Batu Laksamana Mangrove Ecotourism) . The ecotourism development program in Bukit Batu Sub-district was able to reduce mangrove forest degradation, which was in line with the potential of the village that had history as one of the ancient Siak Kingdom Naval Bases. This was marked by the presence of several cultural sites that were in the form of residences and tomb of Laksamana Raja Dilaut (Admiral King of the Sea), which was very famous in Indonesia. Furthermore, the current mangrove management used a local knowledge approach according to the vision of Bengkalis District, as the centre of Malay Culture. This management practice often emphasized on the application of the Malay community's local knowledge, based on preserving natural resources by adhering to the principle of mutual cooperation. Based on local knowledge and culture, a strong capital and attraction in the development of mangrove tourism was expected. According to Friess, ecotourism management in mangrove forest areas bridges human needs and ecosystem conservation [17]. The application of local wisdom as an ecotourism attraction will revitalize the community's conservation spirit while increasing tourists' environmental awareness [18]. Thus, ecosystem management based on local wisdom could to increase the achievement of sustainable development [19].

| Village Name | Village Area (Ha) | Mangrove Forest Area Ha | Proportion (%) |
|--------------|-------------------|-------------------------|----------------|
| Batang Duku  | 2,969             | 184                     | 6.21           |
| Bukit Batu  | 12,433            | 471                     | 3.78           |
| Buruk Bakul | 6,905             | 298                     | 4.32           |
Based on the review of the Bengkalis District Regional Medium-Term Development Plan (RPJMD) and the 2019-2024 Strategic Environmental Study (KLHS) shows that infrastructural development was an obstacle encountered by the government, towards developing mangrove tourism in Bukit Batu Sub-district. This prompted the involvement of the private sector, especially Pertamina, in order to become the driving force for village enhancement. According to the RPJMD, there was no pilot strategy for carbon project in mangrove forest areas, which are expected to be a green economic investment in the future. Furthermore, the challenge encountered in implementing carbon project was the lack of appropriate program, which should be promoted by the central government and international community. Another cause was the non-accommodation of carbon project development in regional enhancement, due to this program not having the legal protection that bonded large internal and external industrial players as one of economic instruments to meet sustainable development requirements. This caused the lack of useful facilitators, and uncertainty on the communal implementation of the carbon project. 

Pešić et al., in their research results explain that the alignment of local, national and international government policies in implementing economic instruments is the first step to ensures the success of reducing greenhouse gas (GHG) emissions[20]

| Village               | Population | Population Growth | Economic Growth |
|-----------------------|------------|-------------------|-----------------|
| Dompas                | 6,232      | 106               | 1.70            |
| Pakning Asal          | 2,312      | 7                 | 0.30            |
| Pangkalan Jambi       | 931        | 39                | 4.15            |
| Kelurahan Sungaipaking| 3,790      | 7                 | 0.19            |
| Sukajadi              | 15,549     | 264               | 1.70            |
| Sungaiselari          | 488        | 58                | 11.97           |
| Sejangat              | 1,223      | 14                | 1.16            |
| **Total**             | **52,832** | **1,449**         | **2.74**        |

Source: Secondary data processing (2021)

![Figure 1. Map of the mangrove forest area in Bukit Batu Sub-district](source)

The dependence of the community on private assistance (Pertamina) without sufficient capacity building for mangrove tourism managers, potentially threatened the sustainability of management, especially in achieving village economic independence. Based on achieving this independence, the community increased its capacity towards being able to innovate and develop technology [18] and [21]. Furthermore, communities with local knowledge strengthened their capacity by adopting...
mangrove management practices from established areas, towards the construction of village economic independence. The carbon credit program was also facilitated by the government, NGOs, donor agencies, and private sectors. This started from the planning, program implementation, monitoring, and evaluation (monitoring, reporting, and verification/MRV) stages, to the carbon market process and credit fund disbursement. The funds from carbon project were available to be allocated for the development of village economic independence, and realization of the sustainable improvement in Bukit Batu Sub-district.

3.2. Best Practice of Community Based Mangrove Forest Management for CO₂ Emission Reduction and Carbon Credits

Indonesia has largest mangrove forest area around 3 million Ha and estimate carbon storage 3.14 billion tons, however 40% of area was threatened by other developments, especially aquaculture [22]. Its carbon storage equivalent to the GHG emission of 2.5 billion vehicles driven for one year. The incentive by carbon credits is one of scheme to reduce deforestation in largest mangrove area. The World Bank has supported mangrove rehabilitation through Oceans Multi-Donor Trust Fund and the Coral Reef Rehabilitation and Management Program (COREMAP). The government has setup target to rehabilitating 600,000 Ha by 2024 [23]. Viable extent area for carbon project in Indonesia around 325,400 Ha with potential NPV = USD 513,327,000/year [24]. In the national scale, mangrove rehabilitation for carbon credit become good efforts and have been supported by international stakeholders. However, in the local scale CBMFM system to support carbon project still yet optimum. It indicated by there are no regulation specifically arranges community-based mangrove forest management for low emission development. This one of reason why currently there are no community mangrove forest organization yet received carbon project certificate and payment environmental services.

In the World, there are two locations of voluntary CBMFM practice was registered as carbon project and have been certified with two different common standards, include: (1) Mikoko Pamoja Mangrove Forest in Kenya that have been certified Plan Vivo Standards; and (2) India Sundarbans Mangrove by Verified Carbon Standards (VCS). The carbon credit project in these two areas is able to increase local economic income and increase people awareness to supports the conservation of coastal areas [25]. The stability of natural resource management institutions involving the community, government, and private sector, also increased the sense of ownership and motivation of farmers, in achieving village development goals [26] and [27].

Outside mangrove forest area, in Indonesia there are several community-based forest management (CBFM) locations which have been received carbon credit funding through Plan Vivo. The project has been giving positive impact to increase local economic and ecosystem rehabilitation. These practices become a good reference to setup carbon project in mangrove forest ecosystem through CBMFM. The project location includes: (1) HKm Aik Bual, Central Lombok Regency, West Nusa Tenggara; (2) Manjau Village Forest, Laman Satong, Ketapang, West Kalimantan; (3) Rio Kamunyang Village Forest Durian Rambun, Merangin, Jambi; and (4) Bukit Panjang Rantau Bayur Village Forest in Bungo, Jambi [28] and [29]. While other forest management units (FMU) which have passed VCS standards dominate by private company such as PT Rimba Makmur Utama and PT Rimba Raya Conservation located in Central Kalimantan which their concession area dominates of depredated peatland forest [30] and [31]. In this case majority of community-based forest management in Indonesia was verified by Plan Vivo standards, while private concession forest verified by VCS standards.

Analysis on the standard documents of Plan Vivo have been use in these projects shown that the important steps to implementing carbon project are; (1) Submit Plan Vivo project idea note (PIN); (2) Project design document (PDD) and technical specification; (3) Validation and registration; (4) Reporting; and (5) Verification. While analysis of VCS document standards, the carbon project in mangrove area classified into Agriculture Forestry and Other Land Use (AFOLU) scopes, the project cycle include: (1) Chose methodology; (2) Describe and list project; (3) Validate project description;
(4) Verify emission reductions; (5) Issues verified carbon units (VCUs). There are several fundamental elements that must be prepared properly before registering a carbon project, namely: (1) Certainty of community-based forest management unit (FMU) area; (2) Strengthening the capacity of managers and institutions; and (3) Agreement of rights and responsibilities among the parties involved in the project. The success of a community group to be able for disburse carbon credit funds is determined by its compliance to meet the stages and standards of the carbon project system. The comparison analysis carbon project standards by Smith and Gerber shows that Plan Vivo standards have higher score in the biodiversity conservation and sustainable community development than VCS Standard. However, its lower score on climate integrity and viability to UNFCC/jurisdiction compatibility than VCS [32]. The strategy for selection a carbon offset project standard is influence by the availability of carbon market, facilitator or private sector investment goals, the development issues which want to be resolves, project scope, multistakeholder and community involvement [33] and [34]. Pieter et al, stated that there was a significant effect between the factors of non-market environmental services for natural resources and the willingness of individuals to pay for the environment [34]. Furthermore, policy development had a positive impact on environmental management and willingness to pay for ecosystem benefits [36].

3.3 Gap Analysis of Mangrove Forest Management in Bukit Batu Sub-district

Based on the comparative results of the implementation CBMFM in established area compared with current mangrove management in Bukit Batu Sub-District, a gap analysis was conducted, respectively. This analysis explained that mangrove management was yet optimal for being a provider of ecosystem services to reduce CO₂ emissions. It was also marked by the need to strengthen several aspects, such as: (1) The capacity of management institutions; (2) Multi-stakeholder collaboration in the management of ecosystem services, especially for carbon project, (3) Independence in the development of mangrove forest conservation programs; (4) Planning for the development of mangrove ecosystem services, in order to reduce CO₂ emissions; and (5) Technological innovation of mangrove management, towards supporting sustainable development. This gap analysis is further shown in Table 2. The implementation of CBMFM for carbon project is one of part to achieving sustainable forest management (SFM) The achievement of SFM through CBFM is determined by the alignment of the interests of improving community welfare and environmental conservation, it be expressed by optimizing the driver factors and eliminating the inhibitor factors/threats to their management [37].

Table 2. Gap analysis of the existing mangrove forest management in Bukit Batu Sub-district compared to best practice in developed location.

| Management Dimensions | Status of existing mangrove forest management in Bukit Batu Sub-district | Best Practice of Established CBMFM |
|-----------------------|------------------------------------------------------------------------|-----------------------------------|
| Management Partnership| In four settlements, the mangrove forest management was carried out by the community which supported by local government and Pertamina, however some villages have not properly managed the forest areas. | Management was carried out by involving community-based multi-stakeholders |
| Management Institution| Forest Farmer Groups (KTH) in four villages were formed by the local government, however, they were yet to receive a license from the Minister of Environment and Forestry to manage mangrove forest management units as legal concession. Some villages still Collaborative conservation was carried out by establishing community-based mangrove forest management institutions, which were strongly supported by local governments and multi-stakeholders which meet al legal |
| Management Dimensions | Status of existing mangrove forest management in Bukit Batu Sub-district | Best Practice of Established CBMFM |
|-----------------------|------------------------------------------------------------------------|-------------------------------------|
| Alignment with sustainable development goals | Mangrove management in the four villages was in line with sustainable development, especially for nature conservation. However, some settlements did not implement sustainable forest conservation | Management considered and collaborated with village development goals, cross-sectoral, and supports sustainable development |
| Program planning and budget | Planning and budgeting were still yet optimal. It dependent on the assistance of the Local Government and Pertamina, which were not yet providing economic independence | Carbon credit project was supported by a management plan according the carbon offset standards, through multi-stakeholder funding assistance (donor agencies, private sector, and local government) |
| Human Resources Management | The ability of human resources related to the management of forest resources and aquatic ecosystems was still limited for mangrove conservation, not to the improvement of innovation capabilities and technology for marketing ecosystem services | The existence of a program with adequate financial support had supported the HR capacity development program |
| Availability of financial resources | There was no independent funding scheme yet, apart from rehabilitation assistance from local government budget and Pertamina's CSR funds | Financial resources were collaboratively conducted by grant providers, government, private sectors, and non-governmental organizations |
| Technological innovation for managing ecotourism supporting ecosystem services | Mangrove forest areas in four villages were developed for tourism, as some settlements were not yet optimal | The mangrove forest area was developed into a centre for recreation, tourism, and production of non-timber forest products, which provided economic value for the local community |
| Development of interpretation paths and environmental education models | The development of paths for interpretation and environmental education were not carried out optimally | The management collaborated with formal educational institutions and NGOs, in order to build paths for interpretation and environmental education, towards increasing awareness for tourists |

Source: Secondary data analysis (2021)
3.4. Mangrove Forest Management Strategy in Bukit Batu Sub-district

Based on the gap analysis results, strategies were carried out towards achieving sustainable mangrove management. The strategy in Bukit Batu Sub-district was carried out by eliminating the following gaps: (1) Increasing the capacity of mangrove management institutions, by participating in carbon credit standards system training and comparative studies to successful conservational areas; (2) Implementing multi-stakeholder collaborative management, by collaborating intensively with local governments, private sector, NGO facilitators, and international donor agencies, in order to register carbon credit projects, as well as prepare program plans and budgets; (3) Developing a transparent and accountable budgeting system towards economic independence, in order to maintain management credibility; (4) Preparing an integrated plan for CO$_2$ emission reduction programs, in accordance the carbon credit project system standards; and (5) Creating development innovations that are in line with local knowledge, towards managing mangrove forests as providers of other ecosystem services, according to the potential environmental capacity to support sustainable improvement. Furthermore, the study of Syahza and Irianti, stated that the application of a good agricultural system on peatlands resolved environmental damage and improved productivity, which in turn increased the income of people [38]. According to Syahza et al, forest resources, especially mangroves, were a contribution to an area due to the environment, as these materials provided beneficial value for the surrounding community [39]. Additionally, the strategies to manage mangroves, increase carbon sequestration and storage, as well as prevent illegal logging, should be carried out by involving the community [4]. The conservation of mangroves and restoration of degraded forests should also be a necessity, in order to support biodiversity and functioning of most tropical ecosystems [5].

4. Conclusion

Based on the analytical results, the existing mangrove management in the Bukit Batu Sub-district was yet optimal, compared to the established conservation in other areas. Furthermore, the human, natural, and financial resource aspects of this forest management still need to be improved, by implementing specific strategies as follows: (1) Increasing the capacity of mangrove managers and institutions, by participating in carbon credit system’s standards training and comparative studies to successful management areas; (2) Implementing multi-stakeholder management, by intensively collaborating with local governments, private sector, NGO facilitators, and international donor agencies, in order to register carbon credit projects, as well as prepare program plans and budgets; (3) Developing a transparent and accountable budgeting system that leads to independence, towards maintaining management credibility; (4) Preparing an integrated plan for CO$_2$ emission reduction program, in accordance the carbon credit system’s standards; and (5) Creating development innovations that are in line with local knowledge, in managing mangrove forests as providers of other ecosystem services, according to their environmental capacity to support sustainable improvement.

These results were used as a reference for policymakers, in preparing community-based mangrove management plans with local knowledge, as they are aligned towards supporting the achievement of sustainable development goals. Meanwhile, this research had limitations, based on the adequacy of time and data. Therefore, it is recommended that future research should be able to improve the accuracy of the study, by expanding the literature that were not covered by this research.

References

[1] Sipongi 2021 Rekapitulasi Luas Kebakaran Hutan dan Lahan Per Provinsi Di Indonesia Kementerian Lingkungan Hidup dan Kehutanan Republik Indonesia, Jakarta. http://sipongi.menlhk.go.id/, accessed at June 4th 2021
[2] BPS Riau 2018 Sebaran Kebakaran Hutan dan Lahan Provinsi Riau 2016-2017 Badan Pusat Statistik Provinsi Riau. Pekanbaru
[3] Murdiyarso D, Purbopuspito and Kauffma J 2015 The Potential of Indonesian Mangrove Forests for Global Climate Change Mitigation Nature Climate Change 5 1089-1092. https://doi.org/10.1038/nclimate2734
[4] Rudianto R, Bengen D G and Kurniawan F 2020 Causes and Effects of Mangrove Ecosystem Damage on Carbon Stocks and Absorption in East Java, Indonesia Sustainability 12(24) 10319. https://doi.org/10.3390/su122410319

[5] Carugati L, Gatto B and Rastelli E 2018 Impact of Mangrove Forests Degradation on Biodiversity and Ecosystem Functioning Scientific Reports 8(13298) https://doi.org/10.1038/s41598-018-31683-0

[6] Richards D R and Friess D A 2016 Rates and Drivers of Mangrove Deforestation in Southeast Asia 2000–2012 Proceedings of the National Academy of Sciences. https://doi.org/10.1073/pnas.1510272113

[7] Asmit B, Syahza A, Mahdum, Riadi R M 2020 Opportunities and Prospect for Tourism Development on Rupat Island, Indonesia Folia Geographica 62(2) 133-148. http://www.foliageographica.sk/unipo/journals/2020-62-2/572

[8] Widiati W, Mulyadi A, Syahza A, Mubarak M 2020 Analysis of Plantation Management Achievement Based on Sustainable Development. International Journal of Sustainable Development and Planning 15(4) 575-584 https://doi.org/10.18280/ijsdp.150418

[9] Priyanto A, Purnomo E P, Adoko B M, Khairina E, Fadhlurrohman M I 2020 The Impact of Covid-19 on Localtourism Sector and Income Mimbar Jurnal Sosial dan Pembangunan 36(2) 383-390

[10] Dewi L 2020 Resilience Ecotourism in Papua Amid Covid 19 Pandemic E Journal of Tourism 7(2) 250-264. https://doi.org/10.24922/eot.v7i2.61831

[11] Letizia A J 2017 Using Strategic Planning to Create the Public Good for Higher Education in Volatile Times International Journal of Progressive Education 13(2) 144-154 Available: https://eric.ed.gov/?id=EJ1145610

[12] KLHK 2021 Peta Kawasan Hutan Indonesia Kementerian Lingkungan Hidup dan Kehutanan Republik Indonesia, Jakarta. http://dbgis.menlhk.go.id/arcgis/services, accessed at June 4th 2021

[13] Pešić R, Ivaniš M, Prodanović R 2018 Economic instruments for reduction of greenhouse gas emission in agriculture and forestry Economics of Agriculture 65(1) 269-291 https://doi.org/10.5937/ekoPolj1801269P

[14] Syahza A., Suwondo, Bakce D, Nasrul B, Mustofa R 2020 Utilization of Peatlands Based on Local Wisdom and Community Welfare in Riau Province, Indonesia International Journal of Sustainable Development and Planning 15(7) 1119-1126 https://doi.org/10.18280/ijsdp.150716

[15] Vitasurya V R 2016 Local Wisdom for Sustainable Development of Rural Tourism, Case on Kalibiru and Lopati Village, Province of Daerah Istimewa Yogyakarta Procedia Social and Behavioral Sciences 216 97-108. https://doi.org/10.1016/j.sspro.2015.12.014

[16] Kusmana C 2016 Integrated Sustainable Mangrove Forest Management Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan 5(1) 1-6. https://doi.org/10.29244/jpls1.5.1.1

[17] Yanti R, Syahza A, Hidir A, Suwondo S 2018 The Communication Model of Forest Management Based on Environmental Awareness Management of Environmental Quality 29(6), 1093-1109. https://doi.org/10.1108/MEQ-02-2018-0028.

[18] Friess D A 2017 Ecotourism as a Tool for Mangrove Conservation. Sumatra Journal of Disaster, Geography and Geography Education 1(1) 24-35

[19] Pešić R, Ivanš M, Prodanović R 2018 Economic instruments for reduction of greenhouse gas emission in agriculture and forestry Economics of Agriculture 65(1) 269-291 https://doi.org/10.5937/ekoPolj1801269P

[20] Syahza A., Suwondo, Bakce D, Nasrul B, Mustofa R 2020 Utilization of Peatlands Based on Local Wisdom and Community Welfare in Riau Province, Indonesia International Journal of Sustainable Development and Planning 15(7) 1119-1126 https://doi.org/10.18280/ijsdp.150716

[21] Murdiyarso D, Sukara E, Supriatna J, Koropitan A, Juliandi B, Jompa J 2018 Creating Blue Carbon Opportunities in the Maritime Archipelago Indonesia CIFOR Policy Brief 3. https://doi.org/10.17528/cifor/007058
[22] 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 Current Biology 31 1–7. https://doi.org/10.1016/j.cub.2021.01.070

[23] World Bank 2021 Mangrove Conservation and Restoration: Protecting Indonesia’s “Climate Guardians” https://www.worldbank.org/en/news/feature/2021/07/26/mangrove-conservation-and-restoration-protecting-indonesia-climate-guardians. Accessed at August 21th 2021

[24] Wylie L, Sutton-Grier A E, Moore A 2016 Keys to Successful Blue Carbon Projects: Lessons Learned from Global Case Studies Marine Policy 65 76–84 https://dx.doi.org/10.1016/j.marpol.2015.12.020

[25] Syahza A 2019 The Potential of Environmental Impact as a Result of the Development of Palm Oil Plantation Management of Environmental Quality 30(5) 1072-1094 https://doi.org/10.1108/MEQ-11-2018-0190

[26] Sutikno S, Amalia I R, Sandhyavitrri A, Syahza A, Widodo H, Seto T H 2020 Application of Weather Modification Technology for Peatlands Fires Mitigation in Riau Indonesia AIP Conference Proceedings 2227(030007) 1-9. https://doi.org/10.1063/5.0002137

[27] Syahza A, Bakce D, Irianti M 2019 Improved Peatlands Potential for Agricultural Purposes to Support Sustainable Development in Bengkalis District, Riau Province Indonesia Journal of Physics: Conference Series 1351. https://doi.org/10.1088/1742-6596/1351/1/012114

[28] Alviya I, Mutaqin Z M, Salminah M, Hamdani F A U 2018 Community-Based Carbon Emission Reduction Program in Protection Forest. Jurnal Analisis Kebijakan Kehutanan 15(1) 19–37

[29] Ayu S 2019 Pembayaran Jasa Lingkungan Karbon dengan Skema Plan Vivo di Hutan Kemasyarakatan Aik Bual Kecamatan Kopang Kabupaten Lombok Tengah (S1 Thesis Universitas Mataram, Mataram. http://eprints.unram.ac.id/id/eprint/15232

[30] Verra 2021 The Katingan Peatland Restoration and Conservation Project. https://verra.org/wp-content/uploads/2016/10/CCB_PROJ_DESC_1477_11MAY16.pdf. Accessed at August 7th 2021.

[31] Verra 2021 Rimba Raya Biodiversity Reserve Project. https://verra.org/wp-content/uploads/2020/01/SD-VISsta-Project-Description-Draft-674.pdf. Accessed at August 8th 2021

[32] Schmidt L and Gerber K 2016 A Comparison of Carbon Market Standards for REDD+ projects. Germanwatch e V. Available: https://germanwatch.org/sites/default/files/publication/17247.pdf

[33] OECD/IEA/NEA/ITF 2015 Aligning Policies for a Low-Carbon Economy. OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264233294-en

[34] Von Unger M and Emmer I 2018 Carbon Market Incentives to Conserve, Restore and Enhance Soil Carbon Silvestrum and The Nature Conservancy, Arlington, VA, USA

[35] Pieter J, Benu F, Kaho M R 2015 Valuasi Ekonomi Ekowisata Terhadap Pengembangan Objek Wisata Kawasan Pesisir Pantai Jurnal Ilmu Lingkungan 13(1) 55-64 https://doi.org/10.14710/jil.13.1.55-64

[36] Khan I, Lei H, Ali G, Ali S, Zhao M 2019 Public Attitudes, Preferences and Willingness to Pay for River Ecosystem Services International Journal of Environmental Research and Public Health 16(3707) 1-17. https://doi.org/10.3390/ijerph16193707

[37] Erbaugh J T 2019 Responsibilization and Social Forestry in Indonesia Forest Policy and Economics 109 (2019) 1-9. https://doi.org/10.1016/j.forpol.2019.102019

[38] Syahza A and Irianti M 2021 Formulation of control strategy on the environmental impact potential as a result of the development of palm oil plantation Journal of Science and Technology Policy Management 12(1) 106-116 https://doi.org/10.1108/JSTPM-06-2019-0059
[39] Syahza A, Robin, Suwondo, Hosobuchi M 2021 Innovation for the Development of Environmentally Friendly Oil Palm Plantation in Indonesia *IOP Conference Series: Earth and Environmental Science* **716**(012014) https://doi.org/10.1088/1755-1315/716/1/012014.