

Blue Carbon Ecosystems for Climate Resilience in Indonesia: A Study of Adaptation Strategy

Ria Tri Vinata*, Masitha Tismanada Kumala and Peni Jati Setyowati

Law Faculty, Wijaya Kusuma Surabaya University, Indonesia

Abstract. Climate change due to global warming will have an impact on marine and coastal ecosystems, including causing loss of biodiversity and threatening the sustainability of marine and coastal resources. The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) made Indonesia, which is a tropical archipelagic state as one of the hotspots that is very at risk of being affected by global warming. This risk is especially experienced by cities on the coast. Therefore the importance of adaptation, especially in dealing with the impacts of climate change that has already occurred. The adaptation process cannot be delayed any longer because the earth's temperature will certainly increase beyond the threshold of 1.5 degrees Celsius in 2030 compared to the pre-Industrial Revolution temperature of 1850. Currently, the global temperature increase has reached 1.1 degrees Celsius. Therefore, Indonesia must immediately make adaptation efforts by utilizing the Blue Carbon Ecosystem which is based on research that blue carbon can absorb and store 100 times more carbon and is more permanent than forests on land. This stored carbon can be stored for thousands of years. Because of this great potential, coastal ecosystems can play many roles as adaptation solutions and mitigation of climate change impacts. Therefore researchers conduct research with the aim of the research is to create Strategies and Adaptation Efforts for Utilizing Blue Carbon Ecosystems: Disaster Resilience, Climate Crisis, and Sustainable Development, with the main target of implementing Resource Based Theory in developing strategies for utilization of Marine Resources, especially Utilization of Carbon Ecosystems Blue in Indonesian marine environment. This research is expected to provide theoretical and empirical evidence related to the development of blue ecosystem utilization strategies, climate crisis, and sustainable development.

Keywords: Blue carbon potential, adaptation efforts, climate resilience, UNFCCC, Paris Agreement, blue carbon ecosystem

1. Introduction

Indonesia is referred to as a coastal state with the largest archipelago. Indonesia has around 17,504 islands and comprises 70% of the water area. The Asia Pacific region is an area that is known as a strategic area and is rich in marine biological resources.¹ Indonesia is one of the states included in the Asia Pacific region and is the largest archipelagic state in the world, so it is necessary to express partiality and attention in 2020 Indonesia will include blue carbon in emission reductions following the 2015 Paris Agreement, where the role of Blue Carbon is still

*Corresponding author. E-mail: riatrivinata@uwks.ac.id.

¹ Anissa Lawrence (2013), Karbon Biru Sebuah terobosan baru untuk mengurangi dampak perubahan iklim melalui konservasi dan pelestarian ekosistem pesisir di kawasan Coral Triangle can be accessed at: https://wwfeu.awsassets.panda.org/downloads/wwf_report_karbonbiru_coraltriangle.pdf.

not accommodated.² The role of Blue Carbon in climate change mitigation and adaptation has now become an international concern. Indonesia has the largest mangrove forest in the world, based on the One Map Mangroves map made by the Environment and Forestry Ministry of Indonesia together with the Marine And Fisheries Ministry of Indonesia,³ National Aeronautics and Space Institute, Coordinating Ministry for Maritime Affairs and Investment of Indonesia, Indonesian Institute of Sciences, and others. Currently, Indonesia's mangrove forests reach 3.31 million hectares, 80% are in good condition and 20% are in critical condition. has a major meaning in the mitigation and adaptation of global climate change.⁴

One of the useful marine biological resources is coral reefs. The area of coral reefs in Indonesia reaches 50,875 square kilometers or about 18% of the world's total coral reef area.⁵ Scientists say that the "center" of the world's coral reef biodiversity is in the Raja Ampat Islands.⁶ Based on the criteria for finding more than 500 types of coral, the Indo-Pacific region is designated as the coral triangle area.⁷ Blue carbon ecosystems have the potential to absorb 50% of the carbon present in the atmosphere. Expansion of marine protected areas with a target of 32.5 million hectares in 2030, targeted at least 20 million hectares that are well managed so that mangrove and seagrass ecosystems can function optimally. Currently, at least 92.73% of the seagrass ecosystem has entered the conservation area.⁸

The fact that territory of Indonesia covers more than 60% of the total area of the world's Coral Triangle, which is mainly dominated by the eastern part of Indonesia.⁹ As a country with the largest mangroves in the world, namely 3.3 million hectares, and the largest seagrass beds, which reach 293,000 hectares, Indonesia prioritizes blue carbon ecosystems in planning spatial management and coastal conservation, both in Indonesia and globally. These two coastal ecosystems are estimated to be able to store large natural carbon (carbon sinks) for a very long time, up to 3.3 Gigatonnes or 17 percent of global blue carbon. However, the destruction of coastal ecosystems has the potential to release carbon dioxide into the waters which is equivalent to 19 percent of total tropical forest destruction emissions.

Until 2020, we can be sure that there will be a decrease in marine debris by 15.30%, so this shows that there is an effort and a massive movement to ensure that blue carbon resources are properly maintained. The potential to become a superpower country with three stretches of mangroves, sea grasses, and coral reefs will be wasted if we don't address the issue of marine debris.

The territory of Indonesia covers more than 60% of the total area of the world's Coral Triangle, which is mainly dominated by the eastern part of Indonesia. The government is currently carrying out mangrove rehabilitation as part of the National Economic Recovery program. this potential cannot be maximized because the activities carried out are generally carried out separately, including several policies related to blue carbon that have not yet been integrated. In addition, there is also a lack of availability of data related to baseline references for blue carbon ecosystems (especially seagrass), weak coordination between ministries and agencies, and a lack of

- 2 I.T.C. Wibisono and Ita Sualia (2008), Final Report: An Assessment of Lessons Learnt from the "Green Coast Project" in Nanggroe Aceh Darussalam (NAD) Province and Nias Island, Indonesia, Period 2005–2008. Wetlands International – Indonesia Programme, Bogor.
- 3 S. Crooks et al. (2011), "Mitigating Climate Change through Restoration and Management of Coastal Wetlands and Near-shore Marine Ecosystems: Challenges and Opportunities," *Environment Department Paper 121*, World Bank, Washington, DC.
- 4 W.H. Schlesinger and J. Lichter (2001), Limited carbon storage in soil and litter of experimental forest plots under elevated atmospheric CO₂, *Nature*, 411: 466-6.
- 5 D. Roe et al. (2011), "Ten Frequently Asked Questions – Ten Policy Implications", *J. Biodiversity and Poverty* 150, July 2011, Gatekeeper Series, International Institute for Environment and Development.
- 6 "Blue Carbon Dalam Pembangunan Blue Economy Dan Pencapaian Target NDC" can be accessed at: <https://kkp.go.id/an-component/media/upload-gambar-pendukung/DitJaskel/publikasi%20materi/blue-carbon/Workshop%20Blue%20Carbon%2018%20April%202022.pdf>.
- 7 Kasta Rosyada (2021), "Potensi Blue Carbon dalam Penanganan Perubahan Iklim Guna Menunjang Keamanan Maritim Indonesia", *Jurnal Maritim Indonesia*, 9: 3
- 8 Nunu Anugrah (2021), "Strategi Pengelolaan Karbon Biru di Indonesia", *Kementerian Lingkungan Hidup dan Kehutanan*, 9 Juli, <http://ppid.menlhk.go.id/berita/siaran-pers/6047/strategi-pengelolaan-karbon-biru-di-indonesia>.
- 9 Mark Dia et al. (2019), Oceans in the Balance: Indonesia in Focus, Greenpeace, <https://www.greenpeace.org/static/planet4-indonesia-stateless/2019/02/c3b005b1-c3b005b1-oib-indonesia-in-focus.pdf>.
- 10 M. Ambari (2017), "Besarnya Potensi Karbon Biru dari Pesisir Indonesia", *Tetapi Belum Ada Roadmap Blue Carbon, Kenapa?*, Mongabay, <https://www.mongabay.co.id/2017/09/11/besarnya-potensi-karbon-biru-dari-pesisir-indonesia-tetapi-belum-ada-roadmap-blue-carbon-kenapa/>.

strengthening the capacity of stakeholders in GHG and MRV inventories. Based on the wrong way of utilization, the coral triangle area will be faced with several threats. Excessive fishing trade or exploitation of fish can cause the state of the ecosystem to become unbalanced. Fishing techniques that do not follow the rules can also cause damage to other marine biota and their habitat. Based on the research, it was found that the coastal ecosystem is also a sink for greenhouse gases. The panda ecosystem (coastal vegetation) is believed to absorb and store 100 times more carbon and more permanently than forests on the mainland.¹¹

The carbon absorbed by coastal ecosystems is no less large than forests. In contrast to terrestrial ecosystems which tend not to increase at certain times, coastal ecosystems can absorb and store carbon in sediments continuously for a long period. About 50–99 percent of the carbon absorbed by coastal ecosystems is stored in the soil at a depth of 6 meters below the ground surface. This stored carbon can be stored for thousands of years. Because of this great potential, coastal ecosystems can play many roles as adaptation solutions and mitigation of the impacts of climate change. but no research studied about the Adaptation Efforts to Utilize Blue Carbon Ecosystems for Climate Resilience and Sustainable Development.

2. Research Method

The research method used in this article is the description and explanation. Descriptive research presents a complete picture of the problems that focus on conditions in Indonesia related to the impact of climate change on Indonesia and Adaptation Efforts to Utilize Blue Carbon Ecosystems for Climate Resilience. We will analyze data related to blue carbon in Indonesia's marine environment with the applicable legal arrangements in Indonesia as well as international cooperation that has been carried out by Indonesia with neighboring states to provide strategies for adaptation efforts to use blue carbon to tackle climate change. This research is expected to provide theoretical and empirical evidence related to the construction of Indonesian legislation and its implementation with the aim of Climate Resilience in the Indonesian Territory.

3. Discussion

3.1. Climate Change Impact in Indonesia

Indonesia is in a very vulnerable position to the impacts of climate change. The IPCC (2021) notes that climate change has an impact on increasing extreme sea waves and extreme weather in the Asian region. Areas that are prone to be affected by climate change are coastal areas. According to the United States Environmental Protection Agency there are at least four impacts of climate change that occur in coastal areas, namely sea level rise, storm surges and rainfall, impacts on coastal water temperatures, and finally impacts on seawater acidification. Changes in sea conditions due to climate change affect marine ecosystems and human activities that utilize the sea. Further increases in sea temperature will risk coral bleaching and a decline in capture fisheries production. Coastal communities are certainly the most vulnerable due to abrasion and coastal inundation by tidal floods and tidal waves. The frequency and intensity of coastal inundation, tidal waves, and coastal abrasion may increase due to high sea levels and in the long term will disrupt the lives of coastal communities and have a direct impact on their economic sector.

The National Disaster Mitigation Agency of Indonesia concluded that the impact of climate change is changing coastal morphology, submerging small islands, and polluting freshwater sources. Indonesian Institute of Sciences estimates that sea level rise in western Indonesia is as high as 3.10–9.27 mm per year. As the 7th largest GHG-emitting state in the world, Indonesia needs to accelerate efforts to mitigate and adapt to climate change, especially in low-lying islands that are vulnerable to the impacts of climate change.¹² Utilization of Nature-based Solutions

11 Agustin Rustam et al. (2014), "Studi Kasus Tanjung Lesung", *Banten, J. Segara*, 10(2): 107-117.

12 Kurniawati Hasjanah (2023), Indonesia's Emission Reduction Ambition Needs to Increase can be accessed at: <https://iesr.or.id/en/indonesias-emission-reduction-ambition-needs-to-increase>.

(NbS), especially blue carbon ecosystems, needs serious attention from the government. Blue carbon ecosystems, which consist of seagrass beds and mangroves, have a higher carbon storage capacity than terrestrial forests.¹³

Indonesia has 25% of mangrove ecosystems, and seagrass meadows (seagrass beds). Through the high percentage, Indonesia will have great significance in mitigating and adapting to global climate change.¹⁴ The impact of global climate change will affect various aspects of life. Indonesia as a coastal state is not immune from these consequences, especially in the maritime sector. This phenomenon will threaten the lives of coastal communities and affect ecosystems and marine biota and will directly disrupt the maritime sector. Blue Carbon or blue carbon is the term for carbon absorbed and stored in coastal and marine ecosystems. This carbon is stored in the form of sediment, such as that stored in mangrove trees, tidal swamp shrubs, and seagrass beds.¹⁵

Coastal ecosystems that contain mangrove forests (mangroves), tidal swamps, and seagrass beds provide impacts and benefits for climate change mitigation and adaptation along the coast globally. The coast plays a role in protecting from coastal abrasion, protection from storms and rising sea levels, preventing tidal flooding, regulating coastal water and air quality, providing habitat for coastal biodiversity, and providing food sources for coastal communities. The Indonesian government proposed the role of Blue Carbon in reducing carbon emissions at the United Nations Framework Convention on Climate Change (UNFCCC) in 2019 in Bonn, Germany. The government actively contributes to reducing carbon emissions according to the agreement in the Paris Agreement.¹⁶

The combination of the concepts of Blue Carbon and Blue Economy is very appropriate when applied to coastal areas. Considering that in Indonesia 60% of the people work as fishermen because Indonesia has a large maritime axis.¹⁷ Through the Blue Economy, it is hoped that economic practices in Indonesia, especially in coastal areas, can move away from economic practices that only provide short-term benefits and switch to more sustainable and low-carbon economic practices. The existence of this concept is expected to minimize the interdependence between ecosystems and the economy and overcome negative impacts such as climate change and global warming caused by economic activities.

One commodity that can unite the concepts of blue carbon and the blue economy is seaweed.¹⁸ Seaweed cultivation can be a win-win solution for the economy and ecology which often sacrifice each other.¹⁹ Seaweed can bind carbon for photosynthesis needs. According to researchers from the Research and Development Center for Aquaculture, Erlania et al., when compared to terrestrial plants, seaweed has a relatively good carbon absorption capacity. This can be seen from the results of Widiyanto's research that conservation forests have a carbon absorption potential of 275 tons per hectare. Not much different from this figure, the results of Erlania et al.'s research show that the carbon absorption capacity of seaweed can reach 173 tons per hectare. This figure shows that seaweed has a fairly high carbon absorption capacity so it can be said to be commensurate with the carbon absorption capacity of conservation forests.

3.2. Sustainable Development Concept

Indonesia is growing at a faster pace than at any other time in its history. With the 2030 Agenda in mind, the state is moving towards a higher-value, globally integrated, low-carbon economy. The United Nations works

- 13 World Rainforest Movement "Blue Carbon" dan "Blue REDD": Mengubah Ekosistem Pesisir Menjadi Barang Dagangan can be accessed at: <https://www.wrm.org.uy/wp-content/uploads/2014/09/BlueCarbon.dan.Blue-REDD.KIARA.Bahasa.pdf>.
- 14 Okta Freida Posisi Dan Potensi Karbon Biru Sebagai Upaya Mitigasi Perubahan Iklim can be accessed at: <https://www.portonews.com/2021/keuangan-dan-portfolio/lingkungan-hidup/posisi-dan-potensi-karbon-biru-sebagai-upaya-mitigasi-perubahan-iklim/>.
- 15 Ambari (2022), Ekosistem Karbon Biru dalam Peta Konservasi Nasional can be accessed at: <https://www.mongabay.co.id/2022/08/12/ekosistem-karbon-biru-dalam-peta-konservasi-nasional/>.
- 16 Luh De Suriyani, Begini Tantangan dan Strategi Pengelolaan Karbon Biru di Indonesia can be accessed at: <https://www.mongabay.co.id/2021/07/12/begini-tantangan-dan-strategi-pengelolaan-karbon-biru-di-indonesia/>.
- 17 M.T. Kumala et al. (2023), "Fishermen Human Rights Protection and Sustainable Development in the Indonesian Marine Sector", *Lex Portus*, 9(4): 16-27. <https://doi.org/10.26886/2524-101X.9.4.2023.2>.
- 18 Lucentezza Napitupulu et al. (2022), "Trends in Marine Resources and Fisheries Management in Indonesia", Report. Jakarta: World Resources Institute Indonesia, https://wri-indonesia.org/sites/default/files/2022-12/Marine%20Trends%20Report_WRI%20format_v14.pdf.
- 19 Martin R. Stuchtey et al. (2020), "Ocean Solutions that Benefit People", *Nature and the Economy*, Washington, World Resources Institute, www.oceanpanel.org/ocean-solutions.

closely with the Government of Indonesia, civil society organizations, academic institutions, and private sector entities to achieve the Sustainable Development Goals effectively through an integrated approach. The UN will also strengthen its partnerships with regional and district authorities and communities to deliver sustainable development outcomes.²⁰ In addition, the UN will expand its cooperation to include industry associations, think tanks, data managers, and science and technology-based institutions that offer innovative prospects for integrated development solutions, which are critical to the achievement of the Sustainable Development Goals.²¹ The United Nations is committed to working with the Government of Indonesia in building a nation that is prosperous, democratic and just, where development benefits everyone, and where the rights of future generations are protected.²² True to the Sustainable Development Goals promise to leave no one behind, the UN's approach incorporates a strong focus on the poorest of the poor, fighting discrimination and rising inequality and addressing their root causes.²³ Leaving no one behind means prioritizing the dignity of people and putting the advancement of the most marginalized and vulnerable communities first. This central and transformative promise is more important than ever to address the impact of the pandemic and work towards a recovery that is sustainable, resilient, and inclusive.²⁴

3.3. Blue Carbon Potential in Indonesia

As the owner of 17 percent of the world's blue carbon reserves, Indonesia has a great opportunity to utilize the Blue Carbon Ecosystem as one of the solutions to tackle climate change. Blue Carbon Ecosystem which includes mangrove forests, seagrass beds, and salt marshes, has great potential as carbon sequestration and storage which plays an important role in climate change mitigation efforts.²⁵ Blue Carbon Ecosystem also plays a significant role in climate change adaptation, especially for coastal communities whose living space and livelihoods have the potential to be affected by climate-related coastal risks, such as extreme weather, storms, erosion, floods, and so on. These risks can result in socio-economic impacts, endangering biodiversity, and reduced ecosystem services that have an impact on human and natural survival.

Indonesia's blue carbon potential is one of the largest in the world and has an important role in mitigating and adapting to climate change nationally and globally.²⁶ Blue carbon or carbon stored in coastal and the sea ecosystem, has an important role in achieving the emission reduction target in Indonesia's Enhance Nationally Determined Contribution (NDC) of 21.89% with own business (National) and 43.20% with international assistance in 2030. Of course, optimizing the potential of blue carbon in reducing carbon emissions and in Carbon trading requires not only healthy blue carbon ecosystems but also integrated policy and financial support.

Indonesia has 5.8 million kilometers of sea area, 3.36 million hectares of mangroves, 3.2 million hectares of seagrass beds, and 108 km of coastline. As much as 20% of the population lives on the coast sea-based solutions (ocean-based solutions) as well as Critical Natural Capital (CNC) for controlling climate change, as well as being a source of livelihood for coastal communities. The consequence of designating Blue Carbon Ecosystem as a CNC means that Blue Carbon Ecosystem is entitled, appropriate, and must be guaranteed with strong

- 20 Budi Utami Hanjani Putri (2016), Distribusi Ekosistem Karbon Biru Di Pulau Kecil Menggunakan Landsat-8 (Studi Kasus: Pulau Pramuka Dan Sekitarnya) Jurnal Pendidikan Geografi, 16(2).
- 21 ICCTF, Mengenal Konservasi Ekosistem Karbon Biru, Didorong dalam Pembahasan G20 can be accessed at: <https://www.icctf.or.id/mengenal-konservasi-ekosistem-karbon-biru-didorong-dalam-pembahasan-g20-di-bali/>.
- 22 Ismadi, Ekosistem Pesisir Jadi Benteng Penyerapan Emisi Karbon, can be accessed at: <https://nusantaramaritimewebnews.id/berita/ekosistem-pesisir-jadi-benteng-penyerapan-emisi-karbon/>.
- 23 Tonny Wagey, Inovasi Pembangunan Penanganan Perubahan Iklim Di Sektor Kelautan & Perikanan can be accessed at: <https://www.icctf.or.id/wp-content/uploads/2022/03/Buku-Inovasi-Pembangunan-Penanganan-Perubahan-Iklim-di-Sektor-Kelautan-dan-Perikanan.pdf>.
- 24 Murdiyarso Daniel et al. (2015), "The Potential of Indonesian Mangrove Forests for Global Climate Change Mitigation", *Nature Climate Change* 5(12): 1089-92. <https://doi.org/10.1038/nclimate2734>.
- 25 Ria Tri Vinata et al. "Prospect of Protection and Development Sea Grass Ecosystem as Carbon Sink and Carbon Source Due to Climate Change", *In Proceedings of the Annual Conference on Social Sciences and Humanities (ANCOSH 2018) – Revitalization of Local Wisdom in Global and Competitive Era*, pp. 177-180.
- 26 Indonesia Ocean Justice Initiative, Blue Carbon Ecosystem Governance in Indonesia: *Threats And Opportunities*, 24 January 2022, <https://oceanjusticeinitiative.org/2022/01/24/blue-carbon-ecosystem-governance-in-indonesia-threats-and-opportunities/>.

protection instruments. CNC itself is a major element of the concept or paradigm of sustainable development with an environmental perspective, which is in line with the constitution, especially Article 33 paragraph 4 of the 1945 Indonesian Constitution. This paragraph states that the national economy is organized based on economic democracy with the principles of togetherness, efficiency, justice, sustainability, an environmental perspective, independence, and maintaining a balance of progress and national economic unity.

3.4. Blue Carbon Adaptation Strategy and Efforts

Indonesia is currently making efforts to reduce emissions and climate resilience. This relates to efforts to implement the Sustainable Development Goals (SDG). One of the priority actions to achieve climate resilience is a comprehensive adaptation-mitigation program and disaster management strategy in dealing with climate change. As a form of participation in global climate change mitigation, Indonesia showed its commitment by ratifying the Kyoto Protocol through Law number 17 of 2004 concerning the ratification of the Kyoto Protocol to the UNFCCC.²⁷ Furthermore, in 2011, the Government of the Republic of Indonesia through Presidential Regulation Number 61 of 2011 concerning Indonesia's Greenhouse Gas National Action Plan (RAN GRK) committed to endeavour to reduce GHG emissions by 26% in 2020 to reach 29% by 2030.²⁸ Over the same period, it is expected that a 41% reduction in emissions can be achieved with external support. Then in September 2022, the government launched Indonesia's Enhanced NDC with the GHG emission reduction target increasing from 41% to 43.20% with international support and the self-sustaining emission reduction target also increasing from 29% to 31.89% (Indonesia, 2022). Not long after the launch of the Presidential Regulation, in 2015, Indonesia participated in the CoP (Conference of Parties) and ratified the Paris Agreement (Paris Agreement) through Law No. 16 of 2016 which was intended to show commitment to efforts to reduce global temperature rise, encourage transparency in carbon accounting, support adaptation and efforts to restore environmental damage. In the same year, Indonesia submitted its First Nationally Determined Contributions (NDC) to the UNFCCC. Five years later the first NDC was submitted to the UNFCCC. Indonesia submitted another Updated NDC in 2021 to the same organization.

One of the efforts in low-carbon development is optimizing the potential of blue-carbon ecosystems in the form of mangroves and seagrass beds. This effort is carried out organization with strategic steps to improve the quality and sustainability of the ecosystem. Optimizing the potential of blue carbon in mitigating climate change is carried out through international carbon trading and contributions to reducing emissions according to the Nationally Determined Contribution document. However, this still requires a number of supports, starting from the aspects of policy, and resources, to coordination. Fulfillment of the NDC in Indonesia is a mandate from the Paris Agreement which has been ratified by Indonesia through Law no. 16 of 2016 concerning the Ratification of the Paris Agreement to the UNFCCC.

Opportunities and constraints faced in mainstreaming coastal areas and blue carbon mangrove ecosystems have been identified and need to be anticipated when coastal areas are included in national strategies to achieve NDC targets. Coastal resilience is not only about the physical aspects (abrasion, sedimentation, and flooding/inundation) but also the social/economic aspects of the community and its supporting institutions. Therefore, the flow of information and funding must be transparent to all stakeholders, so that decision-making and implementation of the adaptation agenda can be carried out effectively, efficiently, and in a balanced manner. As advocated in the Paris Agreement, the bundling of adaptation and mitigation is also demonstrated in this document to achieve maximum results in coastal rehabilitation/restoration. A responsive adaptation cycle is suggested to be adopted so that adaptive actions in these strategic areas can be immediately initiated, monitored, and evaluated. In this regard, several emission mitigation scenarios linked to adaptation actions can be considered to facilitate the achievement of NDC targets and SDG goals by 2030.

The main strategies to achieve the adaptation targets in the 2030 NDC are: 1. supporting economic resilience of at least 1.72% of Gross Domestic Product (GDP) through low-carbon economic transformation, and resilience of food, water and energy systems 2. realising social and livelihood resilience of 0.32% of GDP through capacity

27 Siraj Haekal (2019), "Indonesian Policy in Ratifying The 2015 Paris Agreement", *Global: Jurnal Politik Internasional*, 21(1): 70-100.

28 Indonesia's Updated NDC for A Climate-Resilient Future can be accessed at: <http://greengrowth.bappenas.go.id/en/indonesias-updated-ndc-for-a-climate-resilient-future/>.

building in various living systems 3. enhancing ecosystem services and landscape resilience of up to 0.83% of GDP through integrated landscape approaches in the management of terrestrial, marine and coastal ecosystems.

Blue carbon management in the context of climate change is an important part of two of the five Blue Economy policies being pushed by the Ministry of Maritime Affairs and Fisheries, namely the expansion of Marine Protected Areas by 30% in 2045 and the Sustainable Management of Coastal and Small Islands. Indonesia has made a series of efforts to manage blue carbon ecosystems. From a policy standpoint, a Presidential Regulation regarding the National Strategy for Mangrove Ecosystem Management (NSPEM) was enacted in 2012 by establishing a national coordinating team for mangrove management. Several regulations and follow-up programs have also been initiated by the government, such as the Ministerial Regulation on the implementation of SNPEM, the Indonesian Blue Carbon Strategy Framework (IBCSF), and the development of the 2020–2024 National Medium Term Development Plan which includes blue carbon in low-carbon development initiatives. Although a number of these ideas have encouraged action to rehabilitate mangrove forests, there is still much that needs to be done by this nation to achieve the rehabilitation target of 1.8 million hectares of mangrove forests by 2045, especially in terms of funding, which is still far from sufficient. The steps above have also not had a major impact on seagrass protection given the limited understanding of seagrass ecosystems in Indonesia.

Actual action on the ground is just as important as initiatives initiated at the national level. The government, Civil Society Organizations (CSOs), universities, and other institutions have conducted assessments of blue carbon availability and blue carbon ecosystem protection projects in various locations in Indonesia. Nonetheless, guaranteeing the long-term sustainability of the project is still a challenge for this nation. Even though significant progress has been made, Indonesia still has major challenges in terms of managing blue carbon ecosystems. The goal is very clear: to manage ecosystems in a sustainable manner so as to be able to cope with change and strengthen climate resilience, maintain economic growth, and improve people's welfare.

The need for the integration of new ecosystem management was realized through collaboration between the Deputy Minister for Development Funding, the Ministry of National Development Planning and the Indonesia Climate Change Trust Fund (ICCTF) with the Agence Française de Développement (AFD) which allocated funding of 620,000 euros or around IDR 9.9 billion. This collaboration with a project duration of three years will focus on managing blue carbon ecosystems in three locations, namely Juru Seberang (Belitung), Likupang (North Sulawesi), and Raja Ampat (West Papua).²⁹ This collaborative project aims to integrate blue carbon into national and sub-national policies through the implementation of Indonesia's Blue Carbon Strategic Framework. Another goal is to increase the baseline, inventory and Monitoring, Reporting and Verification (MRV) capacity of national and regional stakeholders.

This collaboration is expected to be able to create policies that support the implementation of blue carbon to mitigate climate change and contribute to reducing emissions. Then it is hoped that it will also be able to answer the challenges of managing blue carbon ecosystems including the degradation of ecosystem quality, limited data, and the absence of standardization of the MRV method. Measuring emissions for blue carbon ecosystems, especially mangroves in Indonesia, must first know the characteristics of a number of areas.³⁰ This is because mangroves in every region in Indonesia, such as in Sumatra, Kalimantan and Papua, have different characteristics.

Blue carbon ecosystems can help reduce the impact of climate change, support adaptation, and secure social, economic, and environmental outcomes. Healthy blue carbon ecosystems store and sequester carbon that helps mitigate climate change, supports biodiversity, and provides valuable ecosystem services to coastal communities.³¹ When degraded or lost, they contribute to climate change by releasing stored greenhouse gases into the atmosphere and can be a significant source of emissions. Blue carbon projects use the climate change mitigation value of marine and coastal ecosystems to support conservation, sustainable use, and restoration. The climate mitigation benefits of a blue carbon project are determined by comparing the change in GHG

29 ICCTF, Bappenas Dorong Pengintegrasian Karbon Biru dalam Kebijakan Perubahan Iklim, 30 Mei 2023, <https://www.icctf.or.id/bappenas-dorong-pengintegrasian-karbon-biru-dalam-kebijakan-perubahan-iklim/>.

30 D. Murdiyarso et al. (2023), "Deriving emission factors for mangrove blue carbon ecosystem in Indonesia", *Carbon Balance Manag.*, 18(1):12. doi: 10.1186/s13021-023-00233-1.

31 Ines Ayostina (2022), "Network analysis of blue carbon governance process in Indonesia", *Marine Policy*, 137: 104955, ISSN 0308-597X, <https://doi.org/10.1016/j.marpol.2022.104955>.

reductions and emissions as a result of the project with the GHG reductions and emissions that would have occurred in the absence of the project. Implementing a national strategy and managing the huge potential of blue carbon ecosystems in Indonesia cannot be done without coordination and integration with ministries and other key stakeholders related to blue carbon. There is a need for standard guidelines in managing blue carbon ecosystems at the regional and national levels, it is also necessary to prepare policy documents that become the legal basis or umbrella documents in the implementation of blue carbon management in Indonesia.

Blue carbon management in the context of climate change is an important part of two of the five Blue Economy policies being pushed by the Ministry of Maritime Affairs and Fisheries, namely the expansion of Marine Protected Areas by 30% in 2045 and the Sustainable Management of Coastal and Small Islands. By expanding the conservation area to 30%, the seagrass and mangrove ecosystems in the conservation area have the potential to absorb around 188 million tonnes of CO₂eq. The five Blue Economy policies that the Marine and Fisheries Ministry of Indonesia is currently pushing include (1) Expanding and Establishing New Conservation Areas of up to 30%, (2) Quota-based Measured Capture Fisheries, (3) Development of Environmentally Friendly Marine, Coastal and Inland Aquaculture Fisheries, (4) Management of Coastal and Small Islands, (5) Management of plastic waste in the sea.

In consideration of implementing the provisions of Article 19 paragraph (1) of Law Number 25 of 2004 concerning the National Development Planning System, on 17 January 2020, President Joko Widodo signed Presidential Regulation Number 18 of 2020 concerning the National Medium-Term Development Plan 2020–2024.³² One of the RPJM policies is signaling a shift towards low carbon development, a paradigm shift towards a new green economy in Indonesia. It is hoped that low carbon development policies can realize an advanced and independent, just democratic, peaceful, and united country. The LCDI policy will be implemented to achieve Indonesia's Vision 2045.

Several steps have been and will be taken, including tightening licenses for extractive and exploitative industries in coastal areas; integrating mangrove management policies in Spatial and Regional Plans; Integrating coastal area management into climate change adaptation policies and NDCs; encouraging Green Investment in coastal areas; Implementing the socio-economic value of blue carbon; preparing a technical plan for the document Indonesia: Long-Term Strategy for Low Carbon and Climate Resilience 2050. Law enforcement in the protection and conservation of coastal ecosystems; improving the quality of research and database development regarding coastal ecosystems. Mitigating now can reduce the impact of climate change in the future. As a regulator, the involvement of stakeholders and relevant ministries and agencies needs to start from the planning process and policy interventions in the form of integrated development of coastal areas and maintenance of coastal ecosystems, to develop the potential of blue carbon, it is necessary to initiate in the realm of policy, science and technology, Sustainable Financing, and Outreach which aims to prioritize various initiatives and plans related to blue carbon in Indonesia's development planning scheme, especially in the field of coastal and marine ecosystems in line with the direction of low carbon development in the National Medium Term Development Plan 2020–2024 from the government and stakeholders.

4. Conclusion

Some of the main activities that can be carried out as a blue carbon adaptation strategy in Indonesia include (1) empowering coastal communities; (2) increasing community participation in monitoring; (3) disseminating and assimilating the results of research and development of marine and fisheries science and technology; (4) developing marine, brackish water, and freshwater aquaculture areas; (5) developing marine and fisheries resources; (6) empowering small island communities and facilitating integrated coastal area management; (7) increasing the capacity of marine and fisheries research resources. The utilization of blue carbon for climate change adaptation in coastal areas requires cross-sectoral cooperation. This is because, in addition to the greenhouse gas emissions generated from various sectors, the impacts caused have consequences for areas of economic development. The issue of blue carbon involves multi-sectors so it requires synergy between

32 Bappenas Prioritizes Blue Carbon Ecosystem Conservation, <https://bappenas.go.id/index.php/en/berita/bappenas-prioritaskan-konservasi-ekosistem-karbon-biru-pEm7m>.

cross-institutions in building national commitment. The establishment of a working group or networking between the scientific community and national policymakers will serve as a forum for sharing lessons learned while strengthening the blue carbon framework in Indonesia.

CORRECTED PROOF