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Mangrove Loss and Blue Carbon decline in Indonesia's Coastal Regions

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Abstract: *Indonesia has the largest mangrove area in the world and supports high diversity, including 92 true mangrove species. They provide critical ecosystem services such as protection from floods, disaster risk reduction, fisheries support, carbon sequestration, and erosion prevention. Despite their importance, Indonesia has experienced significant mangrove loss/destruction over the past two centuries. This is majorly driven by factors such as pollution, illegal logging, rapid urbanization, agriculture, and aquaculture expansion, with shrimp specifically. This leads to mangrove degradation, and it threatens community livelihoods, coastal resilience, ecosystem services, and national climate mitigation goals. In recent decades, Indonesia has begun to recognize mangroves as a key blue carbon ecosystem. Under the Paris Agreement, mangrove conservation and restoration strategies have been included. However, mangrove governance remains an issue due to overlapping land-sea policies, weak regulations, and gaps in regulatory frameworks. This paper reviews the environmental and economic importance of mangroves in Indonesia and examines the key drivers of mangrove loss, and discusses the challenges related to policy integration. The discussion highlights the need for inter-sectoral governance, community involvement, sustainable and long-term restoration practices, and financial sources. Strengthening these areas is essential for safeguarding Indonesia's mangroves.*

Keywords: *Indonesia, mangrove, blue carbon, coastal region*

Introduction

Indonesia's coastal regions are home to some of the world's most important mangrove ecosystems. Mangroves are salt-tolerant trees and shrubs that grow along tropical and subtropical shorelines. These forests provide a wide range of ecological and social benefits. They act as natural barriers against storms, protect shorelines from erosion, and support rich biodiversity. Moreover, they provide food and income for local communities. Mangroves are among the most effective natural systems for trapping and storing carbon, a specific type of carbon known as Blue Carbon because it is stored in coastal and marine ecosystems. The ability of mangroves to store carbon is extraordinary. Studies show that mangrove soils can store between 800 and 1,200 tonnes of carbon per hectare, which is often much higher than carbon stored in many dryland forests. Climate scientists argue that protecting and restoring mangroves is a powerful way to help reduce greenhouse gas emissions and mitigate climate change.

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Despite their importance, Indonesia's mangroves are under serious threat. Human activities such as aquaculture expansion, urbanization, and land conversion for agriculture have resulted in large areas of mangrove forests being cleared or degraded (Butler et al., 2023). Research indicates that about 20% of mangrove forests in Indonesia are already degraded, meaning they no longer function properly as ecosystems or carbon sinks (Rahman et al., 2024). Mangrove loss not only reduces carbon storage capacity but also releases previously stored carbon back into the atmosphere, contributing to climate change (World Wildlife Fund, n.d.).

Scientific research has quantified the impact of mangrove loss on carbon stocks. A systematic review of carbon data from across the country found that intact mangrove forests store an average of over 1,000 megagrams of carbon per hectare, while degraded mangroves and areas converted for aquaculture store much less; sometimes less than 600 megagrams per hectare (Adame et al., 2023). These figures clearly show that when mangroves are damaged, their ability to lock away carbon drops significantly, reducing the natural climate benefits they provide.

Figure 1 shows activities in mangrove forests.

Indonesia plays an outsized role in the global depiction of mangroves. The country's blue carbon ecosystems store an estimated 3,267 million tonnes of carbon, largely concentrated in regions like Papua and Kalimantan (Rahman et al., 2024). At the same time, coastal areas such as Jakarta Bay have experienced rapid mangrove loss due to development and pollution, which caused some areas to lose most of their mangrove cover in the past decade. These losses not only weaken the role of mangroves as climate regulators but also reduce coastal resilience, making nearby communities more vulnerable to sea-level rise and flooding.

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Furthermore, the decline of mangroves is not only an environmental problem but also an individual one. Many coastal communities rely on mangrove forests for their daily necessities (Dawi et al, 2025). Fishing livelihoods depend on these forests as breeding and habitats that ground for fish or shellfish, while local families collect wood, edible plants, and other products for household use and income (Choong, 1990). A study on the food and medicinal value of mangroves in the country highlights how these ecosystems support both security and traditional health practices, particularly in rural coastal regions. When mangroves are exhausted, the benefits disappear, leaving people with fewer resources and greater uncertainty about their future. This topic was chosen because preserving and restoring mangroves aligns with climate change mitigation, sustainable development, and community resilience. These three goals are central to current environmental and social policy efforts. By combining practical engagement with scientific knowledge, the paper aims to spread awareness and empower coastal residents to protect their environment (Arnila, 2023). This community service activity is presented in Figures 1 and 2.

Method

This study uses secondary data-based research methodology to examine mangrove loss and blue carbon decline in Indonesia's coastal regions. The research relies on existing scientific studies, remote sensing data, institutional datasets, and documented case studies. This approach is commonly applied in environmental research to synthesize reliable evidence, identify trends, and support community-based conservation planning.

Result and Discussion

Mangrove Cover Loss in Indonesia:

In Indonesia, the mangrove forests are being severely threatened and have experienced mangrove loss over the past few years. Around 40% of Indonesia's mangrove forests have been destroyed in the past thirty years. The country has 29,00,000 hectares of mangrove forests and is the largest in the world, but over 52,000 hectares of its cover is being destroyed annually. Major threats include aquaculture expansion and land conversion due to coastal development pressures.

There is also data that shows that mangrove loss is highly uneven across different islands. Over 90% of mangroves in protected reserves like regions like Gorontalo in Sulawesi, have been illegally converted to shrimp and fish ponds, which shows hotspots of degradation where policy and regulation gaps persist. (Cifor, 2015)

Blue carbon storage:

Mangrove forests can store about 800-1200 tonnes of carbon per hectare, which is 5 times more than the carbon storage of upland forests. Indonesia's mangroves alone store about 3.14 billion tonnes of carbon, which is one-third of the globally stored

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carbon in coastal ecosystems. (Indonesian mangroves – best hope for slowing climate change:

New study, 2015) (Wanri Sitanggang, 2025). This data clearly shows how significant mangroves are as carbon sinks. These carbon-rich ecosystems, by improving carbon sequestration, contribute to global climate mitigation and as blue carbon strategies.

Figures 2 shows activities in mangrove forests.

Impacts on Marine and Coastal Biodiversity:

Mangrove ecosystems play an important role in marine and coastal biodiversity regulation. They act as homes to several marine species like fish, crustaceans, and mollusks. Some of these species contribute to local and national fisheries that support employment and export-related coastal economies. When the mangrove cover declines, it hurts the populations of these species. It affects their natural habitat and breeding grounds. Mangrove ecosystems also help in nutrient cycling and sediment control, and when this is disrupted, the whole marine ecosystem gets affected (Muhammad Ilman, 2016).

With the mangrove cover declining, coastal biodiversity becomes vulnerable, with species populations declining. There is evidence that some shrimp and fish populations in highly degraded mangrove zones show lower recruitment success and smaller biomass compared to regions with undisrupted forests, showing the cascading effects.

Socio-Economic Impacts on Coastal Communities:

Many coastal communities are completely dependent on mangrove ecosystems for food and livelihoods. There is a close link between healthy mangrove ecosystems and sustainable livelihoods. There is case study evidence that clearly depicts that there is a

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direct effect on income, food security, and livelihood stability of coastal communities with mangrove degradation. These forests also help in providing alternative income sources while controlling shoreline erosion, reducing wave energy, and reducing the impact of storms and flooding (Ella Goodman, 2021; World Bank Group, 2023).

Mangroves help in supporting ecological services like reducing the intensity of sea-level rise and climate-driven issues like coastal flooding. Because of their complex structure with aerial roots and above-ground branches, some dense mangrove systems have the ability to reduce wave length heights up to 66 percent per 100 meters of forest width (Pelayo Menendez, 2020). This majorly reduces the inland flooding and shoreline erosion as they can trap sediments. Low-lying communities and infrastructure near coastal regions will be more resilient with the presence of mangrove forests (Ella Goodman, 2021)

Discussion

For Indonesia, there are more mangroves in terms of area compared to other countries and has about 92 true mangrove species (World Bank Group, 2024). This, therefore makes it the most significant mangrove habitat in the world. Around 1 million hectares of mangrove in Indonesia have been lost since the 1800s, and Indonesia has lost around 200,000 hectares of mangroves by the end of the 1960s (Ilman et al., 2016). These mangroves are disappearing due to reasons tied to human activities and land-use changes. One of the main causes is shrimp farms, as mangrove forests are cleared to create aquaculture ponds (Ilman et al., 2016). Shrimp export supports coastal community livelihoods. Apart from shrimp farms, they have also been converted for palm oil and coconut plantations, as in South Sumatra (Eddy et al., 2021). Rapid growth of cities, port facilities, increase in transportation by water have also been key reasons to replace mangroves. In regions like East Java, there have been illegal logging and timber extraction for fuelwood, coal, and construction purposes (Rudianto et al., 2020). These drivers of mangrove loss are linked to economic development and weak governance, and highlight the need for integrated and sustainable coastal management.

This loss is a serious problem in Indonesia as mangroves protect the coastlines from tsunamis, strong winds, storms, floods, and other ecosystem services. Destruction brings in irreversible changes such as coastal erosion and soil acidification. These mangrove habitats are important for the production of shrimps as it contributes to over 45% of the fish exports (Ilman et al., 2016). This also indirectly highlights the importance of the community's livelihoods. While the economic importance of mangroves is evident through fisheries and export-driven livelihoods, their ecological significance extends beyond this and plays an important role in regulating the global climate. Mangroves play a key role in storing carbon compared to other forest types. For example, mangroves store 3-5 times more carbon than rainforests, and the secret

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is in their roots as mangroves have a unique root system that is present above the ground ("Stop Mangrove Destruction in Indonesia to Slow Climate Change," 2017). Indonesia's mangroves can store about 3.1 billion tons of carbon, which is equivalent to greenhouse gas emissions from 2.5 billion vehicles per year (World Bank Group, 2024b). Hence, preventing the destruction of Indonesian mangroves specifically would help in slowing climate change globally, so mangrove falls under the blue carbon ecosystem.

For the destruction and loss of mangroves to be reduced, clear and well-regulated rules are essential. Confusion arises when the land-based policies and the sea-based policies are not in sync. This often creates confusion about who is responsible for managing and protecting mangroves. Hence, leading to weak enforcement, ineffective protection, and mass-scale destruction (Arifanti et al., 2022). However, the absence creates opportunities as there can be integrated approaches in conserving mangroves, such as involving forestry, fisheries, and coastal planning (Mursyid et al., 2021). Indonesia has made international commitments to reduce greenhouse gas emissions under the Paris Agreement. A huge share of these emission reductions is expected to come from the forest sector. After recognizing this, the government has started to prioritize mangrove conservation and restoration with national climate strategies. This shows that restoring mangroves is not only for the environment but is also a nature-based solution to reduce greenhouse gas emissions, reduce climate change, and help the coastal communities.

Overall, by improving coordination, policy integration, and financing, Indonesia can restore mangroves to support climate mitigation, sustainable coastal development, aiding coastal livelihoods, and ecosystem resilience (Sidik et al., 2023).

Conclusion

Mangrove forests in Indonesia are vital ecosystems that provide environmental, economic, and social benefits. Despite their major role as blue carbon sinks and natural coastal protectors, they still face severe threats mainly because of anthropogenic causes like coastal development and aquaculture expansion. Giving importance to the restoration and conservation of mangrove ecosystems is not a necessity for climate change mitigation, biodiversity conservation, and building resilience for coastal communities. Strong conservation policies, community-based management backed by the government, and constant sustainable practices are needed to ensure the long-term survival of Indonesia's mangrove ecosystems.

References

Butler, R. A. (2023, August 23). Study shows how to maximize mangroves as climate

and community solution. Mongabay. https://news.mongabay.com/2023/08/study-shows-how-to-maximize-mangrov es-as-climate-and-community-solution/ Mongabay News

Rahman, R., Lokollo, F. F., Wawo, M., Lewerissa, Y. A., Hulopi, M., Ceanturi, A., Handayani, L. D., Zuhri, M. I., Effendi, H., & Wardiatno, Y. (2024). Blue carbon potential of mangrove ecosystems and its management to promote climate change mitigation in Indonesia. DOAJ.https://doaj.org/article/9b5a4ffd26734b369303616c1e0d7bc6 DOAJ

World Wildlife Fund. (n.d.). Mangroves as a solution to climate change. World Wildlife Fund. https://www.worldwildlife.org/resources/explainers/wildlife-climate-heroes/m angroves-as-a-solution-to-climate-change/ World Wildlife Fund

Adame, M. F., Sidik, F., Lovelock, C. E., & others. (2023). Deriving emission factors for mangrove blue carbon ecosystems. Carbon Balance and Management, 18.

Rahman, R., Lokollo, F. F., Wawo, M., Lewerissa, Y. A., Hulopi, M., Ceanturi, A., Handayani, L. D., Zuhri, M. I., Effendi, H., & Wardiatno, Y. (2024). Blue carbon potential of mangrove ecosystems and its management to promote climate change mitigation in Indonesia. Jurnal Ilmu Kehutanan, 18(2), 208-218.

Dawi, M. R. S., Sulistiono, & Kamal, M. M. (2025). Blue carbon potential of mangrove ecosystems in Jakarta Bay for climate change mitigation. Indonesian Journal of Marine Sciences, 30(3), 475-484. https://ejournal.undip.ac.id/index.php/ijms/article/view/71628

Choong, E. T., Wirakusumah, R. S., & Achmadi, S. S. (1990). Mangrove forest resources in Indonesia. Forest Ecology and Management, 33–34, 45–57. https://doi.org/10.1016/0378-1127(90)90183-C

Arnila, V. (2023, January 17). Mangroves types in Indonesia and their benefits. Trees4Trees. https://trees4trees.org/five-types-of-mangroves-in-indonesia-and-their-benefits

World Bank Group. (2024, July 31). Mangrove Conservation and Restoration: Protecting Indonesia's "Climate Guardians" World Bank. https://www.worldbank.org/en/news/feature/2021/07/26/mangrove-conserv ation-and-restoration-protecting-indonesia-climate-guardians

Ilman, M., Dargusch, P., Dart, P., & Onrizal. (2016). A historical analysis of the drivers of loss and degradation of Indonesia's mangroves. Elsevier, 54. http://sciencedirect.com/science/article/abs/pii/S0264837716302009

Eddy, S., Milantara, N., Sasmito, S. D., Kajita, T., & Basyuni, M. (2021). Anthropogenic Drivers of Mangrove Loss and Associated Carbon Emissions in South Sumatra, Indonesia. Forests, 12(2), 187. https://doi.org/10.3390/f12020187

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Rudianto, R., Bengen, D. G., & 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

Stop mangrove destruction in Indonesia to slow climate change. (2017, November 17). The Ecologist. https://theecologist.org/2015/aug/08/stop-mangrove-destruction-indonesia-sl ow-climate-change

World Bank Group. (2024b, July 31). Mangrove Conservation and Restoration: Protecting Indonesia's "Climate Guardians" World Bank. https://www.worldbank.org/en/news/feature/2021/07/26/mangrove-conserv ation-and-restoration-protecting-indonesia-climate-guardians

Arifanti, V. B., Sidik, F., Mulyanto, B., Susilowati, A., Wahyuni, T., Subarno, S., Yulianti, Y., Yuniarti, N., Aminah, A., Suita, E., Karlina, E., Suharti, S., Pratiwi, P., Turjaman, M., Hidayat, A., Rachmat, H. H., Imanuddin, R., Yeny, I., Darwiati, W., & Sari, N. (2022). Challenges and Strategies for Sustainable Mangrove Management in Indonesia: A Review. Forests, 13(5), 695. https://doi.org/10.3390/f13050695

Mursyid, H., Daulay, M. H., Pratama, A. A., Laraswati, D., Novita, N., Malik, A., & Maryudi, A. (2021). Governance issues related to the management and conservation of mangrove ecosystems to support climate change mitigation actions in Indonesia. Forest Policy and Economics, 133, 102622. https://doi.org/10.1016/j.forpol.2021.102622

Sidik, F., Lawrence, A., Wagey, T., Zamzani, F., & Lovelock, C. E. (2023). Blue carbon: A new paradigm of mangrove conservation and management in Indonesia. Marine Policy, 147, 105388. https://doi.org/10.1016/j.marpol.2022.105388

Menéndez, P., Losada, I. J., Torres-Ortega, S., Narayan, S., & Beck, M. W. (2020). The global flood protection benefits of mangroves. Scientific Reports, 10, Article 4404. https://doi.org/10.1038/s41598-020-61136-6 Nature

The Leaf Charity. (2021, December 15). Benefits of mangroves — Flood protection. https://www.theleafcharity.com/blog/benefits-of-mangroves-flood-protection Nature

Giesen, W., Wulffraat, S., Zieren, M., & Scholte, R. (2007). A historical analysis of the drivers of loss and degradation of Indonesia's mangroves. Forest Ecology and Management, 261(2), 645–654. https://www.sciencedirect.com/science/article/abs/pii/S0264837716302009 ScienceDirect