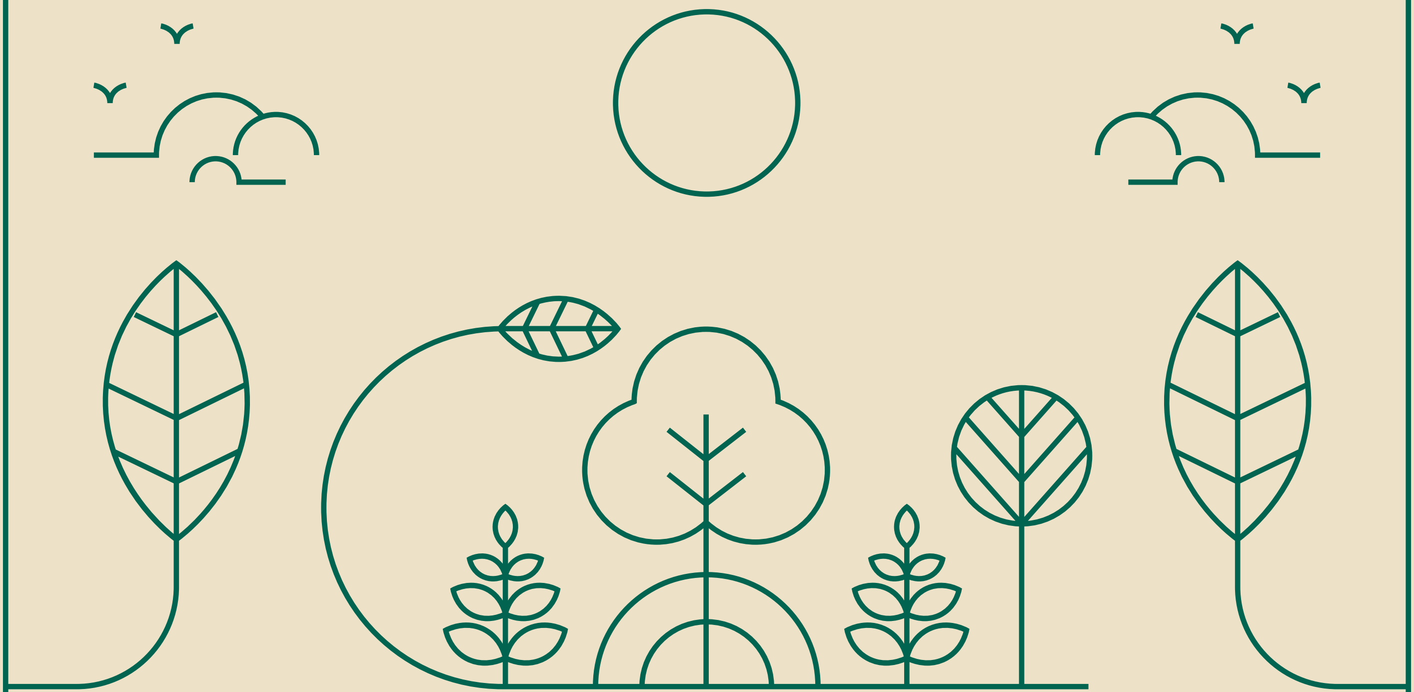

The Economics of Large-scale Mangrove Conservation and Restoration in Indonesia

Briefing Note (Executive Summary)

April, 2022

THE WORLD BANK
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GPS Global Program on Sustainability
SLMP INDONESIA SUSTAINABLE LANDSCAPE MANAGEMENT PROGRAM

Executive Summary

Key Messages

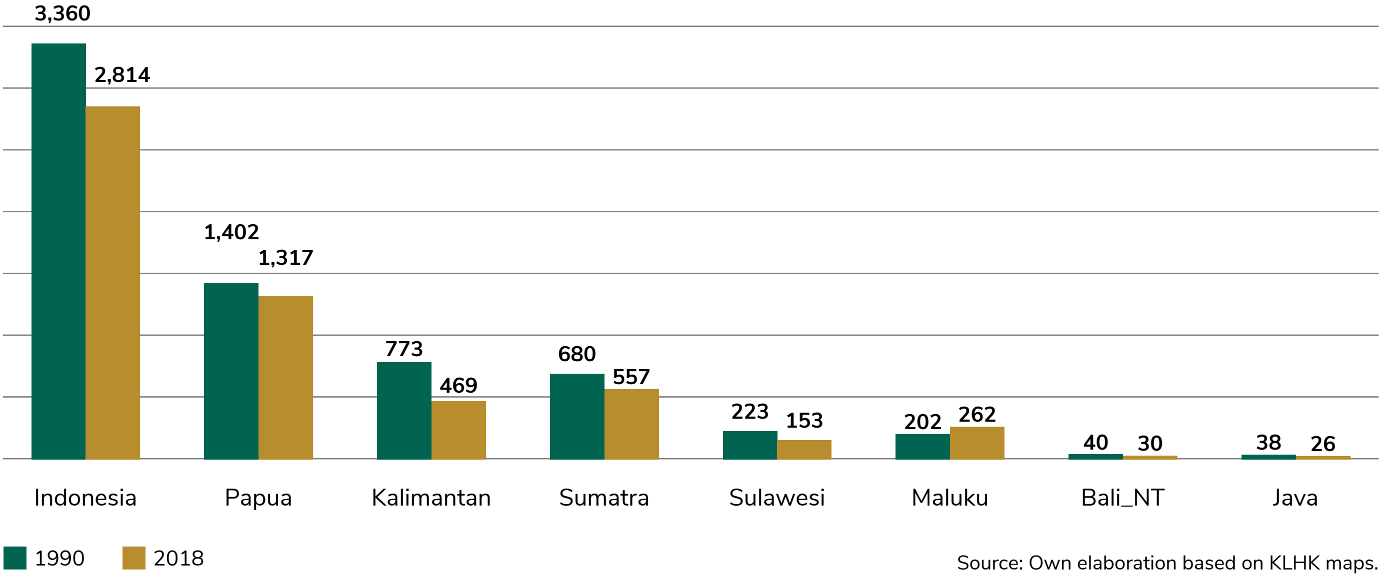
- The loss and degradation of Indonesia's critical ecosystems, including mangroves, is jeopardizing decades of economic achievement.
- The Government of Indonesia is moving in the right direction by setting ambitious strategies to promote a "blue economy," including a target to restore 600,000 hectares of mangroves by 2024.
- The "The Economics of Large-scale Mangrove Conservation and Restoration in Indonesia" study identified key factors to consider in devising the best policies for reaching this target:
    - Mangroves provide valuable ecosystem services that contribute to human wellbeing in Indonesia. On average, these sets of services yield USD 15,000/ha/year in benefits, but some provide benefits totaling nearly USD 50,000/ha/year.
    - The extent and value of mangrove-related ecosystem services vary sharply across regions and types of services. Average financial benefits for protecting coastlines are the largest.
    - Average Mangrove restoration costs in Indonesia are high (about USD 3,900/ha), above the global median (USD 3,500/ha). Low success rates heighten risks and drive up costs.
    - The opportunity costs of conservation and restoration are high and variable, showing a need for differentiated investment strategies. Opportunity cost of up to USD 3,400 is found in areas where mangroves can be converted into high-value commercial agriculture or aquaculture.
    - Conservation net benefits are generally higher than restoration net benefits, but regional differences should still be considered when making investment decisions. For example, conservation benefit/cost ratios vary from less than 1 to more than 5.
- The key policy message stemming from the study's findings is that an efficient mix of mangrove restoration and conservation activities is needed. Conservation of existing mangroves should be prioritized.
- Making the necessary investments will require adopting an integrated mangrove conservation, restoration and blue finance approach to tackle the regional differences. The following recommended policy actions will be vital:
    - Ensure restoration practices and financing include adequate provisions for long-term management and monitoring, including funding for mid-term corrections to increase restoration success rates.
    - Maximize labor contribution in restoration, especially as part of the COVID recovery stimulus.
    - Strengthen the evidence base (data, maps, etc.) for improved enforcement and mangrove management.
    - Explore complementary policies such as implementing a mangrove moratorium.
    - Secure payments for blue carbon and ensure that benefits reach local communities.

Background

Development in Indonesia has reduced poverty but put significant pressure on its natural capital, particularly its mangrove forests, the most carbon-rich ecosystems on earth. Indonesia is home to an estimated 20 percent of the world's mangroves, the largest extent of mangrove ecosystems in the world. Indonesia's mangrove forests are being rapidly and severely degraded, especially in Sumatra, Kalimantan, Java, and Sulawesi (Figure 1). They are threatened by clearing for aquaculture (accounting for nearly half of its removal), agriculture, and coastal development for urban expansion (Giri et al., 2011; Richards & Friess, 2016).

Photo by Joel Vodell on Unsplash

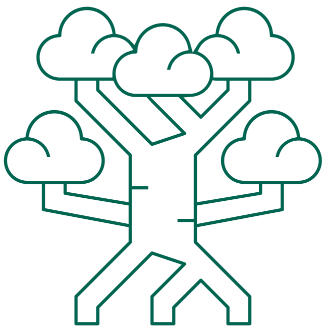
Figure 1. Trends of mangrove cover between 1990 and 2018 (thousand hectares)



Source: Own elaboration based on KLHK maps.

Notes: The region with the highest mangrove cover and one of the lowest degradation rates is Papua with almost half of current mangrove cover of the whole country. Figures adjusted as per standardization developed in the Indonesia pilot natural capital accounts (See Technical Report)

Mindful of the negative impacts of degrading coastal ecosystems, the Government of Indonesia has embarked on a "blue economy" strategy encompassing a range of initiatives, including tackling mangrove degradation and depletion. The Government recognizes that achieving a blue economy will require policy reforms in a range of areas, including the forest sector, marine and coastal management. These include: turning Indonesia's forests and land use sector into a carbon net sink by 2030, strengthening data and monitoring systems, securing new sources of financing, coordinating policies, and rectifying policy and governance gaps between forestry (mangrove) management and marine/coastal and fisheries management. Recently, the Government of Indonesia has set an ambitious target; it plans to rehabilitate 600,000 hectares of mangroves by 2024 (World Bank, 2020b). This target is the total amount of mangrove lost since 1990. How to reach this target and the implications of the steps to be taken are subject to national debate. This document seeks to inform this policy dialogue. It focuses on the need to consider spatial variations in allocating and managing investments and determining which techniques to use. It also highlights the role of land tenure and local communities and governments.



Objectives and Approach

This summary note synthesizes the report's main findings and key messages to inform sustainable mangrove management policies in Indonesia. It examines spatial variations in the values and net benefits of mangrove conservation and restoration.[1] It is spatially explicit, assessing costs and benefits by location to identify cost-effective locations for large-scale mangrove restoration and conservation. This spatial cost benefit analysis (CBA) provides new information that can inform decision-making and contribute to the development of Indonesia's national implementation strategy for mangrove restoration and conservation. This study also contributes to the broader discussion of how to institutionalize environmental valuation, which is becoming increasingly important for policymakers in Indonesia (Phelps et al, 2017).[2]

The results of this assessment should help the Government, the private sector, and other stakeholders identify sustainable mangrove management opportunities across Indonesia and understand the costs and benefits of mangrove management decisions. This will be particularly useful for the Coordinating Ministry of Maritime Affairs and Investment (Kemenkomarves), the Ministry of Marine Affairs and Fisheries (KKP), the Ministry of Environment and Forestry (KLHK), the Peat and Mangrove Restoration Agency (BRGM), the Ministry of Finance (Kemenkeu), and other line ministries that are part of the decision-making process. The report's innovative methodological application also offers new tools and knowledge that can inform think tanks, universities and NGOs working on coastal management, as well as policymakers.

Findings

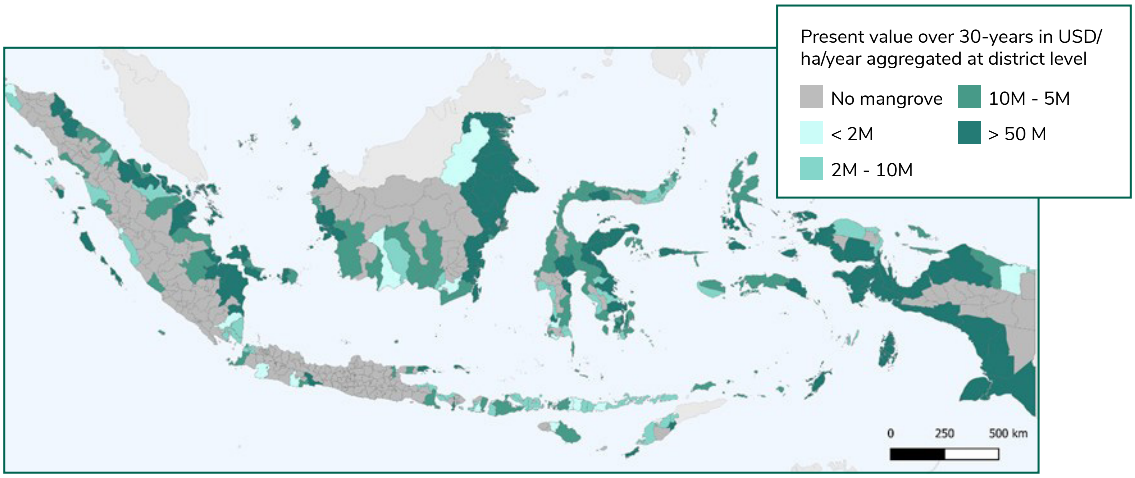
Mangroves provide an important set of valuable ecosystem services that contribute to human wellbeing in Indonesia.

These services include:

- Provisioning (providing commodities such as timber, fuel wood, and charcoal)
- Regulating (mitigating climate change impacts, sequestering carbon, controlling floods, storms, and erosion, and preventing saltwater intrusion)
- Preserving habitat (protecting biodiversity and providing breeding, spawning and nursery habitat for commercial fish species)
- Providing cultural services (recreation, aesthetic, non-use) (Spaninks and Beukering, 1997, UNEP, 2006, TEEB, 2010).

While not all services are susceptible to measurement within this study's methodology, the most prominent are. Figure 2 shows the spatial distribution of the combined values of all of these ecosystem services, such as raw material provision, coastal protection, climate regulation, fisheries support, and cultural services.

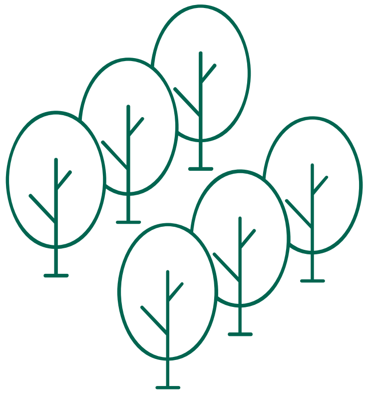
Figure 2. Spatial distribution of ecosystem services provided by mangroves (Values in USD/ha/year aggregated at district level)



Source: Own elaboration (See Technical Report)

1 Spatial CBA includes: the identification of the benefits (or ecosystem services), the identification of costs (including the opportunity costs of alternative uses of land) and the valuation of these costs and benefits. Valuation was conducted either using value transfer or market prices. For further details on the methods applied please refer to Annex 1, Methods Technical Report.

2 The approach used in this report compares the costs and benefits of conservation and restoration (Figure 6). A spatial database was compiled with all cost and benefit components. Initially a set of relevant ecosystem services were identified, and a selection of appropriate datasets and valuation methods was made. Information to be used had to fulfill a set of minimum criteria, including to: (1) be comprehensive enough to include the whole of Indonesia, (2) be susceptible to measurement at least at province level, and (3) be publicly and readily available. As shown in Figure 6, the values of costs and benefits had a different track, but the ultimate goal was to conduct a cost-benefit analysis and obtain the cost-benefit ratios for each district prone to mangrove management investments and obtain values per hectare. The steps were not necessarily sequential, and some feedback loops allowed to control for the quality of the data used.



Provision of mangrove-related ecosystem services vary substantially across regions and in terms of values

The services shown in Figure 2 are grouped in five major categories, as shown in Table 1. Coastal protection (i.e., flood control, storm attenuation, and erosion prevention) and fisheries support services offer the highest present values per hectare, USD 6,760 and USD 3,289 respectively. As shown in Table 1, coastal protection values are key, and mangrove-related ecosystem services offer the greatest value in Bali and Java, which have more developed coastal infrastructure.

Table 1. Value of Mangroves' Provision of Ecosystem Services by Location (Combined present value per hectare by region)

Ecosystem Service	Bali_NT	Java	Kalimantan	Maluku	Papua	Sulawesi	Sumatra	Average
A. Coastal Protection	39,970	6,219	66	49	1	685	331	6,760
B. Climate Regulation	2,798	2,798	2,798	2,798	2,798	2,798	2,798	2,798
C. Fisheries support services	2,912	3,928	2,733	3,348	1,183	6,256	2,662	3,289
D. Raw materials provision	1,138	1,535	1,068	1,309	462	2,445	1,040	1,286
E. Cultural services	1,894	2,344	469	112	438	294	640	885
Total	**48,713**	**16,823**	**7,134**	**7,616**	**4,882**	**12,478**	**7,471**	**15,017**

Source: Own elaboration

Notes: The net present value of benefits is based on a 30-year project lifetime and assuming that mangroves are a 30-year coastal infrastructure asset. A discount rate of 5.5% is applied plus a sensitivity analysis with a 0% and 10% discount rate was used in the analysis. The discount rate was selected based on discussions with the Government of Indonesia. Carbon stocks is assumed to be constant for all mangrove areas in Indonesia.

Coastal protection (Table 1 – item A)**.** Mangroves reduce flood risk and erosion that threaten coastal communities and assets by attenuating storm surge, dissipating wave energy. This report calculates coastal protection values for mangroves based on expected damage that the presence of mangroves prevents. Java and Bali, and other coastal areas with more development, denser populations, and more properties exposed to flooding, face steeper potential economic losses so mangroves in these places offer more protection value per hectare. In many of these areas, annual mangrove coastal protection benefits exceed USD 10,000 per hectare per year.

Climate regulation (Table 1 – item B). Mangroves help regulate the climate by sequestering carbon within soils and forest biomass. Avoiding mangrove loss in Indonesia could potentially reduce carbon emissions by an amount equivalent to 20-25 percent of total carbon stored worldwide in one year (Hamilton and Friess, 2018). This is roughly 0.96 Pg. of CO2e/year to 0.19 Pg. of CO2e/year (Murdiyarso et al, 2015) with an average present value of USD 2,798 per hectare (Table 1).

Fisheries support services and raw materials provision (Table 1 – item C and D). Mangroves play a key role as a fish refugia, nursing ground and source of nutrients for species that are commercially fished/harvested. They also provide firewood and timber to coastal communities. The United Nations Food and Agriculture Organization (FAO) estimates that 55 percent of Indonesia's total fish catch biomass, with a total annual production value of USD 825 million consists of species that depend on mangroves. This study assesses the benefits of mangrove-dependent fisheries in a spatially explicit way with a value function using a meta-regression. Essentially, this approach predicts the value of a mangrove patch's provisioning services by refining and scaling the mean ecosystem services value estimate from a large database of pre-existing valuation studies of other locations with similar characteristics. (Brander et al., 2012). For Indonesia as a whole, the mean value of fisheries services per hectare of mangrove is estimated to be USD 3,289/ha/year, while firewood and timber extraction is estimated to be USD 1,286/ha/year.

Tourism services. Mangroves provide opportunities for wildlife viewing and support other tourist attractions such as coral reefs and sandy beaches (Table 1 – item E). This study applied a unit value transfer method (i.e., extrapolation from other studies) to estimate the value of tourism services provided by mangrove at tourism locations identified through geographic content from TripAdvisor. The median per hectare value of mangrove-related tourism in Southeast Asia is USD 553 per year. In Indonesia, this study identified 319 tourist sites with 53,925 ha mangrove forests in direct proximity. The estimated value of tourism at these sites is just under USD 30 million per year. This figure probably undervalues the benefits mangroves provide to Indonesia's tourism industry but provides a good parameter to include in this economic analysis.

Average restoration costs in Indonesia are about USD 3,900/ha, higher than the global median and low rates of success could increase these costs. The initial costs of planting mangroves in Indonesia are similar to the median global cost estimates but low success rates in Indonesia drive up costs of mangrove restoration. Median global costs of mangrove restoration range from USD 1,000 to USD 9,000 per hectare (Bayraktarov et al., 2016; Narayan et al., 2016). The cost is a function of the technique applied. Basic planting for revegetation afforestation or reforestation is less expensive while habitat and/or ecological and hydrological restoration and experimental erosion control cost more. Using the Government of Indonesia's planting methods, it costs an estimated USD 3,900 to restore one hectare of mangroves. This includes the price of 10,000 mangrove seeds, planting facilities and infrastructure, and mangrove planting and maintenance. These estimates are limited to basic revegetation planting techniques and do not account for broader restoration activities, which raise the likelihood that new mangroves will survive. (Su et al., 2021).[3] Therefore, the true cost of successful mangrove restoration may be considerably higher than USD 3,900/ha.

Because converting mangrove forests to cropland boosts agricultural production, cost assessments need to factor in opportunity costs of alternative land uses. Opportunity costs were estimated based on agriculture and pasture commodities (adapted from Jakovac et al., 2020). On average, opportunity costs are USD 3,400 per hectare for a 30-year project lifetime assuming a 5.5 percent discount rate.[4] Data on aquaculture is not directly included in the calculations because it was not readily available, though it could be in the future. The opportunity costs of mangrove preservation and restoration In Indonesia are comparable to figures elsewhere in the world.

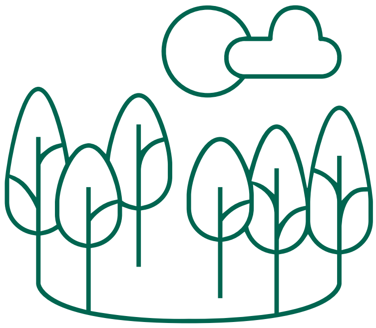
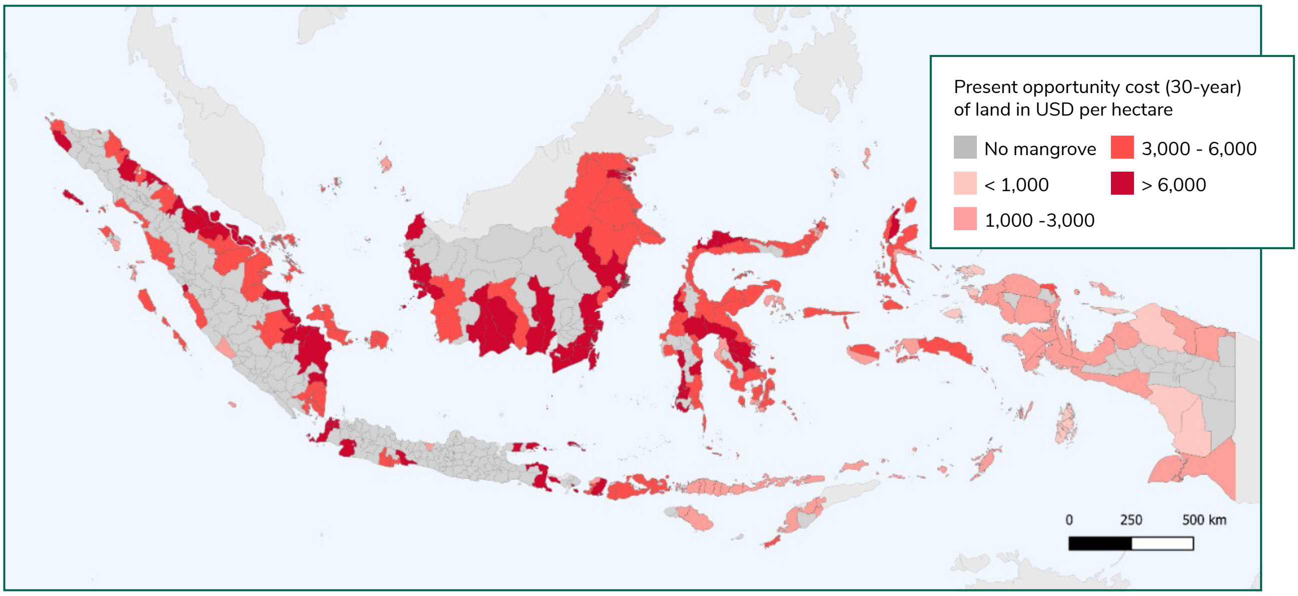


Figure 3. Spatial distribution of opportunity cost of alternative land uses



Source: Own elaboration based on Strassburg (2020); Jakovac et al. (2020) (See Technical Report)

3 This is a reasonable estimate based on calculations by the government, but that restoration costs in reality might strongly vary, also depending on the location:
- in some areas with degraded mangroves planting will occur in lower densities and might therefore be cheaper
- there is generally a lot of uncertainty around the cost of mangrove restoration due to the chance of failure.

4 The choice of discount rate is discussed in the Methods section of the Technical Report.

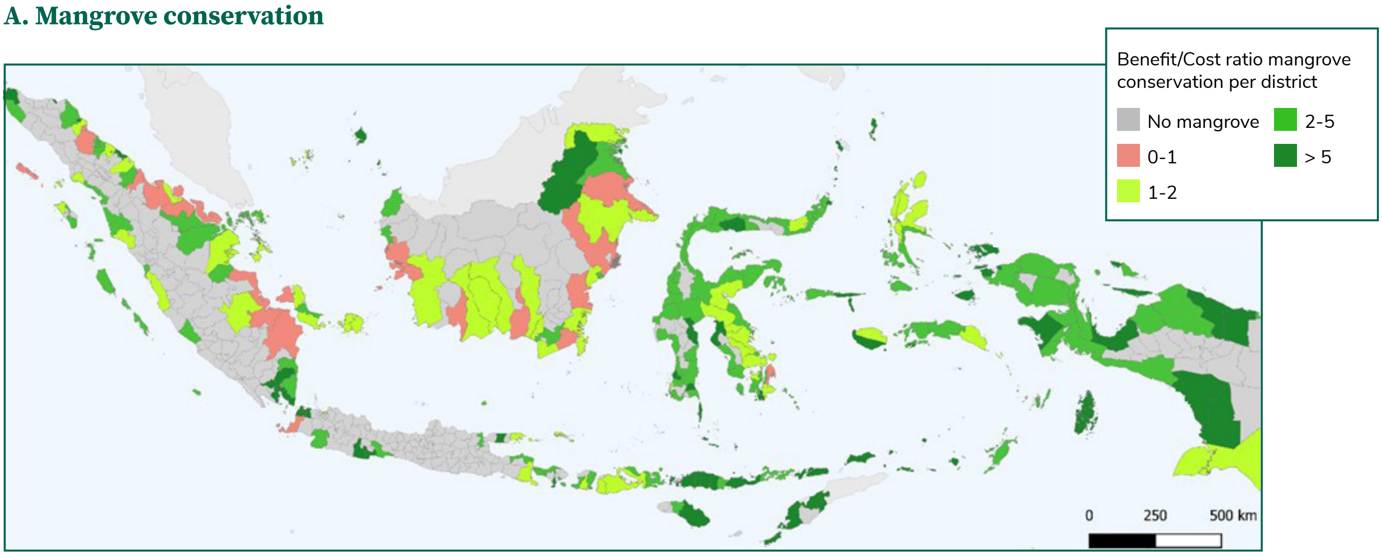
The benefit-cost ratio of a hectare of mangrove restoration is >1 in most districts, indicating a positive net present value of the investment. This assumes a discount rate of 5.5 percent over a 30-year period.

Regional differences should still be considered when making investment decisions. Spatially explicit cost-benefit analysis reveals where either mangrove restoration or conservation could be more economically viable. The more viable option is the one with the higher benefit/cost ratio. Through a spatial overlay of cost and benefit information, cost-benefit indicators are calculated per district, including net present value (NPV) and benefit-to-cost ratios. Figure 4 shows the benefit-cost ratio of mangrove restoration and mangrove conservation at district level.

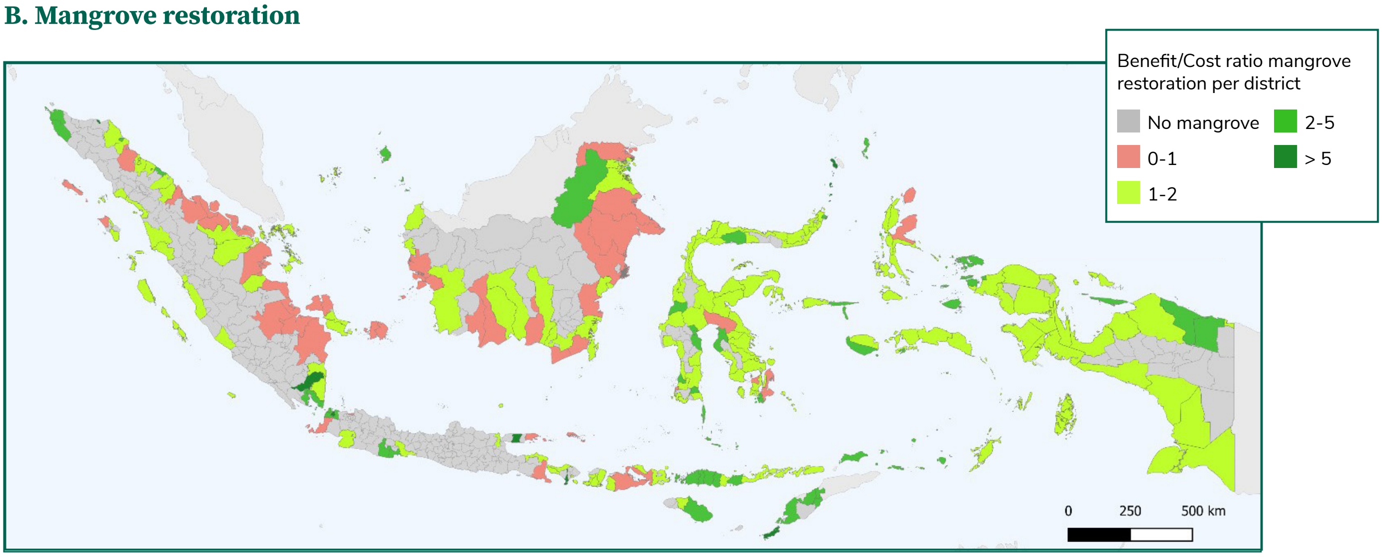
Mangrove conservation has a higher benefit-cost ratio due to the steep initial costs for restoration and the time it takes restored mangroves to deliver ecosystem services. Also, the rate of success of restoration projects is highly dependent on the quality of site assessment and selection, application of appropriate technique, robust monitoring, mid-course corrections and maintenance, and enforcement. This is especially true in areas with low opportunity cost, such as Maluku, Papua and NTT and some districts in Sulawesi.

Figure 4. Spatial distribution of benefit-cost ratios

A. Mangrove conservation



B. Mangrove restoration



A few highlights on the general results presented in this figure:

In areas such as eastern Sumatra and large parts of Kalimantan, where land opportunity costs are comparatively high and site-specific benefits such as coastal flood protection, fisheries and tourism are limited, the benefit-cost ratio of mangrove restoration is <1 indicating a negative net present value. In areas with negative net present values, different types of mixed-use systems could be explored supporting livelihoods (e.g. sustainable aquaculture and agriculture).

In districts with low opportunity costs and high site-specific benefits, such as NTT and West Papua, benefit-cost ratios can exceed 2 and sometimes reach 5. These results suggest that restoration yields stronger economic returns where land values/opportunity costs are low, or where values/opportunity costs are high, but are offset by the high benefits of mangrove protection to existing coastal assets.

The main differences between the costs and benefits of restoration and conservation are that:

- Restoration costs USD 3,900 per hectare.
- It takes 30 years after planting for mangroves to be fully rehabilitated and providing benefits.
- Restoration offers more potential to monetize the value of greenhouse gas reduction than conservation.

Source: Own elaboration based on Strassburg (2020); Jakovac et al. (2020)

Photo by Sanatana on Shutterstock

Policy Recommendations: Adopting an integrated conservation, restoration, and blue finance approach

Mangrove restoration should be considered within the broader policy context of the Government of Indonesia's blue economy strategy, the targets set under the medium-term development plan (RPJMN) for 2020-24, the Indonesia Oceans Policy[5] and the FOLU net sink target by 2030. The main findings of this study could help the Government of Indonesia design an efficient set of investments for sustainable mangrove management. It reveals that an optimal and efficient mix of mangrove restoration and conservation activities could help the Government reach its goal of rehabilitating 600,000 hectares of mangroves and preserving and managing mangroves sustainably.

The spatial cost-benefit analysis helps determine where restoration and/or conservation will bring the highest returns. Spatial cost-benefit or benefit-cost analysis in this study helps determine where restoration and/or conservation will bring the highest returns, albeit certain limitations.[6] The benefit cost analysis framework developed for this study can help inform dialogue and shape alternative scenarios.

5 This broader suite of actions include: (i) improved fisheries governance through operationalization of the Fishery Management Area (WPP) system, (ii) development, integration, and implementation of spatial plans, (iii) expansion of marine protected areas, (iv) a national action plan for marine debris, and (v) an integrated and sustainable tourism development program. Sustainable mangrove management however requires actions on the ground that could potentially mobilize high investments at high returns.

6 It is important for the reader to understand that the study has certain limitations and thus these numbers are informative of policy dialogue but should be analyzed in the context of the methods and data used. In principle, methods are available but the lack of data and quantitative knowledge regarding some key ecological relationships affirm the need for further inquiry, however by using standardized approaches such as natural capital accounting, this study manages to overcome some of these limitations. The basic steps outlined above are conceptually straightforward, but many complications invariably arise in practice. First, it is often difficult to confirm the internal validity of value estimates that are reported in existing nonmarket valuation studies and might be used for benefit transfers. Another potential threat to the validity of primary valuation estimates that might be used for benefit transfers is publication bias, which occurs when the outcome of a study influences the researchers' choice of whether to submit the report for publication or the editors' choice of whether to accept it. Determining the suitability of candidate study cases for transfer to the policy cases is also subject to discussion and here expert judgement plays a big role. Incomplete reporting or lack of access to primary information could deviate the results of the study. The team did a good effort to consult with experts and follow best practices. None of these observations are meant to diminish the importance of this or other meta-analyses of nonmarket valuation studies. The team strongly support making the best possible use of the relevant information that happens to be available, whether it was collected in an experimental or an observational setting, but caveat in their policy use should be considered up front.

Data show that the success of restoration activities depends on:

- The condition of the habitat to be restored (appropriate hydrology, accommodation space, appropriate surface elevation, protected from currents and waves, etc.)
- The willingness, commitment and engagement of local stakeholders to allow/support restoration
- Application of appropriate techniques (planting, hydrological restoration, erosion control, etc.)
- The materials used (quality of seedlings), the medium-term management (e.g. tending, protection)
- Mid-course corrections including hydrological repair, propagule dispersal, enhancement planting
- Data for long-term operational oversight.

Efforts focused on planting alone do not show high rates of long-term success. Successful restoration will probably require prioritizing the most suitable areas – those that provide the greatest net benefits. While restoration can provide significant environmental and economic benefits in many places, it should target areas where benefit cost ratios are highest. Optimally these projects should:

Maximize labor contribution in restoration, especially as part of the COVID recovery stimulus. Promote restoration methodologies that create as many jobs as possible. Expanding labor-intensive coastal and marine restoration activities, including mangrove restoration and coastal cleanups, can provide short-term employment during the post-COVID recession, and an emotional connection between community participants and the restored mangrove area, while providing long-term and resilient rehabilitation of mangrove benefits. This is consistent with the findings of this study and aligned with the findings of the High-Level Panel on Oceans which recommended coastal ecosystems restoration as a top-five blue economic stimulus for the post-COVID recovery. Technological innovations that can increase the effectiveness and efficiency of mangrove restoration should be tested and integrated with local labor utilization, with robust monitoring and analysis to determine optimal or best-practice approaches.

Strengthen the evidence base (data, maps, etc.) for improved enforcement and mangrove management. This could include finalizing the Mangrove One Map to ensure an accepted and consistent whole-of-Government understanding of the extent, quality and trends in mangroves and adjacent coastal ecosystems. Development of a credible and reliable valuation and accounting system could potentially also offer opportunities to better bridge improved data and policy decision making. Building on improved data, natural capital accounting supports marine and coastal policies by providing standardized data on the status and economic values of natural assets and how these assets are affected by human activity. Indonesia began building Natural Capital Accounting (NCA) through the Indonesian System of Environmental-Economic Accounts (SISNERLING) and could continue to include marine and coastal assets including mangroves.

Explore complementary policies, including implementing a mangrove moratorium. Indonesia has a moratorium on land conversion for Indonesia's primary forests and peatlands.

Despite their immense value, including higher carbon sequestration value per hectare, mangroves receive no equivalent protection. Indonesia could expand the scope of its moratorium on issuing licenses to convert primary forest and peatlands to include mangroves. Such an achievement could be done by enacting legislation.

Secure payments for blue carbon and ensure that benefits reach local communities. Indonesia would need to develop blue carbon readiness to ensure Indonesia can benefit from international blue carbon financing, including carbon accounting, monitoring and verification tools. Likewise, by including mangroves as nature-based solutions for coastal adaptation and resilience in the Nationally Determined Contribution, Indonesia could come up with targets for coastal adaptation and resilience. Protecting, managing, or enhancing mangroves could provide nature-based and hybrid solutions enabling Indonesia to reach these targets.

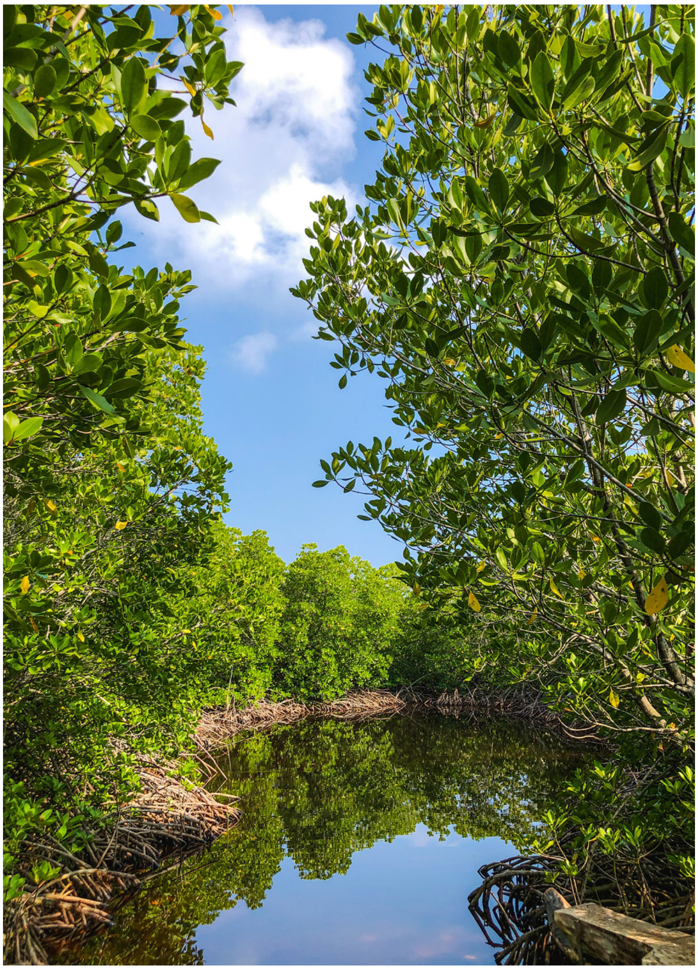


Photo by Muhammadh Saamy on Unsplash

References

This summary is based on the Technical Report that can be found in the following link: https://worldbankgroup-my.sharepoint.com/:w:/r/personal/jpcastaneda_worldbank_org/Documents/Documents/02_Countries/Indonesia/Shared-Mangroves-EA-Dec2021/Revised%20version%20-%20Dec2021/Technical%20Report%20-%20Magroves%20EA%20-%20IDN%20-%2012Dec2021.docx?d=wb03ebf3cab994254978630f9aa9a0f06&csf=1&web=1&e=rsTKcP

Bayraktarov, E., Saunders, M. I., Abdullah, S., Mills, M., Beher, J., Possingham, H. P., Mumby, P. J., & Lovelock, C. E. (2016). The cost and feasibility of marine coastal restoration. Ecological Applications, 26(4), 1055–1074. https://doi.org/https://doi.org/10.1890/15-1077

Brander L.M, Alfred J. Wagtendonk, Salman S. Hussain, Alistair McVittie, Peter H. Verburg, Rudolf S. de Groot, Sander van der Ploeg. Ecosystem service values for mangroves in Southeast Asia: A meta-analysis and value transfer application, Ecosystem Services, Volume 1, Issue 1, (2012). Pages 62-69, https://doi.org/10.1016/j.ecoser.2012.06.003

Giri C, Ochieng E, Tieszen LL, Zhu Z, Singh A, Loveland T, Masek J, Duke N (2011). Status and distribution of mangrove forests of the world using earth observation satellite data (version 1.4, updated by UNEP-WCMC). Global Ecology and Biogeography 20: 154-159. Paper DOI: 10.1111/j.1466-8238.2010.00584.x . Data DOI: https://doi.org/10.34892/1411-w728

Jakovac, C. C., Latawiec, A. E., Lacerda, E., Leite Lucas, I., Korys, K. A., Iribarrem, A., Malaguti, G. A., Turner, R. K., Luisetti, T., & Baeta Neves Strassburg, B. (2020). Costs and Carbon Benefits of Mangrove Conservation and Restoration: A Global Analysis. Ecological Economics, 176. https://doi.org/10.1016/j.ecolecon.2020.106758

Murdiyarso, D., Purbopuspito, J., Kauffman, J. B., Warren, M. W., Sasmito, S. D., Donato, D. C., Manuri, S., Krisnawati, H., Taberima, S., & Kurnianto, S. (2015). The potential of Indonesian mangrove forests for global climate change mitigation. Nature Climate Change, 5(12), 1089–1092. https://doi.org/10.1038/nclimate2734

Narayan, S., Beck, M. W., Reguero, B. G., Losada, I. J., van Wesenbeeck, B., Pontee, N., Sanchirico, J. N., Ingram, J. C., Lange, G.-M., & Burks-Copes, K. A. (2016). The Effectiveness, Costs and Coastal Protection Benefits of Natural and Nature-Based Defences. PLOS ONE, 11(5), e0154735-. https://doi.org/10.1371/journal.pone.0154735

Richards, D. R., & Friess, D. A. (2016). Rates and drivers of mangrove deforestation in Southeast Asia, 2000-2012. Proceedings of the National Academy of Sciences of the United States of America, 113(2), 344–349. https://doi.org/10.1073/pnas.1510272113

Spalding, M. & Parrett, C. Global patterns in mangrove recreation and tourism, Marine Policy, Volume 110, (2019), 103540, https://doi.org/10.1016/j.marpol.2019.103540.

Spaninks, F., Beukering, P.V., 1997. Economic Valuation of Mangrove Ecosystems: Potential and Limitations. CREED Working Paper 14.

Strassburg, B. B. N., Iribarrem, A., Beyer, H. L., Cordeiro, C. L., Crouzeilles, R., Jakovac, C. C., Braga Junqueira, A., Lacerda, E., Latawiec, A. E., Balmford, A., Brooks, T. M., Butchart, S. H. M., Chazdon, R. L., Erb, K.-H., Brancalion, P., Buchanan, G., Cooper, D., Díaz, S., Donald, P. F., … Visconti, P. (2020). Global priority areas for ecosystem restoration. Nature, 586(7831), 724–729. https://doi.org/10.1038/s41586-020-2784-9

UNEP (2006) Marine and Coastal Ecosystems and Human Well-Being: A Synthesis Report Based on the Findings of the Millennium Ecosystem Assessment. United Nations Environment Programme, Nairobi

TEEB (2010) The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Pushpam Kumar (Ed.), Earthscan, London and Washington

World Bank. (2020b). Oceans for Prosperity: Reforms for a Blue Economy in Indonesia.

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