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Indonesia's Mangrove Restoration: Practical Approaches for Coastal Protection and Climate Action

About FINCAPES PROJECT

The FINCAPES project, a 5.5-year, gender-responsive initiative funded by the Government of Canada and jointly undertaken by the University of Waterloo, aids Indonesia in sustainable climate change adaptation, mitigation, and biodiversity conservation. Aligned with Indonesia's national priorities, FINCAPES builds capacity in forecasting and mitigating flood impacts, promoting Nature-based Solutions for peatland and mangrove restoration, and strengthening climate finance policy with a focus on carbon financing.

Summary

Indonesia, home to nearly a quarter of the world's mangroves, faces significant hurdles in protecting these vital ecosystems. Despite their critical role in climate mitigation, disaster risk reduction, economic resilience, and biodiversity, challenges persist in restoration efforts. These include governance issues like land tenure disputes and limited participation from women, environmental factors such as disrupted hydrology and poor site selection, and socio-economic barriers like insufficient incentives and limited local capacity.

This brief synthesizes insights from various mangrove restoration initiatives, including those by the FINCAPES Project in collaboration with IPB University, BRIN, Blue Forests, NASCLIM, and KTH Lestari. These projects highlight innovative approaches such as site-specific restoration with biotechnology, prioritizing natural hydrology and regeneration, community-led education paired with financial incentives, and re-conceptualizing mangroves as economic assets.

Successful restoration hinges on three core pillars: strengthening governance through clear policies and multi-stakeholder collaboration; implementing science-based approaches that prioritize hydrological restoration and species-site matching; and empowering women and local communities through capacity building and sustainable livelihoods. To scale these efforts nationally, it's crucial to prioritize hydrological restoration, advance science-based models, bolster policy frameworks, foster inclusive community participation, establish dedicated learning centers, and secure long-term sustainable financing, including through blue carbon markets.

Introduction

The Flood Impacts, Carbon Pricing, and Ecosystem Sustainability (FINCAPES) Project is a collaborative initiative supported by the Government of Canada led by the University of Waterloo. FINCAPES aims to strengthen climate resilience in Indonesia by promoting nature-based solutions (NbS), advancing evidence-based policy, and supporting community-driven ecosystem management. The project bridges scientific research, policy innovation, and field implementation to address pressing environmental challenges while enhancing local livelihoods.

Under its Nature-based Solutions (NbS) component, the University of Waterloo is working closely with IPB University to develop the IPB Centre for Applied Research in Nature-based Solutions (I-CAN). I-CAN is envisioned as a pioneering research and innovation center, dedicated to bridging scientific inquiry with real-world application of NbS for sustainable development. I-CAN launched the I-CAN Think Forum, a multi-stakeholder platform designed to foster dialogue, knowledge sharing, and collaboration on sustainable ecosystem restoration.

In February 2025, the forum brought together practitioners, researchers, government representatives, NGOs, and community organizations to exchange key lessons, showcase innovative approaches, and identify actionable strategies for strengthening mangrove ecosystem resilience. The forum also provided an opportunity for FINCAPES to present its restoration initiatives in Lampung and share progress achieved to date.

This program brief synthesizes insights drawn from the forum discussions and showcases field experiences from five demonstration projects across Indonesia, implemented by FINCAPES-IPB, NASCLIM, BRIN, Blue Forests, and Farmers Group (Kelompok Tani Hutan/KTH) Lestari—that showcased a range of technical innovations, community empowerment models, and ecosystem-based restoration practices.

Context

Indonesia is home to 23% of the world's mangrove forests, covering 3.44 million hectares across its archipelago. These coastal ecosystems serve as natural shields against climate change, mitigating storm surges, preventing erosion, and acting as highly effective carbon sinks, storing 4-5 times more carbon than terrestrial forests. However, deforestation, land conversion, and climate change pose significant threats to their sustainability.

Picture 1: *The multiple benefits of mangrove restoration*

According to the Directorate General of Watershed Management and Forest Rehabilitation, Ministry of Environment and Forestry (2025), in recognizing the critical role of mangrove, the Indonesian government has prioritized mangrove restoration as part of its national climate action strategy, aligning with policies such as Asta Cita, the Enhanced Nationally Determined Contributions (NDCs) under the Paris Agreement, and the One Map Policy, which is being updated through the development of a 1:25,000-scale National Mangrove Map to support planning and tenure clarity.

In 2025, the forestry sector's development theme focuses on enhancing the production and downstream processing of forest products to drive equitable regional economic growth. Key performance targets include a 3–5% increase in forestry GDP and exports, a 7–8% rise in economic transactions among forest farmer groups, and a 3–4% reduction in forest loss rates.

The sector prioritizes environmental sustainability, economic advancement, and social empowerment through an integrated approach. This includes reducing emissions by

55.38%, limiting deforestation and forest degradation to 0.12 million hectares per year, and strengthening biodiversity conservation.

Economically, the sector is projected to contribute Rp69.17 trillion to the national GDP, expand exports, and attract further investment. On the social front, it supports land redistribution, promotes community forest management, and enhances economic opportunities for forest farmer groups —aligning forestry development with national goals for sustainability, equity, and resilience.

As part of its priority programs for 2025–2029, the Ministry of Environment and Forestry is targeting a total of 80,000 hectares of mangrove rehabilitation—comprising 6,000 hectares by the Directorate General of Watershed Management and Forest Rehabilitation (Ditjen PDASRH), 40,000 hectares by the Peat and Mangrove Restoration Agency (BRGM), and 34,000 hectares through other initiatives (Directorate General of Watershed Management and Forest Rehabilitation, Ministry of Environment and Forestry, 2025). Despite these commitments, mangrove restoration faces persistent challenges related to governance, environmental constraints, and socio-economic barriers.

The Government of Canada recognizes the urgency of global climate action and the value of nature-based solutions like mangrove and peatland restoration. As part of its Indo-Pacific Strategy, Canada is strengthening partnerships across the region to support climate resilience, biodiversity conservation, and sustainable economic development. Canada brings decades of experience and technical expertise in ecological restoration, land use planning, and community-led conservation to its collaboration with partners such as Indonesia, advancing shared goals for a healthy, secure, and sustainable future. This cooperation reflects Canada's broader commitment to climate leadership and resilience in the region and beyond.

Key Challenges in Mangrove Restoration

Picture 2: *The key challenges hindering mangrove restoration efforts*

Mangrove restoration efforts in Indonesia face multiple barriers that hinder progress, generally falling into three broad categories: governance, environmental, and socio-economic factors. In particular, experiences from restoration initiatives in Lampung—including projects led by community groups such as KTH Mutiara Hijau and KTH Bina Jaya Lestari—offer valuable insights into how technical obstacles, institutional gaps, and limited community engagement, gender gap in decision making interact in complex ways, shaping both the risks and opportunities for scaling up effective mangrove rehabilitation (Kusmana & Ekayani, 2024).

One of the most persistent challenges faced in mangrove restoration is hydrological disruption, often caused by abandoned aquaculture ponds, sediment imbalances, and blocked tidal channels. Without proper water flow, newly planted mangroves struggle to survive, emphasizing the need to prioritize hydrological restoration before replanting efforts begin. This challenge was particularly evident in areas such as Pasir Sakti, where reconnecting tidal flows and stabilizing sediments proved critical (Kusmana & Ekayani, 2024).

Governance-related challenges are among the most persistent. Many degraded mangrove areas have been converted into aquaculture ponds, settlements, or industrial zones, complicating restoration efforts. Land ownership disputes between government agencies, the private sector, and local communities frequently delay rehabilitation projects, making it difficult to secure long-term protection for restored areas. This issue was observed in KTH-managed sites in Lampung, where informal land use practices and overlapping claims delayed implementation and reduced coordination among stakeholders. In micro level, the role of farmer group becomes significant as safeguarding and to ensure sustainability of mangrove conservation and restoration. However, the farmer group still face a problem in governance of organization. Imbalance power relation impended to meaningful participation of women in decision making process.

Environmental factors also significantly impact restoration success. Mangrove growth is highly dependent on specific ecological conditions, yet rising sea levels, altered salinity, excessive sedimentation, and disrupted hydrological systems have created unfavourable environments for natural regeneration. Furthermore, past restoration efforts often failed due to inappropriate site selection, with mangroves planted in unsuitable areas such as mudflats below Mean Sea Level (MSL), resulting in low survival rates and ecosystem imbalances. In several project sites, such as Register 15 in Lampung, poor drainage systems and tidal exclusion significantly reduced seedling survival, despite technical planting efforts.

Socio-economic challenges further exacerbate the difficulties (Kusmana & Ekayani, 2024). Limited public awareness and a strong economic dependence on mangrove exploitation activities—such as shrimp farming and logging—undermine local participation in conservation efforts. Without clear financial incentives, communities often prioritize short-term economic gains over long-term environmental restoration. In case of FINCAPES piloting, even though women already have some business, but they faced obstacle to

develop and growth because the limited acces to capacity building, technology and access to market.

Financial constraints also hinder progress: while large-scale projects typically access government or private sector funding, smaller community-led initiatives often struggle to secure consistent financial support (Kusmana & Ekayani, 2024). Groups such as KTH Mutiara Hijau and KTH Bina Jaya Lestari reported difficulties in accessing funding and marketing support for mangrove-based enterprises like eco-tourism and sustainable aquaculture.

Finally, infrastructure and monitoring limitations pose practical barriers to effective restoration. Many planting sites are difficult to access, leading to delays in maintenance and monitoring. At some cluster planting locations in Lampung, access challenges and logistical constraints have prevented regular site inspections, further limiting adaptive management and learning. Moreover, inconsistent monitoring frameworks reduce the ability to track progress, evaluate success rates, and adjust restoration strategies accordingly (Kusmana & Ekayani, 2024).

Lessons from Mangrove Restoration Demonstration Projects

To address these challenges, projects showcased the following key innovations and best practices:

Site-Specific Restoration and Biotechnology Innovation (BRIN)
BRIN's approach to Ecosystem-Based Community Mangrove Restoration (EBCMR) emphasized the importance of tailoring interventions to specific site conditions. Restoration efforts were guided by geo-hydrological assessments and Restoration Design and Evaluation (DRE) maps, ensuring that interventions matched local ecological realities (Suyadi, 2024). In degraded sites with high iron or salinity content, BRIN introduced biotechnological innovations, such as microbial-based fertilizers and bioremediation techniques, to enhance soil quality and improve seedling survival rates (Suyadi, 2024).

Restoring Natural Hydrology and Emphasizing Natural Regeneration (Blue Forests)
The Blue Forests model highlighted the effectiveness of Ecological Mangrove Rehabilitation (EMR) through a structured decision-making framework. Before restoration activities began, thorough assessments of historical land use, tenure clarity, natural regeneration potential, and hydrological conditions were conducted. This model was successfully implemented in Tanakeke, South Sulawesi, where over 500 hectares were restored through major hydrological interventions, allowing mangroves to regenerate naturally without mass planting Massa, 2024).

Community-Led Education and Financial Innovation (NASCLIM)
The NASCLIM project demonstrated that combining ecological restoration with community empowerment yields sustainable resultsThrough Coastal Field Schools (CFS), local communities were trained in sustainable mangrove management practices, while the Bio-Rights Program provided conditional microloans that converted into grants if conservation outcomes were achieved. Women is one of the targeted groups on this CFS. The entry point is capacity building on livelihood activity for financial incentive. This dual focus on capacity-building and financial incentives helped align conservation goals with economic benefits for coastal communities (Dwisutono, 2024).

Shifting Mindsets and Strengthening Economic Incentives (KTH Lestari)
The experience of KTH Lestari in Subang, West Java, illustrated the importance of reframing mangrove ecosystems as economic assets rather than constraints. By demonstrating how mangroves improved aquaculture productivity, reduced erosion, and lowered pond maintenance costs, KTH Lestari successfully increased local participation in restoration initiatives while expanding green livelihoods. Their success in building community ownership has strengthened the long-term sustainability of conservation efforts (Saputra, 2024).

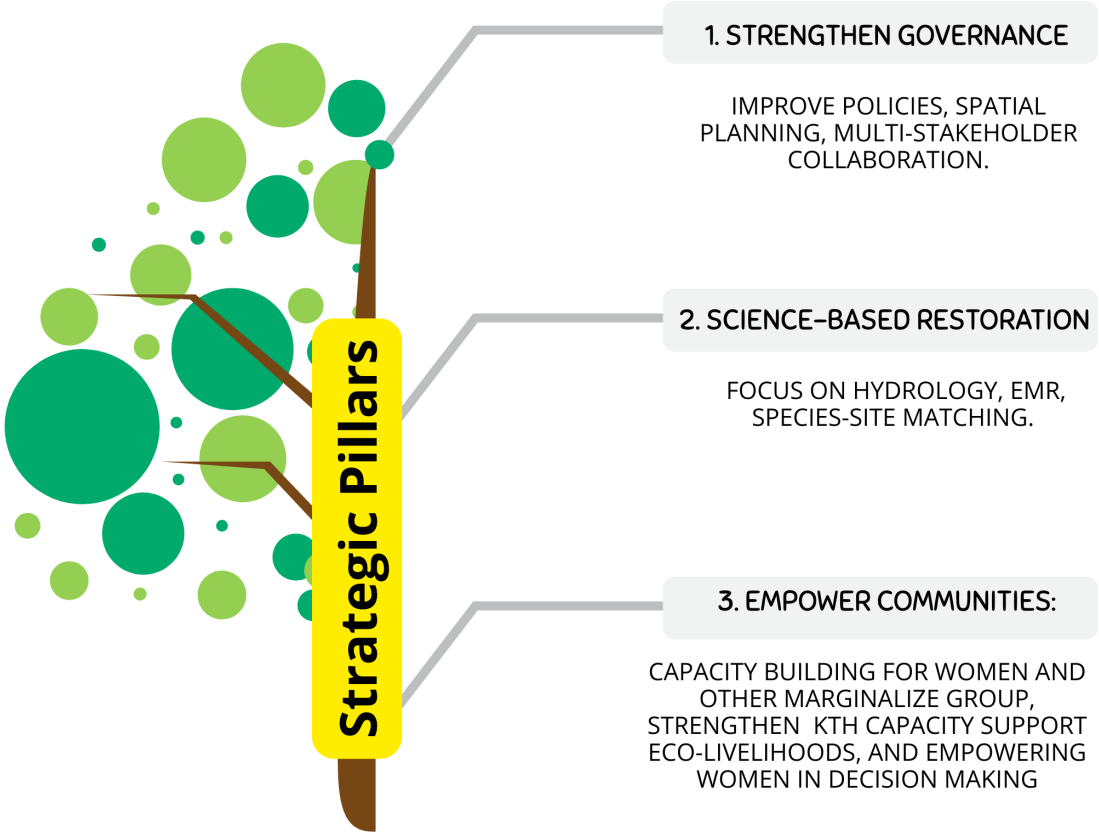
Field Innovations: Techniques and Outcomes from Lampung
Evidence from Lampung shows that quadrant planting with 1x1m spacing achieved survival rates of up to 95% within two months post-planting, significantly outperforming traditional cluster planting methods. However, challenges remain, including access difficulties and tidal management issues, highlighting the need for continuous site maintenance and adaptive hydrological management (Kusmana & Ekayani, 2024).

Hydrological rehabilitation techniques, as applied in projects like NASCLIM, BRIN, and Blue Forests, emphasized restoring tidal connectivity and constructing sediment traps to facilitate natural mangrove regeneration. Meanwhile, community-driven initiatives led by KTH Mutiara Hijau and KTH Lestari demonstrated that combining mangrove conservation with silvo-fishery systems can provide alternative, sustainable income sources for local communities.

These experiences reinforce that successful mangrove restoration is not merely about planting trees—it is about restoring natural processes, empowering local communities especially women and other marginalized groups and aligning ecological resilience with economic viability. Scaling up these integrated, science-based, and community-cantered approaches will be crucial to achieving Indonesia's ambitious mangrove restoration targets and strengthening its climate resilience.

Cultivating Resilient Coastal Ecosystems: A Strategic Approach to Mangrove Restoration

Successfully restoring Indonesia's vital mangrove ecosystems, which face numerous complex challenges, requires a well-planned, adaptive strategy. Building upon lessons learned developed from practical experience in field projects and valuable discussions with stakeholders at the I-CAN Think Forum, a strategic framework is recommended, grounded in three interrelated pillars: governance and policy strengthening, science-based restoration, and community empowerment. This approach aims to ensure that mangrove conservation efforts are sustainable, inclusive, and impactful for both ecosystems and coastal communities.



Picture 3: *The strategic pillars for successful mangrove restoration*

Strengthening Governance and Policy Frameworks

Effective mangrove restoration must begin with a foundation of clear regulations and robust management systems to safeguard existing ecosystems and prevent further degradation. The ongoing enhancement of mangrove mapping under the One Map Policy—with detailed datasets at a 1:25,000 scale—is a critical step forward, improving spatial planning, monitoring, and decision-making for coastal landscapes.

Sustainable management requires coordinated collaboration among multiple stakeholders, including government agencies, the private sector, and local communities.

Integrating diverse perspectives and expertise will strengthen governance structures and ensure long-term stewardship of mangrove areas.

Field experiences from organizations such as BRIN and Blue Forests highlight the importance of incorporating Ecological Mangrove Rehabilitation (EMR) principles – a way of helping mangroves recover naturally –into formal restoration planning. Also, it is crucial to resolve land tenure ambiguities at early stages to avoid delays and conflicts.

Additionally, insights from the I-CAN Think Forum and local consultations emphasize the critical role of village leadership and community champions, particularly those emerging from farmers group (Kelompok Tani Hutan/KTH). These individuals act as key connectors, helping to bridge any gaps in management and encouraging people in the community to get involved in restoration efforts.

Implementing Science-Based Restoration Approaches

The second key element focuses on making sure that the conditions are right for mangroves to grow before planting is started. This means moving away from just planting large numbers of trees and instead using approaches that are tailored to each specific location and based on scientific understanding. Projects have demonstrated that restoration success is closely linked to site-specific variables such as salinity, soil texture, and tidal inundation. For example, in Lampung, sites characterized by high clay content and mesohaline salinity proved optimal for the growth of Rhizophora apiculata.

A main priority is to restore the natural flow of tides, which is essential for the health of these coastal forests. Using natural engineering techniques such as strategically placing bamboo structures to trap sediment and using barriers that allow some water flow have shown good results. These methods help stabilize the coast, reduce the force of waves, and create a better environment for young mangrove plants to survive.

Matching the right species to the right location and using smart planting designs are crucial. Projects implemented by BRIN and NASCLIM emphasize the necessity of conducting comprehensive geo-hydrological and soil assessments to guide restoration design and optimize planting success. From the implementation of FINCAPES Project's Mangrove Restoration involving the local farmers group KTH Mutiara Hijau and researchers from IPB University, thorough assessment of potential planting sites, taking into account soil type and tidal information in developing planting design, has improved the success rate of planting significantly.

When conditions allow, **natural regeneration** is prioritized over mass planting, enabling ecosystems to recover with minimal disturbance and enhancing long-term ecosystem resilience.

Empowering Women and Local Communities Incentivizing Sustainable Livelihoods

The long-term success of mangrove conservation efforts depends on ensuring that local communities derive tangible economic benefits from restoration activities. Initiatives such as NASCLIM's Bio-Rights Program and Blue Forests' community governance models demonstrate the effectiveness of linking conservation incentives—such as conditional loans, benefit-sharing schemes, and local regulations—to sustainable ecosystem management.

Experiences from Pantai Mutiara Baru in Lampung show that structured benefit-sharing mechanisms (e.g., allocating 50% of benefits to members and 50% to program development) strengthen community ownership and commitment to restoration efforts.

Alternative livelihoods, including eco-tourism and sustainable fisheries, offer additional income streams while reducing pressure on mangrove ecosystems. Moreover, the growing potential of blue carbon finance presents an opportunity for communities to access climate finance markets by protecting and restoring mangroves.

Providing good training programs is essential for building the skills of local people in areas such as managing plant nurseries, practicing sustainable aquaculture, and using mangrove conservation techniques. Interestingly, when experienced farmer groups, like KTH Cuku Nyi Nyi in Lampung, share their knowledge with newer groups, it has proven to be a very effective way to strengthen local management and organization.

Restoration efforts led by the community have emerged as some of the most successful, with local fishers and farmers playing key roles in implementing projects and ensuring their continued commitment to protecting mangroves. The integration of silvofishery systems, which combine fish or shrimp farming with mangrove forests, has successfully provided alternative sources of income while maintaining the ecological balance.

Finally, it's crucial to focus on empowering women in these efforts. Women are already significantly involved in plant nurseries and processing mangrove products (like shrimp crackers), which contributes to both their household income and the restoration work. However, to ensure fair outcomes for everyone, we need to further support women in taking on leadership roles and participating in decision-making at all levels – within their communities and in the management of projects.

Scaling Up: Recommendations for National and Regional Implementation

Indonesia's mangrove restoration program represents more than an environmental effort—it is a critical climate adaptation strategy, an economic development opportunity, and a model for sustainable coastal resilience. To meet the country's ambitious restoration targets, scaling up efforts will require a coordinated approach across six key areas:

1. **Prioritizing Hydrological Restoration**

Restoring natural tidal flows and ensuring proper hydrological balance must be the foundation of all mangrove rehabilitation efforts. Reestablishing water connectivity is essential for enabling natural regeneration and improving long-term ecosystem resilience.

2. **Advancing Science-Based, Landscape-Driven Restoration Models**

Restoration initiatives must be informed by scientific assessments of hydrology, soil conditions, and ecosystem dynamics. Using landscape-based approaches, bioengineering techniques (such as bamboo sediment traps and semi-permeable structures), and adaptive species-site matching will significantly enhance restoration outcomes and ecosystem health.

3. **Strengthening Policy and Regulatory Frameworks**

Mangrove restoration efforts must be firmly aligned with national development goals, climate commitments (such as Indonesia's NDC targets), and coastal resilience strategies. Clear policies, effective enforcement, and supportive regulatory environments are essential to ensure the permanence and effectiveness of restoration gains.

4. **Empowering Women, Strengthening Inclusive Community Participation and Local Leadership**

Successful restoration hinges on empowering local communities, especially women and strengthening village-level governance structures. Economic incentives, benefit-sharing mechanisms, and local leadership—such as those fostered through KTH groups—are crucial for mobilizing sustainable, community-driven conservation. To sustain momentum, it is crucial to institutionalize monitoring systems and community-based feedback loops, enabling local knowledge, adaptive practices, and on-the-ground learning to directly inform regional and national planning processes.

5. **Establishing Mangrove Learning Centers**

As envisioned by KTH Lestari, the development of Mangrove Learning Centers can serve as hubs for technical training, innovation, eco-tourism, and peer-to-peer knowledge exchange. These centers can play a key role in replicating best practices across regions and supporting capacity building for future restoration leaders.

6. **Securing Long-Term Sustainable Financing**

Expanding access to blue carbon markets and CSR-funded restoration initiatives is vital for financial sustainability. Structured engagement with the private sector—particularly through partnerships aligned with ESG (Environmental, Social, and Governance) principles—can unlock new investment streams. Integrating carbon valuation and ecosystem service mapping into restoration design is also important to enhance the attractiveness of mangrove conservation for climate finance and corporate investment.

Conclusion

Mangrove ecosystems are critical to building resilient coasts and sustainable communities in Indonesia. As frontline defenses against coastal erosion, storm surges, and the impacts of sea level rise, healthy mangroves play an irreplaceable role in climate adaptation and mitigation. Evidence from national initiatives shows that integrating science-based restoration approaches with enabling policy frameworks, community empowerment especially women and other marginalize groups, and sustainable financing mechanisms is essential for achieving long-term, equitable, and ecologically sound outcomes.

In collaboration with Canada, Indonesia's leadership in mangrove restoration presents an opportunity not only to rehabilitate degraded landscapes but also to catalyze inclusive economic development, particularly for coastal and communities whose livelihoods depend on healthy ecosystems. By strengthening multi-stakeholder collaboration, investing in local capacity, and advancing intersectoral coordination, Indonesia can demonstrate how nature-based solutions contribute meaningfully to national development priorities and global climate goals. In doing so, the country has the potential to set a global benchmark for how ecological renewal, climate action, and sustainable economic growth can be achieved hand in hand.

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