



STRENGTHENING COASTAL RESILIENCE THROUGH SCIENCE-BASED MANGROVE GOVERNANCE IN DAVAO OCCIDENTAL, PHILIPPINES

John Paul R. Pacyao*, Jessa May D. Marquez

*Iloilo State University of Fisheries Science and Technology, 5002 Barotac Nuevo, Iloilo, Philippines
Institute of Fisheries and Marine Sciences, Southern Philippines Agri-business and Marine and Aquatic School
of Technology, 8012 Malita, Davao Occidental, Philippines*

*Corresponding author: JP Pacyao: jrpacyao@spamast.edu.ph

Article History

Submitted: 11/07/2025

Received: 11/11/2025

Revised: 04/14/2026

Published: 04/27/2026

ORCID ID:

Author1: <https://orcid.org/0000-0002-3137-7279>

Author2: <https://orcid.org/0000-0002-2003-8693>



Open Access. This article published by SPAMAST Research Journal is licensed under a Creative Commons Attribution-Noncommercial 4.0 International (CC BY-NC 4.0). You are free to share (copy and redistribute the material in any medium or format) and adapt (remix, transform, and build upon the material). Under the following terms, you must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. You may not use the material for commercial purposes. To view a copy of this license, visit: <https://creativecommons.org/licenses/by-nc/4.0/>

EXECUTIVE SUMMARY.

Mangrove rehabilitation represents a significant public investment in Davao Occidental; however, outcomes remain inconsistent and, in many cases, inefficient. Empirical field evidence from the municipalities of Malita and Santa Maria indicates survival rates ranging from 70% to more than 95%. This variability is primarily attributed to persistent site-species mismatch, continued overreliance on *Rhizophora* species, and weak post-planting monitoring systems. These systemic issues undermine the ecological and economic objectives of mangrove rehabilitation, including coastal protection, fisheries productivity, and climate change adaptation, while also resulting in inefficient use of public resources. Local empirical studies further demonstrate that science-based and site-specific mangrove rehabilitation approaches particularly those incorporating soil and hydrological assessments, species diversification, and sustained community-based monitoring can consistently achieve survival rates exceeding 95%. Despite this evidence, such approaches remain fragmented and are not fully institutionalized within provincial and municipal policy frameworks. This policy brief therefore calls for the institutionalization of a standardized, science-based mangrove governance framework at the provincial

level. Such a framework must mandate site-species matching, promote diversified planting strategies, and establish community-based monitoring systems, all supported by formalized partnerships between local government units (LGUs) and academic institutions. Given the increasing intensity of climate-related hazards, failure to reform current rehabilitation practices will continue to weaken coastal resilience and result in the inefficient allocation of public funds. Immediate and decisive provincial action is therefore necessary to translate existing scientific evidence into sustainable, cost-effective, and resilient coastal governance mechanisms.

Keywords: *Adaptive management; Coastal resilience; Community-based monitoring; Ecosystem-based governance; Mangrove rehabilitation*

PROBLEM STATEMENT

Mangrove rehabilitation initiatives in Davao Occidental are characterized by significant variability in survival rates and ecological performance, reflecting systemic governance deficiencies rather than isolated implementation issues. Reported survival rates across rehabilitation sites range from 70.46% to 97.58%, indicating considerable inefficiencies in both project design and execution.

These inconsistencies are largely driven by the absence of standardized, science-based rehabilitation protocols at the provincial level, which results in highly variable implementation practices among LGUs. Furthermore, there is limited integration of locally generated ecological research into policy formulation and program design, thereby constraining the effectiveness of evidence-based interventions. Monitoring and maintenance mechanisms are often weak, irregular, and project-dependent, which limits opportunities for adaptive management and early detection of mortality. Community participation, while present, is typically short-term and concentrated on planting activities, with minimal engagement in long-term stewardship and monitoring.

Collectively, these governance gaps result in inefficient utilization of public funds, diminished ecosystem services, and reduced provincial capacity to achieve coastal protection and climate resilience objectives. Without comprehensive policy reform, ongoing rehabilitation investments will continue to yield suboptimal and unsustainable outcomes.

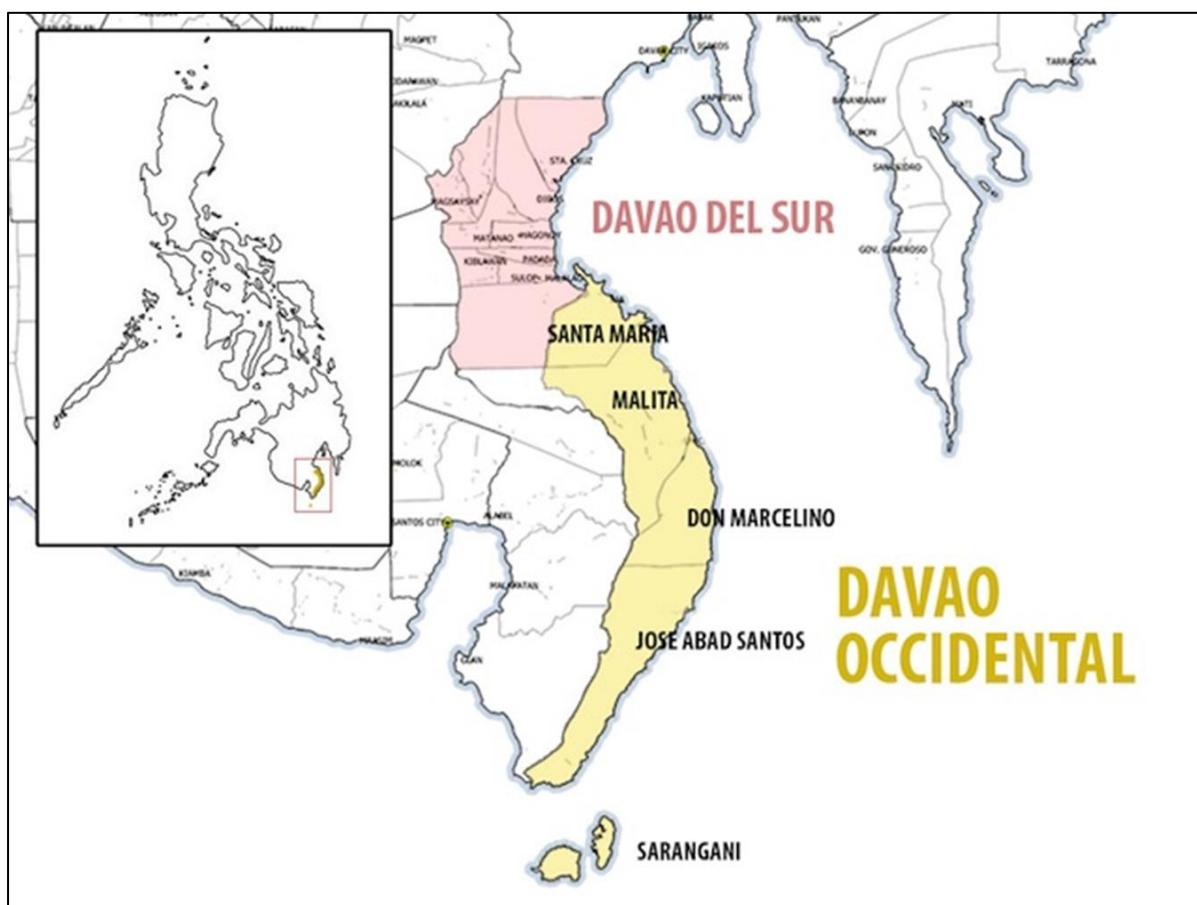


Figure 1. Map of Davao Occidental highlighting the municipalities of Malita and Sta. Maria, designated as mangrove rehabilitation sites.

CONTEXT

Mangrove ecosystems provide a wide range of critical ecosystem services, including shoreline stabilization, storm surge attenuation, nursery habitats for fisheries, and livelihood support for coastal communities. In Davao Occidental, these ecosystems are integral to disaster risk reduction and climate adaptation strategies, particularly in vulnerable coastal municipalities.

While national agencies such as the Department of Environment and Natural Resources and the Bureau of Fisheries and Aquatic Resources provide overarching policy direction, implementation at the provincial and municipal levels remains fragmented and inconsistent. LGUs often face constraints in technical capacity, monitoring systems, and the effective translation of scientific knowledge into enforceable local policies and ordinances.

Empirical studies conducted in collaboration with the Southern Philippines Agri-Business and Marine and Aquatic School of Technology demonstrate that mangrove rehabilitation success is strongly influenced by site-specific factors such as soil composition, hydrodynamic conditions, species zonation, and sustained community engagement. However, these scientific findings are not systematically integrated into planning processes, budget allocations, or regulatory frameworks at the provincial level, thereby limiting their practical application and impact.



Figure 2. Actual mangrove stands established in the designated rehabilitation area, following standard planting techniques and protocols.

CRITIQUE OF EXISTING POLICY

Current mangrove governance in Davao Occidental exhibits several structural and institutional weaknesses that constrain the effectiveness of rehabilitation efforts. A key limitation is the absence of standardized provincial guidelines, resulting in fragmented and inconsistent implementation of rehabilitation projects across LGUs. This lack of harmonization affects critical aspects such as site assessment, species selection, and planting design.

In addition, monitoring systems remain largely project-based and irregular, which limits the capacity for continuous evaluation and adaptive management. The absence of consistent monitoring protocols prevents timely identification of mortality trends and reduces opportunities for corrective interventions. Another significant concern is the weak integration of scientific research into policy frameworks, as empirical findings from local and national studies are not formally embedded in LGU ordinances, technical manuals, or operational guidelines.

Community participation is also insufficiently institutionalized, with most initiatives focusing on short-term planting activities rather than long-term stewardship, monitoring, and maintenance. This limits the sustainability of rehabilitation efforts and reduces community ownership of coastal resources. Furthermore, the continued overreliance on *Rhizophora* species, often planted in ecologically unsuitable areas, contradicts established scientific evidence and contributes to avoidable project failure.

These interconnected policy deficiencies collectively hinder long-term mangrove survival and reduce the overall effectiveness and sustainability of rehabilitation programs in the province.

POLICY RECOMMENDATIONS

The primary policy recommendation is the institutionalization of a provincial science-based mangrove rehabilitation framework. This framework should be formalized through a provincial ordinance that mandates site–species matching for all mangrove rehabilitation and related environmental projects. Species selection must be strictly aligned with site-specific ecological parameters, including soil texture, hydrological conditions, and environmental exposure, and must be supported by standardized, science-based technical guidelines.

The implementation of this framework should be led by the Provincial Government in close coordination with the Department of Environment and Natural Resources and the Bureau of Fisheries and Aquatic Resources, with technical and operational support from LGUs, the Southern Philippines Agri-Business and Marine and Aquatic School of Technology, and the Department of Science and Technology. Policy formulation, stakeholder consultation, and guideline development are expected to be completed within a 12 to 18-month timeframe. The anticipated outcome is the achievement of mangrove survival rates of at least 95%, alongside significant reductions in project failure, inefficiencies, and resource wastage.

Supporting policy measures should include the mandatory adoption of mixed-species planting strategies based on ecological zonation, incorporating appropriate combinations of *Rhizophora*, *Sonneratia*, and *Avicennia* species to enhance resilience. In addition, community-based monitoring systems should be institutionalized by formally engaging fisherfolk and

youth organizations as accredited monitoring partners, supported by LGU-led capacity-building and resource allocation mechanisms.

The integration of mangrove nursery development into livelihood programs should also be prioritized, enabling community-managed nurseries to serve both as sources of planting materials and as income-generating enterprises. Furthermore, long-term partnerships between LGUs and academic institutions, particularly SPAMAST, should be formalized to facilitate continuous technical support, training, research integration, and data harmonization. Finally, standardized monitoring and evaluation indicators should be established at the provincial level to ensure consistent assessment of survival rates, growth performance, species diversity, and ecosystem service outcomes.

CONCLUSION

The primary challenge confronting mangrove rehabilitation in Davao Occidental is not the absence of scientific knowledge, but rather the lack of governance mechanisms capable of translating such knowledge into effective policy and practice. The continuation of fragmented and non-standardized approaches will perpetuate inefficiencies, weaken coastal protection, and undermine climate adaptation efforts. Provincial leadership is therefore urged to take decisive action by institutionalizing a science-based mangrove governance framework. Such an approach will not only enhance coastal resilience and safeguard livelihoods but will also position Davao Occidental as a leading model for evidence-based and sustainable coastal resource management in the Philippines.

ACKNOWLEDGMENTS

The author expresses gratitude to the Institute of Fisheries and Marine Sciences (IFMS) of SPAMAST for technical guidance; the Local Government Units of Malita and Sta. Maria for logistical support; and the fisherfolk associations and DENR and BFAR field personnel whose cooperation and local knowledge greatly enriched this study.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

DECLARATION OF THE USE OF ARTIFICIAL INTELLIGENCE

Artificial intelligence tools (ChatGPT, GPT-5.1) were used exclusively for language refinement, structural organization, and formatting. All research activities including conceptualization, fieldwork, data analysis, and interpretation were performed solely by the author. AI tools were not used to generate original scientific content and are not credited as co-authors.

CRedit AUTHOR STATEMENT

JP Pacyao and JM Marquez contributed to conceptualization, methodology, data collection, formal analysis, writing of the original draft, review and editing, and visualization.

REFERENCES

- Altamirano, J. P. (2012). Mangrove planting guide. Department of Environment and Natural Resources.
- Bersaldo, M.J.I., Llameg, M.B., Avenido, P.M., Pacyao, J.P.R. & Marquez, J.M. D. (2024). Population Dynamics of Mangrove Clam *Pegophysema philippiana* (Reeve, 1850) in Davao Region, Southeastern Mindanao, Philippines. *HAYATI Journal of Biosciences*, 31 (5), 964-979. <https://doi.org/10.4308/hjb.31.5.964-979>.
- Bersaldo, M.J., Macusi, E., Garley, L., Pacyao, J.P.R. & Avenido, P.M. (2023). Biomass Estimates using Species Specific Allometry in Reforested Mangrove Areas of Malita, Davao Occidental Province, Philippines. *Social Science Research Network*.
- Cañeda, J. D., Molina, J. R. H., Pacyao, J. P. R., Cabili, J. R. C., Tabaranza, G. F., & Roquero, D. D. . (2025). Low Species Diversity of Beach Forests among Coastal Barangays of Malita, Davao Occidental. *Davao Research Journal*, 16(2), 88-104. <https://doi.org/10.59120/drj.v16i2.385>
- Pacyao, J.P.R., Barail, S. T. (2020). Anthropogenic Activities inside the Mangrove Conservation and Rehabilitation Area: a Case of Davao Occidental, Philippines. *International Journal of Fisheries and Aquatic Studies* Vo. 8, Issue 5 (2020). E-ISSN: 2347-5129.
- Lopez, A.J.M., Llameg, M.B, Pacyao, J.P.R. & Lubat Jr., G.P. (2024). Utilizing Alternative Carbon Sources for Biofloc System for Growth and Survival of Pacific Whiteleg Shrimp (*Litopenaeus vannamei*). *Sustainable Agroecosystems – Principles and Practices*. IntechOpen. <https://doi.org/10.5772/intechopen.1005537>.
- Pacyao, J. P. R., & Genciano, V. M. P. F. (2018). Management strategies employed under PNAP mangrove rehabilitation project in Davao del Sur, Philippines. *International Journal of Current Research*, 10(7), 71091–71094.
- Pacyao, J. P. R., & Llameg, M. B. (2018). Success indicators of the Philippine National Aquasilviculture Program (PNAP) – Mangrove Rehabilitation Project in Davao del Sur, Southern Philippines. *Open Science Journal*, 3(1). <https://doi.org/10.23954/osj.v3i1.349>
- Pacyao, J. P. R., & Llameg, M. B. (2024). Enhancing mangrove resilience: Assessing *Rhizophora sp.* survival in Davao Occidental’s conservation and rehabilitation zones, Philippines. *Asian Journal of Fisheries and Aquatic Research*, 26(8), 8–13. <https://doi.org/10.9734/ajfar/2024/v26i8790>
- Pacyao, J.P.R., Llameg, M.B., & Jondonero, J.C.O. (2022). Mangrove-epiphytic Plants in Selected Mangrove Rehabilitation Areas of Davao Occidental, The Philippines. *Asian Journal of Fisheries and Aquatic Research*, 17(1), 35-42. <https://doi.org/10.9734/ajfar/2022/v17i130396>.
- Pacyao, J.P.R., Macadog, H.O. (2018). Secondary Productivity of the Philippine National Aquasilviculture Program (PNAP): Mangrove Rehabilitation Area in Brgy. Bagumbayan, Malalag, Davao del Sur, Philippines. *International Journal of Fisheries and Aquatic Research*. Vo. 3, Issue 3 (2018). ISSN: 2456-7248.
- Pacyao, J.P.R., Marquez, E. (2022). Species Composition and Abundance of Seashells in the intertidal zone of Tubalan Cove, Municipality of Malita, Davao Occidental Province,

-
- Philippines. *International Journal of Biology Sciences*. Vol. 4, Issue 1-A. <https://doi.org/10.33545/26649926.2022.v4.i1a.55>
- Primavera, J. H., & Esteban, J. M. A. (2008). A review on mangrove rehabilitation in the Philippines: Successes, failures and future prospects. *Wetlands Ecology and Management*, 16(5), 345–358. <https://doi.org/10.1007/s11273-008-9101-y>
- Walton, M. E. (2007). Contribution of mangroves to coastal fisheries in Southeast Asia. *Wetlands Ecology and Management*, 15(6), 417–426.
- Villalon, D. L. P., Sanico, M. M., & Pacyao, J. P. R. (2024). The Coastal Environmental Profiling (CEP) of Barangay Mana, Malita, Davao Occidental, Philippines: Insights and Implications for Sustainable Management. *Asian Journal of Research in Agriculture and Forestry*, 10(3), 85–101. <https://doi.org/10.9734/ajraf/2024/v10i3302>
- Yparraguire, M. (2008). Mangrove forest conservation in the Philippines. *Philippine Journal of Forestry*, 15(2), 13–19.
- How to cite: Pacyao J.P.R., Marquez JMD. (2026). Strengthening Coastal Resilience Through Science-Based Mangrove Governance in Davao Occidental, Philippines. *SPAMAST Research Journal*, 9(1), 1-7. <https://doi.org/10.64656//spamastrj.v9i1.45>