Asia-Pacific Network for Sustainable Forest Management

and Rehabilitation

COMPLETION REPORT

Integrated planning and practices for mangrove management associated with agriculture and aquaculture in Myanmar (2017P1-MYR)

2018 - 2022

Myanmar Forest Department

The University of Queensland

March 2023

BASIC INFORMATION

Project Title(ID)	Integrated planning and practices for mangrove management associated with agriculture and aquaculture in Myanmar (2017P1-MYR)
Supervisory Agency	Myanmar Forest Department
Executing Agency	The University of Queensland
Implementing Agency	The University of Queensland and Watershed Management Division – Forest Department, Myanmar

Date of Project Agreement: [11/2017]			
Duration of implementation: [01/18-06/22], 54 months (extended by 18 months, if any)			
Total project budget (in USD)	547,070	APFNet assured Grant (in USD)	309,670
Actual project cost (in USD)		APFNet disbursed Grant(in USD)	309,670

Disbursement Status 100 %	Date of disbursement	Amount (in USD)
Initial disbursement	Nov 2017	117,288
2nd year disbursement	Jan 2019	77,517
Last year disbursement	Jan 2020	80,973
Balance to be disbursed		27,392
Reporting Status	Schedule [1]implementation	Project progress status[2]
First reporting (period covered: Jan/18 - June/18)	30 %	Satisfactory
1st year reporting (Jan – Dec 2018)	40 %	Satisfactory
2nd year – mid-term review reporting (Jan – Dec 2019)	70 %	Satisfactory
3rd year – final report (Jan 2020 – July 2022)	100 %	Satisfactory

List of Project Steering Committee and Project Team
(name/title/expertise/responsibility/contact information)

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[1] Schedule [1]implementation status could be on track/behind/ahead of schedule

[2] Project progress status could be ranked as satisfactory, dissatisfactory, moderately satisfactory, moderately dissatisfactory

Executive Summary

This project completion report outlines the background, initiation, and implementation of the project "Integrated planning and practices for mangrove management associated with agriculture and aquaculture in Myanmar (2017P1-MYR)" in the Ayeyarwady Delta of Myanmar. The project was funded by the Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet) and implemented by the University of Queensland (UQ) and the Myanmar Forest Department. The report presents the project's achievements, key learnings, and recommendations for future initiatives.

Despite significant delays due to COVID-19 and political instability, the project's execution was both effective and efficient, resulting in the achievement of the planned goals and objectives. The project, supported by APFNet, managed to utilize the grant effectively, with no major issues concerning disbursement. Notably, the project facilitated the restoration of mangroves, enhanced the quality of life for local communities, and encouraged sustainable forest and mangrove aquaculture management. Over 600 farmers, community leaders, and local staff directly benefited from participating in the project's model establishment, mangrove restoration activities, and capacity building through training. Additionally, 30 national, regional, and township forestry officers have been trained in GIS and land use planning for application to mangrove forest management. Even with the project's completion, its impact will be sustained due to the capacity built among local institutions and communities, enabling them to maintain sustainable forest management practices. Furthermore, a project's major impact is underpinned by its contribution to the development of policies and regulatory frameworks that support these sustainable practices.

However, the experience wasn't devoid of hurdles and lessons. The project's design showed a lack of consideration for Myanmar's policy framework, particularly with respect to land use planning, which couldn't be carried out due to insufficient legal support. This underscores the need for careful research of the local context when designing activities for similar development projects. Moreover, the project's success highlighted the pivotal role of community participation and capacity building in local institutions, such as Community Forestry User Groups (CFUGs). It became evident that without active community involvement, the degradation of mangroves could not be effectively countered. The project thus emphasized the importance of involving local communities and institutions in project design, planning, and implementation.

The criticality of monitoring and evaluation mechanisms was another key learning from the project. These mechanisms, both internal and external, are essential for gauging project progress and identifying areas that require improvement. In addition, the project unveiled the potential of developing value chains for mangrove-based products such as mud crabs, which can provide sustainable livelihoods for local communities.

The project also stressed the need for policies and regulatory frameworks that promote local community participation in forest management. Without such community engagement, the resources of the mangroves could continue to deplete. Hence, future initiatives should work

closely with government entities and other stakeholders to develop such supportive policies and frameworks.

Drawing on these insights, the project offers several recommendations for future initiatives. Projects should prioritize community participation, institutional capacity building, and the implementation of robust monitoring and evaluation mechanisms. Additionally, future initiatives should explore opportunities for developing value chains for mangrove-based products to sustain local communities' livelihoods. Furthermore, future projects should ensure the availability of sufficient funding for all activities, which include but aren't limited to monitoring, evaluation, capacity building, and technical assistance. Transparent and effective project management, coupled with clear communication between partners, should be maintained to ensure successful project execution.

The report emphasizes the significance of effective communication strategies and the need for efficient information dissemination to ensure project information is aptly conveyed to stakeholders. Lessons learned from this project should be widely shared with stakeholders in adjacent areas, to inform the design and implementation of similar initiatives. Encouraging stakeholders to learn from the experiences of this project and apply these learnings to their own initiatives will also be beneficial.

In conclusion, for future projects to succeed, they must prioritize community involvement, capacity building in local institutions, robust monitoring and evaluation mechanisms, and the development of value chains for forest-based products. In addition, promoting policies and regulatory frameworks that facilitate sustainable forest management is equally important. Adequate funding, efficient project management, effective communication, and diligent application of lessons learned will ensure the success of future initiatives in this realm.

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Abbreviations

APFNet	Asia-Pacific Network for Sustainable Forest Management and Rehabilitation
CFUG	Community Forestry User Group
FD	Myanmar Forest Department
GGGI	The Global Growth Green Institute
GIZ	German Agency for International Cooperation GmbH
M & E	Monitoring and Evaluation
UQ	The University of Queensland
WMD	Watershed Management Division, Forest Department
WWF	Worldwide Fund For Nature

1. BACKGROUND AND INTRODUCTION

1.1. Project context

Mangrove forests are vital ecosystems in tropical coastal regions. Mangroves provide sediment trapping to sustain coastal land; habitat for wildlife; protection for inland sites from storm surges and flooding; they provide building materials, food, firewood, traditional medicines and other products that support human needs. Mangrove forests are essential components for climate change mitigation, particularly for sea level rise on low lying coastal deltas[3]. They enhance the resilience of coastal landscapes and provide solutions for climate change and its impacts.

South East Asia has more than one-third of the world's mangrove forests with the highest biodiversity of any region. However mangrove cover has significantly declined in this region, with a loss of more than 100,000 ha per year during 2000 – 2012 period[4].

The Ayeyarwady is the mega-delta of Myanmar. The delta is the major rice and aquaculture production region for Myanmar. But rice agriculture and aquaculture are among the major causes of land use conversion by clearing, leading to the degradation of mangrove forests.

The coastal regions of Myanmar are extremely vulnerable to climate change and sea level rise. Large areas of Ayeyarwady delta are projected to be submerged under even moderate climate change scenarios. Recent monitoring data indicates that many parts of the coast of the Asian mega-deltas are being severely eroded due to mangrove loss and erosion associated with storms, sea level rise and changes in tidal currents[5].

The project area is within Pyindaye Mangrove Forest Reserve which has over 56,000 ha (Figure 1). However, significant areas within the reserve forest map have been agricultural land for many years or converted to paddy rice fields for the last few decades (Figure 2 and table 1).

The project area is facing critical challenges due to the combination of climate change and unsustainable development. A large area of
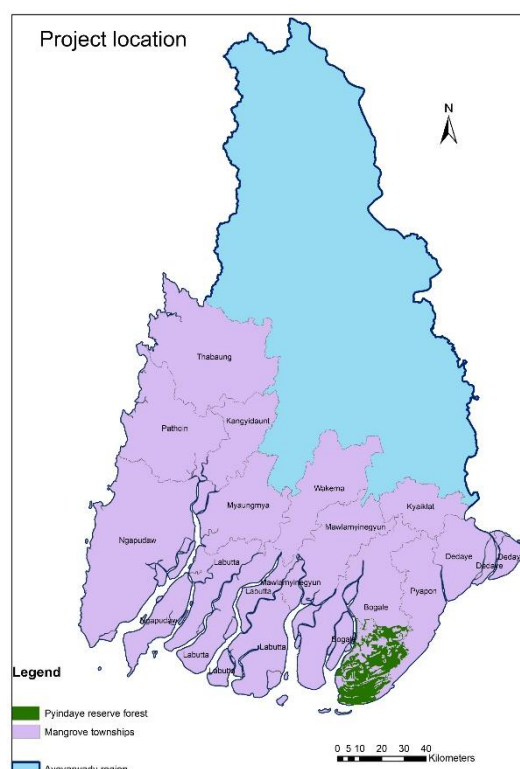
Figure 1 Project location in Ayeyarwady region

[3] The Importance of Mangroves to People: A Call to Action. van Bochove, J., Sullivan, E., Nakamura, T. (Eds). United Nations Environment Programme World Conservation Monitoring Centre, Cambridge. 128 pp. (2014)

[4] Rate and drivers of mangrove deforestation in Southeast Asia, 2000 – 2012. Proceedings of the National Academy of Sciences (PNAS), 113(2), 344-349. Richards, D. R., & Friess, D. A. (2016)

[5] Vulnerability of Indo pacific mangrove forests to sea level rise. Nature 526, 559 – 563. Lovelock CE, Cahoon DR, Friess DA, Guntenspergen GR, Krauss KW, Reef R, Rogers L, Saunders M, Sidik F, Swales A, Saintilan N, Thuyen LX & Tran T. (2015)

Figure 2 Mangrove land in Ayeyarwady Region

Amar sub-township in Myanmar is within the Pyindaye Mangrove Forest Reserve. The sub-township has over 100,000 inhabitants. Local communities, especially villages within the forest reserve have livelihoods that are strongly dependent on mangrove resources.
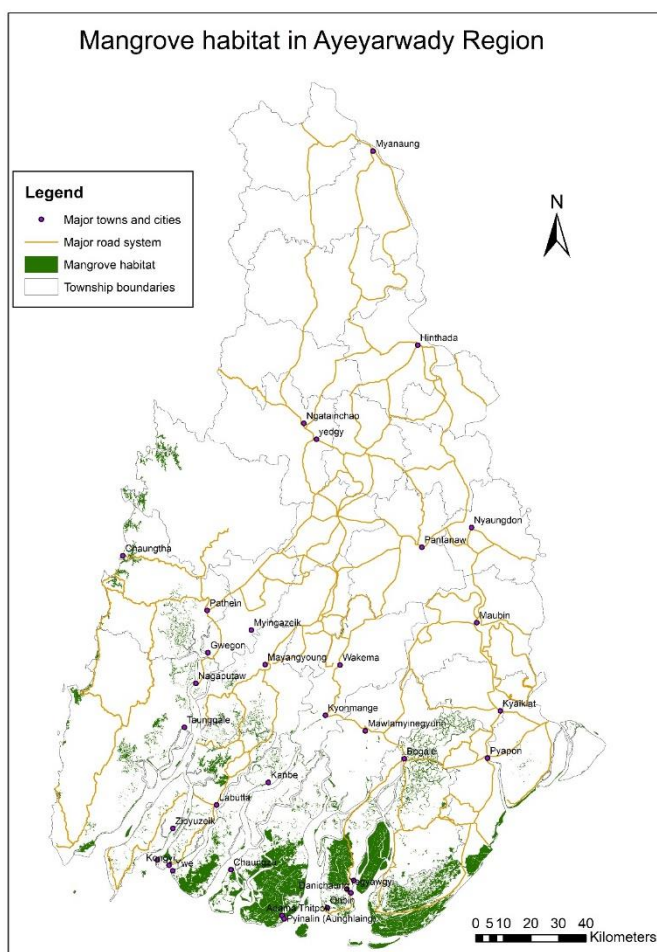
Causes of mangrove deforestation & degradation in Ayeyarwady delta, Myanmar:

It was reported that rice agriculture and aquaculture are major causes of land use conversion of mangrove forests and have resulted in degradation of mangrove forests in Ayeyarwady delta [6]. Other sources have indicated that additional causes of degradation are timber and wood exploitation for charcoal, extraction of firewood for fisheries, and clearing for expanding residential settlements and home gardens[7]. Figure 3 indicates the mangrove status of the Ayeyarwady delta, Myanmar.

Table 1 Mangrove extent in different mangrove status categories within Reserve Forests and National Park and outside Reserve Forests and National Park in the Ayeyarwady Region

Mangrove status	Total area (ha)	Within Reserve Forests and National Park (ha)	Outside Reserve Forests and National Park (ha)
Non-pond mangroves			
Nipa palm	45,055	8,876	36,179
Degraded mangrove	34,650	23,402	11,248
Regrowth mangrove	53,949	36,571	17,379
Unvegetated saline land	5,009	1,664	3,345
Sum of non-pond mangrove land	*138,664*	*70,513*	*68,151*
Ponds within mangrove areas			

[6] Rate and drivers of mangrove deforestation in Southeast Asia, 2000 – 2012. Proceedings of the National Academy of Sciences (PNAS), 113(2), 344-349. Richards, D. R., & Friess, D. A. (2016)

[7] Challenges and lessons learned from ongoing CLEARR project (MERN). Workshop on mangrove rehabilitation and conservation, November 2012, Myanmar.

Pond with degraded mangrove	2,695	1,992	704
Pond with regrowth mangrove	10,489	6,769	3,720
Pond without mangrove	25,112	8,784	16,327
Sum of pond areas within mangrove land	*38,296*	*17,545*	*20,751*
Total mangrove area	178,961	88,059	88,902

Our participatory meeting and interviews with local communities, aquaculture farm owners, local officers and experts revealed that the major causes of mangrove deforestation and degradation within the project region are complex, and include collecting timber and wood for charcoal for the local fishery industry (see the Feasibility report for list of communities, staff, officers and experts were at meetings and interviewed[8]). 100 % of local experts and staff reported that local fishery practices use much of mangrove wood for cooking shrimp and fish because ice is very expensive for fishermen and they have few options for preserving the catch. A key question posed by local stakeholders was how to change fishery practices from using mangrove wood to ice, which would significantly contribute to reducing the demand for mangrove's timber and wood. This is not easily changed in the short term because of the inadequate infrastructure, particularly the electrical systems within the project region[9]. The introduction of solar power for increased lighting in rural areas of Myanmar is occurring, but production of ice is still limited[10,11]. Additionally, as indicated by interviews and surveyed by UQ's researchers, mangrove firewood is used for all residential cooking needs in the project area. These are key reasons for mangrove deforestation and degradation, in addition to land use conversion.

Because of the local importance of timber exploitation to mangrove degradation, projects that focus on how to increase incomes earned from mangrove forests while still meeting the high demand for timber and wood requirements are crucial. Moreover, mangrove forests provide a range of essential ecosystem services, including playing a role in the protection of the shores and the shelter of communities and support of biodiversity and fisheries. Sustainable aquaculture integrated within mangrove forests is one of the most feasible solutions. The design of sustainable aquaculture within mangrove forests would provide both reasonable income, firewood for local communities as well as additional ecosystem services.

Participatory planning approaches for land use, resource utilization and landscape management have been introduced and practiced in developing economies for a long time[12]. A number of successful stories using these approaches have been reported worldwide, including for mangrove restoration[13].

Mangrove rehabilitation techniques have also been developed and practiced for several decades. Research suggests that promotion of natural regeneration through hydrological

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[8] Feasibility Study report for proposed project "Integrated planning and practices for mangrove management associated with agriculture and aquaculture in Myanmar and Vietnam". University of Queensland, 2016

[9] http://www.myanmarsolarpower.net/

[10] Myanmar seafood exports Quick scan of the EU market potential, 2012

[11] http://www.fao.org/fishery/facp/MMR/en

[12] Land use planning – Concepts, Tools and Applications. GIZ, 2012

[13] Brown, B., Fadillah, R., Nurdin, Y., Soulsby, I., & Ahmad, R. (2014). CASE STUDY: Community Based Ecological Mangrove Rehabilitation (CBEMR) in Indonesia. From small (12-33 ha) to medium scales (400 ha) with pathways for adoption at larger scales (> 5000 ha). SAPI EN. S. Surveys and Perspectives Integrating Environment and Society, (7.2).

restoration is a good option to restore mangrove forests[14,15]. However, planting mangrove species can be a feasible approach in some locations where plant establishment is weak or natural dispersal is constrained (for example, abandoned agricultural lands), and is frequently done in South East Asian economies.[16].

There is research available on mangrove restoration, fish production, as well as forestry and aquaculture integrated within mangrove forests. Aquaculture within mangrove forests was introduced in the early 1980s in Myanmar, but this approach has not become a commonplace aquaculture technique[17]. With high demand for fish and other seafood, coastal aquaculture has been expanding in Myanmar and competing with mangrove forests for space in the landscape.

Lessons learned from the project

This project imparted crucial lessons in various areas. In project design, the significance of thorough local context research became evident, particularly in understanding the legal frameworks for land-use planning. This project illustrated that without active community participation, mangrove ecosystems could continue to degrade, emphasizing community involvement as a central pillar in project design, planning, and implementation. It underscored the importance of capacity building for local institutions like CFUGs and the Forest Department, as they were integral to the continued implementation of mangrove restoration and sustainable forest management. The project demonstrated the necessity of comprehensive internal and external monitoring and evaluation, vital for gauging project progress and identifying improvement areas. Collaborating with GGGI on an economic appraisal of mangroves showcased the potential for sustainable livelihoods through developing value chains for mangrove-based products. This observation should direct future project efforts towards value chain development. On the policy front, without community involvement in mangrove management, resource depletion would persist, highlighting the need for policies and frameworks promoting community engagement. In response to these lessons, recommendations for future projects include prioritizing community participation, institutional capacity building, effective monitoring and evaluation, development of value chains for mangrove-based products, and advocacy for policies that encourage community participation in forest management. Other recommendations include ensuring sufficient funding, transparent and accountable project management, efficient communication and dissemination strategies, and sharing learned lessons with stakeholders in similar projects.

1.2. Project Goals and Objectives

Goals: This project was designed to achieve the following overall goals:

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[14] Ecologically based goal setting in mangrove forest and tidal marsh restoration. Ecol. Eng. 15, 191–198. Lewis, R.R., 2000
[15] Ecological mangrove rehabilitation — a field manual for practitioners. Mangrove Action Project Indonesia, Blue Forests, Canadian International Development Agency, and OXFAM. Lewis, R.R., Brown, B., 2014
[16] Plan for Erosion Management, Mangrove Restoration and Coastal Livelihood for Kien Giang Province. Agriculture and Publishing House, Ho Chi Minh city. Michael J Russell, 2013
[17] Sustainable Coastal Zone Management in Myanmar. Fauna & Flora International. Christoph Zöckler et al. 2013

(i) build capacity for restoration and sustainable management of mangrove forests in Ayeyarwady delta, Myanmar

(ii) contribute to livelihood improvement and sustainable development through enhancing aquaculture and agriculture associated with mangrove forests within the project regions

Project Objectives are to:

- investigate key issues associated with mangrove conversion and degradation
- conduct participatory micro-planning for mangrove management associated with agriculture and aquaculture development
- integrate best practices to design mangrove restoration and management and aquaculture in mangrove forests
- demonstrate selected designs and best practices in mangrove restoration and management and aquaculture in mangrove forests.
- enhance policy development capacity in respect to the design and implementation of mangrove restoration and management
- contribute to sustainable livelihood and community development within the project areas
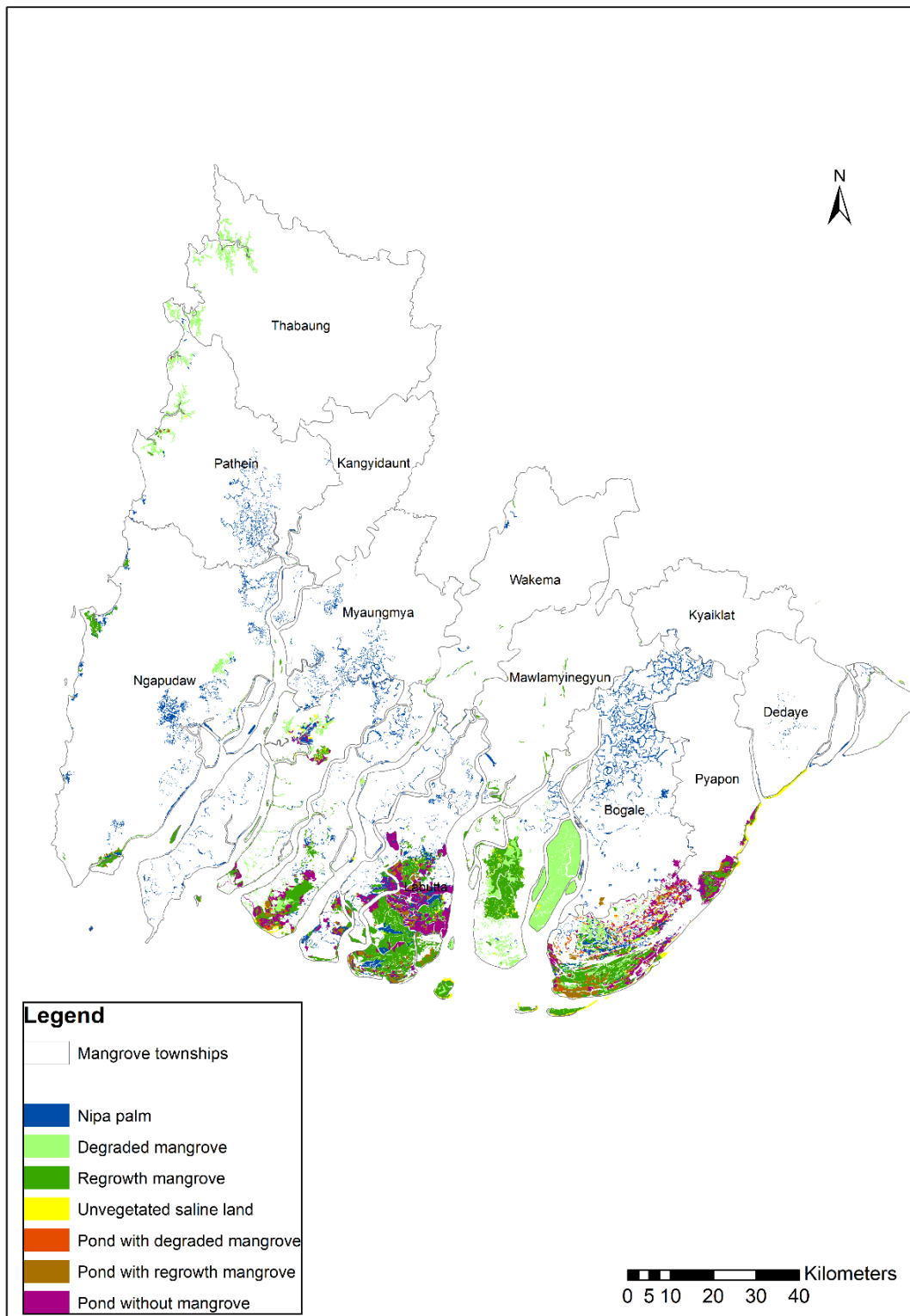
Figure 2. Mangrove status in 2020 Mangrove land in Ayeyarwady Region

The map shows the following locations: Thabaung, Pathein, Kangyidaunt, Myaungmya, Wakema, Kyaiklat, Mawlamyinegyun, Ngapudaw, Dedaye, Pyapon, Bogale, Shitta.

Legend

- Mangrove townships
- Nipa palm
- Degraded mangrove
- Regrowth mangrove
- Unvegetated saline land
- Pond with degraded mangrove
- Pond with regrowth mangrove
- Pond without mangrove

Kilometers
0 5 10 20 30 40

1.3. Project expected Outputs and Outcomes

Output 1. Developing integrated micro-planning approaches for sustainable mangrove management associated with agriculture and aquaculture production in selected landscapes

Output 2. Implementation of developed plans and pilot model establishment for demonstration of best practices in the host economy.

Output 3. Capacity building and expertise exchange

Output 4: Improvement of ecosystem services, local livelihoods, and project's scientific outputs

2. PROJECT IMPLEMENTATION

2.1. Project schedule and implementation arrangements

The project schedule and implementation arrangements were established during the project planning phase and were designed to ensure that the project could be effectively implemented and completed within the specified timeframe. The schedule and implementation arrangements included the following key elements:

Project Timeline: The project timeline was established to ensure that the project activities and milestones were completed within the specified timeframe. The timeline included key deadlines for project planning, implementation, monitoring, and evaluation.

Project Management Structure: The project management structure was established to ensure effective communication and coordination among project partners and stakeholders. The structure included the project manager, project coordinator, technical experts, and field staff, among others.

Project Activities: The project activities were designed to achieve the project objectives and deliverables. These activities included the establishment of community-based forest management practices, the development of sustainable value chains for forest-based products, and the strengthening of local institutions' capacity to manage forest resources sustainably.

Budget and Funding: The project budget and funding arrangements were established to ensure that the project activities and outputs could be effectively implemented within the available resources. The budget included funds for project management, technical assistance, training, and other project-related expenses.

Monitoring and Evaluation: The project monitoring and evaluation plan was established to track project progress and assess the effectiveness of project implementation. The plan included regular site visits, data collection, and analysis of project activities and outputs.

Overall, the project schedule and implementation arrangements were designed to ensure that the project could be effectively implemented and completed within the specified timeframe while achieving the project objectives and delivering the expected outputs. The implementation arrangements were reviewed regularly to ensure that they remained relevant and effective

throughout the project implementation.

Detailed activities implementation arrangements can be found in Table 2.

Table 2. Implementation status (scheduled versus actual)

Project Objective/Outputs/Activities (in line with PD/AWPs)	Indicators (in line with PD/AWPs)	Baseline of activities	Progress made (%completion of activities and degree of output/objective achievement)	Appraisal time	Actual time
Objective 1: Identifying key issues associated with mangrove conversion and degradation	- Socio-economic issues that have direct negative impact on mangrove conversion and degradation identified	- Socio-economic surveys in 01 community - Forest inventory in 01 village - Participatory rural appraisal for 01 community	100 % completed 100 % completed	1st time: Early 2018 2nd time: Late 2020	Feb – March 2018 May – July 2022
Objective 2: Conduct planning for aquaculture and agriculture associated with mangroves by participatory micro-planning approaches	- Participatory micro-planning conducted including: + Land use planning + Forest restoration and management design	- Planning approaches - Planning documents for 01 village - Model design document for 02 areas (04 models) - Maps for 01 village - M & E data & report: every quarter	100 % completed. Planning document extended to region scale (much larger scale)	Various times for documents and maps	Various times for documents and maps
Objective 3: Integrating best practices to design mangrove restoration and management and aquaculture in mangrove	Best practices integrated in 4 models (2 models of aquaculture in mangrove, 2 models of	Model design document Maps Training document M & E data & report for	100 % completed	Various times for documents and maps	Various times for documents and maps

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Project Objective/Outputs/Activities (in line with PD/AWPs)	Indicators (in line with PD/AWPs)	Baseline of activities	Progress made (%completion of activities and degree of output/objective achievement)	Appraisal time	Actual time
	mangrove restoration): Model approaches Model design	every quarter			
Objective 4: Demonstrate selected design and best practices in mangrove restoration and management and aquaculture in mangrove forests	Model areas; number of seedlings and fish, shrimp, crab and scallop breeds Model quality (survival rates, growth rates)	Model document M & E data & report	Over 82 hectares of mangrove rehabilitation models + 05 hectares of pilot models for different species & planting approaches were established (over 100 % completed) 100 % completed (24 crab fattening models established) 100 % completed (Survival rates of mangrove trees are > 80 %)	December 2020	December 2021
Objective 5: Enhancing policy development capacity in respect to the design and implementation of mangrove restoration and management	Good practices and technical procedures draw from outcome of the project	Model documents M & E data & report	100 % Completed	December 2020	December 2021
Objective 6: Contribute to livelihood improvement and	The income of local households increased Local institution	Co-management and sharing mechanism regulations	100 % completed	December 2020	December 2021

Project Objective/Outputs/Activities (in line with PD/AWPs)	Indicators (in line with PD/AWPs)	Baseline of activities	Progress made (%completion of activities and degree of output/objective achievement)	Appraisal time	Actual time
community development within the project areas	strengthened	M & E data and report			
Output 1 Developing integrated micro-planning approaches for sustainable mangrove management in associated with agriculture and aquaculture production in selected landscapes. Responsibility: PMB, international and local consultants	Land use planning manual Aquaculture in mangrove manuals	Technical guidelines Project M & E	100 % completed Micro land use planning manual Crab aquaculture in mangroves Mini-crab hatchery manual	December 2020	December 2021
Activity 1.1 Biophysical surveys and socio-economic information collection for planning and assessment of local capacity and needs	Service provider for forest inventory (at least 04 qualified staff); inventory equipment, forest status maps, inventory manuals and budget	Forest inventory and survey maps and ports M & E data and report	100 % completed Forest and socio-economic surveys successfully conducted	1st time: Early 2018 2nd time: Late 2020	Feb – March 2018 May – July 2022

Project Objective/Outputs/Activities (in line with PD/AWPs)	Indicators (in line with PD/AWPs)	Baseline of activities	Progress made (%completion of activities and degree of output/objective achievement)	Appraisal time	Actual time
Activity 1.2 Participatory micro-planning for mangrove restoration and management integrated with agriculture and aquaculture	Community participation (at least 60 % of households in communities participated) Planning document	Planting document M & E on participatory processes	100 % completed (> 90 % of households of the community forestry user groups participated and benefited from the project)	Project duration	Project duration
Output 2 Implementation of developed plans and pilot models establishment for demonstration of best practices Responsibility: Project management board, consultants, local management bodies, communities	Micro-plan for village tract introduced and approved Number of pilot models established and use of approaches developed	Project report M & E data and report	Village and village tract micro-planning is not applicable because it's inapplicable to land use planning institutions in Myanmar	2019	Not applicable
Activity 2.1 Approval of micro-planning document by relevant	Planning documents are approved	Approved documents	Village and village tract micro-planning is not applicable due to nature of land use planning in Myanmar	2019	Not applicable

Project Objective/Outputs/Activities (in line with PD/AWPs)	Indicators (in line with PD/AWPs)	Baseline of activities	Progress made (%completion of activities and degree of output/objective achievement)	Appraisal time	Actual time
authorities					
Activity 2.2 Technical guidelines development and training for model establishment	Number of technical guidelines Number of training courses Number of participants Training instructors Training budget Training equipment	Trainers, trainees, project staff and experts Training M & E	100 % completed	2018 - 2020	2018 - 2020
Activity 2.3 Establishment of mangrove co-management and sharing benefit mechanisms for local communities and forest management bodies at locality	02 Co-management and sharing benefit regulation for two villages Actual benefit sharing for aquaculture harvest	Signed and approved document Income from models M & E data and report	100 % completed	2019	2019
Activity 2.4 Establishment of mangrove restoration and aquaculture demonstration models by	At least 95 % of model areas established; survival rate of mangrove species > 75 %; survival rate of aquaculture > 50 %	Model M & E data and report Project report	100 % completed	2020	2020

Project Objective/Outputs/Activities (in line with PD/AWPs)	Indicators (in line with PD/AWPs)	Baseline of activities	Progress made (%completion of activities and degree of output/objective achievement)	Appraisal time	Actual time
local communities and technical staff	Number of people involved in model establishment				
Activity 2.5 Model monitoring and evaluation framework and implementation	M & E framework for model. Data collected regularly (quarterly and during establishment & harvesting)	Model M & E data and report	100 % Completed	Project duration	Project duration
Output 3 Capacity building and expertise exchange	Training documents and leaflets developed Training courses organized Training instructors number Number of people attended training by doing	Project document M & E data and report Training evaluation	100 % Completed	2018 - 2020	2018 -2020
Activity 3.1 Development of guidelines, handbooks/manuals on	Number of documents developed Number of leaflets compiled	Project document M & E data and report Technical experts & project's staff	100 % Completed	2018 - 2020	2018 -2020

Project Objective/Outputs/Activities (in line with PD/AWPs)	Indicators (in line with PD/AWPs)	Baseline of activities	Progress made (%completion of activities and degree of output/objective achievement)	Appraisal time	Actual time
technical aspects of projects and international publications	Number of international publications				
Activity 3.2 Training courses and international workshops for capacity building	Number of training courses & participants Quality of the courses Number of international workshops organized - participants	Training M & E Training documents	100 % Completed for training courses and extension activities 2/3 (67%) of international workshops organized (inception and mid-term review workshops. The final workshop won't be organized due to COVID-19 and situation in Myanmar.	2018 - 2020	2018 -2020
Output 4 Improvement of ecosystem services, local livelihoods and project's scientific outputs Responsibility: UQ, PMB, consultants, local management bodies, communities, local partners	Forest areas increased Forest biodiversity improved Income from aquaculture of model areas will be increased at least 50 %	Forest inventory Socio-economic survey Project M & E data and report	100 % Completed	2018 - 2020	2018 -2020
Activity 4.1 Assess production of	Volume of harvested products	Model establishment and harvesting data	100 % Completed	2020	2020

Project Objective/Outputs/Activities (in line with PD/AWPs)	Indicators (in line with PD/AWPs)	Baseline of activities	Progress made (%completion of activities and degree of output/objective achievement)	Appraisal time	Actual time
aquaculture products from the pilot project, marketing and sale	Sale value of harvested products Net income earned from aquaculture increased at least 50 %	Project M & E data and report			
Activity 4.2 Enhancing scientific outputs of the project	Experiment design Field experiment Sample & data collection and analysis At least 02 international publications developed from project data	Data & publications Project M & E data and report	100 % Completed	2018 - 2020	2018 -2023

2.2. Project resources and costs

The project has received a grant from APFNet of US 275,778, cash and in-kind contributions from the University of Queensland and local partners equal to USD 237,400. The project disbursed 100 % of the fund for project activities (UQ paid advanced approximately USD 27,392 to carry out project activities). Details of project costs by category and activity can be found in Annex B1 and B2, respectively.

Several project budget lines have been amended in consultation with and upon approval from APFNet, as detailed below:

- **Establishment of Mangrove Restoration and Aquaculture Demonstration Models:** The planned budget was $138,900 USD, while the actual spending reached $153,900 USD. Due to heightened interest from other communities in mangrove restoration, the project requested APFNet's permission to reallocate funds not used for other activities, such as the final workshop, towards enhancing seedling growth and supporting labor costs for mangrove restoration in local communities. Therefore, the total restoration area covered 87.6 hectares, plus over 300,000 seedlings provided for other restoration efforts by Forest Department - significantly exceeding initial projections.
- **Final Project Workshop:** This was not organized due to COVID-19 and security concerns. Therefore, the allocated budget of $21,550 USD was redirected to other activities.
- **Study Tours and Training Courses on Mangrove-Friendly Aquaculture and Crab Hatchery in Vietnam for Myanmar Key Farmers and Technical Staff:** Since there have been no operating crab hatcheries in Myanmar since the project's inception, and crablets are crucial for sustainable mangrove crab culture, the project proposed to APFNet to reallocate unused funds to conduct these trainings in Vietnam for key farmers and staff. The total costs for these two study tours amounted to $6,286 USD.
- **Boat Rental for Field Activities:** The budget increased from the planned $1,500 USD to cover the actual spending of $4,500 USD.
- **Seeds and Seedlings Production Costs:** These costs rose from $10,560 USD to $28,164 USD due to the production of a significant number of seedlings (nearly 700,000 seedlings produced).
- **Administration support and management cost (University of Queensland)**: There was an increase from the planned $12,000 USD to actual spending of $14,601 USD to meet the actual support needed.

2.3. Procurement and consultant recruitment

2.3.1 Consultant recruitment

The consultant team employed casual short-term or casual part-time for the project from

January 2018 and participated in components of the project where they were responsible for project activities. The consultant teams included: international mangrove restoration and community development expert (Ben Brown), regional GIS, RS and land use planning expert (Dr. Anh Viet Hoang), regional aquaculture consultant (Mr. Truc Van Le), national mangrove restoration expert (Mr. Win Maung), national aquaculture consultant (Mr. Win Sein Naing), local field team leader (Mr. Myo Myint – from Jan 2018 to June 2022) and over 10 local technical staff for field activities. The costs for consultants of the project are described in detail in the annex B1 and B2.

Table 3 The activities performed and outputs of the consultants

Consultant	Activities	Outputs
Dr. Ben Brown: time: 10 days	Field visit and inception workshop	Project's field notes and comments
Dr. Anh Viet Hoang – regional GIS and land use planning expert Time: 35 days	- Preparation of GIS and land use planning training documents - Carrying out training courses on GIS and land use planning for 30 national and regional forestry officers in Myanmar from 19 – 25 Jan 2018	- GIS training document; - Micro land use planning training document; - Two training courses conducted in Myanmar
Mr. Truc Van Le – regional aquaculture expert Time: 65 days	- Field surveys in Ayeyarwady region - Preparation of mini crab hatchery manual - Conduct crab hatchery training in Vietnam for Myanmar staff and farmers	- 02 Study tour and training completed - Mini crab hatchery manual
Mr. Win Maung – National mangrove restoration expert Time: 40 days	- Field surveys - Training manuals (mangrove nursery and planting manuals) - Conducting training for farmers and local technical staff	- 02 manuals developed - 05 training courses on nurseries and mangrove planting were conducted for local staff and farmers
Mr. Win Sein Naing – national aquaculture expert Time: 45 days (including overseas training)	- Field surveys - Training manuals (mangrove-friendly aquaculture; crab fattening) - Conducting training for farmers and local technical staff	- 01 manuals developed - 05 training courses on mangrove-friendly aquaculture were conducted for local staff and farmers

Mr. Myo Myint – Local field team leader (part-time 54 months)	- lead or co-lead field surveys and activities - Conduct training courses with experts	- Successfully completed all field activities
Other local technical staff	mangrove forest inventories, socio-economic surveys, and other field activities (e.g., mangrove restoration)	Field activities completed

2.3.2 Procurement

The project used research facilities of the University of Queensland. The project procured seeds and materials for mangrove seedling growing and equipment for crab hatchery activities in Myanmar. Procurement was based on market competition. A detailed list of procurements is provided in the Annex A.

2.4. Monitoring & evaluation and reporting

The project included regular monitoring and evaluation activities led by both the internal project team and external monitoring and evaluation (M&E) expert Mr Jim Enright (independent mangrove and community expert) hired by APFNet. Mr Enright has visited project sites and participated mid-term review workshop in Myanmar from 7th to 14th October 2019. These activities aimed to assess the progress of project implementation and ensure that it was on track towards achieving the project objectives. The M&E activities involved regular site visits, data collection, and analysis of project activities and outputs.

The project team developed an internal M & E framework and collected data regularly. The M & E framework and data collected are attached in the **attached file.** The project also prepared, annual and mid-term reports every six months as required by APFNet and submitted to the organization.

Besides the internal M & E framework and reporting to APFNet, the project also developed monthly reports to submit Myanmar Government as required.

The M&E findings highlighted several successes of the project, including the successful establishment of community-based mangrove restoration and management practices, the development and application of mangrove-friendly aquaculture practices, and the strengthening of local institutions' capacity to manage forest resources sustainably. However, the M&E activities also identified some areas for improvement, such as the need for stronger communication and collaboration between project partners and a more coordinated approach to project planning and implementation.

Based on the M&E findings, recommendations and suggestions were made to improve project implementation effectiveness. Actions were taken in response, including enhancing communication and collaboration among project partners, especially from project field staff, local communities and local forest departments, providing additional technical assistance and

training to local institutions and communities on crab hatchery and crab fattening, and developing a more comprehensive project planning and implementation framework.

Regular project progress updates and issues were also shared among project team members and stakeholders, including APFNet. High-quality reports and materials were developed and disseminated to ensure that project activities, outputs, and impacts were transparently communicated to all relevant stakeholders. This ensured that project progress and issues were effectively communicated and addressed, enhancing project management effectiveness and stakeholder engagement.

2.5. Dissemination and knowledge sharing

The project team actively engaged in dissemination and knowledge sharing activities at both local and international levels. They presented their project results and findings at international conferences, such as the SER's 8th World Conference on Ecological Restoration in Cape Town, South Africa. The project members presented research on mangrove restoration and carbon sequestration of rehabilitated mangroves in Myanmar, which helped to raise awareness of the project and its objectives among a wider audience. Additionally, the project produced and published a story on APFNet's website to showcase the role of mangrove restoration in improving the livelihoods of communities in the Ayeyarwady delta in Myanmar.

All technical guidelines and leaflets were delivered in other communities in the project regions. Training courses are conducted not only for project's communities, staff and authorities in project areas but are also open for other communities and technical staff at different management levels, from national to grass-root bodies for extending project's approaches and increase long-term development.

Additionally, 02 Myanmar students who studied the International Forestry Master program sponsored by at Vietnam Forestry University conducted Master's research projects based on data & outcomes of APFNet's project.

Furthermore, the project collaborated with other institutions in Myanmar, including GGGI, GIZ, WIF, and local communities, to mobilize additional support for project implementation and knowledge sharing. These collaborations allowed for the exchange of ideas and experiences, which enhanced the project's impact and effectiveness.

List of publications which received the project's support or partially used project research data and analyses are as follows:

- Htike San Soe, 2021. CONTRIBUTION OF SILVO-AQUARCULTURE ON LOCAL COMMUNITIES' LIVELIHOODS (A CASE STUDY IN AMAR SUB-TOWNSHIP UNDER PYAPON TOWNSHIP, AYEYARWADY REGION, MYANMAR). Master thesis.

- GGGI and University of Queensland, 2020. Economic Appraisal of Ayeyarwady Delta Mangrove Forests

- Worldbank 2021. Investment Analysis for Mangrove Ecosystems in the Ayeyarwady Region

Overall, the project team's engagement in dissemination and knowledge sharing activities

played a crucial role in raising awareness of the project's objectives and outcomes, facilitating the exchange of knowledge and experiences, and mobilizing additional support for project implementation.

3. PROJECT PARTNERS' PERFORMANCE

3.1. Performance of Supervisory Agency

Forest Department (FD) of Myanmar is the supervisory agency of this project. Myanmar FD strongly supported this project though it had to deal with a complex administrative procedure in the economy. FD usually responded to the executive agency's requests on time and properly. The local forest department at Pyapon township strongly collaborated with the project partners to conduct field activities.

3.2. Performance of Executing Agency

The University of Queensland is the Executing Agency (EA) and responsible for the implementation and management of a project, including the dissemination of information and resources to stakeholders. UQ had main responsibilities and tasks as below:

Project implementation: UQ was responsible for ensuring that the project is implemented according to the agreed-upon plan, budget, and timeline. This involves overseeing project activities, monitoring progress, and ensuring that resources are used effectively and efficiently.

Stakeholder engagement: UQ was responsible for engaging with stakeholders, including local communities, government agencies, and other relevant actors, to ensure that their needs and interests are taken into account in the project design and implementation.

Financial management: UQ was responsible for managing the project budget and ensuring that funds are used appropriately and transparently.

Reporting and documentation: UQ was responsible for providing regular reports on project progress to APFNet and the supervisory agency, and for maintaining comprehensive documentation of project activities and outcomes.

UQ has fulfilled its responsibilities by providing resources, engaging stakeholders, and coordinating and conducting project activities. The University of Queensland arranged for experienced staff to manage the project directly. With the support of Myanmar Forest Department, the project coordinator selected qualified and trusted local consultants and technical staff for the project.

3.3. Performance of Implementing Agency, consultants (technical assistants) and suppliers

UQ and Watershed Management Division (WMD), Myanmar Forest Department are implementing agencies of the project. UQ and WMD engaged local consultants, technical staff and managers and local workers for project activities. Each of these partners had a specific

set of responsibilities and tasks.

Implementing Agency: UQ and WMD are responsible for managing the overall project implementation. This includes coordinating with other project partners, managing the project budget, overseeing project activities, and ensuring that the project is completed on time and within budget.

Project consultants (technical assistants): Qualified international, regional, and local consultants were selected to provide technical expertise in specific areas of the project. They provided technical advice, prepared technical manuals, conducted training and extension activities, and assisted with project management. All consultants have provided qualified work and helped the project fulfill its planned activities.

Suppliers: Suppliers are responsible for providing the materials and equipment necessary to carry out the project activities. The project has procured equipment, seedlings, and transport services from a number of contractors on a competitive base.

The implementing agencies, consultants and suppliers fulfilled their duties with high-performance results which contributed to the success of the implementation of the project though many instabilities and uncertainties due to COVID-19 and Myanmar politics have occurred during the project period.

3.4. Performance of APFNet

APFNet has provided timely support and clear guidance for project planning, implementation, and management. The organization has also been effective in communicating with project executing agencies and partners to facilitate project activities and dissemination. Additionally, APFNet has provided timely disbursement of project grants, which is crucial for ensuring that projects are implemented on schedule and with sufficient resources. Finally, APFNet has conducted external monitoring and evaluation (M&E) during the mid-term project review mission and promptly shared feedback. After the mid-term review, the comments and recommendations of external experts and APFNet's officers were valuable for the project to finalize activities successfully. This indicates that APFNet is committed to ensuring that the projects it supports are successful and that it is responsive to the needs of project partners. Overall, the funder's support was essential to the successful implementation of the project on mangrove restoration and coastal community livelihood improvement.

4. PROJECT PERFORMANCE

4.1. Project achievements

Output 1*: Developing integrated micro-planning approaches for sustainable mangrove management associated with agriculture and aquaculture production in selected landscapes*

Activity 1.1: *Biophysical surveys and collection of socio-economic information for planning and assessment of local capacity and needs.*

Baseline surveys were completed in early 2018, and final surveys were completed in mid-2022

The baseline inventory assessed the state of mangrove forests and adjacent land uses in the Ayeyarwady delta region. A total of 274 sample plots were surveyed in March and April 2018, with a focus on biomass and soil properties. The data showed significant degradation of natural mangroves, with 96% having a basal area per hectare less than 2 m². Efforts to restore these forests through plantation are in place, with various species demonstrating differing growth rates. Recommendations for management include a shift towards community-led care and revised silviculture practices that maintain 100 mother trees per hectare.

The socio-economic surveys revealed the four major products associated closely with local communities livelihoods, mangroves and mangrove deforestation are fuelwood, crab, shrimp and crop agriculture. Below are our summaries of these product's value chain

Fuelwood

Most families in three research townships use mangrove fuelwood for domestic cooking. The second largest consumer of fuelwood in the Delta is fishers who use bamboo rafts (kyar phaung) for drying fish from the simple on-shore fishing sector. Government authorities, particularly the Forest Department, are the key law enforcement for mangrove management and protection. Until other alternative cooking fuels become readily available that are cheaper and/or local residents can afford, such as national electricity, gas, or fuel from agriculture by-products (e.g. rice husk briquettes), fuelwood collected from mangrove will remain the key domestic energy source for local people.

Crab

The stakeholders for crab wild-caught and fattening products are collectors of wild crabs, local mangrove landholders (who grow out juvenile crabs), middlemen in villages (who buy and transport the product), the Department of Fishery, and consumers, including restaurants in the larger cities. Crab fattening is a key livelihood for many households living in mangrove areas.

Shrimp Production

Shrimp production actors include the collectors of wild shrimp fry (larvae), shrimp farmers, the Department of Fishery, and local buyers who sell product at the wholesale market to exporters and consumers.

Agriculture

The major stakeholders in the agriculture sector are the owners of rice fields, rice farmers, and the Department of Agriculture, Livestock and Irrigation. Large areas within the government managed mangrove Reserve Forest (RF) boundaries were converted from natural mangroves to rice fields (Webb et al. 2014). These areas have high risks of soil acidification and saline water intrusion. Irrigation of rice is not highly developed in the study area, and therefore farmers usually grow only one rice crop per year with relatively low rates of productivity.

Our socio-economic survey in 2018 also revealed that over 70% of families in the project areas are landless people. Their livelihoods depend heavily on catching wild fish, collecting timber and wood from mangroves, casual work, and small-scale trading. A significant number of them are the poorest people in the communities. Within these landless families, more than 50% of them lack the basic food—rice—for 1–4 months a year.

The 2022 mangrove forest survey of 100 sample plots revealed a significant improvement in mangroves of the targeted size of the project. The average number of trees with a diameter at breast height (DBH) greater than 4 centimeters per hectare at these sites increased from less than 200 in 2018 to more than 400 in 2022.

Natural crab fattening in the pilot models of mangrove aquaculture contributed to an increase of 50% in productivity compared to before project interventions. However, due to COVID-19 and unstable conditions in Myanmar, mud crab populations have significantly declined. As a result, the livelihoods of the participating households have not improved significantly in recent years.

Activity 1.2: Participatory micro-planning for mangrove conservation, restoration and management integrated with agriculture and aquaculture

Micro land use planning training and technical guideline were conducted. However, micro-planning was not carried out because it's inapplicable to Myanmar land use planning.

A land use planning training course was organized for 25 national, regional, and township forestry officers in Myanmar in January 2018. Micro-participatory land use planning exercises were also conducted in Haung Gyi Tan CFUG in 2018. 35 members of the CFUG participated in the meeting. The local community drew their own land use map and presented the history, current status, and vision for the village in the future.

Output 2: Implementation of the developed plans and establishment of a pilot model for demonstration of best practices in the host economy.

Activity 2.1: Approval of micro-planning document by higher administration level(s)

Myanmar land use planning has not been effectively institutionalized nationally, regionally, or locally. Therefore, there is no policy framework to develop micro-level land use planning, such as at the village level, for approval by higher administrative levels. As a result, this activity is inapplicable to the current Myanmar land use planning system.

Activity 2.2: Development of technical guidelines and training for the pilot model establishment.

Development of technical protocols and carrying out training courses on different processes are important for achieving the pilot models. This activity included four work packages:

1. *Development of 5 silviculture and aquaculture technical guidelines (forest establishment techniques, promoting natural recruitment, tree planting techniques where necessary, crab growing techniques, crab hatchery, mixed aquaculture & mangrove techniques):* completed

2. *6 general technical guidelines:* completed

3. *5 leaflets on knowledge and techniques of forest restoration, management and aquaculture:* completed

   9 Training courses on silviculture and aquaculture associated with mangroves for local farmers, technical staff and practitioners: 12 training courses completed

In 2018 and 2019, 11 training and technical guidelines were developed for training, research, and extension purposes as below:

- Forest Inventory
- M & E criteria & indicators and data collection
- Geographic information system (GIS) and Remote Sensing (RS)
- Land Use Planning guidelines
- Socio-economic survey guidelines
- Guideline for Mangrove Restoration by planting
- Guideline for Crab Hatchery
- Mud-Crab Fattening
- Guidelines for Mangrove Aquaculture Survey
- Technical guidelines for polyculture mangrove
- Technical plan Aquaculture Development for CFUGs

10 leaflets were developed as below:

- Mangrove value leaflet
- Mangrove restoration leaflet
- *Malaleuca cajuputi* planting
- *Casuarina equisetifolia* planting
- Crab fattening
- Benefits of Community Mangrove Forest Management
- Crab hatchery for sustainable mangrove aquaculture
- Mangrove_Poly_Aquaculture
- *Rhirophora apiculata* planting techniques
- *Rhirophora mucronata* planting techniques

11 technical guidelines and 10 leaflets were revised, printed, and distributed to relevant local staff and communities.

In total, 12 training courses were conducted. Out of these, **10 training courses** were conducted on mangrove restoration and crab fattening. 20-25 key farmers and community leaders participated in each training course. In total, 195 individuals participated in these training courses in 2018 and 2019. The training course on mangrove restoration included the following components:

- The value of mangroves
- Mangrove degradation
- Key mangrove tree species
- How to restore mangroves (mangrove seed collection, nursery, weeding, planting, and tending)

Crab fattening training coaches taught farmers about juvenile mud-crab growing techniques in

pens in mangrove forests.

In addition, **2 training and study tours** on crab hatchery, mangrove aquaculture management, and mangrove restoration by planting were conducted in Vietnam for 8 key technical staff, local experts, and community leaders in September 2018 and February-March 2020.

The University of Queensland also mobilized fund from some other donors, namely GIZ, GGGI, and the World Bank in Myanmar, in the Ayeyarwady delta to strengthen the outputs of this project.

Activity 2.3: Establishment of co-management and benefit sharing mechanisms for local communities and forest management bodies at the locality

A benefit-sharing mechanism was developed and mutually agreed upon within the project's community. It was integrated into the existing forest management plan of the key project's Community Forest User Group (CFUG). Under current Forest Department regulations, a maximum of 10% of mangroves are allowed to be cut for water space for shrimp and crab growing within mangrove aquaculture ponds. At least 90% of the remaining area must be covered by mangroves. The key concept of benefit-sharing is that farmers who received project support for mangrove seedlings and juvenile crabs will contribute 5% of the revenue from mangrove aquaculture activities that year to the CFUG's fund. This budget is limited and is mainly used to help organize community meetings effectively.

Activity 2.4: Establishment of mangrove restoration and aquaculture demonstration models by local communities and technical staff. 71 ha including 5 ha of mangrove restoration and 66 ha of mangrove restoration by enrichment with aquaculture production.

Achievements:

- 5 hectares of mangrove restoration demonstration model
- 71.6 hectares of mangrove restoration in Laykyaw, Boe BaKone, Wa Pa Na, Htan Pin Kone villages, Pyapon township
- 11 hectares of mangrove restoration in Htaung Gyi Tan village, Pyapon township
- Over 30,000 scattered trees planted in the project villages
- Delivery of 300,000 mangrove seedlings to Local Forest Department in Pyapon township for enhancing the government's mangrove rehabilitation program
- Delivery of over 30,000 seedlings of Casuarina equisetifolia and Melaleuca cajuputi to local communities for scattered tree planting
- 7 acres of *Casuarina equisetifolia* and *Melaleuca cajuputi* plantations were established
- 24 natural crab fattening pilot models conducted
- 1 mini crab hatchery rotation was conducted

Photo 1. Restoration experiment 3-year-old *Avicennia officinalis*

Photo 2. Restoration experiment 3-year-old *Bruguiera sexangula*

Photo 3. Htan Pin Kone village nursery was established by the project

Photo 4. New restoration planting of Wapana community forest user group.

Figure 3 Nursery and mangrove restoration models

Activity 2.5: *Development of the monitoring and evaluation framework and implementation*

Designing monitoring and evaluation (M & E) framework and operationalizing the framework to assess the pilot models and their impacts. This activity is comprised of four elements

2.5.1 Development of measurable criteria and indicators for an internal M&E system

Completed (M & E framework attached)

2.5.2 M&E training for project's local staff

Completed in 2018

2.5.3 Collecting data and information for M & E

Completed in 2018, 2019, 2020, 2021 and 2022

2.5.4 Analyzing data for M & E report and other publications

Completed

Output 3: *Capacity building and expertise exchange*

Activity 3.1: *Development of 11 guidelines, handbooks/manuals or reports on the technical aspects of projects (6 technical guidelines – see below, and 5 silviculture and aquaculture model guidelines) and 2 international publications*

> ***See activity 2.1 above***

3.1.8 Two peer review papers on international scientific journals developed from data/results of the project are:

- Mangrove carbon sequestration and land use change impacts in Ayeyarwady Delta, Myanmar

3.1.9 One to two master and/or Ph.D. students will do research projects which will be partially based on the project's data & scientific outputs

Completed (two Myanmar's master students who were enrolled in the Vietnam Forestry University's International Forestry Master program graduated funded by DAAD)

- Htike San Soe, 2021. CONTRIBUTION OF SILVO-AQUARCULTURE ON LOCAL COMMUNITIES' LIVELIHOODS (A CASE STUDY IN AMAR SUB-TOWNSHIP UNDER PYAPON TOWNSHIP, AYEYARWADY REGION, MYANMAR). Master thesis.

Activity 3.2: *Training courses and international workshops for capacity building*

Training courses on different technical aspects will be organized for the technical staff, local practitioners, and farmers. Additionally, we will hold an international workshop to allow for learning among project sites.

20-25 key farmers and community leaders participated in each training course on mangrove restoration and mangrove aquaculture. 25 national, regional and township foresters participated the training courses for GIS and land use planning in January 2018.

3.2.1 1 training course for researchers and technical staff on mangrove forest inventory, socio-economic survey, participatory rural appraisal, and community forest management

Completed in January 2018

3.2.2 1 training course for researchers and technical staff on land use planning and GIS & mapping – 01 week.

Completed in January 2018

3.2.3 3 training courses for technical staff & local farmers on mangrove forest restoration and management associated with aquaculture and agriculture

Completed in 2018 and 2019

3.2.4 4 training courses for technical staff & local farmers on different model techniques of aquaculture in mangrove (e.g. shrimp, fish, crab, etc.)

Completed in 2018 and 2019

Details of training courses are as below. Training courses were conducted for local project staff, regional and international experts, and local participants. These included GIS & RS, and Land Use Planning courses (dates: 20–25 January 2018, 25 participants—key forest department officers from nationwide mangrove townships; key land administration officers from Pyapon township); Forest Inventory (26–27 January 2018, 25 participants); Socio-Economic Surveys (dates: 25 March 2018, 12 local researchers and technical staff trained, 175 people interviewed). Two study tours on crab hatchery, sustainable aquaculture in mangroves, and mangrove restoration to Vietnam were implemented for 8 of the project's staff and farmers in October 2018 and February 2020. In 2019, 8 training courses on mangrove restoration and crab fattening were conducted at the project station for local communities. In total, 212 farmers and local staff participated in mangrove restoration and crab fattening courses.

3.2.5 2 international workshops on: sustainable management and restoration of mangroves associated with livelihood improvement.

The first workshop was organized during the inception workshop for sharing knowledge and best practices on mangrove restoration and sustainable management associated with aquaculture and agriculture in the Asia Pacific region. Due to of COVID-19 and the political situation in Myanmar, the project won't organize the second international workshop as planned. The project is planning to organize an online closing workshop between Myanmar Forest Department, the University of Queensland, APFNet and local project experts.

3.2.6 Mid-term review workshop

Completed in 2019

3.2.7 Training by doing: all project activities will be linked to training courses, allowing trainees to gain direct field experience.

Completed in 2018, 2019 and 2020

Output 4: *Improvement of ecosystem services, local livelihoods and project's scientific outputs*

Activity 4.1 *Assess production of aquaculture products from the pilot project, marketing and sale (report attached)*

In this component of the project has three work packages:

4.1.1 Assessment of the capacity for the harvest of aquaculture products, marketing and sale, especially focusing on fish, shrimp, crabs and clams.

Completed

4.1.2 Harvesting shrimp, crabs, clams and fish and sale if applicable

Completed

4.1.3 Monitoring and evaluation to evaluate the impact of the projects

Completed

The project's pilot model data were used to analyse the environmental and economic values of mangrove restoration and mangrove aquaculture. It was co-published with GGGI as a technical report in 2019[18]. The published report is attached separately.

Activity 4.2: Enhancing scientific outputs of the project

The pilot models for mangrove restoration by planting have been meticulously developed to facilitate comprehensive study and understanding of the various factors influencing successful growth. These models encompass diverse experimental planting formulas, including varying densities and the incorporation of mixed species to promote biodiversity and resilience. Each planting formula has been meticulously replicated across three distinct sites, allowing for the creation of three separate replicates per formula. These multiple replicates ensure the results are reliable and robust, allowing for the identification of optimal methods and strategies for mangrove restoration. The design of the pilot models allows for the accurate assessment of each formula's effectiveness, laying the foundation for large-scale implementation of the most successful practices for mangrove restoration.

There are four restoration techniques has been tested:

- Monoculture planting after improvement felling

- Mixed species planting after improvement felling with low planting density

- Mixed species planting after improvement felling with high planting density

- Improvement felling to promote natural regeneration only

After a three-year observation period, the results indicate that the most efficient methodology is the second one - planting a mixture of planted species after improvement felling with a lower density. This approach could reach similar to the canopy cover that high density planting achieves but at a significantly reduced rehabilitation cost. On the contrary, the least effective strategy was found to be relying on natural regeneration following improvement felling. This was primarily because the seedlings that regenerated had to harshly compete for growth space with other climbing plants and shrubs.

The experimental data were collected annually for M & E and research purposes.

4.2. Project Impacts

The project on mangrove restoration and coastal community livelihood improvement had significant social, economic, and environmental impacts, including changes to forestry sector policies, strategies, and planning. The project aimed to restore degraded mangrove forests and improve the livelihoods of coastal communities by promoting sustainable forest management practices.

Social impacts:

The project had significant social impacts, particularly on the communities living in the

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[18] See Sang et al. (2019): Economic Appraisal of Ayeyarwady Mangrove Forests.

project areas. By providing training and education on sustainable forest management practices, mangrove restoration, and mangrove-friendly aquaculture, the project empowered local communities to take an active role in the management of their mangrove resources. This led to increased community participation in decision-making processes, improved awareness of the importance of sustainable forest management, and the adoption of sustainable practices. The project also promoted gender equality, with a focus on the empowerment of women in mangrove management and utilization activities.

In summary, the following number of people were directly benefited by the project:

- 40 national, regional, and township forestry and land use staff were trained in different training courses of the project.
- 195 village leaders, local staff, and key farmers were directly trained on mangrove restoration and mangrove-friendly aquaculture. 60 of these participants were women.
- Over 400 CFUG member households benefited from participating in project models on mangrove restoration and mangrove-friendly aquaculture.

Many other households indirectly benefited from the project's capacity building because the knowledge and skills were transferred to key staff and farmers who were then able to train others in their management and living areas.

Economic impacts:

The project had several economic impacts, particularly on the livelihoods of coastal communities in the project areas. The project helped to improve the income and food security of the communities by promoting sustainable mangrove-based livelihoods, such as mangrove aquaculture, sustainable mangrove thinning practices, and non-timber forest product harvesting.

Pilot mangrove aquaculture models demonstrated a 50% increase in mud-crab productivity. However, the real gain in economic output was not significant due to low crab prices during the COVID-19 pandemic and Myanmar's unstable conditions. The rehabilitated mangroves of project models are able to provide much higher wood productivity, which are important for income improvement from timber and firewood for mangrove owners.

Environmental impacts:

The project had significant environmental impacts, particularly in the restoration and conservation of mangrove forests. It helped restore over 87 hectares of degraded mangrove areas and delivered more than 300,000 mangrove seedlings for other restoration programs managed by the Forest Department. The project also established 24 natural mangrove crab fattening models for local communities. Additionally, it facilitated the establishment of coastal wind protection forests and scattered planting by delivering over 30,000 seedlings of *Casuarina equisetifolia* and *Melaleuca cajuputi* to local communities. This led to increased carbon sequestration, enhanced coastal protection, and greater biodiversity. Moreover, the project promoted sustainable mangrove management practices, such as mangrove-friendly aquaculture and the use of low-impact thinning techniques, which improved the overall health of mangrove ecosystems.

Change in forestry sector policies, strategies, and planning:

The project had a positive impact on forestry sector policies, strategies, and planning. By promoting sustainable mangrove management practices, the project helped to shift the focus of forest management from purely commercial and exploitative approaches such as monoculture plantations or non-mangrove brackish aquaculture to a more sustainable and community-oriented approach. This led to the development of management policies and strategies that promote sustainable forest management practices, including community forestry and participatory forest management by the local township forestry departments.The township forest department did not issue policies formally. However, the project outputs suggested them to develop and approve CFUG mangrove forest management plan in the sustainable way.

Change in public behavior/practice in forest management:

The project had a positive impact on public behavior and practice in mangrove management in the project's communities. Through training and direct extension activities for over 600 technical staff and key farmers, the project helped to raise awareness of the importance of sustainable mangrove management practices and promoted the adoption of sustainable practices among local communities. This led to a change in behavior and practices, such as reduced-impact thinning, reduced clear-cutting, and the adoption of mangrove-friendly aquaculture techniques.

Beneficiaries:

The primary beneficiaries of the project were the 35 coastal communities living in the project area. These communities benefited from improved livelihoods, increased income, improved food security, and/or capacity building. Additionally, the project had a positive impact on the environment, which benefited the broader community, including the ecosystem services provided by mangrove forests. The forestry sector also benefited from the project, with the adoption of sustainable mangrove management practices leading to improved forest management and conservation.

4.3. Sustainability

Sustainability is a critical aspect of any project, as it ensures that the benefits and impacts of the project are maintained over the long term. There are several aspects of the project that will sustain to deliver project benefits or impacts after the end of the project:

Institutional capacity building: One of the key aspects of the project was to build the capacity of local institutions. The project assisted government organizations, non-governmental organizations, and community organizations in continuing to implement sustainable mangrove aquaculture practices, crab hatcheries, mangrove restoration, and sustainable mangrove management through training sessions, study tours, and learning by doing techniques. This institutional capacity building will enable these organizations and communities to continue implementing sustainable mangrove and mangrove aquaculture management practices beyond the period of the project.

Community participation: The project encouraged community participation in forest management activities, which has given the local communities a sense of ownership and responsibility. This participation will sustain, and the communities are likely to continue

implementing sustainable mangrove management practices after the end of the project.

Value chains for mangrove-based products: The project promoted the development of value chains for forest-based products, which has created alternative sources of income for local communities. These value chains are likely to sustain after the end of the project, providing continued income for the communities.

Policy and regulatory frameworks: The project helped to promote the development of local policies and regulatory frameworks defined in the forest management plans for CFUGs – a popular type of community forestry in the project region. It promotes sustainable mangrove and mangrove aquaculture management practices, including community forestry and participatory forest management. These policies and regulatory frameworks will continue to guide the local forestry sector in the project area and will sustain after the end of the project.

If follow-up activities such as crab hatchery, and extension of natural crab fattening in mangroves are planned, they can further contribute to sustaining the project benefits or impacts. Follow-up activities can include monitoring and evaluation to ensure that the project outcomes are sustained, continued training and education to build the capacity of local institutions and communities, and continued support for the development of value chains for mangrove-based products.

5. CONCLUSION, LESSONS LEARNED AND RECOMMENDATIONS

5.1. Conclusion

Based on the wealth of information provided, it can be concluded that most project activities have been fully completed, and the outputs, objectives, and goals have been achieved as expected and planned. The project has successfully contributed to mangrove restoration, improved community livelihoods, and sustainable forest management and mangrove aquaculture in the project area. The only activity that could not be conducted was the final international workshop for sharing project lessons and closing it while the micro land use planning for the village level was designed but not applicable to the current policy framework in Myanmar.

Though the project completion has been significantly delayed due to COVID-19 and unstable political conditions in Myanmar, the project's implementation can be objectively assessed to be effective and efficient. The project was well-planned, with clear goals and objectives, and the project activities were implemented systematically. The project was also able to effectively utilize the grant provided by APFNet, and there were no major issues with disbursement.

Moreover, the project has been able to build the capacity of local institutions and communities, allowing them to sustain the project's outcomes and continue implementing sustainable forest management practices in the long term. The project has also contributed to the development of policies and regulatory frameworks that support sustainable forest management practices, which will further contribute to sustaining the project benefits or impacts.

Overall, the project implementation can be assessed as being successful, and it has made a significant contribution to the restoration of mangroves, improved community livelihoods, and

sustainable forest management in the project area.

5.2. Lessons learned and recommendations

Lessons Learned:

Project design: The project was designed to help local communities with micro-land use planning and obtain approval from higher administrative authorities to achieve sustainable use of the village's land for different production sectors, conservation, and ecosystem services. However, the legal framework for land use planning was not sufficient to carry out this activity. Our lesson is to carefully research the local context when designing activities for development projects.

Community participation: The project showed that community participation is critical for success. Without the active participation of local communities, mangroves will continue to degrade to the point that they cannot longer be restored through assisted natural regeneration. Therefore, it is essential to involve local communities in project design, planning, and implementation.

Micro institutional capacity building: Community forestry user groups (CFUGs), a type of community forest management, and their plans and regulations have been proven to be an effective micro-institution for mangrove management and restoration. The project demonstrated the importance of building the capacity of local institutions, such as CFUGs, the forest department, and other village groups and organizations, to continue implementing mangrove restoration, mangrove-friendly aquaculture, and sustainable forest management practices after the end of the project. Therefore, capacity building should be a key component of future projects.

Monitoring and evaluation: Monitoring and Evaluation: The findings from this project highlight the essential nature of both internal and external monitoring and evaluation (M&E) for tracking progress and identifying improvement opportunities. Through internal M&E, we were able to adapt our project's goals, activities, and methods as needed. For instance, we introduced training sessions on crab hatchery techniques for staff and key farmers in Myanmar, despite it not being part of the original project plan. This adjustment was made recognizing that mud crab culture aligns well with mangrove conservation efforts, indicating that hatcheries for young crabs could play a key role in promoting sustainable practices in mangrove aquaculture. Therefore, future projects should ensure they include strong monitoring and evaluation processes to allow for such adaptability and to better secure sustainable outcomes.

Value chains for mangrove-based products: The project collaborated with the Global Green Growth Institute (GGGI) on an economic appraisal of mangroves in the Ayeyarwady Delta. The results showed that the development of value chains for mangrove-based products, such as mud crab, can provide sustainable livelihoods for local communities. Therefore, future projects should explore opportunities for developing value chains for mangrove-based products.

Policy and regulatory frameworks: Our analysis revealed that without community engagement in mangrove restoration and management, mangrove resources will continue to be depleted. The project showed that policies and regulatory frameworks that encourage local

communities to participate in forest management are critical for promoting sustainable forest management practices. Therefore, future projects should work with governments and other stakeholders to promote the development of policies and regulatory frameworks that enhance community participation in mangrove management..

Recommendations:

Technical: Future projects should prioritize community participation, institutional capacity building, monitoring and evaluation, and the development of value chains for mangrove-based products. Technical assistance and training should be provided to local institutions and communities to enable them to implement sustainable forest management practices effectively.

Financial: The project had a significant fund shortage in implementing a mini crab hatchery, thus consequently delayed several hatchery activities for finding additional supports. Future projects should ensure that adequate funding is available for all project activities, including monitoring and evaluation, and capacity building.

Administrative: Project management should be transparent and accountable, with clear lines of communication between project partners. Effective project management will ensure that project activities are implemented on time and within budget.

Information dissemination: The project demonstrated the importance of effective communication and dissemination of project information. Therefore, future projects should prioritize the development of communication and dissemination strategies to ensure that project information is effectively communicated to stakeholders.

Applying lessons learned: The lessons learned from this project should be shared with stakeholders in adjacent areas to inform the design and implementation of similar projects. Stakeholders should be encouraged to learn from the successes and challenges of this project and apply these lessons to their own projects.

In summary, future projects should prioritize community participation, institutional capacity building, monitoring and evaluation, the development of value chains for forest-based products, and the promotion of policies and regulatory frameworks that support sustainable forest management. Effective project management, adequate funding, and communication and dissemination strategies are also essential for project success. The lessons learned from this project should be shared with stakeholders in adjacent areas to inform the design and implementation of similar projects.

Annexes

A. Project Implementation status
B. Financial statement (including balance sheet, source and use of Funds statement, and expenditure details) by both category and activity
C. Project's   financial statement   report
D. Project outputs, such as technical reports, key project documents (workshops, field visits, technical visits, trainings etc.), publications, brochures, webpages, etc.
E. 2-3 Feature stories from the project for promotion
F. Photos, media cliffs and other materials used/available for project outreach