ASIA-PACIFIC NETWORK FOR GLOBAL CHANGE RESEARCH

Final Technical Report
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Sustainable Mangrove Rehabilitation for Global and Local Benefits

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Project Overview

Project Duration	**:**	15 July 2017 – 15 July 2019
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Project Summary

This collaborative research project was aimed at distilling the best mangrove rehabilitation practices in the Philippines, Myanmar, India, China and Japan. It responds to the growing concerns of the need to counter mangrove deforestation and provide science-based approach in coastal forest rehabilitation. The Research Team employed rigorous review of secondary information and conducted policy consultations with relevant government and non-government organizations to capture lessons and challenges in mangrove rehabilitation. Results were synthesized to identify common issues and best practices among participating countries. Further, this information was used to develop common guidelines in pursuing sustainable and community-based mangrove rehabilitation. The suitability of these guidelines was further examined through the conduct of in-depth case studies in the Philippines and Myanmar. Case studies mainly comprised: 1) documentation of local or community-based mangrove rehabilitation practices through key informant interviews and focus group discussions; 2) land cover change analysis through GIS;3) carbon stock assessment; and 4) identification of potential strategies/recommendations for sustainable mangrove management. Key findings showed that local communities have pivotal role in ensuring correct and sustainable mangrove rehabilitation. The proposed guidelines also served as an evaluation tool for gauging the sufficiency and suitability of current practices in meeting the goals of mangrove rehabilitation. Some policy gaps need to be addressed in order to overcome the

challenges in mangrove conservation. Lastly, successful mangrove rehabilitation experiences rest very well on good governance, commitment and collaboration among key government and non-government stakeholders.

Keywords: coastal forest, guidelines, policy, rehabilitation, sustainability

Project outputs and outcomes

Project outputs:

1. Review report of past mangrove rehabilitation projects/efforts highlighting the common best practices, success and challenges/policy issues;
2. Proposed policy recommendations and mangrove rehabilitation guidelines; and
3. Case studies summarizing policy recommendations for sustainable mangrove rehabilitation vis-à-vis creating local and global benefits

Project outcomes:

1. Improved capacity and skills among governments and other relevant practitioners in mangrove rehabilitation;
2. Increased consciousness on the critical biophysical/ecological and socio-institutional requirements of mangrove rehabilitation;
3. Promotion of community-based mangrove rehabilitation approaches, ensuring the equitable and inclusive local development likewise; and
4. Provided basis for calibrating policies encouraging science-based and participatory mangrove rehabilitation and restoration

Potential for further work

Implementation of the project's recommendations through capacity building activities entitled "Science and Community-Based Mangrove Management for Global and Local Benefits: A Pilot Demonstration Project of the Philippines, Myanmar, Thailand, China and India".

This interdisciplinary research enhances scientific and technical capabilities as well as facilitates a long-term research network on coastal forest rehabilitation between the Philippines and other ASEAN countries through collaboration and exchange.

Publications

Gevaňa, D.T., Camacho, L.D., Pulhin, J.M. 2018. Mangroves for the Blue Carbon: Insights and Prospects for Community-Based Mangrove Management in Southeast Asia. In Makowski C., Finkl (eds) Threats to Mangrove Forests. Coastal Research Library, Vol. 25. Springer Nature. Pp. 579-588 (Clarivate Analytic-indexed)

Presentations in Conferences/Workshops/Seminars

L.D. Camacho, D.T.Gevaňa, J.E Garcia, C.D. Ruzol, L.L. Sabino, A.D.Camacho. 2019. *Pursuing Sustainable Rehabilitation: Lessons Learned from Community-Based Mangrove Management Practices in the Philippines.* **Poster paper** presented during the College of Forestry & Natural Resources' 09th Founding Anniversary & Alumni Homecoming, with the theme, "Philippine Green Growth Initiatives for Sustainable Development" held on April 25, 2019, at Nicolas P. Lansigan Auditorium, CFNR, University of the Philippines Los Baňos.

L.D. Camacho, D.T.Gevaňa, J.E Garcia, C.D. Ruzol, L.L. Sabino, A.D.Camacho. 2019. *Promoting Sustainable Coastal Rehabilitation: Lessons Learned from Community-Based Mangrove Management Practices in the Philippines.* Oral Paper presented during the Asia-Pacific Forestry Week Side Event on Forest Transition, Forest Landscape Restoration and Forest Forest Ecosystem Services held in Songdo ConvensiA, Incheon, Republic of Korea last June 19, 2019.

L.D. Camacho, D.T.Gevaňa, J.E Garcia, C.D. Ruzol, L.L. Sabino, A.D.Camacho. 2019. *Sustainable Coastal Mangrove Rehabilitation through Community and Science-Based Approaches: Lessons Learned from the Philippines.* Poster Paper presented during the Asia-Pacific Forestry Week Side Event on Forest Transition, Forest Landscape Restoration and Forest Forest Ecosystem Services held in Songdo ConvensiA, Incheon, Republic of Korea last June 17 to 21, 2019.

Support to Undergraduate Theses

Ayla Denise M. Trinidad. 2019. *Suitable Sustainable Forest Management Criteria and Indicators for Successfully Rehabilitated Mangroves on Barangay Nabitasan, Leganes, Iloilo, Philippines.* An Undergraduate Thesis submitted as a requirement for the BS Forestry degree major in Social Forestry & Forest Governance. June 2019. College of Forestry & Natural Res0urces. University of the Philippines Los Baňos, College, Laguna, Philippines.

Lara Melissa A. Bernabe. 2019. *Local Awareness, Knowledge, and Attitude Level as Influencing Factors for Participation in Mangrove Rehabilitation: The Case of Barangay Nabitasan, Leganes, Iloilo, Philippines.* An Undergraduate Thesis submitted as a requirement for the BS Forestry degree major in Social Forestry & Forest Governance. June 2019. College of Forestry & Natural Res0urces. University of the Philippines Los Baňos, College, Laguna, Philippines.

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In the Philippines:

- Department of Environment and Natural Resources
- Bureau of Fisheries and Aquatic Resources
- Zoological Society of London (Philippine Office)
- NGOs for Fisheries Reform
- University of the Philippines
- Iloilo State College of Fisheries
- Ateneo De Manila University
- Municipal Government of Leganes, Iloilo
- Municipal Government of Barotac Nuevo, Iloilo
- Community Based Mangrove Seedlings Growers Association
- San Roque Coastal Environment Program Association, Inc. (SARCEPA)
- Jalaud Fisherfolk's Association

In Myanmar:

- Forest Research Institute
- District Forest Department of Myeik
- Local Community of Taw Htwin

In India:

- Jawaharlal Nehru University
- Annamalai University
- University of Delhi
- AICRP on Agrometeorology
- Wildlife Trust of India (
- Nature Environment and Wildlife Society of India
- Kerala, Dagagiya Social Welfare Society
- Tagore Society for Rural Development,

In Japan:

- United Nations University Institute for Advanced Study of Sustainability (UNU-IAS)

In China:

- Xiamen University

1. Introduction

Mangrove forests provide a wide range of vital ecosystem services for global and local communities, such as climate change mitigation (through high carbon sequestration), climate change adaptation (through protection from floods, tides and storms), biodiversity conservation, and local livelihoods (through community fishery, aquaculture and forest products). However, overharvesting and land-use change have resulted in widespread degradation of mangrove forests, leading to loss and reduction of the above vital ecosystem services. While mangrove planting has been promoted to restore vital ecosystem services most of such efforts were largely monoculture plantation and were not effective in restoring the wide range of vital ecosystem services. The collaborative research project reviewed past experiences of mangrove planting to elicit best practices for sustainable rehabilitation to integrate global and local benefits. Findings from in-depth case studies of community-based mangrove rehabilitation efforts of both countries were also synthesized to determine policy recommendations that will help improve mangrove rehabilitation strategies in the future.

The overall goal of the project was to distil the best mangrove rehabilitation practices in the Philippines, Myanmar and India while extracting relevant lessons from China and Japan, so as to identify policy recommendations in order to mainstream these into strategies. Specifically, the project was aimed at achieving the following objectives:

1) To develop guidelines on the best rehabilitation practices from previous mangrove development efforts in the participating countries through literature review;
2) To conduct policy analysis with relevant institutions/stakeholders;
3) To conduct case studies by looking at the following components:
    - the socio-economic condition of local communities
    - biophysical / environmental aspect: species composition, and status of mangrove cover, etc.
    - technical: approaches or techniques and progress in making rehabilitation efforts
    - facilitating and constraining factors in mangrove rehabilitation efforts
    - potential ecosystem benefits of mangrove rehabilitation such as carbon sequestration and provision for marine-based food and income
4) To recommend strategies/policies to promote sustainable mangrove rehabilitation and management based on literature review and case studies.

2. Methodology

To satisfy objective no.1***"to develop guidelines on the best rehabilitation practices from previous mangrove development efforts in the participating countries through literature review"***, the project accomplished the following activities:

- Review of past reports (from the year 2000 onwards) on rehabilitation studies and projects in Asia (particularly the Philippines, Myanmar, Japan, China and India) was done. The state-of-the-art knowledge on mangrove ecology also reviewed to identify inter-linkages between mangroves, carbon sequestration, coastal protection, biodiversity, fishery and forest products. This distilled the issues, best practices and strategies for sustainable mangrove rehabilitation in Asia. A list of criteria summarizing the success and challenges of the rehabilitation project/research reports was developed to form part the proposed mangrove rehabilitation guidelines. These

primarily included: 1) site, location and area; 2) duration and budget; 3) planting design (including species composition); 4) survival rate; 5) stakeholders participation; 6) provision of socio-economic benefits, and 7) success and constraining factors.
- In-depth case studies in the Philippines and Myanmar further validated the suitability of the proposed rehabilitation guidelines.

Given objective no. 2 "***to conduct policy analysis with relevant institutions/stakeholders***", the research team conducted policy, dialogue/consultation and analysis on mangrove rehabilitation.

- Policy consultations with relevant institutions (including those whom the project has established linkages) were done to elicit/distil: 1) key mangrove policies and programs on mangrove rehabilitation, appropriateness or suitability of existing policies as far as their adherence to sustainability goal(s) is concern, i.e. equity, economic development, and environmental stability; 2) functions and effectiveness of key institutions in implementing these policies; 3) perceived issues and challenges in policy implementation; and 4) recommendations to improve policies.

For objective no. 3 "to ***conduct case studies***, the research team accomplished the following activities:

- On socio-institutional aspect: Household survey, key informant interviews (KII) and focus group discussions (FGDs)with relevant stakeholders
- On biophysical/environmental aspect: species composition, and status of mangrove cover, etc. (land use/landcover analysis thru GIS; 10m x 10m plot sampling for biodiversity assessment and carbon stock measurement)
- On technical aspect: approaches or techniques and progress in making rehabilitation efforts (HH survey, KII, FGD)
- On facilitating and constraining factors in mangrove rehabilitation efforts: KII and FGDs

In view of Objective no. 4 "***recommend strategies/policies to promote sustainable mangrove rehabilitation and management based on literature review and case studies***.

- Information obtained from case studies, policy consultations and literature review were synthesized during the synthesis workshop that was held in the Philippines. The final outputs of this workshop included technical final reports and sustainable mangrove rehabilitation guidelines. These documents will be made available and open-access through the websites of UNU-IAS website, University of the Philippines and FRI. Information that will be worth of scientific publication will also be published in a peer-reviewed journal.
- The Team also conducted research mission visits to India, Myanmar and the Philippines to discuss and distil best practices and recommendations for sustainable mangrove rehabilitation.

3. Results & Discussion

Part i. Guidelines for Sustainable Mangrove Rehabilitation

Mangrove Rehabilitation Concepts and Definitions

Forest rehabilitation and *forest restoration* share a common intention of bringing back the healthy vegetation of degraded forest site. These concepts, however, differ in their end goals as *rehabilitation* focuses on bringing back the vegetation cover but partially replacing the original structural or functional characteristics that have been diminished or lost; while

restoration aims to revert the site into its prime and nearly original ecosystem conditions (Field 1998).

Mangrove rehabilitation is currently being promoted as one of the best solutions to solve worsening coastal environmental problems. This is in response to the need of myriad ecosystem values and services that mangroves provide. In pursuit of sensible and successful rehabilitation, a good understanding of the: 1) drivers of mangrove deforestation or degradation; 2) intention of mangrove rehabilitation (for what and for whom); 3) site condition and ecological preferences for rehabilitation; and 4) how rehabilitation should be done, were noted to be critical.

Lessons learned from the four collaborating countries underscored that there had been several motivations in pursuing mangrove rehabilitation. In Japan and India, the foremost goal was resiliency improvement against natural disasters such as typhoons and tsunami. For the Philippines, China and India, mangrove rehabilitation goals are generally mixed, to include: improving biodiversity; disaster risk reduction; ecologically sound aquaculture production; and climate change mitigation. Most of the rehabilitation programs in these countries had been institutionalized into policies.

A number of challenges were also identified in the conduct of mangrove rehabilitation programs. Foremost is the poor survival rate of planted mangroves which is deeply rooted to other and inextricably linked issues of 1) poor planning; 2) limited understanding of the site's ecology; 3) poor program management/governance; 4) tenure insecurity; 5) occurrence of natural disasters damaging rehabilitation sites, 6) poor monitoring and lack of corrective measures to improve rehabilitation work; and many others.

According to Field (1998), there are two main criteria for assessing the success of mangrove rehabilitation, namely: *effectiveness* and *efficiency*. *Effectiveness* pertains to the closeness to which the new mangrove forest meets the original goals of the program. On the other hand, *efficiency* which measures the amount of labour, resources and material that were used to satisfy the rehabilitation goal. Yap (2000) emphasized that there is always a high degree of uncertainty in meeting the rehabilitation success in view of these criteria. The level of difficulty varies from various site conditions, policy environment, and commitment over the program.

This guidelines, therefore, aims to respond to this challenge, taking the lessons learned from five collaborating countries. A comprehensive mangrove rehabilitation framework was also developed to help governments and other practitioners in formulating their mangrove rehabilitation plans, programs and projects.

Principles for Successful Mangrove Rehabilitation

A successful mangrove rehabilitation program embraces certain principles that adhere to shared local environmental, economic and social needs, and of meeting the broader global challenges of climate change and poverty. These principles can be summarized in the following:

i. Correct site selection.
   - Mangrove sites may vary in sizes from a very small strip to several thousand hectares hence careful selection and planning based of rehabilitation scale is critical to the program's success as it is often limited by time, budget and human resources.
   - Mangrove rehabilitation should focus on original mangrove sites, and not on other natural coastal ecosystems that have important and unique biodiversity set.
   - There are social and legal constraints of doing mangrove rehabilitation. These include land tenure, land use preferences (production or protection), coherence with existing

policies and government plans, and most importantly the buy-in of local stakeholders (both public and private) such that they should have a good appreciation of their roles, responsibilities and benefits in joining the program; and

- Sufficient and correct information on the site's ecology and hydrology play a vital in designing a rehabilitation program. Planting on wrong site, at the wrong time, with the wrong species beset failures. In sum: a) Get the hydrology right; b) Do not start by planting mangroves: first find out why mangroves are not there; 3) see if the reason for mangrove absence can be corrected; if not choose another site; 4) Use a reference site to identify the conditions suitable for mangroves in the project area; 5) For the reference site, be clear about its topography before considering another area; and 6) Evaluate costs and benefit early in project planning– to maximize cost-effectiveness.

ii. Well-understood drivers of mangrove deforestation or degradation.
Vegetation cover loss is often a symptom of a more in-depth and interconnected social, institutional, economic and environmental problems. Designing effective, efficient and suitable rehabilitation program rests on how well the foundational or root problems are will-understood.

iii. Holistic system approach.
Holistic systems approach in mangrove rehabilitation ensure that concerns spanning the biophysical, social, economic, and institutional characteristics are well-taken into consideration. Such an approach provides multidiscipline analysis of the problem and solutions.

iv. Stakeholder engagement.
Participation of stakeholders in the whole rehabilitation process (from planning to monitoring and evaluation) is essential. Ensuring a transparent, just and sound stakeholder engagement is at the heart of all successful rehabilitation projects. Shared needs and aspirations should be met, and mangrove rehabilitation must be pursued with a common or unified vision. Roles, responsibilities and benefit-sharing should also be clear to each stakeholder. This likewise set the foundation for ensuring accountability. Stakeholder engagement should also adhere to gender and cultural sensitivity, i.e. by making sure that shared concerns of marginalized sectors are well-heard.

v. Empowerment.
One of the significant objectives of mangrove rehabilitation is to equip local stakeholders with the necessary knowledge and skills and enhance commitment in pursuing and sustaining forest conservation. The more they are included in the rehabilitation process, the better they grow collectively in taking care of the program by themselves and for themselves.

vi. Adaptive and responsive.
Rehabilitation plans and programs should be adaptive or responsive to changing circumstances in order to avoid setbacks and failures. The institution (s) implementing the program should be proactive in discovering pitfalls, making adjustments and corrections, and in harnessing opportunities that come along the way.

vii. Culture of sharing. Lessons learned and best rehabilitation practices need to be communicated in order to help others who are also pursuing similar work. Publishing of case studies and technical rehabilitation guidelines and the conduct of seminars on successful mangrove rehabilitation practices are important initiatives that can be done.

viii. Volunteerism. In many cases, volunteerism or 'non-paid planting' provides a better approach to increase local awareness, commitment and sense of ownership in pursuing mangrove rehabilitation. Rehabilitation sites can also be developed as a learning venue for more stakeholders to appreciate the value of mangrove conservation.

Key Activities in Mangrove Rehabilitation

Mangrove rehabilitation is not mere planting of trees but involves a series of key activities that requires participation and commitment of various stakeholders. These key activities are summarized in Figure 1.

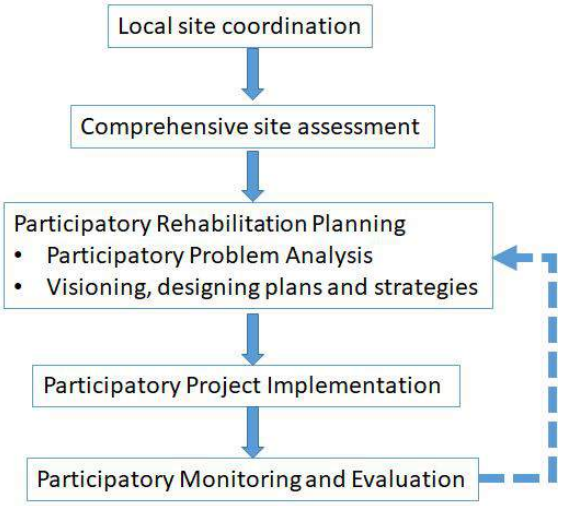

Figure 1. Key activities in the mangrove rehabilitation process.

i. **Local Site Coordination.** Interest to pursue forest rehabilitation should be properly coordinated with key stakeholders or institutions who have jurisdiction or management rights over the area. Frequently these include a series of meeting with local government, local communities, farmer and fisherfolk groups, private entities, and non-government organizations to explain the need and benefits of doing rehabilitation, as well as the policy environment that requires or encourage such action. This activity also serves as an avenue for securing consent and raise local interest to contribute to the rehabilitation endeavour to be proposed. Strategically, it also provides opportunities for the proposing team to gather relevant secondary data to enrich the comprehensive site assessment that will be undertaken.

ii. **Comprehensive site assessment.** Comprehensive site assessment should be done by an interdisciplinary research team. It should be composed of researchers/experts in the field of mangrove taxonomy and ecology, socio-demography, policies and governance, economics, remote sensing and mapping, forestry and fisheries. The conduct of site assessment activities should be in collaboration with local community. Selected members from the local community can be trained in-field data collection (e.g. measuring trees, assisting in social surveys and focus group discussion, and ground validation of land uses and maps). By doing this, the community can develop sense of ownership of the information they gathered. Comprehensive site assessment has two major components, namely: biophysical; and socio-economic.

a. **Biophysical characterization.** Vegetation analysis can be done through rapid appraisal or in terms of rigorous assessment following a sampling design. It is essential to note in the vegetation analysis the historical changes (including land-use

patterns) that occurred in the area. The conduct of key informant interviews can help enrich and validate the vegetation analysis.

Further, physical assessment (topography, hydrology, sediment and water properties, climate, etc) is needed to provide the basic information for designing the appropriate rehabilitation strategies. Participatory resource mapping can also help determine and validate the extent of mangrove cover, and identify hazards and other environmental problems that are present in the area.

A major output of biophysical characterization is the description of existing mangrove zones. Figure provides a typical picture of likely species composition along with tidal regimes. Such output can also be produced during participatory resource mapping activity which aims to increase local awareness of the ecological considerations of growing mangroves with respect to tidal exposures and regimes.

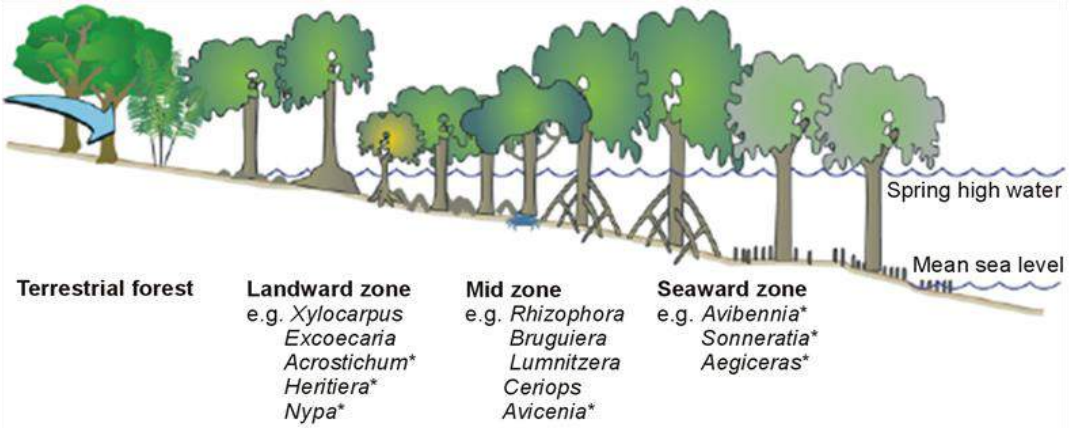

Figure 2. Mangrove zonation according to the tidal regime (Waycott et. al. 2007)

b. **Socio-economic characterization.** This generally aims to capture the socio-economic and demographic condition of the local community and stakeholders. Participatory Rural Appraisal (PRA) techniques such as key informant interviews and focus group discussions would be the ideal approach for this work. Local awareness of mangrove values must be assessed first in order to elicit varying needs and interests of the stakeholders. Likewise, demographic (population, gender distribution, ethnicity, etc), socio-economic (income and livelihood), and cultural (traditional use and management of mangroves) profiles need to be captured as these largely influence mangrove resource utilization and management. Perceived economic benefits from mangroves can be captured through PRA, which is relevant in accounting ecosystem services values that provides the rationale for pursuing rehabilitation. Finally, the Research Team (with local community partners) should assess existing institutional arrangements in managing mangroves such as property rights, stewardship arrangements, and traditional /cultural knowledge systems, and elicit key issues related to these.

iii. Participatory Mangrove Rehabilitation Planning

Rehabilitation planning starts with a multi-stakeholder Problem Tree Analysis. This participatory activity (usually in the form of a forum or focus group discussion) aims to have a collective view of the key problems and underlying causes that contribute to mangrove deforestation and degradation. A good understanding of the root or foundational causes is critical to designing appropriate rehabilitation and conservation strategies. Results of the comprehensive site assessment should also be discussed to highlight the key issues facing the mangrove site.

The visioning exercise follows the problem analysis. This multi-stakeholder activity aims to solicit a shared and ideal vision for the mangrove forest. Such unified vision is further interpreted into goals and specific list of objectives that should be met.

Stakeholders after that proceed with strategic planning exercise. This involves crafting priority plans and activities in pursuing mangrove rehabilitation and conservation. Result of the comprehensive site assessment should be sufficiently utilized as guide for crafting strategies, as well as realistic targets.

A large part of participatory planning activity is the development of the technical guideline or plan for field rehabilitation work. There have been several published technical guidelines that can be used. These include:

- In the Philippines. Primavera JH, Savaris JD, Bajoyo B, Coching JD, Curnick DJ, GolbequeR, Guzman AT, Henderin JQ, Joven RV, Loma RA &KoldeweyHJ (2012). Manual on community-based mangrove rehabilitation. Mangrove Manual Series No. 1. London, UK: ZSL. viii+ 240 p.
- In China. Liao et al., 2005. Advance in researches on rehabilitation technique of mangrove wetlands, Ecological Science, 24(1): 61～65 (in Chinese)

The following are the significant components of technical mangrove rehabilitation guidelines:

a. Site selection
   Mangrove planting should only be done within the middle to upper intertidal zones of the coastal area. These zones are the tidal levels where mangroves naturally grow and thrive. Moreover, original mangrove sites (including those that are abandoned fishponds) should be the target of rehabilitation, and not on any areas with unique ecosystem such as seagrass beds.

b. Nursery Management

   The size, cost and location of nursery depend on the number of planting materials that need to be produced to complete the rehabilitation target, foreseen expenses in maintaining nursery operations, and the proposed site's tidal exposure, respectively. A nursery should be established in a strategically located area that is in proximity with the seed or wildling source, sheltered from waves, relatively flat ground, under the shade of tall trees, and easily accessible to nursery workers.

   Before collection of planting materials (e.g. propagules, seeds or wildings) planning for fieldwork is critical. This mainly includes scheduling fieldwork based on tidal schedule and preparations of collection bags. Short training on how and what (species, maturity/age) of planting materials to be collected is also important to ensure the health and viability.

   Seedlings are thereby grown in the nursery using appropriate silvicultural techniques. Tending of seedling largely includes watering, cleaning, and hardening-off (exposure to full sunlight) to ensure vigour.

   Seedling transport may be needed if planting site is far. If to be transported, proper packaging is needed to avoid seedling from getting shocked during travel, which might result in mortality when planted.

c. Outplanting
Outplanting generally involves 1) selection of appropriate species to be planted; deciding on the desired planting design or density (number of seedling per unit area); planting based on tidal schedule; and adoption of appropriate planting techniques for each species.

d. Site maintenance
This involves regular monitoring that could be undertaken by the local community or PO partner(s). Key activities include removal of algae and barnacles on seedlings, replacement planting of mortalities, the establishment of wave barriers such as rock walls, bamboo fence, to name a few.

e. Field monitoring
Regular monitoring is essential to check if the rehabilitation objectives are met. Through simple ocular inspections, measurement of height, and counting of survival, silvicultural interventions can be determined to address observed problems. If the site is too large, sampling can be done by establishing small plots (which are the best representative of the site's condition).

iv. Participatory Project Implementation

There are no specific guidelines on how plans should be executed. However, ideally, project implementation should pursue the following, on top of the field planting activities.

a. Forging agreements with partner government and academic institutions.
This involves a series of meetings with key local government officials/officers to convey the key issues and justifications for pursuing mangrove rehabilitation, clarification of tenure/property rights over mangrove forest, and thus making it clear that such issue is within the government's concern. Eventually, an agreement (e.g. Memorandum of Agreement or resolution) with essential stakeholders (mainly local community) should be sought to ensure provisions of sustained support or commitment to rehabilitation.

Likewise, academic institutions are tapped as partners in conducting researches. Scientific findings generated from their researches can help improve rehabilitation work and ultimately the management systems. In addition, academe can contribute to information and education campaign (IEC).

b. Community organization and strengthening.
COs immersed themselves in the partner local community in order to gain an in-depth understanding of the local needs, problems, strengths and opportunities. Once COs have a thorough feel of these aspects, they conduct capacity building activities such as leadership training, People's Organization formation, livelihood training, to name a few. One of the primary goals of these activities is to increase local awareness/knowledge about the importance of mangrove conservation, and how such endeavor will uplift their general well-being. Cross-site visits provided to local communities to witness other successfully managed sites (e.g. income-generating mangrove eco-park) is vital in raising interests and morale that they can also succeed in their rehabilitation efforts. Further, hands-on training on mangrove ecology assessment, nursery management, site monitoring can be given to equipping local community partners with the technical knowledge of mangrove rehabilitation.

Establishment or strengthening of a formal People's Organization or PO (duly registered by the government) is also an important output of community organizing.

This gives the local community a legal identity to partner with local government and other organizations in pursuing mangrove rehabilitation projects.

c. Community mobilization
To translate local capacities into practice, the PO should be mobilized in conducting their project planning, implementation and monitoring & evaluation. In some cases, POs are tapped as partners in mangrove planting projects of the government other than their own. This, therefore, provides additional income source.

Other likely opportunities include providing assistance and venue for interested organizations (such as schools) in conducting mangrove tree planting activities, hence another income or livelihood source. This will likewise promote or advertise their success story.

In some cases, well-rehabilitated mangroves provide the local community the necessary condition to set-up their ecotourism enterprise. Pursuing this is very much encouraged by the government since it is compatible with the strict protection policies that are being enforced.

d. Mainstreaming rehabilitation strategies
Memoranda, partnerships and other forms of agreements on mangrove rehabilitation should be further elevated into local government resolutions or ordinances. In doing so, rehabilitation will surely be included in local development plans of which funds and local community involvement are ensured.

The conduct of case studies will also help in providing information about the success and best practices of the community, of which other communities can learn from.

v. Participatory Monitoring and Evaluation

Monitoring the project's progress, vis-à-vis the satisfaction of objectives and targets is vital to elicit corrective measures to keep the project on its accomplishing pace. Furthermore, monitoring data serve as evaluation (or decision-making) reference to determine if the project is successful, should be continued, in need re-panning, or should be aborted. This information can also be translated into lessons learned that can be conveyed to other rehabilitation practitioners.

Part ii. Policies and Programs on Mangrove Rehabilitation

PHILIPPINES

The Philippines has an estimated mangrove forest of about 356,000 ha, with a recent decadal deforestation rate of only 0.5% (Gevaña et al. 2018). The main reasons for mangrove loss include: 1) conversion to aquaculture ponds; 2) reclamation for settlement and industrial development, and 3) conversion to rice paddies. This rate has declined over time because of the increasing forest conservation programs and appreciation of mangrove's ecological values (Pulhin et al. 2017). In 2014, the national government allotted one billion pesos (approximate 22.7 million USD) for the massive reforestation of coastal areas. This also entailed massive involvement of local communities in the implementation of reforestation activities. Further, the adoption of community-based forest management programs has spurred collective efforts to rehabilitate other degraded coastal environment.

Despite the increasing appreciation of the need for mangrove rehabilitation, there remain some policy concerns constraining the sustainable implementation of mangrove rehabilitation. Results of the consultations with various government and non-government agencies underscored the following important information to understand these policy concerns better.

i. Key Policies and Programs

Presidential Decree No. 705 of 1975 or the *Revised Forestry Code of the Philippines* provides the basis for determining the appropriate forest management systems in the country. This policy defines *mangrove* as a type of forest that thrives on tidal flats and seacoast and those that extends through streams where the water is brackish. Section 16 of this policy provides that the state owns mangrove stands of at least 20 meters wide hence they cannot be privately possessed. However, Section 13 placed an exemption on mangrove stands that are not needed for shore protection and allowed them to be converted to aquaculture ponds. The ensuing massive conversion of mangrove areas to fish ponds has led tremendous loss in mangrove cover.
For this reason, the government passed policies to protect the remaining mangrove cover seriously. These include Republic Act (RA) 7161 or an *Act of Incorporating Certain Sections of the National Revenue Code* in 1991, (RA) 7586 or *National Integrated Protected Areas System Act* (NIPAS) of 1992, and (RA) 8550or *The Philippine Fisheries Code of 1998*. Under Section 71 of RA 7161, the government bans commercial cutting for all mangrove species. Moreover, Section 2 of RA 7586 had further placed mangrove as the first component in the list of protected areas. Hence land-use conversion was not allowed. Lastly, Section 94 of RA 8550 stipulates that abandoned fishponds (previously mangrove areas) shall be reverted to mangrove stands through reforestation.

The focus of mangrove management policies and programs over the past four decades is protection and rehabilitation. Recognizing the vital role of local communities in pursuing this direction, the Department of Environment and Natural Resources (DENR) has placed several implementing rules and regulations to effectuate these mangrove policies. These include the following:

- DENR Administrative Order (DAO) 76 (1987): Local communities and fishpond leasers are required to establish mangrove buffer zones of a) 50 meters fronting seas and oceans; and b) 20 meters along riverbanks.
- DAO 34 (1987): Guidelines on Environmental Clearance Certificate (a strict permitting system that applies to fishpond development over mangrove areas);
- DAO 123 (1989): Local mangrove planters are awarded 25-year tenure through the *Community Forestry Management Agreement (CBFMA). H*ence domestic mangrove use, establishment of *Rhizophora* and *Nypa* plantation, and quasi-silviculture are allowed; and
- DAO 15 (1990): a) Mangrove Stewardship Contracts (similar to DAO 123) are given to local communities and fishpond leasers, stipulating therein all the rights, roles and responsibilities to conserve mangrove resources; b) abandoned fishpond are required to be reverted to mangrove forest through reforestation, c) ban tree cuttings in fishpond leased areas; and d) prohibit conversion of thickly vegetative areas.

The Department of Environment and Natural Resources - Forest Management Bureau (DENR-EMB) is the primary agency responsible for the management of the country's forest resources. Non-government organisations on the other hand, served as partners in rehabilitation efforts. For instance, the *Zoological Society of London* (*ZSL*) in 2007 started its mangrove rehabilitation work through the Community-based Mangrove Rehabilitation Project (CMRP), to increase coastal protection, food resources and diversifying livelihood options through community empowerment. Promoting science-based methods is one of the main

thrusts of ZSL. To date, ZSL-led projects in the Philippines have rehabilitated and protected over 100 hectares of abandoned fishpond mangroves (https://www.zsl.org/conservation/regions/asia/rehabilitating-mangroves-in-the-philippines)

Furthermore, Executive Order No. 263 or the *Community Based Forest Management* ensures social equity and the sustainable development of the country's forest resources. Thus far, the **DENR** as of 2017 is continuously pushing for the periodic planting of **mangroves** and is targeting to cover more than 50,000 hectares of swamps, especially in areas frequently hit by typhoons with a budget of roughly Php50,000 per hectare as part of the **National Greening Program (**http://maritimereview.ph/2017/11/22/mangrove-forests-in-the-philippines/**)**

The government is also providing various incentives to CBFM participants in its upland sites such as security of tenure and exemption from forest charges for harvesting forest crops. However, in the case of mangrove CBFM participants and other forest developers, they cannot avail of these incentives because of the prohibitions stated in the Philippine Republic Act RA 7161 which bans the cutting of all mangrove species. Many drivers of mangrove forest loss operate over large scales and are most effectively addressed by policy interventions. Unfortunately, conflicting or unclear policy objectives exist at multiple tiers of government, thereby resulting in contradictory management decisions (Friess*et. al.*, 2016).

There are numerous national mangrove-related laws/policies and some of these are listed below:

- Presidential Decree No. 705 of 1975 – The Forestry Reform Code of the Philippines
- Presidential Decree No. 953 of 1976 - Requiring the Planting of Trees in Certain Places and Penalizing Unauthorized Cutting, Destruction, Damaging and Injuring of Certain Trees, Plants and Vegetation
- Proclamation No. 2152 of 1981 – Declaration of Palawan province and parts of the public domain as Mangrove Swamp Forest Reserves
- DENR Administrative Order No. 77 of 1990 – Revised Regulations Implementing the Integrated Social Forestry Program
- DENR Administrative Order No. 15 of 1990 – Regulations Governing the Utilization, Development and Management of Mangroves Resources
- DENR Administrative Order No. 03 of 1991 – Policy and Guidelines for the Award and Administration of the Mangrove Stewardship Agreement
- DENR Administrative Order No. 23 of 1993 – Forest Land Management Program
- DENR Administrative Order No. 30 of 1994 – Implementing Guidelines for Non-Government Organization Assisted Community-Based Mangrove Forest Management (NGO-Assisted CBMFM) for the DENR.
- Letter of Instruction 917 – Declaration of Mangrove Forests as Wilderness Areas
- Republic Act No. 7661 – Strategic Environmental Plan (SEP) for Palawan Act
- Republic Act No.7586 – National Integrated Protected Area System Act of 1992
- Administrative Order No. 363 – Prescribing Guidelines for the Protection of Areas Non-negotiable for Conversion and Monitoring Compliance with Sec. 20 of the Local Government Code
- Administrative Order No. 270 – Rules and Regulations Implementing the Local Government Code of 1991
- Republic Act No. 8550 – The Philippine Fisheries Code of 1998
- Executive Order No. 192 – Reorganization Act of the Department of Environment and Natural Resources.
- Republic Act No. 8371 Chap. VIII Sec. 58. The Indigenous People Rights Act – Environmental Consideration

The DENR (2013) through the Protected Area and Wildlife Management Bureau -Coastal and Marine Management Office (PAWB-CMMO) and the Integrated Coastal Resources

Management Project (ICRMP) drafted the following administrative orders namely: (1) Draft JAO: "Guidelines on the Reversion of Abandoned, Undeveloped and Underutilized Fishponds under Fishpond Lease Agreements to the Department of Environment and Natural Resources through the National Convergence Approach"; (2) Draft DAO: "Cancellation of Illegally Titled Fishponds and Illegally Constructed Fishponds in Classified Forestland and Reclassification of Intact Mangrove Forest in Classified Alienable and Disposable Land"; and (3) Draft DAO: "Special Agreement for Mangrove Area Development as a Legal Instrument for the Development and Management of Mangrove Areas Including Beach Areas and Foreshore Areas under the Administrative Jurisdiction of the Department of Environment and Natural Resources". These administrative orders will address the urgency of restoring, developing, protecting, maintaining and managing mangrove resources in light of the current problems on food security, environmental stability, social development and economic growth in coastal communities. As of the present, all these policies remain on-hold.

Although numerous laws and administrative orders had been passed to protect and manage mangrove forests, none was explicitly made for rehabilitation. As such, there is a need for harmonized mangrove policies and institutions to help promote effective sustainable development, management and rehabilitation of mangrove forest areas in the country.

ii. Policy Consultation Insights

- ***Science-based process in the selection of appropriate species for a given location.*** Area suitability is seen as one of the reasons why seedlings do not survive. Generally, only a 30% survival rate was observed. Thus, planting the appropriate species for a certain location must always be taken into account. *Bakhawan*or *Rhizophora spp.* is usually planted because of its availability and ease of planting. However, such species are not adapted in open or seaward areas which are more exposed to typhoons and storm surges. In short, wrong species were planted in the wrong place thereby resulting in high plant mortality. Planting of native species (endemic) was seen to be more productive. Propagules coming from native species should be used as planting materials due to their territorial characteristics.

  Moreover, majority of rehabilitation projects are target driven in terms of number and areas, while timeframe did not also consider the tidal and seasonal schedules. Negligence in considering the species, timing and locations were the primary reasons for 80-90% plant mortality. Low survival rate was also due to the infestation of barnacles, algal proliferation, coastal erosion, human activities like boating, and the people's lack of concern in caring for the mangroves. Thus, concerned agencies like the DENR should consider establishment of nurseries with diverse species within the planting site as its primary concern in mangrove rehabilitation projects. This is to prevent casualties during transport and for easy replanting. Selection of fast-growing species is also of advantage. In addition, site preparation and assessment must also be given attention (e.g. soil testing) as well as the scheme and time of planting.

- ***Social preparation among POs and stakeholders***. The POs and other stakeholders play a vital role in the success of rehabilitation projects, especially in upland areas. This was the case in Katunggan Ecopark which was established in 2012 through the joint participation of schools, organizations, and LGU. Stakeholders' participation is very critical in field implementation. POs on the ground can police mangrove protected areas and serve as social fencing. Preparing the people encourages them to care for the mangrove. Everyone must have a contribution and should function in mangrove forest rehabilitation and its protection.

- ***Revisit mangrove policies and employ strict management and enforcement of policies.*** There is a need to amend some policies that are already obsolete like PD705 where penalties for violators only amount to 1,000 pesos. There are issues regarding conflicts of interest about government projects as well as on cancellation and reversion process. For instance, mangroves were cut down due to the establishment of infrastructure. Reversion of abandoned fishponds into mangrove is not clear and not well implemented. The Bureau of Fisheries and Aquatic Resources (BFAR) has programs for the development of sites for aqua-silviculture. Aqua-silviculture has its share of negative consequences to mangroves particularly if it is not properly maintained. There is a need to designate production area and protection for sustainability.

- ***Close collaboration and linkages among stakeholders and institution are encouraged.*** For instance, partnership and coordination between BFAR, DENR, Academe and LGU's should be strengthened to avoid overlapping of projects. Genuine convergence among agencies is the pillar of success in any rehabilitation efforts. Policies on reversion should be revisited and establishment of a functional technical working group is encouraged. A unified target must also be agreed upon. For instance, if mangroves are the main focus, harmonization among BFAR and DENR projects must be taken into account. In FLA, LGU's do not have a role. Only BFAR and DENR have their share of responsibilities. Also, there is no database of FLA in the LGU. They are not fully aware of their FLA ownerships because leaseholders often act as private owners. Thus, it is recommended that a signboard must be procured indicating the FLA number, date, area, etc.

  Moreover, in the DENR, it is not clear whether FMB or BMB will be in charge of mangroves. The natural presence of mangroves in a specific area is a requirement for FLA application, but people commonly plant mangroves to gain approval. Even though the FLA 161-1 provisions were clearly stated, misinterpretations still arise from them. Thus, there is a need to enhance IEC campaign. For LGUs concern, tax which is viewed as revenue must be collected from using the land owned by the LGU, but the lessees instead apply for a real property tax which is illegal. Prior to the year 1972, FLA were given titles. Titles beyond such year are considered null and void, so they apply them for RPT. Thus, concerned stakeholders like BFAR, DENR and LGUs must sit down and settle the arising issues in the field to avoid conflicts. Commitment among the academe and POs must also be encouraged in order to gain sustainability among projects.

- ***A natural calamity such as typhoon sparks interests to plant mangroves as storm buffers.*** Typhoon Yolanda devastated about ninety per cent (90%) of the houses in Ajuy, Iloilo. Because of such havoc, more stakeholders became involved in community mangrove rehabilitation initiatives. Such circumstances also gave way to employment and income opportunities from house construction and seedling production respectively.

- ***Communication networks and monitoring system facilities should be in place.*** The standard monitoring plan is also critical in the success of mangrove rehabilitation. To some, the number of propagules planted and not the survival is the only indicator of success. Monitoring after planting must be heightened and an external/third party monitoring and evaluation are recommended.

- ***Ensure sustainability among FLAs and technical personnel.*** To date, there is a limited number of FLAs and technical personnel. There is no regular staff and only contract job workers assigned in reversion or rehabilitation of mangroves areas. There is a need to secure sustainability of networks among different institutions and protocols or guidelines should be developed. Changes in positions and leadership affect the sustainability of rehabilitation efforts. Also, the lack of *plantilla* (permanent job in the government) for a regular staff was a challenge for BFAR. The hiring of contract job workers is not a

sustainable mechanism in mangrove rehabilitation. Having *plantilla* for staff with technical capacity is encouraged.

- ***Security of tenur***e. A PO is present in the community, but there is no tenure (CBFM). The absence of tenure can lead to illegal cutting. Informal settlers also cut mangroves. Securing tenure can help in mangrove rehabilitation because it strengthens the commitment of the PO.

- ***Improvement of IEC materials or methods is encouraged*.** Perceived low awareness about mangroves and their values is a significant problem why rehabilitation fails. Information, education and communication (IEC) should be strengthened of which NGOs, schools, media, local government, DENR and BFAR should collaborate. Many suggest the further establishment of mangrove ecotourism sites as means for increasing awareness on the importance of mangroves.

- ***Proper allocation of regular budget for mangrove rehabilitation.*** To ensure sustainability in the management of mangrove areas, allocation and timely release of regular funds are critical.

- ***Integration of non-mangrove livelihood programs.*** The community was hesitant in planting mangroves because of the no cutting law; hence, other projects and other livelihood sources must be put in place in order to persuade them. Lapu-lapu (grouper fish) rearing and seaweed farming were among their sources of income.

- ***Aside from being science-based, political will and sense of volunteerism are other factors to consider in the success of mangrove rehabilitation***. As mentioned by Dr Primavera, paid to plant is a perverse subsidy. Proper care and monitoring are not usually done after planting. Others kill their plants in order to gain more income. Hence, paid planting encourages mortality. The survival rate is not taken into account. Success is not only determined by the amount of dispersed budget but by the amount of volunteerism and passion of the people. A BFAR representative witnessed such commitment, stating that not all communities plant for the sake of the budget or the target.

- ***Continued research and development, as well as national policy consultation, must be pursued***. One of the avenues for research and development is through national policy consultation. This would take into account the various perspectives of agencies involved in mangrove rehabilitation. The academe could play a vital role in making such policy consultation possible.

- ***Tracking progress.*** Setting up a mangrove rehabilitation database system is needed to track efforts around the country, share lessons, identify research gaps, and provide the basis in calibrating policies and plans for future mangrove management.

MYANMAR

Mangrove forests are of the fundamental natural resources found in coastlines throughout tropical and subtropical regions of the world. In Myanmar, mangroves occur extensively in three geographical regions, namely, Taninthayi Division, Rakhine State and Ayeyarwaddy Delta. Along the 14708 km-long coastlines of the country, these mangrove forests serve as the link between inland and marine ecosystems.

According to the FRA 2015, Myanmar defines “Forest” as “Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 per cent or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use.” Mangrove is one of the major forest types in Myanmar. Reporting mangrove cover was included since FRA 2015.

The area of mangrove of Myanmar stands Seventh/Eighth largest extent of mangroves worldwide and third in the ASEAN Region (World mangrove atlas, 2010: Toe, 2017). Mangroves in Myanmar cover an area of 502,911 hectares (1,242,190 acres) along 2832 km coastline. There are about 34 true mangrove species and 148 true plus associate mangrove species (Toe, 2017).

Of the total Myanmar primary mangroves, the majority is located in Ayeyarwady flood plains, with the remainder in Tanintharyi and a lesser portion in the Rakhine area. Species distributions and compositions of mangroves differ amongst the three coastal regions. Along the 14,708 km-long coastlines of the country, these mangrove forests serve as the link between inland and marine ecosystems.

Mangroves along the Myanmar coast are of immediate value to local people, particularly as firewood and charcoal for cooking, timber for construction and as productive habitat for fisheries. A positive correlation between fish and shrimp catches in nearshore waters and the extent of mangrove area has been widely proven. Artisanal fisheries along the Myanmar coast are largely mangrove dependent. Mangrove forest ecosystems contribute a wide range of goods and services from which local people have benefited since time immemorial. There is a wide range of direct and indirect products from mangrove, which forms the basis for mangrove dependent economic activities vital to many coastal peoples in Myanmar.

Along with high dependence on mangroves for subsistence and livelihoods, unsustainable exploitation has led to the forest cover depletion. Deforestation was at an alarming rate in the past three two decades due to various reasons. The forest cover change data for the years 2000 – 2015 indicate accelerating rates of deforestation over the last 10-15 years while the rates of opening up forests (a proxy for forest degradation in Myanmar) are changing from very high rates during the early 2000s to lower but still considerable change rates in recent years. The overall forest loss calculated for the 15-year period of 2000 – 2015 is 1.22% annually and for the last 10 years (2005 – 2015) nearly 2% per year and positions Myanmar among the tropical countries with the highest rates of forest area loss worldwide, only behind Brazil and Indonesia (FRA, 2015).

Results of series of experts meetings and policy consultation meetings also expressed that major issues and challenges (social, natural resources and management aspects) being faced in mangrove areas of Myanmar:

- Uncontrolled and increased population growth
- Inadequate efforts to reduce poverty of local people
- Low education and awareness, limited group activities
- Weak cooperation between immigrants and inherent local residence
- Limited technology and utilization of natural resources
- Lack of suitable land for integrated land use.
- Land-use conflicts among stakeholders (Private, CF and shrimp culture)
- Lack of proper land use policy and incentives of CFI (2016) which is the revision of CFI 1995.
- Insufficient resources of FD (Man, material, money, machine, method)
- Emphasize on agriculture & fisheries due to economic policy

There are several forest reserves with scrubby mangroves in the western regions that are heavily utilized for fuelwood and charcoal. Conversion of mangroves into human settlements and rice paddies are also a major concern over the last 20 years. Recently, mangrove areas are also being heavily converted to shrimp ponds. The Ayeyarwady Delta was the most affected area of these land-use changes because of the increasing demand for goods out of

mangrove conversion. Other relevant causes of mangrove area decline were also the large scale commercial fish and prawn farming, which were introduced in the country in 1995.

Urbanization and off-site activities also lead to degradation through siltation and changes in water temperature and flow other physical factors and salinity. The presence of existing agricultural and urban development and dykes would in many cases prevent the establishment of new mangrove areas.
Furthermore, with a scarce budget, expertise, human resources, the forestry sector faces increasing challenges.

i. Major issues and concerns in mangrove rehabilitation

- The major issues for rehabilitation are in the area of environmental uncertainty, policy, gaps in basic knowledge, monitoring issues, assessing the feasibility and the need for multi-disciplinary approaches. The issues appear to be most problematical in the developing world and this may relate to issues of economic and human capacity.

- Lack of full understanding of mangrove processes is also one of main issues in rehabilitating mangroves.

- Poor understanding of socio-economic and political factors, lack of scientific process to assess the causes of degradation and insufficient communication of results also cause mangrove rehabilitation failure.

- While the ecological and physical environment is the focus of on-ground rehabilitation activities, the role of government policy, its enforcement and involvement of communities and stakeholders is often neglected. These are of critical importance for providing legitimacy, support and commitment. Clear organizational structure to facilitate projects and provide legislative support and legitimacy for rehabilitation is also a prerequisite for better collaborative mangrove rehabilitation.

- Community involvement is critical to success. Human impacts are one of the drivers of mangrove degradation and loss, and such necessitates human inclusion in rehabilitation. Thus, rehabilitation specific issues include a need for institutional strengthening and community support; feasibility- the likelihood of economic or ecological success-and the importance of integrated approaches.

- Limited knowledge about ecological function also indicates a lack of baseline information about the rehabilitation site. This can lead to selecting sites with unsuitable hydrology, soil and/or topography or sites subject to erosion, or planting inappropriate species.

- Rehabilitation needs to be underpinned by strong, clear, implementable and enforceable policy including setting priorities and balancing interests. It is basically an issue of carefully planned integrated approach of mangrove rehabilitation which includes the immediate needs of coastal communities, based on the following priorities: a) Knowledge-based planting methods b) Public education and social mobilization of local communities c) Livelihood support to reduce economic exploitation of natural resources d) Compensation for forest harvests in the form of alternative sustainable energy for people's daily needs e) Implementation practices based on long term sustainable goals.

- Integration of the local community in the restoration process is paramount in order to prevent destruction due to sheer poverty. This includes practical efforts to introduce

fuel savings stoves and other renewable energy sources and create new livelihood opportunities.

ii. Best practices and strategies for mangrove rehabilitation

a. ***Integrated Coastal Management (ICM).***The Myanmar National Strategy and Action Plan of mangroves outline Integrated Coastal Management as the overarching strategy for the sustainable management and rehabilitation of mangrove ecosystems in Myanmar. Integrated coastal management (ICM) is widely accepted throughout the world as the best approach to dealing with coastal issues. ICM is guided by the Rio Principles with special emphasis on the principle of intergenerational equity, the precautionary principle and the polluter pay principle (Cicin-Sain & Knecht, 1998). ICM is an adaptive, multi-sectoral governance approach, which strives to balanced development, use and protection of coastal environments. Importantly, it acknowledges the interrelationships that exist among coastal and ocean uses and the environments they potentially affect, in both public and private sectors, according to an agreed-upon set or resource management policies and practices.

b. ***Community-Based Mangrove Management.*** Community-Based Mangrove Management (CBMM) is the participatory management of mangrove forests with the underlying belief that sustainable management of mangroves can be achieved by securing the well-being of the local communities dwelling around the mangrove forests. CBMM is particularly crucial in areas where local communities rely on the mangrove areas for their livelihoods. CBMM also involves the notion that community participation is incentivized by knowledge of the benefits they are able to retrieve by sustainable management. CBMM is widely practised in developing countries where mangroves are an integral part of the local communities. Although there is some scepticism regarding the realization of CBMM and inevitability of the tragedy of commons, many researchers believe that CBMM leads to better management of mangroves and sustainable ecology.

c. ***Ecological Mangrove Restoration (EMR).*** Ecological restoration is defined as the process of repairing damage caused by humans to the diversity and dynamics of indigenous ecosystems. Ecological Mangrove Restoration (EMR) is a holistic approach to mangrove restoration that also includes a view of the proposed plant and animal community to be restored as part of a larger ecosystem with other ecological communities that also have functions to be protected or restored. EMR aims at the restoration of certain ecosystem traits and the replication of natural functions. It has been shown that mangrove forests around the world can self-repair or successfully undergo secondary succession over periods of 15-30 years if: 1) the normal tidal hydrology is not disrupted and 2) the availability of waterborne seeds or seedlings (propagules) of mangroves from adjacent stands is not disrupted or blocked.

   Most of the mangrove rehabilitation projects are donor-initiated projects. Previous experiences with the mangrove rehabilitation show that many rehabilitation initiatives halted when the funding is ended. Availability of sustainable funding sources is one of the major constraints in mangrove rehabilitation in the country. Therefore, it is widely suggested, Ecological Mangrove Restoration (EMR), which emphasizes natural colonization of mangrove ecosystems, is the most cost-effective way for rehabilitation. Unlike the planted mangrove forests, EMR has the potential to reintroduces the biodiversity in mangrove ecosystems.

d. ***Mangrove-based agroforestry practices (e.g. Silvo-aquaculture: fish, ponds, trees and farms).*** Mangrove ecosystems are also used for aquaculture, both as open-water estuarine mariculture (e.g. oysters and mussels) and as pond culture (mainly for shrimps). Because of its high economic return, shrimp farming has been promoted to boost the national economy and alleviate poverty in several countries. However, if unsustainably planned and managed, it can lead to uncontrolled deforestation and pollution of coastal waters, damaged or destroyed coastal ecosystems and the loss of the services and benefits provided by mangroves. Further, clearance of mangroves, and degradation of the coastal environment involved with more intensive shrimp pond-farming in the intertidal zone leads to loss of various goods and services from the coastal zone (Rönnbäck, 2001), something that impacts negatively on other people living within and from the coastal or adjacent inter-linked ecosystems (i.e. in the seascape).

e. ***Aqua-silviculture*** is a multi-purpose production system that allows the production of fish in a mangrove reforestation project. It is a mangrove-friendly aquaculture technique of producing fish in a watered area enclosed with net but does not allow cutting of mangrove trees. Crop diversification on a farm also reduces the risks from income and food loss, something that is especially important for subsistence farmers. Mangrove and nipa plantation within a fishpond was established following the Aqua-silviculture concept which is a combination of fish, ponds, trees and farms — crops planted at the dykes and surroundings. The mangrove stand at the seaward fringe was protected and mangrove and coastal organic matter used as soil conditioner and organic fertilizer for the crop production. Mixed mangrove-aquaculture systems have been sustainable for a long time (FitzGeralds, 2002); while semi- and intensive shrimp pond farming have had limited lifetime due to their environmental impacts (Kautsky et al.,2000).

iii. Key considerations in mangrove rehabilitation

Policies and laws related to the rehabilitation and management of mangrove in Myanmar

The 2008 Constitution of Myanmar is the foundation for the conservation and rehabilitation of mangroves in Myanmar. Article 45 of the constitution stipulates that "*the state shall protect the natural environment of the country"* and article 390 requires "*every citizen of the country to protect natural environment"*. In addition to the 2008 constitution, the following are the key policies and legislation related to the rehabilitation and management of mangroves in Myanmar:

- Forest Policy
- National Land Use Policy
- Environmental Conservation Policy
- Climate Change Policy
- Agricultural Policy
- Forest Law
- Forest Rules
- Environmental Conservation Law
- Environmental Conservation Rules
- Protection of Wildlife and Wild Plants, and Conservation of Natural Areas Law
- Vacant, fallow and virgin land management law
- Farm Land Law
- Farm Land Rules
- Fishery Law
- Fishery Rules

Institutional Arrangement

The National Coastal Resources Management Central Committee (NCRMCC) is chaired by the Vice President of the country and was formulated in 2016 aiming to achieve the sustainable development of the coastal areas in Myanmar. The Central Committee is the highest national body that has a mandate over mangrove ecosystems. One of the key tasks of the committee is to develop the Integrated Coastal Management (ICM) system in Myanmar. Under the policy guidelines of the committee, Ministry of Natural Resources and Environmental Conservation (MONREC) is the main government organization for the management and rehabilitation of mangrove ecosystems in Myanmar. Under the MONREC, Forest Department is concerned with the day to day management of mangrove ecosystems and is responsible to implement the policies and legislation set out by the MONREC. The following is the organizational structure of the Forest Department.

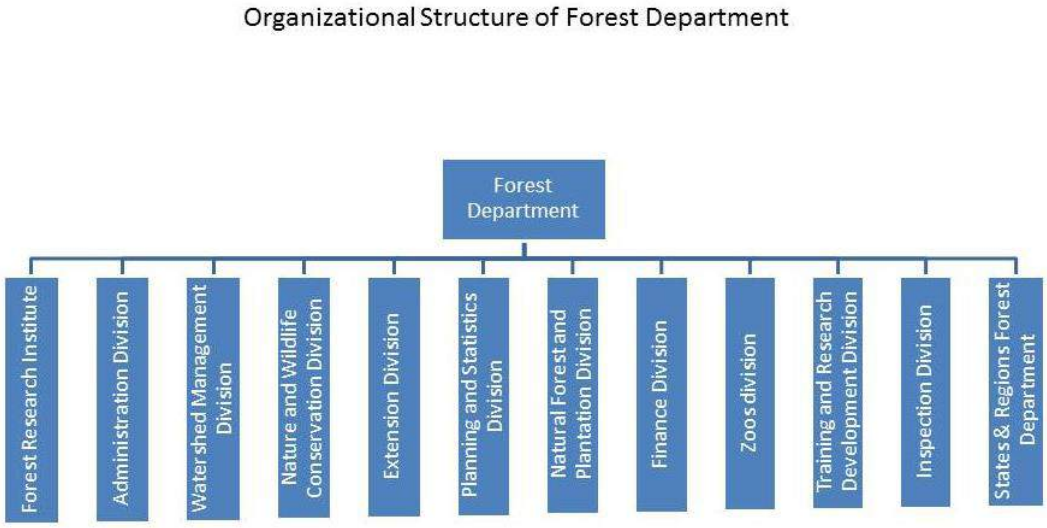

Figure 3. Organizational Structure of the Forest Department

Scientific and Ecological Preferences for Mangrove Rehabilitation

As discussed in the above section, it is widely suggested that Ecological Mangrove Rehabilitation (EMR) should be the key mangrove rehabilitation strategy. Given the lack of financial resources and sustainable financing scheme for mangrove rehabilitation, mangrove experts advise that natural colonization of the mangrove areas are the best way to rehabilitate the degraded mangrove areas in Myanmar. An analysis of the mangrove forest cover trend in Tanintharyi Region between 1994 and 2014 found out that losses of mangrove areas were cancelled out by the natural formation of mangrove forests in new areas. It shows that there is considerable potential for natural colonization to be applied as a mangrove rehabilitation technique in Myanmar.

Participatory Approaches for Mangrove Rehabilitation

Regions and state endowed with mangrove ecosystems ecosystem do not do very well in the wealth ranking of the states and regions in the country. The Ayeyarwaddy Region, which possesses the most areas of mangrove ecosystems, is the second most populated region, after the business capital Yangon, and is among the poorest state/region in the country. Most of the population in the region also depends on mangrove ecosystems for their livelihoods. Therefore, integration of the local

communities in the mangrove rehabilitation is the paramount importance in sustainable rehabilitation of mangrove ecosystems. Community-Based Mangrove Management (CBMM) has the potential to fulfil the needs of the local communities dwelling on the mangrove ecosystems while rehabilitating the mangrove forests.

Ways Forward

- The Integrated Coastal Management (ICM) should be adopted as an overarching strategy for the sustainable management and rehabilitation of mangrove ecosystems in Myanmar
- In rehabilitating mangrove ecosystems, Ecological Mangrove Restoration (EMR) approach should be utilized
- Community participation is the key to the successful management and rehabilitation of mangrove ecosystems. In this regard, Community Based Mangrove Management (CBMM) should be employed as a tool to achieve the active participation of local communities in mangrove rehabilitation.
  Moreover, it is recommended that the government should take the following policy initiatives to ensure the effective protection of existing mangroves and to restore mangrove ecosystems:
- Government policies should focus on the rate of successes rather than the number of plants that have been planted
- Forest reservation in mangrove area should be accelerated
- Provision of alternative energy in Mangrove dwelling communities
- Fuelwood demanding industries such as brick-making, fish crackers and prawn etc. should establish their own fuelwood plantation to reduce pressures on remaining natural mangrove forests
- Formulation of regional development plans that will ensure sustainable land uses and protect mangrove forests
- Urbanization in the Mangrove area should be prohibited
- Demonstration plots in mangrove areas should be established to educate the local communities for the importance of mangrove ecosystems and to provide livelihood options for the local communities
- Establishment of a network of Mangrove Protected Areas within the country

OTHER COLLABORATING COUNTRIES

i. India

Policy/Program Background

Restoration of mangroves is at the forefront of global environment-development agenda for multiple benefits accompanying it: climate change mitigation and adaptation, disaster risk reduction, sustainable livelihoods of the poorest of the poor, food security, detoxification, ecotourism, bioprospecting and conservation of an ecosystem with unique biodiversity, high productivity and high fragility confined to tropical and subtropical region of the planet. With rampant deforestation in the past, mangroves cover hardly 0.4% of the global forest area at present. South Asia shares 6.8% of global mangrove area (150,000 km2), with India alone sharing 46% of it (Spalding et al. 2010).

The Sundarbans of India has one of the largest mangrove forests in the world of colonized by the Royal Bengal Tigers. The Mangrove area of India has 4921 sq. km, occupying 3.2% of global mangrove forests. It can be broadly classified into three regions based on the geomorphological features influencing vegetation structure and ecosystem processes: (i) deltaic region where huge amounts of sediments are deposited by the glacier-fed rivers traversing through highly dissected and geologically young Himalayas in the north-east (the

state of West Bengal) and by the rainfed ones traversing through a less dissected and old terrain of peninsular India in the south-east (the states of Orissa, Andhra Pradesh and Tamil Nadu) and salinity is relatively low because of massive freshwater inflow to the sea; (ii) estuarine and backwater region bordering the more stable Western Ghats and thus much lower sediment deposition, freshwater inflow and thereby high salinity (states of Kerala and Karnataka; and (iii) insular region of Andaman and Nicobar Islands (Union Territory of Andaman and Nicobar Islands).

India is the third richest country for mangrove biodiversity in the world, after Indonesia and Australia (Ragavan 2016). Bhitarkanika is considered as the "mangrove genetic paradise" in the world, and associated with the largest population of birds and crocodiles (e.g., albino crocodiles). Additional natural treasures along mangroves in India are: (i) world's largest nesting site for the Olive Ridley turtle in Gahirmatha coast of Odisha; (ii) seagrass meadows associated with the sea cow (Dugong); (iii) coral reefs associated with most beautiful ornamental fishes; and (iv) intertidal mudflats crowded with the migratory and residential birds, of about 2 million, belonging to 200 species (Kathiresan and Qasim 2005). Mangroves are worshipped in several places around the world. In Chidambaram of Tamil Nadu, there is a temple for mangroves, where mangrove species *Excoecariaagallocha* has been worshipped for the last 17 centuries (Kathiresan et al. 2001; Kathiresan and Qasim 2005)

In general, mangroves on the east coast cover large areas, show luxuriant growth and have high species richness as compared to those on the west coast. Across the region, mangrove tree height rarely exceeds 15 m, clean bole 3 m and crown density 80% arising largely from a unitary canopy. Further mangrove species are rarely highly palatable. Tree species like *Rhizophoramucronata* and *R.apicuata* start flowering and fruiting after 4-5 years. Profuse propagule production is a common feature of most mangroves but advance regeneration and coppicing are uncommon.

Enormous variation exists within a region, with charismatic and high profile tiger confined to only Sundarbans in the state of West Bengal, ancient forest tribe Shoempens and nest swiftlet bird only to the Andamans, extremely rich bird fauna to Bhitarkanika in Orissa and cooperative paddy farming below sea level in Kuttanad area of Kerala (a GIAHS site). Sundarbans in the east coast covers 40% of total mangrove forests of the country, while Andaman and Nicobar islands harbour all mangrove species even though it covers around 20% of the country's mangrove forests.

Present status of mangroves

All mangrove species are threatened (ENVIS, 2002). Most of the mangroves are state or private lands, with usufruct rights of people in the former. Private ownership is most pronounced in the state of Kerala on the west coast. Rampant extraction of industrial raw material continued until the 1970s when policies recognized the satisfaction of basic needs of local people and global ecological benefits from mangroves more important than revenue earning by supplying raw material to the industries.

Local communities have a rich knowledge of species uses distribution and passive restoration. People did convert mangroves in the past but this conversion was limited to meet essential food and living needs. Traditional forest management was distinguished by small-scale disturbances like the collection of deadwood, drift biomass, lopping and single tree harvesting for house construction, boat making, and other subsistence needs unlike intense disturbances of commercial logging set out by modern forestry or large-scale conversions driven by policies tending to increase revenue from developed land. Local people use *Rhizophora mucronata* wood for handicrafts, *Sonneratia alba*/*S. apetala* foliage as fodder, *Derris trifoliat*a like bamboo and *Kandeliacandel*fruits as low-quality food and high-quality crab feed. *Excoecariaagallocha* latex is considered injurious to eyes but its roots are utilized as cork. People prefer to use drifted deadwood/debris of mangrove forests deposited on river banks as fuelwood. Unlike

Myanmar, extensive planting and use of *Nypa fruiticans* are lacking in the Indian region. Commercial cultivation of betel leaf is an indigenous innovation confined to some communities, while low livestock productivity is a common feature across the region.

People are aware of the indirect benefits derived from mangroves in terms of providing protection from surges and storms, providing breeding/protection sites to economic fish, prawns, and crabs, increasing returns to labor in collection of economic species, reducing ingression of saline water/sediment in inland aquaculture ponds, paddy fields, and settlements, maintaining high populations of beneficial organisms like honey bee and crop pollinators and checking crop pests. They do not understand the role of mangroves in detoxification and carbon sequestration. Cultural values have contributed to the strict protection of mangrove forests manifested in the designation of some patches as sacred forests and a top carnivore or ecologically keystone species like tiger believed to be the preferred carrier of the goddess (Untawale et al. 2003).

All settlements in Sundarbans have earthen embankments. The villages could be classified as the ones, (i) with a belt of mangrove bordering riverfront/embankment, e.g., Chandmari, Ramganga, Patharpratima; and (ii) with isolated mangrove patches (e.g. Kumarimarii, the latter damaged more severely by catastrophic events like Aila in 2009). People understand multiple benefits from mangroves and their natural regeneration at no cost to them opposed to the sole benefit of blocking flood water by embankments which cannot be reconstructed only with external support (4).

Figure 4. People understand the multiple benefits from mangroves and the sole benefit of blocking flood water by embankments

Like in most countries of Southeast Asia, mangrove deforestation in India is anthropogenic by cause. Table 1 summarizes the key drivers of mangroves, as well as the potential strategies to reverse them.

Table 1. Major causes of forest degradation and possible strategies to address mangrove loss in India

Major causes of forest loss and degradation	**Possible strategies to reduce loss**
Conversion to agriculture	Supply of imported food grains at subsidized price; guaranteed employment in government works; ecological intensification; Forest Conservation Act 1980
Conversion to urban development	Forest Conservation Act 1980

Conversion to shrimp farms	Forest Conservation Act 1980
Overharvesting	Legal Protection, Tiger Reserve, National Park, Biosphere Reserve, preparation of Working Plans; promotion of alternatives to forest products, e.g., cooking gas, cement-concrete-iron sheet based houses, modern medicine; promotion of forest based sources of income, e.g., honey production and ecotourism; awareness, education and non-forest based livelihoods; restoration of degraded forests
Urban pollution	Enforcing zero discharge levels
Mining and salt pans	Landscape management plans; Compensatory Afforestation Management and Planning Authority
Siltation	Landscape management plans
Top dying	Reduce pollution
Storms	Minimizing disturbances/reforestation

Mangrove Forest Management

Forest Management and Community have always played a significant part in the protection and conservation of mangroves. The utilization of forests was overseen beneath a common property administration but its possession and ownership were generally restricted to the administering rulers and the consent for the exploitation of forest assets were generally granted by the King (Iftekhar 2004). Natural forests were mainly explored for the provisioning services (e.g., wood). Conversely, in India due to geographical location, mangrove forests were largely intact and were not subject to over-exploitation.

There were legal and regulatory institutions have been set up for the protection of mangroves in India. For example, the mangroves which are located near a notified forest area are covered under the Forest Conservation Act of 1980. This act theorized the judicial use of resources where the National Forest Policy of 1988 encouraged community participation in management, protection, and regeneration. The need to ensure sustainable management in addition to conservation was realized between the period 1985-1990, thus, the National Conservation Strategy and Policy Statement on Environment and Development (1992), National Forest Policy and National Wildlife Action Plan which highlights the importance of conservation and sustainable use of mangroves through various mechanisms.

Currently, India focuses on a combination of legislative conservation as well as sustainable exploitation through cooperative management (Das Gupta 2013). It was after the Ramsar Convention, where conservation and sustainable use of wetlands and mangroves were under surveillance for deforestation. India formulated a comprehensive plan and committees such as the National Mangrove Committee, an advisory body to promote scientific assessment and evaluation of mangrove habitats. In addition, realizing the importance of marine ecosystems, such as mangrove, the Government of India designated special Marine and Coastal Protected Areas. Marine ecosystems in Islands are considered as Category II (MoEF 2008). The role of these areas is to preserve biodiversity, genetic diversity, 10 conserving and maintaining the ecological process. The other legislative initiative is through coastal zoning for effective management in order to restrict coastal urbanization through setting up of Coastal Regulation Zone. All the Indian mangroves receive legal protection under the Environment Protection Act and are responsible for regulating activities that may affect mangrove ecosystems through the setting up of Environment Impact Assessment Notification.

Restoration programmes

Restoration activities could be broadly classified into (i) passive restoration, i.e., natural regeneration which requires a reduction in dependency on mangroves, protection of the remaining intact forests dispersing propagules in the degraded sites and promoting economic activities necessitating mangrove conservation and (ii) active restoration implying interventions like planting and drainage management, the former being a less expensive process capable of restoring moderately degrade sites and the latter an expensive process needed for the intensive degraded sites.

- Honey production

  To avoid degradation of the remaining relatively intact forests, the government has notified them as reserved forests, wildlife sanctuaries and national parks and assured income to local people from the honey collection. Maintenance of rich forest and freshwater sources is a necessity of high honey production. Local people willing for honey collection have to register with the Forest Department. In Sundarbans, hosting carnivores like tiger, the Department allows movement in forests only in groups of at least 12 individuals and ensures each individual for a minimum sum of Rs 35000. Further, the honey collection is allowed only during April-May.

The Forest Department also supports interventions outside mangroves viz., planting trees around roadsides, embankments and village common lands creating opportunities of comb formation outside mangroves coupled with the availability of subsistence products. Incentives for vegetable crops in private farmland have also favoured high honey production.

Promotion of alternatives to mangroves

Utilization of mangrove biomass has been reduced by promoting alternatives like cooking gas, use of *Shorea robusta* and bamboo in boat making and stakes of jute in betel leaf garden. Apart from reducing pressure on mangroves, promotion of these products has been improving social capital and marketing skills of people.

Figure 5.*Shorearobusta* and bamboo used in boats and Jute stakes used in betel leaf gardens (all non-mangroves) transported from far off areas

Ecotourism

Ecotourism promotes conservation and restoration together with income generation by people as well as the conservation-restoration agencies. Several Eco-tourism Centres have been established at Sajnekhali, Dobanki, Netidhopani and BurirDabri in Sundarban Tiger Reserve,

and at Boniecamp (Sundarikati), Bhagabatpore Crocodile Project, Lothian Island sanctuary and Kalash beach. Mangrove trail developed by Sundarban Biosphere Reserve authorities and by Wildlife Trust of India in the Kerala state are some recent examples of the development of ecotourism. By guiding the tourists and arranging homestay facilities, people earn income from protected forests and at the same time the Forest Department earns some revenue ploughed back to conservation and restoration.

Further, the organization of Eco-development Committees, Forest Protection Committees, Women Welfare Groups and Youth welfare groups by the Forest Department promote community solidarity and enrichment of traditional knowledge. In the state of Kerala, apart from ecotourism, "health tourism" (herbal medicine practitioners prescribe stay in the clean environment around mangroves) is also expanding fast. This has led to mangrove planting by private resorts. Small uninhabited or recently abandoned islands are unique sites of tourist attraction. However, most tourist places are developed and maintained by government or private agencies and thus local communities are only indirectly benefitted from employment.

Clarity in property regime

The clarity in land ownership and usufruct rights is now considered as the essential requirement of sustainable mangrove management. Since the last 10 years or so, the Kerala Forest Department notifies an area as state forest land soon after planting mangroves (e.g., 85 ha in Thalssery).

The NGOs like the Wildlife Trust of India, Society for Environmental Education in Kerala (SEEK) and Kandal Protection Committee with social corporate responsibility support from the Apollo Tyres has started procuring degraded forest/agricultural lands (Rs 500000/ha), restoring them and making people aware of the potential benefits of mangroves since last 2-3 years (Figure 6).

Figure 6. Land procured by Wildlife Trust of India restored and developed for awareness in Kerala

In some locations in Kerala, financial support for planting mangrove from the Government is more than the cost of abandoned paddy fields which led to utilization of public funds more for creating land property than mangrove restoration.

Figure 7. Encroachment of plantations for fishery is quite common

Challenges and Best Practices

Even though there are adequate legal supports for the conservation of mangroves, it lacks in terms of effective management. Although the data from the Forest Survey of India reveals that the overall trend of mangroves is not depleting, there is a need to protect the ecosystems simultaneously. There are protected areas recurrently violated the policy and laws, due to inadequate manpower, lack of facilities, and inappropriate use of financial resources.

a. National Restoration Programme

The current restoration and rehabilitation programmes supported by the Government of India are based on the following premises:

- In the absence of positive attitudes of people, irrespective of state or common property regime, the restoration will not succeed and investment of public funds will be a wasteful expenditure.
- Community will have positive attitudes to restoration only when it enhances their livelihood and when community is party to decision making
- Being slow, expensive and uncertain process, input costs should be borne from public funds so that restoration is not a burden on people.
- Funding should be assured for at least 5 years, the minimum waiting period for any economic returns from mangrove plantation.
- A waiting period of 5 years for economic returns is too long to attract people. Entry point activities, the ones which create community assets (e.g., roads, school) would be crucial for successful restoration.
- Problem lands like saline-alkaline soil and chemically polluted areas would require higher levels of expenses than normal soil.
- Utilization of improved technologies (use of quality seeds, mycorrhiza, rhizobia, biofertilizer, vermicomposting, root trainers) will involve additional cost but will accelerate restoration and enhance local knowledge and skills,
- Four levels of hierarchy are needed for effective restoration: (i) National Level Steering Committee/National Mangrove Committee as an advisory body to the national government; (ii) State Level Monitoring Committee/State Forest Development Agency for overall guidance and linkages with other environment-development programmes in

the State; (iii) Forest Development Agency (=District Rural Development Agency) for developing plans for funding, monitoring, evaluation, training, value addition and marketing; and (iv) Joint Forest Management Committee for developing and implementing micro-plans.

- Public funds alone will not be sufficient for restoration and hence contributions from individuals, private agencies, corporate bodies and international donors should be mobilized
- Non-government organizations can help village communities to prepare micro-plans within the framework of a macro-plan designed by Forest Development Agency and approved by the Provincial/Central Government.
- Restoration should be planned as a component of sustainable landscape management and livelihood enhancement programme.
- People should be sensitized for the long term and global benefits from mangroves.
- Commercial utilization of timber and fuelwood will not lead to sustainable mangrove rehabilitation.

The survey indicated that:

- Programme implementation was such that local communities had to buy planting material from the Forest Department and thus had to plant species which were available rather than the ones they preferred
- Planting wildlings was likely to reduce time and money on nursery development.
- High-density planting (> 200-2000 plants/ha specified in the programme) was feasible because of profuse natural regeneration of mangrove species and was likely to result in the desired survival rate but was not allowed.
- There were no recommendations for silvicultural treatments and thereby poor survival and growth in many cases.
- The operational arrangements (release of funds and supply of saplings) were such that transplanting was done during the optimal period, i.e., April-June when temperature and water conditions were favourable.
- In the absence of any formal commitments from the community, in many cases, people viewed these projects as means of some income from wages rather than sustainable restoration.
- A five year period of support was too short to realize economic benefits. There was no provision for maintenance after 5 years leading to plantation degradation both because of natural and human disturbances.
- Evaluation of project success merely in terms of achievement of physical (area planted, number of saplings produced) and financial targets (fund utilization within time) rather than ecological recovery above a threshold led to repeated replanting of the same area and thus wastage of public funds.
- Awareness component was quite weak as local people were not given the opportunity of reflexive discussions with researchers and decision-makers.
- People had a fair knowledge of species suitability for plantation in low tide area, intertidal area and the area beyond tidal water reach which needs to be capitalized on and enriched with scientific studies. People considered *Acanthus ilicifolius*as a species facilitating mangrove tree regeneration. Appreciation of traditional knowledge could be an effective means of securing people's participation in restoration (Figure 8).
- Most of the plantations were monospecific and thus served the purpose of carbon sequestration and protection from storm surges and fast wind but not of maintaining high species richness.

Figure 8. *Acanthusilicifolius* was considered as a species facilitating mangrove tree regeneration

Restoration activities supported by international agencies

Over the last two decades, several restoration projects are funded by international organizations establishing direct connections with the NGOs or through national government/state government involving village communities and line agencies (Table 2).

Table 2. A selected list of restoration projects supported by international agencies

Implementing organization, funding agency and time period	***Restoration activity***
Dhagagiya Social Welfare Society with support from Save the Children; post Aila 2010	Plantation (3850 saplings/ha) on 65 ha of river bank in 5 villages; use of bamboo guard walls
Tagore Society for Rural Development with support from Felissimo Forest Foundation, Japan, ABC India Limited and Ministry of Labour, Government of India; 2016-17	Plantation (3500 saplings/ha) in 100 ha of mudflats; distribution of saplings on non-profit basis; plantation of non-mangroves to reduce pressure on mangroves
Nature Environment and Wildlife Society (NEWS) with support from the Royal Bank of Scotland; 2008--	Sustainable Livelihood and Mangrove restoration in Four Forest Finge villages of the Sundarbans Biosphere Reserve
Nature Environment and Wildlife Society (NEWS) with support from Ristic GmbH, Oberferrieden, Germany; 2017-2020	Mangrove restoration of up to 30 ha; Integrated Mangrove-Shrimp Farming/Integrated Mangrove Aquaculture (IMA) up to 9 ha farm area; wild honey (*Apisdorsata*) processing unit; community capacity building
Nature Environment and Wildlife Society (NEWS) with support from Global Nature Fund, Federal Ministry for Economic Co-operation and Development (BMZ)2017-2020	Afforestation and restoration of mangroves in 70 ha; livelihood improvement; conservation awareness and reduce dependency on natural resources; increased sharing of knowledge and good practices
Nature Environment and Wildlife Society (NEWS) with support from JSW steel limited2016-CSR	Restore the mangrove ecosystem engaging local communities along the mud-embankments of Dolvi, Mumbai; secure livelihoods of local

Implementing organization, funding agency and time period	*Restoration activity*
	communities by sustainable management, ecosystem rebuilding and conservation; increase community awareness through an interpretation center on mangroves & its biodiversity
Nature Environment and Wildlife Society (NEWS) with support fromAlnatura, Germany;	Mangrove restoration with the local communities, especially involving women; 1 ha of land at Madhusudanpur Gram Panchayat of Kakdwip Development Block, South 24 Parganas, Sundarbans
Nature Environment and Wildlife Society (NEWS) with support fromDanone Fund for Nature, Paris and later on taken up by LIVELIHOODS;	Regenerate the wetland ecosystem in the Sunderbans for protecting the age-old earthen embankments and human life and property; plantation and carbon credits for income; community participation.
Mangroves for future, UNDP-IUCN-GOI; third phase 2015-2018	Improve, share and apply knowledge to support the conservation, restoration and sustainable use of coastal ecosystems; Strengthen Integrated Coastal Management institutions and empower civil society (including local communities) to engage in decision-making and management that conserves, restores and sustainably uses coastal ecosystems; Enhance coastal governance at all levels (regional, national, provincial, district and community) to encourage integrated management programmes and investments that are ecologically and socio-economically sound, and promote human well-being and security.
Public-Private Partnership Model for Mangrove Restoration, Plantation, Conservation and Management in Gujrat with support from India Canada Environment Facility, NIKO, ADANI Industries, Pipavav Port Ltd., Gujarat Mineral Development Corporation, Bayer, Essar, Shell Hazira, AmbujaCement, GPPC, GHCL, LNG Petronet Ltd., Jaypee Cement, ABG shipyard	8000 ha
Snehakunja, Karnataka with support from Ford Foundation and Coordinated by CCD, Madurai	10 ha (4400 seedlings/ha)
Wildlife Trust of India(WTI) World Land Trust (WLT) with support from Apollo Tyres	Degraded mangrove forest and abandoned agricultural lands purchased by the NGO; nursery established, plantation done, protection provided an awareness created around Kunhimangalam village, which is one of the largest mangrove villages of Kerala,.
Society for People Education and Economic Development (SPEED) with support from IUCN/Mangrove for Future Programme, 2013-2015	Developed a model for the restoration of mangroves so as to enhance the livelihoods of fisher folks; provided supplementary livelihood training sessions for fisher women; and improved the resilience of the village to natural disasters. Karankadu, a coastal village in Ramanathapuram district, India
MANGREEN Project supported by European organization 2005-2006	Tamilnadu village severely hit by Tsunami

Source from http://naturewildlife.org

Nature of financing in these projects is quite different from the national programmes. In general external funded programmes treat mangrove restoration as a component of community development and landscape management programme.

A survey of these areas indicated the following:

- Site treatment (cleaning of old roots, solarisation and draining soil) resulted in improved survival and growth. Wildlings were successful if they had not developed aerial roots and were not infested by insects.
- Containerised planting is more expensive but less risky than naked root transplants.
- Protection from fast-flowing water, trash/pollutants and unregulated fishing can improve plantation performance.
- Marshy grasses can serve as a natural fence and safe sites of propagules.
- Providing physical support to the transplant by a twig/stake or sandbags can improve vigour.
- A larger number of species were planted (*Rhizophoramucronata*, *R. apiculata*, *Sonneratia alba*, *Avicennia marina*. *A. officinalis*, *Brugieracylindrica*, *B. sexangula*, *B. gymnorhiza*, *Kandeliakandel*, *Exocariaagallocha*) than nationally funded programmes.
- High-density planting (1-1.5 m spacing which means 4450-10000 saplings/ha) was adopted to ensure sufficient survival as well as high-quality wood/straight boles.
- Multiple methods, such aspoly pot planting, direct sowing, enrichment planting, and fishbone channel method.
- Mangrove plantations in some cases were integrated with the fishery.
- Sequential planting on the riverfront was common, i.e.., planting one or two rows of trees at 2-3-year interval rather than massive planting at a time
- Adoption of social fencing (people deciding not to disturb an area) induced passive restoration in many cases

Figure 9. The two treatments: exclusive plantation and plantation + fish production by Dagagiya Social Welfare Society in Sunderbans, West Bengal

Figure 10. Sequential plantation by Tagore Society for Rural Development in Sunderbans, West Bengal

Figure 11.Natural regeneration of mangroves

Figure 12.Plate-Plantation catalyzing natural regeneration

Figure 13.Physical fencing by Government agencies and social fencing by the NGO

Recommendations

Many researchers have shown the high economic value of ecosystem services flowing from mangroves. Examples of voluntary restoration in public or common lands are altogether lacking. The valuations of ecosystem services ignoring the species or terrain specific contributions and, by and large, based on reported rather than measured services, need to be revisited. Systematic research is needed to identify keystone species and keystone managerial actions. Both plantations and natural forests in the deltaic region suffer massive losses due to erosion by natural processes that need to be checked. The existing knowledge of deforestation, forest degradation and restoration is based largely on changes in aggregate areas which has many limitations. There is a need for long term repeated measurements in the same to gain a better understanding of land use, land cover, ecosystem services, and livelihood dynamics.

CHINA

Policy/Program Background

Mangroves in China are mainly distributed in five provinces of tropical and sub-tropical climates in China, including Guangdong Province, Guangxi Autonomous Region, Hannan Province, Fujiang Province and Zhejiang Province (Figure 14). The areas of mangroves in these five provinces account for 57.30%, 25.47%, 13.74%, 3.43% and 0.06% of the total area in China. Natural mangroves are distributed up to 27° 20‘N in Fuding County, Fujian Province while artificial mangroves are planted up to 28°25‘N in Leqing County, Zhejiang Province. The total area of mangroves in China has decreased sharply from 42,000 ha in 1950’s to 17,030 ha in 1980’s. The area has gradually recovered from 22, 025 ha in 2000 to 34, 472 ha in 2013 (Dan et al, 2016).

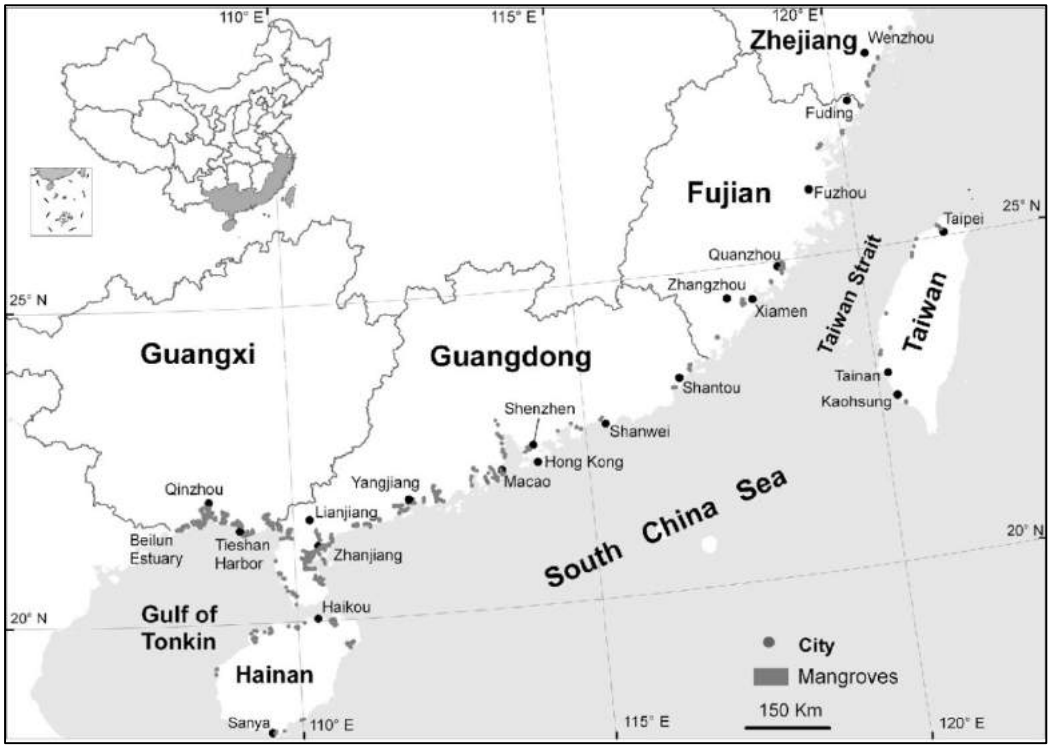

Figure 14. Distribution of mangroves along the coast of China (Source: Jia et al. 2013)

The main threats to mangroves in China are pollution, conversion to agriculture/aquaculture, reclamation for urban development and infrastructure, overfishing and exploitation, invasive species (such as *Spartinaalterniflora*, *Mikaniamicrantha*), sedimentation, illegal harvesting, man-made drainage and desertification (Dan et al, 2016). Currently, there are 26 species of true mangrove plants and 12 species of semi-mangrove plants.

Importance of mangroves in China

The importance of wetlands, including mangroves, is now widely recognized. The State Council, the central government of China, promulgated on 30 Nov 2016 "Wetland Conservation and Rehabilitation Institutional Arrangements. The Arrangements include relevant articles for mangrove rehabilitation:

- Article13: Those who converted wetlands to other uses without approval are responsible for rehabilitating the damaged wetland. Local governments are responsible for rehabilitating wetlands damaged in history or by public works and natural disasters.
- Article 14: Wetland should be restored through converting farmland/ponds back to wetland, and flooding those areas which were drained and prone to salinization.
- Article 15: Governments at all levels shall formulate plans of wetland conservation and rehabilitation works. The natural recovery shall be promoted as the main approach to wetland rehabilitation. The artificial rehabilitation shall complement natural recovery. The priority of rehabilitation works should be put on nationally and locally important wetlands whose ecological functions are severely damaged. The ecological functions and carbon storage of wetlands can be gradually restored and enhanced through cleaning up of pollution, land adjustment, geomorphological restoration, natural shoreline conservation, re-connection of river and lake systems/hydrological systems, re-vegetation, restoration of wildlife habitats, removal of man-made nets and fences, ecological relocation, control of invasive species etc.

Current management of mangrove resources

The Forestry Ministry is the government agency in charge of the management of forests in China, including mangroves forests and wetland resources. While, the Environment Protection Bureau is the office in charge of the management of environmental resources, where its main responsibility is to assess the resources and approves the creation of nature and mangrove reserves. Fishery Department is also involved in mangrove management, which closely monitors the fishery resources.

The legislative, laws and regulations in China are usually drafted by administrative organizations/agencies and then passed by the People Congress for validation. The law creation procedure usually causes disagreement among different government agencies that determine their function on their own account. Therefore, mangrove has become a cross-sector management resource.

Challenges and Best Practices

With the support of the government at all levels, nine models of mangrove rehabilitation have been tested. These models include the following (Fan et al. 2017):

- Natural recovery
- Rehabilitation of secondary forests
- Replacement of exotic species with indigenous species
- Gap planting after cleaning up dead woods caused by invasive species and natural disasters
- Reforestation on suitable areas
- Reforestation on barren areas to be improved
- Conversion ponds back to mangrove
- Ecological aquaculture to integrate both mangrove rehabilitation and shrimp farming
- Integration of mangrove rehabilitation and man-made fish reefs/platforms

Reforestation on bare beaches and integration with man-made fish reefs are very costly to implement. Other models are not costly to implement. It is important to integrate economic, social and environmental dimensions in mangrove rehabilitation. The model of ecological aquaculture is one of the examples to combine mangrove rehabilitation with shrimp farming.

Mangrove rehabilitation in China had started during the last century (Zheng et al. 2003). The earliest records of mangrove rehabilitation with seedlings from southeast Asia was made to protect coasts in 1882 and in 1932. 7 ha of *Avicennia marina* were planted for fodder in Guangxi in 1956. More than 100 ha of *Rhizophorastylosa*and several patches of *Kandeliacandel*were planted for coastal protection in Guangdong and Fujian in late 1950's. Unfortunately, there were an extensive conversion of mangroves to salt production, agriculture, and aquaculture from 1966-1979. Pioneer works of mangrove rehabilitation have been initiated from 1980 to 1990. Gap planting in nature reserves, rehabilitation of secondary forests, the introduction of *Sonneratiaapetala*from Bangladesh was been made. However, the initial results of rehabilitation were mixed. The survival rate of mangrove planting remained quite low.

Mangrove rehabilitation works, including research. have been accelerated with increasing supports of government since 1990's (Liao et al, 2005; Zheng et al. 2003). The mangrove areas in China have gradually recovered since 2000. The systematic characteristics of eight mangrove species are developed, such as their phonologies, seed collection, seed storage, nursery, and planting techniques. Among these eight species are *Sonneratiacaseolaris*（L.）Engl.,*Kandeleacandel* (L.) Druce, *Aegicerascarniculatum* Blanco., *Avicennia marina* Vierh., *Bruguieragymnorrhiza*（L.）Lamk etc. Selective cutting and gap planting of *Sonneratiaapetala*are effective techniques for rehabilitation of secondary forests. Planting

mangrove species further north in Zhejiang Province beyond the natural distribution is successful. Reforestation techniques and the selection of suitable species for polluted areas have also been developed. The provenances are identified to prepare seedlings for different parts of intertidal zones. Selection of suitable areas for mangrove rehabilitation is critical to the success of rehabilitation. The factors for land suitability include the following:

- Temperature: air 9 .8 ℃, water 10 .9 ℃
- Water salinity: <2 ‰ in summer; 15 ‰～ 20 ‰ in winter
- Sediments: particles >0 .02 mm accounts for >50 % for tall or medium mangroves; <50 % for short mangroves
- Best location: between high tide and medium tide
- Frequency and strength of waves

Land suitability of mangrove plant species in intertidal zones in China is summarized in Table 3 (Zheng et al, 2016):

Table 3. Land suitability of mangrove plant species in intertidal zones

Climate	High tide	Medium tide	Low tide
Tropical	*Bruguierasexangula, Bruguieragymnoihiza, Ceriopstagal, Excoecariaagallocha,Xylocarpusgranatum, Lumnitzeraracemose, Nypafruticans, Lumnitzeralittorea,Laguncularia racemose,Hibiscustilisceus, Pongamiapinnata, Cerberamanghas, Thespesiapopulnea, Heritieralittoralis, Barringtoniaracemose, Acrostichumaureum*	*Rhizophorastylosa, Rhizophoraapiculate, Kandeliaobovate, Scyphiphorahydrophyllacea, Sonneratiacaseolares, Sonneratiaapetala, Sonneratiahainanensis*	*Avicenniamarina, Aegicerascorniculatum, Acanthus ilicifolius*
Tropical northern margin	*Bruguieragymnoihiza,Ceriopstagal, Excoecariaagallocha, Lumnitzeraracemose, Laguncularia racemose, Thespesiapopulnea, Hibiscus tilisceus, Pongamiapinnata, Cerberamanghas, Heritieralittoralis, Acrostichumaureum*	*Rhizophorastylosa, Kandeliaobovate, Sonneratiacaseolares, Sonneratiaapetala*	*Avicennia marina. Aegicerascorniculatum, Acanthus ilicifolius*
Sub Tropical southern zone	*Bruguieragymnoihiza, Laguncularia racemose, Hibiscus tilisceus, Pongamiapinnata, Thespesiapopulnea, Cerberamanghas, Acrostichumaureum*	*Kandeliaobovate, Acanthus ilicifolius, Sonneratiaapetala*	*Avicennia marina, Aegicerascorniculatum*
Sub Tropical northern zone	*Hibiscus tilisceus*	*Kandeliaobovata*	*Aegicerascorniculatum*

Recommendations

The future strategy for mangrove rehabilitation should strengthen protection of mangrove nature reserves, rehabilitation of degraded mangroves, and afforestation of barren beaches, and provide more support for research and rehabilitation works. Future research may be focused on the introduction of exotic mangrove species for mangrove restoration, monitoring impacts of introduced mangrove species, silviculture of semi-mangrove species, and adaption of mangrove species to tides and long-term monitoring of mangrove ecosystem succession.

JAPAN

Policy/Program Background

Mangroves found chiefly in the southernmost prefectures of Kagoshima and Okinawa, with its northern limit located in Kiire, Kagoshima City of Kagoshima prefecture at 31'20'N (Figure 15). With more than 80 mangrove communities, the total mangrove area in Japan was 553ha where mangroves in Iriomote Island of Okinawa account for 80% of the total (Minagawa, 2000). A more recent finding by the World Atlas of Mangroves reported that the total area of mangroves in Okinawa records 770ha (Spalding et al. 2010), showing an increasing trend of mangrove coverage in Japan.

Figure 15. Distribution of mangroves in Japan (Source: World Atlas of Mangroves, 2010)

Mangroves in Japan grow on silt and mudflats in bays, estuaries, lagoons, and along the shores of estuaries and could grow up to 5 - 8 m in height on Iriomote, Ishigaki, Miyako, and Okinawa islands (Miyawaki, Suzuki, et al. 1983; Miyawaki, Okuda, et al. 1983). They occur as fragmental outliers, typically with only one or a few species, and from scrub or low forests with only one or two vegetation layers **(**Miyawaki, 1995). For instance, i**t** was also found that the mangroves in Iriomote island are poorly developed and low-growing, occupying zones parallel to the coastline or the banks of tidal estuaries **(**Miyawaki, 1995). According to Minagawa (2000), there are seven typical constituent species in Japan (Table 10 and Figure 25), although mangrove areas have 7 to 19 species.

Uses of Mangroves

Traditionally, mangroves were used as timber, firewood, dyeing materials and antiseptic, etc. However, except for their use as textile dyes, they are seldom utilized as raw materials in primary industries now.

While the importance of mangroves as nurseries for many aquatic lives is highly recognized, fisheries in mangrove areas are limited to several fishes, crustaceans and molluscs. They include shellfish (*Terebraliapalustris)*, mud crab (*Scylla oceanica)*, shrimps

(*Penaeusmonodon, Metapenaeusmoebi, Macrobrachiumspp),* black porgy (*Acanthopagrussivicolus*), mullet (*Mugilidae*) and snapper (*Lutjanidae*) etc, but only theblack porgy registered annual landings worth recording of approximately 20-45 tons per year. Also, there are no aquaculture farms in mangroves area, due to limitations which include (i) the suitable area for aquaculture being too small; (ii) cutting and destroying mangroves are strictly restricted, and (iii) tourism is a more beneficial industry than aquaculture.

In particular, mangroves are more commonly recognized for their tourism value in Japan. For instance, the largest mangrove in Japan, located along the 17.5km long Nakama River, Iriomote Island, Okinawa Prefecture, is marketed for its mangrove cruises, kayaking and eco-tourism guides tours rather than for other economic activities. Mangrove area in its virgin form, the total mangrove area 158ha (30%), with most constituent species and largest area in Japan and home to many roots and embryonic seeds. The Nakama River, also designated as a national protected area, attracts visitors on mangrove cruise tours and academics for its research value (Figure 16).

Figure 16. Eco-tourism activities at Nakama River such as mangrove cruises and kayaking activities

Thus socio-economic values of mangroves in Japan include (1) tourism potential, (2) fishery potential, (3) landscape protection, and (4) education for science and (5) nature conservation. Thus, mangroves in Japan are not used directly for subsistence as like that how mangroves are used by local people in South-East or South Asia, i.e. no materials are extracted from the mangroves community except for small amounts of mud-crabs and fishes, but instead, they are conserved more for tourism and educational purposes.

Protection of Mangroves

Mangroves in Japan have been subjected to human impact which altered, degraded, or completely destroyed the vegetation of the mangrove community. These activities included (i) cutting mangrove forests for firewood and construction material (mostly in the past), (ii) disturbance by building river-bank levees and by road construction, and (3) reclamation for

urban and industrial areas **(**Miyawaki, 1995). Also, land-based problems such as red-soil runoff due to unsustainable agriculture practices and garbage pollution are also other threats to the health of mangroves.

Today, deforestation of mangroves is not permitted with the exception of some cases such as research purposes. Pressures on mangrove forests by human activity come from direct destruction like the construction of ponds and ports, and from indirect effects of these works. Even tourism can bring negative impacts. Large motorboats on mangrove tours run at high-speed in mangrove areas and, as a result, mud near the roots of mangrove is washed away by waves made by boats; one probable cause of mangroves falling down and decaying. Fortunately, some mangrove areas are being protected as national or prefectural natural monuments or by various laws, such as mangroves community in Adake River in Tanega Island, Kagoshima Prefecture in March 2017.

Challenges and Best Practices

Mangroves are well conserved in Japan for their ecological, educational and touristic values. While there is no major nationwide rehabilitation effort, local environmental NPOs and civil groups are conducting small-scale efforts of replanting and work in collaboration with academics are monitoring impacts on mangroves caused by river works, coastal fortifications and increase cruise boat traffic. Local mangroves provide Japanese opportunities in learning and research, in the hope to extend and generate this interest to the rehabilitation of mangroves overseas through international cooperation efforts.

Recommendations

Coastal forests are historically recognised for their disaster reducing functions but are being replaced by concrete seawalls and wave breakers. Mangroves as coastal forests have mitigated the force and damages of the typhoon, tidal surges and, winds in southern Japan, where is prone to typhoons. Taking the “Ridge to Reef” approach to integrated coastal management, the conservation of mangroves should take on a “Mountains to Mangroves” approach in capturing holistically the interactions between terrestrial and coastal ecosystems, and also involving all sectors and stakeholders concerned. Mangroves and coastal forests play an important role in demonstrating as alternatives to the conventional way of “protect by concrete” approach to coastal management by using green infrastructure. The challenge is to find a balance between humanmade and green infrastructure.

Part iii. Case Studies on Sustainable Mangrove Rehabilitation

PHILIPPINES

Three case studies were accomplished to assess mangrove rehabilitation vis-à-vis the proposed guidelines developed, namely: *Katunggan Ecopark* in Leganes, Iloilo (Scheme: local community in partnership with local government unit (LGU); *Taklong Island Marine Reserve* in Guimaras Province (local community in partnership with the Department of Environment and Natural Resources (DENR); and *Jalaud Mangrove Rehabilitation* in Barotac Nuevo, Iloilo (Scheme: local community in partnership with academe) (Figure 17). A mixed-method of data collection involving key informant interview, focus group discussion and policy consultation was done with key national and local stakeholders involved in mangrove rehabilitation. In evaluating rehabilitation progress of each site, the study the framework (Figure 18) on mangrove rehabilitation stages as a guide (Figure 2). This framework provides an ideal and systematic approach to pursuing community-based mangrove rehabilitation.

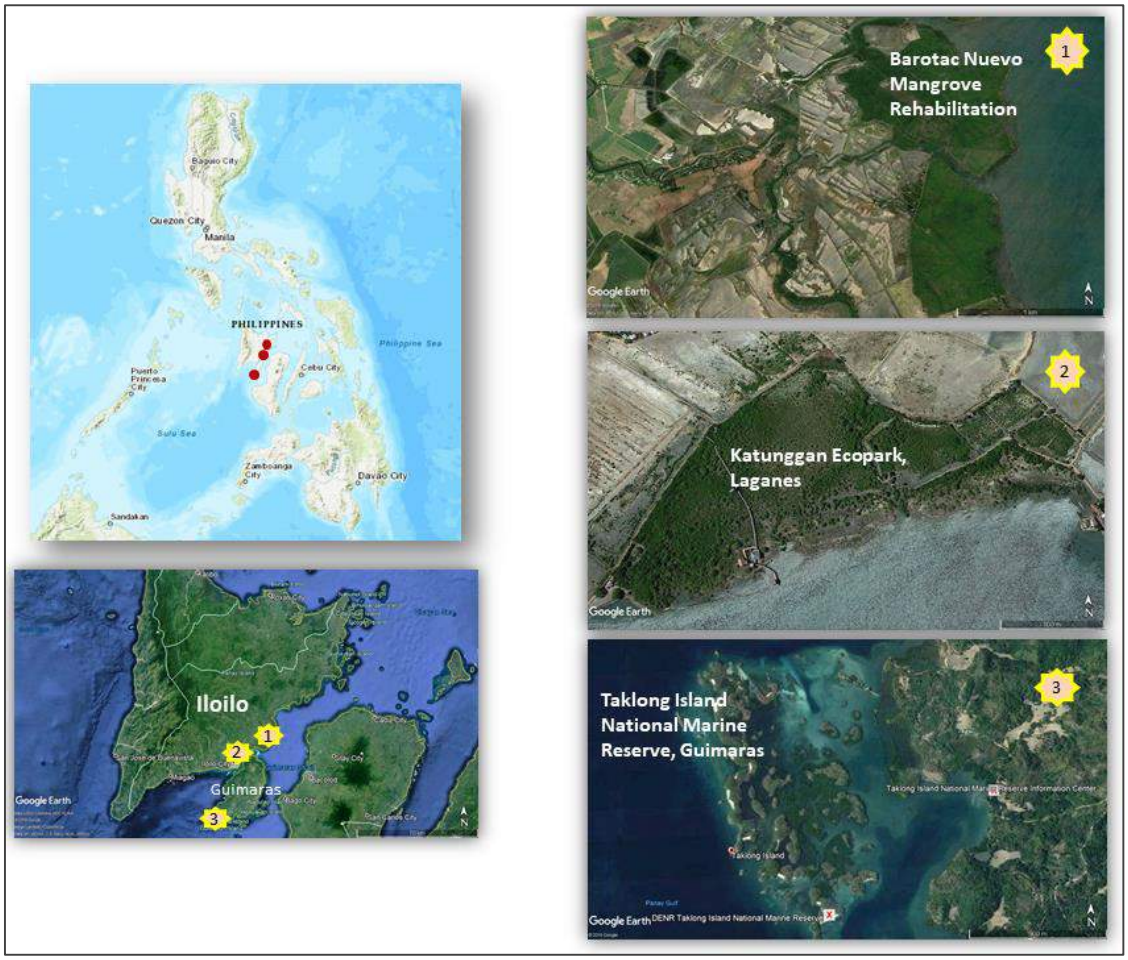

Figure 17. Map of case study sites

Figure 18. Participatory Mangrove Rehabilitation Framework

A narrative analysis of focus group discussions (FGDs) among members of the People's Organizations (POs) implementing the mangrove rehabilitation projects was also done. Information from FGDs were supplemented and validated through structured interviews of key informants. Data gathering were done in the months of January and September 2018 and April 2019. Table 1 enumerates the POs that participated in the FGD and the key informant interview.

Table 4. List of People's Organizations and Key Informants who participated in the study

Case Study Site	People's Organizations that participated in the FGD	Key informants
KatunnganEcopark, Leganes, Iloilo	Community-Based Mangrove Seedlings Growers Association	• Municipal Environment and Natural Resources Officer • Officers of the People's Organization
Taklong Island Marine Reserve	San Roque Coastal Environment Program Association, Inc. (SARCEPA)	• Park officer • Officer of the People's Organization
Jalaud, Barotac Nuevo, Iloilo	Jalaud Fisherfolk's Association	• Faculty member of Iloilo State College of Fisheries (ISCOF) • Municipal Environment and Natural Resources Officer • Officers of People's Organization

Case 1: KatungganEcopark in Leganes, Iloilo

The mangrove rehabilitation project in Leganes in Iloilo started in 2009. It began with the initiative of the Zoological Society of London (ZSL) to find a site of abandoned and damaged fishponds within the municipality for its planned mangrove rehabilitation project. After consultations with the local government unit (LGU) of Leganes, the area in Barangay Nabitasan was identified as the prospective project site for mangrove rehabilitation. However, upon several visits to the site, the local people and leaders in the adjacent barangay of Gua-an were appealing that they too should be considered as interest groups of the project. The LGU and ZSL agreed to include Barangay Gua-an in the project since part of the barangay were still covered with mangrove where they could source out for seedlings. Consent was then secured among interest groups, particularly the LGU, ZSL, and Barangay Nabitasan and Gua-an represented by the barangay captains, through signing a Memorandum of Agreement in 2009.

During the site coordination and assessment, it is important for the project proponents to establish a sense of ownership among all interest groups, not just among technical staff. In Leganes, the community members of Barangay Nabitasan and Gua-an did not feel any form of ownership over the information that was gathered in their locality. This had implications on the level of motivation to participate in the future activities of the project, especially in the planning process. Consequently, the local people commented that the assessment study for the mangrove rehabilitation project did not regard the community and the individual's needs and interests, nor assessed their understanding of the benefits of a mangrove ecosystem. This was one of the reasons why the people were organized into an association relatively late in the project. According to the Municipal Environment and Natural Resources Office (MENRO), this was because the LGU did not see the enthusiasm in the local people to participate in the project until the mangrove forest was starting to grow back.

It was during the planning stage that interest groups envision the goals and objectives of the mangrove rehabilitation. It was clear with the LGU and ZSL that the goal of the project was the reversion of denuded areas to the forest to prevent coastal erosion and as a means for climate change mitigation and adaptation. However, the key problems and underlying causes that contributed to mangrove deforestation were not discussed among interest groups. Decision-making and planning of activities were only upon the discretion of the LGU and ZSL. The community only proceeded to do the tasks that were prescribed to them by the MENRO.

As part of the planning process, ZSL and LGU conducted site visits to Nabitasan where they oriented the students of Nabitasan National High School and members of the *Sangguniang*

Barangay about mangrove ecology and biology. DENR Region 6 also initiated the planning for the Coastal Resource Management Plan of the LGU in 2009, which was approved later that year. The LGU has grown its network since the project coordination phase, especially during seedlings production and planting. From 2009 to 2013, the project has involved more than a thousand volunteers in seedling production and planting, and out planted almost 60,000 seedlings in the site. However, it was only during the implementation stage when the community members were realizing the benefits, they were getting from the mangrove rehabilitation did they envision programs that could augment their livelihood, particularly through tourism and recreation, such as making souvenir items and food catering. There have been several capacity building activities that were conducted in order to sustain the project. Members of the Community-Based Mangrove Growers Association listed these activities during the focus group discussion and ranked them according to the level of contribution to project implementation (Table 5).

Table 5. Capacity building activities and their perceived contribution to project implementation

Capacity building activity	Description	Frequency	Ranking
People's Organization (PO) formation	• Organized by MENRO • Formed in 2017, i.e. the Community Based Mangrove Growers Association	once	4
Leadership training, including logistics	• Participated by the PO president and vice president • Facilitated by ZSL	once	6
Livelihood training	Seedlings bagging	once	5
Study site visit	*Participated only by the MENRO and not yet with PO	none	3
Hands-on training on mangrove ecology assessment	Technical training through ZSL and UP Visayas like seedling production, schedule	thrice	1
Training on nursery management and production	Provided by ZSL but trained members are already training other members	once	2
Site monitoring	Provided by ZSL, including the method for measuring the height	every 6 months	3

** by level of contribution to project implementation*

When the PO was organized, information sharing and reinforcement of rules and regulations have become more effective. They also noticed that they have become more efficient in accomplishing tasks since they were following the guidelines together while checking the work of one another. Capacitating their leaders were also perceived as important. The president and the vice president of the PO became capable of managing the people and leading them. The PO was becoming independently capable of self-governance.

The most beneficial capacity building activity in project implementation as perceived by the members of the PO was the hands-on training on mangrove ecology assessment. When they were trained, they came to know parameters for increased chances of survival of the seedlings, for example, its height should be at least 1 ft or the number of leaves should be 6 and above. Members remarked before the training:

> "*Datibahalakana. Hindi alam kung anongklaseng species angdapatitanim. Yung ibangitinanimnaminnamataydahilhindipalapwedesalupa o yung facing sadagat."*
> (We were not guided before. We did not know what species to plant on where. Some of those we planted died because they were not supposed to be planted on dry land or others should be facing the sea)

Additional funding from the National Greening Program was received for another 5has amounting to PhP 1.5M. This was allotted for payment for labor and sale of seedlings.
When asked to rank the influence and importance of each interest group in the success of the project implementation, the community members grouped together the LGU, the people's organization, ZSL, DENR, as well as partners in funding and tree planting to having both high importance and influence (Figure 19).

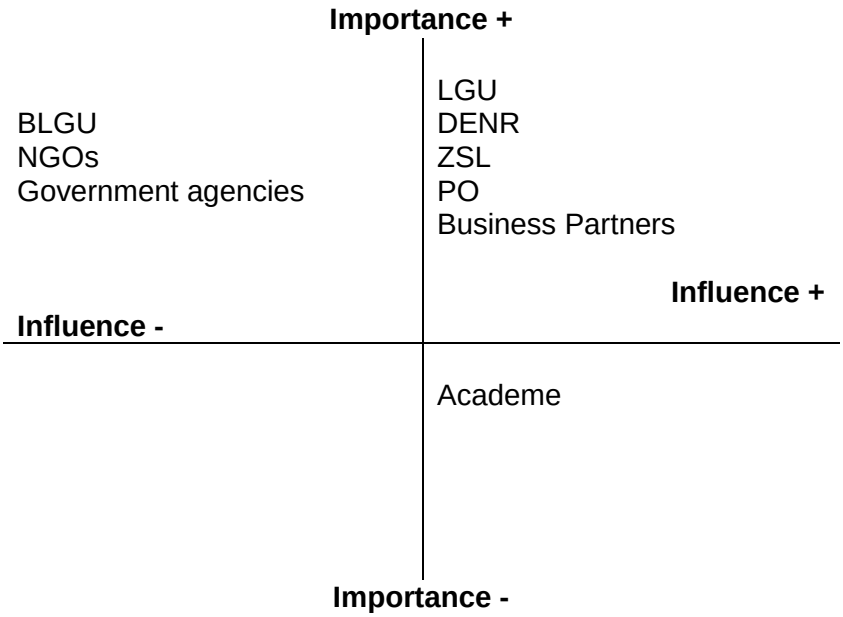

Figure19. Importance-influence matrix in the implementation of the mangrove rehabilitation project in Leganes

The PO is participating in the monitoring and evaluation of seedlings planted, primarily to assess if replacement planting is needed. However, they do not have a monitoring and evaluation plan which the PO and the LGU assumed is with ZSL. Similarly, the results of the monitoring and evaluation were not being relayed to the PO, which could be used for replanning and strategizing. The project was deemed successful since it has brought back the mangrove cover in Barangay Nabitasan. According to the MENRO, the project was a success because of the collaboration between interest groups and the aid of volunteers. The MENRO also noted the significant contribution of the PO when the obligations of sustaining the project were transferred to them. The hindrances to success, on the other hand, are the limited budget, overworked MENRO staff consuming almost 30% of the MENRO's work, and the lack of enthusiasm among local people about the beneficial impacts of the project.

Case 2: Taklong Island Marine Reserve

The Taklong Island National Marine Reserve (TINMAR) is one of the 372 designated marine protected areas in the Philippines (Marine Conservation Institute, 2019). It was declared as a protected landscape and seascape in 1990 under Presidential proclamation No. 525 and was one of the core sites of the National Integrated Protected Areas System (NIPAS), also known as the Republic act 7586 of 1992. TINMAR covers an area of 1,143.45 has made it the biggest among the 13 marine protected areas being managed by the Protected Area Management Board (PAMB) in Guimaras.

There were two mangrove rehabilitation efforts done in TINMAR. The first was done in 2009-2010 and the other which is still on-going since 2011 through the National Greening Program (NGP). The first rehabilitation initiated was in response to the oil spill event in 2006. TINMAR

was affected when the motor tanker Solar 1 sank on 11 August 2006. According to Paringit and Santillan (2009), the tanker carried more than two million litres of bunker fuel, of which an estimated 200,000 litres spilt in the southern coast of Guimaras. It affected the 50-km area of TINMAR that included the marine sanctuaries, mangrove reserves, coral reefs and seagrass beds, shellfishes and other marine life. The livelihoods of the local fisher folks and a total of 13,917 households were directly affected (Lizada, 2010).Some species of mangroves in the severely impacted areas exhibited significant reduction in leaf sizes (Barnuevo and Sadaba, 2014). Baleña (2015) reported that the Guimaras oil spill of 2006 was the worst environmental accident in the Philippines. The oil spill contaminated 239 km of coastline comprising 1.8 km^2 of terrestrial land, 9.6 km^2 of brackish/marine waters of TINMAR, 15.8 km^2 of coral reefs, 1.0 km^2 of mangroves, and 0.4 km^2 of seaweed farms. Thus, rapid habitat assessment and rehabilitation efforts were considered (UN-OCHA, 2006 as cited in Baleña, 2015). A rapid assessment was only initiated by the technical staff of PENRO Guimaras, but hydrology patterns, slope and topography /factors existing in the area were not considered. On-the-spot planting was done utilizing *Rhizophora* and *Avicennia* as the frontline species in areas damaged directly by oil spill. The planting materials were sourced from outside of the reserve. The DENR led the mangrove rehabilitation in TINMAR in collaboration with other local stakeholders. Partnerships continued upon the implementation of the NGP that do not only aim to reforest but also envisioned the provision of livelihood opportunities to communities, including the establishment of an ecotourism site and the protection of nursery grounds of marine flora and fauna.

The second mangrove rehabilitation project was under the NGP. Local site coordination was done through the stakeholders within the two barangays, namely, Lapaz and San Roque covered within TINMAR. The peoples' organization namely, San Roque Coastal Environment Program Association, Inc. (SARCEPA) and LapazFisherfolk Aquatic Reources Mangrove Management Association, Inc. (LAFARMA) were tapped as the direct collaborators of NGP. Barangay resolutions were submitted to the Protected Area Management Board (PAMB) indicating the strong involvement of two barangays in rehabilitation activities. Rehabilitation projects were first presented to the PAMB where the barangay captains of respective barangays and PO leaders were members. A series of consultations and meetings with the POs were also conducted. Partnerships with local people in the implementation of DENR-NGP were built as they are considered fundamental in the sustainability of the project. The NGP was well-explained to the stakeholders before project implementation. Site assessment, area survey and validation were done by the Ecosystems Research and Development Bureau (ERDB-DENR) regional office. Land use survey, mapping and zoning were done by the National Mapping and Resource Information Authority (NAMRIA), the central mapping agency of the government. The plans for mangrove rehabilitation under NGP were presented to PAMB and table mapping was conducted as well as ground validation followed by the presentation of plans to the communities. The POs within TINMAR were not directly involved in the planning process but they were involved in the project implementation. During site selection and setting of targets, community members were informed and consulted through a series of FGDs and consultations. The University of the Philippines Visayas was tapped to do the socioeconomic and demographic survey. Area survey was done by DENR following the distance of 1x1 meter spacing. The planting materials were grown within the site. On average, the survival rate was only 30% using direct planting, which is less laborious. The members of SARCEPA and LAFARMA were directly involved in the NGP implementation from nursery management and planting as well as mangrove monitoring and evaluation of project but not in site assessment.

The budget for mangrove rehabilitation implementation was also laid down directly to the POs. During the FGD, participants relayed that under NGP, the allocated budget was P7,500 per hectare where both POs (SARCEPA and LAFARMA) served as collaborators. Then, under the program "individual plus trees" (IPT) in 2016, an amount P50,000 was allocated for every PO per year. An enhanced NGP has been implemented since 2017 under the Sustainable

Integrated Area Development (SIAD) Project, a DENR foreign-assisted/special project. Private corporations (Globe and Smart) also initiated rehabilitation efforts in the area.

During the implementation stage, the members of SARCEPA and LAFARMA were not only directly involved in the process but at the same time benefited from the rehabilitation projects. The rehabilitation projects gave the PO members an opportunity to conduct meetings for updating ad regular sharing of information. Participants of the FGD also mentioned that their social capital and network increased as they build a good rapport among members of the people organization and external organizations from both the government and civil society. They especially enjoyed the camaraderie within the association.

Members of PO enhance their skills in the attainment of goals and objectives of NGP. Several capacity development activities were provided and supported by DENR and LGUs to both POs.These capacity training increased their awareness on the importance of the mangrove ecosystem. As they relayed, “One leaf is equivalent to one fish.” Technical trainings were also conducted such as hands-on training on GPS reading, tagging, bagging, planting, and identification of seeds as well nursery management, and mangrove pest diseases prevention and control. They learned that planting of mangroves should be done in areas where there is mud and not in those with sea grasses and sand. They were taught on what were the suitable species for a specific area and identification of species type. Moreover, DENR has a communication plan within TINMAR which aimed to raise awareness on the importance of the protected area (PEMSEA and Provincial Government of Guimaras, Philippines, 2018). According to the FGD, the NGP implementation increased the level of people’s awareness in terms of the importance of mangroves in terms of its economic and ecological values. These activities helped develop their knowledge and skills.

Majority of the participants appreciated the importance of protecting their own environment. Social–organizational training included leadership training, organizational strengthening, personal development, bookkeeping and assessment of earnings. They were also provided with alternative livelihood opportunities including souvenir-making, seaweed farming, oyster culture, and sardines processing. The identified capacity building activities were ranked by the participants according to their level of contribution to the success of project implementation (Table 6).

Table 6. Capacity-building activities and their perceived contribution to project implementation

Capacity building activity	Description	Frequency	Ranking*
PO formation	Both SARCEPA and LAFARMA were organized under NGP Opportunity for meeting and gathering	2	1
Leadership training	There 3 members trained on leadership	2	2
Livelihood training	Catering, souvenirs making, seaweeds/oyster making, hat and bags making, sardines processing through Gina Lopez and cucumber salad/jam processing	It depends on the needs	4
Team building	Team building was initiated by PO (food) with assistance from DENR	1	6
Study site visit	POs visited Aklan – Kalibo/Boracay for study visit attended by 8 members from SARCEPA and funding came from DENR	1	4
Hands-on training on mangrove ecology assessment	The POs learned to do GPS reading, tagging, bagging, site guide, planting, identification of seeds, mangrove pest control	5	4
Nursery management	Sticking, fencing, labelling, species identification and every day planting	Everyday	5

Mangrove Assessment	POs can identify which trees/mother plant is healthy or can determine best mangrove source of seedlings	As needed	3
Site monitoring	When to plant, areas to be planted (muddy)	Once a week	3
Orient students	PO gave orientation to school		

** by the level of contribution to project implementation*

Aside from being capacitated, FGD participants also enumerated the direct benefits from the NGP project they gained as members of the PO. All of the participants in the FGD mentioned that they earned an income or received wages ranging from PhP 200-800 per day for being directly involved in cleaning, preparation, planting and monitoring, and even in welcoming visitors. As a result, they were able to send their children to school. Parents were also able to educate their children regarding environmental protection and its importance.

In 2015, the floating cottage was established. Thus, PO members learned to welcome or entertain guests and tourists. Based on the report of PEMSEA and the Provincial Government of Guimaras, Philippines (2018), the floating cottage in Taklong Island is one of the biodiversity-friendly enterprises provided by DENR-PENRO in Nueva Valencia, Guimaras. One participant also mentioned that she gained additional income when visitors came in and requested her to do massage work. By being a member of a certain people's organization (i.e. SARCEPA), each member was tasked to do duty work in the floating cottage at least once a week in order to welcome guests and visitors.

Participatory mangrove rehabilitation was indeed beneficial not only to the ecosystem but also to residents in the area providing livelihood opportunities. When the members of SARCEPA were asked to identify and rank the stakeholders in terms of importance and influence in the success of mangrove rehabilitation, among the identified stakeholders with strong influence and high importance were DENR-PENRO, PAMB, MLGU/BLGU, PO - SARCEPA, PO-LAFARMA, UPV, GIZ and a Japanese NGO. The Bureau of Fisheries and Aquatic Resources (BFAR) was also placed under high importance but of less influence since the area is under the jurisdiction of DENR (Figure 20).

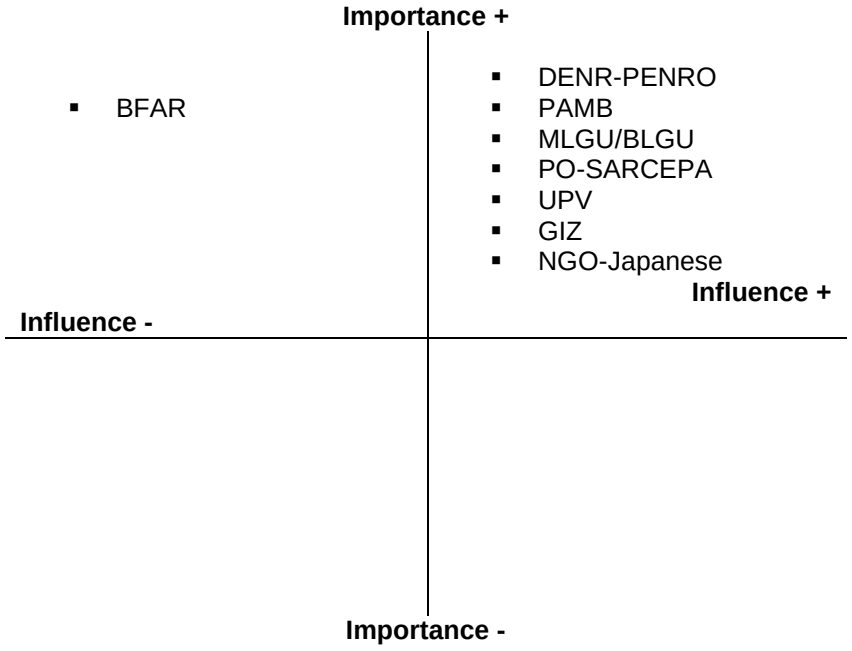

Figure 20. Importance-influence matrix in the implementation of the mangrove rehabilitation project in TINMAR

Both POs in TINMAR were trained on how to assess the health of mangroves planted under the NGP project. Thus, they also participated in monitoring. They replaced dead seedlings since payments were made based on the seedling survival in the area. There was quarterly monitoring of mangroves planted done by parties including PAMB, DENR-PENRO and POs. The monitoring plan served as a basis for evaluating if the target and activities were achieved.

The six-year NGP implementation in TINMAR was considered successful as perceived by members of SARCEPA. Strong collaboration among stakeholders was one of the essential factors in the success of the project. In addition, the information and education campaign (IEC) on the importance of mangrove ecosystems complemented the capacity training that the community received. Moreover, constant meetings between the DENR personnel and POs also served as an opportunity of replanting. Accordingly, the NGP rehabilitation efforts within TINMAR, not only increased the vegetation cover but also addressed the needs of local communities. The communities were given utmost importance by being involved and increasing their livelihood opportunities. In 2017, the communities were able to meet their targets of rehabilitating around 38 has of the area of TINMAR.

Case 3:Barotac Nuevo Mangrove Rehabilitation Project

The Barotac Nuevo mangrove rehabilitation site in Iloilo was originally planted with species such as *bakhaw*, *bungalon*, *pagatpat*, and *lapis-lapis*. However, due to government lease agreements, the mangrove forestwas destroyed and converted to fishponds. Table 1 shows the timeline of the status of mangroves in Barotac Nuevo from 1970s to present. According to a focus group discussion conducted among community members in Jalaud, Barotac Nueva, productive fishponds were present from 1970-1989. The community benefited from marine products such as fishes (e.g. milkfish), crab, shells, and shrimps (*pasayan*). Dikes were built during this time and fishpond lease agreements (FLAs) were established. However, the fishponds were abandoned in 1990 due to the destruction of the main dike brought about by strong waves. The local government unit (LGU) was later notified by the community on the presence of the abandoned and unutilized fishponds. This gave way to the reversion of the site back into mangroves. Hence, marine products, primarily crabs, were once again made available to the community. The mangroves also acted as wave-breakers against strong winds and waves.

In 2012, the Philippine National Aquasilviculture Program (PNAP) was introduced to the community with the participation of various agencies namely, the Bureau of Fisheries and Aquatic Resources (BFAR), the local government unit of Barotac Nueva, the Iloilo State College of Fisheries (ISCOF), the Provincial Environment and Natural Resources Office (PENRO), and the Provincial Agriculture Office (PAO). This gave way to frequent visits and projects from ISCOF, LGU, and BFAR. PAO and PENRO were also involved with the community but not as frequent as the three abovementioned agencies.

Mangrove rehabilitation started in Barotac Nuevo in 2013 due to the havoc caused by Typhoon Yolanda (Haiyan). In response, the BFAR-PNAP included a mangrove rehabilitation program that was assisted by the academic institution of ISCOF. It was through the assistance of the LGU that the Jalaud Fisherfolk's Association was organized in 2008 and registered to the Department of Labor and Employment (DOLE). The PO now consists of 23 members and is managing the mangrove rehabilitation projects in Jalaud.

In the onset of projects, it is the barangay officials who were first coordinated by PNAP implementers, followed by the PO, then a meeting with BFAR was scheduled. An orientation about the proposed project was then conducted before the planting proper. The LGU was the one in charge of coordination and providing information. ISCOF, on the other hand, was the one that conducted the training and was later involved in the project after the LGU. Funding

based on submitted LGU documents was provided by BFAR while the DENR implemented policies. Lastly, the fisherfolks were the ones who provided manpower for the execution of the projects.

There was no inspection on the condition of mangroves before the rehabilitation, although socio-economic surveys were performed in the community. The members of the PO on the other hand had many ways to assess if the site was appropriate for planting, one of which was when the fruit has already fallen. This was learned by the members through experience.

The PO was involved in the planning process. Residents who were at the age of eighteen years and above were the ones allowed to register together with their boats. An orientation was conducted wherein the elevation, soil, area, and the like are the ones discussed. It was the LGU who were orientated together with technicians and DOST officers. DENR and BFAR were the ones who conducted the seminar with resource speakers from other regions experienced in successful mangrove rehabilitation.

Part of the decision-making process was the consensual agreement among members. A decision must first be agreed upon by 70% of the community members. The goal of the project was to assure that the mangrove reached a 90% survival rate at the least. In line with this, the protection and maintenance of the mangroves must be given importance. Meetings were held once a month during Sundays at 2 o'clock in the afternoon wherein the process of seedling production and planting were among the topics discussed.

Capacity building activities were conducted as part of the project's implementation (Table 7). These included PO formation, leadership training, livelihood training, study site visit, hands-on training on mangrove ecology assessment, nursery management, site monitoring, and gender training. Examples of trainings were on the planting protocol and livelihood. Other trainings that were included under the PNAP were on gender and development (more than 30 members attended), cooking (*puto* or rice cake, crackers, *gulaman*or gelatin, shrimp, *lukon*or shrimp) and food processing (shrimp, '*bagoong*' or fish paste, milkfish).

Table 7. Capacity building activities and their perceived contribution to project implementation

Capacity building activity	Description	Frequency	Ranking
PO formation	assisted by the LGU	3	1
Leadership training	conducted by ISCOF	Once for 3 days	2
Livelihood training	• processing and Gender and Development (GAD) through the Regional Fisheries Training Center (RFTC) • shrimp-paste making through BFAR • cooking	2	4
Study site visit	None	0	5
Hands-on training on mangrove ecology assessment	"*hunol"/sticking*	1	6
Nursery management	Individual (based on experience)	0	7
Site monitoring	1 member involved	1	8
Gender Training		1	3

PO formation was conducted with the assistance of the LGU while the leadership training was done by ISCOF. Moreover, as part of the livelihood training, processing and Gender and Development (GAD) were tackled through the Regional Fisheries Training Center (RFTC) and shrimp-paste making was taught through BFAR. Study site visits were not conducted in the community (Table 21). Instead, as part of the activities, hands-on training on mangrove

ecology assessment was conducted wherein *hunol*, also known as sticking, was imparted among the members of the PO. There were also activities that involved individual participation. These were nursery management and site monitoring.

In assessing the role of stakeholders in the project's implementation, their importance and influence were mapped out (Figure 5). Importance was assessed in terms of how the stakeholder was able to meet the objectives of the project, while influence was in terms of its capacity to influence project decisions. As shown from the map in Figure 5, among the various agencies involved, ISCOF, MLGU (DA), and PAO had positive importance and influence on the implementation of the project, whereas PENRO, BLGU, and the 4Ps of DSWD had positive importance yet a negative influence. Hence considering these, ISCOF, MLGU (DA), and PAO were able to meet the needs and interests of the mangrove site as well as influence project decisions. PENRO, BLGU and the 4Ps of DSWD, on the other hand, were able to meet the needs and interests yet were not able to influence the project decisions.

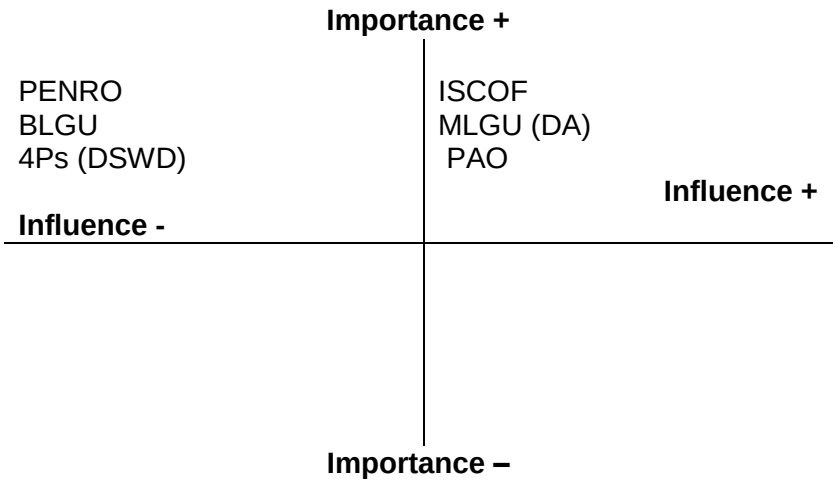

Figure 21. Importance-influence matrix in the implementation of the mangrove rehabilitation project in Barotac Nuevo

An overall monitoring plan does not exist in the project. Coordination is the one given more emphasis. PO members were given the task of monitoring the site, while the LGU visits weekly or sometimes 3 days a week. BFAR also does its monitoring, although rarely. Survival rate on the hand is being monitored through BFAR.

Implications to Mangrove Conservation

a. Causes of deforestation

Mangrove degradation in the coastal areas of Leganes and Barotac Nuevo in Iloilo Province were primarily driven by the pressures of socio-economic development. In particular, mangrove forests were converted to commercial fishponds. Destructive fishing and exploitative cutting of mangroves by communities within and nearby mangrove habitats also contributed to deforestation. These livelihood choices were taken advantage of because cash return was easy and local people were unaware of the ecological value of mangroves. Institutions, the government in particular, also fall short on the enforcement of laws on mangrove protection. Government policies were found to be irrational and conflicting in terms of laws on mangrove conservation and management. Such conflict can be traced back to the lack of information dissemination among the enforcing units (Primavera, 2000). On the other hand, the enforcing institutions are also being criticized to prioritize mangrove protection over community needs and interests, in particular, poverty alleviation. Environmental stressors also

contribute to the destruction of mangroves. Climate-driven calamities, such as typhoons, have been documented to destroy mangroves. However, a more salient narrative in the Leganes and Barotac Nueva was the discontinuity of fishpond operations because of damage from typhoons. Hence, these fishponds were abandoned in its barren state and unutilized. In Guimaras, the major cause of the mangrove habitat inside the protected area was the oil spillage from the sinking of motor tanker Solar 1 due to strong winds, waves, and thunderstorms across Guimaras brought about by Habagat (southwest monsoon) and strengthened by Typhoon Saomai (local name Typhoon Juan).

b. Motivations for rehabilitation

Among the three case study sites, the motivations for and benefits from mangrove rehabilitation are similar. Members of the people's organizations perceived economic benefits from the revitalized mangrove ecosystem in terms of increase in marine products and additional income sources. Ecotourism was especially being promoted in Leganes and Taklong Island. In a decade that the mangrove rehabilitation project in Leganes is being implemented, the PO and the LGU are now trying to generate income from the Katunggan Ecopark. There have been consultations with the LGU Tourism for their vision to be supported and realized. The communities who volunteered in tree planting and monitoring have now realized the environmental values of mangroves particularly as protection from both coastal erosion and strong waves. While there were scepticisms towards the benefits of rehabilitation at the onset of the projects, it has gradually shifted to become aspirational throughout the years as the area coverage of rehabilitated mangroves increased. Local people have acquired both technical and organizational skills necessary for the successful management of the project. Establishing a people's organization, identifying leaders, and capacitating its members are crucial in the sustainability of the project.

On a broader picture, mangrove rehabilitation and protection was not a priority among decision-makers in the Philippines. But the values of mangroves are now being realized with the popularity of studies on the role of mangroves in climate change adaptation and mitigation. While the political platform for mangrove rehabilitation is emerging, challenges in the current management of mangrove rehabilitation projects are important to be documented to inform future efforts.

Environmental challenges that manifest during the implementation of mangrove rehabilitation in the three case study sites include extreme climate events (e.g. typhoons, monsoons), pest infestations, and coastal erosion that inhibit the growth of mangroves. These are being exacerbated by drivers that motivate the commitment of policymakers to invest in rehabilitation, namely, urbanization, tourism development, enabling policies to secure tenure, and land-use conversion to fishponds, farmlands, or grazing lands. There are also lapses in the current environmental policies, such as the lack of a prohibition to delineate a buffer zone in marine reserves and the mismanagement of local solid waste as well as domestic water waste. There were also instances when the implementing institution, i.e. the government, did not consider the interests of the communities and perceived them as passive actors in the rehabilitation project when they constitute the core manpower in the different stages of the project. This practice did not cultivate a sense of ownership, and both positive attitudinal and behavioural change may be hindered. Communities also had certain conflicts due to their power dynamics (Bosold, 2012). Gossip, jealousy, and favoritism are often cited as issues between and among members and non-members of the organization. Commitment among members is also hard to sustain when they do not experience or understood both the tangible and intangible benefits from the project. There have been technical challenges as well. The lack of tested treatments and accurate knowledge on the scientific protocol of planting and maintenance present barriers during the early stages of implementation often relying on trial and errors. This situation also did not help motivate the local communities to commit in the early stages of the project.

Other challenges in mangrove rehabilitation pertain to governance and the assessment of the success of a project. On the former point, foreign or external non-government organizations and academia are essential in initiating efforts but takes involvement of authorities to ensure effectiveness. In the Philippines, governments cannot give local community groups if they are not organized and registered as a people's organization. Mangrove rehabilitation with capital support from local and national governments necessitates the bureaucratic process of organizing a community that may either result in empowerment or disenfranchisement of rights certain people. Social inclusiveness is crucial in mangrove rehabilitation because the project initiators (i.e. the government or non-government organizations) inevitably rely on local people to patrol and monitor illegal activities that may persist in the area. In fact, illegal activities such as blast fishing are still occurring in Barotac Nuevo. Hence, compensation for co-benefits from rehabilitation should also be considered available to local communities that essentially take care of the rehabilitation area. Lastly, experiences from documenting the three case studies also invite us to revisit and rethink the measures of success of mangrove rehabilitation. Researches should question if the survival rate of mangroves is the most if not the only reliable measure of success. Key problems and underlying causes of mangrove deforestation should be understood in its historical, political, and cultural context, especially when common assumptions about sustainability are time and again being challenged. For example, it may take years after initiation of projects for the community to realize the benefits as opposed to the rhetoric of participatory approaches that fail to explain the temporal context of how communities will be partners and stewards.

c. Climate change mitigation potential

Methodology

To describe the blue carbon potential of mangrove rehabilitation, a simple vegetation cover change analysis and carbon assessment were done covering the Case 1 site in Katunggan Ecopark (KE) Mangrove Rehabilitation in Leganes, Iloilo.

Geographically, Katunggan Ecopark (KE) Mangrove Rehabilitation is located between 10°46'47.90" and 10°46'53.17" N latitudes and 122°37'25.38" and 122°37'42.33" E in the southern part of Leganes, Iloilo, Philippines (Figure 1). The Katunggan Ecopart has an approximate total land area of 8.28 hectare, a sea-facing abandoned fishpond which was reverted and replanted under a partnership between the Zoological Society of London (ZSL) and Leganes LGU in 2009 (Leganes Coastal Resource Management Plan CY 2008-2017).

In terms of topography, the KE has relatively flat, with elevation ranging from 2 to 4 meters. The climate in the belongs to the Philippines' Climate Type III, characterized by not very pronounced season; relatively dry from November to April and wet during the rest of the year. The mean annual rainfall at the KE from 2008 to 2013 was around 2,348.14 mm, while the average monthly temperatures were about 28.28°C, respectively (Province of Iloilo: Annual Provincial Profile, 2014).

We used remote sensing satellite imagery (Landsat: https://glovis.usgs.gov/) (Figure 22) to map the Land Use/Land Cover (LULC) of the area in 1988, 2008 and 2015. The 1988-2008 and 2008-2015 time periods were decided based on two concerns: (i) to capture and compare the spatiotemporal landscape change dynamics in the KE before and after its major rehabilitation; and (ii) availability of (clear) satellite imagery.

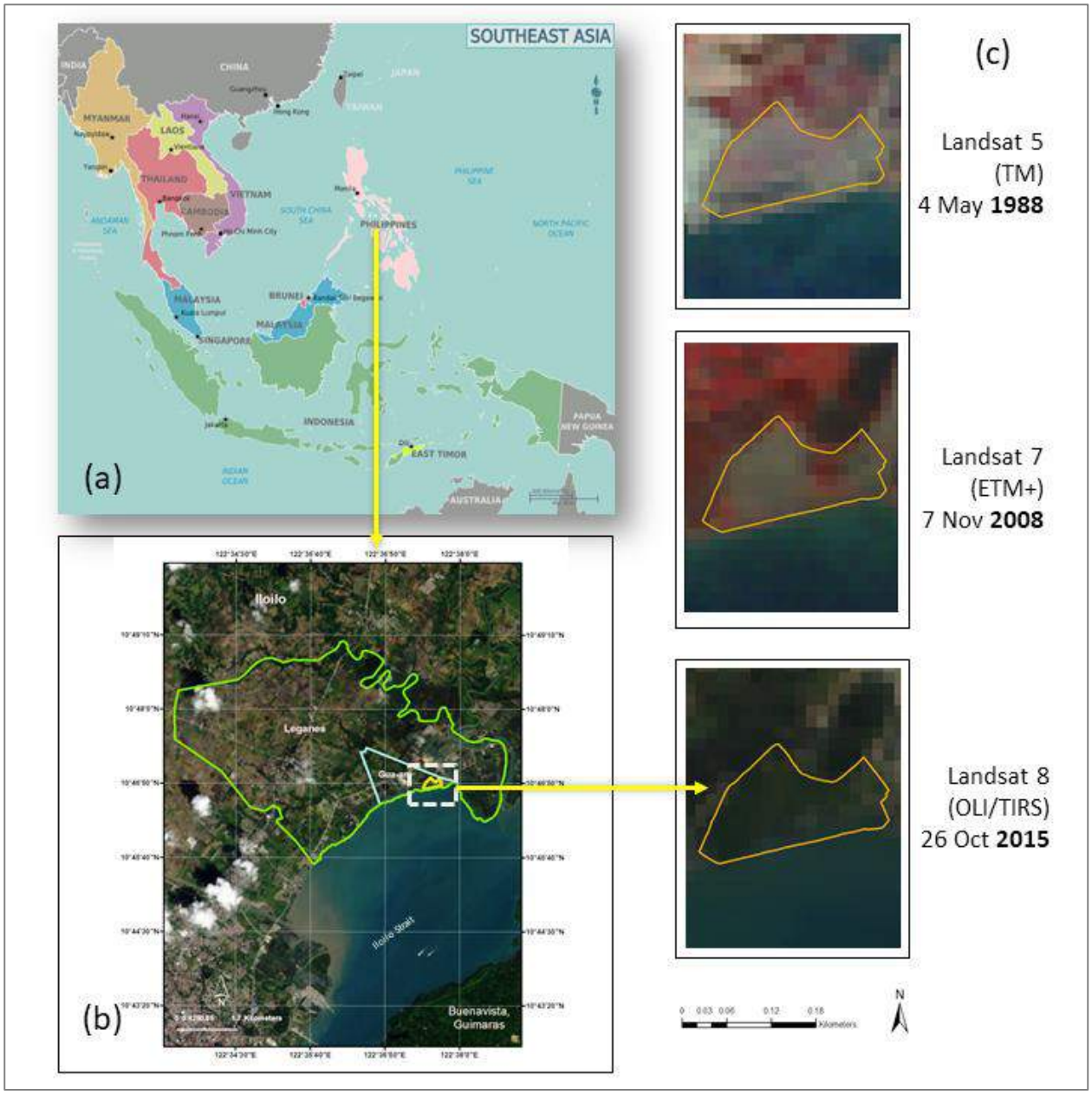

Figure 22. Location of the project site, the KatungganEcopark (KE) and its surrounding areas, Iloilo and Guimaras, Philippines. (a) Map of Southeast Asia showing the location of Iloilo Province, Philippines (Map Source: https:// wikitravel.org/en/Southeast Asia); (b) Landsat 8 image of some part of Iloilo and its adjacent area (WRS PATH 114/WRS ROW 53); and (c) Landsat imagery used in this project showing the boundary of the KE in orange line.

LULC change detection and analysis

Before LULC mapping and analysis, the three (3) satellite images were subjected to a set of preprocessing procedures. More especially, the digital number or DN values of the multispectral bands of the satellite images from the three different sensors (TM, ETM+, OLI/TIRS) had to be converted into surface reflectance values. It is vital to investigate the nature of wavelength reflectance of the area of interest (AOI) in order to determine which bands will be most effective in discerning the AOI (Butler, et al., 1988).

Multi-band analysis was used to calculate the degree of interrelation between bands. Further, the covariance and correlation coefficient was used. The results were graphically shown

through spectral plots to recognize the energy spectrum of specific land covers while scatter plots are applied to illustrate the correlation between bands (Fisher, 2012). Atmospheric correction was also performed using the dark object subtraction model to remove any atmospheric effects/interferences due to absorption and scattering. To obtain all these pre-processing procedures, we used the image processing software package of Bilko Version 3.2, a free/open-source remote sensing image analysis to coastal resource management (www.bilko.org).

The subset of the project area (Figure 1c) was clipped from the three pre-processed satellite images before classification. We used the maximum likelihood supervised classification technique to classify the LULC of the project site. The technique involves digitizing of training sites for each LULC class based on 'a priori knowledge' and these training sites to train and eventually classify the pixels in the images. This method is commonly used in remote sensing-based LULC mapping (Thapa and Murayama, 2009; Rozenstein and Karnieli, 2011; Estoque and Murayama, 2016).

From the subset of the area (Figure 1b), we classified eight (8) LULC classes, namely: inland water, mangrove, annual crop, perennial crop, fishpond, built-up, brush/shrubs and open barren land. As our guide to avoiding spectral confusions, we used the official land satellite images from NAMRIA (for 1988 image) and Google Earth Pro.For 2008 and 2015 maps, Google Earth and pan-sharpened Landsat images (Du et al., 2014; Estoque and Murayama, 2015) for references during the assessment.

The detection of changes in the extent of each LULC class across the years 1988, 2008 and 2015, we overlaid (cross-tabulated) the 1988 LULC map with the 2008 LULC map, and the 2008 LULC map with the 2015 LULC map to determine the total area and location of pixels of the specific class that converted to another class. In this particular analysis, we focused on the conversion of fishpond to mangrove gains and losses.

For carbon stock assessment, standard plot sampling technique was used to gather the necessary baseline biomass and carbon stock measurements. Seven (7) sample plots measuring 10m x 10m were randomly established in the site (Figure 23).

Figure 23. Location of sample plot within Katungan Ecopark.

All trees and saplings were accounted within the 10m x 10m or 100sqm plot using the non-destructive technique. This mainly involved identification of tree species and measurement of

their stem diameter (cm) and height (m). To calculate biomass (dry mass in kg), appropriate allometric equations were used for various carbon pools, namely: aboveground biomass (AGB: stem, branch leaves); and belowground biomass (BGB: roots). These included the following:

General allometric equation (Komiyama et al. 2008)

Aboveground biomass (AGB): $\boldsymbol{y = 0.251p\ D^{2.46}}$

Root / belowground biomass (BGB): $\boldsymbol{y = 0.199p^{0.899}\ (D2)^{2.22}}$

where: y = biomass (kg)
D = diameter (cm)
p = wood density

Two sets of soil samples were collected from each plot. First, soil sample for bulk density and soil biomass analysis was gathered using a 1-meter core sampler. Samples were obtained within the 1-meter depth of the undisturbed portion of the plot. These samples were later sent to laboratory for over-drying (at 105 °C). A separate 100g sample was collected in the same spot for the soil carbon content analysis. Soil samples were also sent to the laboratory and were analyzed using Walkley-Black method. Soil carbon stock estimation involves the following equations:

Bulk density (g cm^3) = Dry wt. of soil (g)/ Vol. of cylinder (cm^3)

Volume of 1 ha soil = 100m x 100m x 0.3 m (or 0.1 m per soil level/depth)

Weight of soil (t) = Bulk Density x Soil Volume

SOC = Weight of soil (t) x % C

Total site carbon stock was calculated by combing the values obtained from vegetation and sediment.

Results

Analysis of Land Use/Land Cover Dynamics

Land cover classification of the eight land use/land cover types identified across the three periods indicates the conversion of annual cropland to fishpond and build-up area (Tables 8 and 9; Figure 24). The inland water, mangrove forest and fishpond were increased over the study period. Inland water increased by 117.75% from 2008 to 2015, while mangrove forest and fishpond both increased by almost 500.00% and 12.31% respectively. On the other hand, annual crop and built-up area decreased by 16.98% and 14.06% from 2008 to 2015. Some area of annual crop was mainly converted to fishpond, perennial crop and built-up area.

Table 8. Land use/land cover changes of landscape in Leganes, Iloilo

LULC Class	Area Coverage (ha)			Cover Change between Periods (%)	
	1988	2008	2015	1988-2008	2008-2015
Inland water	525.13	14.99	32.64	-97.15	117.75
Mangrove forest	162.53	5.18	31.06	-96.82	499.66
Annual crop	2,328.92	2,142.11	1,778.33	-8.02	-16.98
Perennial crop	0.00	158.95	0.00	0.00	0.00
Fishpond	0.00	609.87	684.95	0.00	12.31

Built-up area	0.00	184.14	158.25	0.00	-14.06
Brush/shrubs	0.00	0.00	394.33	0.00	0.00
Open/barren	0.00	0.00	0.45	0.00	0.00

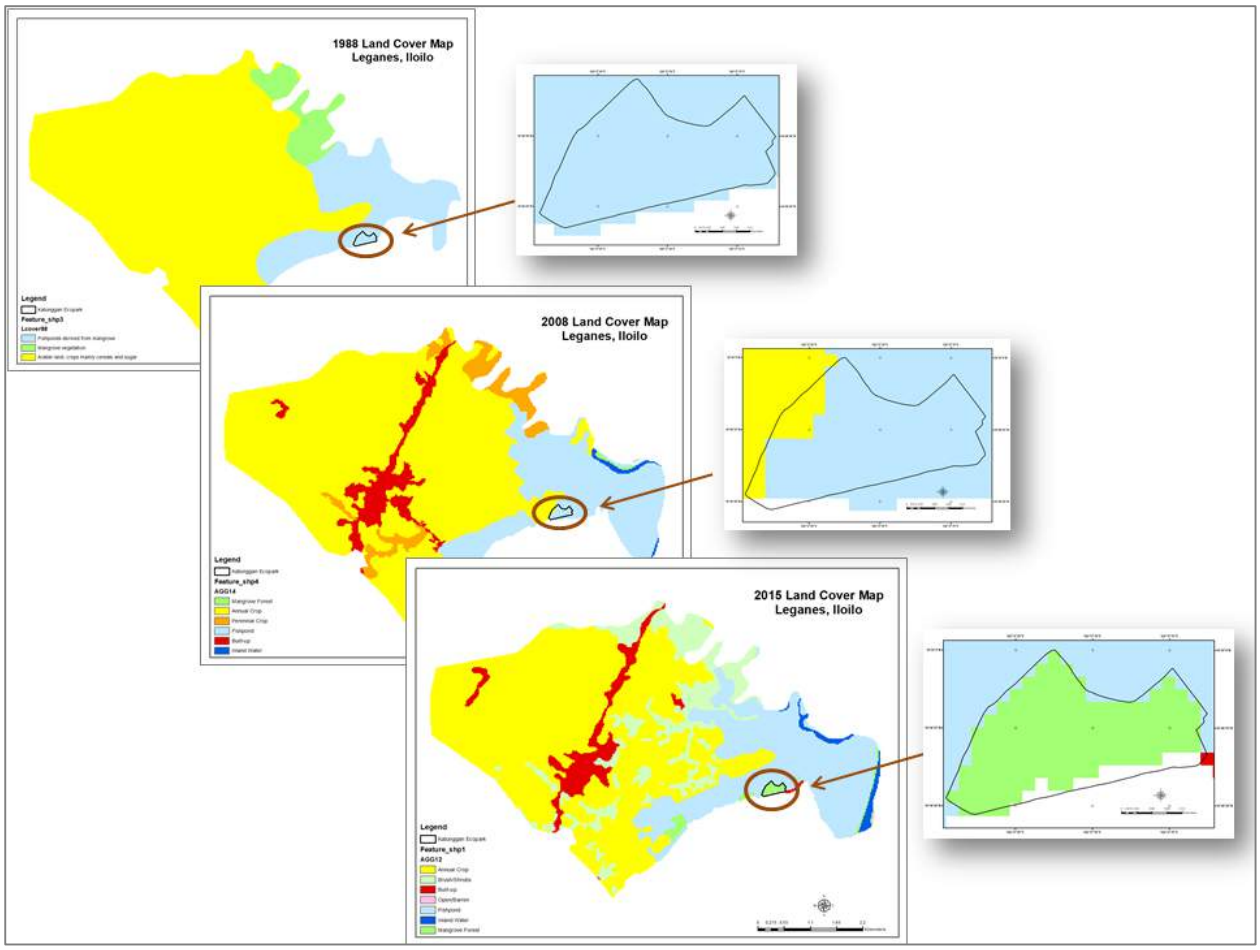

Figure 24. Land use/land cover maps (1988, 2008 and 2015) of Leganes, Iloilo (inset: Katunggan Ecopark)

Table 9. Structure and changes in land use/land cover of Leganes, Iloilo: 1988, 2008 and 2015

LULC Class	1988		2008		2015		Relative Change (%)
	Area (Ha.)	%	Area (Ha.)	%	Area (Ha.)	%	
Inland water	525.1	0.2	15.0	0.0	32.6	0.0	-93.8
Mangrove forest	162.5	0.1	5.2	0.0	31.1	0.0	-80.9
Annual crop	2328.9	0.8	2142.1	0.7	1778.3	0.6	-23.6
Perennial crop	0.0	0.0	159.0	0.1	0.0	0.0	
Fishpond	0.0	0.0	609.9	0.2	685.0	0.2	11.0
Built-up area	0.0	0.0	184.1	0.1	158.3	0.1	-16.4
Brush/shrubs	0.0	0.0	0.0	0.0	394.3	0.1	
Open/barren	0.0	0.0	0.0	0.0	0.5	0.0	

Blue Carbon Stock Potential

Table 10 provides the summary of stand density, biomass and carbon stock values of the sample plots. On average, vegetation cover is about 1943±802 trees per ha. This indicates the site's well-vegetated condition which therefore contributed to tree biomass of as much as 22.8 t/ha. The average total blue carbon stock is about 407.8±136.3 t/ha. Big share (as much as 97%) of this value came from sediment.

Table 10. Ranges and distribution of carbon stock

PLOT	Stand Density (trees/ha)	Tree Biomass (t/ha)	Carbon Stock (t/ha)		
			Tree	Sediment	Total
1	2500	18.6	8.6	269.4	278.0
2	1900	7.7	3.6	375.1	378.7
3	1000	11.7	5.4	501.6	507.0
4	1600	25.6	11.8	192.8	204.5
5	1000	8.6	4.0	513.7	517.6
6	3100	31.1	14.3	606.8	621.1
7	2500	56.0	25.8	322.0	347.8
AVE	**1943**	**22.8**	**10.5**	**397.3**	**407.8**
SD	**802**	**15.8**	**7.3**	**137.7**	**136.3**

In general, the richest blue carbon is situated along the middle portion of the site. This is largely attributable to the vast amount of sediment carbon that is stored here since: 1) these portions are relatively more protected against strong tidal movements, and 2) thicker vegetation and dense root system facilitate sediment accretion.

By estimate, the whole site stores about 17.7 kiloton of carbon stock (kt C). This value can be transposed to as much as 46.4 kt CO2 sequestered, which could worth around USD 236,859 (based on the prevailing USD 5.1/ ton CO2 price in the voluntary market according to Ecosystem Marketplace 2017). Such value, therefore, necessitates the strict conservation of existing natural forest and proper stand management of plantations.

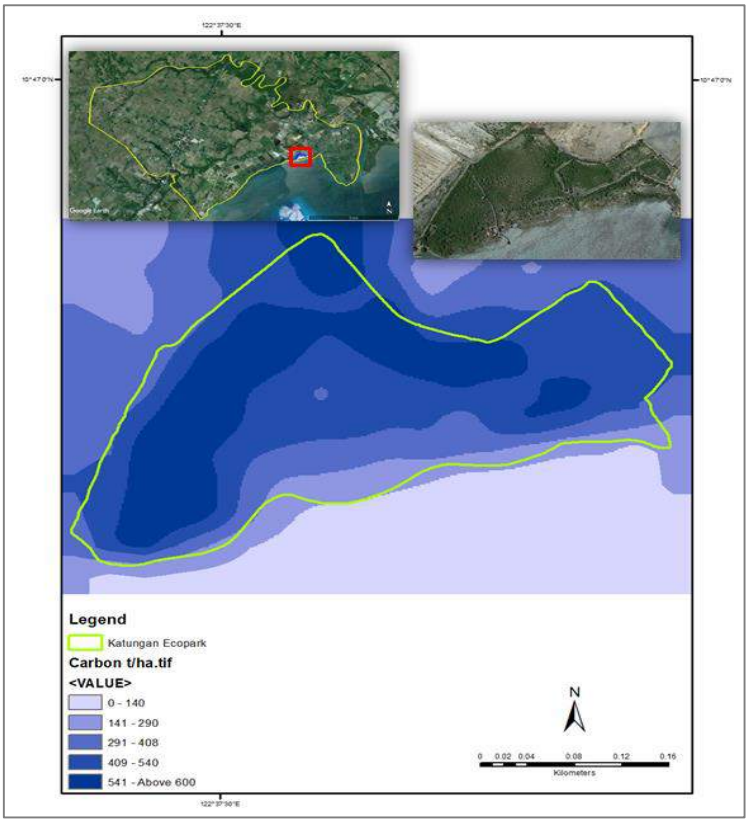

Figure 25. Map showing the mangrove blue carbon stock distribution in Katungan Ecopark, Leganes, Iloilo.

Conclusion

The case studies in the Philippines provide insights on how a deforested mangrove area can be reverted to forests. Engaging in mangrove rehabilitation has a lot of local and global benefits. Among these are livelihood and income sources which largely contribute to well-being, and improvement of ecosystem services such as carbon sequestration. A number of factors contribute to the successful reversion of the mangrove cover. These factors do not work independently but are rather dynamic and emerging. These include a strong commitment between different stakeholders, which can be manifested in terms of sustained volunteer efforts. Leadership to initiate, manage, and politically support the ground-level efforts are crucial but may come from not just one individual or organization. Hence, cooperation through mutual understanding of goals and project outcomes can help build up leaders that can facilitate government and external support, regular monitoring, consideration of local needs, and cultivation of a sense of ownership. The research assessment team should also be interdisciplinary in order to capture the biophysical and social dimensions of the area. Some remarkable practices that positively contribute to mangrove rehabilitation in Leganes, Barotac Nueva, and Taklong Island are the strict implementation of a science-based planting scheme (i.e. species identification and spacing) while taking into consideration the traditional type of planning, such as the *hunol*(sticking) in Barotac Nuevo. The use of a T-fence in Leganes for maintenance has also been proven effective, while the presence of many fisheries college graduates in the community in Barotac Nuevo also helped external organizations to coordinate with the local people. To ensure the sustainability of the project, enabling policies and its enforcement should also be taken into consideration. The network of volunteers, funders, people with technical knowledge and capacities who work together with the local communities is also fundamental in mangrove rehabilitation.

MYANMAR

Case Study of Taw Htwin Community Forestry, Myeik Township, Tanintharyi Region

Background

HtawHtwinGyi is a community in Myeik Township of Tanintharyi region. The community depends on shrimp farming for their livelihoods. Recognizing the threats on the mangroves, the Myeik Forest Department and HtawHtwinGyi community organized the HtawHtwinGyi Community Forestry in 2017. Prior to the establishment of the Community Forestry, mangroves were cleared for urban expansion and agriculture. Local communities informed that patches of mangrove forests were cleared by the outsiders to establish agricultural field and to claim the ownership of the land.

The main livelihood of the HtawHtwinGyi community is traditional shrimp farming. Shrimp farming depends on healthy mangrove ecosystem for its productivity. However, in the past decade, the community has experienced the gradual decrease in shrimp catch. They believe that it is due to the degradation of the mangroves in the area. Although the community has traditionally conserved the area to sustain the production of shrimp, they lack the power to protect because the mangrove is located on a public land. The community cited the lack of ownership as the major challenge to the mangrove conservation.

Figure 26. Shrimp farming community of HtawHtwinGyi.

In 2016, the local community approached the local Forest Department to apply the conserved mangrove areas to be recognized as the Community Forestry under the Community Forestry Instruction (2016). Flora and Fauna International (an international NGO) and Myanmar Green Network provided helped in pursuing this. With the success of organizing, the local community is now taking care of about 300 acres of mangrove forest. Of these, 200 acres are natural forests and the other 100 acres are gap areas where the replanting of 20 acres annually was planned. In 2018, the community has replanted 20 acres with *Avicennia* and *Brugueria* species. The purpose of the CF is as follow:

a. To conserve natural mangrove ecosystems and rehabilitate degraded areas and thereby sustaining the shrimp farming
b. To meet the basic needs for timber of the community
c. To improve the livelihoods of the community through community forestry

Given this, a case study was done to assess the community-based mangrove rehabilitation model vis-à-vis the proposed mangrove rehabilitation guidelines developed as reference.

Figure 27. Taw HtwinGyi Community Forestry

Key Findings

Local site coordination

The Taw HtwinGyi Community Forestry is a community-initiated mangrove conservation and rehabilitation project. The establishment of Taw HtwinGyi CF dated back to 2016 when the community realized the increasing pressures on the nearby mangroves from the land prospectors. After consultations with the local Forest Department officials, the community decided to establish the Community Forestry to protect the remaining natural mangroves and to rehabilitate the depleted areas.

Forest Department helped the community to get contact with a local NGO called Myanmar Green Network to provide the community with necessary technical and financial inputs. Myanmar Green Network (MGN) and Flora and Fauna International (FFI) facilitated the coordination meetings among the key stakeholders such as General Administration Department, Forest Department, Settlement and Land Record Department to get permissions for the CF. Community meetings were also held to elect the chairman and management committee members for the community forestry.

Comprehensive site assessment

The site assessment was conducted in 2017. The Forest Department organized the site assessment team and it included CF management committee members, representatives from MGN and FFI. However, the site assessment team did not involve scientists such as marine biologists or zoologists. Instead, FFI and MGN organized training on data collection and documentation for the community members. The site assessment team has found out that out of the 300 acres of potential CF area, about 200 acres are covered with natural mangroves and about 100 acres need to be rehabilitated. The depleted area of 100 acres are scattered throughout the CF areas and thus were proposed to be restocked with gap planting. The local species found in the remaining surrounding natural mangroves were used for the gap planting. The seedlings are to be cultivated in the nursery within the CF.

It is suggested that, during the site assessment, both biophysical and socioeconomic assessment should be done. However, in this project, the assessment of the socio-economic

status of the community was not conducted. The reason for this was because this is a community-initiated project without external funding support. Being a self-initiated CF, the sense of ownership among the community members is high and all the CF members are well aware of the ownership of the CF and potential benefits they could gain from CF.

Figure 28. Meeting with community members of Taw HtwinGyi community

The team assessed the extent of the existing mangroves through a rapid appraisal. The community members also prepared a participatory resource map to identify potential areas for restoration and conservation. Based on the field site assessment and participatory resource mapping, the CF areas were divided into different zones such as gap planting areas and natural mangrove areas. Areas for annual gap planting were also identified.

Although the site assessment team did not include any marine biologists or zoologists, the site assessment team included the CF members with high local knowledge on mangroves and foresters from the Forest Department. Therefore, the selection of species and planting methods were mainly based on the local knowledge and by looking at the nearby natural mangroves.

Participatory mangrove rehabilitation planning

MGN and FFI facilitated the participatory development of the management plan for the Taw HtwinGyi Community Forestry. The management plan was developed by the management committee of the CF in consultation with the members of the CFUG. The management plan details the activities for the next five years including the rehabilitation plan for gap areas and cultural operations for the remaining natural mangroves. The management plan will be renewed at every five-year interval.

Community meetings were held during the development of the management plan. Forest Department officials were invited to those meetings and MGN took the facilitator role for the meetings. During the community meetings, the CF areas were divided into conservation zones, the village uses zones and rehabilitation zones.

Selection of species for mangrove rehabilitation was based on local knowledge of t community members and the professional knowledge of the foresters of Forest Department. Notably, species were selected based on the nearby natural growth of mangroves, elevation, tidal behaviour and tide level of the rehabilitation site. The training was organized during the planning stage of the CF. Forest Department provided two training on nursery management and seedling production. Upon the completion of the management plan, the community submitted the management plan to the Forest Department for approval.

Figure 29. Gap planting site

Participatory Project Implementation

Apart from the technical support, training and facilitation by the FFI, MGN and Forest Department, the Taw HtwinGyi CF did not receive any funding. However, the Forest Department provided the community with the necessary seedlings for the gap planting. A gap planting of 10 acres with *Avicennia*and *Brugueria*species was planted in 2017 in the depleted areas within the CF. Another 20 acres were planted in 2018. The community plans to rehabilitate 20 acres every year until they reach a target of 100 acres. When we visited the rehabilitation sites in 2018, it was reported that about 85 % of the seedlings survive. The community also has the plan to refill the decayed seedlings. However, being an early stage of rehabilitation, it is yet to see the long term survival rate of the plants.

Forest Department provided two technical training for nursery management practice. Forest Department also provided seedlings for the first year of gap planting by the Community Forestry Instructions. MGN and FFI also provided training on facilitation skills, forest management, and planting techniques for the mangroves. The community themselves manages the nursery. Women are mainly responsible for the production and nurturing of seedlings.

Challenges

The Taw HtwinGyi CF was established because the community feared that the mangroves would disappear due to the land confiscation and land clearing of the local businessmen. Therefore, the community endeavoured to be legally recognized the surrounding mangroves as the community forests and to rehabilitate and conserve the delegated areas. Notwithstanding these efforts, land confiscations and land conflicts remain a major threat because of the increased demand for land in the region.

Tanintharyi Region, particularly Myeik District, is a popular tourist destination in Myanmar. Myeik Archipelago is a tourist hotspot nowadays. It has expanded to accommodate tourism expansion and coasts are in high demand for hotel construction. In the interview of CFChariman, he reported that businesspeople from Myeik cleared the mangroves near their village and practised some cultivation with the hope that they could claim the ownership of the land later. We also saw that a proposed mangrove eco-park, which was formerly under the management of Myiek University, is being transformed into a new suburb of the Myeik city.

The community reported that another major challenge for the sustainability of CF is the availability of fund for conservation and rehabilitation. Being a self-initiated, CF without external funding, it is challenging for the community to raise funds required for the rehabilitation works. At the initial stage of the CF establishment, MGN and FFI covered the costs for organizing training, participatory resource mapping, participatory planning and zonation of the CF. Other challenges for the CF include cattle grazing and encroachment of rice farm and aquaculture.

Participatory Monitoring and Evaluation

The Taw HtwinGyi community has organized an internal audit team by the Community Forestry Instructions. The audit team nor only audits the financial matters but also monitors and assesses the activities of the CF. However, they do not have a systematic framework for monitoring and evaluation of the CF. On the other hand, as required by the Community Forestry Instructions, Forest Department monitors and evaluates the successes of activities of the CF every year. Forest Department also ensures that the community undertakes the activities outlined in the management plan and assesses whether the community is implementing the management plan properly. The evaluation team also includes members of the management committee of the CF.

Lessons Learned

It is still early to assess whether the CF is successful. However, the Forest Department reported that the Taw HtwinGyi CF is very encouraging and has the potential to be progressive. The motivation of the community is relatively high because of the economic interests of shrimp farming. There is also potential for additional income generation from CF such as by growing seagrass within the CF. Forest Department and Taw HtwingGyi Community Forest Users Group reflect upon the success factors for the CF as follow:

- High motivation of the community to conserve and rehabilitate mangroves
- Economic incentives from CF by sustaining shrimp farming
- Potential income from CF by income-generating activities such as seagrass
- Selection of the species for restoration based on the nearby natural growth, elevation, tide level and local knowledge
- Active participation of the community members
- Technical training provided by FD, MGN and FFI
- Inclusive community meetings with all the members (including men and women) of the CF

In spite of the promising signs of the Taw HtwinGyi CF, the community and FD confessed that there are still overarching challenges which will need to be addressed in order to ensure the sustainability of the CF:

- Lack of funding for rehabilitation and conservation activities
- Land confiscation and land conflicts
- Urbanization and clearing of the mangroves
- Cattle grazing and farmland encroachment
- Weak land tenure rights

The long-term sustainability of the CF depends on the availability of funding for rehabilitation and conservation activities. Moreover, it also needs to ensure that the CF can generate income from activities such as shrimp farming and seagrass growing so that the livelihoods of the community are improved and their motivation remains high. Forest Department and local authorities must be able to guarantee the land ownership of the CF in accordance with the Community Forestry Instructions and should be able to provide legal support to protect the CF against intruders.

One possible way for the funding support for the CF is through the Myanmar Reforestation and Forest Restoration Program (MRRP). MRRP is the main reforestation and rehabilitation program implemented by the Forest Department. In an era when the Forest Department is promoting community forestry and community forestry enterprises, the CF has the opportunity to become the CF enterprise with sustainable shrimp production and seagrass growing. Local forest department will need to work closely with the community to provide necessary technical supports and should link the CF to the other CFs within the district and the region.

4. Conclusions

Mangrove rehabilitation experiences in the collaborating countries present diverse best practices and challenges. Based on policy consultations and case studies, there are vital elements for achieving successful and sustainable mangrove rehabilitation. These include:

- An integrated and ecosystem-based approach to mangrove rehabilitation from planning to implementation;
- Prioritization of long-term survival goal rather than just 'survival';
- Adoption of multi-stakeholder or participatory approaches in all rehabilitation/restoration
- activities;
- Ample and clear policy environment ensuring institutional commitment and funding
- support; and
- Sustained monitoring system that will guide decisions in managing mangroves.

Such elements were then synthesized to come up with proposed mangrove rehabilitation guidelines, which could serve as a helpful reference for mangrove rehabilitation/restoration practitioners.

The study also underscored that most of the successful rehabilitation programs are done through community-based and multi-stakeholder approaches. Commitment to mangrove rehabilitation and conservation are reflective of the community's wide appreciation of mangroves' ecosystem values. Similarly, the interests to partake in mangrove protection were found to be attributable to the increasing regard for mangrove's role in meeting basic needs and ultimately towards the improvement of human well-being.

An equally relevant success factor is the collaboration among various government and non-government institutions to assist local communities. Complementation of work among research institutions (providing the scientific basis for rehabilitation), funding agencies (sustained financial support on rehabilitation and related livelihood development), and local and national government (sustained funding and necessary policy mechanisms) are critical to sustaining both mangrove rehabilitation and conservation.

5. Future Directions

Having learned from the case studies that the proposed guidelines on sustainable mangrove rehabilitation was well-received and hence can be adopted and implemented on the ground, the Team recommends that future work should be on action-research (extension) activities. This will involve: 1) development of IEC materials to layman the mangrove rehabilitation guidelines; 2) conduct of training to local communities and relevant stakeholders; 3) pilot demonstration of ecosystem-based mangrove rehabilitation; 3) documentation of results and learnings; and 4) publication of key findings. A proposal on "Science and Community-Based Mangrove Management for Global and Local Benefits: A Pilot Demonstration Project of the Philippines, Myanmar, Thailand, China and India" has been developed for submission to APFNet and other potential donors for funding.

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7. Appendices

Appendix A. Project Workshop Programme, New Delhi, India, April 2018

Appendix B. Project Mission Trip to Myanmar, January 2019

Appendix C. Project Synthesis Workshop in the Philippines, April 2019

Appendix D. CFNR Foundation Day & Alumni Homecoming/Forum, April 2019

Appendix E. Asia-Pacific Forestry Week Conference, Incheon, Korea, June 2019

Appendix F. Photo-Documentation of the Project Activities

Appendix G. Case Studies of the Project

Appendix H. Draft Article from the Project for Submission to Journal