S.A.P.I.EN.S
7.2 (2014)
Vol.7 / n°2 - Large-Scale Restoration

Ben Brown, Ratna Fadillah, Yusran Nurdin, Iona Soulsby and Rio Ahmad

CASE STUDY: Community Based Ecological Mangrove Rehabilitation (CBEMR) in Indonesia

From small (12-33 ha) to medium scales (400 ha) with pathways for adoption at larger scales (>5000 ha)

INSTITUT
Veolia Environnement

S.A.P.I.EN.S
Volume 7 issue 2 2014

Case Study

Community Based Ecological Mangrove Rehabilitation (CBEMR) in Indonesia

From small (12-33 ha) to medium scales (400 ha) with pathways for adoption at larger scales (>5000 ha).

Ben Brown, Ratna Fadillah, Yusran Nurdin, Iona Soulsby and Rio Ahmad

Abstract

While successful examples of large-scale (5 000-10 000 ha) ecological wetland/mangrove rehabilitation projects exist worldwide, mangrove rehabilitation efforts in Indonesia, both large and small, have mainly failed. The majority of projects (both government programs and non-government initiatives) have oversimplified the technical processes of mangrove rehabilitation, favouring the direct planting of a restricted subset of mangrove species (from the family Rhizophoracea), commonly in the lower half of the intertidal system (from Mean Sea Level down to Lowest Atmospheric Tide) where mangroves, by and large, do not naturally grow. Aside from lack of appropriate technical assessment, these lower inter-tidal mudflats are often targeted for rehabilitation because true degraded mangrove forests are frequently linked to tenurial issues that require significant effort and investment to resolve.

Ecological Mangrove Rehabilitation (EMR) has been implemented and well documented for the past several decades in New World mangrove systems (Lewis, 2005, 2009b) and was selected as a best practice for adaptation and trials in Indonesia. Whereas in the US, the five-step process primarily focuses on biophysical assessments and eco-hydrological repair, when applied to the Indonesian scenario, EMR requires both lower-cost biophysical approaches and greater attention to socio-cultural-political approaches common in sustainable development and coastal resource management programs.

The adaptation of EMR was initially tested in small-scale projects, ranging from 12-33 ha in sites from the islands of Sumatera and Sulawesi. Biophysical adaptations included use of low-cost biophysical assessment methods, reliance on manual labour, strategic breaching of aquaculture ponds dike walls, manual construction of tidal channels, and human assisted propagule dispersal while socio-political adaptations included land tenure settlement, increased use of training of trainers programs, gender assessments and sensitisation, enhanced community organising, co-ordination with numerous government agencies and participatory monitoring. Initial projects succeeded in rehabilitating mangrove coverage and diversity, while catalysing community-based or collaborative management. The most recent Community Based Ecological Mangrove Rehabilitation (CBEMR) project took place on Tanakeke Island, South Sulawesi, where 1776 ha of mangroves were reduced to approximately 576 ha over two decades due to development of 1200 ha of aquaculture ponds. At least 800 ha of ponds on the island were disused as of the start of a four-year project to restore 400 ha at a cost of US$590,000 and initiate adaptive collaborative management. Local communities from six villages willingly made their ponds available for rehabilitation, as their main livelihood had switched to seaweed mariculture and they recognised the urgent need to restore mangrove coverage for fisheries value and storm protection. The initial site restored (43 ha) has naturally recruited to an average density of 2171 stems/ha., 32 months after initial restoration. Three more recent sites have already demonstrated natural recruitment between 767-1450 seedlings within 7-10 months after restoration. Local communities have developed mangrove management groups and regulations for both remnant mangrove forests and rehabilitation areas,

Published: 22 April 2014
This manuscript was published as part of a special issue on the subject of largescale restoration of ecosystems. Edited by: Gaell Mainguy. This manuscript was reviewed by three anonymous referees.

which have been acknowledged at higher levels of government. The implementation of gender analyses, gender sensitisation and the development of Womangrove groups have been crucial to ensure the equal involvement of women in the process of mangrove rehabilitation and management. The process of CBEMR at this point is being considered for upscaling and replication, and has been included as a best practice in both the South Sulawesi Provincial and Indonesian National Mangrove Strategies. The CBEMR process has been recommended by the Ministry of Forests – Natural and Protected Forest Management Agency (PHKA) as a requisite practice to restore the 4000 ha in the Tanjung Panjang Nature Reserve in Gorontalo Province, which were nearly completely and illegally converted to aquaculture ponds over the past two decades. CBEMR and strategic breaching is also being considered for restoration in Indonesia's largest contiguous converted mangrove forest, which includes 60 000 ha of largely abandoned and disused shrimp ponds in the Mahakam Delta, East Kalimantan. The proven effectiveness of the CBEMR process at small and medium scales relies on its ability to resolve both biophysical and socio-political issues underscoring mangrove forest degradation in Indonesia. If and when this is applied to large-scale restoration, it is sure that continued attention will need to be paid to both biophysical and socio-political approaches.

TABLE OF CONTENTS

1. FACTS AND FIGURES

1.1 LOCATION

Tanakeke Island is located just off the mainland of South Sulawesi Province, Indonesia (Figure 1). A coral atoll, the island exhibits coral reef, seagrass and over-wash mangrove forest ecosystems, with a small proportion of terrestrial area. The main livelihood of most islanders is seaweed farming which takes place in expansive sub-tidal lagoons. Fishing along the reefs and out to sea is undertaken by the entire community of 10 073 inhabitants.[1] During the 1990s, 1200 ha of the island's 1776 ha of mangrove forest were converted to shrimp/milkfish aquaculture ponds (Ukkas, 2011). Of this total, 800 ha are community owned – yet largely disused – as Tanakeke Islanders have difficulty purchasing external inputs, maintaining dike walls and productivity, and have largely switched to seaweed mariculture. Tenure over 400 ha of converted mangrove forests has been granted to the Ministry of Transmigration, and as such has not yet been considered for mangrove rehabilitation (*ibid.*). The remaining 576 ha of mangroves is frequently clear-felled, for charcoal production, fuelwood, construction poles, fishing equipment and structural supports for seaweed mariculture.

Of the 800 ha of community owned ponds, 400 ha were made available for Ecological Mangrove Rehabilitation (EMR) (Lewis, 2005, 2009b) over a four year period, the process and results of which are discussed below.

Social organising and physical work were initiated and implemented by Mangrove Action Project – Indonesia as part of the 4.5 year, USD 7.7 million Restoring Coastal Livelihood (RCL) project funded by the Canadian International Development Agency (CIDA) and OXFAM-GB. Yayasan Konservasi Laut, a local NGO partner based in Makassar, provided community organising and policy assistance. Numerous government agencies were involved in terms of coordination, training, and policy development at four levels:

1 South Sulawesi Department of Statistics – 2010 Census

- Village level: Village Government, Community Representative Board (BPD);
- Sub-district/District level: Fisheries Dept., Forestry Dept., Planning Dept., Social Agency, Technical Outreach and Extension Agency (PPL), Multi-stakeholder Mangrove Management Working Group (KKMD);
- Provincial level: Fisheries Dept, Forestry Dept, Planning, Technical Outreach and Extension Agency (PPL), KKMD;
- National level: Ministry of Environment, Ministry of Forestry, Mangrove Management Agency (BPHM I), Multi-stakeholder Mangrove Management Working Group (KKMN).

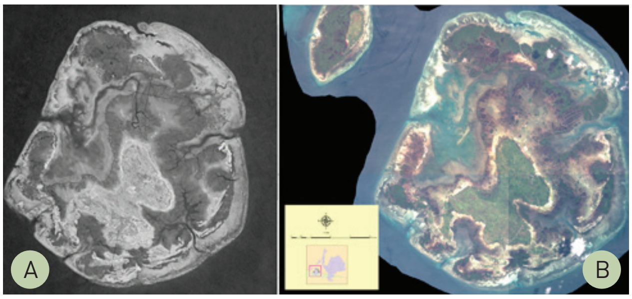

Figure 1: Tanakeke Island, South Sulawesi

A: This landsat photo was taken in 1976, depicting 1776 hectares of intact over-wash mangrove forest. (Source: Landsat.org, Global Observatory for Ecosystem Services, Michigan State University, http://landsat.org.)

B: The recent Quickbird image reveals approx. 1200 hectares of conversion to aquaculture ponds, which took place in the 1990s and early part of the 21st century. The inset indicates the location of Tanakeke approximately 12 km off the southeast corner of South Sulawesi. (Source: Quickbird Satellite Image. Longmont, Colorado: Digital Globe, 2010.)

The University of Hasanuddin provided technical support, background studies, guidance and eight university undergraduate and graduate volunteers. Additional, on-going technical support is being provided by National University of Singapore — Geography Department (modeling, substrate elevation measurements) and Charles Darwin University — Research Institute for Environment and Livelihoods (carbon stock assessment, livelihood monitoring guidance).

1.2 MAIN OBJECTIVES

- Improved hydrology and promotion of natural revegetation in 400 ha of disused aquaculture ponds with minimal need for planting mangroves.
- 1250 – 3750 volunteer (not planted) seedlings established and growing healthy (compared to benchmark) three years after initial hydrological rehabilitation.
- Re-establishment of the natural biodiversity of mangrove fauna (species and community associations) — based on previous surveys and interviews with elders.
- Development of community based mangrove management regulations; primarily delineating sustainable timber harvest practices and zones, as well as village conservation forests (*hutan pangandriang*).
- Improved community awareness and vigilance through formation of forest management learning groups (FMLGs) and "Womangrove" groups, development of sustainable livelihood alternatives and support of environmental education for school children.
- Formation of a KKMD at the district level with a long-term mandate to guide conservation and sustainable utilisation of Tanakeke Island's mangrove ecosystem.
- Legitimisation of village community management plans by the KKMD.

Figure 2: From Vulnerability to Resilience

From the onset of the mangrove rehabilitation effort, local communities and other stakeholders expressed concern that improved mangrove management was essential to ensure the long-term ecosystem services and other benefits. Use of mangrove wood on the island is unavoidable, due to lack of terrestrial area, and distance to the mainland where liquefied petroleum gas and kerosene are sold. Nonetheless, lack of managed timber harvest was identified as the biggest threat to the future of Tanakeke's mangroves. Clear felling for charcoal production (top) places villages at risk of increased impacts from waves, wind and flooding. Villages along the Western (windward) side of the island have all experienced increased flooding due to clear felling of coastal mangroves for charcoal production and pond development. Bottom: Villagers from Lantang Peo, Tanakeke Island, participated in a cookstove comparison between an "improved" fuel-efficient cookstove and a pair of traditional stoves. This activity was run as part of a Forest Management Field School, intended to develop more resilient socio-ecological systems, and resulting in the development of Community Based Forestry Management Plans. (Photos: top – Ben Brown; bottom – Abdul Munir Roy Alfatoni.)

1.3 BENEFITS TO COMMUNITY

- *Storm protection.* Villages on the Western end of the island have experienced extreme flooding events and erosion of landforms after conversion of mangroves to

aquaculture.
- *Enhanced fisheries.* Although not scientifically monitored, communities are currently monitoring crab, shrimp and fish populations in tidal creeks twice a year through participatory monitoring. Fisheries studies will be built into future projects, with the intent of re-establishing a certain percentage of a functional fisheries equivalent to the mangrove area within five to seven years of restoration.
- *Improved growth of tree biomass.* Current clear-felling practices (on 6-8 year cycles) and dense re-growth have resulted in low overall biomass production.
- *Increased resilience* of the mangrove system due to enhanced biodiversity; especially re-establishment of mangrove species at lower intertidal elevations (*Sonneratia alba*, *Avicennia marina* and *A. alba*).
- *Development of non-timber forest* products for subsistence use and local markets.

2. CASE STUDY – COMMUNITY BASED ECOLOGICAL MANGROVE REHABILITATION

2.1 PRESENTATION OF THE CHALLENGES

The following four challenges were identified by local communities and other stakeholders during this project:

1) Resolving land tenure/utilisation rights

An initial concern during project conceptualisation was committing to a total amount of mangrove rehabilitation without prior resolution of land tenure issues. Many mangrove restoration projects by-pass this time-consuming process, electing to plant mangroves in inappropriate areas (sub-mean sea level intertidal mudflats) as these areas are free from land-tenure issues. The resulting attempts at *afforestation* mostly fail (Lewis, 1999, 2005, 2009b; Erftemeijer & Lewis, 2000) except in the off-chance where significant sedimentation is occurring, which raises the substrate level to or above mean sea level.

An initial visit to the provincial forestry department of South Sulawesi clarified that both forested lands and aquaculture ponds on Tanakeke Island fell outside of their direct jurisdiction, and were rather, under the jurisdiction of the district Bureau of Land Management (Badan Pertanahan – Takalar), who issue private ownership certificates. Of the 800 ha of community owned ponds, less than half had formal certificates, but all 800 were recognised by traditional ownership. An additional 400 ha of ponds had been developed for aquaculture by the Ministry of Transmigration, but were not considered for rehabilitation under the RCL project as they are still actively managed.

The majority of coastal community members in each of the six partnering villages, either with or without formal ownership, were eager to rehabilitate disused ponds, although some owners wished to revitalise their ponds for aquaculture. It was also common that additional land owners pledge their ponds for rehabilitation, in year two after initial rehabilitation in each village.

Pond owners, both formal and informal, required assurances that once rehabilitated to mangroves, they would maintain land ownership over their areas, fearing that restored forests might subsequently be claimed by the district or provincial forest department. This issue was resolved through a series of public forums which led to the development of community forestry management plans, where legal title over rehabilitated forests was guaranteed to be retained by individual owners, with the following conditions:

- Rehabilitated lands may not be clear-cut in the future. Timber harvest would be allowed in accordance with village forestry management plans (see Figure 2).
- Access to non-timber forest products including fisheries products is to be open to all community members.
- Landowners will no longer be required to pay land or aquaculture-use taxes, as their ownership certificates are now classified as conservation/sustainable utilisation easements.
- Traditional owners without certificates will be assisted by the project and the newly formed district level KKMD to register their lands with the Bureau of Land Management and tax office.
- Each village will designate a *hutan pangandriang*, which is a strict reserve for ecological services.

These stipulations also provide communities with long-term assurance that mangroves will not be encroached upon or degraded by outside stakeholders.

2) Challenge to normative, project-oriented, over-simplified planting practices

As stated above, the majority of mangrove "restoration" projects in this region of the world involve preparing seedlings in polybags or direct root propagules (usually of the genus *Rhizophora*), which are then hand-planted in straight rows at spacings of less than a metre. Little attention is paid to planting appropriate substrate elevations (between mean sea level and high mean water spring). Fences are sometimes constructed to protect against livestock grazing. Little to no monitoring is undertaken, and mortality is often blamed on livestock, poor planting practices, poor planting material, pests, or high waves/currents.

Overcoming this was achieved through EMR workshops, after which workshop participants prepared mechanisms to build community awareness about the EMR process (described in section 2.0). A study tour to a previous successful EMR site (Tiwoho, North Sulawesi) was also used to build consensus for the EMR process.

3) Developing near-term sustainable livelihood assistance while communities wait for mangrove recovery.

Coastal communities in Indonesia often consider themselves poor, due to lack of cash savings, although many have substantial capital assets (home, boat, farmland, fishponds, *etc.*). Many rural coastal community members, however, are genuinely poor, with incomes of less than $2 a day in the four RCL work districts. Livelihood assistance in this project took two major forms: 1) improved management of existing natural resource based livelihoods (often reducing reliance on external inputs) and 2) development of alternative livelihoods. Without a livelihoods focus, it was feared that communities would be less supportive of mangrove rehabilitation efforts, especially leeward communities which were not directly threatened by the strong winds and waves experienced on the windward side of the island.

4) **Building gender awareness, ensuring equal female participation throughout the process.**

Women are responsible for half of the food production and collection on Tanakeke Island, yet do not have formal title to land, and are often excluded from decision-making (Restoring Coastal Livelihoods, 2012). Prior to the project, male stakeholders all too easily discounted female participation in mangrove rehabilitation and management programs. A concerted effort, not only to involve women equally as participants, but to involve all project participants in gender awareness trainings and activities was required. Today, "Womangrove" groups have a strong voice in how mangrove resources will be managed and used on the island, with gender sensitivity embedded in all programs, government meetings, processes and regulations. Representatives of four out of six Womangrove groups on Tanakeke are members of the KKMD.

2.2 DESCRIPTION OF THE POOL OF EXPERTISE

Mangrove Action Project (MAP) learned the principles of EMR and strategic breaching of pond walls from a pioneer in the field, Roy R. Lewis III of Florida, USA, who has served as lead practitioner on several thousand hectares of mangrove rehabilitation in the USA and Latin America as well as leading technical trainings in Asia (Lewis 2005, 2009a,b) Ben Brown of MAP-Indonesia has led ten EMR trainings in Southeast Asia, and designed successful EMR projects in North Sumatera (10 ha), Riau (33 ha), and North Sulawesi (12 ha) prior to the 400 ha of EMR on Tanakeke Island. The MAP-Indonesia EMR team consists of three full-time ecology staff, three full time community organisers, eight university volunteers, and twelve villagers from Tanakeke Island trained in community organising. This gender-balanced team is assisted by technical, planning and regulatory government agencies from the sub-district and district level, and technical extensionists from district and provincial level.

Additional technical support is being provided by a pair of regional universities. Ph.D. Dan Friess of National University of Singapore — Geography Division and his student Rachel Oh are assisting with substrate elevation measurements and modeling. Ph.D. Lindsay Hutley and Clint Cameron from Charles Darwin University — Research Institute for Environmental and Livelihoods (CDU-RIEL) are assisting with a carbon stock assessment, while Ph.D. Natasha Stacey, also of CDU-RIEL is assisting with livelihoods and social welfare indicators.

2.3 FUNDING RESOURCES AND MECHANISMS

The RCL project totals CAD 7.7 million, funded 90% by CIDA and 10% by OXFAM-GB who also facilitate the project out of Makassar, South Sulawesi. The project works in four districts in South Sulawesi: Takalar, Maros, Pangkep and Barru. Among its goals are 400 ha of mangrove rehabilitation and 2000 ha of improved management of intertidal resources. Mangrove rehabilitation at Tanakeke Island totals 400 ha with an additional 25 ha being implemented on the mainland in the district of Maros. The total cost of 425 ha of mangrove rehabilitation is USD 440,000 (including physical rehabilitation, community organising and governance work) plus USD 150,000 to support MAP staff assigned to EMR over a four-year period. This works out to a project total of 425 ha of restoration at a cost of USD 590,000 or $1388/ha.

The value of mangroves, once restored, has not yet been determined. A participatory Total Economic Valuation[2] is being carried out on Panikiang Island, which serves as the nearest reference forest for Tanakeke, three districts to the North in the Barru District.

A KKMD is being formed at the district level in Takalar, enabled by Presidential Decree 73, 2012 and described in the National Mangrove Strategy. The KKMD will be able to access short and medium term government budgets in order to continue support of rehabilitation, monitoring and management activities, being termed Adaptive Collaborative Management. No form of carbon finance has yet been developed for this site, but carbon finance is on the agenda of the KKMD.

2.4 REGULATORY CONTEXT: FACILITATING ACTIONS OR CONSTRAINTS

Both a bottom-up and top-down approach was used in this project. Community leaders in each village helped identify poor and vulnerable community members who comprise at least 75% of any activity group. Initial activities include; EMR, livelihoods development (through a program called Coastal Field School), and literacy programs. After these activities were run for one or more seasons, community members became engaged in a process to designate community based mangrove management regulations. This activity eventually became formalised as a Forest Management Field School participated in by FMLGs. A pair of curricula for this had originally been created by the Regional Community Forestry Training Center (RECOFTC) based in Bangkok in 2002, and translated into Bahasa Indonesia for the purposes of dissemination (Miagostovich, 2002b, 2002c).

2 Following the methodology provided in IUCN Ecosystems & Livelihoods Group (2006).

Currently these curricula are being used to build the capacity of forestry extensionists (called PPL) at the sub-district and district levels.

After 1-2 years in FMLGs, group members gain audiences with government officials to present their community forestry management plans for formal government acknowledgement. These government officials are prepared beforehand, during office and field visits, and participation in trainings, workshops and seminars.

Regarding the top-down approach, MAP-Indonesia met with national level government officials tasked with mangrove management and coastal community welfare. Most prominent amongst these were agencies such as the Directorate General of Watersheds and Social Forests, the Office of Mangrove Management (BPHM) and the National Mangrove Working Group (KKMN). In 2013, the head of BPHM Region I visited South Sulawesi for a public consultation to adapt the National Mangrove Strategy, to fit the needs of the Province. Subsequently, a regional KKMD was formed at the Provincial level, with management of Tanakeke Island and promotion of EMR explicitly mentioned in three points of an eleven point agenda. In late 2013, a district level KKMD was initiated in Takalar District to more adequately address the specific mangrove management needs of Tanakeke Island. Members of FMLGs and Womangrove groups both continue to participate in the District KKMD.

2.5 DETAILS OF RESTORATION PLANS AND RESULTS

The EMR process, as developed by R.R. Lewis and Mangrove Action Project contains six steps (Lewis, 2005, 2009a,b; Brown & Lewis, 2006):

1. Ecological assessment (autecology and community associations in reference forest and the rehabilitation site).
2. Hydrological assessment (in reference forest and the rehabilitation site).
3. Disturbance Assessment.
4. Land ownership resolution, planning & design.
5. Implementation.
6. Monitoring and Mid-course corrections.

This general pattern was followed during the projects in Tanakeke, but in practice required the addition of numerous sub-steps (up to 22), predominantly dealing with community organising. Below we present a process involving nine major steps, which takes into consideration the evolution of the process as mangrove rehabilitation efforts expanded from an initial site to six villages over four years.

2.5.1 STEP ONE: RAPID ASSESSMENTS

Experienced mangrove rehabilitation practitioners meet with village leaders and walk around the perimeter of the mangrove area, occasionally transecting the area to gain a quick understanding for the potential of rehabilitation. On Tanakeke Island this process began in Lantang Peo village. A quick walk revealed approximately 45 ha of aquaculture ponds adjacent to the village. Ponds on the outskirts of the aquaculture complex were largely disused (for approximately 6 years), and showed excellent levels of natural colonisation, due to lack of dike wall maintenance. These ponds served as chronoseres, aiding in the understanding of local natural revegetation processes and thus natural breaching of pond walls. The "empty" ponds in the middle were recently disused (fewer than three years beforehand), mostly unvegetated (<550 plants/ha) and were not excavated, so that substrate levels in the middle of the ponds were adequate for seedling colonisation, although deeper troughs adjacent to dike walls filled with fluid mud were unable to support colonisation. It was rapidly assessed that species normally located at lower elevations in the intertidal zone (*Sonneratia alba*, *Avicennia marina*) were largely absent from the site, having been removed historically due to community preference for *Rhizophora* species. Subsequently, the lower extent of the mangroves (coastal mangrove zone) was missing, as *Rhizophora* mangroves were not able to colonise these lower substrate elevations with higher wave energy.

In terms of community willingness to be involved in mangrove rehabilitation, within 36 hours of the initial field visit, 30 pond owners had pledged 30 ha of disused ponds for rehabilitation. The majority of community members had given up on aquaculture, switching their main livelihood to the mariculture of carageenan seaweeds. The community was well aware of the benefits of mangroves, and wished their forests back, for fisheries production, timber, and storm protection. Planting projects, however, initiated by the government in the past, had been largely unsuccessful. Determining why required more deliberate assessment.

This pattern of acquiring rapid community support for mangrove rehabilitation continued throughout the project in the next five villages, assisted by testimonials from the villagers of Lantang Peo, including the village head, Daeng Opu.

2.5.2 STEP TWO: SOCIAL ASSESSMENTS

It was the intent of the project to provide equal opportunity to women and to vulnerable and poor community members. As such, village leaders were asked to assist in identification of vulnerable community members, who were to make up at least 75% of all program participants, with greater than 50% women. The following assessments were undertaken in a variety of settings including community meetings, field schools and other activities:

- stakeholder analysis;
- gender analysis;
- gendered seasonal calendar;
- land tenure/ownership survey.

2.5.3 STEP THREE: EMR TECHNICAL TRAINING

Three EMR technical trainings were run over the course of four years with members of all six participating villages. Trainings ran for four days and covered the major points of EMR including: a review of past projects; a review of the environmental needs of mangroves; field surveys of hydrology, ecology and disturbance; mapping exercises; development of a draft rehabilitation plan; and draft community organising plan and monitoring.

2.5.4 STEP FOUR: BASELINE SURVEYS

MAP-Indonesia has developed a baseline survey and monitoring methodology described in detail in section 3.6. These surveys were informed by methods from a time zero survey developed for the Cross Bayou Restoration project (Florida Dept. of Env. Protection, 1999), as well as the "Long Plot Method For Determining Biomass," developed by Norm Duke and colleagues at James Cook University (TropWATER, 2013).

2.5.5 STEP FIVE: STAKEHOLDER MEETINGS AND DESIGN

Informal discussions, focus group discussions, and community meetings (*musyawarah*) are run quite often in the build-up to a community based EMR effort. During the initial project in Lantang Peo, government was minimally consulted. Over time, government agents are increasingly involved, to the point where formal multi-stakeholder forums are initiated. Ramping up government involvement over time is intentional, in order to provide community members with opportunities to build skills, knowledge and experience to a point where they are empowered enough to meet with government officials on equal footing.

2.5.6 STEP SIX: IMPLEMENTATION

All six mangrove rehabilitation projects on Tanakeke Island involved:

- Local community labor with hand tools;
- Strategic Breaching of Dike Walls (Brown & Lewis, 2006);
- Creation of tidal channels;
- Periodic hand distribution of all native propagules into the rehabilitation area;
- Planting trials;
- Mounding trials (increasing substrate height with fill from dike walls; occasional inclusion of beach wrack, charcoal or bamboo into the substrate).

No substantial addition of fill, or erosion control measures were attempted in the Tanakeke project. Some amount of hand-planting is taking place in certain villages, up to 10% of any given village site.

Heavy machinery was not used on Tanakeke Island, due to distance from the mainland and lack of excavated ponds to repair. A 25 ha trial in Maros District, scheduled for 2014, will use heavy machinery to selectively breach dike walls, dig tidal channels and created mounded areas, in combination with local labor and hand tools.

2.5.7 STEP SEVEN: AS-BUILT SURVEYS AND MONITORING

Described below in 2.6.

2.5.8 STEP EIGHT: DEVELOPMENT OF FOREST MANAGEMENT LEARNING GROUPS

MAP-Indonesia translated a pair of training manuals from the RECOFTC on development of FMLGs (Miagostovich, 2002b, 2002c). These curricula use the field school methodology, which was already familiar to community participants and extensionists in South Sulawesi, who took part in the RCL Coastal Field School program, as well as prior farmer field school programs in the region.

The long term objectives of FMLGs are (Miagostovich, 2002a):

- Identifying, generating and testing locally appropriate forest management practices to ensure local users' needs are being met;
- Improving the capacities, knowledge and confidence of users to more actively manage local forest area to satisfy local needs;
- Strengthening the capacities, knowledge, analytical skills and confidence of facilitators in working with local forest users;
- Improving the relations between users and forest department staff.
- Gradually improving existing management plans to ensure that they are addressing the changing needs of local people;
- Generating locally developed information and create opportunities for networking and the spread of locally appropriate information.

2.5.9 STEP NINE: MID-COURSE CORRECTIONS

Mid-course corrections are informed by analysis of data collected during both participatory and academic monitoring activities (see section 3.6). Communities and mangrove rehabilitation practitioners determine appropriate mid-course corrections during community meetings. Common mid-course corrections on Lantang Peo included:

- Hand-digging perpendicular branches on tidal channels;
- Connecting tidal channels;
- Closing off select dike wall breaches to increase flows and (scouring effect) through primary channels;
- Continued propagule dispersal;
- Augmentation planting;
- Creating mounded areas above MSL.

A search for halophytic grass species growing near mean sea level was undertaken but unsuccessful. In other projects, planting of halophytic grasses is used to stabilise substrates, capture mangrove propagules, and enhance edaphic conditions for mangrove colonisation (Friess *et al.*, 2011; Lewis & Dunstan, 1975).

2.6 MONITORING METHODS

A pair of monitoring methods are employed in this project, both academic and community-based/participatory.

2.6.1 ACADEMIC MONITORING

Academic monitoring consists of baseline surveys, as-built surveys and periodic monitoring, undertaken by a team of community members, MAP staff and volunteers from University of Hasanuddin.

Baseline surveys include autecology, community associations, hydrological features, disturbances and land ownership. As-built surveys rectify the mangrove rehabilitation plan using a GPS to place ecological and hydrological repairs on a site map. Monitoring of vegetation and development of tidal channels uses the following method.

Prior to rehabilitation of each site, ten 20m x 5m vegetation plots (Duke *et al.*, 2013) were permanently established shore-left in a random stratified design. Within each 100m^2 plot, total counts of trees (dbh[3] > 2.5 cm, height > 130 cm), saplings (dbh < 2.5 cm, height > 100 cm) and seedlings (height < 100 cm) of each species were determined. Girth of each tree was recorded using a tape measure and from this the cross-sectional area, or basal area (BA), was calculated to give an indication of growth and dominance. Tree height was recorded using an extendable height stick. Heights of the first ten saplings and seedlings encountered were recorded.

All current and historical water flows were mapped using a GPS tracking device and personal interviews with village elders. Measurements were repeated at quarterly intervals during the first year, semi-annually two and three years after the initial intervention, and annually thereafter (planned and funded for a total period of five to seven years depending on the starting time of the intervention).

To reduce variability caused by small areas of localised high recruitment (on dike walls and previously abandoned ponds), only plots located in "empty" (< 550 trees per ha before rehabilitation), recently disused (< 3 years) shrimp ponds were used in data analyses. The relationship between average stem densities over time were examined per site using a correlation analysis. Changes in mangrove densities between the baseline survey and most recent survey were analyzed with paired student t-tests using "months since rehabilitation" and "average densities" as group factors at 95% confidence levels.

2.6.2 PARTICIPATORY MONITORING

3 Diameter at breast height

Figure 3: Two levels of mangrove rehabilitation monitoring: 1) academic and 2) participatory.

A: The academic EMR monitoring team working on a long-plot at a 10 month old site in Balang Datu Pesisir. Monitoring in the first year takes place quarterly, semi-annually in years 2 and 3, and annually thereafter for a total period of at least 5 years. (Photo: Ben Brown.) B: Participatory monitoring takes place twice a year. Here a community member records data in front of the group immediately after returning from the field. (Photo: Rio Ahmad.) C: The participatory monitoring data sheets are graphic and user friendly. They qualitatively track the amount and diversity of vegetation and select biota, as well as the condition of dike walls and drainage channels forming in the rehab area. (Source: RCL Project Data Sheet.)

Participatory monitoring was developed as a community organising activity, to engage the local community in tracking the success or failure of their efforts, and in prescribing mid-course corrections. A simplified, highly graphic data sheet was created to allow all community members to participate, even those uncomfortable with reading. An example of the data sheet is provided in Figure 3. Community organisers and members of the academic monitoring team lead community groups in indoor discussions about monitoring, and then head to the field for full day monitoring events, twice a year. The results of each event are discussed and saved for comparison over time.

2.7 GOVERNANCE: FORMS OF COOPERATION, INNOVATIONS ETC.

As described above, Presidential Decree No. 72, 2012 put forth a National Mangrove Strategy, in which multi-stakeholder boards were called for at the national, provincial and district levels (known as KKMN and KKMD respectively). This project had both a bottom-up and top-down approach. Grassroots development of community skills, knowledge and experience in mangrove rehabilitation and mangrove resource management was accomplished through EMR, Coastal Field Schools and environmental education programs. The project also actively initiated the development of a multi-stakeholder forum, which, although mandated by central government, was slow in forming at the provincial level. Providing real-life examples of mangrove management for the working group to "champion," enabled the more earnest development of the KKMD, and set the stage for equitable participation by community practitioners.

Improving the capacity of forestry and fisheries extension agents ensures that increased collaboration will take place in the field, between government and community. Formalisation of this process involved development of Coastal Field School, FMLG and EMR curricula as well as training of trainer programs.

Into the future, the KKMDs formed at the Provincial and District levels will be able to access government budgets, but alternative sources of financial support from business and potentially carbon finance are being considered.

3. FINDINGS

3.1 ANALYSIS OF THE KEY FACTORS FOR SUCCESS

A table summarising recruitment for four sites on Tanakeke Island is presented along with a representative chart depicting recruitment at Lantang Peo village (Time Zero [T0] + 32 months) in Figure 4.

The first site rehabilitated of the six villages, Lantang Peo, has already exceeded success criteria for mangrove recruitment

Site	Size (ha)	Months After Initial Rehabilitation	Avg. Mangrove Density/ha	Species Recruiting
Lantang Peo	64	32	2171	6
Balang Datu Pesisir	54	10	1450	3
Bangko Tinggia	39	10	900	4
Dande Dandere	33	7	767	2
Average	47.5	14.75	908	3.75

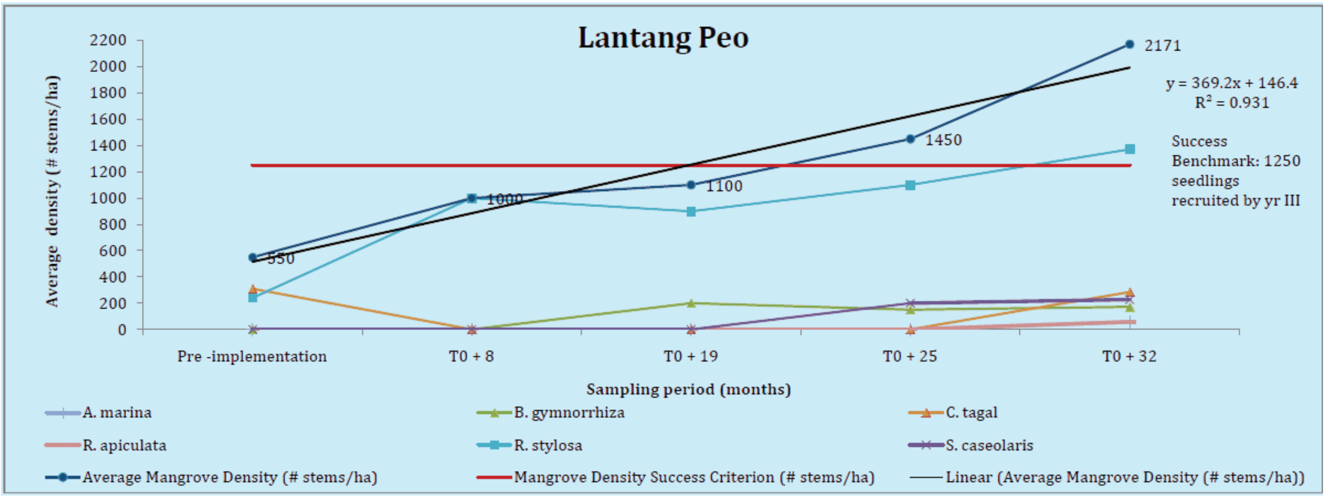

Figure 4: Recruitment at four sites on Tanakeke monitored as of Nov. 2013, and a chart depicting changes in seedling density over time for Lantang Peo (T0 + 32 months). (Source: Authors.)

The average density of the Lantang Peo site is 2171 plants per hectare 32 months following initial rehabilitation. There is an increase in species present within the site, from 2 prior to rehabilitation to 5 species established and growing after 32 months. The additional 3 species are the same as species that have been dispersed within the site during rehabilitation. A linear analysis has indicated there is a strong positive relationship between average site density and months since initial rehabilitation (R2 is close to 1.00). An independent two-tailed t-test shows there is a real change in the average density of the population, i.e. the change seen is not due to sampling variability (Stat = 2.44 > t Critical two–tail = 2.07).

Figure 5: Community Based EMR in South and North Sulawesi. A: Members of a "Womangrove" group hand-dig a 1.2 km tidal channel, to facilitate drainage of disused shrimp ponds at Lantang Peo village, Tanakeke Island, as part of mid-course corrections 12 months after initial rehabilitation. B: The resultant, meandering tidal channel. Material on the side of the channel was eventually moved away into island-like mounds in the middle of ponds. C: Natural recruitment of *Sonneratia alba* and *Rhizophora apiculata* 32 months after initial rehabilitation. D: The middles of some ponds are being recruited as well, again by *Sonneratia alba* and *Rhizophora apiculata*. E: Villagers from Tiwoho, North Sulawesi spent several weeks in the shrimp ponds (abandoned since 1991), filling in man-made drainage channels, and strategically breaching fish pond dike walls. F: The site had been hand planted by the government 6 times over a nine year period, with total mortality in each instance. After hydrological improvements, mangroves grew back in three major sections, to densities ranging from roughly 5000 - 20,000 seedlings per hectare. A biodiversity survey revealed 32 species of true mangroves in and adjacent to the mangrove rehabilitation area. (Source: All photos by Ben Brown.)

and early growth, averaging 2171 plants per hectare, and exhibiting natural levels of biodiversity based on comparison with references (historical and Panikiang Island reference forest). Note, there is no upper mangrove or terrestrial area at this site, which explains the relatively low species diversity.

Three relatively new sites which were monitored in November, 2013 along with Lantang Peo include Balang Datu Pesisir (T0+10 months), Bangko Tinggia (T0+10 months) and Dande Dandere (T0+7 months), which were already exhibiting densities of 1450, 900 and 767 mangroves per hectare. All sites showed a strong positive linear correlation between average mangrove density and time after rehabilitation except for the Bangko Tinggia site, which showed weak positive linear correlation.

A pair of sites rehabilitated In the past two years was monitored in February, 2014, but the data was not yet ready for presentation at the time of writing. A full monitoring summary for this data can be made available upon request from the author.

In terms of analysis, there has been significant recruitment of mangroves into rehabilitated ponds, with target densities reached within 2-3 years of ecological and hydrological rehabilitation. Nearby chronoseres (6-8 years after pond abandonment and dike wall degradation) show that mangrove densities can reach upwards of 6000-8000 plants per hectare, yet are currently dominated by *Rhizophora apiculata*, which was anthropogenically selected for by local fisherfolk over time.

Members of each of the six participating villages on Tanakeke also participated in a pair of study tours, one to a reference forest in Panikiang Island, Barru District, South Sulawesi, and one to and older EMR site, at Tiwoho Village, Bunaken National Park, North Sulawesi.

After the trip to the reference forest, community members themselves observed that:

- Mangroves grow better on Panikiang island, due to:
    - Nearer proximity to the mainland and a major river, supplying freshwater and sediment;
    - "Better" spacing of mangroves, less dense because not planted by humans;
    - Availability of fuelwood from terrestrial parts of the island — lack of pressure on timber from local community;
    - Clear local regulations on protection of mangroves.
- Mangroves on Tanakeke may not grow as large, overall, as those on Panikiang, but can grow better if managed better by the local community.

Participants also travelled to Tiwoho Village in North Sulawesi to meet community members who were involved in EMR of 12.28 ha of ponds. This project relied solely on the use of manual labour to strategically breach dike walls, and block unnatural drainage channels (see Figure 5E&F). Hand-digging of tidal channels was not undertaken. A mix of planting and natural recruitment took place. Study tour participants prepared transects in three areas of the rehabilitation site ranging from T0+7 years to T0+10 years, to better understand the long-term trajectory of mangrove rehabilitation. The group found mangrove densities ranging from 9,467-27,093 stems/ha, with an average of five species recruited per area. The total number of recruits in the approximately 15 ha site (12 ha of ponds and 3 ha of adjacent area) was measured at 24 species.

The apparent success of the low-cost method of strategically breaching dike walls is clear to community participants, who are keen to continue applying the method in Tanakeke Island. The method seems feasible for disused aquaculture ponds that have not been excavated with heavy equipment. Deeper ponds, with stronger dike walls, may or may not require the use of heavy equipment and fill material. At a certain scale, greater than 100 hectares, heavy equipment may also be required, even in non-excavated ponds.

Certainly at larger scales (landscapes requiring thousands of hectares of repair) use of heavy equipment will be required, but the same use of strategic breaching and tidal creek creation may be feasible. Projects have already been identified in Indonesia of up to 7,500 ha (Tanjung Panjang, Gorontalo) and up to 60,000 ha (Mahakam Delta, East Kalimantan). Political will of local stakeholders to rehabilitate a portion of disused ponds has already been established, and EMR and Strategic Breaching of Pond Walls — with a high degree of genuine community involvement — are recommended as best practice approaches.

3.2 KNOWLEDGE GAPS

- Low cost methods for substrate elevation measurement at large-scale;
- Sizing tidal channels during restoration;
- Solutions for enhancing recruitment in fluid substrates;
- Calculating rates of sedimentation with low-cost methods;
- Developing benthic macroinvertebrate indicators;
- How to convince government, aid projects, to abandoned simple planting practices;
- Clear cost benefit analysis of mangrove vs. aquaculture.

3.3 MAIN CHALLENGES AND INNOVATIONS

- Achieving low-cost, effective rehabilitation.
- Developing rural coastal community awareness and capacities to the point where they were empowered and experienced enough to engage government agents in meaningful and productive dialogue.
- Engagement of men and women alike in gender analysis and gender sensitisation trainings and development of "Womangrove" groups to ensure high quality female

participation in rehabilitation and future management.
- Key hydrological innovations strategic breaching, hand dug drainage channels.
- Key ecological innovations; human assisted propagule distribution, especially of pioneering species which were anthropogenically selected against during 75+ years of logging.
- Integration of methods into National Mangrove Strategy through Multi-stakeholder Mangrove Working Groups (KKMN and KKMD).
- Establishing meaningful demonstrations at scale (25 ha and 400 ha) to be able to engage government and other stakeholders to undertake large-scale efforts (7500 ha — Tanjung Panjang, Gorontalo Province to 60,000 ha — Mahakam Delta, East Kalimantan Province).

References

Brown, B. & R.R. Lewis (2006). *Five Steps to Successful Ecological Restoration of Mangroves*. Lewis, R. *et al.* (Eds.) Yogyakarta, Indonesia: Yayasan Akar Rumput Laut (YARL) and the Mangrove Action Project.

Duke, N.C., J. Mackenzie & A. Wood (2013). *Preliminary assessment of biomass and carbon content of mangroves in Solomon Islands, Vanuatu, Fiji, Tonga and Samoa.* Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER) Report 13/24, James Cook University, Townsville.

Erftemeijer, P.L.A. & R.R. Lewis (2000). Planting mangroves on intertidal mudflats: habitat restoration or habitat conversion? In: *Enhancing Coastal Ecosystems Restoration for the 21st Century.* Proceedings of the ECOTONE VIII Seminar, Ranong, Thailand, 23-28 May 1999, pp. 156-165. Bangkok: Royal Forest Department of Thailand.

Florida Department of Environmental Protection (1999). *Time zero report for the Cross Bayou mangrove restoration site*. Prepared by R. R. Lewis III for The Cross Bayou Project Review Group. Pinellas County, Florida.

Friess, D.A. *et al*. (2011). Are all intertidal wetlands naturally created equal? Bottlenecks, thresholds and knowledge gaps to mangrove and saltmarsh ecosystems. *Biological Review*. doi: 10.1111/j.1469-185X.2011.00198.x Cambridge Philosophical Society.

IUCN Ecosystems and Livelihoods Group (2006). *Valuation, rehabilitation and conservation of mangroves in tsunami affected areas of Hambantota, Sri Lanka: Economic valuation of tsunami affected mangroves*. Ranasinghe, T. & M. Kallesoe. Sri Lanka: The World Conservation Union (IUCN) Ecosystems and Livelihoods Group Asia.

Lewis, R.R. & F.M. Dunstan (1975). The possible role of *Spartina alterniflora* loisel in establishment of mangroves in Florida. In: *Proceedings of the Second Annual Conference on Restoration of Coastal Vegetation in Florida*. Tampa, Florida: Hillsborough Community College.

Lewis, R.R. (1999). Key concepts in successful ecological restoration of mangrove forests. In: *Proceedings of the TCE-Workshop No. II, Coastal Environmental Improvement in Mangrove/Wetland Ecosystems*, *18-23 August 1998*, pp. 19-32. Bangkok: Danish-SE Asian Collaboration on Tropical Coastal Ecosystems (TCE) Research and Training.

Lewis, R.R. (2005). Ecological engineering for successful management and restoration of mangrove forests. *Ecological Engineering* 24: 403–418.

Lewis, R.R. (2009a). Mangrove field of dreams: If you build it, they will come. *Society of Wetland Scientists – SWS Research Brief*. No 2009-0005

Lewis, R.R. (2009b). Methods and criteria for successful mangrove forest restoration. In: Perillo, G.M.E., E. Wolanski, D.R. Cahoon & M.M. Brinson (Eds.) C*oastal Wetlands: An Integrated Ecosystem Approach*, pp. 787-800. Elsevier Press.

Miagostovich, M. (2002a). Building forest users' capacity to develop silvicultural practices. In: *International Learning Workshop on Farmer Field Schools (FFS): Emerging Issues and Challenges, 21-25 October 2002,* pp.413-434. Yogyakarta, Indonesia.

Miagostovich, M. (2002b). *Forest Management Learning Group (FMLG) - The Facilitator's Field Manual*. Bangkok: Regional Community Forestry Training Center for Asia and the Pacific (RECOFTC).

Miagostovich, M. (2002c). *Forest Management Learning Group (FMLG) - The Trainer's Manual*. Bangkok: Regional Community Forestry Training Center for Asia and the Pacific (RECOFTC).

Restoring Coastal Livelihoods (2011). *Kajian Risilian [Resilience Assessment]*. Situational and Contextual Field Assessment and Analysis Restoring Coastal Livelihoods Project. Prepared by Jajang Agus Sonjaya. Makassar, Indonesia.

TropWATER (2013). *Preliminary assessment of biomass and carbon content of mangroves in Solomon Islands, Vanuatu, Fiji, Tonga and Samoa*. A Report for the MESCAL Project, IUCN Oceania Office, Suva Report No. 13/24 May 2013. Prepared by Duke, N.C, J. Mackenzie and A. Wood. Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER). James Cook University, Townsville, Australia.

Ukkas, M. (2011, July). *Status of Tanakeke Island mangroves and livelihoods since aquaculture development*. Paper presented at Restoring Coastal Livelihoods Regional Seminar on Ecological Mangrove Rehabilitation, July 18-22, 2011, Makassar, Indonesia.