Ecological Mangrove Rehabilitation (EMR) Workshop

PPLH-Puntondo, South Sulawesi

October 18-21, 2010

Facilitated By:

Funded By:

Published by:

First Published in Electronic Format in

This version first published Dec 15, 2010

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Ecological Mangrove Rehabilitation Workshop PPLH, Puntondo, Indonesia, 2010.

1. Mangrove forests--Indonesia--Workshops. 2. Mangrove ecology--Indonesia--Workshops.
3. Mangrove conservation--Indonesia--Workshops.

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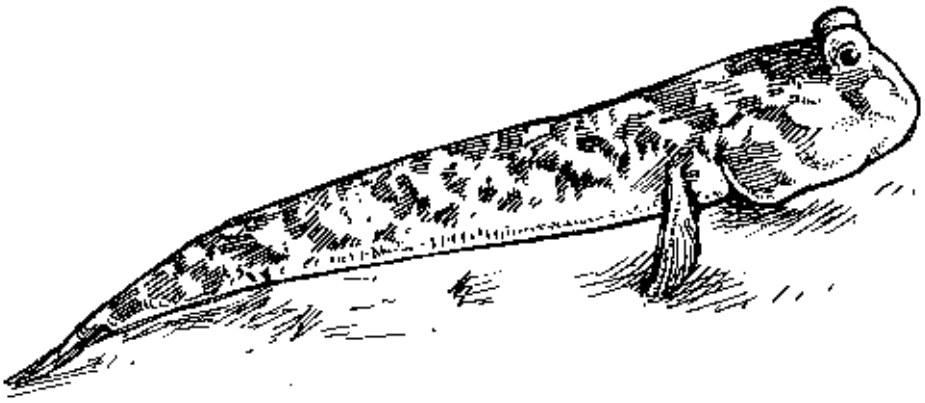
Acknowledgements: On behalf of MAP-Indonesia, I would first and foremost like to thank the community of Puntondo and PPLH-Puntondo for hosting the workshop, and being such excellent and active participants, students and teachers. Thanks to all the participants, including community members from the Takalar District, members of Yayasan Konservasi Laut, and the Department of Fisheries - Takalar, for enthusiasm and very active participation. Thanks to the team at MAP-Indonesia for their hard work as facilitators and in handling logistics. Thanks also to OXFAM-GB as co-funders and chief partners on the Restoring Coastal Livelihoods project, and CIDA Canada for the financial support that made this training possible and follow-up work possible.

- Ben Brown, October, 2010.



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Ecological Mangrove Rehabilitation Workshop
PPLH - Puntondo, South Sulawesi

Facilitation: Mangrove Action Project – Indonesia (MAP-Indonesia)

1.0 Background

1.1 Mangroves and Resilience

Whole mangrove ecosystems have a high degree of resilience. Ecosystem resilience is the capacity of an ecosystem to tolerate disturbance without collapsing into a different state that is controlled by a different set of processes. A resilient ecosystem can withstand shocks and rebuild itself when necessary. Resilience in socio-economic systems have the added capacity of humans to anticipate and plan for the future. Humans are part of the natural world. We depend on ecological systems for our survival and we continuously impact the ecosystems in which we live from the local to global scale. Resilience is a property of these linked social-economic-ecological systems (SEE).

Resilience as applied to integrated systems of people and mangroves, has three defining characteristics:

- The amount of change the system can undergo and still retain the same controls on function and structure;
- The degree to which the entire mangrove ecosystem is capable of self-organization/self-renewal
- The ability to build and increase the capacity for learning and adaptation – Management based on a continuous cycle of field trials and reflection is known as adaptive management and is discussed in the final section of this report under considerations.

Catastrophic Shifts In Ecosystems

The amount of resilience a system possesses relates to the magnitude of disturbance required to fundamentally disrupt the system causing a dramatic shift to another state of the system, controlled by a different set of processes. Reduced resilience increases the vulnerability of a system to smaller disturbances that it could previously cope with. Even in the absence of disturbance, gradually changing conditions, e.g., sedimentation, sea-level rise, habitat fragmentation, etc., can surpass threshold levels, triggering an abrupt system response. When resilience is lost or significantly decreased, a system is at high risk of shifting into a qualitatively different state. The new state of the system may be undesirable, as in the case of a mature mangrove forest that becomes a pock-marked terrain full of *Acrostichum* fern or an abandoned shrimp pond complex. Restoring a system to its previous state can be complex, expensive, and sometimes even impossible.

How Is Resilience Lost In Mangrove Systems?

The resilience of a mangrove forest as a complex social-ecological systems depends largely on underlying, slowly changing variables; such as climate, land use, water balance, human values and policies. Resilience can be degraded by a large variety of factors including:

- loss of biodiversity
- disturbance to natural hydrology
- toxic pollution
- inflexible, closed institutions
- perverse subsidies that encourage unsustainable use of resources
- a focus on production and increased efficiencies of a specific part of the mangrove system

How Is Resilience Enhanced?
Mangrove forests are inherently resilient, but just as their capacity to cope with disturbance can be degraded, so can it be enhanced. One key to resilience in social-ecological systems is diversity. Biodiversity plays a crucial role by providing functional redundancy. This means that more than one species can fill an important ecological role when other species may be absent or unable to fulfill such a role. As an example from Takalar; different mangrove species occur at various substrate heights or levels of tidal inundation. As sea-level rises (noted by communities on Tanakeke Island) mangroves which are not used to frequent inundation will need to be replaced by species tolerant of increased submerged periods. Mangrove species nearer to land, in turn, would need to migrate inland over time, requiring a buffer area in which to retreat. A resilient forest, would have enough different types of mangroves to adapt to increased inundation periods, and also room to spread inland. Without species that tolerate longer periods of inundation (*Rhizophora* spp, *Avicennia* spp, *Sonneratia* spp) and a hinterland for colonization of back mangrove species (such as *Pemphis acidula, Lumnitzera racemosa, Aegiceras corniculatum*), the mangrove system will cross a threshold into the new (and potentially less valuable) regime.

Likewise in socio-economic systems, diversity and redundancy are important. More than one government agency tasked with community outreach for mangrove habitat protection, allows for greater opportunity for iterative dialogue with fisherfolk who are constantly interacting with the resource. In the case of Laekang Village, the Fisheries Department may be interested in maintaining aquaculture ponds, while promoting coastal buffers of mangroves. But with this singular goal in mind, they may be ignorant of the importance of maintaining mangroves from hinterland to foreshore, and keeping tidal creeks in tact, which enable sediment, to be deposited to maintain a substrate height capable of colonization by mangroves. In this case, collaboration with local communities, NGO's and other government agencies interested in encouraging mangrove ecosystem health for multiple benefits, will help the Fisheries Department achieve its own management objectives of establishing and maintaining a coastal greenbelt.

1.2 Ecological Mangrove Rehabilitation
Rehabilitation of existing and former mangrove forest areas is more important nowadays that ever before. Healthy mangrove ecosystems offset some of the effects of collapsing fisheries, climate change and sea level rise, increasing storm events and water pollution. Whole mangrove ecosystems, however, are becoming increasingly disturbed, fragmented and rare, due primarily to lack of perceived by governments, investors and to some extent coastal communities. Mangrove systems provide open access goods and services, and are therefore targets for conversion and privatization; evident in the large-scale expansion of shrimp aquaculture, charcoal production and conversion to oil palm plantations in recent decades.

Worldwide, over 150,000 hectare of mangroves are lost each year. This necessitates practitioners to be both effective and efficient in rehabilitation activities. Actual planting of mangroves is rarely needed as mangroves annually produce hundreds or thousands of seeds or seedlings per tree, which under the proper hydrologic conditions can re-colonize former mangrove areas, returned to normal hydrology, very rapidly.

Over the years, there have been many different attempts to restore mangrove trees. Some of these efforts have been gargantuan, involving several thousand hectares of coastal lands. Other efforts have been small in comparison, with perhaps less than an hectare of mangroves restored. Yet, in these efforts, both large and small, the lessons learned in this important process are vital in re-establishing otherwise rapidly vanishing mangrove forests. Without taking those necessary steps now to restore mangroves, our planet's coastal regions will be seriously impacted by erosion, declining fisheries, vanishing wildlife, and displaced coastal peoples.

There are many different techniques and methods utilized in planting mangroves. Because some of these have resulted in identifiable successes or failures, we wish to present herein a summary description of particular case studies which are representative of some of the recommended methods for rehabilitating mangroves. It should be borne in mind from the start, however, that mangrove forests cannot in general be rehabilitated cheaply or rapidly. What we describe here is rehabilitation of a limited variety of mangrove trees and plants, but a restoration of an entire forest ecosystem is a very difficult task. In Southeast Asia, for instance, there may exist some 40 or more mangrove plant varieties, of which an ambitious restoration program

might handle only half a dozen varieties, or so. What we describe, therefore, is a simpler and manageable process of partially rehabilitating a mangrove forest, while hoping that in time the great diversity of the original forest will again return.

Obviously, the way to retain the great biodiversity of the mangrove ecosystem is to protect and conserve those intact mangrove ecosystems that still exist. The mangrove forests that have been lost account for over half of our planet's original mangrove forest cover. In 1995 roughly 16 million hectares remained from a former area of 32 million hectares. The remaining mangroves are still in great peril, and vanishing fast under development pressures from shrimp aquaculture, charcoal, and timber industries, agriculture expansion, population pressures, coastal pollution, and tourism developments. Rehabilitating mangroves is only a partial solution. Protecting those precious remaining mangrove ecosystems must become an imperative for all nations, before too much is lost, and our efforts to restore are in vain.

The following is meant to provide only a rudimentary understanding of some proven techniques and advice from a few experts on restoring mangroves in their areas. However, for a fuller understanding and a more certain approach to restoration, the reader should research more thoroughly this subject, and consult more directly with those who are experienced experts in hands-on restoration techniques (see list at the end of this report). The techniques outlined herein are only a basic guide, and should be tailored to each unique situation and coastal region where restoration is being attempted.

A Simple Guide To Restoring Mangroves.
There are basically four approaches, which are used in mangrove rehabilitation programs:

1. Hydrologic rehabilitation with no planting
2. Hydrologic rehabilitation with planting
3. Planting without consideration for hydrology
4. Removal of stress in the form of overgrazing, or intense wood cutting to allow either natural regeneration, or planting. Planting for future harvests of wood (silvaculture) is a common practice, but ecological impacts of too much wood removal at one time need to be carefully examined.

Method 1 has proven very successful (Lewis 1990a; Brockmeyer *et al*., 1997; Turner and Lewis, 1997), but does take some time for mangrove seeds to colonize sites with restored hydrology. It is the most cost effective of the first three methods.

Method 2 has also proved effective, and can provide visible recovery very quickly (Lewis *et al*., 2000), but planting costs can double the overall cost of a project and may limit the biodiversity of the site due to competition from planted mangroves (usually only one or two species) with volunteer species (5-15 species).

Method 3 is perhaps the most common method tried, and almost always has significant problems in achieving success. It is not easy to create a garden of mangroves where none existed before. Mangroves have very restricted tolerance for inundation, salinity and flooding, and where the water fluctuations are not suitable, such as natural mudflats, mangroves typically do not grow, and are almost impossible to successfully plant and grow into trees. A few may survive for a few years, but nearly always they eventually disappear. Despite these failures, often after millions of dollars have been spent (see Lewis, 1999 and Erftemeijer and Lewis, 2000 for examples), planting continues without consideration of the hydrologic site conditions.

We caution that existing site conditions need to be carefully assessed before any thought of planting is considered. Why does the site not now have mangroves? Is there documentation that they existed in the past? What happened? Was hydrology altered due to creation of bunds, dikes, roads, aquaculture ponds, agriculture or drainage canals? Is excessive sedimentation taking place? If overharvesting removed mangroves, then planting may make sense. Perhaps there is a lack of seed sources (propagule limitation). Providing seeds to an area by simply harvesting them and broadcasting them on a rising spring tide in the area may be enough to begin reestablishment. Actual planting by hand of the larger propagules of *Rhizophora* and

related species is popular, and may be a good community activity. It may also decrease community interest in future mangrove conservation, if planting activities fail. Don't plant too close together (2 – 8 meter spacing is fine) and don't be surprised if Mother Nature plants mangroves better than you do! Large expensive nurseries to grow mangroves are rarely essential, cost a lot of money, and take valuable resources away from real mangrove restoration efforts.

The various ways in which to rehabilitate mangroves can often confuse practitioners, especially those coming into mangrove rehabilitation without prior experience in either habitat restoration or mangrove ecology. The six-step Ecological Mangrove Rehabilitation Method was designed in order to provide a consistent process for mangrove rehabilitation projects, to increase the likelihood of success.

6 Steps to Successful Ecological Mangrove Rehabilitation (EMR):
Work together with local communities, NGOs and government to:

1. Understand both the individual species and community ecology of the naturally occurring mangrove species at the site, paying particular attention to patterns of reproduction, distribution, and successful seedling establishment;
2. Understand the normal hydrology that controls the distribution and successful establishment and growth of targeted mangrove species;
3. Assess the modifications of the mangrove environment that occurred and that currently prevent natural secondary succession;
4. Select appropriate restoration areas through application of Steps 1-3, above, that are both likely to succeed in rehabilitating a forest ecosystem and are cost effective. Consider the available labor to carry out the projects, including adequate monitoring of their progress toward meeting quantitative goals established prior to restoration. This step includes resolving land ownership/use issues necessary for ensuring long-term access to and conservation of the site;
5. Design the restoration program at appropriate sites selected in Step 4, above, to restore the appropriate hydrology and utilize natural volunteer mangrove recruitment for natural plant establishment;
6. Utilize actual planting of propagules or seedlings only after determining through Steps 1-5, above, that natural recruitment will not provide the quantity of successfully established seedlings, rate of stabilization, or rate of growth as required for project success.

1.3 Ecological Mangrove Rehabilitation (EMR) Workshops

As a means of disseminating and training practitioners in the methods of EMR, workshops are held for practitioners at various levels, government & academia as well as community. EMR workshops were first held by the creator of the EMR method, Robin Lewis, in Florida, USA. Community EMR workshops in Asia have been held in Indonesia, Sri Lanka, Cambodia, India and Malaysia. Community EMR workshops adhere to an action-research/problem-solving method. The typical flow of an EMR workshop, follows the six-step EMR method. Mural drawing, field visits, powerpoint presentations and group discussions are the main activities undertaken during a training.

An understanding of the past history of the mangrove is achieved through presentations by the local community, field visits and interviews with community elders. The present status of the mangrove area is mapped in small groups, assigned various tasks (autecology, hydrology and analog forestry mapping) during a second field visit and presented in front of the entire group.

After understanding the local situation, both past and present, the group then learns how other coastal communities have taken action in similar situations, both within their own region as well as internationally. The group is also presented with global resources to assist them in future action planning and implementation (methods, tools, techniques, networks).

After this global investigation of other mangrove action projects, the group comes back to the local level to engage in action planning. Action planning is also a visual activity, usually combining the use of maps, powerpoint, mural drawing, role playing and presentations.

The paradigm, followed during the action-research/problem-solving process is known as local to global to local, a step beyond the common phrase think globally, act locally. It encourages a local investigation, followed by a global search for alternative solutions, culminating in local action planning.

1.4 The Mangroves of Takalar Past and Present

A US Army Corps of Engineers map for the Takalar District based on data compiled between 1946-1962 shows a relative scarcity of mangrove coverage along the majority of coastline of the district. The exception occur in major bays such as Laekang Bay, along significant estuarine river mouths such as the Djene Tjikoang and Djene Dinging, as well as the island of Tanakeke. This data, may be inaccurate, as it was collated without the aid of remote sensing imagery. MAP-Indonesia is currently commissioning a 20 year trend analysis based on more accurate satellite imagery, to uncover changing patterns in mangrove coverage.

As will be seen in the proceedings section of this workshop report - information from elders in the Laekang Bay, indicate historical mangrove coverage that may pre-date data compiled for the above US Army Corps of Engineers map, potentially evidenced by significant peat layers underneath coral rubble along the coast.

What is clear, however, is that a majority of Takalar coastline can be considered high energy throughout a significant portion of the year. Those areas without major rivermouths, are largely eroding environments with sandy/coral rubble substrate, not conducive for mangrove proliferation.

Where mangroves do exist, a narrower range of species occur than is common in the larger, alluvial plains of other parts of Sulawesi island (Kendari, Gorontalo, Luwuk, etc.). Trees are often small or even stunted, as a mixed result of environmental and human caused factors. Associate mangrove fauna exist in a significant diversity where mangroves occur, but how this diversity, as well as abundance compare with more undisturbed sites has yet to be studied in recent literature. MAP-Indonesia has undertaken a participatory ecology survey of Tanakeke Island, in partnership with the University of Hasannuddin Department of Biology, but raw data are yet to be analyzed.

1.5 Special Topic: Current Mangrove Uses

Series: Islanders on Tanakeke have developed numerous uses for mangrove wood, preferring Rhizophora spp., for fuel wood, charcoal production, and construction purposes. Here we see mangrove wood being prepared for grilling fish. The wood is burnt down to embers on an open fire, and the fish are grilled quickly on remaining embers. Field school programs will look at the practices involved in mangrove logging, in an attempt to improve management for timber by determining best selective logging practices through fisherfolk managed scientific trials. Field School will also look at ways to improve efficiency of mangrove wood use, such as development of fuel efficient cookstove and grills.

Mangrove wood is sold per bundle at 5000 rupiah. Although there is much consumption of mangrove wood locally (indeed it is the only locally available fuel source for many of the dusun on Tanakeke, the islanders also send wood to the mainland, where it is used primarily for grilling fish in Makassar.

Above Left: Charcoal is also produced in buried pits and sold to the mainland. This is an occupation run by men and women alike. The process, however, is highly inefficient. Field School will explore if improved technologies such as use of a kiln (from recycled oil drums or clay and bricks) are appropriate for continual use on the island.

Bottom Right: Another main use of mangrove wood is to hold seaweed lines - for the major livelihood of the island. There may be no appropriate alternative for this use.

2.0 EMR Workshop Proceedings - Puntondo Environmental Education Center (PPLH), Laekang Village, Takalar, South Sulawesi, Indonesia, 18-21 October 2010

This Ecological Mangrove Rehabilitation workshop was attended primarily by local community fisherfolk, from villages partnering with OXFAM GB and MAP-Indonesia in the 5 year "Restoring Coastal Livelihoods" program. All fisherfolk came from Laekang Village (sub-villages Puntondo and Laekang), as well as Tanakeke Island (Maccinibaji or Mattirobaji? Village). The workshop was also attended by NGO members of Yayasan Konservasi Laut (YKL), Lembaga Maritim Nusantara (LEMSA), University of Hasannudin Faculty of Marine Science and Fisheries, as well as a pair of representatives from the District of Takalar Fisheries Department. A complete list of participants is presented in the appendix. All participants were engaged in hands-on learning about Ecological Mangrove Rehabilitation, through a series of field and classroom lessons. Stress was placed on value-sharing, open communication and participation.

2.1 DAY ONE

2.1.1 Overview, Welcome, Ice-Breaker and Introduction to EMR

Warm welcomes were provided by the local community, PPLH and MAP-Indonesia.

Ice Breaker – Participants gathered in a circle and state their names. A ball was introduced and participants were asked to shout someone's name, make eye contact with that person and pass the ball. This continued until everyone in the circle touched the ball. The activity was timed, and timing improved from around 2 minutes to 40 seconds. The team was then asked how to break the record for this event, which is under one second. They figured out the trick, and a discussion ensued about problem solving and team work, which would be important skills throughout the training.

Discussion of Agenda – Opportunity to learn about, question and fine tune the agenda together.

Identify Mangrove Goods & Services – This discussion was led by the participants themselves. The extensive list generated, depicts their deep understanding of the value of mangrove ecosystems.

Mangrove Uses	Mangrove Ecosystem Services
Fuel Wood	Protection from coastal abrasion
Charcoal	Bird Habitat
Medicine	Fish nursery
House construction	Fish habitat/gathering place
Poles for seaweed farming	Food chain
Dye	Tourism
Paper	Waste management
Alcohol	Education
Sugar	Reduce air pollution
Cake	Carbon storage
Crackers	
Fish/shrimp pond (conversion)	
⇧ positive	
⇩ negative	
⇳ both	

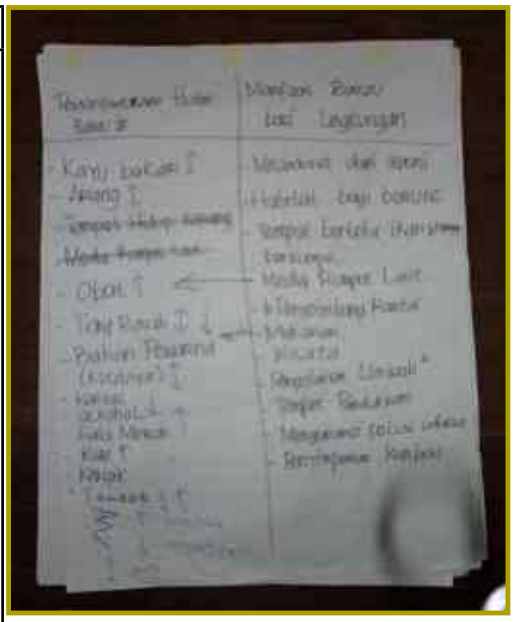


Table 1 - Results of a group discussion on mangrove goods and services.

Expectations of the Workshop – Participants were asked to write down their hopes and expectations for the workshop. These were referred to by organizers/facilitators throughout the workshop, to make sure that content was appropriate to participant needs.

2.1.2 Six Critical Steps Necessary To Achieve Successful Ecological Mangrove Rehabilitation (EMR):
PowerPoint Presentation

This presentation gave a general overview of MAP programs, before delving into detailed instruction on each of the six steps of EMR. Case studies from Indonesia and around the world looking at mangrove rehabilitation successes and failures. MAP discussed it's six pronged approach to sustainable coastal community development and mangrove conservation; 1) community based mangrove resource management and policy development, 2) environmental education, 3) mangrove rehabilitation, 4) coastal field schools leading to livelihood and small business development, 5) In the Hands of the Fisherfolk workshops, and 6) media development and dissemination.

It was underscored that protection of existing mangrove resources was to be prioritized over mangrove rehabilitation, due to the complexity and inherent value of mature mangrove forests. However, seeing that the world loses 150,000 ha of mangroves a year, rehabilitation is an important activity as well. What is more important, is that rehabilitation efforts follow a process, including assessments and participatory planning. The 6 step EMR process is such a tool, and this workshop is to focus on understanding and using this tool.

During the presentation, special attention was paid to understanding the community ecology and individual species ecology of mangrove trees, and how these related to key hydrological features such as tidal inundation frequency and substrate height. A discussion on the importance of conservation as opposed to restoration only took place. The group looked closely at satellite images of Laekang Bay and Tanakeke Island. A group discussion to understand the restoration goals of workshop participants.

Top Right: Ben Brown of MAP, relating the 6 steps of Ecological Mangrove Rehabilitation.

Bottom Right: A good mix of participants, learning both theory and practice resulted in a continuous high level of participation and interest. A truly excellent group.

2.1.3 Ecology Field Trip to PPLH Lagoon – Three Groups

This initial field trip was intended as a general mangrove ecology walk, to begin to understand concepts from the first step of EMR, and more specifically, the individual ecology of mangrove species in the area (autecology). Three small groups started at different points around the lagoon, and were led by MAP staff as well as the numerous participants who had special knowledge, interest and experience of local mangroves. Armed with field guides, laminated identification sheets, binoculars (for bird watching), and data sheets, the group recorded key information of mangrove species present, as well as general information about the various habitat types and general substrate height where true mangroves and mangrove associate plants were occurring.

Top Center: Between the human create berm and what used to be an old fishpond. The surface of the lagoon was higher than that of the nearby bay, as the lagoon drains slowly after high tide through only a single breach.

Clockwise from bottom left: Using laminated identification sheets to determine species composition in the area; standing in a grove of *Lumnitzera racemosa* - typically found near the terrestrial edge, these trees are growing on the human made berm, along with typical beach species. Bees attracted by the fragrant white flowers make excellent honey, and provide a potential economic option for this area; a young *Rhizophora apiculata* is growing well atop the pneumatphores (air breathing roots) of a *Sonneratia ovata*. Under the shade of a *Xylocarpus moluccensis* - one of the only two trees of this species found near PPLH; coming out of the lagoon the group begins to notice how species change with substrate height.

2.1.4 Mural Drawing - Past Condition

Throughout the workshop, small groups would come together after field exercises to create a series of mural drawings. These would include drawings of the past and present condition of mangroves in the study areas, detailed mangrove transects depicting species in relation to substrate height, and on the final day of the workshop, a mural of the future, which would be part of an overall action plan.

Below, we see an example of a mural depicting the past condition of mangroves. Participants drew these based on their understanding of mangrove ecology in the field, as well as interviews with community elders.

2.2 Day Two

2.2.1 Participant Presentations

All participant groups were given the opportunity to present information about their previous experience with mangroves and community based coastal resource management in general. It was noted that women's voices were being overshadowed by men, and an extra session was added toward the end of the workshop to understand more specific issues from a female perspective. The content of these presentations will not be discussed thoroughly in this report, however, we will provide highlights from some of the groups who presented.

PUKAT (Tanakeke Island Youth Group): This local community group delivered an inspiring oral presentation about the history of Tanakeke, the formation of their group, and activities to date. Their primary mission is to help Tanakeke Islanders become self-sufficient. They expressed their eagerness, as well, for sharing information and knowledge on appropriate mangrove rehabilitation techniques, mangrove area management and sustainable utilization of mangrove products. The enthusiasm shown by this group, is a testament to their own capacity as well as the hard work of Yayasan Konservasi Laut who had facilitated this group prior to the RCL project.

PPLH (Environmental Education Center of Puntondo): PPLH began in Java, and has a pair of branches in Bali and Sulawesi. PPLH Puntondo - being situated along Laekang Bay is largely dedicated to coastal resource protection. They currently coordinate village groups, including women's groups in nearby Puntondo, for livelihood development, coral rehabilitation and resource protection. Environmental Education is their strong suit, and they have frequent programs with visiting school groups as well as outreach. PPLH is now engaged in rehabilitation of their grounds from a Landscape Ecology perspective, and mangrove rehab of the lagoon behind their facility fits in with the grand scheme. They own 2/3 of the lagoon, the other third being owned by members of Pasir Putih, who are interested in partnershing with PPLH and MAP for whole system rehabilitation, conservation and sustainable use.

Department of Fisheries - Takalar District: Officers from the fisheries department spoke of previous outreach, especially in the aquaculture sector, as well as experience in mangrove planting. They admitted lack of capacity in coordinating with local communities. There were some tough questions on behalf of local community aimed at the fisheries department, but these were fielded with dignity and humility. Hopefully, forums like this workshop, can help develop improved communications between coastal communities dependent on access to health natural resources, and government.

Pasir Putih (White Sands): This local community group is newly formed, and at the time of the start of this meeting had 42 members. They planned on limiting membership to 50 individuals. PPLH staff and volunteers have integrated with this group, including a female volunteer from Canada who broke through the gender barrier of this all boys group by playing soccer. During the meeting, Pasir Putih added 8 women to the group, bringing their total to 50, and have since added another 5 women, in an effort to achieve gender balance. The group is involved in volunteer work projects, mangrove planting, and development of small livelihoods.

Special Women's Perspective): As women's voices were under heard during this first sharing session, Linda of MAP held a side discussion to help uncover information about women's roles in their communities, community organizations and experiences with mangroves. These roles will be further understood through other MAP programs, such as field school, where gender analyses are taking place. On Tanakeke Island, women and men share equally the task of mangrove cutting for fuel wood.

2.2.2 Field Work - Understanding Hydrology

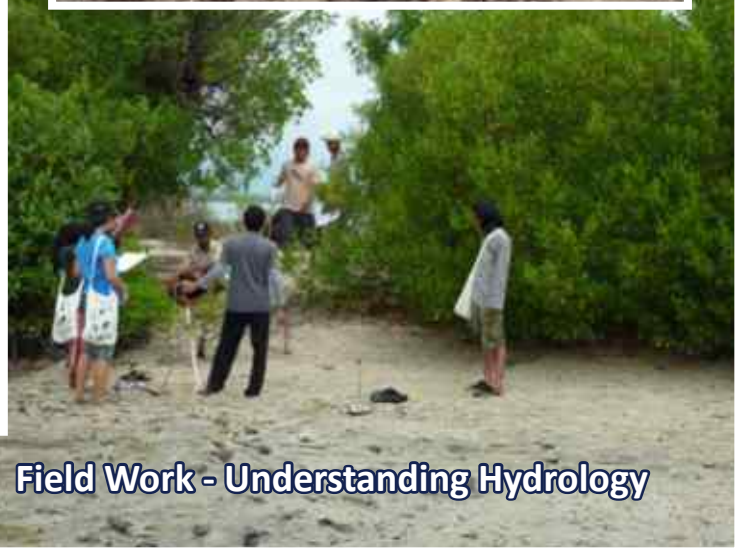
Background: The coastal area along Laekang Bay experiences semi-diurnal tides. Originally, if a mangrove forest belt existed in the PPLH area, it likely had a full complement of lower, mid and upper mangrove species, transitioning into a terrestrial buffer zone. Over 16 remnant species of mangroves exist in the lagoon, many of which are back mangrove species. This is verified when looking at remnant mangroves in other parts of the bay. When the area behind PPLH was converted into an aquaculture pond, a high berm was built to seperate the bay from the pond area. As this pond area was allowed to degrade, the berm was kept in tact, as villagers feared occasional flooding during high wave seasons and exceptionally high tides. The presence of this berm, acts to create an artificial lagoon behind PPLH. What differentiates this lagoon from usual mangrove lagoons, is the conspicuous lack of fresh water entering the area from the mainland, with the exception of seasonal small streams during the rainy season. Nonetheless, the area can be seen to function as a lagoon system, with an inner area of deep water (fish refuge), micro-delta formation, and mangrove vegetation typical of lower mangroves dominated by *Rhizophora apiculata* and *R. stylosa*. As one nears the terrestrial edge or the berm, mangrove species transist quickly into upper mangrove species, dominated by *Lumnitzera racemosa*.

Exploration: The task of the team, was to determine the correlation between mangrove species distribution, and substrate height (which is related to tidal inundation). Outfitted with a meter stick, measuring tape, and some small diameter plastic tubing (known as a *waterpas* - or Archimedes water level, a common tool amongst Indonesian construction workers), three groups took to the field. First, there was a briefing about how to read a tide table, and where to procure them. Terms such as Lowest Gravitational Tide, Low Mean Water Spring, Low Mean Water Neap, Mean Sea Level, High Mean Water Neap, High Mean Water Spring and Highest Gravitational Tide were plotted and discussed. Ways in which communities members understand changes in high and low tide throughout the year were also discussed, along with natural ways to determine tidal levels.

Next the group went to the field, and in a large group practiced measuring a short transect from seaward edge to landward edge. At a certain point, the Archimedes level was required. With skill and patience, it is easy to master this low cost technique, which is useful for short transects. Longer transects require different approaches which will be demonstrated on Tanakeke Island during EMR implementation.

The groups then set out to measure a single transect each, from seaward to land edge. Several challenges existed, such as negotiating over the berm, which required frequent use of the water level, and also calculation of changing surface water height (compared to sea level), as the surface of the lagoon was notably higher than current sea level do to restricted drainage of water out of the "lagoon."

All groups did an excellent job, working together to collect this data, which they would use the following day when drawing out their transects, to understand how substrate height and tidal inundation determine species distribution, and the limits of where mangroves will grow.



Field Work - Understanding Hydrology

2.2.3 SPECIAL TOPIC - SEAFRONT MANGROVE AFFORESTATION and REFORESTATION

Across the SE Asian region, there have been increasing attempts to either establish or re-establish mangroves at the interface with the sea. Attention is being given to the seafront for a variety of reasons in a variety of scenarios;

- mangrove used to exist at the seafront, were disturbed, and humans are experience exacerbated negative effects of mangrove lost such as coastal erosion and storm surge,
- natural recruitment of sediment from inland rivers has been hindered, leading to changes in sediment distribution patterns - erosion is taking place where accretion used to occur,
- mid and upper mangroves have been disturbed, and enhancement of seafront mangroves are seen as a suitable stop-gap to provide mangrove coverage,
- economic pressures and land-use/ownership issues are highly politicized, leaving only seafront areas as politically un-contestable areas for mangrove establishment/re-establishment.
- coastal communities exist to close to the sea, desire some form of protection from wind and waves, and attempt to force mangroves to grow in areas unsuitable for mangrove growth (tidal mudflats, seagrass beds, etc.)

As a result of the above scenarios and assumptions (some of which are false assumptions), stakeholders including government, local communities, NGO's and academics have been engaged in an in proportionate attempt to establish mangroves along the seafront. "The majority of these projects target seafront sites despite their suboptimal location for mangroves, and complex hydrology and sediment dynamics." (Primavera *et al.*, 2009)

> Much of the mangrove planting in the Philippines (and elsewhere) is done in lower intertidal and even subtidal flats that are relatively accessible untitled public lands but not optimal for survival. The Philippine Association of Marine Science in 2003, and again in 2005, called on the national government agencies, local governments and NGOs to stop planting in the lower intertidal and subtidal zones and transforming seagrass beds to mangroves (ibid).

Mangroves exist in a range of conditions, but their distribution is largely controlled by lengths of tidal inundation. Even the most seaward mangroves (those that would be underwater for the longest periods of time throughout a year), are only inundated approximately 30% of their lives. The lowest elevation of a natural mangrove in Laekang Bay is 0.67 m above Lowest Gravitational Tide (measured in the workshop). Substrates lower than this are inundated for periods greater than 30% of the time, and, due to the nature of the substrate, interstitial water remains in between the mud/silt particles. This long term standing water leads to anaerobic conditions, causing the production of hydrogen sulfide. Hydrogen sulfide is toxic to the root hairs of plants. Mangroves, further inland, can withstand lower levels of hydrogen sulfide, by pumping oxygen (breathed in through specialized breathing cells known as lenticels), down to the roots. The oxygen acts as a barrier to Hydrogen Sulfide. Seedlings, planted too far out to sea, have little to no chance to ward off hydrogen sulfide, due to lack of lenticels and the fragility of their root system.

Some of these sites are sandy-muddy flats rich in mollusks and other invertebrate epifauna and infauna that provide food and income to gleaners, and are important feeding grounds of migratory birds (Erftemeijer and Lewis, 2000). Given their importance as bird habitats and in rural food security and livelihoods, and the high mortality rates of seedlings due to barnacle infestation and wave action, afforestation of tidal flats should not be allowed except for coastal protection.

The desire to plant mangroves out to sea is evidenced in the entire Laekang region, both in Laekang bay and on the leeward side. In all cases, only mangrove species of the Rhizophora genus are planted, sometimes by direct planting of propagules, and other times seedlings reared in polybags (planted either with polybag still in tact or removed). These mangroves are typically planted at a high density, of 25-50cm spacing. In most cases, these plantings fail entirely within 1-2 years. In some cases, however, the seed

lings take hold and grow. Local communities attribute this growth to avoidance of predation by goats, and planted areas are often protected with fishing nets as fences. Other factors, which likely determine the success or failure of such initiatives, are as of yet, not regarded. The most likely of these are the sedimentation pattern of the planted area, tidal inundation depth and frequency, and periodic disturbances such as high wave seasons, high currents, and floating debris.

In all cases where planted mangroves are surviving, the community notes that their growth is stunted, and the mangroves do not attain a significant height. The oldest plantings (8-10 years old) have only attained a maximum height of 3 meters, this being in an area where a seasonal stream contributes significant sediment to the coast, and accretion is evident.

This workshop attempted to find and document a natural lower edge for mangroves (an area where mangrove were growing naturally out to the seaward edge), and measure the substrate depth at this point. A suitable area was found several kilometers "inland" along the Western shore of Laekang Bay (name?). The results of this exploration are discussed later.

It was also uncovered during the workshop, that participants from Puntondo had interviewed several village elders who claimed that thick mangroves lined the shore of the bay up until World War II, when they were cleared for ship timbers, ostensibly at the command of the Japanese Navy.

If this is true - it does provide sufficient motivation to attempt to revegetate the shoreline of Laekang Bay. Core samples were taken from sediment in the unvegetated coast of the bay, and revealed significant peat accumulation beginning 20-30 cm under the sand/coral rubble, also potentially indicating historical mangrove coverage. The remnant mangrove species in PPLH's lagoon and along the berm, also indicate previous mangrove coverage.

Subsequent to the workshop, the community group Pasir Putih, was contracted to run planting tests in strips perpendicular to the shore of Laekang Bay. These tests have the purpose of additionally determining the viability of mangrove establishment/re-establishment along the coast, and the minimum substrate height (in comparison to Lowest Gravitational Tide (LGT) at which success can be expected.

Measuring substrate depth during high tide (left). This data was compared to data gathered from the seaward-most mangrove edge of other sites, to determine a seaward boundary for succesful mangrove seedling establishment.

Aside from local communities, there is political will to plant mangroves along the coastline of Takalar. A spatial plan commissioned by the Takalar District Fisheries Department reveals the desire to turn the entire coastline into a mangrove greenbelt, regardless of the viability of large portions of the coastline to support mangroves. Indeed, the majority of the Takalar coastline is not suitable mangrove habitat, as it is a high energy coast through much of the year, and there is little sediment deposit vis a vis rivers. There is little historical evidence that mangrove grew in most areas along this coast. It would be prudent for the district government to re-evaluate this plan, and only attempt mangrove rehabilitation where feasible. Involvement of coastal communities and other stakeholders, and use of appropriate methods/techniques including ecological and hydrological assessment are necessary to avoid failure. All too often, blind will to plant mangroves (as a budget spending mechanism), ends up wasting resources and disappointing coastal communities involved as objects of top-down government policy.

If there is a way to extend mangroves seaward, the hope lies in restoring the natural functioning of the inner mangrove forest, and reconnection to freshwater inputs, which will distribute sediment along the coast. Mangroves can colonize an accreting, or building environment, but it is not true that planting mangrove seedlings will actively capture or accrete enough sediment to extend their own environment. The failure of numerous previous planting projects provides an important learning opportunity . No matter what human intentions are, working against nature is costly, and seldom results in success.

2.2.4 Discovering Disturbances (Step 3 of the 6 step EMR process)

In the last part of the field trip on day one, a rudimentary exploration of hydrological disturbance was made. This would be continued on day two, by a focus group. The entire group, circled the lagoon area, noting the extent of the bund which is the major hydrological disturbance to the area. Participants explored the bund on the seaward side, in places where it was severely deteriorated and also entirely in-tact, correlating differences in forest composition and health to the condition of the bund.

As the group explored the landward edge of the lagoon, they crossed over an unvegetated area of smooth bedrock and wondered if this could be altered to support vegetation. They also discovered a semi-abandoned inland fish pond, which contributes nutrients, fresh water and sediment to the lagoon.

Above Left: In some instances the bund is reinforced with stone, trapping water on both sides of the lagoon. Removal of the bund is not an option, as communities and PPLH fear damage from wind and waves in the West Wind season. Rehabilitation and enhancement of the mangrove area to function as an artificial lagoon is the preferred management option by local stakeholders, and is feasible from a landscape ecology point of view.

Above Right: In some places, the bund is reinforced by a sand dune, well vegetated with a mixture of back mangrove species and beach community, such as the Pandanus pictured here.

Top and Middle Left: Silt-covered bedrock (sorry, unsure of geology), extends along the landward edge of the "lagoon," up to the border with PPLH. There may be no potential to develop a vegetated buffer in this area, due to the nature of the substrate, but the rock may play a protective function in terms of stabilizing the lagoon and feeding it with rainfall runoff.

Bottom Left and Top Right: The outward edge of the bund contains the single major inflow/outflow of water. Potentially. Due to its restricted size, it traps water in the "lagoon" for longer periods, which may be beneficial as fisheries habitat, but restricts the amount of area where mangroves can grow. Participants will make descisions about the desired width and nature of this breach, as well as deeper water refuges for fish, and the shape and extent of tidal creeks within the lagoon.

Not pictured: Closer to PPLH, there exists a land bridge, which fragments the lagoon. This should also be considered for breaching, either with culverts or spanned by a bridge, which could serve the dual function of an observation area.

2.3 DAY THREE

2.3.1 Integrating Mangrove Restoration into Community Based Mangrove Management – Case Studies from Sumatra" Powerpoint - Ben Brown

This presentation discussed a pair of case studies from Sumatra. In the first case study, a fishing community of 3300 people living on the mouth of the Wampu River, had managed a 40 hectare mangrove as a village forest since the establishment of their village. All the while, the adjacent 9000 hectare NE Langkat Wildlife Sanctuary was ravaged by illegal logging. This case study presented the process by which the community gained collaborative management rights in 500 hectares, and became engaged in ecological mangrove rehabilitation and sustainable livelihood development. The second case study, from Bengkalis Island Riau, depicted the process by which 10 community stewardship groups were granted management rights in a total of 300 hectares of degraded mangrove forest (due to charcoal production), which they are also rehabilitating. Based on the success of these steward groups, the District government has made charcoal production from mangroves illegal on the island. Charcoal production used to claim over 600 hectares of mangroves per year, with minimal rehabilitation.

A question and answer period and discussion on collaborative (community and government) mangrove management ensued.

2.3.2 Field Trip to ????

The intention of this field trip, was to practice ecological and hydrological surveys, and to determine the natural extent of mangrove growth in another Laekang Bay site. The site chosen is an abandon shrimp pond complex of several hectares. The outer edge of the complex exhibits mangroves growing (as a green belt to protect the ponds), and it was hoped that these trees provide clues as to the seaward range of mangroves with regards to tidal inundation.

Again, three groups set out to create transects from this site. The results of this study are incorporated into the transect presentation in section xx. It was also noted that several new species were found in this area, including *Ceriops decandra*, *Rhizophora mucronata*, and *Avicennia alba*.

Top left: Rhizophora on the outer edge of the pond complex. *Ellipse*: Ceriops decandra, a species not found at PPLH. *Below*: A panoramic of 6 mangrove species growing on the degraded dike wall of the ponds (indicating feasibility of natural rehabilitation.

2.3.3 Transect Drawings

The transects data collected on days one and two were drawn by the three groups, and then hung up for comparison and trend analysis.

Trends

- *Rhizophora stylosa and Rhizophora apiculata* are dominant at the lowest substrate heights. There occur occasional *Avicennia marina, Sonneratia ovata and Rhizophora mucronata at these depths as well.*
- The substrate height at the natural limit/edge of mangroves in the region occurs around 65 cm above Lowest Gravitational Tide.
- Mangroves have been planted as low as 30 - 40cm above Lowest Gravitational Tide, but have a high mortality rate, with survivors experiencing slowed growth.
- Occurrence of natural seedlings is adequate within the lagoon in many areas, although poor drainage seems to be limiting their distribution.
- Not enough information is available about the limited mesozone (middle mangrove), although some *Ceriops tagal* and *Brugueira* spp. are present.
- Back mangrove species are existing on human made bunds, these are dominated by *Lumnitzera racemosa* and *Exoecaria agallocha*, but also include *Xylocarpus moluccensis, Pemphis acidula* and *Ceriops decandra.*

Many of the group members are now ready to prepare long-distance transects, which will be necessary on Tanakeke Island (300-500 m). They also have the skills to read a tide chart, and take measurements to determine substrate depth. With these tools, the community can now determine appropriate habitat for the natural establishment or planting of all varieties of naturally occurring mangrove species in the area. They will also be able to understand where not to plant certain mangrove species, in order to avoid wasting important resources such as time and money.

2.4 DAY FOUR - Action Planning

2.4.1. Mural Drawing - Present Day Situation

After attending 3 full days of training, all participants had a strong understanding of the mangrove areas they had visited. The combination of theory and field work resulted in a group ready to take on rehabilitation design, which are the 4th and 5th steps of EMR. To begin planning and design - more drawing was in order, this time, entailing the creation of murals depicting present day conditions. New groups were created, clumping participants from the same village together, so that action plans could be created to match future rehabilitation.

Villagers from Tanakeke Island worked together, to draw the abandoned shrimp pond complex around Lantang Peok sub-village. This area has already been targeted for rehabilitation in 2010-2011, and measures approximately 30 hectares in size. To assist the group in their drawing, satellite images were distributed.

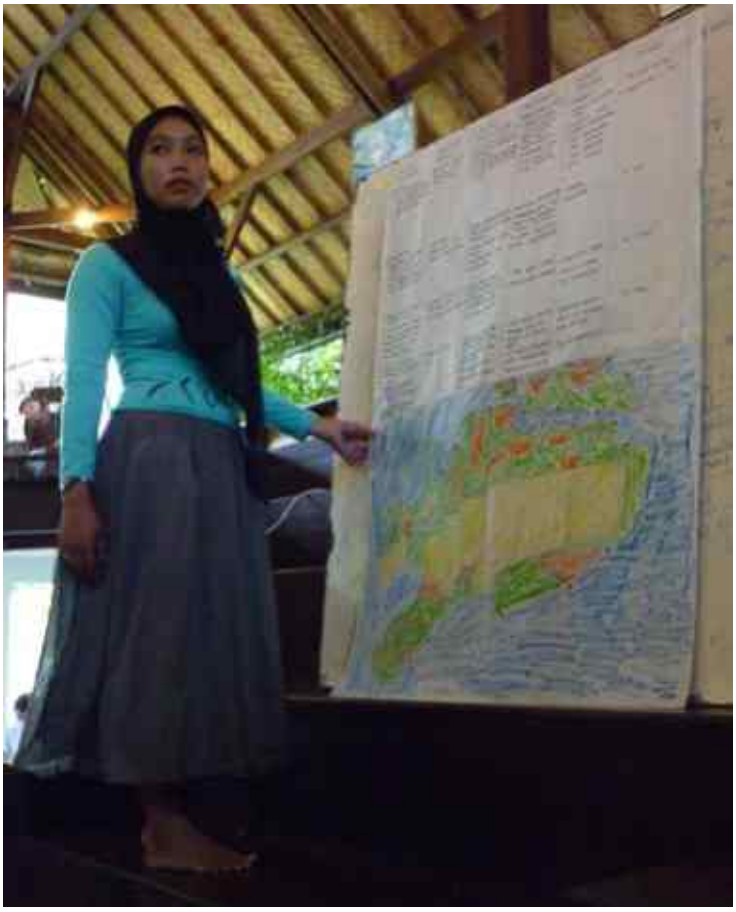
Villagers from Laekang were split into two groups, one involved in planning for the artificial lagoon behind PPLH, while the other would concentrate on the 3 hectare abandon pond complex visited on day three.

2.4.2. Future Planning

After the present day murals were completed, it was explained that to create an action plan, we would follow a two step process. The first step involved augmenting the present murals, to depict changes that we would make in our mangrove system. Changes could include breaching of dike walls, re-grading of substrate, digging of tidal creeks, and trial planting. Methods used were to be clarified, for instance, if planting, which species would be planted, where and why? What spacing should be targeted. Also, clear areas for natural revegetation should be delineated.

The second step of planning involved completion of a matrix which was facilitated by Yusron Nurdin of MAP. The matrix allowed for detailed planning of social, economic and ecological factors. These include resolving land tenure issues and obtaining appropriate government permission. Monitoring plans were also included. Participants were presented with a typical monitoring plan for mangrove rehabilitation, but also made aware that MAP would develop more in-depth monitoring protocols together with communities before the actual implementation of EMR in their regions. As an additional option, groups were allowed to begin to think about potential management of rehabilitated areas. Who would have ownership, access and control over these areas? What types of regulations would be imposed on these areas? Who would be involved in making these regulations? Who would enforce the regulations? What plans would be made to explore sustainable economic options in newly rehabilitated mangrove forests?

The following pages summarize action plans. Action plans in their entirety are attached as an appendix.



EMR ACTION PLAN

Location: Dusun Lantang Peok, Tanakeke Island

Community Group(s): PUKAT

Other Important Stakeholders: BAPPEDA (Planning Agency) Takalar, Department Pertanahan Takalar (Land Agency).

Size of Rehabilitation Area: Approx 30 hectares

Social:

- Continue to gain support from 20+ land owners, to convert their ponds back to mangroves.
- Cross check with Land and Planning Agencies in Takalar
- Explore need for UKL, UPL with Environment Dept in Takalar (MAP)
- Explore, promote and include women's roles in planning, implementation, monitoring and future management of the rehabilitated area.
- Develop work and oversight system, through series of discussions (musyawarah)
- Develop future management plans at sub-village level, to be included in larger area plans for mangrove use and conservation.

Economic:

- Develop budget for physical rehabilitation with MAP and local community
- Explore opportunity for volunteer labour, with financial support from RCL project allocated to village fund, for more equitable benefit to village at large.
- PUKAT to be contracted for oversight of entire 6 step process at Lantang Peok
- Explore timber and non-timber forest product development in adjacent mangroves, which can be applied to rehabilitated area once grown

Ecological:

- Undertake participatory ecology and hydrology survey with MAP and additional partners (UNHAS)
- Create approximately 50 strategic breaches to encourage tidal exchange in pond area
- Initiate digging of tidal creeks, to encourage water flow between strategic breaches
- Wait several months after hydrological repair, to determine if some planting is necessary.
- Plant only in trial plots, at densities to be determined together with MAP
- Collect and introduce wide variety of propagules (from Tanakeke and Sulawesi at large) to enhance biodiversity of flora in rehabilitated area. Introduce these propagules on high tides for natural disbursement.
- Select ecological indicators and monitoring periodically (quarterly in year one and annually thereafter for minimum of 4 years)

EMR ACTION PLAN

Location: Dusun Puntondo/PPLH, Laekang Village

Community Group(s): Pasir Putih, Bunga Desa

Other Important Stakeholders: PPLH, BAPPEDA (Planning Agency) Takalar, Departemen Pertanahan Takalar (Land Agency).

Size of Rehabilitation Area: Approx 2 hectares

Social:

- PPLH purchase inner third of lagoon area from local landowner
- Negotiate with land owner (a Pasir Putih member) for the rights to rehabilitate the final third of the lagoon, including the outflow. Develop clear regulations for future use of this area, to ensure long-term mangrove conservation, sustainable utilization and equitable distribution of goods and services.
- Develop working group from local community groups and stakeholders (Pasir Putih, Bunga Desa, PPLH, MAP, etc).
- Coordinate with other PPLH supports to synchronize rehabilitation efforts with new Landscape Ecology and Eco-tourism plans.
- Coordinate with or at least inform necessary government agencies
- Develop educational signage and self-guided tour through area (PPLH volunteers and partners).

Economic:

- Seek options for co-funding for aspects of the rehabilitation (signage, bridges)
- Develop alternatives for current dike walls, which allow for foot traffic and observation of lagoon ecology. A bamboo bridge, other bridge, or culvert will be required to connect lagoon waters right behind PPLH.

Ecological:

- Develop the lower part of the lagoon as a functional fisheries habitat (see video in appendix for explanation)
- Do not make major adjustment to coastal berm.
- Enhance, create tidal creeks within system.
- Enhance habitat connectivity, connect major water bodies in system.
- Enhance breach in lower part of lagoon.
- Promote high species diversity of mangroves through propagule introduction and some strategic planting.
- Trial plantings outside of the lagoon system, with Pasir Putih to determine appropriateness

EMR ACTION PLAN

Location: Dusun ???, Desa Laekang, Laekang Bay

Community Group(s): None

Other Important Stakeholders: PPLH, BAPPEDA (Planning Agency) Takalar, Departemen Pertanahan Takalar (Land Agency).

Size of Rehabilitation Area: Approx 2 hectares

Social:

- Contact pond owner. Development agreements for EMR
- Survey
- Socialization with local community
- EMR mini-Training
- Develop agreements to derive community based protection and benefits of rehab area

Economic:

- Determine lowest cost method to rehabilitate area
- Potentially provide financial incentive to pond owner

Ecological:

- Perform basic sediment budget to determine if re-grading or other types of EMR are feasible,,
- Undertake steps 1-6 of EMR again,
- Potentially develop area as example of eco-friendly aquaculture, if unable to obtain EMR rights.

3.0 CONSIDERATIONS

3.1 Understanding Mangrove Systems in Terms of Resilience

There have been many puzzling, paradoxical, failures of management of mangrove resources, and coastal resources in general, for example:

- Why do fisheries collapse in spite of widespread public support for sustaining them and the existence of a highly developed theory of fisheries management?
- Why do shrimp ponds, meant to produce a cheap, abundant, sustainable supplies of shrimp for local and global consumption, result in impoverishment of local communities and local environments, and lower long term productivity than the original mangrove system?
- Why do flood control, irrigation developments and salinization barriers create large ecological and economic costs and increasing vulnerability?

In each case, a target variable (natural fish stocks, cultured shrimp, and water levels) is identified and successfully controlled. Uncertainty in nature is presumed to be replaced by certainty of human control. Social systems initially flourish from this ecological stabilization and resulting economic opportunity. Paradoxically in each case success creates its own failure.

Paradox 1: The Pathology of Regional Resources and Ecosystem Management

Many management problems can be analyzed from an economic and human behavioral standpoint. According to this view, resources are appropriated by powerful minorities who are able to influence public policy. Hence inappropriate measures such as perverse subsidies are implemented that deplete resources and create inefficiencies. A fundamental cause of these failures are the political inability to deal with the needs and desires of people, in this case local fishing communities. In mangrove areas, this pattern is so common (conversion to aquaculture and agriculture being the two most dominant and destructive paradigms, although poorly managed charcoal plantations are also highly disruptive) that collapse of the new regime, is nearly a certainty. What more, it is 100% certain that replacement or disruption of mangrove ecosystems will result in less resilient, less valuable social-economic-ecological system.

Observation: New policies and development usually succeed initially, but they lead to agencies that gradually become rigid and myopic, economic sectors that become slavishly dependent, ecosystems that are more fragile and a public that loses trust in governance.

The Paradox: If that is as common as it appears, why are we still here? Why has there not been a profound collapse of exploited renewable resources and the ecological services upon which human survival and development depends?

Paradox 2: The Trap of the Expert

As part of the fundamental political causes of failure, there are, as well, contributing causes in the way many, including scientist and analyst, study and perceive the natural world. Their results can provide unintended ammunition for political manipulation. Some of this ammunition comes from the very disciplines that should provide deeper and more integrative understanding, primarily economics, ecology and institutional analysis. That leads to the second paradox : The Trap of the Expert. So much of our expertise loses the sense of the whole in the effort to understand the parts.

Observation: In every example of crisis and regional development we have studied, both the natural system and the economic components can be explained by a small set of variables and critical processes. The great complexity, diversity and opportunity in complex regional systems emerge from a handful of critical variables and processes that operate over distinctly different scales in space and time.

The Paradox: If that is the case, why does expert advice so often create crisis and contribute to political gridlock? Why, in many places, does science have a “bad name”? As a local example, we can look at the rapid expansion and nearly wholesale collapse of the shrimp farming industry. Continual quick fixes, such as the recent introduction of the Ecuadorian Panaeus vanameii shrimp are bound to meet with the same failure as previous species, do to lack of will to address root causes, and address issues of holism.

Unravelling the Paradoxes
These paradoxes can be unraveled by beginning with an examination of the obstacles that arise not just from multiple, competing scientific perspectives but also from disciplinary hubris. The complex issues connected with the notion of sustainable development are not just ecological problems, nor economic, nor social ones but a combination of all three. Actions to integrate all three typically short-change one or more. Sustainable designs driven by conservation interests can ignore the needs for a kind of economic development that emphasize synergy, human ingenuity, enterprise and flexibility. Those driven by economic and industrial interests can act as if the uncertainty of nature can be replaced with human engineering and management controls, or ignored altogether in deference to market dynamics. Those driven by social interests often presume that nature or a larger world present no limits to the imagination and initiative of local groups.

Compromises among those viewpoints can be arrived at through a political process. However, mediation among stakeholders is irrelevant if it is based on ignorance of the integrated character of nature and people. The results may be momentarily satisfying to the participants, but ultimately reveal themselves as based upon unrealistic expectations about the behavior of natural systems and the behavior of people. As investments fail, the policies of government, private foundations, international agencies and non-governmental organizations flop from emphasizing one kind of partial solution to another. Over the last three decades, such policies have flopped from large investment schemes, to narrow conservation ones to equally narrow community development ones.

Each approach is built upon a particular world-view or theoretical abstraction, though many would deny anything but the most pragmatic and non-theoretical foundations. The conservationists depend on concepts rooted in ecology and evolution, the developers on variants of free market models, the community activists on precepts of community and social organization. All these views are correct in the sense of being partially tested and credible representations of one part of reality. The problem is that they are partial. They are too simple and lack an integrative framework that bridges disciplines and scales. Such integration is possible in a dynamic cross-scale multi-domain view - that is in a *Panarchy.*

3.2 Ways Forward in South Sulawesi's Mangroves – Developing Adaptive Management at Various Levels
In this final section, we will look briefly at future paths toward building social, economic and ecological resilience. A lot of good ground-work has already been accomplished, both by local communities themselves, as well as community organizers from local NGO's such as YKL and LEMSA. Nonetheless, there is still a lot of work that still needs to be done in each of the above overlapping domains, to ensure the recovery and long-term resilience of even a small fraction of South Sulawesi's original mangrove forest.

3.2.1 Social Resilience – As has been stated several times in the body of the report, members of local community organizations such as PUKAT, Pasir Putih and the community at–large, have a high level of social capital. First, and foremost, they care about their local environs. A substantial amount of people care about the environment, albeit currently this is mosatly related to utilitarian benefits derived from exploitation of resources.

That social institutions such as PUKAT and Pasir Putih exist makes work easier in the future. Working through such institutions is one way to garner support from the community-at-large. It is also clear, that the community-at-large, likes to be engaged in activities which have practical value to them. For this, a Field School methodology is suggested; where groups of up to 25 fisherfolk or farmers are engaged in season long, field-based learning activities, relative to natural resource management and ecology. Examples of Field School themes appropriate in coastal areas include; Capture Fisheries FS, Ecological Mangrove Rehabilitation FS, Fish Farmer Field School, Non-Timber Forest Product FS, Hinterland Agroforestry FS, as well as financial field schools on topics such as micro-credit and savings and loans. More information on Coastal Field School methodologies are being developed as part of the RCL project.

Field Schools, or other outreach types of activities, should not only be facilitated by NGO's, but government outreach specialists as well. Currently, in South Sulawesi, this capacity only exists in the Agriculture Department. Cross-training, to involve agencies such as Fisheries and Forestry Departments, as well as the Brackish Water Aquaculture Center in Galesong, Takalar, in hands-on learning as a community outreach tool, is an important step towards trust-building between communities and government. Trust needs to be established, before moving into activities like adaptive collaborative management.

Including different segments of the local community, in ALL activities is also a challenge for the region. This is especially true in gender considerations. Every activity run, be it mangrove rehab, field school or collaborative management, needs to make gender based considerations and ensure equal participation, access and control by women and men.

Establishing collaborative management over time, with local communities being granted significant roles and responsibilities, is again, something local stakeholders understand better in the local setting. Study tours to neighboring regions, such as North Sulawesi, East Kalimantan, North Sumatera, Thailand and the Philippines, or at least presentation of case studies from these areas would be useful. Perhaps translation of a set of case studies into Bahasa Indonesia is in order. It is clear that collaborative management of mangroves is not yet on the agenda of lead agencies involved in mangrove management. A grass-roots approach, however, is usually most effective. Local communities are already quite aware of the importance of functional, whole mangrove ecosystems. Augmenting social capital, with financial capital based on development of cooperatives and resilient, mangrove resource-based businesses (discussed below) will make all stakeholders (not only government, but local community and business as well) take notice of the need for improved management of mangrove systems.

3.2.2 Economic Resilience – There is certainly interest, amongst members of PUKAT, Pasir Putih, Bunga Desa and communities at large, in developing small to medium scale businesses based on harvesting/use/processing products, goods (fisheries, non-timber forest products) and services (carbon storage, eco-tourism, storm and inundation protection, etc.) related to the mangrove area. Field Schools can develop the skills and knowledge of how to use and develop products and services from mangroves. But to go beyond NGO-type sustainable livelihood programming, communities need to be engaged in developing good business processes.

MAP-Indonesia has developed a process by which cooperatives are set up as a result of a field school, and ongoing business planning takes place, in order to help the cooperatives establish good and resilient business practices. Resilient mangrove businesses are based on the use and processing of a variety of goods and services, and also require the cooperative to agree to growth limits, in order not to over-exploit local resources. Coordination, of course, with local stakeholders, such as business/industry and government will be essential. Business planning, and adherence to good business practice, will go a long way in terms of truly building community capacity to not only manage their resources, but command the respect of other stakeholders. Continuing adaptive management, in time, becomes supported by these cooperatives/businesses, as part of self-interest. MAP-Indonesia can provide more information on development of mangrove cooperatives and good business practices, upon request.

3.2.3 Ecological Resilience – Much of the above report, and indeed the training workshop, discussed and demonstrated methods to build ecological resilience, initially through Ecological Mangrove Rehabilitation. A more in-depth discussion of options is presented here.

It is important to initially distinguish between mangrove restoration and mangrove rehabilitation. Mangrove restoration, turning a mangrove back into it's originally form, is a difficult, time-consuming process, and in many cases impossible. It would certainly be an expensive and time consuming feat to restore the Laekang mangroves to their original state, as there are current competing land uses in the coastal zone, substrate depth along the coast may have changed significantly, and establishment will be at risk during high wave/ current seasons. In search of a natural, reference forest for the region of Laekang, we also come up empty handed. All possible analogues have been converted into fish ponds, or clear-cut entirely.

Tanakeke Island presents different opportunities. Fish pond development in many parts of the island are relatively new, and ponds were not excavated, allowing for the potential to strategically breach dike walls to promote the development of tidal creeks for water exchange between pond and sea. There is also significant evidence of sedimentation, and natural recruitment of various mangrove species within ponds where walls are already degraded. Indeed, a moratorium for 5 years on fish pond operation and dike wall repair, may be all that is needed to effectively rehabilitate the ponds. Socially, however, it is better to take a pro-active role in rehabilitation, to increase a sense of ownership of the effort. It is also best to guide, and learn from the processes of ecological mangrove rehabilitation, no matter the level of technical ease. Indeed, in terms of triage, it is an important lesson to push for rehabilitation in areas which have a high likelihood of success and minimal financial investment.

4.0 PARTICIPANT EVALUATION

4.1 Method

Participants used the "plus-minus-change" method (described below) to evaluate the effectiveness of the "Ecological Mangrove Rehabilitation Workshop" and reflection to describe the participatory processes and material covered in the EMR workshop. These two simple evaluation processes have proven effective when working with multi-stakeholder groups.

1. "Plus-minus-change"

   a. On the blackboard or a large piece of paper, create three columns and label them "plus," "minus," and "change."

   b. Have program participants consider a question such as : "How well did the Field Portions of the program" help you to understand ecological needs of mangroves and ecological methods to restore mangroves?" (See footnote on alternative questions). Participants will be asked to list what they liked about the field excursions under the "plus" column and what they did not like under "minus." The "change" column is for listing any changes they would make in the future and how the EMR field excursions could be improved. This was done orally, with the whole group, in order not to exclude participants uncomfortable with writing.

2. Reflection

   a. Each participant should write down a brief:

   i. Restatement of the original intent of the EMR Workshop?
   ii. Outline of the activities/discussions they participated in during the EMR workshop.
   iii. Summary of new skills and knowledge they learned at the EMR workshop
   iv. Description of how they might apply the new skills and knowledge they learned at the EMR back in their home regions.
   v. List of new friends, contacts they met at the EMR who they feel they wish to contact in the future.
   vi. Description of how new friends and contact can help them improve the quality of their lives and the health of the coastal zone in their homes.

   b. Have a discussion in which participants share their depictions of the teamwork process.

   i. Did some fisherfolk participants feel that the EMR meeting should have proceeded differently? If so why? Was there adequate communication between participants? Was everyone fully involved throughout the entire program?
   ii. Did the fisherfolk participants feel free to participate fully in the workshop? Did the workshop feel dominated by NGO members and/or Government?
   iii. What part of the workshop was most difficult or frustrating? Why? What can you do in the future to make it easier?
   iv. What was the most interesting part of the workshop to you? Are you likely to try and use the skills and knowledge you learned at the EMR workshop in your village? Why /why not?

4.2 Evaluation Results

Summary of Plus-Minus-Change Answers:

Plus (+)	Minus (-)	Change (Δ)

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Appendix A: List of Participants of EMR Workshop in Kuala Gula

No	Nama	Jenis Kelamin	Affiliasi
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Abbreviations:

PUKAT	Keindahan Alam Laut Aktiviti Manusia (an Action-oriented Nature Lover's Group)
YKL	Sahabat Hutan Bakau (Friends of Mangroves)
MAP	Penang Inshore Fisherfolk Welfare Association
LEMSA	Department of Wildlife & National Parks

Appendix B: Original Agenda (note - agenda changed significantly within the course of the workshop)

Rehabilitasi Hutan Bakau Secara Ekologis dan Berbasis Masyarakat

Oktober 18-22, 2010

PPLH - Puntondo, Sulawesi Selatan

Tgl/ Jam	Kegiatan
Hari 1 (Senin, Okt 18)	
9:00 – 9:30	**Selamat Datang dan Perkenalan** PPLH - Alimin Kepala Dusun Puntondo Mangrove Action Project – Ben Brown - Perkenalan - Agenda - Kenapa Merehabilitasi? (Brainstorm) > pengenalaan jasa lingkungan hutan bakau - Konservasi dan Rehabilitasi? - Harapan Peserta
9:30-9:45	*Rehat Teh/Kopi*
9:45-12:00	**"Enam Tahapan Rehabilitasi Hutan Bakau Secara Ekologis"** Powerpoint – Ben Brown - Diskusi - Tujuan Restorasi Peserta
12:00-13:30	*Makan Siang and Sholat*
13:30-17:30	**Kunjungan ke Laguna PPLH – Kelompok Besar** • Survei Ekologi • Survei Hidrologi • Survei Gangguan • Transek
19:00-20:00	*Makan Malam - PPLH*
20:00	**Penyelesaian Gambar Transek dari Hari 1** - Presentations & discussion of transects and other findings from reference forest. *Panitia – Review dan Perencanaa Hari Kedua*
Day 2 (Selasa, Okt 19)	**Presentasi Lokal dan Kerja Lapangan**
8:30-10:45	**Presentasi Lokal (15 menit masing2)** **PPLH – YKL – LEMSA - PUKAT – Dinas Kehutanan – Dinas Perikanan** - Pekerjaan Sebelumnya berkaitan dengan isu Mangrove, - Isu2 mangrove saat ini - Diskusi
10:45-11:00	*Rehat Teh/Kopi*
11:00-12:30	**Pengenalan Tabel Pasang Surut** – Yusran/Ibek
12:30-13:30	*Makan Siang dan Sholat Dzuhur*
13:30-17:30	**Penentuan Wilayah Pasang Surut** - Yusran/Ibek - Wilayah Pasang Surut di Sekitar PPLH dibelajari dan ditandai
19:00	*Makan Malam – PPLH*
20:00	*Video - Green Belt Reports / (Optional)* *Panitia – Review dan Perencanaa Hari Kedua*
Hari 3 (Rabu, Okt 20)	**Kunjungan ke Teluk Laekang - Boat**
7:30-12:00	**Kunjungan ke Teluk Laekang (Pasang)** Kerja Kelompok Kecil • Survei Ekologi • Survei Hidrologi • Survei Gangguan

Tgl/ Jam	Kegiatan
	• Transek
12:00-13:30	*Makan Siang dan Sholat Dzuhur (Laekang)*
13:30-15:00	**Lanjut Kerja Lapangan**
15:00-15:15	*Rehat Teh/Kopi*
15:15-17:00	**Lanjut Kerja Lapangan**
19:00-20:00	*Makan Malam – PPLH*
20:00	Panitia
Hari 4 (Kamis, Oct 21)	**Studi Kasus dan Perencanaan Tindak Lanjut**
8:30-12:30	**Studi Kasus – Pengelolaan Hutan Bakau Berbasis Masyarakat di Sumatera dan Sulawesi Utara** Powerpoint – Ben Brown Diskusi
12:30-13:30	*Makan Siang dan Sholat Dzuhur*
13:30-15:00	**Presentasi Transek** *Diskusi*
15:00-15:15	*Rehat Teh/Kopi*
15:15-17:00	**Perencanaan Rehabilitasi utk PPLH dan Tanakeke (Klpmk Kecil)**
19:00-20:00	*Makan Malam – PPLH*
20:00	Panitia
Day 5 (Jumat, Oct 22)	**Monitoring, Presentasi dan Perencanaan**
8:30-10:00	**Monitoring** ○ **Kenapa Monitoring?** ○ **Apa Itu Monitoring?** ○ **Bagaimana Memonitor?** ▪ Metode ▪ Pengunaan Foto/Gambar
10:00-10:15	*Rehat Teh/Kopi*
10:15-12:00	**Perencanaan Rehabilitasi PPLH dan Tanakeke** - Penyelesaian Rencana
12:00-13:30	*Makan Siang dan Sholat Jumatan*
13:30 - selesai	**Presentasi – Rencana Rehabilitasi PPLH dan Tanakeke** - Rencana masing2 akan disampaikan kepada siapa lagi? - Evaluasi Pelatihan - Terima Kasih/Penutupan

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