Ecological Mangrove Rehabilitation Workshop

Kuala Gula, Malaysia

June 12 - 15, 2009

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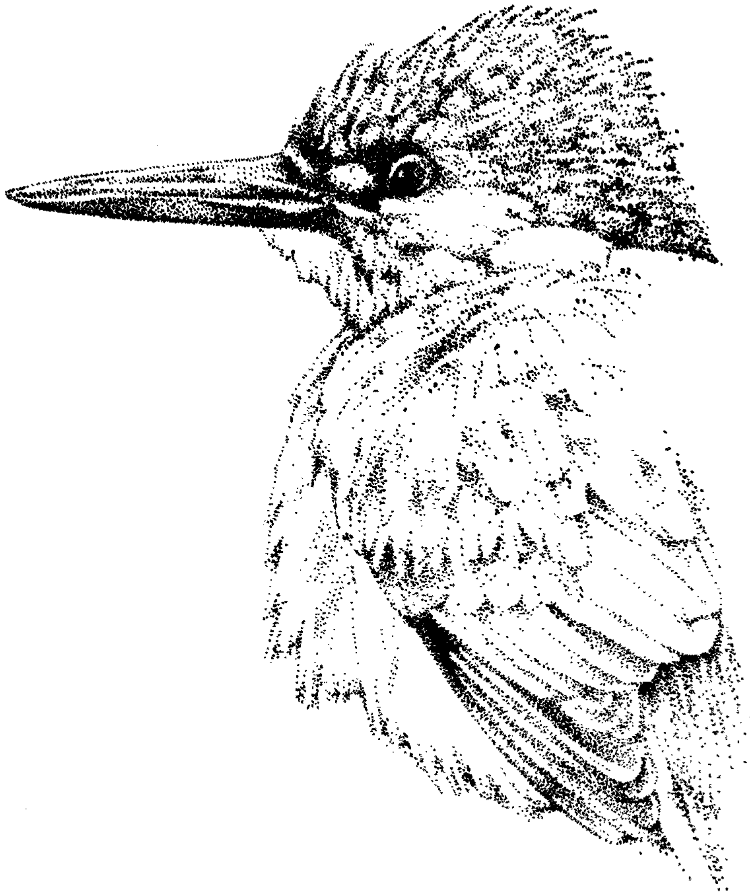

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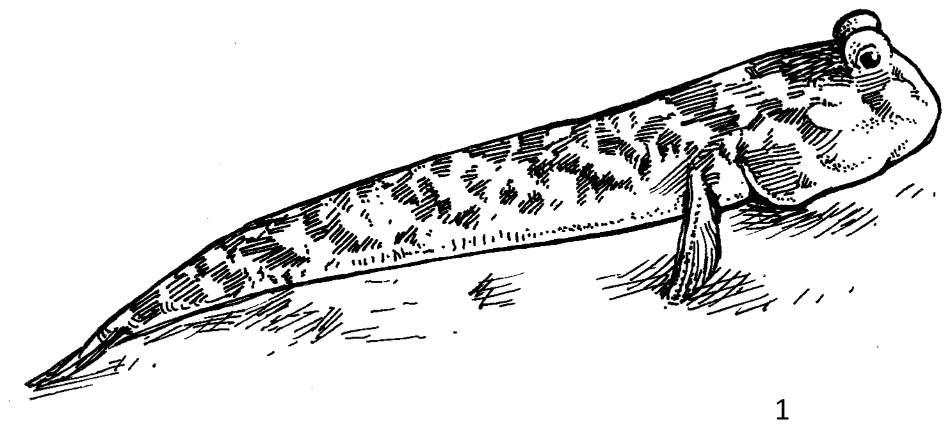


Ecological Mangrove Rehabilitation Workshop
Kuala Gula, Malaysia

Facilitation: Mangrove Action Project – Indonesia (MAP-Indonesia)
Local Coordination: Global Environment Centre (GEC)

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 it's 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 the Kuala Gula; different mangrove species occur at various substrate heights or levels of tidal inundation. A change in substrate height (due to sedimentation) would lift previously existing mangroves out of the tidal zone, and create new areas appropriate for mangrove colonization. A resilient forest, would have enough different types of mangroves, including colonizers, to vegetate uplifted areas. Nonetheless, continual filling of the mangrove area of Kuala Gula, will turn the system into a marsh or other terrestrial habitat over time. Without adequate hydrology, both in terms of tidal inundation as well as fresh water inputs (surface and groundwater), the mangrove system will cross a threshold into the new (and potentially less valuable) regime. One can think of a diversity of water inputs as well, as being important to the long-term resilience of a mangrove system. When fresh and ground water inputs are cut off, as is the case in Kuala Gula, the system becomes more vulnerable.

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 Kuala Gula, the Wildlife Department may be interested in maintaining open water in the system as bird watching habitat. But with this singular goal in mind, they may be ignorant of the importance of maintaining tidal creeks, which enable open water to exist. Collaborating with NGO's and other government agencies who manage for mangrove ecosystem health will help the Wildlife Department achieve its own management objectives.

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 now 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 Kuala Gula Past and Present

Kuala Gula is a coastal area in the State of Perak, Malaysia existing at the mouth of the river by the same name. Kuala, in Malay means river mouth/ estuary while the word Gula refers to sugar plantations present in the countries colonial past.

Dr. J.E. Ong, retired mangrove scientist from the University Sains Malaysia in Penang, made a site visit to Kuala Gula after the EMR workshop, and wrote the following bullet points in his brief report to GEC about the history of the area.

- The land was previously mangrove but has been enclosed by a bund on the seaward side and converted to agriculture (mainly coconut).
- The adjacent landward area was likely also mangrove [back mangal and hinterland] but has been converted to oil palm plantation (presently owned by Sime Darby and Eng Thye Plantations).
- A second layer of bund (with a water table control canal) protects the oil plant plantation. There is consequently no direct freshwater runoff to the project site.
- A significant part of the bund on the seaward side, and some of the bund separating current mangrove area from the oil palm plantation, has been breached and the area has started to revert back to mangroves (although there are still many bare areas).
- The species diversity of the mangroves here is low.
- This is currently a great place for bird-watchers [with significant open water areas].
- There has been previous work (first Wetlands International and now GEC), mainly with the participation of the local communities, in the ecotourism development (by Wetlands International) and rehabilitation of mangroves (by GEC).

To augment the above information, the site which is the focus of this EMR workshop, measures approximately 500 hectares and is known as Teluk Rubiah or "Ban Chu Kao" by the locals. It was converted for agricultural use around 1963 however unsuccessful. Teluk Rubiah currently functions like a human-made lagoon, having been bunded both landward (East) and seaward (West), with a constricted opening to the South. Both bunds are actively eroding due to scouring of incoming tidal waters. The Eng Thye company has indicated its desire to seek alternatives to the landward bund, which is costly to repair.

The inside of the lagoon is undergoing dramatic ecological change. Mangrove trees, of various species are colonizing some areas, while undergoing shock and dying in others. Sedimentation leading to micro-delta formation is occurring within the area, as tidal creeks are becoming choked with silt as well. This is all caused by disturbances to natural hydrology. It has rendered the system a low-value mangrove area. Open water areas still maintain high values for fisheries production and migratory bird habitat, but if left on its current trajectory, the system will silt up, reducing the amount of open water as well.

The hydrology of a natural mangrove system in this type of delta area would be normally be maintained by an extensive system of tidal creeks, allowing regular tidal inundation and drainage, receiving freshwater inputs in the back mangrove/hinterland interface both via surface and groundwater. What is present in Kuala Gula, is a highly altered system, where tidal inundation comes through one main opening, tidal creeks are choked, and freshwater connections to the mainland blocked by a bund.

More on the condition of the area, and recommendations for rehabilitation are discussed below, in the workshop proceedings.

Box 1: *This article by Wetlands International underscores current use values of the Kuala Gula site. In order to maintain, and enhance these and other values, goods and services, a program to rehabilitate the ecology of the system, and build the capacities of local stakeholders in adaptive management of the region will need to be initiated, a task being taken on by GEC.*

Kuala Gula in Perak is made up of different wetlands consisting of rivers, mangrove islands, mudflats, estuaries and fringes of mangrove forests along the coast. It is an important area for fisheries as a majority of the local community (nearly half of them are involved in the fishing industry) involved in the harvesting of fish, shrimp and shellfish as well as in post harvesting activities.

The mudflats and adjacent mangrove areas are attracting many species of migratory shorebirds and water birds where some species have become residents. It is the only wetland site in Malaysia, which has a viable population of the globally endangered Milky Stork. Kuala Gula wetlands is an important stopover site for migrating shorebirds along East-Australasian Flyway.

Kuala Gula has a large ecotourism potential and this has been addressed both at the state and federal levels. Local ecotourism initiatives have potential to grow if carried out sustainably. Based on the keen interest in ecotourism among local community. Wetlands International developed a project document on the wetland conservation and wise us at Kuala Gula. Funding was approved for a 2-year project to implement the wise use resources at Kuala Gula wetlands. Emphasis was given to the following objectives to achieve results on the ground:

- To equip local communities with the appropriate skills, knowledge and understanding of the eco-tourism field.
- To enhance appreciation of the goods and services provided by the wetlands amongst local community and relevant government stakeholders along the principles of the Ramsar Convention on Wetlands.
- To strengthen co-operation between government agencies, local community groups and NGOs in achieving the common conservation goals of the site.

Abundant bird life sits perched waiting for their next foray into the open waters of Kuala Gula (above left) Both the trees they are perched in (right), and the open waters are at risk of drastic ecological change.

2.0 EMR Workshop Proceedings - SRK Kuala Gula, Perak, 12-15 June 2009

This Ecological Mangrove Rehabilitation workshop was attended primarily by local community fisherfolk, together with representatives of government agencies involved in the management of the Kuala Gula Wildlife Sanctuary. 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 Workshop Day One

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

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

Ice Breaker – All participants and organizers were asked to take their name card out of the plastic holder, and draw a self portrait on one side. These were then placed in a bag and mixed. The bag was passed around and participants drew a card. Once all cards were drawn, the participants were given 15 minutes to find the owner of the card, get to know them through a personal interview and introduce their new friend to the group. This activity was effective in breaking the ice, setting the tone for open communication throughout the workshop. Participants have also been through a good many participatory processes with GEC and Wetlands International prior to this training.

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

Why Rehabilitate? (Brainstorm) > Identify Mangrove Goods & Services – This discussion was led by university students from University Malaysia Terengganu (UMT) and University Malaysia Sarawak (UNIMAS). The extensive list generated by participants, depicted their deep understanding of the value of mangrove ecosystems.

Goods	Services
Work opportunities	Fresh Air
Fisheries: Fish, Clams, Crabs, Shrimp, Snails, Horseshoe Crab	Pollution Filtration
Wildlife	Wildlife Conservation
Tourism	Primary Production – Base of
Timber/Bark	Food Web
Government Revenue	Trash Capture
Traditional Medicine	Knowledge Garden
	Fisheries Nursery
	Migratory Bird Rest Stop

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 Mangrove Rehabilitation:

PowerPoint Presentation – Ben Brown

Key topics presented in this PowerPoint presentation was information on each of the six steps of EMR. Case studies from Indonesia and around the world looking at mangrove rehabilitation successes and failures. A discussion on the importance of conservation as opposed to restoration only. A look at satellite images of Kuala Gula. A group discussion to understand the restoration goals of workshop participants.

2.1.3 Field Trip to Reference Mangrove Forest to Kuala Gula – Large Group

This initial field trip was intended as a general mangrove ecology walk, as well as to begin to understand concepts from the first few steps of EMR, including, autecology and hydrology.

The first task was to learn to undertake a mangrove transect. Two small sections of mangrove were chosen. The first existed outside of Teluk Rubiah, near to the Chalet of Tan Sri Razali, a well-known ex-government agent. Five participants hopped in the water, geared with a fiberglass measuring tape, a 2 meter long staff, and a notebook. The measuring tape was stretched from landward edge to seaward limit of the mangroves, and acted as a center line for the transect. Substrate depths were recorded every 5 meters along the center line, as well as tree species (mature trees, seedlings and saplings) within 1 meter to the left or right of the measuring tape.

Above: Transect in the heart of the *Rhizophora* zone. Numerous wildlings (natural seedlings), indicate that this is a healthy site with adequate natural regeneration. Substrate depth and other hydrological conditions are appropriate for young mangrove growth.

Learning Autecology

Top Right: Second transect, in the "lagoon" area. The main point of this activity was to determine natural substrate depths for various species of mangroves in the Kuala Gula area.

After recording transect data, the group continued by boat, touring the inner lagoon area. Along the way the group and guides noted, bird and wildlife, natural seedling establishment, condition of planted seedlings, condition of adult trees, evidence of bund deterioration, local mangrove species, and evidence of sedimentation and micro-delta formation.

Wildlings/Natural Seedings as Indicators of Mangrove Heatlh

Healthy mangrove areas generally have abundant recruits – seedling (<1 m height) counts of 45,000-343,333/ha and saplings (>1 m ht, <4 cm diameter at breast height, DBH) of 5,733-10,533/ha taken in different months over a 1.5 year period in Aklan, Philippines (Primavera *et al*., 2007). Similar numbers can be expected in Malaysia, and used as a benchmark for monitoring health of a mangrove stand.

Above Left - planted seedlings, surviving and growing well for the time being, but unsure over the long term due to sedimentation. *Above Right* - Full grown mangroves experiencing die-off due to deepening of the main water-exchange channel, a result of high volumes of water forced through a limited opening. Scouring is also causing the deterioration of parts of the bund. *Right bottom* - Gathering *Acanthus ilicifolius* to learn how to make herbal tea. Women in this group are especially knowledgeable and interested in fishery and non-timber forest products from the mangrove.

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 distrubed, and humans are experience excacerbated 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 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 inproportionate 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).

Beyond the natural limit of mangroves, the Forest Research Institute of Malaysia (FRIM) has been experimenting with engineered pillows which use coir-log as a planting medium, known as "Comp-pillow Planting Technique." "Seedlings are planted on coir logs, which are intended to firmly anchor the roots, similar to the action of marine grass acting as a nurse species for broadcase A. marina seeds in Pakistan (Qureshi, 1996 - from Primavera, 2009).

These pillows are purported to allow mangrove seedlings to maintain themselves at an appropriate substrate depth and have been placed in what is known as fluvial mud, an inappropriate substrate for mangrove establishment. 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 Sungai Haji Dorani in Malaysia is 0.70 m above MSL (Hashim *et al.*, in press). The fluvial mud substrate, however, is inundated for longer periods 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.

FRIM is hopeful that a technique for planting mangroves further out to sea will be possible, supposedly to combat coastal erosion. This is wishful thinking, and goes against certain trends such as sea-level rise. Currently at Kuala Gula, the outer edge of full gown, adult mangrove trees, are succumbing to longitudinal offshore currents. What chance do young seedlings have in this scenario?

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.

In Iloilo, central Philippines total mortality has likewise been observed in mangroves planted below MSL along beaches and riverbanks due to frequent inundation and wave action (J.H. Primavera, pers. observation). Aside from sandbar closure, mangroves may also be impacted by altered hydrology from land reclamation (Lee et al., 1996) or damming of rivers that decreases freshwater flows (Rubin *et al*., 1998).

What are the real causes of mangrove demise in Kuala Gula? How can the causes be addressed with real, working solutions?

The presence of the FRIM plantings, in the transect area, providing an important learning opportunity to the group. No matter what human intentions are, working against nature is costly, and seldom results in success. This lesson would later be applied inside the "artificial lagoon" of Kuala Gula, to the communities own mangrove planting efforts.

Mangrove seedlings planted on coconut fiber pillows in fluvial mud, beyond the extent of the natural mangrove-open water interface. The above photo was shot at low-tide, and depicts inadequate drainage. The pillows, meant to float, are sinking into the fluvial mud. Improper drainage will result in anaerobic substrate conditions, and hydrogen-sulfide toxicity of the roots.

Measuring substrate depth during high tide (left). This data was compared to data gathered from the seaward-most mangrove edge of several other sites.

Discovering Disturbances

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 climbed onto the landward bund, maintained by the Oil Palm Plantation, they began to tell stories about the history of the area. Learning the history of the mangroves first hand from a village elder is one of the best ways to understand not only how the mangrove has changed over time, but to spark ideas of how to appropriately rehabilitate the area.

Top Left: Examining the seaward bund where it is still intact. The forest within is somewhat dry, lacking the number and volume of tidal creeks which would normally facilitate the inundation and drainage of the mangrove forest.

Top Right: Learning about the history of Kuala Gula, from those who experienced it first-hand.

Bottom: The Sime Darby and Eng Thye oil palm plantations lie below the level of the "mangrove lagoon." This necessitates them to maintain a bund, as well as a pumping system for times when the bund fails or spring tides find their way into the plantation. These pumping stations are located at intervals along the bund. Locals say that fish kills, within the mangrove area, occur occasionally when the pumps are operated.

2.2 Day Two

2.2.1 Participant Presentations

Powerpoint presentations were given by many of the participating organizations and agencies. 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. Some presentations were moved back to day three, but will be included in this discussion from day two.

Sahabat Hutan Bakau (Friends of Mangroves - Kuala Gula): This local mangrove stewardship group delivered an inspiring oral presentation about the history of the Kuala Gula area, the formation of their group, and activities to date. 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 GEC and Wetlands International before them, in community organizing.

Penang Inshore Fisherfolks Welfare Association (PIFWA): PIFWA began by discussing their role in replanting mangroves, primarily *Rhizophora* species, in eight locations and their experience with both success and failure. Interesting questions and feedback arose in terms of why mangrove planting sometimes failed. PIFWA spoke of their extensive network of fisherfolk members and partners, including friends from the Kuala Gula area, and closed with a heartening invitation to the local community of Kuala Gula to become more deeply involved in exchange with other members of the PIFWA network.

Johor National Parks Corporation (PRNJ) – Tanjung Piai Johor National Park: An extensive presentation about the condition of mangroves, other wetland habitats and wildlife from this National Park in the South. Problems with pollution, high volumes of visitors and mangrove degradation were broached. A desire to work closer with local communities, especially in terms of providing livelihood opportunities and potential collaboration for conservation was an unexpected but extremely relevant highlight of this presentation.

University Malaysia Terengganu (UMT): Presented on a joint community-based mangrove management program between UNDP, Petra Perdana, the State Government of Terengganu and UMT. Program components included; eco-tourism, mangrove planting, sustainable mangrove resource use and cooperative formation, women's empowerment, awareness building and development of a collaborative management team.

Department of Wildlife and National Parks (PERHILITAN): An extensive slide-show about the birds and other wildlife of the Kuala Gula Bird Sanctuary (KWBS). The Wildlife Department clearly stated their desire to maintain Kuala Gula as an important migratory bird sanctuary. Maintaining both forest and open water areas will be important in this mission. The point was made, however, that to maintain the KGWS, a greater understanding of ecological processes is required by all stakeholders.

Perak State Forest Department: No powerpoint this time, but a discussion, primarily on forestry rules and regulations. This presentation was met with enthusiasm and a bevy of questions from the local community, who wished clarification on forestry rules and regulations within the mangrove area. There is clearly a need for improved collaboration with the forestry department, in terms of increasing their capacity on both ecology of mangroves, as well as community outreach and potential collaborative management. Malaysia is behind many other SE Asian nations with regards to willingness to recognize the rights of forest communities.

2.2.2 Completion of Transect Drawings

The transects from the previous day were drawn by a pair of groups, and then hung up for comparison and trend analysis.

Trends

- *Rhizophora mucronata, Rhizophora apiculata* and *Avicennia marina* are dominant in the seaward most mangroves.
- The substrate depth at the natural limit/edge of mangroves in the region occurs around 180-185 cm above lowest low tide.
- In some places, mangroves exist, but are dying out at lower substrate depths, of 110-160 cm above lowest low tide. Erosion of substrate due to scouring and long-shore currents is responsible for "deepening" of water in these regions.
- Occurrence of natural seedlings is highest under adult mangroves, in this foreshore area, at 200-230 cm above lowest low tide.
- We did not gather information about the mesozone or back mangrove area. (Note: natural back mangrove area is largely missing in the Kuala Gula region due to conversion to oil palm plantation).
- The comp-pillows, planted by FRIM, exist at 165-175 cm above lowest low tide, which is lower than the lowest naturally existing mangroves from this site.

Many of the group members are now ready to prepare long-distance transects in the Kuala Gula area. 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.

2.2.3 Specialized Field Trips

After presentation of the transects, the group was split into three smaller groups, for continued, specialized study of the mangrove areas of Kuala Gula.

<u>Group 1 - Hydrology - Past and Present</u>: This group was tasked with touring the entire bunded area of mangroves in Kuala Gula, and mapping where water currently enters and exists the system, both fresh and salt. They were also asked to depict the historical flow of tidal and fresh water into and out of the system.

<u>Group 2 - Autecology Survey</u>: This group was tasked with entering the bunded area, and filling out a prepared data sheet on all species of true mangroves present in the area. This group also prepared a herbarium.

Group 3 - Reference Forest Location: The final group was asked to search for potential reference forests in the nearby area. A reference mangrove forest (also known as an Analog mangrove forest), is a natural forest stand, existing in similar geomorphological conditions as the intended rehabilitation area. For Kuala Gula, a reference forest would be a nearby forest, that also existed at the mouth of a large river system, yet would not be bunded or subject to other hydrological disturbances.

Each group took the rest of the afternoon for their full day field trips. They would be asked to present their findings to the group on the morning of day three.

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 Presentations from Day Two Field Trips

Group 1: Hydrology

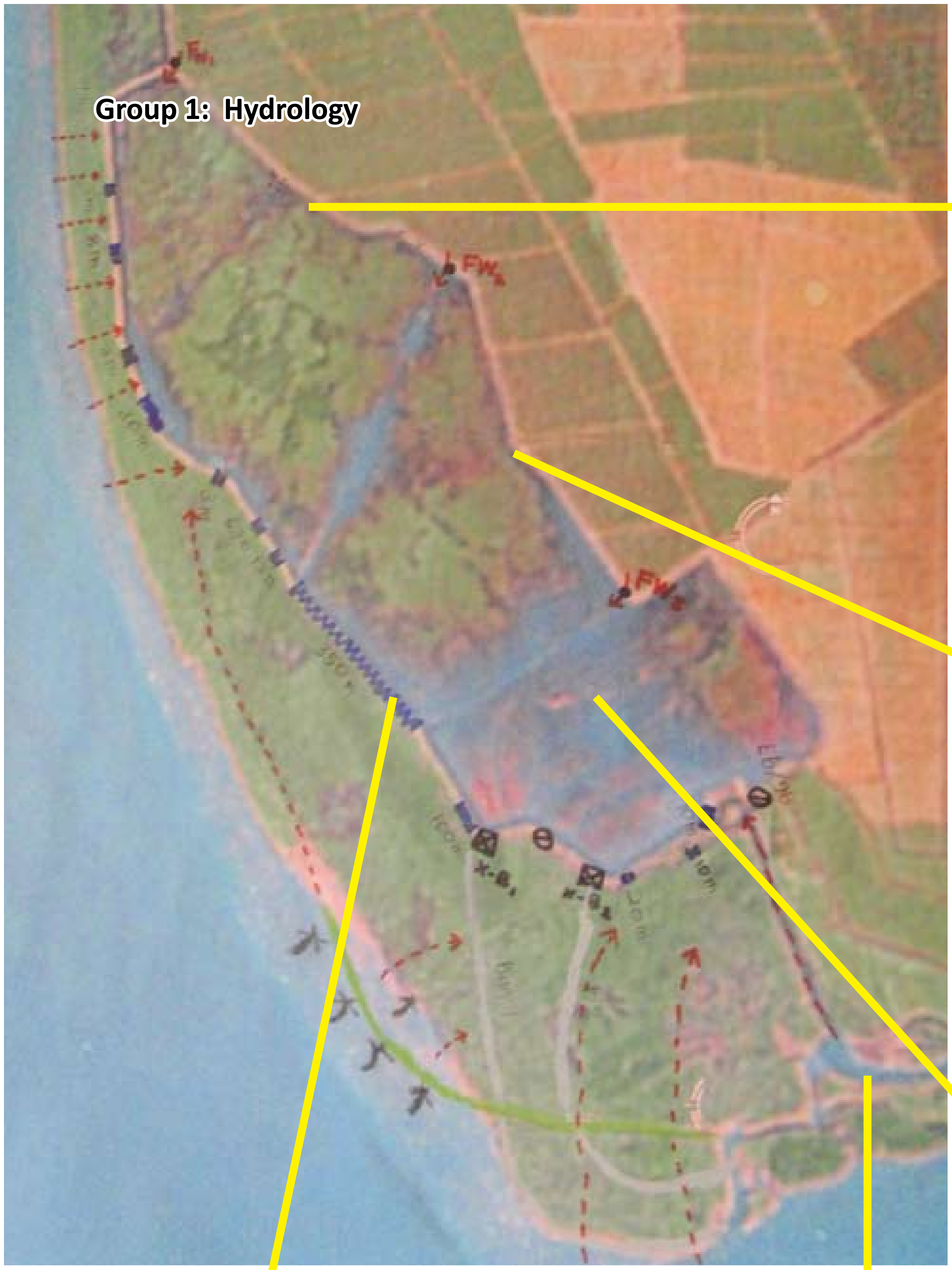
This group was led by Yun of GEC. This group was tasked with touring the entire bunded area of mangroves in Kuala Gula, and mapping where water currently enters and exists the system, both fresh and salt. They were also asked to depict the historical flow of tidal and fresh water into and out of the system.

Highlights:

- Presently, the bund on both the seaward and landward sides are deteriorating. This is especially prominent near in the Southern section, near to the main waterway which brings tidal water in and out of the area. Where the bund is breaking on the seaward side, mangroves, outside of the bund (toward the sea) are growing well, and tidal creeks are starting to form.

- Freshwater flows into the system are limited. Rainwater, during the rainy season adds freshwater to the system, but not in significant quantities. Freshwater, in the form of surface water from the landward area is prevented from entering the mangroves regularly due to the bund. Fresh water from ground water, is also limited, as the oil palm plantation lies lower than the back mangrove area. Freshwater is pumped into the mangrove area, sporadically, from ditches separating the oil palm plantation from the mangrove area. Sometimes this water is tainted with pesticides, and fertilizers. Sometimes it is quite brackish, after seasonally high tides have breached the bund. Fish kills have been noted by the community related to this pumping.

- One of the oil palm plantations, Eng Thye, is interested in working together to develop an appropriate alternative to the bund. The key issue is whether an alternate solution, such as building up a back mangrove area, is feasible since freshwater inputs are low.



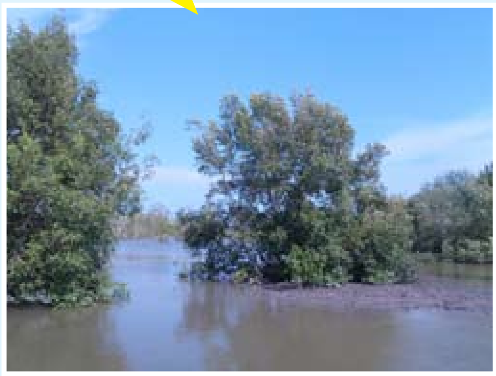
The group used a satellite image from google earth to mark notable hydrological sites. This base map was later used to create future action plans.

This deep channel exists between mangrove area and the bund. It is an un-natural channel, good for boat traffic, but resulting in bund deterioration, and seasonal flooding. A good candidate for re-grading into a back mangrove area.

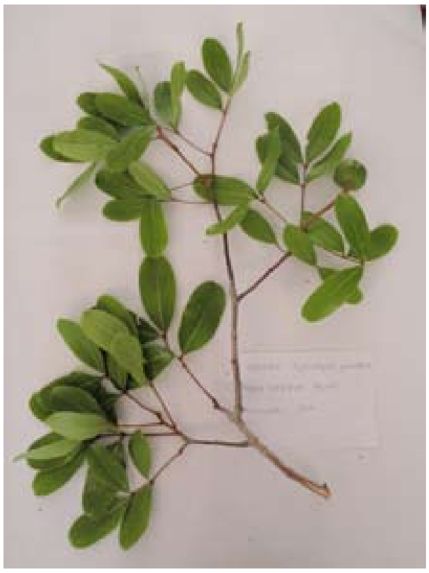
Bund on the right, oil palm plantation on the left. The bund is expensive to maintain. A workable solution should be sought, involving Sime Darby and Eng Thye in back mangrove creation as a long-term low maintenance solution.

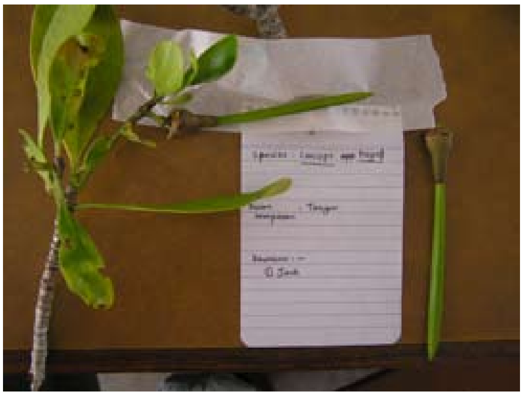
The bund on this side has deteriorated in many places. Mangroves inside the bund are thriving with, as tidal water now finds its way into the area. Nonetheless, connecting this area to the sea, by encouraging the formation of tidal creeks, will help both the impounded mangroves as well as the mangroves that currently exist between bund and sea.

This is currently the main area where tidal water exchange takes place. This bottleneck experiences high levels of flushing, as large volumes of water are restricted into a relatively narrow area. Over time, deterioration of the bund will reduce the velocity of tidal surge in this area.



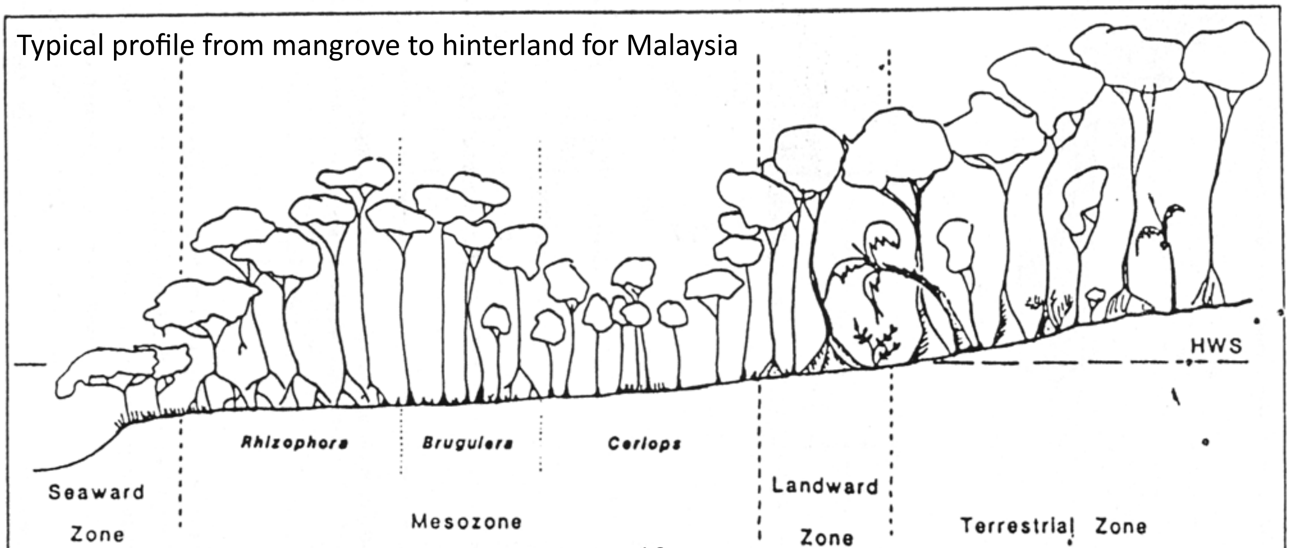
Because of limited exchange of water, the impounded area of mangroves experiences sedimentation. In this case, a micro-delta has formed. Without hydrological alteration, micro-deltas like this will continue to form and grow, until the system no longer is able to maintain mangrove growth or open water areas.





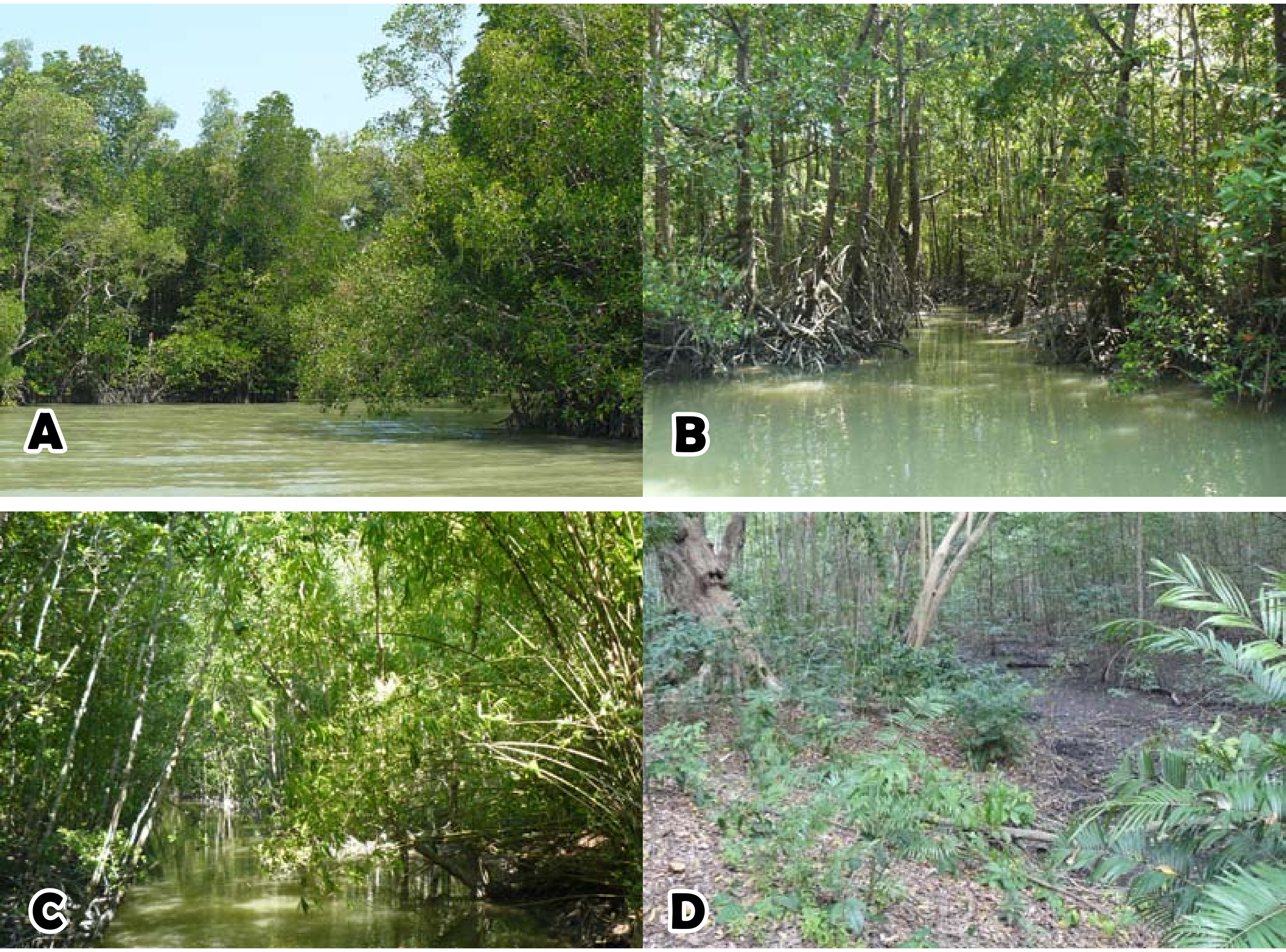
Group 2 - Autecology Survey: Southeast Asia's mangroves are the best developed and most species-diverse in the world. A total of 268 plant species have been recorded in SE Asian mangrove areas, including 129 trees and shrubs, 50 terrestrial herbs (including 27 grasses and grass-like plants), 28 climbers, 28 epiphytes, 24 ferns, seven palms, one pandan and once cycad. Of these 268 species, 52 are found in the mangrove habitat only, and are named "true-mangroves." Around 25 true mangrove species exist in and around the Kuala Gula and Matang Mangrove Reserve area.

The group that went into the impounded area of Kuala Gula, took information on species encountered, relative substrate depth (low, middle, high), means of reproduction and dispersal, as well as fruiting season. The group took home leaves, fruits and twigs from over 22 species, most of which were true mangroves. By understanding the habitat requirements of individual species, and their local availability, natural re vegetation and appropriate planting can be planned for, before further attempts of mangrove rehabiltiation are undertaken.



<u>Group 3 - Analogue Forest/Reference Forest</u>: Analogue forestry is a system of establishing trees and plants that seek to establish a tree-dominated ecosystem that is analogous in architectural structure and ecological function to the original climax and sub-climax vegetation community. Thus, Analogue Forestry draws design input from the natural forest. When an ecosystem is designed to be analogous to the indigenous climax state, the efficiency and dynamics of the natural processes can be replicated. These quasi-natural forests are designed to mimic the structural and functional aspects of indigenous forests and are referred to as analogue forests.

It starts with an analysis of the local environment. Information on the composition and structure of the local forest is collected, including composition of tree and plant species endemic to the area, as well as physical factors of their habitat.



The group journeyed to Pulau Kelumpang, in the Matang Mangrove Reserve, in search of analogues. Although much of the Matang reserve has been logged, and replanted, specious areas, similar enough to natural mangrove forest stands do exist. Photo A) depicts the seaward mangrove, dominated by large *Rhizophora*, *Xylorcarpus* and *Avicennia* trees, with significant tidal inundation. Photo B) exists further upstream in the mesozone or middle mangrove. Tidal creeks as smaller here, but plentiful. *Rhizophora* exists on the banks of tidal creeks, but gives way quickly to *Brugueira* and *Ceriops* trees as one walks inland. Photo C) depicts the landward mangrove zone, with a mixture of mangrove trees species, including *Heritiera, Lumnitzera, Exoecaria* and *Aegiceras*. Bamboo of the genus *Schizostachum*, can be seen along the river banks above the tidal influence. Photo D) depicts the interface between the landward mangrove and the terrestrial forest. Here a variety of mangrove associates exist, as well as the plentiful varieties of plant-life that live in the terrestrial system.

Zones C and D are what are entirely missing from the impounded mangrove of the Kuala Gula system, having been converted to oil palm plantation. These zones require a significant input of fresh water, which is now lacking in the Kuala Gula area. The fresh water acts to buffer salinity levels in the back mangrove. The back mangrove is only occasionally inundated with salt water. When these infrequent tides recede, they leave behind a thin film of salt water, which evaporates, increasing the salinity of the substrate beneath. Without adequate flushing by fresh water, the back mangrove area quickly becomes hypersaline, only allowing strict halophytes to inhabit the area. This will be an important point to consider, when considering future options for rehabilitation in Kuala Gula. It is not only the slope and substrate height which determines forest/vegetation type (thought tidal inundation), but also freshwater inputs.

2.3.3 Lagoon Ecology - Dr. Oswin Stanley - Powerpoint
As chance would have it, Mangrove Action Project affiliate Dr. Oswin Stanley of India, was on hand in Malaysia, assisting with research at a Malaysian university for the past year.

Dr Oswin arrived mid-way through the workshop, and took a tour of the impounded mangrove area in Kuala Gula, to provide the group with an expert opinion of mangrove dynamics in the region.

Dr. Oswin is a lagoon specialist in India, and agreed that due to hydrological barriers, the mangrove area at Kuala Gula is currently behaving like more like a lagoon, rather than a mangrove typical of the river mouth area in which it is situated. Dr Stanley discussed that the mangrove area was in constant flux, due to lack of normal freshwater inputs, and restricted entrances and exit of tidal waters. Decaying biomass, as well as siltation from outside the system were collecting and being constantly redistributed within the system. This is apparent in the formation of micro-deltas, and the die-off of older mangrove trees sitting atop substrates which are rising.

Dr. Oswin went on to caution against future planting, without considering hydrological alteration. She suggested working together with Sime Darby and Eng Thye, to fill in the canal which separates the bund from mangrove growth in the "lagoon," in essence creating a type of back mangrove. This area, however, will not receive significant freshwater inputs, and may only be appropriate for growth of species tolerant of hypesaline conditions.

Tidal creeks should be encouraged both through the "lagoon" area, and especially in the area to the West of the deteriorating bund. This will encourage proper drainage from the lagoon, and reduce the level of sedimentation. Sediments will also become available for distribution on the seaward edge of the mangrove area, which is currently eroding, and could potentially lead to mangrove stabilization and colonization of that coastal section.

2.4 DAY FOUR

2.4.1. Monitoring: Day four was set aside for action planning, but before participants could begin, a brief session on monitoring was presented by MAP-Indonesia. Topics covered included;

- Why Monitor?
- What is Monitoring?
- How to Monitor?
- Before and After Photography
- Community Based Monitoring Methods

The group was provided with a handout, in Malay, for mangrove monitoring.

2.4.2 Action Planning

During the beginning of the workshop, we discussed the paradigm of action-research and problem solving, with its local to global to local paradigm. Participants, over days one and two, were involved in local investigations of the mangrove area. On day three, they gained exposure to global case studies, through presentations collaborative mangrove management in Sumatra, as well as a presentation from Dr. Oswin Stanley of India.

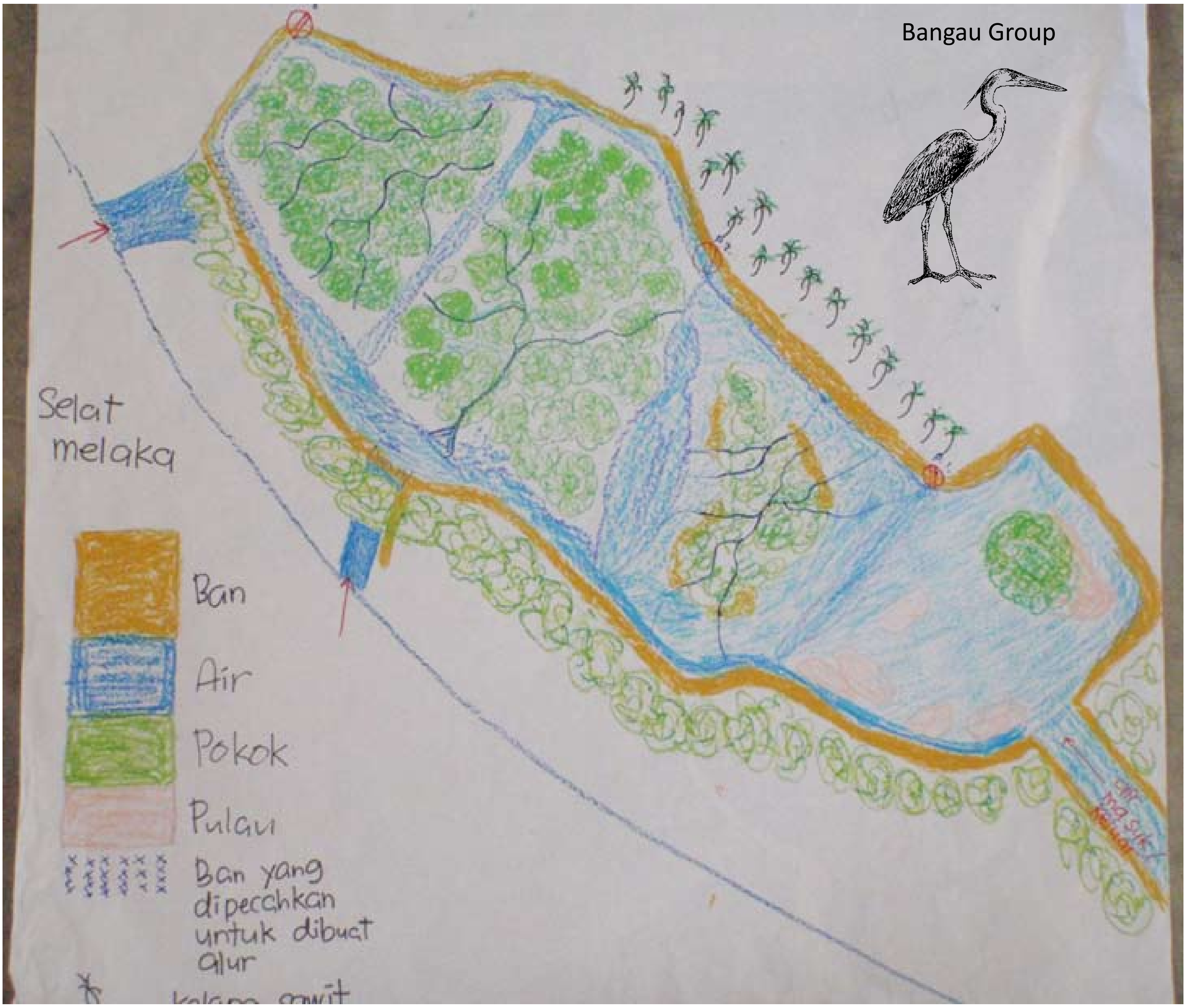
It was now time to come back to the local level, to become engaged in action planning, which will lead to local action taking.

Participants were split into two groups and given 1 hour and 30 minutes for the exercise. They were provided with satellite images of the mangrove region in question, and were asked to consider the 6 steps of Ecological Mangrove Rehabilitation in order to create their plan. They were also asked to consider, who they would present their plans to, in order to garner the necessary permission and support to implement their plans.

Two groups, *Kurau* (Threadfin), and *Bangau* (Heron), went to work creating and presenting their action plans. The plans were critiqued by all participants and organizers. It must be said, that the groups had come a long way in a mere four days, fully grasping EMR concepts, and also becoming strong proponents of collaborative management. There are many hurdles in the way, but participants took an impressive step by creating a solid vision.

Key Points

- The impounded mangrove/temporary lagoon, was split into four zones. Each region would have different use patterns, ranging from strict preserve, to limited use of timber and non-timber products to capture fisheries and also a clam farming area.
- Open water areas would be maintained for migratory bird habitat.
- Negotiations would take place with Sime Darby and Eng Thye, to create a back mangrove area by the bund, in effect widening the area of the bund, but creating a long slope on which appropriate species of grasses, herbs and trees would be planted.
- Tidal creeks within the "lagoon" area would be enhanced, by digging in a more natural, meandering pattern.
- Four tidal creeks would be created joining the impounded area to the sea (West).



Key Points

- Priority to revegetate degraded areas
- Priority for sustainabilize the system
- Collaborate with government, NGO's and local community to repair degraded areas
- Assessment
- Create or fix tidal creeks and other waterways
- Utilize more effective methods and techniques when planting.
- Hold a rehabilitation workshop with government agencies, NGO's and local community.
- Keep records of tree health and monitor regularly
- Maintain some areas for migratory birds and activities of the Wildlife Department
- Strengthen regulations
- Create zones for eco-tourism, education and research.

3.0 Considerations

3.1 Paradoxes of Management

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.

<u>Paradox 1: The Pathology of Regional Resources and Ecosystem Management</u>

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?

<u>Paradox 2: The Trap of the Expert</u>

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 need only look at the FRIM comp-pillows, placed in fluvial mud, failing, and costing a significant percentage of the annual mangrove restoration budget of Malaysia.

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 Kuala Gula – 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 GEC and WI before them. Nonetheless, there is still a lot of work that still needs to be done in each of the above overlapping domains, to ensure long-term resilience of the Kuala Gula mangrove forest and community.

3.2.1 Social Resilience – As has been stated several times in the body of the report, members of Sahabat Hutan Bakau, and the community at –large, have a high level of social capital. First, and foremost, they care about their local environs. They are far ahead of most local communities that we work with in Indonesia, in that a substantial amount of people care about the environment, not just for the utilitarian benefits derived from exploitation of resources, but many people also have an appreciation for the inherent value of nature itself. This is an invaluable asset, and a testament of the good organizing work done by GEC and other NGO's in the past.

That the social institution of Sahabat Hutan Bakau, and likely other fisheries cooperatives, etc, are built makes work easier in the future. Going 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 can be provided upon request.

Field Schools, or other outreach types of activities, should not only be facilitated by NGO's, but government outreach specialists as well. Developing the capacity of Wildlife, Fisheries, Forestry and Agricultural government staff in hands-on learning as a community outreach tool, is an important step towards trust-building. 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. Sahabat Hutan Bakau, is largely, if not entirely comprised of Malay fisherfolk. Although gender balance is strong, ethnic balance is not represented. Concrete activities, which are interesting and important the Chinese-Malay fishing community need to be developed.

As trust becomes established across a broader reach of stakeholders, resolving some of the pressing issues which face restoration and conservation in Kuala Gula can be broached. The first of these, is the complicated process of sorting out land-use issues. Of course, local stakeholders (community, GEC, government) have a greater understanding of the specific intricacies involved in this process.

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 countries, such as Thailand, Cambodia, Indonesia and Philippines, or at least presentation of case studies from these areas would be useful. Perhaps translation of a set of case studies into Bahasa Melayu 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.

A final major stakeholder in the region, Sime Darby, has a significant incentive to assist in supporting ecological mangrove rehabilitation, and also future mangrove protection initiatives. If designed appropriately, a healthy mangrove forest can eliminate the need for engineering solutions to salt-water intrusion into the oil palm plantation (discussed below under Ecological Resilience). Partnering on this a straightforward activity such as "ecological engineering," should open doors for inclusion of Sime Darby in future adaptive collaborative management, as well as continued financial support in the form of CSR. Sime Darby (warranted or not) has a good name in the international community as a producer of sustainable palm oil (due to their involvement in the RSPO). The fact that their plantation sits on previous back mangrove, and negatively impacts on the health of the remaining mangrove system, has not yet been brought to public attention. It is clear, in the mandate of RSPO, that palm oil plantations should not negatively impact upon, or replace, high-value ecosystems. All forms of mangrove systems, be they just the back mangrove section, are considered high-value ecosystems under the RSPO methodology for valuation. This methodology has been included as an appendix. If leverage is needed, the RSPO provides appropriate mechanisms.

3.2.2 Economic Resilience – There is certainly interest, amongst members of Sahabat Hutan Bakau, and the community 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 and its parent organization Ishwara Environmental Institute, have developed a process by which cooperatives are set up as a result of a field school, and on-going 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.

Exploring options for voluntary carbon finance is also an option for mangrove areas. In terms of reforestation, carbon finance in mangroves is not so attractive, as carbon sequestration rates are low (1.5 tonnes/ha/yr). However, under REDD (and shortly REDD Plus), there can be significant benefits from mangrove carbon. Mangroves store, on average, 700 tonnes of carbon in peat layers within their substrate, per meter depth, per hectare. Some mangroves exhibit up to 4 meter peat layers, containing nearly 3000 tonnes of stored carbon. When the mangrove is destroyed, or converted, this carbon is exposed, oxidized and "lost." REDD Plus will have the added advantage of valuing contributions of mangrove conservation towards social, economic and ecological welfare, which are surely prevalent in the Kuala Gula setting. Although the Malaysian Forestry Department has yet to seriously consider carbon finance in mangroves, significant opportunity exists.

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 is certainly impossible to restore the Kuala Gula mangroves to their original state. The entire, original back mangrove ecosystem, and it's adjacent hinterlands, has been converted into an operational oil palm plantation, which is not going to disappear anytime soon. Aside from the loss of the back mangrove, freshwater inputs are severely limited, as both surface water from the terrestrial area has been diverted into a drainage canal, separated from existing mangrove by a bund, and ground water flows avoid the mangrove area, which is situated at a higher altitude than the oil palm plantation. This leaves us with no possibility of mangrove restoration, and fewer options for mangrove rehabilitation.

In search of a natural, reference forest for the region of Kuala Gula, we also come up empty handed. The nearest possible analogues, exist in the Matang Mangrove Reserve. This reserve, although purported as the best managed mangrove forest in the world, is no longer a natural system. It has been managed for silvacultural purposes for a century, and has lost some of the functions and characteristics of a natural mangrove forest, especially in terms of species diversity and natural zonation.

It may be interesting, at this time, to introduce the reader to the main categories of natural mangrove ecotypes existent in the region. Understanding the different forms that entire mangrove ecosystems may take, will help us better understand our own rehabilitation goals, and also assist us in planning and design. We apologize beforehand for providing Indonesian examples when discussing examples of these different forest types, as we are not familiar with Malaysian mangrove forests. Nonetheless, the following geomorphological classifications for mangrove forests, will serve as a relevant example for Malaysia as well as Indonesia.

Special Topic: Geomorphological Classification of Mangroves (adapted from Ecology of Indonesian Seas)

Thom (1982) described five terrigenous coastal environmental settings (i.e. physical) in which Australian mangrove forests are commonly found. Hutchings and Saenger (1987) added a sixth class, namely the carbonate (coral coast of coral island) setting. They pointed out that on a global scale the carbonate class is relatively insignificant. However, in Indonesia, the carbonate setting is 'locally' important, considering the fact that the vase majority of the 17,000-plus Indonesian islands are carbonate in origin. In the case of Kuala Gula, this six class is not relevant, but is still presented below.

ALLUVIAL PLAINS

Alluvial plains are among the most characteristic coastal features of all large islands in the Indonesian archipelago (i.e. Sumatra, Java, Kalimantan, Sulawesi and Papua) and also in Malaysia. These are depositionary environments, where terrestrial runoff leads to rapid accumulation of terrigenous (siliclastic) sediments (sands, silt and clays) and coastal accretion. The extensive alluvial plains among much of the north coast of Java are prime examples, even though over 90% of the mangroves were long ago logged and converted to fish ponds. Coastal accretion is generally most rapid at river deltas. For example, the Solo River delta is accreting at a horizontal rate of about 70 m per year (Hoekstra, 1989). In Bintuni Bay, numerous rivers discharge large volumes of siliclastics at the river mouth-forming large mud banks or mud islands, which are rapidly colonized by mangroves. For example, Pullua Keraka at the mouth of the Tatawori River consists entirely of alluvial deposits (fine clays) and has been colonized by a young *Avicennia* forest (Erftemeijer *et al*., 1989; T. Tomascik, pers. obs). The vast Mahakam delta supports 150,000 ha of mangrove forests (Dutrieux, 1991). With high sediment load and a discharge rate of some 1500 m2/sec, the Mahakam delta is continually accreting (Allen *et al*., 1979). The seaward margin of the delta (salinity range 20-32 psu) is vegetated by diverse mangrove forests, with *Avicennia* spp. being the prominent mangrove along with *Brugueira gymnorrhiza, Aegiceras corniculatum* and the fern *Acrostichum aureum* (Dutrieux, 1991). Under more fresh water conditions behind the *Avicennia* forests, thick *Nypa fruticans* vegetation dominates the intertidal areas. Further upriver salinity drops to 0-10 psu, and the monospecific Nypa forests are slowly replaced by the paired association of *Heritiera littoralis,* and *Oncosperma tigillarium* (Dutrieux, 1991). In areas where rapid coastal accretion is occurring, *Soneratia caseolaris* is the pioneering species (Dutrieux *et al.*, 1990b). The transitional community from marine to fresh water-dominated mangrove flora is at the apex of the delta (Dutrieux, 1991).

The Mahakam delta mangrove forests are physically controlled, with biotic factors such as competition or predation playing sub-ordinate roles. Dutrieux (1991) recognized four environmental zones, mainly the fresh water apex zone, middle distributary zone, river-mouth zone and central non-distributary zone. While the mangrove flora occupies most of these environmentally distinct zones, the abundance and diversity of aquatic flora and fauna vary greatly. Highest diversity occurs at both the fresh water apex zone (i.e., predominantly freshwater flora and fauna) and at the river mouth zone (i.e. predominantly marine flora and fauna) (Dutrieux, 1991).

TIDAL PLAINS

The environmental [geomorphological] setting of tidal plains is very similar to those of alluvial plains, but in this setting tidal influence predominates. Coastal areas under this classification are dominated by strong bi-directional tidal currents generated by high tides. Terrigenous sediments discharged by rivers are dispersed along the coastline by the tidal and long-shore current, and often form elongated mud banks seaward of the river mouth. According to Thom (1982), the main river channels are typically funnel-shaped and are fed by numerous tidal creeks, which are separated by extensive tidal-flat surfaces (e.g., mud flats). The Berau River may be an example of this type of environmental setting. A number of rivers along the southwest coast of Irian Jaya, with a tidal range of up to 10 m, may also be placed in this environmental setting.

BARRIERS & LAGOONS. This environmental setting is characterized by higher wave energy and relatively low amounts of river discharge (Thom, 1982). This setting is associated with offshore barrier islands, barrier spits or bay barriers. (Thom, 1982) In Indonesia, this environmental and geomorphological setting would most likely occur in the southeastern regions of the archipelago, where it may be associated with barrier reefs. For example, mangroves form a thin belt along the northeast coast of Adonara Island, which is protected by a small barrier reef. Fresh water discharge is limited to the Northwest Monsoon (wet season), thus the mangroves are predominantly under a marine influence.

ALLUVIAL PLAINS & BARRIERS
According to Thom (1982), this geomorphological setting represents a combination of high wave energy and high river discharge. Fluvial sediments are rapidly redistributed along the coastline by wave action and strong longshore currents and form extensive sand sheets. Segara Anakan on the south coast of Central Java may be considered as a variant of this geomorphological setting. The major difference lies in the origin of the barrier which in the case of Segara Anakan is the rocky islands of Nusa Kambangan. The lagoon of Segara Anakan is a bar-built estuary (Barnes, 1984) receiving high volumes of river discharge. In fact, the lagoon has all but entirely filled with sediments over the past 3 decades, due to high rates of upland soil erosion from mainland Java. Originally 3300 hectare of surface water existed in the lagoon, whereas less than 400 hectares remain in 2009 (Brown pers. obs.; Djohans, 2004)

DROWNED BEDROCK VALLEYS
This geomorphological setting is characteristic of drowned river valleys (Thom, 1982). This setting may occur on slowly subsiding islands with open estuaries that resulted from recent transgression over a former bedrock river valley. It is most likely that this type will be rare in the Indonesian archipelago and also Malaysia, given the tectonic nature of the region, where uplift (i.e. regression) is relatively more common than subsidence.

CORAL COASTS
In this geomorphological setting, mangroves are associated with coral reefs either indirectly or directly (see Budiman *et al.*, 1986). Numerous mangroves occur on terrigenous sediments that have accumulated behind fringing reefs, where they are protected from strong wave action. While they are not universal, by any means, these environmental settings are found throughout the archipelago. Their presence in one area and absence in another has not been studied. Some excellent examples can be found in the Salabanka Islands, Southeast Sulwesi, where a luxuriant mangrove belt is protected by a fringing reef for a considerable length of coastline. This geomorphological setting is frequently used as a classical example of mangrove/coral reef/seagrass linkage, however, in Indonesia this association is, in fact, quite rare.

The direct mangrove/coral reef/seagrass setting is best exemplified by the mangrove vegetated coral islands that are found throughout the archipelago (Budiman *et al.*, 1986). Rhizophora stylosa is the most important coral reef-associated mangrove species. Soemodihardjo *et al.* (1977) noted significant differences in mangrove species composition between the fringe mangrove type along the coastline of Jakarta Bay and the coral reef-associated mangroves common on many sandy cays in the Kepulauan Seribu patch reef complex. It was noted that while *Avicennia* was the dominant pioneering species along the rapidly accreting Java coastline, the hard coralline substrates characteristic of coral cays were dominated by *Rhizophora stylosa*, and to some extent by *Sonneratia alba*. Throughout the archipelago, where mangroves are associated with coral cays, *Rhizophora stylosa* replaces *Avicennia* as the primary pioneering mangrove. However, the distribution of *R. stylosa* in the archipelago remains problematic, since many areas of the archipelago have yet to be surveyed.

The mangroves at Kuala Gula, could have originally been categorized as either Alluvial Plains or Tidal Plains systems, based on the above descriptions. Due to conversion of the back mangrove and hinterlands into oil palm plantation, and the development of bunds on both seaward and leeward sides of the remaining area, the area now functions somewhat as a human made lagoon. One would ideally, through Ecological Mangrove Rehabilitation, hope to rehabilitate the bunded area back into an alluvial or tidal plain system, however, these systems rely on significant freshwater inputs and resultantly a vast network of tidal creeks in order to function properly.

Were this possible, the tidal creeks and rivers would again facilitate coastal accretion, and current issues of coastal erosion (seaward of the bund), might be remedied. This would likely alleviate the “need” for expensive, non-effective engineered solutions, such as the comp-pillows and geo-tubes developed by FRIM.

However, rehabilitation of the back mangrove and hinterlands, and re-connection with significant freshwater is not an option to us at this time. So, what is left to us?

If, we look at the entire "impounded" mangrove system, we may try and design, the best, most ecologically functioning mangrove system possible. It may help us, to refer to the above 6 geomorphological types of mangroves as a potential reference.

1) The area adjacent to the bund, on the side of the oil palm plantation, is currently in the form of a deep, straight channel, varying between 10-20 meters in width. This channel currently functions as fish habitat and for boat traffic, but also erodes the bund (and occasionally facilitates flooding over the bund) as large amounts of tidal water flush in and out of the restricted system at abnormally high velocities.

One possible solution for this area, would be to fill the channel, and create a graded substrate, sloping from the bund, down into the impounded mangroves. Some mangrove trees, growing West of the channel, would initially be disturbed, or even felled, during this process. Nonetheless, one would be creating an artificial back mangrove area, much like the back mangrove/terrestrial interface photo in the section above on reference forests/analogue forests. The difference would be, this back mangrove area would not have a sufficient amount of freshwater buffering the soil, allowing for the growth of terrestrial species and mangrove associates. Instead, the soil would likely become hypersaline, due to occasional inundation, and would host plants tolerant to salt. No worries, it would sort of function like a raised, dry, salt marsh. But a variety of grasses, succulents, beach vegetation and salt tolerant mangrove associates would be able to grow there. It would provide habitat for a variety of wildlife, and would likely function better than the current bund/channel system in terms of protecting the oil palm plantation from salt water inundation. For this service, you would expect Sime Darby to foot the bill for the rehabilitation work.

2) The middle of the "lagoon," needs to stabilize. Currently, the region is host to relatively few tidal creeks which are mostly straightened. Sedimentation takes place rapidly, evidenced by micro-delta formation, and the desiccation of some adult mangrove trees, whose substrates have risen significantly. This area would be greatly assisted by a general opening of the seaward bund, and creation of tidal creeks leading from the sea, into the mangrove area from the South and West. Open water areas would also benefit from increased tidal flushing. No need to plant in this region, it is in a dynamic state of change. What is important, is that a variety of mangrove types be kept in the system, so that trees may establish themselves (through natural revegetation) as substrate and tidal inundation levels change.

3) The seaward bund is currently deteriorating, mostly at the southern-most section of the area. If the entire bund is not to be removed, at least, strategic breaching of the northern wall, to connect it to existing flows to the sea, should be attempted. Creation of meandering tidal creeks, connecting the impounded mangrove to the sea, should be attempted. If not, they will form over time after breeching, and especially if the entire bund were dismantled.

Facilitation of improved tidal exchange in this manner, will have several potential positive effects.

- Greater tidal exchange will improve the health of mangroves both East and West of the present bund.
- Increased fisheries habitats
- Improved drainage of the "impounded" area
- Recruitment of sediment along the coast, which may lead to accretion in some areas, counteracting the trend of coastal erosion on this side.

In closing, a whole ecosystem approach is not possible at this site. Nonetheless, an ecological approach to mangrove rehabilitation, will work better than current practices of mangrove planting and engineered solutions. The resultant system, will not appear as a tidal or alluvial plain mangrove system, but likely imitate more of a barrier mangrove system, dominated by salt water. That Kuala Gula sits at the mouth of a large river, will to some extent mitigate domination of salt water. If no hydrological action is taken, the system will continue to move towards a threshold, due to the slow moving variables of sedimentation and lack of water exchange. The resultant system will likely turn into a saline, marshland habitat, of lower value and productivity. After this, it is a short step to conversion to privatized agriculture, and the loss of open access benefits to the fisherfolk community at-large.

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. <u>“Plus-minus-change”</u>

   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. <u>Reflection</u>

   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)
Learned something new	Need to involve representatives from Department of Environment (DOE/JAS), Department of Irrigation & Drainage (DID/JPS), as well as other stakeholders	Take a study tour to another location, including a location already engaged in EMR and collaborative management such as Sumatra.
Understood a new and correct method for planting and restoring mangroves	Quantity of food was unsatisfactory	Hold a larger workshop with more powerful agencies.
Very appropriate workshop location	Service from the canteen was unsatisfactory	Longer workshop needed
The workshop was held during quarter moon (low tidal exchange) enabling fisherfolk to attend.		Self-service at the canteen.

Thought Questions and Answers

1. Was there a good mix of indoor and outdoor activities in this workshop? *Adakah pembahagian aktiviti dalaman dan luaran untuk bengkel ini seimbang?*

» Well - balanced
» More outdoor work would have been better.
» Need a more systematic method for outdoor lessons.

2. Did powerpoint presentations help explain the concepts of Ecological Mangrove Rehabilitation? *Adakah pembentangan "powerpoint" membantu anda dalam pemahaman konsep ekologi HutanPaya Laut?*

» Very helpful.
» The powerpoint sessions served as proof that these methods work.
» Yes, but need better translation to Melayu in order to be understood by villagers.

3. Did the workshop themes and objectives match the needs of the fisherfolk participants? *Adakah tema dan objektif utama bengkel ini bersesuaian dan penting untuk peserta golongan nelayan?*

» Yes, but better to invite more representatives from relevant government agencies.
» Themes were appropriate but not enough fisherfolk attended. Need to show clearly, before hand that this workshop will be beneficial to local fisherfolk.

4. How was the facilitation of the workshop handled? *Bagaimana penyelarasan bengkel ini dijalankan?*

» This workshop met the needs of Sahabat Hutan Bakau (Friends of the Mangrove)
» More small group work for better understanding
» Extremely good in terms of technical and location, service (food, accomodation) could improve

5. Where you able to fully participate in discussions and activities? *Adakah anda berpeluang mengambil bahagian dalam perbincangan dan aktiviti-aktiviti bengkel ini dengan sepenuhnya?*

» Yes, both men and women were able to fully participate.
» Some participants, perhaps, didn't feel comfortable speaking in public.
» All activities were very open to participation.

6. Did women have equal opportunity to participate in discussions and activities? *Adakah golongan wanita berpeluang mengambil bahagian dalam perbincangan dan aktiviti dengan sepenuhnya dalam bengkel ini?*

- Yes, and also it appeared that women more fully understood and enjoyed this program
- There were still some participants not comfortable with sharing/speaking

7. List new skills and knowledge that you learned during this EMR workshop. *Rumusan kemahiran dan pengetahuan yang dipelajari dalam EMR workshop.*

- Understand how to properly plant mangroves (where, what and when)
- Working with nature/ecology is better than working against nature
- Participants did not have a good understanding of ecology before the workshop and lacked experience. After the workshop, our knowledge of mangroves became much deeper.
- New skills and knowledge such as; measuring sea level and substrate level, taking transects, positive identification of mangrove species in this region, understand normal hydrology, undestand which species are most appropriate at various substrate depths.

8. Which parts of this workshop were most difficult? Most dissapointing? How could this be fixed in the future? *Bahagian mana dalam bengkel ini adalah paling susah dan mengecewakan? Mengapa? Bagaimana anda boleh memudahkannya pada masa akan datang?*

- No dissapointments or difficulties
- Powerpoint presentations make you sleepy, better to have more field sessions.
- The language of the presenter was difficult (Bahasa Indonesia mixed with some English), need to fully use Bahasa Melayu
- Not enough time spent learning monitoring. Should be a full field session.
- Need more clarification on measuring substrate depth and sea level height.

9. What parts of this workshop were most interesting? Will you be able to use new skills and knowledge learned during this workshop back in your home villages? Why or why not? *Bahagian mana dalam bengkel ini adalah paling menarik? Adakah anda akan menggunakan kemahiran dan pengetahuan yang anda mempelajari dalam Bengkel Restorasi Hutan Paya Laut dalam perkampungan anda? Mengapa atau kenapa tidak?*

- Overall, it was an interesting and very good workshop.
- Doing the transects and comparing them was fun and informative. We can use these methods in our own work, with trials and adaptation.
- It was all interesting because it gave us useful information related to fish.
- EMR and group work were most interesting. I will certainly use these skills and knowledge in my work rehabilitating mangroves and ensuring their sustainable management.
- Learning to measure substrate depth, appropriate planting in appropriate locations.
- Interacting with the other participants is inspiring to other participants. The collaborative work done by PIFWA was also inspiring. More case studies and experience in the next session.
- Discussions were most interesting, and I will continue the discussions with other fisherfolk upon returning home. In that way I can spread new knowledge that I have learned.
- The workshop helped us better understand and care for our mangroves.

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List of Participants of EMR Workshop in Kuala Gula

	Name	Organization
1	Anuar b. Jamil	KALAM
2	Diana bt. Dzul	SHB
3	Habibah bt. Mat Noon	SHB
4	Harison bt. Jamahari	SHB
5	Jamnah bt. Mat	SHB
6	Mohd Radhi b. Mahadi	SHB
7	Norhasikin bt. Husin	SHB
8	Norlia bt. Mahadi	SHB
9	Normala bt. Mohd Nor	SHB
10	Norzana bt. Samsudin	SHB
11	Rahamah bt. Awang	SHB
12	Ropeah bt. Atan	SHB
13	Saadiah bt. Kamarudin	SHB
14	Salmah bt. Ahmad	SHB
15	Sarimah bt. Mohamed	SHB
16	Suhaida bt. Mhd Desa	SHB
17	Wahab b. Arop	SHB
18	Zakaria b. Mohamed	SHB
19	Ilias bin Shafie	PIFWA
20	Aziwan bin Ali	PIFWA
21	Nayan bin Said	PIFWA
22	Musa bin Ali	PIFWA
23	Ishak bin Jusoh	PERHILITAN
24	Hamzah bin Saad	PERHILITAN
25	Anne Majanil	PTNJ
26	Nur Suhaina Zakaria	UMT
27	Emilia Hazrina bt. Ashari	UMT
28	Ahmad Fuad b. Abdullah	FD
29	Rahimah bt Abdul Razak	GEC/UNIMAS
30	Mohd. Amir Hashimi b. Hashim	GEC/UMT
31	Lew Siew Yan	GEC
32	Chin Sing Yun	GEC
33	Balu Perumal	GEC
34	Benjamin Brown	MAP-Indonesia

Abbreviations:

KALAM	Keindahan Alam Laut Aktiviti Manusia (an Action-oriented Nature Lover's Group)
SHB	Sahabat Hutan Bakau (Friends of Mangroves)
PIFWA	Penang Inshore Fisherfolk Welfare Association
PERHILITAN	Department of Wildlife & National Parks
PTNJ	Johor National Parks Corporation
UMT	University Malaysia Terengganu
FD	Perak State Forest Department
UNIMAS	University Malaysia Sarawak
GEC	Global Environment Centre
MAP	Mangrove Action Project

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