Policy Brief: Suggested Practices for Post-Disaster Mangrove Rehabilitation

Ecosystems and Livelihoods Group, Asia

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100 percent mortality of planted *Rhizophora apiculata* on Simeulue Island - Aceh
Planted by Australian Red Cross

1.0 SUMMARY

Stephen Hill is Director of UNESCO's Regional Bureau for Science in Jakarta. He has assumed the dual role of Resident Coordinator of the United Nations and Coordinator of Humanitarian Relief in Aceh on a number of occasions. Below, he reflects specifically on post-tsunami mangrove reforestation efforts in Aceh.

> While the generosity of the private donor community was of enormous importance, the activities of NGOs and volunteers were not always helpful. The rush of activity has also tended to sweep past the scientific and technical (S&T) knowledge that is essential for the recovery process to be sustainable. To take an example: having committed funds to activities for which they had technical competence, a number of the large NGOs then moved into areas in which they lacked competence. Planting mangroves along the coast to mitigate against another potential tsunami became a popular movement, even though there is still limited evidence of how to do this. Relatively wealthy agencies therefore moved into mangrove replanting operations. However, without their own technical experts, their mode of operation was to fund local communities to do the job: people without any experience or technical knowledge who were unsupervised by experts. This often resulted in failure, perhaps simply because there had never been mangroves in that particular location and mangroves were extremely unlikely to find it habitable in the future.

Aside from various technical pitfalls, issues of planning, monitoring, community involvement and in a larger sense building and restoring social and ecological resilience in the coastal zone plagued the coastal restoration and rehabilitation[1] effort in Aceh.

This paper serves as a 'suggested or improved practices' policy brief on post-tsunami coastal restoration, with particular attention paid to potential impacts on coastal ecosystems in Indonesia. The format used for this discussion follows a typical project cycle used by project planners and managers. It was decided to adhere to the project cycle, rather than go into a technical discussion of mangrove rehabilitation for a couple of reasons. First and foremost, as Stephen Hill mentions above, most organizations involved in the support of mangrove rehabilitation have little technical experience in the realm of habitat rehabilitation. They are, on the whole, disaster relief agencies and NGO's with expertise in other areas. A technical discussion of all of the detailed aspects of appropriate mangrove rehabilitation techniques would be voluminous and would not serve the target audience of this paper, who are generally project managers. Project managers speak the language of project development and management which are best encapsulated in the project cycle. The second reason, is that adequate resources on mangrove rehabilitation do exist, and it is more a matter of making these available to a larger audience by perfecting their content and developing them with the use of multi-media tools so as to spread the word.

[1] *Restoration* is defined in this paper as activities geared at transforming a damaged ecosystem into a previous natural state. An example would be restoration of an original highly biodiverse mangrove forest. *Rehabilitation* is defined as activities geared at transforming a damaged eco-system into a useful and functioning ecosystem although not necessarily with the purpose of restoring to a previous condition. An example would be rehabilitation into a system of two species of mangroves scattered with several environmentally friendly aquaculture ponds. We will primarily use the term rehabilitation in this paper, as restoration is a more narrowly defined term.

Therefore, since most people making the field level decision to become engaged in mangrove rehabilitation are project managers, the project cycle (sometimes known as the management cycle) was chosen as an outline form for this paper. Each step of the project cycle has been broken down into the following components for elaboration – Intent, Approach, Considerations, Resources, and Definitions. It is thought that adherence to the project cycle as a preferred method of project planning will be of immediate use as a planning and learning tool to future practitioners of post-disaster coastal restoration and rehabilitation. This discussion emphasizes community involvement in an consultative process which involves setting clear objectives with benchmarks for success, and then monitoring results *during* rather than *after* project implementation (or as was the case with so many rehabilitation projects in Aceh, no performance monitoring at all). It must be noted that monitoring of mangrove rehabilitation efforts worldwide, and not just in post-disaster scenarios, has been poor in the past. Due to the importance of learning lessons from past efforts, added emphasis has been placed on monitoring in this paper. Robin Lewis, a 35 year veteran implementer and researcher of mangrove rehabilitation brings to bear the scope of the problem facing us.

> We need to restore 150,000 hectares of mangrove area per year in order to keep up with current rates of mangrove destruction worldwide. Without proper dissemination of lessons learned, most mangrove rehabilitation projects will continue to fail into the future, wasting valuable resources. We can not afford to continue wasting time and money.

2.0 THE PROJECT CYCLE IN MANGROVE REHABILITATION PLANNING

The approach almost universally used by development agencies in project planning and implementation is project cycle management (see Figure 1); which simply describes the sequence of identifying, designing, monitoring and evaluating a project so that the lessons learned can be applied to improve future projects. Various aid agencies, international NGO's, relief organizations and government agencies will have their own terminology and approaches for project planning, although these are normally variants of the following method. Other alternative planning methods include the "Conceptual Model Approach to Planning Projects" developed by Margoulis and Salafsky in 1998, and the ZOPP method (ZielOrientierte ProjektPlanung = Objectives Oriented Project Planning) first introduced in 1983 and used by organizations such as GTZ of Germany. The ZOPP process is driven, for the most part, by the creation of a Logical Framework Analysis (log frame) matrix, but inclusive program design needs to go beyond simply the creation of a log frame. The basic components of the project cycle are depicted below in Figure 1, and form the outline for discussion in this paper.

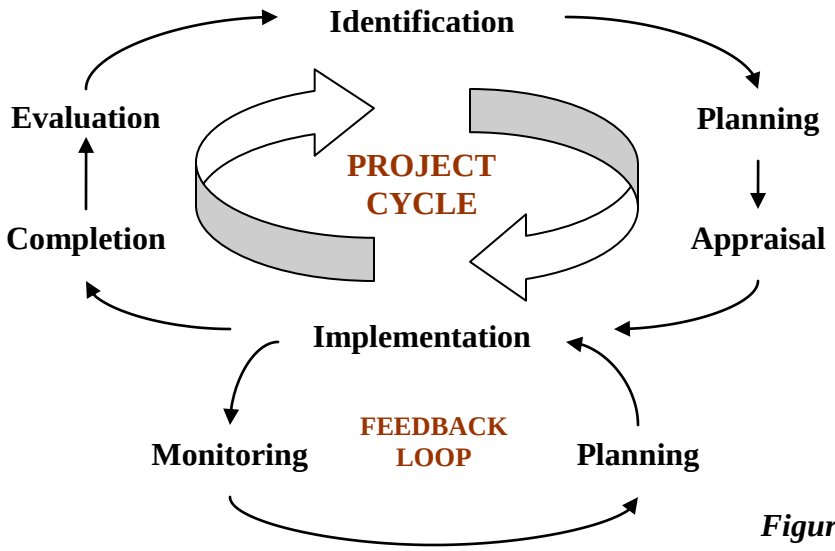

Figure 1

3.0 PROJECT IDENTIFICATION

3.1 Intent

Identification begins with determination of a problem area or set of issues for resolution through project work. In the case of mangrove rehabilitation, project identification can be intended to quantify and qualify the extent of the problem of damaged mangrove systems, initiate interest amongst donor organizations, and begin the process of site selection, stakeholder selection and prioritization.

3.2 Approach

Identification usually develops out of some sort of a rapid assessment process. Proposals for mangrove rehabilitation and integrated rehabilitation/community development plans usually arise once priority areas have been identified and mangrove destruction issues have been discovered. Further research is carried out to consider whether it is possible that a mangrove rehabilitation or integrated rehab/development project may help to resolve these issues. This stage usually involves considering "what could be done," "who will be involved" and "who might finance it." Typically, many more projects are identified as potential projects than are actually carried out. In the post-tsunami scenario in Aceh, however, it is likely that more projects were carried out than should have been (e.g.. planting mangroves in areas where mangroves previously did not exist such as high-energy coastlines). This was due to the amazing out-pouring of financial support for post-tsunami rehabilitation, coupled with restrictions in terms of time and pre-conceived expectations on how the money needed to be spent.

3.3 Considerations

Important considerations for identifying sites for mangrove restoration or rehabilitation fall into four main categories; social factors, political factors, economic factors, and ecological factors. Below are some considerations that should be taken into account when first undertaking rapid assessment (Participatory Rural Appraisal, Rapid Rural Assessment, etc.) as part of project identification.

- *Social Factors*: Are local communities involved in project identification? Are communities still engaged in other more pressing issues (building temporary-short term shelter, acquiring basic necessities etc)? What do land ownership and utilization issues at the community level look like?

When discussing a potential mangrove rehabilitation project with local communities, touch upon incentives for local community involvement. Sustainable use of the mangrove resources is of great advantage for community members, who can benefit from the improved inshore fishery, storm buffer protection, availability of fuel wood and timber resources, medicinal uses, and other functions which are provided by maintaining healthy and productive mangrove forests.

- *Political Factors*: Is government interested in playing a role in restoration (provision of resources, clarification of land tenure, etc.)? Does government need to be involved in the project? What do land ownership/utilization issues look like at various government levels (village, municipal, district, regency, province, national)? Is there political will to rehabilitate and conserve mangroves? Is the government mandated to "plant mangroves?" Are government officials willing to work together to develop their skills in new more holistic rehabilitation methods?

- *Economic Factors*: Is there likely to be financial support available for mangrove rehabilitation and monitoring? Is information available on how much mangrove rehabilitation costs per hectare in the region? Is there too much money available for identified projects? If so, can this money be re-allocated elsewhere? Have any valuation studies been performed on the mangroves in this region? Were these studies community based or academic? What are the potential financial impacts of mangrove rehabilitation in the area?

- *Ecological Factors*: In terms of project identification, there are some broad questions which need to be answered before delving into more detailed ecological analysis in planning and implementation. Premiere among these questions is; "Was the coastal area in question originally a mangrove forest?" Afforestation of non-mangrove areas suitable for planting (i.e., newly emerged mud flats on tidal deltas) may play some role in re-establishing an ecological balance to our tropical and sub-tropical coastal regions, but more often than not, afforestation is simply an attempt to convert one valuable marine habitat (i.e., mud flats) into another (i.e. mangroves) (see Erftemeijer and Lewis 2000). We therefore caution its use as a management technique. Many failed attempts are made to afforest coastal areas that are not conducive to mangrove growth such as; tidal mudflats, salt marshes and rocky/sandy beaches in high energy wave areas.

Other Considerations: Use of remote sensing technology and GIS mapping in site identification, selection and prioritization should be further developed for the future. For more information on techniques for Remote Sensing refer to Farid Dahdouh-Guebas et. Al, 2005.

3.4 Resources

Brown, Benjamin. "Do Your Own Mangrove Action Project – An Action Research – Problem Solving Method" MAP-Indonesia. 2004

Farid Dahdouh-Guebas**,** Elly Van Hiel, Jonathan C.-W. Chan, Loku Pulukkuttige Jayatissa & Nico Koedam "Qualitative distinction of congeneric and introgressive

mangrove species in mixed patchy forest assemblages using high spatial resolution remotely sensed imagery (IKONOS)" Systematics and Biodiversity 2 (2): 113–119 Issued 26 January 2005
DOI: 10.1017/S1477200004001422 Printed in the United Kingdom C_ The Natural History Museum

IUCN, "Tsunami Damage to Terrestrial Coastal Ecosystems: IUCN Guidelines and Methodology for Rapid Assessment." 2005

PMMR, OXFAM, CBNRM, WI. "A Field Manual For Facilitators On The Basic Concept and Process of Community Fisheries Management." Phnom Penh. 2002

Ranasinghe, Thushara and Mikkel Kallesoe, 2006. Valuation, Rehabilitation and Conservation of Mangroves in Tsunami Affected Areas of Hambantota, Sri Lanka: Economic Valuation of Tsunami Affected Mangroves — The World Conservation Union, Ecosystems and Livelihoods Group Asia.

Some simple resource on PRA

Vinaluan, Randy John and Paulo C. Campo. Satellite-Based and Community Based Coastal Resource Maps, Complementary or Contradictory, Univ. of Philippines. 2001

Additional resources in Bibliography

3.5 Definitions

Afforestation: Creation of a mangrove forest ecosystem or plantation where previously none existed.

Creation: The conversion of a persistent non-wetland area into a wetland through some activity of man. (Lewis 1990)

Enhancement: The increase on one or more values of a wetland, often accompanied by a decrease in other values. (Lewis 1990)

Land Ownership and Land Utilization: Lands in the upper inter-tidal region can legally be placed under private individual or corporate ownership in most parts of Aceh. Mid and lower intertidal areas are considered government "lands" although special use permits can be procured for development of aquaculture, logging concessions, port development and other non-permanent uses.

Rapid Appraisals: Use of one or more rapid appraisal methods which may or may not involve local community as practitioners. Examples include RRA (Rapid Rural Assessment) and PRA (Participatory Rapid Appraisal or Participatory Rural Assessment)

Rehabilitation[1]: Any activity which aims to convert a degraded system to a stable alternative use which is designed to meet a particular management objective"

Rehabilitation[2]: Is intended as an umbrella term that includes both restoration and creation"

Restoration: Activities geared at transforming a damaged ecosystem into a previous natural state

4.0 PLANNING

4.1 Intent

The intent is too create a feasible action plan ensuring the success of a mangrove rehabilitation effort. This includes planning for adequate monitoring to take place in parallel with implementation of the rehabilitation work.

4.2 Approach

"Most mangrove restoration projects fail completely, or rarely achieve their stated restoration goals." (Field 1999; Lewis 1999, 2000) This was true before the tsunami and was certainly true with regards to post-tsunami rehabilitation. The true number of failed projects would likely increase if proper monitoring and honest reporting had been undertaken.

Rigorous project planning can provide the advantage of helping overcome three of the major reasons for failure of mangrove rehabilitation projects. The reasons which are as following; 1) a tendency to concentrate on the project (e.g. planting of mangrove seedlings) while losing sight of the goal (conserving biodiversity, enhancing coastal resilience or reducing poverty), 2) not considering carefully the reasons why the project might fail and the risks involved, and 3) not having a coherent process for making decisions.

When planning any rehabilitation project, it is necessary to understand existing institutions, culture and a wide array of constraints (social, political, economic, and ecological). Many post-tsunami mangrove rehabilitation projects failed to go beyond rudimentary planning for seedling procurement and planting. Others completed logical framework matrices but failed to take into account the above mentioned constraints, failed to correctly identify assumptions and risks, and failed to identify resources and individuals who could assist with proper planning based on relevant experience.

The ZOPP project planning method first introduced in 1983 and promoted by GTZ, has been very influential and its principles have been widely adapted and used. The ZOPP process is the most commonly used process by development agencies in the planning phase of the "project cycle." The creation of the logframe analysis matrix (step 5 in the ZOPP method) drives the whole planning process. Although the LFA or logframe matrix, as it is commonly called, was used by all international agencies in planning for mangrove rehabilitation, it is mentioned again here in the context of the over-arching ZOPP method in the hopes that planinng for future coastal rehabilitation is more rigorous.

The ZOPP method is as follows (for a more complete description of each step mentioned below, see Sutherland, 2000).

1. *Participation analysis*. This stage decides who should be involved and whose interests should be given priority.
2. *Problem analysis*. A problem tree
3. *Objective analysis*. An objective tree is created to analyze what can be done to remove the problems.
4. *Discussion of alternatives*. Decisions are made, by using options analysis about which approach is to be adopted or even whether it is better to do nothing.
5. *Project planning matrix*. Decides upon and describes necessary activities, the logic linking these activities to the goals and the necessary monitoring. This is all done using logical framework analysis.

It is then necessary to identify and allocate tasks.

To re-iterate, most development agencies use similar planning structures and similar components. Planning is often completed at a workshop which should involve those that will carry out the work and should be multidisciplinary. Such a collaborative production is likely to result in both a better plan and greater commitment to the project.

Coordinated planning workshops for coastal rehabilitation in Aceh were notably lacking, and are suggested in the case of future disasters related projects where appropriate.

4.3 Considerations

Consider involving a mangrove restoration consultant to assist in planning. Ask for documentation of involvement in previous successful mangrove restoration projects. Note if these projects involved local communities in planning, design and implementation. Note if these projects paid attention to issues of intertidal hydrology (in this context, the frequency and duration of tidal innudation of the intertidal area. which underscores the ability of mangroves to survive in the coastal zone). Note if gender consideration were made. Ask for samples of data monitoring and analysis. You can consider this a form of due diligence.

Refer to the 5-step (now 6-step) Ecological Mangrove Restoration method when planning your project (Lewis, 2000, Brown and Lewis 2006)

Social: Full participation of local communities is desirable from the planning stages through to implementation and monitoring. Only with local acceptance of the project and full participation can you expect long-term and sustainable success for your mangrove restoration effort. Organization of a key community group, genuine participation of women, inclusion of local government, and involvement of youth and youth groups should all be considered. The more people in a community that know about a mangrove rehabilitation effort, the better the chances are of long-term stewardship. Many projects, especially in post-disaster scenarios, fail because consultation of local stakeholders only occurs after project planning. Local communities are usually involved minimally, for procurement of propagules/seed sources, nursery development, and planting. Maintenance is often hinted at but seldom undertaken and community participation in monitoring is seldom supported. Lack of full community participation in implementation is a direct outcome of a lack of community involvement in the planning stage.

It is also important to understand that a coastal community is not a homogenous entity. A single coastal community is comprised of various factions, some with greater power, prestige, wealth, skills, experience and knowledge than others. A program which goes through the government appointed village leader may not involve more marginalized members of the community. This has been noted numerous times in mangrove restoration projects in Indonesia, which may involve the village head and several of his or her close family, but not a larger cross-section of the community. Underserved/marginal segments of the community are traditionally left out of mangrove restoration efforts in Indonesia, although these people may be more dependent on mangroves both directly and indirectly for livelihoods.

Efforts should be made to involve a variety of community groups in the restoration effort. Special attention needs to be paid to local knowledge of the area. Traditional understanding of tides, high wave and current seasons, historical flows of freshwater through the area and historical distributions of mangrove species are essential to the success of the project from an ecological perspective. Equally important is the understanding of existing social capital, such as volunteer work (*gotong royong*), traditional management practices and beliefs. These things should be adequately revealed during a participatory assessment.

Political: Clarifying land ownership and land use issues may be the most important and often overlooked aspect of mangrove restoration work. In post-disaster Aceh, this was exacerbated by changes in coastal geomorphology, loss of land titles, disappearance and death of titled owners and users, and pressure to develop a coastal greenbelt along the majority of the coast.

Coastal communities are not often involved in development planning at either village or district levels. Although participatory mechanisms exist in government planning processes in Aceh, communities are for the most part not aware of their rights and these mechanisms are seldom utilized. This can result in planning and policy development that is biased in favor of elite interests. When there is involvement at the village level, government appointed village leaders dominate these processes. District and sub-district authorities usually assume that the development agenda proposed by village heads reflects the needs of coastal communities, including poor and vulnerable households. Unfortunately, village governments rarely consult their own people to accommodate local needs and interests. Representative and fair coastal village development plans are thus not in place, and needs of the coastal communities are not being met.

Political will is required to restore and better manage mangrove areas, especially when dealing with privatized inter-tidal areas for more equitable access to mangrove resources for conservation and sustainable utilization.

Economic: Mangrove restoration is sometimes a difficult activity for which to budget, but the physical work itself in Aceh should cost approximately $1000 - $2000 per hectare for projects of 5-25 hectares in size and less than $1000 per hectare for projects larger than 25 hectares. In general, the larger the project the cheaper the cost per hectare if adhering to the hydrological rehabilitation method. This is especially true for projects which employ the use of heavy machinery (bulldozer, backhoe, etc). Additional funds for social organizing and administrative costs will depend upon the implementational organization. It is important, in the future, for organizations to transparently provide information about project budgets as a guideline for future mangrove rehabilitation planning. Worldwide there are millions of hectares of mangroves that could potentially be restored. Understanding the real costs of mangrove rehabilitation is crucial to garnering continued donor support for mangrove rehabilitation and for ensuring that mangrove rehab is allocated for in government budgets.

Equally important to understanding the costs of mangrove rehabilitation is an understanding of potential economic benefits. Mangrove restoration practitioners can assist in the compilation of this information by planning for economic valuations and forecasts to be taken of their mangrove restoration areas. Academic studies should also be commissioned for each region to determine the economic value of healthy mangrove ecosystems.

Ecological: First and foremost, it is necessary to assess which mangrove trees or plants are desired for rehabilitation. Since there are scores of varieties and species of plants in the mangrove forest, certain ones are typically chosen over others for a rehabilitation program. Usually, mangrove tree species are selected in an attempt to restore the forest canopy, biomass functions, support fisheries production and provide valuable direct wood resources to humans. The most common species selected for restoration in Aceh (and in fact the entire SE Asian region) are invariably *Rhizophora apiculata* and *R. mucronata*, although these species have a limited and distinct niche in the intertidal

region. Other species for consideration include *Avicennia* spp.*, Sonneratia* spp.*, Ceriops* spp.*, Bruguiera* spp.*, Aegiceras* spp.*, Lumnitzera* spp.*, Heritiera littoralis, Scyphyphora hydrophyllacea, Pemhis acidula, Xylocarpus* spp. and *Nypa fruticans*. These tree species would be selected for three main reasons 1) their availability and ease of collecting and propagating their seeds, 2) the economic resource benefits gained from restoration and eventual harvesting of wood from the forest, or fishery resources from adjacent waters, and 3) their suitability for various intertidal habitats and tidal inundation periods.

It is possible to restore some of the functions of a mangrove, salt flat or other system even if parameters such as soil type and condition may have been altered and the flora and fauna may have changed (Lewis 1990, 1992). However, if the goal of restoration is to return an area to a pristine predevelopment condition, then the likelihood of failure is increased. That is, restoration of selected ecosystem traits and the replication of natural functions stand more chance of success than complete restoration to pristine conditions (Lewis, Kusler, and Erwin 1995). This reality should be considered during project planning.

The six-steps of successful mangrove rehabilitation are listed below and should be considered in the planning phase of all mangrove rehabilitation projects.

Work together with local community organizations, NGO's, academic institutions and government to:

1. ASSESS ECOLOGICAL FACTORS
Understand both the autecology (individual species ecology) and community ecology of mangrove species at the site, paying particular attention to patterns of reproduction, propagule distribution, and successful seedling establishment.

2. ASSESS HYDROLOGIC FACTORS
Understand the normal hydrologic patterns that control the distribution and successful establishment and growth of targeted mangrove species; this step involves participatory mapping.

3. ASSES DISTURBANCES
Assess modifications of the previous mangrove environment that currently prevent natural secondary succession.

4. SELECT AND PRIORITIZE SITES

Select appropriate mangrove restoration sites through application of the above steps 1-3, that are likely to succeed in restoring a sustainable mangrove forest ecosystem and be cost effective. Consider available funds[2] and staff/labor to carry out projects. Community organizing may be required at this stage if not already working through a local community organization. This step includes resolving land ownership/use issues necessary for ensuring long-term access to and conservation of sites.

[2] Ideally the cost of the community actions in mangrove restoration could be included in the budget of the village government or obtained from relevant government projects. While efforts to lobby the district government for budget allocations for mangrove rehabilitation will be done, it might be necessary for the project to step in and provide support for these actions through cash-subsidies.

5. PLAN AND DESIGN THE PROJECT

Design restoration plans for appropriate sites selected in Step 4 to initially restore the appropriate hydrology and take advantage of natural volunteer recruitment[3] of mangrove propagules for plant establishment. In the restoration plan, be sure to include adequate monitoring for at least three years to measure progress towards meeting quantitative goals established prior to restoration. Involve local communities in designing the implementation and monitoring plans.

6. IMPLEMENTATION AND MONITOR THE PROJECT

Take baseline monitoring data for the restoration area before implementation of the restoration plan. When baseline monitoring is complete, implement the plan. Involve local communities in implementation and monitoring.

Note: Utilize actual planting of propagules, collected seedlings, or cultivated seedlings ***only*** after determining through Steps 1-5, that natural volunteer recruitment will not provide the quantity of successfully established seedlings, rate of stabilization, or rate of growth of saplings established as quantitative goals for the restoration project.

4.4 Resources

See bibliography for more complete listing of mangrove restoration planning and implementation references.

Brown, Ben and Robin Lewis. "Five Steps to Successful Ecological Restoration of Mangroves" MAP/YARL 2006

Lewis, R. R., and W. Streever. 2000. Restoration of mangrove habitat. Tech Note ERDC TN-WRP-VN-RS-3.2. U.S. Army, Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi. 7 p. (Available to download at: http://www.wes.army.mil/el/wrtc/wrp/tnotes/vnrs3-2.pdf)

Sutherland, William. "The Conservation Handbook – Research Management and Policy" Blackwell Science, 2000

4.5 Definitions

Autecology – The ecology of individual species of mangroves, e.g. life history, distribution, reproductive methods, hydrological requirements etc.
Gotong Royong – Indonesian terms for voluntary community labor.
Natural Recruitment – The process by which naturally occurring propagules become distributed and established in the intertidal zone.
Propagules – The floating fruits, seeds and embryo of mangrove plants. These put down
roots and grow into seedlings
Propagule Limitation – When an area can not be expected to be colonized by natural

[3] Natural volunteer recruitment means the establishment and growth of mangrove seedlings due to tidal distribution of naturally occuring propagules (mangrove seeds and fruits).

sources of propagules. This occurs when healthy, fruit bearing mangroves are located to far away from the restoration site, when nearby mangroves have stopped producing and distributing adequate amounts of propagules, or when the propagules access to the restoration site is blocked (e.g. by the dike walls of a shrimp farm).
Tidal Inundation – The period and frequency by which the substrate in which mangroves grow are covered by oceanic tides.

5.0 APPRAISAL

5.1 Intent

The appraisal part of the project cycle involves systematically determining whether or not an identified project and project plan should be supported and move into the implementation phase.

5.2 Approach

The project is reviewed to decide whether to proceed, based on the likelihood of success, the costs, the social implications and whether the project is compatible with existing institutional structures. When applying for outside funding this is usually a formal process. If funding is already available it is still sensible to carry out a full appraisal to examine the quality of the plan and decide whether the investment is sensible. The project design may be altered as a result of appraisal. In many organizations, initial appraisal of an outline plan may be followed by a stage in which detailed plans are created, followed by a stage of final approval.

5.3 Considerations

Social: Has the project adequately involved local community in planning for implementation and monitoring? Involvement of local community in all three phases should be considered essential to the long term success of the mangrove restoration effort. If you do not have the time and resources to involve local community, abandon the project or seek additional resources.

Political: Have land use and ownership issues been adequately addressed? Is the government aware of this project?

Economic: Costs of mangrove rehabilitation varies widely depending on conditions specific to individual projects. The price of labor and the extent of necessary earth-work will dramatically affect costs. Milano (1999) describes in some detail the planning and construction process for ten - wetland restoration projects in Biscayne Bay (Miami), Florida, of which eight were mangrove restoration projects. Careful planning to achieve success is emphasized, as are methods of ensuring cost control. The eight projects ranged in cost from about $5,300 to over $200,000 per hectare, with a mean of about $99,000 per hectare. Hydrologic restoration in Indonesia without major excavation costs as little as $500 per hectare (MAP-Indonesia, Bengkalis Project) and up to $2000/hectare if using both heavy equipment and planting of seedlings. Development of large nurseries to grow mangroves are rarely essential, costs a lot of money, and takes valuable resources away from better planned mangrove rehabilitation efforts.

Is the planned project appropriately funded? If there is not adequate funding to both implement and monitor, the project should be altered. Likewise, if the program budget is too large, you should consider increasing the scale of the project, or allocating funds into additional activities that work towards building the long term social and ecological resilience of the mangrove area. These activities might include environmental

education, development of mangrove based sustainable livelihood alternatives, greater attention to the development of community based coastal resource management systems, capacity building for local stakeholders, and scientific studies such as participatory biodiversity monitoring.

Ecological: Consider whether or not the project plan has paid significant attention to steps 1-4 of the six step method for successful mangrove rehabilitation. Keep in mind that rehabilitation may be recommended when a system has been altered to such an extent that it cannot self-correct or self-renew itself. Under such conditions, ecosystem homeostasis (the ability of an ecosystem to withstand shocks or disturbance while maintaining its basic functions) has been permanently stopped and the normal processes of natural recovery from damage are inhibited in some way. This concept has not been analyzed or discussed with any great detail in relation to mangrove habitat (Detweiler et al. (1976), Ball (1980), and Lewis (1982b) are the few exceptions). As a result, project managers have frequently emphasized the planting of mangroves as the primary tool in rehabilitation. However, a better approach to rehabilitation would determine the causes for mangrove loss, remove these causes, and work with natural recovery processes to reestablish mangrove habitat. Mangrove stock would only be planted when natural recruitment mechanisms were inadequate for re-establishment of mangroves and only after appropriate hydrological conditions had been established.

5.4 Resources

There is a distinct lack of literature on appraising coastal rehabilitation projects. Given the large amount of potential sites for rehabilitation, methods for site selection and project appraisal should be further developed in the future.

6.0 IMPLEMENTATION

6.1 Intent

The intent would be to work with local stakeholders, primarily local coastal communities, to actively rehabilitate damaged mangrove forest areas while monitoring the results of the rehabilitation. Baseline monitoring needs to begin ***before*** implementation, and carry on for a period of at least 3 years.

6.2 Approach (adapted from Quarto and Lewis, 2003)

There are many different techniques and methods utilized in both planting mangroves and rehabilitating mangrove forests. Because some of these have resulted in identifiable successes or failures, herein is a summary description of some of the recommended methods for rehabilitating mangrove forests. 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. True restoration of an entire forest ecosystem is a very difficult task. In all of Aceh, for instance, there exist approximately 30 true mangrove species and a host of mangrove associates. An ambitious rehabilitation program might attempt to re-establish 5-10 of these. What we describe, therefore, is a simpler and manageable process of rehabilitating a simplified mangrove forest, while hoping that in time the great diversity of the original forest will return.

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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. For a

fuller understanding the reader should research more thoroughly this subject, and consult more directly with those who are experienced experts in hands-on rehabilitation techniques (see bibliography). 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.

There are basically four approaches, which are used in mangrove restoration programs:

1) Hydrologic restoration with no planting,
2) Hydrologic restoration 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.

Of these four approaches, number four is unlikely to apply to a post-tsunami situation, although, nonetheless dealing socially with the issues of human caused stresses to mangrove growth need to be addressed as part of the project.

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

Method 2 has also proved effective, and can provide visible recovery very quickly (Lewis et al. 2000), but planting costs can increase the overall cost of a project and may limit the biodiversity of the site due to competition between 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 successful planting and growth of trees is almost impossible. 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.

If after all the considerations are made and planting of mangroves is selected as a rehabilitation method, please consult the JICA Manual on development of a mangrove nursery for Bali and Lombok (Hachinoe, 1998). But it is strongly recommended to understand and practice a mangrove rehabilitation method which pays attention to the sites hydrological conditions.

6.3 Considerations

Remember that monitoring is an essential part of mangrove restoration, and should always be undertaken. Monitoring needs to be initiated before implementation of the restoration work, in order to compile baseline data. Time lapse photos should begin at this time. This will be discussed further in section 7.4. Monitoring should be undertaken five times in the first year, at months 0 (before implementation), 3, 6, 9, 12, and then annually for years 2 and 3. Building community capacity to monitor in a participatory manner will be essential in a post-disaster context as nearly all aid agencies will pull out within a few months to several years.

Consider capacity building as a key part of implementation. Involvement of local stakeholders in the implementation process will build their experience and knowledge for future restoration efforts. This too, is essential in a post-disaster context, in preparation of departure by most organizations within a few years.

Pay attention to seasonal differences when undertaking a mangrove restoration effort. In terms of timing, it is usually beneficial to have all work completed during the onset of a rainy season, to help young mangroves grow. Getting past the first three dry seasons is a sign of general health for young mangroves in Aceh.

In the case of breaching of dike walls from aquaculture ponds, be aware that you may cause excessive siltation of nearby coastal ecosystems and the release of pollutants. When breaching of dike walls is a significant portion of your project, you may consider undertaking the work in stages and taking precautions against the sudden release of sediment.

6.4 Resources

Mangrove Action Project reports on mangrove rehabilitation are available at www.mangroveactionproject.org. Specifically refer to final reports from Bengkalis Island, Riau Province the NE Langkat Wildlife Sanctuary, North Sumatera Province and Tiwoho, North Sulawesi Province.

Robin Lewis' papers also provide numerous case studies of ecological mangrove rehabilitation in action.

6.5 Definitions

Normal Hydrology - The single most important factor in designing a successful mangrove restoration project is determining the normal hydrology (depth, duration and frequency, and of tidal flooding) of existing natural mangrove plant communities (a reference site) in the area in which you wish to do restoration or rehabilitation.
True Mangrove v. Mangrove Associates – A true mangrove species exists primarily in mangrove habitat, that being within the inter-tidal region and along estuarine river banks. A Mangrove associate may exist within the mangrove area, but also succeeds in terrestrial habitats. Mangrove associates, when found in the mangrove, usually occur in the upper mangal or terrestrial interface between mangrove and land.

7.0 MONITORING

7.1 Intent

Monitoring involves analyzing the current situation regarding the restoration effort in order to improve the existing program. Monitoring of outcomes is critical for future learning, but there are a number of obstacles to monitoring in practice. One of the main purposes of this paper is to underline the importance of mangrove restoration practitioners setting clear, measurable objectives and then monitoring results during implementation, rather than after the implementation period has ended. Because monitoring is such an important part of the project cycle, and was largely ignored in post-tsunami mangrove restoration efforts, this section on monitoring is more elaborate than the previous sections.

All mangrove restoration projects should be able to set clear benchmarks for success and monitor progress so as to know whether or not these benchmarks have been achieved.

7.2 Problems With Monitoring

Most restoration plans implemented after the tsunami had procedures for checking on implementation, usually in the form of a technical report (control). These "control" mechanisms were often designed merely to check that the planned activities were carried out. For instance, 100 hectares of mangroves were planted with 1,000,000 seedlings at spacings of 1 meter x 1 meter. In some of these cases, even the simple reporting of planting activities provided us with incorrect or falsified data. One case of a government mangrove planting effort in Aceh reported 75% success of planted seedlings in a 100 hectare area, when in reality the site in question experienced 0% survivorship within 6 months after planting, and only one to two hectares were planted. The site was planted a second time (again around 1 hectare), and experienced 55% survivorship within a two months of planting, with more and more seedlings dying each week. Data for this project finally appeared in a Aceh and Nias – Bureau of Rehabilitation and Reconstriction (BRR) report with a 55% success rate in 100 hectares of land.

In some instances, organizations and agencies went beyond mere "control" (a very simplified check-list form of moniitoring e.g. "planting completed or planting incompleted") and provided some information for a new analysis phase, in which case we might use the term 'monitoring'. When monitoring provides feedback in this way, we have a complete feedback loop in the project management cycle which enables the practitioner to rectify mistakes. This should be the goal of all mangrove restoration projects.

In practice, the project cycle rarely works as efficiently as it should in theory. When new plans have to be made, planners do not always look for monitoring information; when they do, it is often not available or not particularly useful. There are several reasons why monitoring has been badly done or not done at all.

First, monitoring is generally not planned and implemented until an activity has finished. Those responsible for monitoring are not always the same people involved in preparing or implementing the original restoration plan (especially true given high turnover of disaster relief agency workers and volunteers, or the disintegration of a group such as the Department of Forestry's *SATKER*[4] work group). When those responsible set about monitoring, it is not often clear what they are supposed to measure: the objectives are usually immeasurable and often vague. Moreover, assessment depends on measuring change or improvement, but no information on the sites previous condition is normally collected and recorded before the activity/intervention is carried out. Change cannot be measured without baseline information. Monitoring needs to be planned in advance, before implementation, and should be an integral part of the restoration plan.

Secondly, monitoring does not receive enough time or other resources. Resources are usually limited, and the demands for resources for management activities often take priority over those needed for monitoring the results. In the case of post-tsunami

[4] SATKER literally translates to Work Unit and was a technical task force or work group set up to oversee technical coastal rehabilitation efforts.

rehabilitation in Aceh, however, financial resources were not in short supply, in fact they were in excess of what could be realistically spent. In this case, why did monitoring, by and large still not take place?[5] It seems that relief agencies feel that medium term monitoring falls out of the realm of their responsibilities. But even when dealing with short term disaster responses, such as food provision, health care and shelter, these organizations engage in monitoring and analyzing feedback from the field. This enables fine-tuned provision of services; more tarpaulin in Village A and C, enough tetanus vaccine in Village B, etc. Mangrove rehabilitation deserves the same treatment, otherwise it will not be known if time and money are well-spent or wasted, and professionals engaged in mangrove rehabilitation will continue to lack information that can help with making decisions on how to improve mangrove rehabilitation efforts in the future, disaster or no.

The third problem with monitoring may be the most widespread and difficult to solve. Often the people involved do not really want to know, simply because they are afraid that monitoring the projects progress may show that the results of their work are not good enough. There is always a risk that a close look will show that objectives have not been met, or at least that little has been achieved for the effort and money put in. It is much more comforting to report that we have worked very hard to achieve worthy objectives, rather than reporting on how unsuccessful we have been. There are good reasons for this, quite apart from personal feelings: reporting any result which falls short of total success might make it more difficult to get future funding or staff or a promotion. The present system itself discourages honest assessment.

Poor monitoring of mangrove restoration has become an epidemic. When we look at reports on-line, we find scores of projects reporting 'good results.' Interviews with BRR and the Forest Department provide us with similar surface responses, which prove to be untrue more often than not. Before concluding that mangrove restoration efforts are achieving their goals, we need to remember that people will always put a positive 'spin' on their project reports, and if it goes really wrong, they won't write it up at all. By cutting back on the monitoring, lessons shall not be learnt and bad practice shall continue; and so we miss the opportunity to learn new and better ways.

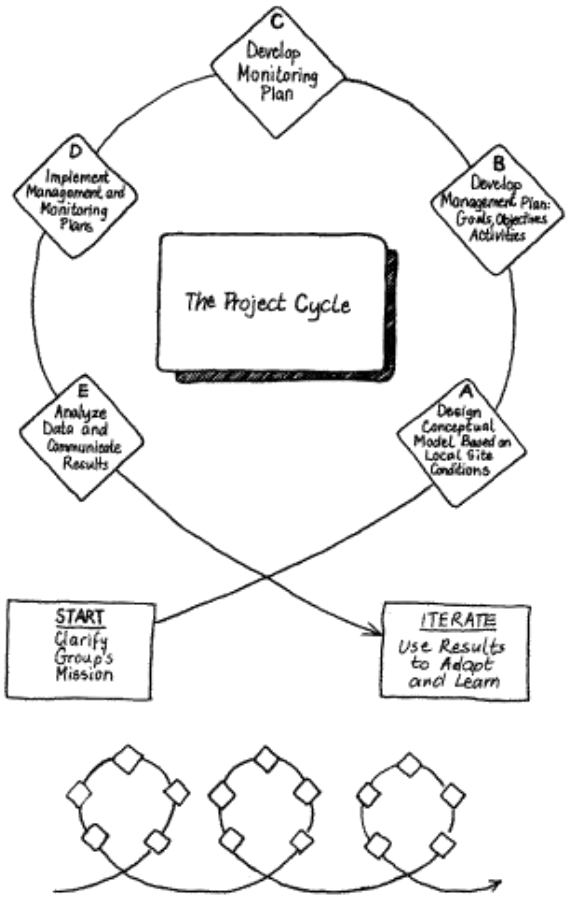
[5] There were certainly exceptions to this, such as WI-IP's 3 year monitoring program

7.3 Approaches

To begin with, use of a Logical Framework Analysis Matrix, especially as part of the ZOPP planning method introduced in section 4.2, will go a long way to ensuring that effective monitoring takes place. These project planning tools require the practitioner to set clear, measurable objectives and also to write out explicit assumptions that can be tested during monitoring.

Thinking about mangrove restoration in terms of an *adaptive* process is also beneficial. An adaptive process requires continual monitoring of indicators which measure progress toward goals. Practices then change when it is clear that current practices are not achieving their objectives. In this approach, every activity or decision is treated as an experiment to test a hypothesis, with conclusions based on measurement of specific parameters. Local managers including local community members have the power to change detailed restoration and management practices in the light of these results, within a broad framework set by top management.

Figure 2 – The Project Cycle
(from Margoluis and Salafsky 1998)



At this point, we can conceptualize the project cycle in a new way as seen in Figure 2. Indicated at the bottom of the diagram, the project cycle is re-interpreted as an iterative process, with each completed cycle providing the starting point for the next. The various steps are also better integrated, so that working on one step may suggest ideas and improvements for the previous step. Looking more closely at Step C - 'Develop Monitoring Plan' - we see that monitoring is planned *before* the management plan is implemented. A feature of the project cycle is that the management plan - in this case a rehabilitation plan (Step B) - is based on clearly stated and measurable objectives, which also form the starting point of the monitoring plan. The monitoring plan sets out to gather information on various indicators, each of which is related to specific objectives or activities. Information gathered is clearly linked to management decisions about the activities carried out and the extent to which objectives are being met. Monitoring pinpoints problems, related to implementation and to the assumptions underlying management decisions, which are made explicit in the logical framework matrix.

In this revised version of the project cycle, monitoring and management plans are implemented in parallel (Step D). Collecting information and reviewing implementation are on-going processes, so that activities can be adjusted immediately and made more effective during the period of the plan; it is not necessary to wait until the end of the planning period to make changes. This approach to monitoring should be less threatening to managers, as it aims to provide ongoing 'tutors' comments', not just to be

a 'final examination' which some pass and others fail. Australian Red Cross provided a good example of this when, through monitoring, they realized that their rehabilitation targets were not being met and hired external consultants for deeper analysis.

The main thrust of this amended project cycle as an approach is to *integrate monitoring into mangrove restoration implementation*, which means that management of the project itself must be based on measurable objectives and goals. This enables the project cycle to work as it should in theory and provides feedback on what additional knowledge or skills are required.

7.4 Considerations

Remember that we want to integrate monitoring into implementation of mangrove restoration. The indicators - the specific parameters which we are going to measure - must be related to detailed, measurable objectives.

Examples of Poor and Well Conceived Restoration Objectives

Poor	Good
Planting of mangrove seedlings	Successful establishment and growth of 1250 planted seedlings per hectare and a minimum of 1250 additional natural recruits per hectare in a 50 hectare site 3 years after initial rehabilitation.
Strengthen capacity of local mangrove restoration practitioners	Training of four community groups in the methods of Ecological Mangrove Restoration per district in four districts (16 total groups) over two years.
Awareness raising on the value of mangroves.	Participatory economic mangrove valuation run in partnership with 8 community groups over phase I of the program.

It is imperative to clarify goals and objectives, and the indicators which we want to monitor, for mangrove rehabilitation. In doing so, we need to discuss what goals and objectives we need to set for each rehabilitation area, so that they contribute to the overall objectives of the larger program scope, such as disaster relief, community based coastal management, or sustainable livelihood development. At this stage, we will be able to define techniques to measure our parameters and to decide on the training needed by staff to take these measures. A subsequent step may be to devise and run training courses where people learn both rehabilitation and monitoring skills, *and* use them to improve the effectiveness of their mangrove rehabilitation programs.

As an example, to ensure maintenance and monitoring, Wetlands International signed contracts with Community Groups (KUB) formed by the WI-IP rehabilitation project, who were provided with small grants (approx $300 per group member) to initiate savings and loans if at least 75% of their mangrove seedlings survived after a period of 3 months. If less than 75% of the mangrove seedlings survived, the loans would have to be paid back. This mechanism indeed increased maintenance and monitoring of plants, but only for a period of three months. Other mechanisms to ensure longer term monitoring need to be developed.

Developing a Monitoring Plan

Mission: purpose, strategy, [values]
Conceptual Model: subject, direct factors (priority threats), indirect factors, activities
Goal: general, brief, measurable
Objectives: SMART = Specific, Measurable, Achievable, Relevant, Time-limited
Activities: Linked, Focused, Feasible, Appropriate

Information needs
Indicators: Measurable, Precise, Consistent, Sensitive
Methods: Accurate and reliable, Cost-effective, Feasible, Appropriate
Tasks: what? when? who? where? Fig 3: Steps for developing a monitoring plan

Meredith, 1998

Technical Monitoring Activities for Mangrove Restoration

Activities	Remarks
Monitor mangrove species that develop	Check correctness of original provenance of propagules and seed.
Monitor growth as a function of time	Parameters include the density, percent cover and species composition of both planted and volunteer mangroves over time.
Monitor growth characteristics	Include determination of stem structure, node production, phenology, fruiting and resistance to pests.
Record level of failure of saplings	Provide a scientific explanation of failure.
Record levels of rubbish accumulation	Note source of rubbish and steps taken to minimize the problem.
Adjust density of seedlings and saplings to an optimum level	Degree of thinning, replanting or natural regeneration should be noted. Growth should be monitored.
Estimate cost of restoration project	The estimation of costs should include all the undertakings including site preparation, propagule collection, nursery establishment, field transplantation, etc.
Monitor impact of any harvesting project	This should be part of any long-term record for rehabilitation.
Monitor characteristics of the rehabilitated mangrove ecosystem	This involves detailed measurement of fauna, flora and physical environment of the new mangrove ecosystem and comparison with similar undisturbed mangrove ecosystems.

- From Robin Lewis

Time Lapse Photography – One excellent way to track the changes taking place in a mangrove rehabilitation project is time lapse photography. These shots can be taken either level with the ground or from an aerial vantage point (hill, plane, satellite imagery…). The first shot is taken either before any intervention, or immediately after hydrological amendments. Subsequent shots are taken at 6 month to one year intervals. Make sure to take the shot from the same place, using the same camera angle. A permanent reference point in the background is useful in convincing viewers that the shot sequence was taken in the same place. Time lapse photos are also invaluable for promoting mangrove rehabilitation successes.

7.5 Resources

Fancy, S.G. April 9, 2001. Characteristics of a good monitoring protocol. http://www1.nature.nps.gov/im/monitor/index.htm.

MAP-Indonesia. "Long Term Monitoring Plan Mangrove Rehabilitation & Sustainable Livelihood Alternative Development For 500 Hectare Co-Management Area SE Langkat Wildlife Sanctuary – North Sumatera." 2007

Margoluis, Richard and Nick Salafsky. 1998. "Measures of Success: Designing, Monitoring and Managing Conservation and Development". Island Press

7.6 Definitions

Adaptive Management – Characterized by a program of continual monitoring of indicators which measure progress toward goals, ongoing analyses of policy alternatives, and an institutional capacity to change management practices when better alternatives are available and current practices are not achieving their objectives.
Control – Simply checking that a project was carried out or not (e.g. 100,000 mangrove seedlings planted)
Evaluation – The process of analyzing the entire completed project to consider the successes and failures in order to improve future projects.
Monitoring – The process of analyzing the current situation in a project, in order to improve the existing program.

8.0 COMPLETION

8.1 Intent

Completion of the project cycle marks the end of the provision of external funding or support.

8.2 Approach

For most projects, the expectation is that the project will continue and will be self-sustaining. This is often only likely to occur if capacity building has be an integral part of the project.

Formation of a community group and capacity building of existing groups to maintain, monitor and protect restored mangroves is essential in Aceh and the region in general. Creating liaisons with NGO's, academia and government offices can ensure that local communities have access to information and resources needed to maintain conservation efforts. Development of local legislation for mangrove protection is also essential.

Wetlands International provided a good example of this in their integrated rehabilitation and livelihoods work (see Part A – Technical Summary and Analysis of Initiatives)

Development of sustainable livelihood options based on healthy mangrove environments is an excellent way to build community support for mangroves. Strategies employed by MAP in Aceh include development of women's cooperatives based on processing of mangrove resources including non-timber forest products. Enhancement of mangrove forests for fisheries production, linked with support of silvafisheries and capture fisheries is a strategy often employed with men's fishing cooperatives.

8.3 Considerations

The most essential point is that although the project may be coming to an end in a short time frame, monitoring needs to be carried on for at least 3 years. There needs to also be a strategy for enhancing mangrove rehabilitation (hydrological adjustments, additional plantings, improved maintenance strategies) if monitoring indicates that objectives are not being met.

It is also important to remember, that restored mangroves may not significantly function to augment fisheries and other livelihoods for a time period of 10-15 years or more. While the mangroves are growing, it will be important for fisher folk communities to both protect the rehabilitation area, and also to be involved in alternative livelihoods that are not entirely dependent on healthy mangroves.

8.4 Definitions

Non-Timber Forest Products – Products derived from mangrove habitats excluding the felling of trees (ex. tea from mangrove shrubs or direct use of mangrove fruits as food items).
Silvafisheries – Culture of fisheries products (fish, shellfish, crabs, prawns etc.) in conjunction with mangrove trees.

9.0 EVALUATION

9.1 Intent

Evaluation of a project involves analyzing the entire complete project to consider the successes and failures in order to improve future projects.

9.2 Approach

As well as monitoring the project as it progresses and modifying accordingly, it is useful to evaluate the success of the project once it has ended. The actual progress is compared with the plans, decisions, and actions that were taken and are reviewed, and ideally made available to others. The lessons learned from the successes and failings of a mangrove rehabilitation project can then be used to improve subsequent projects.

One issue is that everyone is looking for success. In post-tsunami relief work, both government budgets (APBN) and donations from around the world came in with stipulations of wanting to know that their donations were well spent, i.e. that the project was a *success*. Forgetting for the time being the special circumstances of the tsunami, where nearly limitless funds were available for rehabilitation, as with most government agencies, Indonesian Forestry Department annual budgets are allocated by the Finance Ministry based on past performance. This provides the Forestry Department with a strong incentive to report success rather than reporting setbacks. Local communities want continued funding, project teams want to show that they have performed their tasks

well and donors wish to show that they have spent their money efficiently and wisely. The truth of the matter, however, is that most mangrove restoration projects fail to meet their objectives, and many fail even to set measurable objectives. Rigorous monitoring and evaluation are the solutions to this problem. External monitoring and evaluation, in addition to participatory monitoring is the best possible scenario.

9.3 Considerations

Most projects perform some form of project evaluation. This is often in the form of a report, and is usually filled out by project staff, who have a vested interest in reporting success. The following two evaluation alternatives (external evaluation and SANE analysis) are suggested for mangrove restoration projects, in order to best uncover valuable lessons learned from the field.

External Evaluation

Although numerous organizations likely hired external evaluators for their projects, we would like to shed light on one specific case as a positive example of the use of external evaluation. The Australian Red Cross (ARC) had undertaken mangrove planting with local communities as part of their livelihood program at four sites; utilizing *Rhizophora mucronata* and *R. apiculata* seedlings from the neighboring province of North Sumatera. ARC performed baseline data (although they left out counting natural seedlings in the restoration area prior to planting) and also performed monitoring twice after the initial plantings (between 2 weeks – 9 months after planting). Data revealed that 2 of 4 sites had experienced 100% mortality after planting, with one site performing at 75% survivorship and one newly planted site at 65% survivorship but fading fast. ARC called in a MAP-Indonesia team to assess the reasons behind the failures and make recommendations for the continuation of their work. Before the evaluation, grazing by water buffalo was assumed to be the main reason for the demise of the plants.

The MAP team quickly determined the root cause to be a major change in hydrological patterns and tidal inundation due to seismic uplift of the entire island from between 25cm – 110 cm. Since the tidal range for the island was only 75-80cm, many of the mangrove areas were lifted completely out of the tidal zone. Planters of mangroves, without having taken new tidal measurements were left to guesswork in determining were to plant their mangrove seedlings. In two sites, over half of the planted seedlings were planted entirely outside of the tidal range, either too high or too low. Another site that was planted was a sandy, high wave beach, which had never supported mangroves. Lack of propagules (propagule limitation) was also an issue in all sites, leading to a low rate of natural re-establishment. MAP's assessment led to the hosting of a workshop to train community members in ecological mangrove rehabilitation, along with other topics such as community based coastal resource management and small scale livelihood development. This combination of an implementing agency (ARC) monitoring reporting honestly, and then seeking appropriate expertise for external mid-term evaluation during the project period is a model that should be promoted for the future.

SANE Analysis – Reporting and monitoring usually focus on goals and finances. Field workers rarely have the opportunity, time or mechanism for sharing their experiences, yet it is usually they that have gained the practical knowledge and learnt lessons as to what works and what does not. Systematic analysis of experience (SANE) is a simple method of learning from projects (IUCN International Assessment Team 1997). Writing SANE analysis into each mangrove restoration project is an excellent way to pull lessons learned directly from the field. The method runs as follows:

1. *Tell the story*. One staff member describes the experience of the project as a story while a facilitator records it on a flip-chart. Discussion is encouraged to refine, dispute and correct the story. Gaps in the knowledge and disagreements are documented.

2. *Identify turning points*. Analyze the story to determine changes and why these occurred.

3. *Identify phases of experience*. Intervals between turning points can be called phases and it is useful to name these after distinguishing features.

4. *Phase analysis*. Within each phase analyze the main issues such as objectives, hypotheses, activities, participants, methods, successes and failures.

5. *Analysis*. Compare phases to identify changes and the causes and consequences of changes. Identify trends and evolution of ideas and hypotheses.

6. *Lessons learnt*. It should be straightforward to synthesize the lessons learnt in terms of what should or should not have been done.

7. *Communication*. Record and circulate to those that would benefit.

Information and Knowledge Sharing – This section on considerations of evaluation ends with a note on sharing and networking. Disaster agencies were well networked in certain areas, but poorly networked in others. Aside from government coordination by the BRR (Aceh and Nias Rehabilitation and Reconstruction Agency), forums such as the Shelter Cluster were hosted and attended by numerous organizations. This coordination role for coastal rehabilitation was taken on by the Green Coast Program, spearheaded by Wetlands International – Indonesia Program. WI-IP was not, however, able to coordinate with many practitioners, and was only able to provide limited training and the resources provided were inadequate. Cluster formation around coastal rehabilitation, improved coordination between practitioners, and readiness of appropriate resources for outreach is another recommendation for future post disaster relief.

Aside from clusters, international clearing houses were formed to assist in sharing information with practitioners. The UN Food and Agricultural Organization based in Bangkok, (FAO - Bangkok) and the Asian Wetland Symposium acted as two such clearing houses. The FAO is an example of a coordinating body for post-tsunami mangrove rehabilitation, that primarily fed information through government agencies from the affected Asian nations. Unfortunately, dissemination to the hundreds of practitioners in the field in Aceh was for the most part un-felt. Better strategies for dissemination of information, from government to field practitioners, need to be a focus of future facilitation agencies.

9.4 Resources

9.5 Definitions

SANE - Systematic analysis of experience, is a simple method of learning from projects focusing on debriefing sessions with field staff.

Seismic Uplift – Ex. the islands of Simeulue and Nias experienced uplift of between 50cm – 3 meters after the tsunami and subsequent March 2005 earthquake causing large-scale die off of coastal habitats including mangroves, seagrass beds and shallow coral reefs.

10.0 CONCLUSIONS

This paper intended to describe a process for undertaking mangrove rehabilitation in a post-disaster context, largely for organizations and agencies with little planning and implementation experience in that arena. It was written in the language of the project cycle in order to be useful to project managers, who were chiefly responsible for identifying and planning mangrove rehabilitation activities in post-tsunami Aceh. It is certainly not the fault of an organization with little or no previous experience in coastal habitat restoration, that they were at a loss for materials, information and contacts needed to help plan and implement their rehabilitation activities. That burden lies on the organizations and agencies engaged in day to day coastal resource management and specifically mangrove rehabilitation. There is a dearth of resources available on appropriate restoration planning and implementation techniques, due to a lack of time and resources to appropriately monitor and document succesful restoration practices. Documentation that does exist is largely found in scientific journals and is inaccesible to the lay-reader. Below is a partial list of some of the tools we need to develop to help inexperienced practitioners develop their own rehabilitation projects. To some extent this work has begun, but it lags far behind the extension strategies of other development realms, for example; sustainable agriculture.

Immediate Needs

- ✓ All-in-one information packets on mangrove rehabilitation planning and practice
- ✓ Clear lists of regional experts with proven and monitored success in mangrove rehabilitation
- ✓ Preferred methods and protocols for effective mangrove rehabilitation
- ✓ List of land tenure/land use regulations for coastal areas in each country
- ✓ Monitoring protocols and outreach materials
- ✓ Information on Government willingness to adopt alternative methods to planting for mangrove restoration
- ✓ Demonstrations of various types of successful and unsuccessful mangrove restoration projects (hydrological amendment without planting, hydrological amendment with planting, planting only) for each region.

Future Needs

- ✓ Special localized coordination meetings on coastal rehabilitation in each region during the times of disaster
- ✓ Project planning and implementation assistance/expertise
- ✓ Better understanding of gender sensitive coastal rehabilitation issues and strategies for issue resolution in practice.

It must be accepted that, by and large, both before and after the tsunami, most mangrove rehabilitation projects failed to meet measurable benchmarks for success. In South and SE Asia alone, over the past 20 years, there have been thousands of projects that have experienced 100 percent mortality rates of planted seedlings within a year or two of planting. Even expert non-government organizations and government agencies are experiencing this type of failure. If these failures were infrequent and lessons were being learned and applied to the next set of projects, the time and money put into failed rehabilitation efforts would be well spent. But the reality is that there is little learning

taking place from failed projects, with blind planting of *Rhizophora* propagules and seedlings at one meter spacing dominating the scene in terms of practice. Not learning from our mistakes is a shameful waste of time, money and other resources, and also discourages those involved. It is disheartening to plant an area only to come back a year later and see ones efforts dying before ones eyes. Poor success in mangrove rehabilitation consequently leads to lack of concern for mangrove environments in general, which is certainly the most negative outcome of poor practice.

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Bibliography on Restoration of Mangrove Forests

Ball, M. C. 1980. Patterns of secondary succession in a mangrove forest in south Florida. Oecologia (Berl.). 44:226-235.

Brockmeyer, R. E. Jr., J. R. Rey, R. W. Virnstein, R. G. Gilmore and L. Ernest. 1997. Rehabilitation of impounded estuarine wetlands by hydrologic reconnection to the Indian River Lagoon, Florida (USA). Wetlands Ecology and Management 4(2):93-109.

Brown, Benjamin, and Robin Lewis. "5 Steps to Successful Ecological Restoration of Mangroves." MAP/YARL. 2006 available for free download at www.mangroveactionproject.org

Cintron-Molero, G. 1992. Restoring mangrove systems. Pages 223-277 *in* G. W. Thayer (ed.), Restoring the Nation's Marine Environment. Maryland Seagrant Program, College Park, Maryland, USA. 716 pp.

Crewz, D.W. and R.R. Lewis III. 1991. An evaluation of historical attempts to establish emergent vegetation in marine wetlands in Florida. Florida Sea Grant Technical Publication No. 60. Florida Sea Grant College, Gainesville, Florida, USA. 76 pp. + append.

Davis, J. H. 1940. The ecology and geologic role of mangroves in Florida. Carnegie Inst. Wash. Pap. Tortugas Lab. No. 32. Publ. 517:305-412.

Detweiler, T.E., F. M. Dunstan, R. R. Lewis and W. K. Fehring. 1976. Patterns of secondary succession in a mangrove community. Pages 52-81 *in* R. R. Lewis (ed.), Proceedings of the Second Annual Conference on Restoration of Coastal Plant Communities in Florida. Hillsborough Community College, Tampa, Florida, USA.

Duke, N. 1996. Mangrove restoration in Panama. pp. 209-232 *In* C. Field (ed.) Restoration of Mangrove Ecosystems. International Society for Mangrove Ecosystems, Okinawa, Japan. 250 pp.

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

Field, C.D. (ed.). 1996. Restoration of Mangrove Ecosystems. International Society for Mangrove Ecosystems, Okinawa, Japan. 250 pp.

Hamilton, L. S. and S.C. Snedaker (eds.). 1984. Handbook of mangrove area management. East West Centre, Honolulu, Hawaii, USA. 123 pp.

Hachinohe, Hideli et. Al., "Nursery Manual for Mangrove Species at Benoa Port in Bali," JICA & Ministry of Forestry and Estate Crops, Indonesia. 1998

Jackson, L. L., N. Lopoukhine and D. Hillyard. 1995. Ecological restoration: a definition and comments. Rest. Ecol. 3(2):71-75..

King, D. 1998. The dollar value of wetlands: Trap set, bait taken, don't swallow. National Wetlands Newsletter 20(4):7-11.

King, D., and C. Bohlen. 1994. Estimating the costs of restoration. National Wetlands Newsletter 16(3):3-5+8.

Lahmann, E.J., S.C. Snedaker, and M. S. Brown. 1987. Structural comparisons of mangrove forests near shrimp ponds in southern Ecuador. Interciencia 12: 240-243.

Lewis, R.R. 1982a. Mangrove forests. pp. 153-172 *In* R.R. Lewis (Ed.), Creation and Restoration of Coastal Plant Communities. CRC Press, Boca Raton, Florida, USA. 219 pp.

Lewis, R.R. 1982b. Low marshes, peninsular Florida. pp. 147-152 *In* R.R. Lewis (Ed.), Creation and Restoration of Coastal Plant Communities. CRC Press, Boca Raton, Florida, USA. 219 pp.

Lewis, R.R. 1990a. Creation and restoration of coastal plain wetlands in Florida. Pp. 73-101 *In* J.A. Kusler and M.E. Kentula (Eds.) Wetland Creation and Restoration: The Status of the Science. Island Press, Washington, D.C., USA. xxv + 595 pp.

Lewis, R.R. 1990b. Creation and restoration of coastal wetlands in Puerto Rico and the U. S. Virgin Islands. Pp. 103-123 *In* J.A. Kusler and M.E. Kentula (Eds.) Wetland Creation and Restoration: The Status of the Science. Island Press, Washington, D.C., USA. xxv + 595 pp.

Lewis, R.R. 1990c. Wetlands restoration/creation/enhancement terminology: suggestions for standardization. pp. 417-422 *In* J.A. Kusler and M.E. Kentula (Eds.) Wetland Creation and Restoration: The Status of the Science. Island Press, Washington, D.C., USA. xxv + 595 pp.

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

Lewis, R. R., R. G. Gilmore, Jr., D. W. Crewz and W. E. Odum. 1985. Mangrove habitat and fishery resources of Florida. Pages 281-336 in W. Seaman (ed.), Florida Aquatic Habitat and Fishery Resources. Florida Chapter, American Fisheries Society, Eustis, Florida. 543 pp.

Lewis, R.R. and M.J. Marshall. 1997. Principles of successful restoration of shrimp aquaculture ponds back to mangrove forests. Programa/resumes de Marcuba '97, September 15/20, Palacio de Convenciones de La Habana, Cuba. Page 126 (abstract).

Lewis, R. R., and W. Streever. 2000. Restoration of mangrove habitat. Tech Note ERDC TN-WRP-VN-RS-3.2. U.S. Army, Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi. 7 p. (Available to download at: http://www.wes.army.mil/el/wrtc/wrp/tnotes/vnrs3-2.pdf)

Lewis, R. R. 1999. Key concepts in successful ecological restoration of mangrove forests. Pages 12-32 in Proceedings of the TCE-Workshop No. II, Coastal l Improvement in Mangrove/Wetland Ecosystems, 18-23 August 1998, Ranong, Thailand. Danish-SE Asian Collaboration in Tropical Coastal Ecosystems (TCE) Research and Training. NACA, P.O. Box 1040, Bangkok, Thailand 10903

Lewis, R. R. 2000. Don't forget wetland habitat protection and restoration for Florida's fisheries. National Wetlands Newsletter 22(6): 9-10 + 20.

Lewis, R. R. 2000. Ecologically based goal setting in mangrove forest and tidal marsh restoration in Florida. Ecological Engineering 15(3-4): 191-198.

Lewis, R.R., P.L.A. Erftemeijer, A. Sayaka and P. Kethkaew. 2000. Mangrove rehabilitation after shrimp aquaculture: A case study in progress at the Don Sak National Forest Reserve, Surat Thani, Southern Thailand. A report to the Rockefeller Brothers Fund. New York, New York.

Moulton, D. W., T. E. Dahl and D. M. Dall. 1997. Texas coastal wetlands - status and trends, mid-1950s to early 1990s. U. S. Fish and Wildlife Service, Albuquerque, NM. 32 pages.

Milano, G. R. 1999. Restoration of coastal wetlands in southeastern Florida. Wetland Journal 11 (2): 15-24+29.

National Academy of Science. 1994. Restoring and protecting marine habitat-the role of engineering and technology. National Academy Press, Washington, D.C., USA. 193 pp.

Riley, R. W. Jr. 1995. Encased restoring - a red mangrove replenishment methodology. Pages 165-179 in F. J. Webb, Jr. And P. J. Cannizzaro (eds.), Proceedings of the Twenty Second Annual Conference on Ecosystems Restoration and Creation. Hillsborough Community College, Plant City, Florida. 230 pp.

Riley, R., D. Kent, C. Salgado and T. DeBusk. 1999. The Riley encased methodology for establishing mangroves. Land and Water, May/June 1999. Pages 48-49.

Saenger, P. 2002. Mangrove ecology, silvaculture and conservation. Kluwer Academic Publishers, Boston, USA. 360 pp.

Sanyal, P. 1998. Rehabilitation of degraded mangrove forests of the Sunderbans of India. Program of the International Workshop on the Rehabilitation of Degraded Coastal Systems. Phuket Marine Biological Center, Phuket, Thailand. 19-24 January 1998. Page 25 (abstract).

Snedaker, J. 1987. Mangrove mythology. Florida Naturalist. Fall, 1987, pp. 7-8.

Soemodihardjo, S., P. Wiroatmodjo, F. Mulia, and M.K. Harahap. 1996. Mangroves in Indonesia - a case study of Tembilahan, Sumatra. pp. 97-110 *In* C. Fields (ed.) Restoration of Mangrove Ecosystems. International Society for Mangrove Ecosystems, Okinawa, Japan. 250 pp.

Stevenson, N. J., R. R. Lewis and P. R. Burbridge. 1999. Disused shrimp ponds and mangrove rehabilitation. Pages 277-297 in "An International Perspective on Wetland Rehabilitation", W. J. Streever (Ed.). Kluwer Academic Publishers, The Netherlands. 338 pp.

Turner, R. E., and R.R. Lewis. 1997. Hydrologic restoration of coastal wetlands. Wetlands Ecology and Management 4(2): 65-72.

Quarto, Alfredo and Roy R. "Robin" Lewis III, A Summary Guide To Mangrove Restoration, Mangrove Action Project. 2003

Other Sources of Information:

- Sutherland, William J. "The Conservation Handbook: Research, Management and Policy." Blackwell Science. 2000
- "Comparative Strategies In Community-Based Mangrove Rehabilitation Programs In The Philippines", by J.H. Primavera and R.F. Agbayani, Aquaculture Dept., SEAFDEC, Philippines, Jan. 1996
- "Community Participation in the Restoration of Degraded Mangroves; a Case Study of Pichavaram Mangroves, Tamil Nadu, India", by V. Selam and K.K. Ravichandrum, M.S. Swaminathan Research Foundation, Jan. 1996
- "Our Mangroves", Dr. Phan Nguyen Hong, et al, MERC Publication, Publishing House of Education, Hanoi, 1995
- GTZ (Deutche Gesellschaft für Technische Zusammenarbeit). 1990. *ZOPP: An Introduction to the Method.* GTZ, Frankfurt
- "Thai Binh Environmental Preservation Project, Review" , by the Danish Red Cross, Hanoi, Vietnam, 1995
- "Mangrove Restoreation In Ky Anh District, Ha Tinh Province, Vietnam, by Nguyen Thanh Binh, OXFAM UK/I in Vietnam, Jan. 1996
- "Mangroves Are Easy To Plant, But Much Profitable", an educational comic by Drs. Duong Quang Dieu, Phan Nguyen Hong, et al, MERC, Vietnam National University, Hanoi, Apr. 1995
- "Land From The Sea: The Mangrove Afforestation Program Of Bangladesh, by Dr. P. Saenger , Center for Coastal Management, University of New England, Northern Rivers, East Lismore, NSW 2480, Australia, and, Dr. N. A. Siddiqi, Plantations Trial Unit, Bangladesh Forest Research Institute, Barisal, Bangladesh, from the Publication, Ocean & Coastal Management 20, (1993) pages 23-39
- "ACTMANG Starts Its Activities, Cooperation For Mangrove Reforestation In Vietnam", by Mr. Motchiko Kogo, Chairman of ACTMANG, April, 1984 , from the

publication "Mangroves", ISME Newsletter No. 12, June 1994, International Society for Mangrove Ecosystems

- "Restoration and Afforestation of Mangroves In Vietnam, Proceedings of the National Workshop, Can Gio, Hoh Chi Minh City, 6-8 August 1994, Mangrove Ecosystem Research Centre (MERC), Hanoi Natl. Pedagogic University, and Action for Mangrove Restoration (ACTMANG), Oct. 1994
- "Ecology and Management of Mangrove Restoration and Regeneration in East and Southeast Asia, Proceedings of ECOTONE IV Regional Seminar , 18-22 Jan. '95, UNESCO/National MAB Committee, held in Surat Thani, Thailand,
- "Community Participation In Conservation, Sustainable Use and Rehabilitation of Mangroves in Southeast Asia", ECOTONE V Regional Seminar, Hoh Chih Minh City, Vietnam, 8-12, Jan. '96, UNESCO/ MERC
- "Mangrove Planting Is Helping To Halt Desertification", by Motohiko Kogo, INTEGRATION, March 1992, pp 24-25
- Margoluis, Richard and Nick Salafsky. 1998. *Measures of Success: Designing, Monitoring and Managing Conservation and Development.* Island Press
- "Out To Double The World's Mangrove Forests", by Motohiko Kogo, Exec. Dir. for Action For Mangrove Restoration, Motohiko Kogo, PACIFIC FRIEND, Feb. 1993, pp 36-37
- Re-establishing Mangrove Forests on the Coasts of the Arabian Peninsula", by Motohiko Kogo, Spirit of Enterprise, The 1987 Rolex Awards
- "ITTO and Communities in Latin America", by Gary Burniske, Conservation Officer, Restoration and Forest Management, ITTO,
- "The Fishers That Rescued The Sea", by Alfredo Quarto, Director of Mangrove Action Project, 1995
- "Mangrove Forests Declining In Satun", Bangkok Post, May 19.'94
- "Mangrove Restoring Program In Desa Tapak Kuda Baru, Kabupaten Langkat, Eastern Coastline of Sumatera Island, North Sumatera, Indonesia, by the NGO YASIKA , Indonesia
- "Mangrove Regeneration and Management", Fisheries Sector Program, Dept. of Environment and Natural Resources, Ecosystems Research and Development Service, DENR-Region IV-A, Philippines, 1994
- Meredith ,Michael E, "In-Service Training And Adaptive Management Methods" Hornbill 2 (1998) pp 106-114
- Farid Dahdouh-Guebas**,** Elly Van Hiel, Jonathan C.-W. Chan, Loku Pulukkuttige Jayatissa & Nico Koedam "Qualitative distinction of congeneric and introgressive mangrove species in mixed patchy forest assemblages using high spatial resolution

remotely sensed imagery (IKONOS)" Systematics and Biodiversity 2 (2): 113–119 Issued 26 January 2005 DOI: 10.1017/S1477200004001422 Printed in the United Kingdom C_ The Natural History Museum