# Mangrove Rehabilitation in the West Coast of Aceh – Issues and Perspectives

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## Abstract

The condition of mangroves pre- and post- tsunami and the socioeconomic role of mangrove forests in the livelihoods of coastal communities along the west coast of Aceh province, Indonesia are examined. The findings indicate that community livelihoods are significantly linked to the mangrove ecosystem. However, most of the mangrove rehabilitation programs are conservation orientated, aimed primarily at land conservation, and are not necessarily linked with livelihood options for local people or integrated resource management. This is a cause for concern as rehabilitation will only succeed when conservation measures are balanced with local community needs to obtain sustainable benefits from the rehabilitated systems. The rehabilitation efforts do involve the communities to a certain extent, but a more holistic and integrated approach needs to be adopted to ensure better management and sustainability of the rehabilitated mangrove forests.

## Introduction

Almost 70 per cent of the coastal population in Nanggroe Aceh Darussalam (NAD) depend on coastal and marine resource use for their livelihoods. Rehabilitating coastal mangrove forests that support coastal marine resources and that were damaged during the 2004 tsunami would, therefore, be an appropriate post-tsunami response. This is especially so given some evidence that mangrove forests provided a degree of protection from the impact of the tsunami (Padma 2004; Danielsen et al. 2005; UNEP-WCMC 2006). One example of this protective capacity was the case of the Island of Simeulue on the west coast of Aceh located close (40 km from the northernmost tip of the island) to the epicenter of the earthquake that triggered the tsunami. The death toll on this particular island, compared to other areas, was lower than expected and this has, in part, been attributed to the intact mangroves surrounding the island that acted as a buffer to the force of the waves (Pushparajah 2005; Sharma 2005). Such observations in the aftermath of the tsunami brought a strong response from the government and NGO's in the region to encourage coastal communities to re-plant or plant and rehabilitate mangroves forests along exposed coastlines. The Government of Indonesia has set a five year planting target for a mangrove cover of 164 840 ha (BAPPENAS 2005) in the tsunami devastated Aceh province, supported by various international donor agencies and NGOs.

In general, tropical mangrove forests are known to support diverse communities of plants and animals that provide a number of ecosystem services, e.g., coastal protection, nursery and foraging habitats, bio-filtration, and primary and secondary production (Clough 1992). Many of these services are directly linked to community livelihoods, including forestry and fisheries. Mangrove trees are an important source of wood for local people to use for fuel, and constructing houses and fishing equipment. Mangrove forests provide habitat for several fish species that choose to reside in the mangroves and are also critical habitats for juveniles of fish whose adults occupy coral reefs, seagrass beds and the pelagic zone (Kathiresam and Bingham 2001). For example, the number of fish species in the coastal mangroves of Malaysia is greater than in inshore waters, mudflats and near inshore waters (Chong et al. 1990). Also, mangrove habitats and shrimp populations are often tightly linked (Sasekumar et al. 1992; Kathiresan et al. 1994). Ecosystem benefits also extend offshore. Mangroves trap sediment and provide a suitable environment for the processing of nutrients from river systems, an important service for the maintenance of suitable water quality for seagrass beds and coral reefs growing offshore (UNEP-WCMC 2006).

While many applaud the plan for planting or replanting mangroves, concern has been expressed that issues related to mangrove planting (such as workforce training and supervision; maintenance of seedlings; and increased public awareness about coastal land use) are not being adequately addressed (Smith 2006). Furthermore, there is need for better understanding of the relationship

between these ecosystems and the communities that rely on them. Understanding this pattern of use will enable the authorities to develop specific coastal management policies for the sustainable use of the mangrove rehabilitated areas.

This paper is based on the findings from the study titled Appraisal of Coastal and Marine Resources of the West Coast Aceh conducted by the WorldFish Center, in collaboration with the World Agroforestry Centre (ICRAF) and funded by the Ford Foundation. The west coast was identified as the focal area of the study owing to the severe destruction of its coastal resources by the tsunami. The study assessed: (1) the mangrove condition and mangrove rehabilitation efforts along Aceh's west coast; and (2) identified the importance of community livelihoods that relied on mangrove and mangrove supported resources. The recommendations made through the study aim to strengthen the national government's goal of ensuring that coastal resources are able to meet the future livelihood needs of coastal communities in a sustainable manner.

## Research Methodology

Primary data on the condition, function, management and rehabilitation of mangrove and mangrove supported resources were collected through focus group discussions (FGD), key informant interviews and a reconnaissance survey. Secondary data included a review of the literature and assembling village profiles, maps, statistical reports and reports of previous assessments and surveys. The fieldwork was carried out during July and August 2006.

The thirteen study sites on the west coast were chosen to cover a range of conditions and included tsunami affected areas as well as on-going mangrove rehabilitation sites. The study sites were broadly clustered into Setia Bakti sub-district of Aceh Jaya (1 village), Samatiga sub-district of Aceh Barat (7 villages), and Pulau Banyak sub-district of Aceh Singkil (4 villages) (Fig. 1).

## Condition of Mangroves Pre- and Post- Tsunami

A global survey by the Food and Agriculture Organisation indicated that over 1.3 million ha of


Figure 1. Location of the mangrove study sites in three districts on the west coast of Aceh province, Indonesia.

[1] This Study is part of a project on Integrated Natural Resources Management and Livelihood Paradigms in Recovery from the Tsunami in Aceh that was initiated by three Future Harvest Centers of the CGIAR: the World Agroforestry Centre (ICRAF); the WorldFish Center; and the Center for International Forestry Research (CIFOR). The project goal was to identify coastal zone development opportunities in tsunami affected parts of Aceh that meet the expectations of the people affected. Such development opportunities must be able to bring direct benefits to poor people, whose poverty and lack of power put them at a relative disadvantage when disaster strikes.

Table 1. Extent of damage to mangrove forests along the west coast of Aceh.

| Area | District | Extent of damage |
|---|---|---|
| Calang | Aceh Jaya | 100 per cent of mangrove trees destroyed or subsequently died. |
| Samatiga | Aceh Barat | Approximately 50 per cent of the mangrove trees uprooted. Most trees left standing have broken tops. Tangled parts of broken trees were lodged in the damaged *tambak* ponds. Extensive damage to *Nyp.a* |
| Pulau Tuangku | Aceh Singkil | Approximately 70 per cent of trees damaged. The front-line *Rhizophora* was extensively damaged. The mangroves left standing are now dead. |
| Pulau Bangkaru | Aceh Singkil | 30 to 40 per cent of the trees were destroyed. Some of the broken and tangled parts of the mangrove trees lodged on the sandy beach threatening the nesting areas of endangered leatherback turtles |
| Other smaller islands around Pulau Banyak | Aceh Singkil | Depending on the site and distance from the sea, up to 100 per cent of the mangrove trees died subsequent to the earthquake due to extended submergence. |

Source: Field observations by the WorldFish team; Notes from community focus group discussion and key informant interviews in Samatiga (21-28 July 2006) and Pulau Banyak (3-5 August 2006), west coast of Aceh.

mangroves in Indonesia were lost to deforestation and land conversion activities between 1980 and 2000, a loss of 31 per cent (Wilkie, Fortuna and Souksavat 2002). An analysis made by Wetlands International in 2000 estimated that human activities potentially threaten more than half of the mangroves and their ecosystem in Aceh province, with 25 000 ha of mangroves as having sustained damage that is likely to have considerably reduced their ability to provide expected ecosystem services. A further 286 000 ha of mangroves were described as being at high risk largely due to over exploitation and conversion to settlements. Only 30 000 ha of mangroves were estimated at being low risk or in good condition (Meldrilzam et al. 2005). These impacts are consistent with observations that in the coastal areas of Aceh province, pre-tsunami economic development largely revolved around aquaculture that resulted in the loss of large areas of mangrove forest (Pushparajah 2005). This has been described as the destruction of one of the most effective barriers to ocean forces (Smith 2006) as well as the loss of the high value role of mangroves as nursery grounds for coastal fisheries (Wilkinson 2006). The structurally weakened coastline was, therefore, more vulnerable to the powerful tsunami waves which swept over almost 800 km of coastal Aceh in December 2004 (BRR 2005). Besides the conversion of mangrove land into fish and shrimp ponds (tambak), the use of mangrove for both household and commercial purposes has also caused mangrove forest degradation in Aceh. Mangroves are generally used for house construction and firewood. In Aceh, they are also commercially exploited to produce charcoal and wood, which is then exported to Malaysia and Singapore (Sharma 2005).

The majority of Aceh's mangrove forests are on the east coast where the coastline is more suitable for mangrove growth (Pushparajah 2005). However, mangroves do provide important goods and services for the people who live on the west coast as well. The west coast was exposed to much more devastation by the tsunami than the east coast. Depending on the location, from 30 to 100 per cent of mangroves along the west coast was destroyed (Table 1). A number of community leaders did agree that some areas of mangrove were destroyed prior to the tsunami as a result of destructive practices like clearing of mangroves to accommodate shrimp and fish ponds. According to the local communities, the front-line mangrove forests were uprooted or broken when the waves of the tsunami hit.

The southern parts of Aceh were also subject to the strong earthquake (8.7 on Richter scale) which struck in March 2005. Singkil, a district on the southwest coast of Aceh, and its sub-district of Pulau Banyak (offshore island archipelago) suffered massive infrastructural and environmental damage. The earthquake caused the land to drop by around 50 cm in some areas, resulting in a rise of the sea level and destruction of a large numbers of trees due to prolonged submergence.

In other areas community members described the tsunami wave as having converted mangrove areas into open coastline while many mangrove trees left standing after the wave have subsequently died due to significant changes in soil and water conditions (Fig. 2). The soil around many *Nypa* (a brackish palm) forests and paddy fields located close to the coast was washed away leaving either freshwater wetlands or inter-tidal zones depending on local hydrological conditions and watershed configurations.

## Contribution of Mangroves to Livelihoods

The economic value of mangrove forests in the west coast is largely based on the direct use of mangrove wood for fishing poles, building

posts, boat making and firewood (Table 2). However, the indirect use of mangrove supported resources is also of considerable economic importance to local communities. Indirect uses include fish, bird and honey collection that contributes to the livelihood of communities living around the mangrove ecosystem. Mangrove contributions to livelihood can be considered as subsistence (for household use) or commercial.

Table 2. Uses of mangroves and associated species on the west coast of Aceh.

| Scientific name | Local name | Key description | Uses |
|---|---|---|---|
| *Nypa* fruticans | Nipah | Grows in soft mud and slow moving tidal and river waters; the leaves can extend up to 9 m in height; trunk branches and each branch ends with a bunch of fronds; fruits are white translucent and hard jelly-like | Tobacco wrappers |
| | | | Straw brooms |
| | | | Fruit used in making dessert |
| | | | Roof thatch |
| | | | Woven baskets and covers |
| *Rhizophora spp.* | *Bakau* | Grows to 25 m tall; stilt roots that emerge in arches from the lower trunk; sturdy prop roots arch above the ground to 2 m | Fish aggregating device |
| | | | Fuel wood |
| | | | Charcoal |
| | | | Building material |
| *Sonneratia sp.* | *Langade* | Tall straight trees; 15-20 m tall; with many branches | Fences |
| | | | Processed logs |
| | | | Frames for the *bagan* boats |
| *Sonneratia alba* | *Berambang* | Grows up to 15 m tall; fruits are large (4 cm), green in color and edible; lots of brunches and leaves; leaf size larger than the leaves of *Avicennia* species | Wooden crushers |
| | | | Fruits as delicacy |
| *Avicennia sp.* | *Api-api* | Grows up to 25 m tall; fruits are small; small leaves; hard trunk; many branches | Fences |
| | | | Building materials |
| | | | Honey collection |
| | | | Boat building (prow/bow of the boat) |
| *(Not identified)* | *Meri* | The wood is reddish to brownish in color; the skin of the branch/trunk is yellow; fruits are big; shape of the leaves are similar to the leaves of *Rhizopora* species; broad branches; lots of leaves | Bark used to strengthen fishing net |
| *Cerops tagal* | *Tengar* | Bark is very hard and sturdy; small leaves; color of leaves yellow-green. | Fences |
| | | | House construction |
| *Pandanus* | *Pandan* | Small to medium-sized trees | Floor mats |
| *Metroxylon sagu* | *Rumbia* | Grows up to 15 m high; large pinnate leaves; ascending stems | Sago starch |

Source: Community focus group discussions and key informant interviews in Samatiga (21-28 July 2006) and Pulau Banyak (3-5 August 2006. Mangrove trees that were pointed out by locals were identified using various reference materials including Ng and Sivasothi (1999); Lovelock (2003) and Ministry of Forestry, Republic of Indonesia (1994).

In the study sites, it was noted that mangroves for subsistence purposes were dominant pre-tsunami.

Local names describe the commonly exploited mangrove trees. These include Nipah (*Nypa fruticans*), Bakau (*Rhizophora spp.*), Langade (*Sonneratia sp.*), Berambang (*Sonneratia alba*) and Api-Api (*Avicennia spp.*). The mangrove palm *Nypa fruticans* plays an important role in the livelihoods of the population along the west coast of Aceh. Before the tsunami, the use of young *Nypa* leaves for rolling cigarettes (Fig. 3) was an important secondary livelihood activity for many households. Some areas reported earnings of up to US$220 from a one-hectare harvest. This was considered to be a substantial income for the local people, who usually earned less than US$3 per day from primary activities like fishing or farming. Nearly 50 per cent of the villagers in Cot Darat of Samatiga sub-district owned or worked in *Nypa* farms. They produced tobacco wrappers, roof thatches and woven products for sale. In Alue Raya of Samatiga sub-district, many of the women reported involvement in *Nypa* based activities which gave them incomes in excess of their primary farming activities in certain months.

*Rhizophora* is well known amongst the coastal people for its hard and strong branches. Its branches are used to form fish aggregating structures known as 'brush piles' or 'brush parks'. This is a popular method used for fishing for subsistence purposes along rivers and small estuaries. The branches of *Rhizophora* are also used as firewood. Firewood use was estimated at an average of 40 kg per month per family.

The *Sonneratia* species is also used as firewood, but it is not the preferred mangrove tree for this purpose. Although it produces a lot of heat, it also produces a lot of ash and salt. Its

Figure 2. Some of the mangrove trees survived the tsunami wave but are subsequently dying.

heavy timber is resistant to shipworm and pests and is, therefore, used for building boats, piling and posts for bridges and houses. The *Sonneratia* species regenerates branches easily from the trunk, so it is possible to harvest branches on a regular basis. In Pulau Banyak, the sturdy wood of the *Cerops tagal* species is widely used by the local community to construct houses and wood fencing.

*Metroxylon sagu* (sago palm), locally known as *Rumbia*, is a member of the *Arecacea* (palm) family and is often found growing in association with the mangrove ecosystem. The palm generally tolerates salinity and prolonged flooding as well as acidic and wet soils (McClatchey et al. 2006). In Samatiga, the local people described the abundance of sago palm growing at the freshwater margin behind mangrove wetlands before the tsunami. The palms were important for the production of sago starch and house thatch. The starch was used to produce syrup and starch pearls (similar to tapioca pearls) usually used in fruit drinks and puddings. This activity largely involved women but had a poor commercial market. The women are hoping for a better market and increased income from these home-made products.

The mangrove ecosystem on the west coast of Aceh provides an important habitat for a variety of animals including various fish, crustaceans, and mollusks. The local community understands that the roots of mangroves provide refuge from predators for young fish. When the fish mature, they leave the wetlands and move out to estuaries, reefs or the open sea. The main types of fish caught in the near-shore coastal fishery of the study sites include snapper, grouper and anchovy. Most of the fish were caught using hook and line, cast nets, traditional fish traps and *tangguk* (a small fishing net made of nylon). The division of the catch for sale and home consumption varies from household to household Households with farming land tend to use most of the catch for personal consumption while landless households have a tendency to sell the higher-value fish and consume the lower value fish.

Given that much of the farm land close to the coast was lost to the flood water of the tsunami, many former farmers have now turned to fishing activities, including mangrove based fisheries, for both subsistence and commercial purposes. Where mangrove based fisheries remain, they are experiencing additional fishing pressure from former offshore fishers who have yet to receive aid in the form of boats that will allow them to resume off-shore fishing.

Fishers also noted that it has become increasingly difficult to catch fish in the mangrove areas since the tsunami and they attributed this to the fact that the fish hide amongst the tangled roots of dead mangroves. On the other hand, at all the study sites an increase in catches of mangrove crabs was noted. Many local people were of the opinion that, although there has been an increase in the number of the economically important *Penaeid* shrimp, there has been a decrease in catch as they are harder to catch amidst the dead mangroves. The increase in the number of shrimps within the surviving mangrove ecosystem is a result of the destruction of shrimp ponds in the mangrove areas, while a reduction in the suitability of the inner mangrove habitat has forced crabs to move out to the outer layer of the mangrove forest where they are more easily caught.

All these changes highlight the fact that the tsunami related alterations to the mangrove habitat have impacted the inhabitants of these areas. Mangrove crabs and shrimps depend on a healthy and productive mangrove ecosystem. The local communities expressed the fear that the increase in the number of fish, crabs and prawns would not last because: (1) eventually the young fish and other aquatic species will need healthy mangroves to survive; and (2) continued intense fishing amidst the surviving mangrove ecosystem will quickly deplete stocks.

Figure 3. Rolling cigarettes using young *Nypa* leaves, a major secondary livelihood activity.

In contrast to the fish and crustacean species, mollusks appear to have declined significantly after the tsunami. The blood cockle (*Anadara granosa*), a common species on the harder sediments of the mid-layer of the mangrove ecosystem, used to be harvested in the coastal islands of Singkil district. Before the tsunami, in Pulau Balai the cockle harvests were sold to middlemen in Medan to be exported to Singapore and Malaysia. In other study sites, cockles were collected by local fishermen and women for subsistence. This

species was a major food source for the lower income households. They speculated that one reason for the reduction in the number of cockles may be the increase in the salinity of the sediment in areas further away from the sea. However, a study by Wahyono and Murdjani (1989) had noted a declining trend in the cockle stock in the late 1980s. These findings point to the need for preservation of suitable habitats and management of harvesting.

The local communities reported that the number of migratory shore birds has declined noticeably since the tsunami. The number of pigeons, which were the most common type of bird caught for sale or consumption in the west coast area, especially in Aceh Jaya and Aceh Singkil districts, have also declined. In some areas, it was estimated that up to 80 to 100 per cent of the bird population has been lost because of the fact that few live mangroves remain. In Calang of Aceh Jaya district, bird hunting or trapping in the mangrove forests used to supplement the incomes of 20 to 30 per cent of the households in this area.

## Mangrove Rehabilitation

The Master Plan for the Rehabilitation and Reconstruction of the Regions and Communities of the Province of Nanggroe Aceh Darussalam and the Islands of Nias Province of North Sumatera, henceforth called the Master Plan, is a critical national document for medium-term rehabilitation and reconstruction efforts. In the Master Plan following the tsunami, the Government of Indonesia set a five year planting target for a mangrove cover of 164 840 ha for the whole of Aceh province. On the west coast of Aceh, the largest forest based rehabilitation, involving a number of NGOs and government institutions, is in the district of Aceh Barat (Fig. 4). This has been done partly through

Figure 4. Mangrove rehabilitation - planting of propagules in Samatiga in Aceh Barat district.

community and individual initiatives but has predominantly been in return for payment under the cash-for-work schemes operated by relief agencies.

One of the major on-going mangrove rehabilitation efforts in Aceh is a re-planting program through the central government funded National Movement for Forest and Land Rehabilitation (or *Gerhan - Gerakan Nasional Rehabilitasi Hutan dan Lahan*) project. *Gerhan* is a national program managed by the Directorate General of Land Rehabilitation and Social Forestry. The purpose of this project is to rehabilitate all types of degraded forest and land in Indonesia (Ashadi 2006). It was not designed exclusively for Aceh or for mangrove rehabilitation. In Aceh, the Department of Forestry and Plantation (*Dinas Kehutanan dan Perkebunan*) in each district has the responsibility for planning and implementation of the *Gerhan* supported mangrove rehabilitation covering some 7150 ha of land. This covers almost four percent of the total mangrove forest rehabilitation plan for Aceh under the Master Plan. The rehabilitation activities funded through the *Gerhan* project are being implemented in the west coast and east coasts of Aceh. On the west coast, the *Gerhan* project covers six districts and Aceh Barat and Aceh Singkil districts have the largest coverage. On the east coast it is being implemented in ten districts (Table 3).

The replanting projects were an appropriate option in the immediate aftermath of the tsunami and provided a positive and tangible reconstruction effort that communities could be involved in and that aid organisations could facilitate. The large number of the trees planted may appear to constitute a successful replanting program. However, with the replanting programs winding down on the west coast of Aceh, it is now necessary to assess their long-term potential.

Potential areas for concern regarding the success of mangrove replanting projects in Aceh have been highlighted earlier (Check 2005) and were emphasized at the specific study sites targeted in this study. The first of these was the apparent lack of a wider community participation in some cases. A majority of the people surveyed in Setia Bakti of Aceh Jaya district and Samatiga of Aceh Barat district reported that the number of people directly involved in the

Table 3. Mangrove rehabilitation through *Gerhan* Project (2005) in Aceh.

| Location | Area (ha) |
|---|---|
| **West coast** | **2550** |
| Aceh Barat | 1000 |
| Simeulue | 200 |
| Aceh Singkil | 850 |
| Aceh Barat Daya | 300 |
| Aceh Jaya | 100 |
| Aceh Selatan | 100 |
| **East coast** | **4600** |
| Aceh Besar | 300 |
| Aceh Utara | 600 |
| Bireun | 500 |
| Banda Aceh | 500 |
| Pidie | 600 |
| Aceh Tamiang | 700 |
| Aceh Timur | 800 |
| Kota Langsa | 100 |
| Sabang | 200 |
| Lohkseumawe | 300 |
| TOTAL | **7150** |

Source: *Department of Forestry, Jakarta*

replanting initiatives was limited to the village leaders and farmer groups formed at the early stage of the program. The planters mostly joined on the basis of cash-for-work (Rp. 350 per plant, which is less than US$0.04). As part of the forestry department's responsibility, training was provided to a few people from the groups of planters who then led the planting process. Equipment for planting was also provided, including boats. Land owners who considered that there was still a possibility of using their land for aquaculture declined to be involved in the program.

In all the study sites in Samatiga, it was noted that the majority of the villagers were not aware of the on-going mangrove rehabilitation program and its details, e.g., who is implementing the rehabilitation and what will be the future arrangement for users. This is because most community members were not involved in the planning stage – which included site selection for mangrove rehabilitation and the type of species that could be planted.

Such issues were not identified to the same degree in Pulau Banyak of Aceh Singkil, where offshore fishery rehabilitation was a priority for the predominantly fishing communities in these islands. In addition, the majority of the local people are confident that the mangroves will recover through natural re-growth. It was observed that almost 30 per cent of the destroyed mangroves, specifically around Pulau Tuangku have re-grown naturally. The remaining old mangrove trees have successfully spurred growth and provided natural protection for the new mangroves.

The lack of specific and clear plans for the sustainable use of the mangrove rehabilitated areas along the west coast of Aceh is potentially a significant barrier to the future success of the replanting projects. Even issues related to the post-rehabilitation monitoring, e.g., who has responsibility for the planted seedlings and how should they be best taken care of, remain unresolved. According to the staff of the local forestry department, the program is based on conservation priorities and land rehabilitation without adequate attention to the future livelihood issues of the local communities. Unless there is a direct economic benefit or other form of incentive for the local community, it is unlikely that they will look after the planted seedlings. Additionally, there remains a potential conflict of interest between mangrove planting for land conservation and land use for aquaculture. However, mangrove-friendly aquaculture systems have been developed and used throughout Southeast Asia and elsewhere (Primavera 1998; Sukardjo 1999). The majority of the communities studied indicated future plans for exploiting the mangroves for firewood, building materials and charcoal. In a similar case study by Tabuchi (2003) in Karawang, northwest Java, Indonesia, the government forestry organization raised a mangrove plantation on abandoned farmland. The plantation technologies were so effective that the average tree grew to a height of 8-10 m over a 10 year period. There were, however, no plans for sustainable use and conservation of the rehabilitated areas. Vegetation that had been recovered was once again lost due to unsustainable extractions by local people. This experience highlights that rehabilitation will succeed only when land conservation measures are balanced with local community needs to obtain a sustainable benefit from the rehabilitated systems.

Another problem that was observed in Samatiga was poorly defined property rights. At the study sites on the west coast of Aceh, wild mangroves and mangrove supported resources are common property (*milik alam* – a local term which means belonging to the nature). However, in the *Gerhan* project, the mangrove seedlings are sometimes planted in former paddy lands that are under private ownership. One of the key elements of property rights is that territorial boundaries (Pollnac 1984) largely disappeared as the paddy-fields were washed away by the tsunami and in some cases became inter-tidal habitat. Although people still claim ownership over the land, it is difficult to know exactly which plot of land belongs to whom. If the economic value of mangroves and their supported resources increase, some people may want to harvest them for their own benefit. This may stimulate property claims to what is currently considered 'common property' (Hviding 1989) eventually leading to conflicts over resource ownership.

## Summary

The livelihoods of a number of coastal communities in the west coast of Aceh are strongly linked to the mangrove ecosystem. Prior to the tsunami, the livelihood of many households in Samatiga of Aceh Barat district and Setia Bakti of Aceh Jaya district depended on direct exploitation of mangrove trees that were used as building material and fuel wood as well as to produce commercial products like roof thatches and cigarette covers. Many of the households were also involved in harvesting mangrove supported resources, e.g., fish and shrimp for subsistence and/or commercial purpose. The tsunami destroyed between 30 to 100 per cent of the mangrove forest along the west coast and directly or indirectly caused the loss of income for nearly 50 per cent of the surveyed coastal households.

Despite extensive mangrove re-planting programs, the lack of a community based approach means that there are no specific and clear plans for sustainable use of the mangrove rehabilitated areas in the future. Even issues related to the post-rehabilitation monitoring, e.g., who and how the planted seedlings will be taken care of, remain unresolved.

Most mangrove rehabilitation programs are orientated towards land conservation and are not necessarily linked with livelihood options or integrated resource management. In many cases, mangroves are being planted on inundated agricultural land where pre-tsunami boundaries have now disappeared. Unless the boundaries of the privately owned lands are re-mapped, property rights are likely to become an issue in the future, particularly when the economic value of mangrove trees and related resources are high.

Looking toward the future there is a lack of a clearly defined management plan for sustainable use of the replanted mangroves. Rehabilitation will succeed only when conservation measures are balanced with the needs of the local communities to obtain sustainable benefits from the rehabilitated systems.

## Recommendations

The key recommendations of this study are that a Mangrove Management Plan be formulated to include a systematic and comprehensive assessment of the extent of tsunami damage and identification of other areas in need of, and suitable for, mangrove restoration. It would consider the biological, social and economic factors likely to influence the future use of mangroves and develop a protocol for assessing the most appropriate species to be replanted. Species selection or habitat enhancement must be based on post-tsunami habitat suitability, economic benefits, and long-term environmental and economic sustainability.

To date there has been little effort made to compile and manage systematically the post tsunami data relating to coastal and marine resources. The development of a management plan would benefit from the development of a database facility to store baseline data that exists to date and data that will be collected as part of the management plan. The preparation of highly accurate baseline maps on mangroves in the west coast of Aceh would be critical baseline tools for mapping land ownership and in making resource management decisions.

To help in eliciting community support for the development of a management plan the study proposes a network of capacity building centers along the coast. Such centers would provide an opportunity for professionals to have sustained engagement with local communities and would aim to ensure that education, social mobilization and adherence to regulations become a strong foundation for sustainable coastal livelihoods. This would include exploring options for providing alternative livelihoods to reduce the pressure on rehabilitated resources.

The Master Plan is a critical national document for medium term rehabilitation and reconstruction efforts. One of the key criteria emphasized through the Master Plan is that the rehabilitation and reconstruction of the natural resources and environment must be community-oriented and focused on participatory, holistic and integrated approaches. It is now time for these medium term goals to be realized.

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