After the Tsunami

Coastal Ecosystem Restoration

Lessons Learnt

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Preface

The tsunami of 26 December 2004 swept along 800 km of the coast of the Indonesian province of Nanggröe Aceh Darussalam (NAD, or Aceh), causing the loss of at least 167,000 lives. A further 500,000 people lost their homes and livelihoods.

A year later, as many as 124 international NGOs, 430 national NGOs, dozens of donor and UN organizations, a variety of Government institutions and military institutions had been recorded, together with the community, to be working on rebuilding Aceh (BRR, 2005).

The first step in the reconstruction effort focused mostly on the emergency response, particularly with regard to fulfilling the victims' need for basic items such as food, clean water and shelter. As conditions in the field began to improve, the emergency gradually subsided and work moved to the next phase, rehabilitation. From that point on, attention began to be directed towards restoration of the environment, particularly in those areas hit by the tsunami.

A number of organizations, both governmental and non-governmental, initiated a variety of environmental restoration activities, in particular the planting of mangrove and other coastal vegetation in an effort to restore the coastlands. Within only a few months, coastal rehabilitation actions had mushroomed throughout the Aceh coast, and the hitherto unknown term 'mangrove' suddenly became familiar in the community, who had previously called it by its local name "*bak bangka*".

After 18 months of coastal rehabilitation activity, the results are now clear. Only a few activities of it have been fully successful, the rest has failed. This can be seen simply from the low survival rate of plants in the field. Reasons given for the failures include: mistakes in the selection of planting sites, unsuitable choice of plants, insufficient preparation, inadequate guidance, no tending of the plants, and the low capacity of human resources.

Another weakness found in the field was the very limited amount of community involvement in the rehabilitation activity. Communities tended to be included only as workers, not as partners involved actively and continuously. Moreover, coordination and information sharing among the stakeholders concerned with the rehabilitation activity were very poor.

A mistaken perception among the implementers was that rehabilitation activity ended once the seedlings had been planted in the field. The result as they saw it, therefore, was the number of seedlings planted, not the number that survived after planting.

Apart from the matters mentioned above, the coastal rehabilitation activities underway in NAD province have provided a great many experiences and valuable lessons. Unfortunately, these lessons have not been brought to the attention of the stakeholders in Aceh. For this reason, Wetlands International-Indonesia Programme collaborated with the United Nations Environment Programme (UNEP) to undertake this study of lessons learned from coastal ecosystem restoration efforts in Aceh since the tsunami.

In this study, the causes of failures have been identified and extracted from a variety of stakeholders. In addition, this study also provides a range of information, experience, strategies and other matters relevant to supporting the rehabilitation activities undertaken by both government and NGOs. It is hoped that the suggestions and recommendations made here can be used to support rehabilitation efforts in NAD Province.

Executive summary

This report explains what is known about coastal ecosystems in the Indonesian province of Nanggröe Aceh Darussalam (NAD or Aceh), their status before the tsunami of 2004, and how they fared after it. It reviews the ecosystem restoration activities that were undertaken in 2005-2006 by a variety of governmental and non-governmental actors, in partnership with many different stakeholder groups, and updates findings into 2007. Specifically, it critically examines the various means by which the re-planting of mangroves and other coastal vegetation was attempted, and quantifies the outcome in terms of success as measured by long-term seedling survival. A total of almost 30 million seedlings were recorded to have been planted on 27,500 ha in Aceh since the tsunami. Unfortunately, the mangroves were often planted in damaged pond areas before the ponds were repaired, and many were destroyed by the heavy machinery used in repair work. Other mangrove planting areas were later destroyed through the construction of infrastructure, suggesting a lack of coordination among the various actors. The need to avoid such mis-sequencing and mis-location of planting effort is one of a number of lessons learned, the others being:

- that short-term, project-based, cash-for-work schemes in which local people are used as paid labourers, with limited supervision, training or education, tend to result in little after-care of planted seedlings, and high seedling mortality rates;
- that with 95% of planted seedlings being Rhizophora (mostly R. mucronata), the resulting mangrove monocultures lack structural and taxonomic diversity and zonation, which may render them vulnerable to environmental shocks and disease;
- that importing seeds and seedlings from Java to relieve local supply shortages meant that many (35-50%) died in shipping and the rest were stressed and weakened;
- that the use of mature and qualified seed and seedlings is essential to high survival rates after planting;
- that the choice of site for nurseries is important to seedling production, the best sites being tidal, flat and sheltered from the wind;
- that the use of growth media with too little mud content causes seedlings to die;
- that a 1-2 month 'hardening off' period is needed before planting, during which the seedlings are progressively deprived of fresh water and shade;
- that seedlings were often planted in the wrong sites, that is in sandy areas, in areas prone to drying out, and in high-energy locations vulnerable to currents and wind;
- that planting in privately-owned areas without the owner's permission may result in the seedlings being removed later;
- that various technical errors can kill or weaken seedlings, including planting at the hottest times of day, transporting seedlings with bare roots, and planting seedlings still in their plastic polybags;
- that young seedlings are vulnerable to pest attack, especially by barnacles, crabs and mud shrimps; and
- that seedlings need to be protected against browsing livestock.

The net result of a failure to address these challenges was that around half the planted mangroves did not survive. The study concludes that key priorities include a need for stakeholder coordination, full long-term community participation in all stages of the process and its planning, and awareness of the correct techniques, sites and species for planting, and of the key indicators that suggest good sites (i.e. mud skippers) and bad ones (i.e. barnacles). Educational and awareness-raising activities are therefore important. Diversification of species planted should also be encouraged.

1. Introduction

1.1. Profile of Aceh

The Indonesian province of Nanggröe Aceh Darussalam (NAD, or Aceh) is situated between latitudes 2–6 ° North and longitudes 95 –98 ° East, and occupies the northern tip of the island of Sumatra. It has an area of 57,365.57 km^2, and is divided into the four municipalities (kota) of Banda Aceh, Langsa, Lhokseumawe, and Sabang, and 17 districts (kabupaten), each divided into sub-districts (kecamatan). To the north and east lies the Strait of Malacca, to the west is the Indian Ocean, and to the south Aceh's only land frontier, with the province of North Sumatra.

Figure 1-1. Map of NAD Province

Aceh lies in the moist equatorial zone and has a mean annual rainfall of 1,500-5,000 mm depending on location and rain-shadow effects, being drier in the north and west, and wetter in the south and east, and in the mountains. The geology is largely granitic and volcanic but there are significant areas of limestone (karst) in the north. Farmland includes wet rice, which may be irrigated or rain-fed, mixed gardens of fruit trees and vegetable crops, and many areas are suitable for coconut, cocoa, coffee and other pan-tropical crops. There is a clear distinction between the flat coastal plain and the steeper upland areas, which are more suitable for tree crops. The main crops grown are rice, maize, soybean, ground-nut, green beans, cassava and sweet potato. The dominant food crop is rice, while maize and cassava are the most important supplementary starch sources.

In 2003, NAD Province had a population of 4,218,486, which was growing at 1.26% annually. In-migration had declined since 1999 due to the conflict, and there was significant out-migration as well. Average population density in 2003 was 74 people/km2, but varied considerably from one district to another. The six districts most severely affected by the tsunami included Banda Aceh, the most densely populated with 3,669 people/km2, the others being Aceh Jaya, Nagan Raya, Aceh Barat, Simeulue and Aceh Besar. The total population after the tsunami had been reduced to about 4,010,860.

1.2 Apparent changes in land cover

Figures 1-2 and 1-3 show land cover conditions for NAD Province based on the interpretation of Landsat Satellite Imagery ETM 7 in 1999-2000 and in 2002-2003 respectively (Ministry of Forestry, 2002, 2005). These interpretations appear to show that, within three or four years, land cover in Aceh province had undergone drastic change, especially in the reduced area of Primary Dry Forest relative to Secondary Dry Forest. These differences in forest cover interpretation between 1999-2000 and 2002-2003 are summarised in Table 1-1.

Table 1-1: Changes in forest cover in Aceh (source: satellite image interpretation by Ministry of Forestry, 2002, 2005)

	Area in hectares	
	1999-2000	2002-2003
Primary dry forest	1,471,000	480,000
Secondary dry forest	1,179,000	2,413,000
Primary swamp forest	1,000	0
Secondary swamp forest	117,000	165,000
Secondary mangrove forest	24,000	18,000
Plantation forest	269,000	36,000
Total forest cover	**3,061,000**	**3,112,000**

Figure 1-2. Land cover conditions for NAD Province, based on interpretation of Landsat imagery 1999-2000 (Ministry of Forestry, 2002).

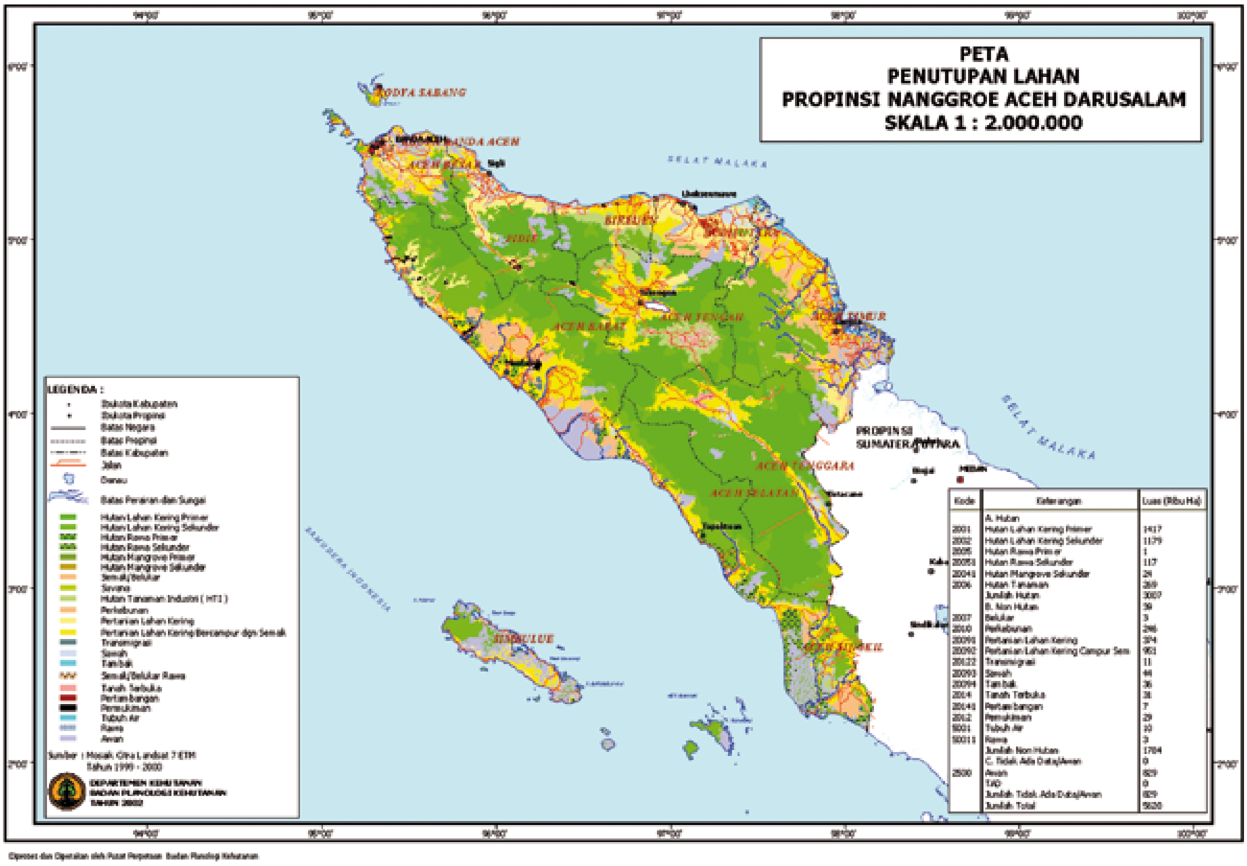
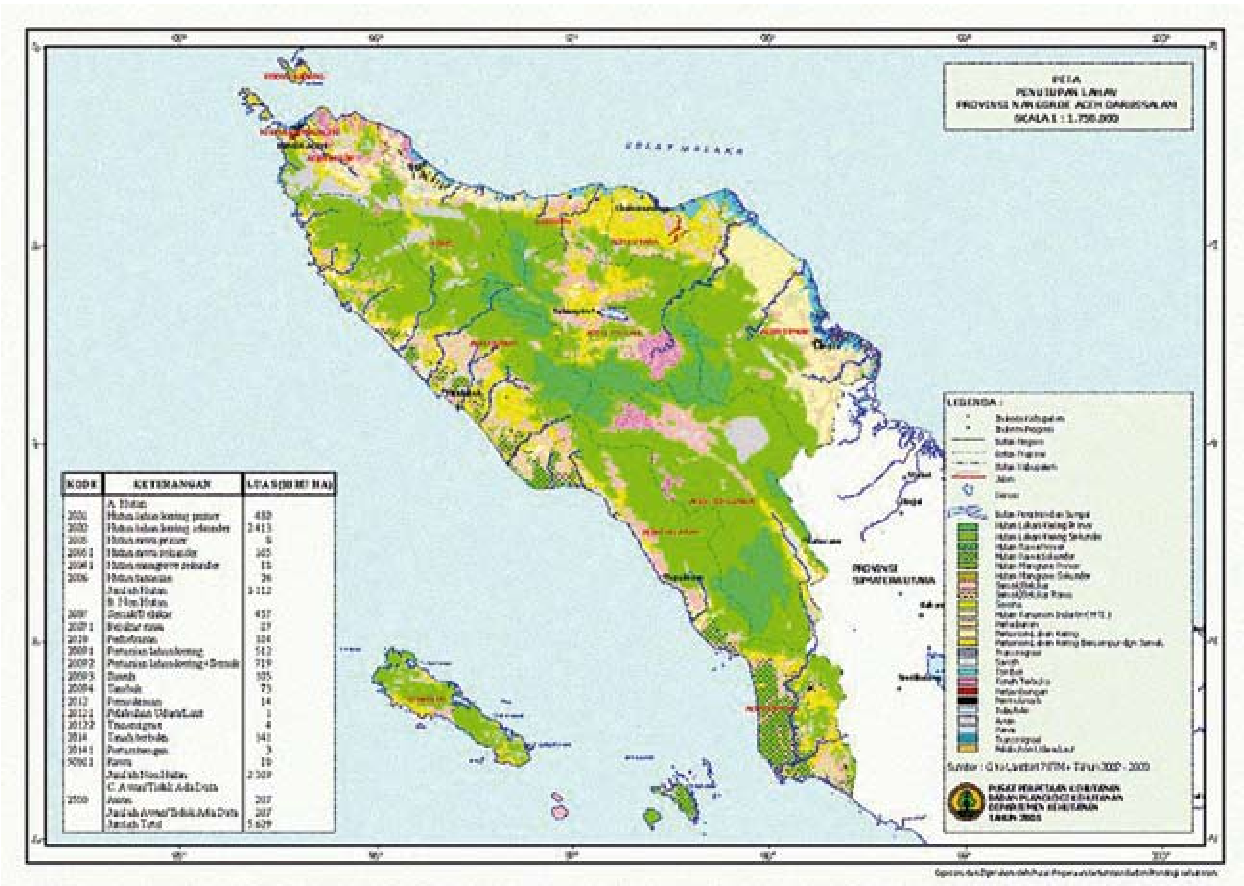


Figure 1-3. Land cover conditions for NAD Province, based on interpretation of Landsat imagery 2002-2003 (Ministry of Forestry, 2005).



2. Coastal Conditions Before the Tsunami

Aceh's eastern coastline is 761 km long and is mostly muddy beach which had once been covered by extensive areas of mangrove forest. The eastern coastal districts comprise Aceh Besar, Banda Aceh, Pidie, Bireun, Aceh Utara, Lhokseumawe, Aceh Timur, Langsa and Aceh Tamiang. The western coastline is 706 km in length and is dominated by sandy beach covered by casuarina (sea pine), coconut, hibiscus, and other species of coastal vegetation. The western coastal districts are: Aceh Besar, Aceh Jaya, Aceh Barat, Meulaboh, Nagan Raya, Aceh Barat Daya, Aceh Selatan, Simeulue Island and Aceh Singkil. The following is a description of the condition of the various coastal ecosystem types as they existed before the tsunami; these are mangrove, coastal forest, peatland, swamp, aquaculture ponds, and sandy beach together with the surrounding vegetation formations.

2.1 Mangrove forest

2.1.1 Condition of mangrove vegetation

Mangroves are a common type of vegetation found on muddy tropical shores, in the inter-tidal zone. Based on a number of studies in Aceh during the period before the tsunami (Noor *et al.*, 1999; Iwan Hasri, 2004; Siswani Sari, 2004) and field visits by a Technical Team from Wetlands International Indonesia Programme (Suryadiputra *et al.*, 2006), it is known that the mangrove species in Aceh comprise: *Avicennia marina*, *A. officinalis*, *A. alba*, *A. lannata*, *Rhizophora mucronata*, *R. apiculata*, *R. stylosa*, *Bruguiera gymnorrhiza*, *B. parviflora*, *Ceriops tagal*, *C. decandra*, *Lumnitzera littorea*, *L. racemosa*, *Scyphiphora hydrophyllacea*, *Sonneratia alba*, *S. caseolaris*, *Excoecaria agallocha*, *Aegiceras cornoculatum*, *Xylocarpus rumphii*, and *X. granatum*.

Mangrove forest growing on a flat muddy shore along a straight coastline characteristically shows zonation. The zone nearest the sea is dominated by *Avicennia* spp., which tolerate high levels of salinity. Landwards from this, in the middle or mesozone, grow a variety of species, in particular *Rhizophora* spp., *Lumnitzera* spp., *Scyphiphora hydrophyllacea, Bruguiera* spp., and *Ceriops* spp. Further inland where the land is drier (i.e. not affected by tides), species of *Xylocarpus* and *Aegiceras* grow well (Noor *et al.*, 1999).

Figure 2-1. Scyphiphora hydrophyllacea (a), Ceriops decandra (b), Bruguiera gymnorrhiza (c), and Lumnitzera littorea (d)

Even before the tsunami, Aceh's coastal areas had already been extensively degraded, mainly along the east coast where serious damage had been done. The main causes of this were the development of shrimp ponds, oil palm plantations, and the felling of mangrove trees for charcoal, all of which had been going on many years.

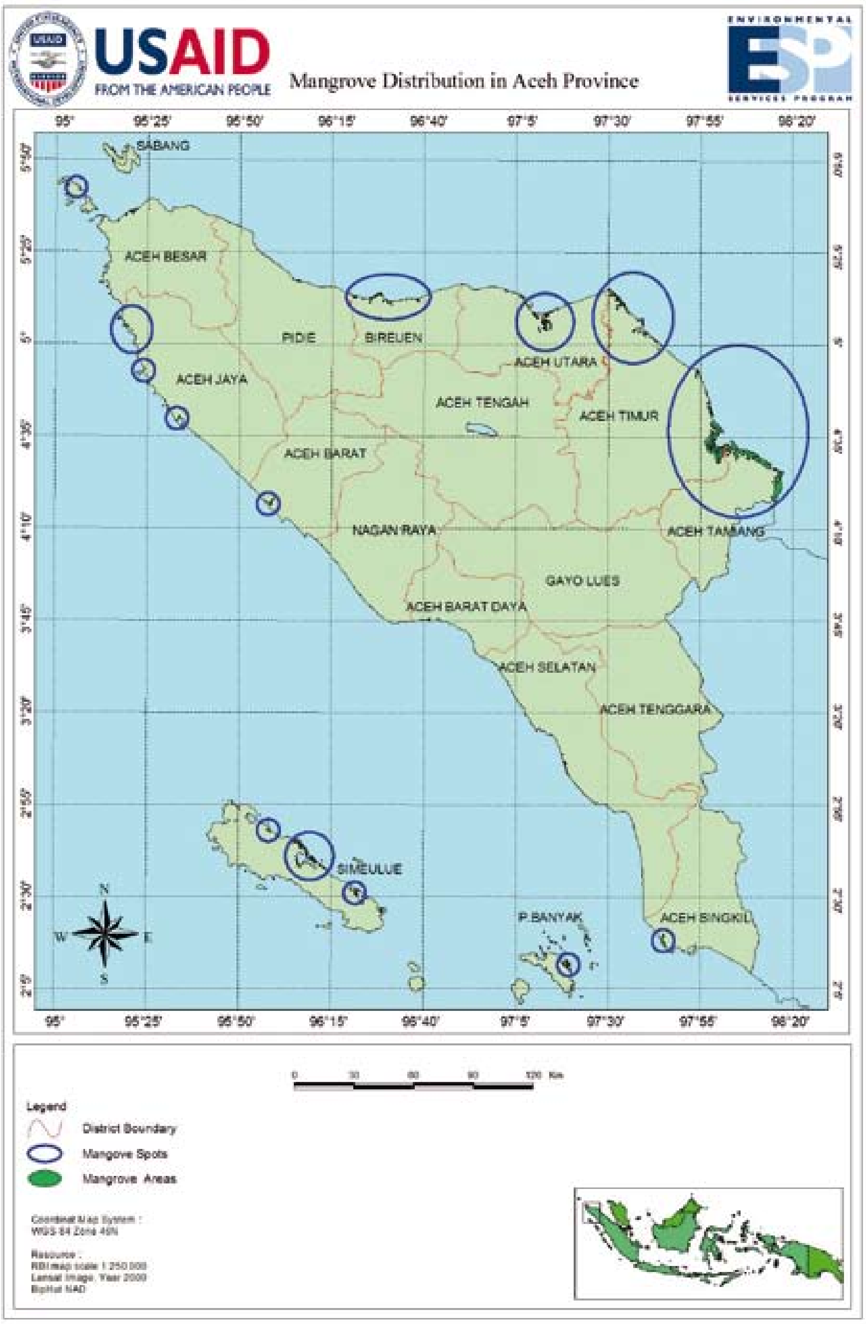
Local people have a long tradition of making charcoal from mangrove trees, and the commercial use of mangrove for the production of timber, tannin (from the bark) and charcoal also has a long history, with records of mangrove charcoal-making in Riau going back to the nineteenth century. The large scale exploitation of Indonesia's mangroves appears to have commenced at the beginning of the twentieth century, especially in Java and Sumatra (van Bodegom, 1929; Boon, 1936 in Noor *et al.*, 1999), although it seems that heavy equipment only started to be used in 1972 (Forestry Department & FAO, 1990 in Noor *et al.*, 1999). In 1985, 14 companies were granted licences to exploit a total of 877,200 hectares of mangrove forest, that is about 35% of the mangrove forest remaining in Indonesia at that time (Forestry Department & FAO, 1990 in Noor *et al.*, 1999).

2.1.2 Distribution of mangroves in Aceh

The most extensive mangrove areas on Aceh's east coast were in Aceh Timur and Aceh Tamiang. Moderate amounts of mangrove were also found in Aceh Utara and Bireun. Although very limited in area, mangroves also occurred in places on the west coast, in Aceh Jaya, Aceh Barat and Aceh Singkil. There were also extensive areas of mangrove on the east coast of Simeuleu island, and moderate amounts on the east coast of Pulau Banyak island. The map in Figure 2-2 shows mangrove distribution in Aceh in 2000.

Data on the extent of mangroves in NAD Province vary considerably, mainly because of differences in the methods and definitions used in each case.

Figure 2-2. (Right) Map of Mangrove Distribution in NAD Province (Landsat image, 2000)



Box 2-1. Mangroves' function in protecting the coast

Mangroves play an important role in protecting the coast from waves, wind and storms. Mangrove stands can protect settlements, buildings and agriculture from strong winds and from intrusion by sea water. The villages of Tongke-tongke and Pangasa, in Sinjai, South Sulawesi, which both possess a dense strip of mangrove along their coast, were protected from the Flores Tsunami in 1992, whereas neighbouring villages that did not have such dense mangrove cover suffered serious damage. In Bangladesh in June 1985, 40,000 coastal dwellers suffered as a result of hurricanes. Knowing the benefit of mangrove in mitigating storm damage, the Bangladesh Government then planted 25,000 hectares of coastlands with mangrove (Maltby, 1986 in Noor *et al.*, 1999).

Table 2-1 gives data from several sources on the extent of mangrove in Aceh province from 1982 to 2002.

Table 2-1. Extent of mangrove forest in Aceh Province before the tsunami

Source of data	Year	Extent (ha)
Bina Program	1982	54,335
Silvius *et al.*	1987	55,000
INTAG	1996	60,000
Giesen *et al.*	1991	60,000
Forestry Planology Agency	2002	24,000

In 2004, the Ministry of Forestry announced in a press release that mangroves covered 296,078 ha on the east coast, 49,760 ha on the west coast and a total of 1,000 ha in the Simeulue District (press release no. S. 32/II/PIK-1/2004).

In 2000, however, the Ministry of Forestry had reported that only 30,000 ha of Aceh's coastal mangrove forests were still in good condition, including the mangroves on Simeulue Island. A total of 286,000 ha of mangrove was in moderate condition, and 25,000 ha were badly degraded.

One area of mangrove forest that was still in good condition and growing densely, according to a study done in January 2004, was that on the coast of Ulee lheue, before it was swept by the tsunami. An analysis of the vegetation in this forest recorded 167 *Rhizophora stylosa* trees and 9 *Rhizophora apiculata* in a small plot measuring only 10m x 10m (Siswani Sari, 2004).

Prior to the tsunami, the main threats to the mangrove's continued survival were charcoal making and conversion to aquaculture ponds. In the district of Aceh Tamiang, it is reported that only 8,800 ha (44%) of the 22,000 ha of mangrove remained, the rest having been converted to aquaculture ponds and oil palm plantation (*Serambi Nanggroe*, 13 July 2006). The same trend was observed in other districts, particularly those on Aceh's east coast.

2.2 Beach forest

There are no data on the extent of beach forests in Aceh as they are not listed separately but are instead classified under Primary Dry Forest or Secondary Dry Forest (see Section 1.2). There are no comprehensive studies of biodiversity in the whole of Aceh, let alone in its beach forests, although many data are available from the inland forests of the Leuser Ecosystem. This large area has more than 4,500 species of higher plants, 434 species of birds, 392 species of mammals, 171 species of amphibians & reptile, and at least 81 species of fish (UML Database, 2002, in Irfan, 2002). This means that around 45% of the total estimated number of plant species in the West Indo-Malayan region, 85% of all the bird species in Sumatra, and 54% of the estimated total land fauna in Sumatra, are all found in the Leuser Ecosystem.

One comparative study is available for beach forests, in the Pulot area. With its unique conditions, from the ocean shore in the west to the hills in the east, this location still provides good habitat for a wide variety of wildlife species. Sightings have been recorded of no fewer than 44 species of bird, including three of hornbill and three of eagles or other large birds of prey. Around 15 species of mammal are thought to live here still, based on evidence including sightings, tracks, food remnants and faeces, and information from the local inhabitants. Herpetofauna diversity has not yet been studied specifically, but the small streams in the area are likely to be home to some of the 171 species of amphibians and reptiles recorded from the Leuser Ecosystem.

Although the Pulot area is not as rich as the Leuser Ecosystem, a brief study by a survey team from Wetlands International Indonesia Programme found that it is still habitat for a number of rare and protected species, such as siamang *Symphalangus syndactylus*, gibbons *Hylobates agilis*, leaf-monkeys *Presbytis thomasi*, several species of hornbill (Bucerotidae), birds of prey (Accipitridae), and honeysuckers (Nectariniidae) (Hasudungan, 2006).

Compared to upland forest, trees in beach forest are much smaller but grow at high densities. Tree species often found in beach forest include: *Pterospermum diversifolium*, *Eugenia cumini*, *Alstonia macrophylla*, *Macaranga tanarius*, *Guettarda speciosa*, *Peltophorum pterocarpum*, and *Ficus* spp. Various types of palm also grow there, in particular Lontar *Borrassus* spp., and Aren *Arenga pinnata*.

2.3 Aquaculture ponds

According to the Fisheries and Marine Affairs Department (FMAD, 2005), the total area covered by aquaculture ponds in NAD Province before the tsunami was estimated to be 36,597 ha. Of this, the largest area was in Aceh Utara (10,520 ha), followed by Aceh Timur (7,822 ha) and Pidie (5,056 ha). Most of these had previously been flourishing

Box 2-2. Green belt policy and spatial planning

The green belt is the zone of protected mangrove which is maintained all along the coast and which it is forbidden to cut down, convert or damage. The function of this mangrove green belt, in principle, is to preserve the coast from the threat of erosion and to act as a nursery and breeding ground for a variety of fish species. Government policy to formulate a green belt began in 1975 with the publication of a decree by the Director General for Fisheries (SK Dirjen Perikanan No H.I/4/2/18/1975) which pronounced the need to maintain a belt of land along the coast, with a width of 400m measured from the average low tide level. The Director General for Forestry subsequently issued decree No. 60/KPTS/DJ/I/1978 concerning guidelines for silviculture in areas of brackish water. This decree stipulated a 10m green belt along the length of rivers, and a 50m one along the coast, measured from the lowest point at low tide.

In 1984, the Forestry and Agriculture ministers issued joint decrees No. KB 550/246/KPTS/1984 and No. 082/KPTS-II/1984, which called for the conservation of a 200m green belt along the coast, forbade the felling of mangrove trees in Java, and placed a conservation order on all mangroves growing on small islands (i.e. those of less than 1,000 ha).

In 1990, Presidential Decree No. 32 concerning the Management of Conservation Areas replaced all previous regulations on green belts and granted more satisfactory protection to green belt zones. The decree stipulated that coastal mangrove green belts should be a minimum of 130 times the average tide, measured landwards from the point of the lowest tide mark. In practice, however, this decree suffered from a number of weaknesses as regards its application in the field. Some of the criticisms leveled at the decree are as follows.

- The decree cannot be applied to areas which, as a result of exploitation or conversion at some time in the past, no longer possess mangroves. Provision has to be made for this.
- This decree cannot be used to make an effective determination of green belt on very wide flat shores or mud flats. In several such areas, if the green belt is measured from the lowest point at low tide, it will comprise nothing but mud flats and will not reach as far as the mangroves. This problem can be solved by having a definition of measurement that starts from the seaward edge of the mangrove.
- This decree does not press for the protection of mangroves as a whole nor of their ecological function. It disregards their ecological interdependence with, for example, terrestrial forests, freshwater sources or freshwater swamps. Unless the supporting ecosystems are also protected in a properly integrated manner, the future survival of the green belt will be at risk.
- This decree gives only one choice, conservation. This choice is inadequate for areas where the intensive use of mangroves has long been a tradition, with the result that it will be difficult to reach consensus on the management of mangroves in such areas. In Java, for example, almost the entire mangrove area has been used for aquaculture ponds and for a variety of other uses which do not support the conservation of mangrove ecosystems.

In 1993, the Ministry of Forestry advocated that the total extent of protected areas needed to be doubled from 15 million to 30 million hectares. This was relevant to much of the nation's mangroves. In response, a variety of organizations active in the field of nature conservation submitted proposals for new conservation areas and extensions to existing ones. One proposal for an additional 630,000 hectares of mangrove to be conserved was submitted by the Asian Wetland Bureau and the Wetlands International Indonesia Programme in 1994.

The most recent regulation on green belt is the Minister of Trade's instruction of 1997 concerning the Designation of Mangrove Forest Green Belts (Inmendagri No. 26, 1997). This instructed all governors and heads of local government throughout Indonesia to determine mangrove forest green belt areas in their respective part of the country (Noor *et al.*, 1999).

mangrove forests, which investors had then cut down and converted to ponds. Their two main reasons for choosing these sites had been:

- To sell the wood obtained from cutting down the trees during land clearing. Thus the investors would receive money before starting to construct the ponds.
- The mangrove forest environment is particularly suitable for the cultivation of shrimps and milkfish because it possesses a source of brackish water. Ponds will therefore be cheaper to construct as the land will not need to be modified.

The area taken up by aquaculture ponds on the west coast was much less, only 289 ha in Aceh Barat and 25 ha in Aceh Utara.

BPS (2004) presents the data in more detail and differing somewhat from that provided by FMAD (2005). This document specifies the area covered by aquaculture ponds in each district/town as shown in Table 2.2 below.

Table 2-2. Total area of aquaculture ponds for each district/town in NAD Province
Source: BPS (2004)

No	District/Town	Pond area (ha)
1	Simeulue	34
2	Aceh Singkil	-
3	Aceh Selatan	648
4	Aceh Timur	8,474
5	Aceh Barat	679
6	Aceh Besar	979
7	Pidie	2,689
8	Bireuen	5,580
9	Aceh Utara	8,789
10	Aceh Barat Daya	-
11	Aceh Tamiang	-
12	Nagan Raya	907
13	Aceh Jaya	-
14	Banda Aceh	427
15	Lhokseumawe	-
	TOTAL NAD	36,439

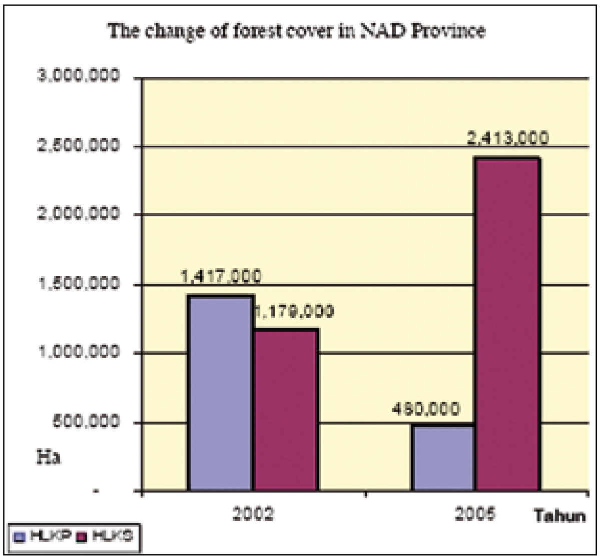
2.4 Peatland

NAD Province possesses 274,051 hectares of peatland (including peaty mineral soil), which is found only along a narrow strip on the west coast. Of this, 169,000 ha (61.6%) is in Aceh Selatan district and 105,000 hectares (38.4 %) in Aceh Barat (Figure 2-4).

The extent of peatland of various depths in each district in Aceh is as follows:

- **Moderate depth peat**: Aceh Selatan 96,900 ha (67.0%) and Aceh Barat 47,852 ha (33.0 %).
- **Deep peat**: Aceh Selatan 40,150 ha (56.4%) and Aceh Barat 31,107 ha (43.6%).
- **Shallow peat**: Aceh Selatan 15,181 ha (76.8%) and Aceh Barat 4,591 ha (23.2%).
- **Very shallow peat**: Aceh Barat 21,867 ha (57.1%) and Aceh Selatan 16,403 ha (42.9%).

Figure 2-3. Map of peatland distribution in NAD Province (Wahyunto et al. 2005)



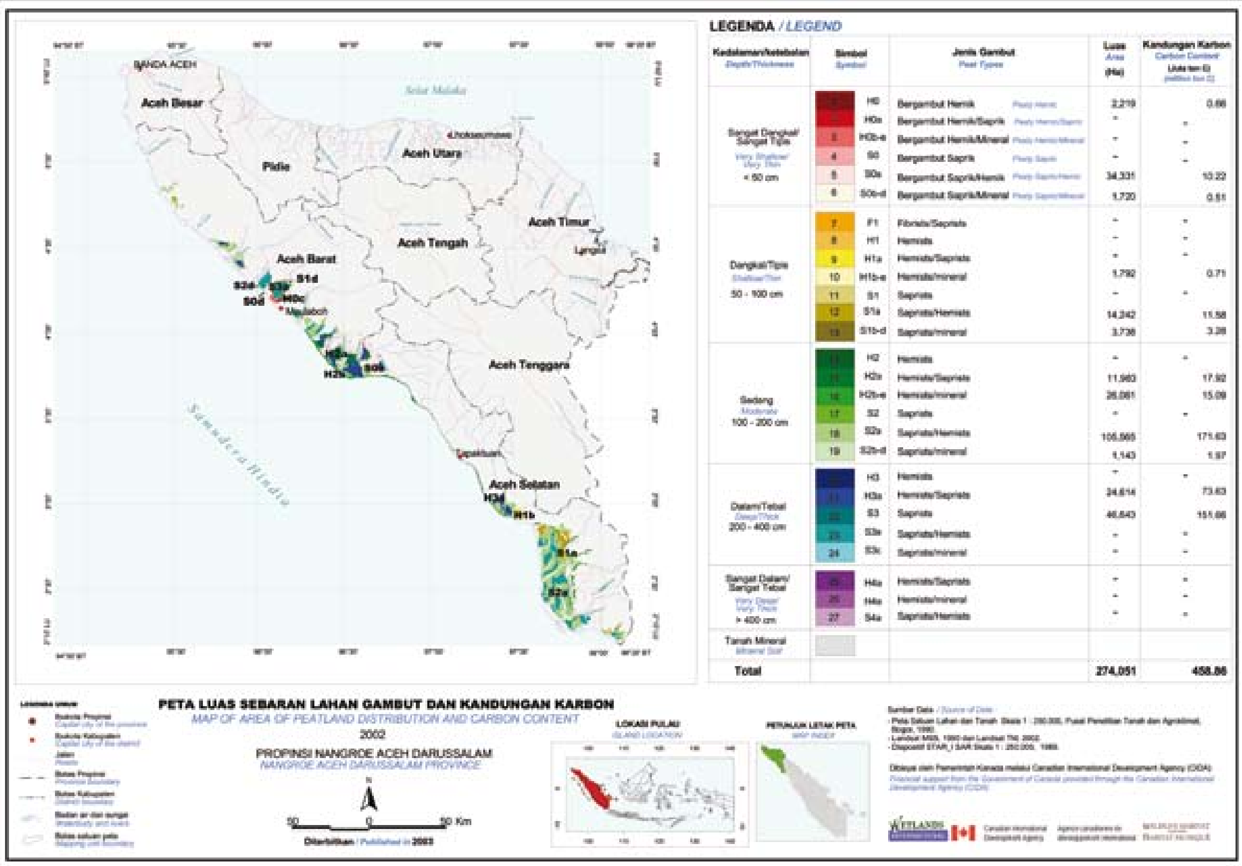
Based on the types and degree of decomposition, the peat composition of each layer found in NAD is:

- **Very shallow peat**: Hemists/mineral and Saprists/Hemists and Saprists/mineral.
- **Shallow peat**: Hemists/mineral, Saprists/Hemists and Saprists/mineral.
- **Moderate depth peat**: Hemists/Saprists, Hemists/mineral, Saprists/Hemists and Saprists/ mineral.
- **Deep peat**: Hemists/Saprists and Saprists/ Hemists (Suryadiputra *et al*., 2006).

This unique ecosystem is characterised by certain species that are only rarely found in drier forests, such as *Dyera lowii*, *Alstonia pneumatophora*, *Vitex pubescens*, and *Campnosperma macrophylla* (Wibisono *et al*., 2005). Some peatland has been degraded, mainly as a result of fire or conversion to oil palm plantation.

Based on field observation and information from the local community, the peatland had become degraded several years before the tsunami. In Cot Rambong village in the district of Nagan Raya, hundreds of hectares of peatland forest had been felled and converted to oil palm plantation. This damage had been further exacerbated by the digging of canals at right angles to the peat dome. Local inhabitants reported that this area was often subject to fire in the dry season because the peat was so dry.

Figure 2-4. Degradation of peatlands (Cot Rambong village, Nagan Raya)



2.5 Swamps

The Planology Agency of the Ministry of Forestry classifies swamp into several types of cover. These are: Primary Swamp Forest, Secondary Swamp Forest, Swamp Shrub, and Unforested Swamp. Data from ETM 7 Landsat imaging in 1999 and 2000 (Ministry of Forestry, 2002) showed the extent of each type to be as follows:

- Primary swamp forest: 1,000 ha.
- Secondary swamp forest: 117,000 ha.
- Swamp shrub: 3,000 ha.
- Open swamp (unforested) 3,000 ha.

However, very different conditions were shown by the ETM 7 Landsat imaging for 2004 (Ministry of Forestry, 2005):

- Primary swamp forest: none remaining
- Secondary swamp forest: 165,000 ha.
- Swamp shrub: 37 ha.
- Open swamp (unforested) 10,000 ha.

Freshwater swamp ecosystems are rich in aquatic plant species, including *Pistia stratiotes*, *Nyampae nouchali*, Lotus *Nelumbo nucifera*, *Echinodorus paleafolius*, *Hydrocleydes* spp., and *Typha angustifolia.* Besides aquatic plants, several species of grasses also grow well, such as *Phragmites karka* and *Saccharum spontaneum.* One species of palm, the sago palm *Metroxylon sagu* is a landmark species characteristic of a freshwater swamp ecosystem. However, other palm genera such as *Oncosperma* spp. and climbing palms *Calamus* spp. are also common in and around swamps. Other trees common to freshwater swamp include *Ficus microcarpa*, *Barringtonia racemosa*, and *Artocarpus elastica*.

2.6 Sandy beach vegetation

Information on condition of sandy beaches in NAD Province is limited, but their condition before the tsunami can be seen clearly from the remains of trees and other vegetation found along the sandy beaches. From observations of these and from information supplied by the local community, it can be deduced that the dominant species growing on the sandy beaches along Aceh's west coast just before the tsunami struck included: *Casuarina equisetifolia*, *Hibiscus tilaceus*, *Pongamia pinnata*, *Ficus septica*, *Timonus compressicaulis*, *Pterospermum diversifolium*, *Cerbera manghas*, and *Barringtonia asiatica.*

Aceh's west coast is dominated by sandy beaches, which stretch from Banda Aceh to Nagan Raya. It is reported to have been very common for communities living on the west coast to grow plantations of coconut *Cocos nucifera* and rubber *Hevea brasiliensis.* Usually, coconut groves were planted near the coast, and rubber plantations further inland.

Two formations of coastal vegetation commonly found near the beach were the 'Pes-caprae Formation' and the 'Barringtonia Formation'.

2.6.1 Pes-caprae formation

This formation is dominated by the herb *Ipomoea pes-caprae*, which is common on dune strands. The herbs grow from the back edge of the beach towards the front and sides. Its rate of growth and expansion depends on the condition of the substrate. If the substrate is stable, the plant will grow rapidly and dominate the back part of the sandy beach. This herb is usually also followed by the growth of species of grass such as *Spinifex littoreus, Cyperus maritima, Ischaemum muticum*, and herbs such as *Desmodium umbellatum*, *Vigna marina*, *Crotalaria striata*, and *Calopogonium mucunoides*.

For practitioners of coastal rehabilitation, *Ipomoea pes-caprae* also functions as a biological indicator that the area is especially suitable for the planting of *Casuarina equisetifolia*, *Callophyllum innophyllum*, *Cerbera manghas*, *Terminalia catappa*, *Barringtonia asiatica*, *Pongamia pinnata*, *Hibiscus tiliaceus,* and other beach trees.

According to information from the local community, before the tsunami *Ipomoea pes-caprae* only inhabited the back part of the sandy beaches. After the tsunami, however, it was found growing far inland.

2.6.2 Barringtonia Formation

This formation is usually found behind *Pes-caprae* formation, on sand mixed with ordinary mineral soil. An examination of the remnants of trees and plants left on the sandy beaches indicates that this formation consisted of big trees such as *Barringtonia asiatica*, *Cerbera manghas*, *Terminalia cattapa,* breadfruit *Artocarpus* sp., *Morinda citrifolia*, *Erythrina variegata*, *Hibiscus* sp., *Hernandia peltata*, and sea pine *Casuarina equisetifolia.*

In addition to the large trees, a number of shrubs and other plants are also found in this formation, including *Pluchea indica*, *Desmodium umbellatum*, *Sophora tomentosa*, *Pemphis acidula*, and *Ximenia americana*.

3. Coastal conditions after the tsunami

3.1 Impact of the tsunami and earthquake

3.1.1 Mechanisms of impact

The 10-15 metre high tsunami travelling at more than 40 km per hour which hit the coast of Aceh caused tremendous damage, the most devastating of which was along the length of Aceh's west coast (comprising Aceh Barat and Nagan Raya), and the districts of Banda Aceh, Aceh Jaya, and Aceh Besar.

According to the analysis carried out by the national aerospace agency (*Lembaga Penerbangan dan Antariksa Nasional*, or Lapan, in DAS, 2005), of the 21 districts/towns in NAD Province, at least 15 were affected by the earthquake and tsunami, while the total area affected was 649,582 ha, including 131,810 ha of wet rice fields, 9,448.5 ha of swamp, and 32,004 ha of mangrove forest and coastal vegetation.

Damage to coastal areas was caused not only by the tsunami but also by the violent earthquake that altered the landscape along the west coast of Aceh and the islands of Simeulue and Nias. The following paragraphs describe some of the impacts on these coastal areas.

Damage to coastal ecosystems arising from the Tsunami was brought about by two mechanisms:

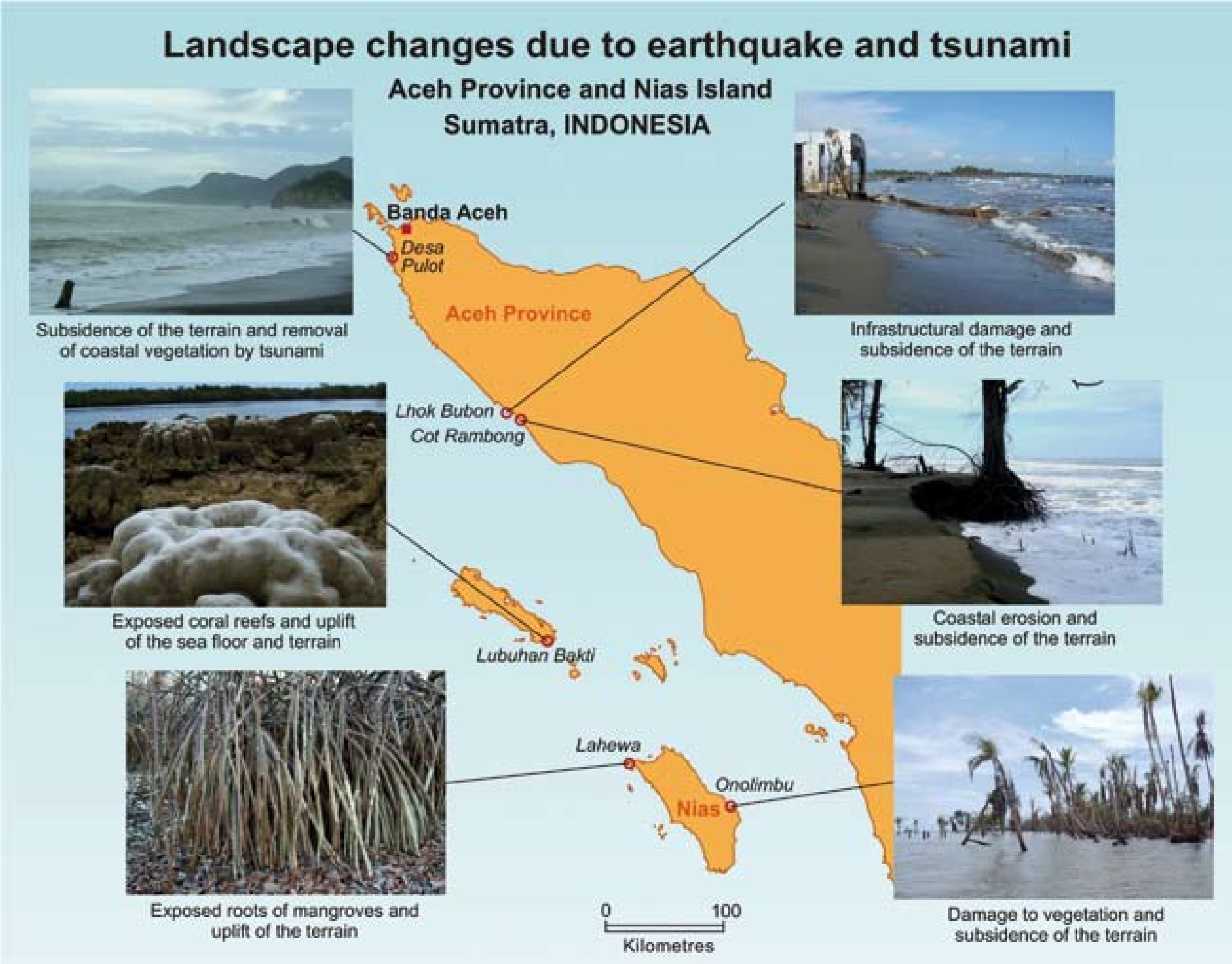
- Mechanism 1: the energy of the tsunami, which directly struck the coast and destroyed mangrove forests, casuarina (sea-pine) stands, coconut groves, and a range of other vegetation. This happened extremely fast. Vegetation was damaged, and parts were torn off. In the worst-struck areas, mangrove trees were uprooted by the force of the waves.
- Mechanism 2: inundation by the sea water brought by the tsunami, the high salinity of which caused coastal vegetation to become stressed, dry up and die. Plant death due to saltwater inundation happened relatively gradually, with the trees that died from inundation generally remaining whole and standing upright.

Almost all the formations and types of vegetation existing along Aceh's west coast were severely damaged. More than 60,000 ha of rice fields were badly affected by sea water inundation. To date, only 21.6 % of the total area of rice field has yet been rehabilitated, while most of the remainder has been abandoned (BRR, 2005). Neither mangrove forests, beach forests, sea pine forests, swamps nor any other type of vegetation along the coast escaped damage. The following paragraphs describe the damage done to several types of wetlands along the coast.

3.1.2 Changes to coastal landscapes

The powerful earthquake of 26 December 2004, which triggered the tsunami, caused changes to the landscape, mainly on the west coast of Aceh and the islands of Simeulue and Nias. According to an assessment conducted by a team from Wetlands International in (Suryadiputra *et al.*, 2006), Aceh's west coast experienced subsidence causing the shoreline to advance 100 to 200 m inland. On Simeulue island, in contrast, part of the land was lifted up by 2 m, thereby exposing the coral reef and killing the mangrove forest. The same happened in the north part of Nias island, causing similar damage to the coral reef and mangrove. Nevertheless, not all parts of Nias were lifted up. In the southern part of the island the land subsided, thus causing the shoreline to advance inland by 200 m. Figure 3-1 gives a general picture of the landscape change, based on field observations by the WI-IP Team on the west coast of Aceh, Simeulue island and Nias island.

Figure 3-1. Landscape change caused by earthquake and tsunami along the Aceh coast



The greatest impact from subsidence was on the west coast of Aceh, where an estimated two-thirds of the coast line was affected to a degree that in many places meant that the shoreline moved up to 200 m inland. Areas that had once been inhabited and cultivated are therefore now part of the ocean. For the inhabitants, the greatest economic impact has been the loss of their land, coconut trees and other property upon which their livelihoods depended. Similar land subsidence also occurred on the southern edge of Nias island.

Seen from another angle, the loss of a substantial part of the coastland also means the loss of prospective rehabilitation sites. In other words, the available space has decreased as a result.

Figure 3-2. Loss of land as a result of earthquake and tsunami (Lhok Bubon, Aceh Barat)

The uplifting of land on Simeulue island and the northern part of Nias island not only exposed the coral reef, causing it to dry out and die, but also had a detrimental impact on the mangrove forest which, now too high above sea level to be inundated by sea water, also dried out and died (see Figure 3-3 below).

These changes to the landscape on Aceh's west coast, Simeulue and Nias islands automatically have an effect on the availability of land for rehabilitation, as follows:

- Subsidence along Aceh's west coast accompanied by the advance of the shoreline and consequent loss of land automatically reduces the space potentially available for rehabilitation activities.

- Although uplifting has caused the emergence of new land, this does not necessarily mean that it can be used for planting. In fact, much of it consists of coral reef or sand which is highly saline and infertile.

Box 3-1. The status and management of new and lost land (resulting from landscape change)

Changes to the landscape along the west coast of Aceh, Simeulue and Nias islands have created problems concerning the status both of the land lost and the new land that has emerged. For those inhabitants whose land has become part of the ocean, the problem is one of loss. According to information obtained during field observation, they want the government to compensate them by providing them with new land nearby. To date, however, it is still unclear how this problem is being handled and what stage of progress has been reached in the process towards a solution. As regards the new land that has emerged due to the uplifting of the substrate, the foremost problem is the question of who has the responsibility for this land. According to a variety of different parties, this new land belongs to the state and an institution should be appointed without delay to administer it. In addition, the future utilization of this land is still undecided. However, there is little or no possibility of planting mangrove or coastal species on it as much of it is covered by coral.

Figure 3-3. Impact of uplifting of substrate: coral reef exposed and dying in Labuhan Bhakti-Simeulue, emergence of new land in Alus-alus, Simeulue, and dried, dead mangrove in Lahewa, Nias (clockwise)

3.1.3 Degradation of mangrove forest

a) Tsunami impact effects

Mangrove forests were among the worst-damaged wetland ecosystems in Aceh, but sources vary widely as to the extent of mangrove forest damaged by the tsunami. Bappenas (2005) estimates it to be 25,000 ha. Lapan (in DAS, 2005), however, gives a higher figure stating that some 32,000 ha of Aceh's mangrove forest were severely damaged by the tsunami, as detailed in Table 3-1.

By interpreting volunteers' photographs of the coast and other available information, it can be estimated that the extent of tsunami damage to mangrove was as follows:

- Aceh Besar 100% (approximately 26,823 ha)
- Banda Aceh 100% (<500 ha)
- Pidie 75% (17,000 ha)
- Aceh Utara and Bireun 30% (26,000 ha)
- Aceh Barat 50%, (14,000 ha)

Figure 3-4. Mangrove forest destroyed by tsunami in Tibang, Aceh Besar

Table 3-1. Area of mangrove forest damaged by the tsunami in Aceh. Source: Lapan (in DAS, 2005)

District/Town	Area (ha)
Banda Aceh	111.3
Lhoksumawe	308.6
Aceh Jaya	67.6
Aceh Selatan	0
Aceh Singkil	1,460.4
Aceh Tamiang	16,095.0
Aceh Timur	10,453.6
Aceh Utara	0
Aceh Bireun	0
Nagan Raya	0
Pidie	32.3
Aceh Barat Daya	2.7
Aceh Barat	361.6
Aceh Besar	53.9
Simeulue	3,056.9
Total	32,003.9

Field orientation in Tibang village revealed that all of the mangrove forest on the coast had been totally destroyed. However, young mangroves which the community had planted around their tambak aquaculture ponds had escaped serious damage.

Figure 3-5. Surviving young mangrove stand belonging to the community

Damage to the mangrove forests was not limited to the loss of several species of mangrove, but also involved the devastation of the mangrove's habitat. The loss of mature trees automatically means the loss of seed production, while the degradation of so much of the habitat means a great reduction in the area suitable for replanting mangrove.

b) Uplift effects

Another cause of mangrove degradation was the lifting of the substrate with the result that the mangrove was no longer tidally inundated. This was common on Simeulue and in part of the Nias island coast.

Observation of the impact of substrate uplifting on the mangrove forest was carried out by the WI-IP Team in September 2005 in Lahewa village on Nias. It was found that the tides no longer reached the mangrove, with the result that almost all of the mangrove trees had dried up. The dominant species in Lahewa's mangrove forest was *Rhizophora apiculata*, interspersed with *Ceriops decandra.*

Observation at this site revealed that all *Rhizophora apiculata* trees had become desiccated. All their leaves had fallen, creating a layer of dry litter extending across the floor of the stand. However, on cutting the twigs and branches, it was discovered that the interior parts (xylem, phloem) were still moist, indicating that the trees were still alive. The shedding of leaves is most probably the mangrove's response to the suddenly dry conditions. This same leaf-shedding phenomenon also occurs in teak trees during the dry season. Regular monitoring will reveal whether or not this species of mangrove is capable of adapting to its new environment. Amid the dry *Rhizophora* stands, the assessment team found several trees of *Ceriops decandra* that had stayed in leaf in spite of the dry condition, and trees of this species generally seemed to be growing normally.

In the vicinity of the mangrove forest, several other species of mangrove were found to be growing well on the dry land. These were *Aegiceras corniculatum, Ceriops decandra, Xylocarpus rumphii* and *Dolichandrone spathacea*.

The assessment team also discovered that the floor of the mangrove stands had been invaded by a number of pioneering species, in particular the fern *Acrostichum aureum.* This indicates that the floor of the mangrove stands is now never inundated by sea water. If these conditions persist, the invasion will presumably continue until the entire forest floor is covered with this vegetation (Suryadiputra *et al*., 2005).

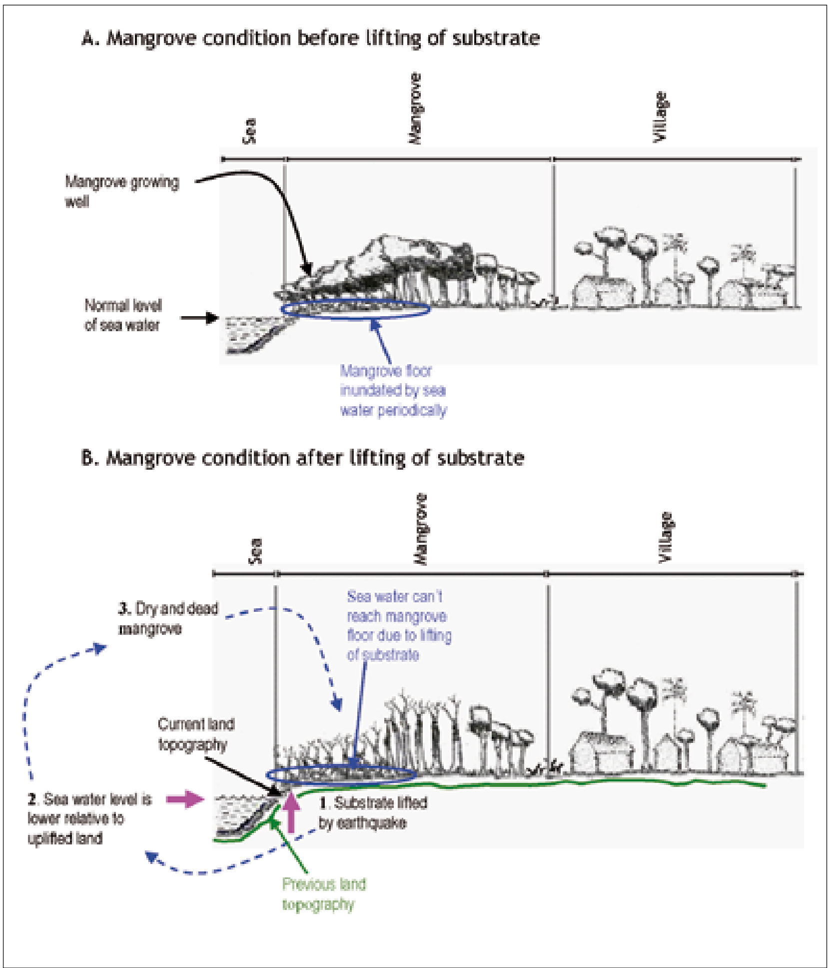
In August 2006, WI-IP's local partners in Lahewa-Nias reported that desiccated *Rhizophora* trees had eventually died. Part of the mangrove stand had also been cut by the community for fire wood.

Figure 3-7. Invasion of mangrove stand floor by pioneer species of vegetation

Figure 3-6. Mangrove which has desiccated due to uplifting of the substrate at Lahewa village, Nias.

The illustrations in Figure 3-8 show two different conditions: before and after the lifting of the substrate. Diagram B is a cross-section of the condition actually observed in the field after uplifting, while diagram A shows the condition before the substrate was lifted based on field observations enriched with information from the local community.

Figure 3-8. Illustration of mangrove death caused by lifting of the substrate at Lahewa-Nias



3.1.4 Damage to aquaculture ponds

Aquaculture ponds, generally constructed behind the shoreline or mangrove forest, did not escape the tsunami, which destroyed the dikes, ditch banks, water channels, water-gates, and buildings. According to data from the Fisheries and Marine Affairs Department, almost half of the total pond area suffered serious damage. In Banda Aceh, all the ponds were destroyed. Table 3-2 below presents the Department's analysis of the area of aquaculture ponds damaged by the Tsunami in NAD Province.

Data from BRR suggest that the figure is higher, stating that the total area of aquaculture ponds which were either destroyed or made unusable reached 20,000 ha. Of these, 5,000 ha or 25% have since been repaired.

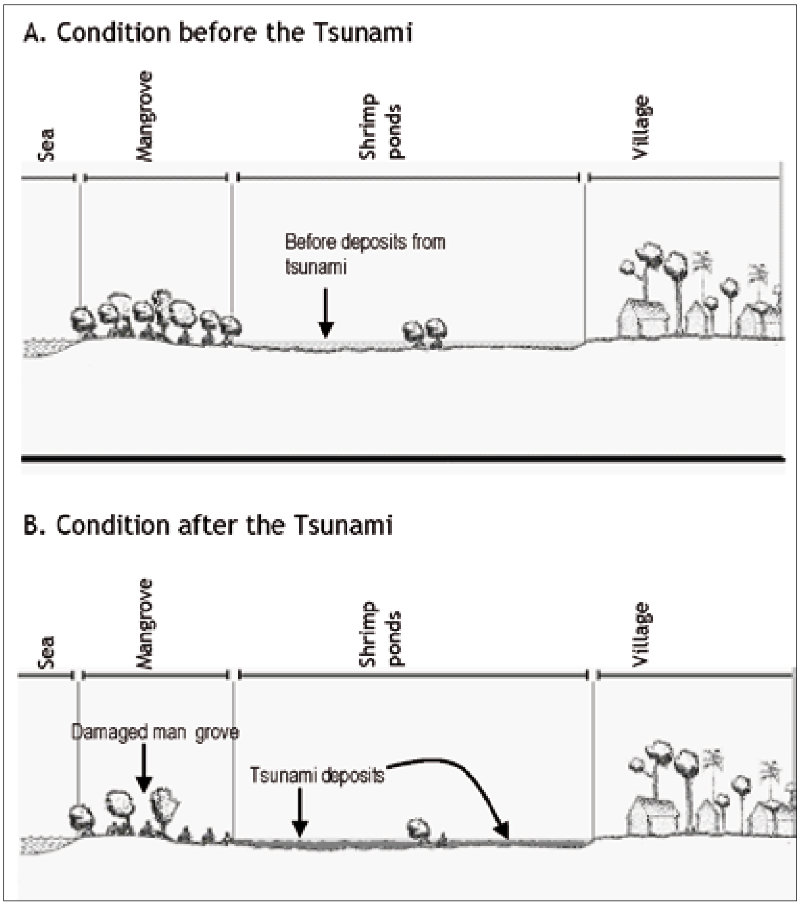
Table 3-2. Area of aquaculture ponds damaged by the Tsunami

Tsunami damage to aquaculture ponds in Aceh (source: FMAD, 2005)		
District	Pond area (ha) before tsunami	Damaged pond area (ha)
Banda Aceh	724	724
Aceh Selatan	25	10
Aceh Timur	7,822	2,347
Aceh Utara	10,520	4,208
Pidie	5,056	2,573
Aceh Barat	289	289
Aceh Besar	1,006	1,006
Kota Sabang	28	28
Langsa	2,122	424
Total	27,592	11,609
NB No data are available for Lhoksumawe, Aceh Jaya, Aceh Singkil, Aceh Tamiang, Aceh Bireun, Nagan Raya, Aceh Barat Daya, and Simeulue, which between them had had about 9,000 ha of ponds.		

There is a strong link between pond rehabilitation and coastal reforestation, in particular the planting of mangroves. This is because, in Aceh, most mangrove planting has been done in and around aquaculture ponds. Ideally, mangrove planting should be done after the pond has been repaired, so that the dikes are clear to see and the deposits left by the tsunami have been removed. If mangroves are planted before the ponds are repaired, there is a risk that the seedlings will be destroyed later by the heavy equipment used to reconstruct the ponds.

Figure 3-9. Tsunami deposits on pond floor

Figure 3-10. Condition of aquaculture ponds at Lham Ujong before (top) and after (bottom) the tsunami



The tsunami brought up an enormous volume of material from the ocean bed. This material was carried a considerable distance inland by the wave, then deposited over a large part of the coastal area.

The material deposited consisted mostly of sand, ranging from fine to coarse. Ponds were one of the receptacles for these deposits, which were up to 0.5 m thick.

The illustrations in Figure 3-10 show two different conditions: before and after the tsunami. Diagram B is a cross-section of the condition actually observed in the field, showing the mangrove damage and tsunami deposits, while diagram A shows the condition before the tsunami based on field observations enriched with information from the local community.

The deposited material totally altered the condition of the ponds, causing the land's carrying capacity to decline drastically to the point where the area was no longer suitable for aquaculture. The ponds had, however, been an important asset to the community because they provided a source of income. For that reason, one of the most important programmes carried out by the government and several NGOs has been the rehabilitation of these ponds. The rehabilitation activities generally consisted of removing the materials deposited by the tsunami and rebuilding the damaged dikes.

At present, most of the mangrove planting in NAD Province has been in coastal aquaculture ponds. However, only a small proportion of this can be considered successful, the rest having failed, with tsunami deposits being one factor in this failure. To find out in more depth about the impact of tsunami deposits on mangrove planting, a study was carried out at Lham Ujong, Aceh Besar (see Box 3-2)

3.1.5 Damage to peatlands

All of the peatland in NAD Province is situated on the west coast, where the tsunami hit hardest. Ecological assessment conducted by WI-IP in Cot Rambong village (Nagan Raya district) found that the tsunami had reached peatland areas. The sea water dumped there by the tsunami was unable to flow away and became trapped in the peat. Being highly saline, it had a detrimental effect on the peat and on the vegetation above. Some plants became stressed and subsequently died as a result. It was even reported that entire rubber plantations had died from the effect of the sea water entering the peatland where they were growing.

3.1.5 Damage to swamps

Swamps affected by the tsunami were generally in areas close to the coast. As well as physical damage from the force of the tsunami, swamps also suffered damage due to inundation by sea water, one obvious result of this being the death of some of the swamp vegetation.

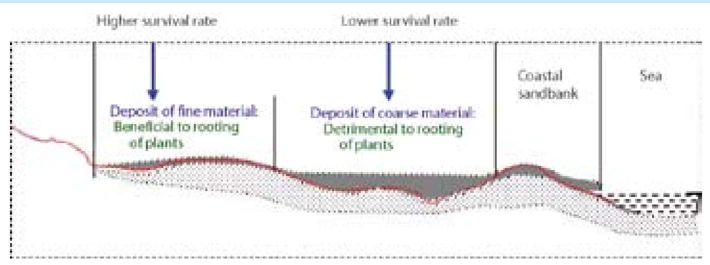
Based on the interpretation of satellite images, Lapan (in DAS, 2005) states that 9,448.5 ha of swamp were affected by the tsunami. The district of Aceh Jaya suffered the greatest area of swamp damage (3,126.8 ha), followed by Aceh Timur (1,558 ha) and Aceh Besar (945.9 ha). A list of the area of swamp damaged in each district is given in Table 3-3.

In addition to swamplands, a total of 131,809.7 hectares of rice fields in NAD Province were affected by the tsunami. Lhokseumawe was the district with the greatest area of damaged rice field (39,929.4 ha) while Aceh Utara had the smallest (11.9 ha). Besides rice fields, at least 22,618.7 hectares of dry agricultural land was also affected by the tsunami, the most damage being in Aceh Timur (9,199.5 ha; Lapan in DAS, 2005).

Box. 3-2. The impact of tsunami deposits on the environment's carrying capacity (Case study in Lham Ujong village)

The tsunami brought material from the sea and deposited it as much as 1 - 2 km inland. In order to determine the impact of this deposit, a case study was carried out by an Assessment Team from Wetlands International in August-September 2005 in the coastal area of Lham Ujong village (Aceh Besar). The study found that coarse material (like sand) had been deposited in locations near the shoreline to a thickness of 20 – 50 cm. This deposit then formed a solid barrier to soil aeration, while also absorbing and conducting heat easily. **Under such conditions, the seedlings' rooting process was seriously obstructed.** Meanwhile, finer material (dust and clay) has been deposited further inland. If this material has been deposited on coastal plain to a thickness of less than 20 cm, it will have a more beneficial effect as it will supply additional minerals thus making the soil more fertile. (See Figure 3-11 below).

Figure 3-11. Correlation between location of Tsunami deposit and success of mangrove rehabilitation in Lham Ujong village, Aceh Besar



Preliminary results illustrated in the diagram above are as follows:

1. Mangroves planted in ponds containing thick tsunami deposits are less likely to survive. This is strongly believed to be because the deposit is formed of coarse and solid materials. Such conditions cause the seedlings to become stressed and then die. Thick deposits are generally found in ponds near the shoreline.
2. Mangrove planting in ponds further inland shows a higher survival rate. This is thought to be because the deposit consists of fine materials (dust and clay). A provisional hypothesis is that this fine deposit enriches the soil and is beneficial for plant rooting. Thus, seedlings planted here can grow well.

Table 3-3. Area of swamp damaged by Tsunami
Source: Lapan (in DAS, 2005)

District/Town	Area (ha)
Banda Aceh	797.0
Lhokseumawe	120.1
Aceh Jaya	3,126.8
Aceh Selatan	60.9
Aceh Singkil	633.4
Aceh Tamiang	325.5
Aceh Timur	1,558.0
Aceh Utara	0.3
Bireuen	623.1
Nagan Raya	-
Pidie	708.1
Aceh Barat Daya	171.7
Aceh Barat	274.6
Aceh Besar	945.9
Simeulue	103.1
TOTAL NAD	9,448.5

Observations in Lhok Bubon village, Aceh Barat revealed that the tsunami had inundated swamps behind the sandy beach. This had increased the salinity of the swamp, thereby causing some vegetation to die off. Aside from sea water inundation, vegetation along the coast was also severely damaged by the force of the tsunami. Figure 3-12 illustrates the impact of the tsunami on swampland.

3.1.6 Damage to coastal vegetation

Coastal terrestrial vegetation is defined as all that growing on dry land in coastal areas, not in inundated or tidal zones. Terrestrial vegetation includes beach forest, rubber plantation, coconut plantation, cultivated gardens, barringtonia formation, and casuarina pine forest. It is estimated that the damage caused by the tsunami to this kind of ecosystem covered more than 80,795 ha (source: EU Joint Research Centre).

Figure 3-12. Condition of swamp before and after the Tsunami, at Lhok Bubon-Aceh Barat

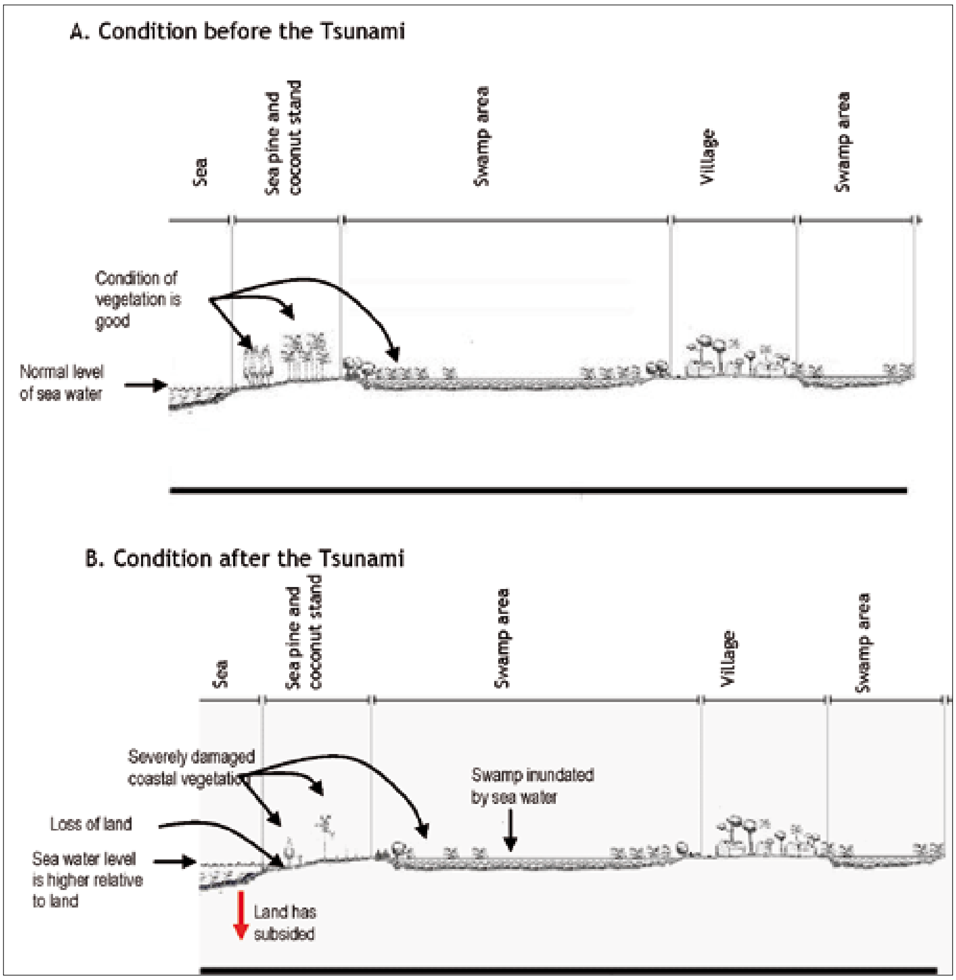


Figure 3-13. Damage to coastal zone of West Aceh, caused by tsunami

Table 3-4 below lists the areas of forest, shrubland, plantation and open land affected by the tsunami in NAD Province.

Table 3-4: Habitat areas affected by the tsunami (hectares) Source: Lapan (in DAS, 2005)

District / Town	Forest	Shrubland	Plantation	Open land
Banda Aceh	0	181	1,508	184
Lhokseumawe	0	14,114	8,677	2,035
Aceh Jaya	3,499	8,764	595	676
Aceh Selatan	6,630	14,180	3,118	570
Aceh Singkil	17,923	14,314	3,627	2,913
Aceh Tamiang	0	11,848	14,675	1,505
Aceh Timur	50	16,203	10,577	1,641
Aceh Utara	0	3	85	119
Bireuen	0	3,532	5,276	1,121
Nagan Raya	7,074	22,026	26,624	343
Pidie	139	4,201	0	1,338
Aceh Barat Daya	2,005	7,748	8,686	1,127
Aceh Barat	12,450	19,520	9,833	4,016
Aceh Besar	692	2,964	3,434	346
Simeulue	8,983	11,070	808	3,975
TOTAL NAD	**59,445**	**150,668**	**97,523**	**21,909**

Figure 3-14. Impact of Tsunami: coconut tree (left) and pine (right) broken, swept by the Tsunami at Lhok Nga-Aceh Besar

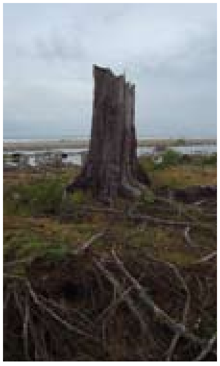


Figure 3-15. Effect of sea water: Breadfruit tree alive and healthy (left), Mangosteen tree dead as a result of sea water inundation (right)

The tsunami's sweeping devastation of the coastland and its vegetation is apparent all along the west coast of Aceh. The wave's force was so great that it smashed all the vegetation up to several kilometres inland.

Vegetation along the coast was damaged and killed not only by the direct force of the tsunami but also as a result of sea water inundation which lasted for several days. In general, it was areas further inland that were inundated.

3.1.7 Formation of new lagoons

Seismic and tsunami impacts in Aceh have created lagoons, which were not previously seen in Aceh. These are bodies of sea water newly isolated from the sea to form a new coastal wetland ecosystem.

The assessment carried out by the Wetlands International team on the west coast of Aceh in 2005 found at least 4 new lagoons, one of them near Pulot village. The Pulot village lagoon had originally been a river estuary facing the sea, and the tsunami drove sea water far upriver, thereafter blocking the estuary mouth with deposits of marine sand as well as material from the land.

Thus the Krueng Pulot estuary became separated from the sea and formed a lagoon.

This lagoon is fairly big, covering an area of ± 25 ha, its waters reaching a depth of 2 to 8 metres. Fishes commonly found there include *Lates calcarifer*, *Caranx* sp., *Epinephelus* spp. and *Mugil cephalus*.

Steps to protect the Pulot lagoon would be justified, for the following reasons:

- The management status of the lagoon is unclear, which could encourage over exploitation of its resources.

Figure 3-16.
Lagoon at Pulot village, formed by the Tsunami

- The banks of the lagoon are eroding, which could accelerate shallowing of the lagoon and cloud its waters.
- The waters of the lagoon are threatened with pollution from a number of potential sources, both from tsunami debris and from current activities being carried out in the area of the lagoon.
- The lagoon promises economic and ecotourism potential which can contribute to the future development of Pulot village.
- It is a natural reservoir which can mitigate flooding of the surrounding land during high tides and rain.
- It can prevent the subterranean intrusion of sea water to the surrounding land (especially if the lagoon is filled with freshwater from rainfall).
- It holds good potential for fisheries, with a variety of economically valuable fish species.
- The lagoon creates a micro-climate for the surrounding area, making the air feel fresher and more pleasant.

In order to protect the lagoon, it needs to be managed in an integrated manner with the participation of the local community. Some of the actions needed include the following:

- Determine the lagoon's management status through participatory mapping, zoning of the lagoon and its surrounding area, and formulation of regulations for the use of resources in and around the lagoon.
- Prepare seedlings for planting around the lagoon in order to prevent abrasion of its walls and to prevent the surrounding area from becoming arid.
- Clear away the debris left by the tsunami in and around the lagoon.
- Raise the community's awareness of the lagoon's functions and benefits to the economy and to the aquatic environment.
- Promote the beauty of the lagoon for eco-tourism, so as to increase income to the local community.

3.2 Regeneration of vegetation

3.2.1 Regeneration of mangrove

Field observation revealed that the process of recovery through natural regeneration and succession has been much slower and more difficult for mangrove than for other species of coastal vegetation. This is generally because the habitat had been destroyed or drastically altered, thus making it unsuitable for mangrove. Changes to the habitat could be due to physical and chemical changes to the substrate or because it was no longer influenced by ocean tides. The mangrove's poor capacity for recovery could also be caused by the loss of parent trees, without which there was no possibility of regeneration except through the arrival of floating propagules from elsewhere.

However, in several places (one being Lamsenia village, Aceh Besar) the regeneration of Nypa fruticans and Avicennia spp. was progressing well. From information provided by the local inhabitants, it was discovered that some trees had survived the tsunami. These have managed to live and can produce seeds, as a result of which the stands of Nypa and Avicennia are able to recover (see Figure 3-18).

3.2.2 Regeneration of coastal vegetation

Moments after the tsunami, almost all the vegetation along the coast had gone leaving nothing but bare ground. Now, however, coastal conditions have changed as succession and regeneration have occurred naturally along Aceh's west coast. Areas that had been completely bare are now supporting the growth of a variety of species.

Compared to mangroves, the regeneration of terrestrial areas has been much more rapid. The sea water flowing across the land helped to disperse seeds. These came from a wide variety of species that had been growing along the coast, including *Casuarina equisetifolia, Pterospermum diversifolium, Peltophorum pterocarpum, Guettarda speciosa, Trema orientalis, Muntingia calabura, Terminalia cattapa*, and many others.

Figure 3-17. Mangrove habitat so badly devastated that mangrove can not recover

In less than two years, a number of locations have become vegetated by a variety of species, ranging from grasses to shrubs. Observations along Aceh's west coast (from Banda Aceh to Pulot village) found naturally-formed shrublands dominated by the species listed in Table 3-5.

3.3 Prospects for rehabilitation

Rehabilitation activities should always take into account the land's carrying capacity. Mistakes made in the selection of suitable sites can lead to failure, resulting in a waste of money, time and effort. Planting must always be preceded by a careful assessment of the site. If its carrying capacity is found to be low and conditions do not meet those required by the seedlings, then a different site should be sought. The following paragraphs describe a variety of different site conditions in the context of their prospects for rehabilitation.

Figure 3-18. Regeneration of mangrove in Lamsenia village, Aceh Besar.

Figure 3-19. Shrublands formed 1.5 years after the Tsunami.

3.3.1 Locations with good prospects for rehabilitation

Not all areas affected by the tsunami have the necessary carrying capacity for rehabilitation. Some were so badly damaged that they are no longer suitable for the type of vegetation which used to grow there. Many others, however, do possess the necessary conditions for rehabilitation.

Locations which hold good prospects for mangrove rehabilitation are generally muddy beaches, river estuaries and brackish aquaculture ponds (*tambak*). Nevertheless, in every case, the mangrove species chosen must be suited to the condition of the substrate at the particular site where it will be planted.

A number of substrate conditions are described below, together with recommendations for suitable species of mangrove for each:

- Muddy substrates with fine clay and high salinity are recommended for *Avicennia marina*, *A. lanata*, *A. alba*, and *Rhizophora mucronata*.
- Non-muddy substrates with a sandy to sandy clay texture and high salinity are recommended for planting *Rhizophora stylosa*, *R. apiculata*, *Sonneratia alba*, *Aegiceras floridum*, and *Bruguiera spp*.

Box 3-3. Natural regeneration; the threats and recommendations for better management

Lhok Nga was once famous for the beauty of its beach and pine forest, but the whole area was destroyed by the 2004 tsunami. Most of the pine stands died while the remaining few were very badly degraded. Only moments after the tsunami, most of the Lhok Nga area had been reduced to empty land. Now, however, the emptiness has been replaced by young stands of *Casuarina* growing very close together. WI-IP's survey of the vegetation in July 2006 recorded that in a single plot measuring 20 m x 2 m there were 153 individual saplings with heights ranging from 50 cm to 350 cm, suggesting an overall density of nearly 4,000 saplings per hectare.

Figure 3-20. Condition of young Casuarina stand in Lhok Nga, Aceh Besar

There are concerns that this dense, lush stand of *Casuarina* will suffer degradation from causes such as the uncontrolled taking of wildlings, forest fire, and land conversion. Hence the stands require protection, although carefully-managed use of *Casuarina* wildlings would be feasible. This location is also highly suitable for research, particularly to monitor the dynamics of *Casuarina* populations.

Table 3-5. Species of vegetation commonly found in shrublands.

Local name/Species	Family	Abundance
Mengkirai *Trema orientale*	Ulmaceae	+++
Bayur *Pterospermum diversifolium*	Sterculiaceae	++
Jati pasir *Guettarda speciosa*	Rubiaceae	+
Petai cina/Lamtoro *Luacana glauca*	Leguminosae	+++
Kresen *Muntingia calabura*	Tiliaceae	++
Ketepeng *Senna alata*	Leguminosae	+
Peltophorum pterocarpum	Leguminosae	+++
Cemara *Casuarina equisetifolia*	Casuarinaceae	+++
Macaranga tanarius	Euphorbiaceae	+
Jatropha gossypiifolia	Euphorbiaceae	+
Pulai *Alstonia macrophylla*	Apocynaceae	++
Callicarpa arborea	Verbenaceae	+
Abelmoschus moschatus	Malvaceae	+
Timonius compressicaulis	Rubiaceae	+
Acacia auriculiformis	Leguminosae	++
Acacia mangium	Leguminosae	++
Crotalaria striata	Leguminosae	+
Indigofera suffruticosa	Leguminosae	+
Gmelina elliptica	Verbenaceae	+
Abutilon hirtum	Malvaceae	+
Sesamum indicum	Pedaliaceae	+
Premna coryombosa	Verbenaceae	++
Kayu tua *Leea indica*	Vitaceae	+
Gamal *Gliricidia sepium*	Leguminoseae	+
Kuda-kuda *Lannea coromandelica*	Anacardiaceae	+
Abroma mollis	Sterculiaceae	+
Aeschynomene indica	Leguminosae	+
Galaran *Ipomoea pes-caprae*	Convolvulaceae	++
Gelagah *Sacharum spontaneum*	Poaceae	+
Lantana camara	Verbenaceae	++

Note : + : sparse ++ : moderate +++ : abundant

Figure 3-21. Suitable locations for mangrove; pond dikes (left) and river estuary (right).

- Non-muddy substrates with clay texture and high salinity are suitable for *Ceriops tagal*, *Osbornea octodonta* and *Scyphiphora sp*

Unlike mangrove, species of coastal vegetation such as *Casuarina equisetifolia*, ketapang *Terminalia catappa*, coconut *Cocos nucifera*, *Hibiscus tiliaceus* and several others prefer soil which is sandy and dry. It is recommended that planting is done in *Ipomoea Pes-caprae* formations usually found at the back of sandy beaches.

For organosol (peat), indigenous peatland species are recommended, such as *Dyera lowii*, *Alstonia pneumatophora*, *Vitex pubescens*, and *Campnosperma* spp.

3.3.2 Locations not suitable for rehabilitation

Observations along the coast of Aceh and Simelue island have identified a number of locations which should be avoided for rehabilitation because of the high risk of failure. These are:

- **Labile sandy beach**. A labile beach is generally affected by wind and waves. Wind can erode the beach and move it from one location to another. The dynamic behaviour of waves often reaches the rear line of the beach and causes the substrate to become highly saline. Seedlings planted in this type of location stand very little chance of survival.
- **Empty sandy beach**. The absence of vegetation on sandy beaches is generally due to their high salinity resulting from high tides. High salinity is most unsuitable for most plants and, for this reason, rehabilitation should not be carried out at this kind of location.

Figure 3-22. Pes-caprae formation on sandy beach suitable for planting activities.

- **Totally altered mangrove habitat**. Not all of the places where mangrove used to grow are still suitable for replanting with mangrove. Some have been totally transformed, in particular those which are no longer inundated by sea water or which have been covered in a layer of coarse material deposited by the tsunami. Attempting to plant mangroves in such locations will usually end in failure.
- **Newly formed land**. Newly formed land is not fertile. It is often covered by coral and is highly saline. Moreover, it is usually no longer inundated by sea water, so is not suitable for mangrove. Other species of coastal vegetation will not grow there either, because of the extreme substrate and high salinity.

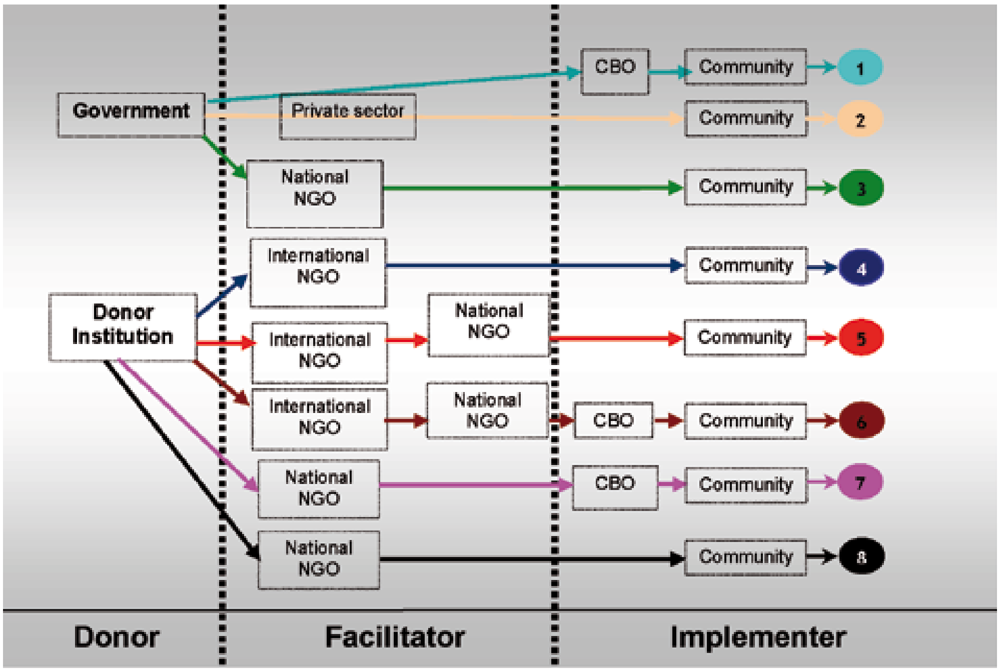
Figure 3-23. Locations where rehabilitation should be avoided

4. Lessons learned

The recovery of tsunami-affected areas in Nanggröe Aceh Darussalam and Nias is being carried out in three stages: emergency response, rehabilitation, and reconstruction. The initial emergency response stage, which focused on rescuing survivors and providing for their basic needs, lasted from January 2005 to March 2005. The second stage, rehabilitation, began in April 2005 and is scheduled to end in December 2006. During this stage, a variety of rehabilitation activities have been carried out, including cleaning up tsunami debris and repairing mosques, hospitals and infrastructure. This will be followed by the reconstruction stage, which is scheduled to start in July 2007 and finish in December 2009 (Bappenas, 2005).

During the second stage, those parts of the coast damaged by the tsunami are being reforested through the planting of mangrove and other coastal species. Most of the mangrove planting has been done in Banda Aceh, Aceh Besar, Pidie, a little in Aceh Jaya and other parts of Aceh's eastern coast that have muddy beaches. Meanwhile, the planting of other coastal species (generally sea pine *Casuarina equisetifolia*) has been mainly along the western coast, particularly in the districts of Aceh Besar, Aceh Barat, Nagan Raya and Aceh Selatan.

Figure 4.1. Flowchart showing the mechanisms for rehabilitation activities



4.1 Actors in coastal rehabilitation

The rehabilitation of degraded coastal areas involves various stakeholders, each with their particular role and position. The main roles of all those involved in rehabilitating Aceh's coastal vegetation can be grouped into three simple categories: donor, facilitator, and implementer. The role of donor is usually played by official agencies, foreign governments and international organizations having access to funds raised from the international community. These funds (part of which are also allocated to the emergency and reconstruction stages) are then dispersed to a number of stakeholders, primarily to international and national NGOs, to facilitate efforts towards the goals of rehabilitation. These NGOs then play the role of facilitator; they channel funds from the donors to the implementers in the field, and are responsible to the donors for the results of field activities (including the use of the funds). Meanwhile, the implementers are those (usually the communities living on the coast) who undertake the actual physical work of rehabilitation activities in the field and who are responsible to the facilitator for the work and its results.

Besides the main actors, other parties are involved as supporters. They are not part of the implementation mechanism but provide support for an activity. They include labourers, seedling suppliers, etc. They are only involved when a particular activity is going on, and their involvement automatically ceases as soon as the task is finished. The result of the activity is not their responsibility.

The relationships between these roles is illustrated in the flowchart, left.

As can be seen from the chart, coastal rehabilitation activities are carried out through at least eight pathways of cooperation among the stakeholders concerned. The following paragraphs describe the roles and involvement of each stakeholder.

4.1.1 Government

Government actors include those at all levels, whether central, provincial, district or municipal. The position of BRR (Agency for the Rehabilitation and Reconstruction of Aceh and Nias) also represents the government role having specific responsibility for the coordination and implementation of the rehabilitation and reconstruction of Aceh and Nias.

Only a few government institutions are involved directly in coastal rehabilitation. These include: the Provincial Forestry Agency, the Forestry Agency for each District, BKSDA (Agency for the Conservation of Natural Resources), and BP-DAS (the Watershed Management Service). Most of the coastal rehabilitation activities carried out have involved the planting of mangroves at locations affected by the tsunami. GNRHL (the National Movement for Forest and Land Rehabilitation) is the channel through the Ministry of Forestry which is most often used by government institutions to facilitate coastal rehabilitation activity in Aceh.

As it did before the tsunami, government has generally used a project approach to organise rehabilitation activities. As its capacity for simultaneously planning and implementing such activities is limited, the government has needed to work with other actors, for example to supply seedlings and labour in the field. Seedlings are usually obtained from private companies or farmers' groups, and labour for field work (e.g. land preparation, planting) is usually obtained by engaging the private sector (e.g. by tender) or communities.

4.1.2 International Non-Governmental Organizations (NGOs)

Up to December 2005, as many as 124 international NGOs had been recorded by BRR as being involved in the rehabilitation and reconstruction of Aceh and Nias. Few of these have a particular interest in environmental issues, and no more than 20 are known to have a coastal restoration programme. Oxfam International, Islamic Relief, Mercy Corps, Wetlands International Indonesia Programme (WI-IP), Care International Indonesia and other international NGOs have worked or are working on coastal rehabilitation activities in Aceh. Although some of them use the same patterns and approach in implementing the activities, others employ a different approach. For example, Oxfam International has combined reforestation activities with job creation through its cash for work programme, while WI-IP has combined coastal rehabilitation with livelihood development through its small grants mechanism.

4.1.3 National NGOs

National NGOs are those which are either domiciled in Aceh or come from other provinces of Indonesia and have new (post-tsunami) or old (pre-tsunami) activities in Aceh.

Local NGOs usually have links with international NGOs or even directly with donor institutions. Via these links, some national NGOs have gained the trust of international NGOs and donors to manage the implementation of rehabilitation activities in Aceh. This is based on a variety of considerations, such as the belief that the local NGOs understand field conditions in Aceh, have better access to local government and other relevant institutions, understand the sociocultural character of the local communities, and share the same language. In fact, however, not all these local NGOs possess adequate skills to manage coastal rehabilitation.

At present, no fewer than 430 National NGOs are recorded by BRR as being involved in the rehabilitation and reconstruction of Aceh and Nias (BRR, 2005). It is estimated that fewer than 20% of them are dealing with coastal rehabilitation.

4.1.4 Private enterprise

Although there is a feeling that the profit motive is inconsistent with relief work, private companies have been involved both in reconstruction work, such as in supplying materials and building houses, and in rehabilitation activities funded by the Indonesian Government. The latter role has involved them in providing mangrove seedlings, and these companies have then employed local people to plant them in the field. One example of this is the coastal rehabilitation programme in Lham Nga village, Aceh Besar, which according to labourers at the site in June 2005 was facilitated by BP-DAS of Krueng Aceh.

4.1.5 Community

The chief victims of the tsunami are found at the community level, where the proportion of total assets exposed to the disaster was greatest (e.g. few families had bank accounts where assets were kept safe). Besides the tragedy of losing their family and relatives, the survivors also lost their property and livelihoods. For this reason, the various parties concerned with the rehabilitation and reconstruction of Aceh have tried as far as possible to involve them in the projects, including coastal rehabilitation.

Nevertheless, the community's position is more that of field implementers. Their involvement has tended to be passive in nature, depending simply on whether or not an activity was being organized in their area, and on whether there were any third parties who needed them.

Field observations indicate that community involvement was limited to certain activities, mainly transporting and planting seedlings. In most cases, they had no involvement at all in the processes of planning, preparation, acquisition of seedlings, etc., these activities usually being performed by a facilitator (private enterprise, NGO or other).

BOX 4.1 *Cash for work* in rehabilitation activities

Many of the rehabilitation activities in Aceh, especially during the early phases, used the *Cash for work* mechanism. In this way, the community were involved in carrying out coastal rehabilitation by being paid around Rp 30,000 (ca US$ 3.25) for each day's work.

The main reasons behind the *Cash for work* programme were:

- It provides opportunity for employment, where jobs and livelihoods have been lost
- In the short term, the money earned can be used to pay for daily necessities such as food, etc.
- It injects money into the economy at the grass roots
- It helps people deal with psychological trauma by keeping them occupied
- It can help develop communication and relationships among people in the community

(Oxfam International, 2005)

Observations at several planting sites using the *Cash for work* approach showed that at least two mechanisms were being applied. These were:

Mechanism 1: Payments were made by the fund manager/owner directly to the community in return for their involvement in planting seedlings. The money was calculated at a daily rate, but was usually paid out weekly.

Although successful at some planting sites, most efforts that used this mechanism failed, as indicated by the seedlings' low survival rate. Failure was generally due to the following factors:

- Planting was usually done by the community *en masse* and was therefore very difficult to control. As a consequence, it was very hard to ensure that the seedlings were planted in a careful, serious manner.
- People participating in the *Cash for work* program were not given adequate technical guidance and information on how to plant the seedlings.
- Timing was not appropriate. The best time to plant coastal species is in the early morning or late afternoon when it is relatively cool. In fact, however, some participants were busy with something else at those times and therefore did the planting in the middle of the day. The intense heat of the midday sun caused many seedlings to become stressed and die.
- The location chosen for planting was unsuitable. For example, mangroves were planted on dry land, casuarina trees were planted on barren sand.
- Once planted, the seedlings were not tended. Under the *Cash for work* program there was no obligation on the participants to tend the seedlings, thus their responsibility ended with the planting. As a result, many seedlings died from lack of water, were uprooted by high tides, or else were attacked by pests or livestock.

In general, therefore, the coastal rehabilitation *Cash for work* programme can be said to have been successful in promoting community participation, and in providing employment and income, but it did not succeed in rehabilitating the coast.

Mechanism 2: The fund manager entrusted the running of the *Cash for work* program to a local NGO. In this case, there was a closer relationship with the community and some technical guidance was provided, although this was often limited. The time schedule for the activity was usually determined jointly.
This mechanism showed better results compared to the first, with higher survival rates at several of the planting sites.

Conclusion:
Cash for work is more effective when used for physical, labour-intensive work that does not require carefulness, experience, or specific skills (for example, unskilled labour to help skilled construction workers, or to clean up the environment).

The *Cash for work* approach is not recommended for the planting of seedlings, which requires special expertise, experience, carefulness and continuous maintenance.

At the beginning of the rehabilitation stage in Aceh, the NGOs involved the tsunami survivors in their programmes through a cash-for-work approach. From this, the participants received wages of around Rupiah 30,000 (*ca* US$ 3.25) per day for a variety of tasks. At first, cash-for-work focused on clearing away the wreckage and debris left by the tsunami. As conditions improved, it was extended to coastal rehabilitation, thus involving the community in coastal reforestation.

Information from the field revealed that mangrove planting under the cash-for-work programme was not accompanied by adequate training in planting techniques, etc. The community simply followed instructions given by the field supervisor, who's target was usually the number of seedlings planted. How they should be planted and what procedure should be followed were not a high priority for field supervisors. Hence most cash-for-work activities had a low success rate, in terms of seedling survival. Nevertheless, there were a few locations where the percentage surviving was fairly high.

As time passed, the form of community involvement began to change from an individual to a group basis. Many members of the community therefore formed groups. One of the main aims of this was to accommodate the local community's own aspirations, and to enable them to cooperate collectively with NGOs, particularly with those that had a community empowerment programme.

4.1.6 Community-Based Organizations (CBOs)

A Community-Based Organization or CBO is a non-profit organization or group comprising members of a community who have a common mission and goals, and who have a strong commitment to progress and work together. Generally, these CBOs are formed with the assistance of local NGOs, which play a role both in their formation and in strengthening their capacity.

Although their management is very simple, CBOs fulfil the administrative and legal requirements to implement coastal rehabilitation.

Lately, CBOs have become a possible choice of partner for facilitators and donor agencies, especially for those concerned with community empowerment. Field observation shows that one CBO can be involved in several activities facilitated by a number of different facilitators or donor agencies. CBOs in Aceh include those already in existence before the tsunami (such as the *Lembaga Panglima Laut* and numerous cooperatives) as well as the many formed after it. These latter were usually created under the auspices of a national NGO, and their continued existence is still a matter of uncertainty.

Apart from those mentioned above, a number of other parties play a role in the rehabilitation

Figure 4.2. Various species of coastal vegetation: sea pine, hibiscus, pandanus, cerbera and tamarind (clockwise from top left)

of Aceh's coast, including research institutions, universities, Scouts, seedling suppliers, etc.

4.2 Progress in implementation

The planting of mangroves and other coastal vegetation was first initiated by a number of International NGOs (Oxfam, Islamic Relief, Mercy Corps, etc.) through *Cash for work* programmes in April 2005 in several locations in Aceh Besar, and in Simeulue through a programme of planting by community groups facilitated by Care International-Indonesia in cooperation with Wetlands International (from June 2005). Subsequently, the Watershed Management Service (BP-DAS - *Badan Pengelolaan Daerah Aliran Sungai*) began the planting of mangroves in Lham Nga village in Aceh Besar, attended by Forestry Minister M.S. Kaban. It was not until 21 November that BRR officially launched the 'Coastal Re-greening Project' in collaboration with WI-IP and WWF-Indonesia. From then on, a variety of other institutions, both governmental and non-governmental, have been quick to join in the coastal rehabilitation effort.

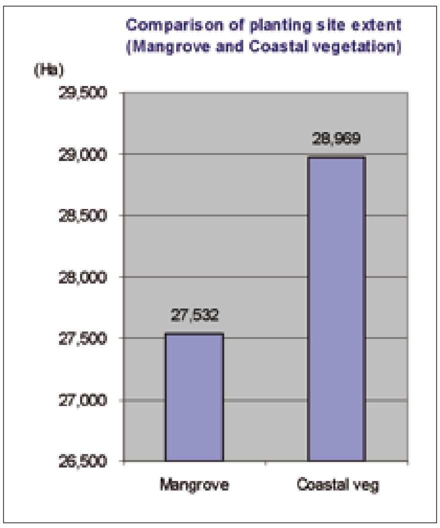
Mangroves are usually planted in brackish aquaculture ponds, degraded mangrove habitat, and along river banks. Mangroves were also found to have been planted in unsuitable places, however, such as on deep sandy beaches and dry land. The seedlings' survival rate differed widely between these two types of site, being much higher on muddy sites (ponds and river banks) than on sandy beaches. Almost all of the mangrove planting done on sandy sites totally failed.

The assessment conducted by the WI-IP team in September-October 2005, identified 25 true mangrove species in Aceh (including Simeulue island) and Nias, of which 20 were considered to have good potential for cultivation and planting in Aceh. In practice, however, no more than 5 species of mangrove have been planted and 95% consisted of *Rhizophora apiculata* and *R. mucronata*, the remaining 5% being Nipah *Nypa fruticans*, Tengar *Bruguiera* spp. and Api-api *Avicennia* spp.

A wider variety of species was found to have been used for coastal dry land rehabilitation, however. Those most commonly planted included coconut *Cocos nucifera*, sea pine *Casuarina equisetifolia*, *Terminalia cattapa*, *Cerbera manghas*, *Hibiscus tiliaceus*, neem *Azadirachta indica*, *Callophylum inophyllum*, *Jatropha curcas*, and *Pandanus tectorius.*

Besides these, several multi-purpose and economic tree species were also planted, including Tamarind *Tamarindus indica*, Areca palm *Areca cathecu*, Breadfruit *Artocarpus spp.*, Cocoa *Theobroma cacao*, and others in limited numbers.

According to WI-IP's analysis of available data from various sources in Aceh, plans have been made for the rehabilitation of at least 56,502 hectares of coast. Of this, 27,532 ha is planned for mangroves and 28,969 ha for other species of coastal vegetation. Only a few of the implementers have reported the actual extent of their activities, and there is nothing to confirm that the others have in fact carried out any rehabilitation. Nevertheless, a total of 29.84 million seedlings were supposed to have been planted, of which 98.65% are mangroves and the rest other coastal species (Figure 4-3).



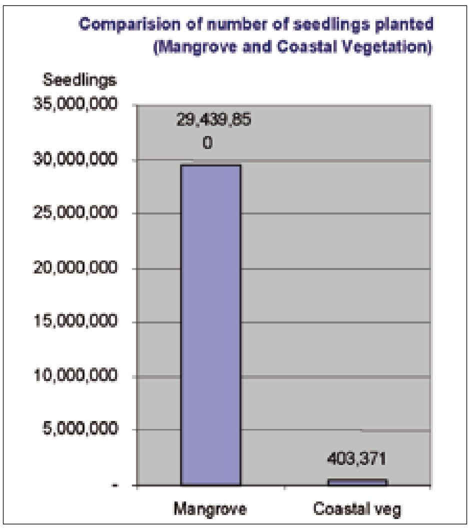


Figure 4.3. Rough calculation of the total area rehabilitated and number of seedlings planted (based on data compiled from various sources)

Coastal rehabilitation in Aceh has involved various parties, both government agencies and non government organizations. Tables 4-1 to 4-3 below show the figures for the plans for and/or realised coastal rehabilitation activities of each implementer, together with other accompanying information.

Table 4-1. Data on plans for or realization of mangrove planting conducted by Government agencies. Based on data from various sources, compiled and analyzed by WI-IP.

NO	Facilitator/Implementer	District/Subdistrict/Village	Species	Area (Ha)	Number of seedlings
1	BP-DAS-Krueng Aceh Propinsi NAD	Aceh Besar (Lham Nga)	Rhizophora spp.	50	267,500
2	GERHAN BP-DAS	Aceh Besar	Rhizophora spp.	300	1,080,000
3	Dishut A. Besar	Aceh Besar	Rhizophora spp.	900	?
4	GERHAN BP-DAS	Pidie	Rhizophora spp.	600	?
5	Disbunhut Pidie	Pidie	Rhizophora spp.	1,000	?
6	GERHAN BP-DAS	Aceh Jaya	Rhizophora spp.	100	360,000
7	Disbunhut A. Jaya	Aceh Jaya	Rhizophora spp.	700	
8	GERHAN BP-DAS	Aceh Barat	Rhizophora spp.	800	2,880,000
9	Dishutbuntrans A. Barat	Aceh Barat	Rhizophora spp.	1,200	
10	GERHAN BP-DAS	Aceh Utara	Rhizophora spp.	600	2,160,000
11	Disbunhut A. Utara	Aceh Utara	Rhizophora spp.	1,650	
12	GERHAN BP-DAS	Simeulue	Rhizophora spp.	200	720,000
13	Dishut Simeulue	Simeulue	Rhizophora spp.	1,000	
14	GERHAN BP-DAS	Aceh Singkil	Rhizophora spp.	850	3,060,000
15	Dishut A. Singkil	Aceh Singkil	Rhizophora spp.	1,275	
16	GERHAN BP-DAS	Bireuen	Rhizophora spp.	500	1,800,000
17	Disbunhut Bireuen	Bireuen	Rhizophora spp.	1,850	
18	GERHAN BP-DAS	Banda Aceh	Rhizophora spp.	500	1,800,000
19	Dinas PPPK	Banda Aceh	Rhizophora spp.	600	
20	GERHAN BP-DAS	Aceh Barat Daya	Rhizophora spp.	300	1,080,000
21	Dishut Abdya	Aceh Barat Daya	Rhizophora spp.	610	
22	GERHAN BP-DAS	Aceh Selatan	Rhizophora spp.	100	360,000
23	Disbunhut A. Selatan	Aceh Selatan	Rhizophora spp.	1,100	
24	GERHAN BP-DAS	Aceh Tamiang	Rhizophora spp.	700	2,520,000
25	Dishut A. Tamiang	Aceh Tamiang	Rhizophora spp.	1,850	
26	GERHAN BP-DAS	Aceh Timur	Rhizophora spp.	800	2,880,000
27	Disbunhut A. Timur	Aceh Timur	Rhizophora spp.	1,100	
28	GERHAN BP-DAS	Kota Langsa	Rhizophora spp.	100	360,000
28	Dispertanhutbun Langsa	Kota Langsa	Rhizophora spp.	1,284	
30	GERHAN BP-DAS	Kota Sabang	Rhizophora spp.	200	720,000
31	GERHAN BP-DAS	Kota Lhokseumawe	Rhizophora spp.	300	1,080,000
32	Dishutbun Gayo Lues	Gayo Lues	Rhizophora spp.	1,150	
33	Dishutpertrans Nagan Raya	Nagan Raya	Rhizophora spp.	800	
34	Disperhut Kota Sabang	Sabang	Rhizophora spp.	700	
35	Satker BRR Pesisir	Aceh Besar, Kec.Pkn Bada 1	Rhizophora spp.	47	77,500
36	Satker BRR Pesisir	Aceh Besar, Kec.Pkn Bada 2	Rhizophora spp.	91	350,350
37	Satker BRR Pesisir	Aceh Besar, Kec. Masjid Raya	Rhizophora spp.	91	123,200
38	Satker BRR Pesisir	Pidie	Rhizophora, Avicennia spp.	42	231,000
39	Satker BRR Pesisir	Aceh Jaya	Rhizophora spp.	60	330,000
	TOTAL			**26,100**	**24,239,550**

Table 4-2. Data on plans for or realization of mangrove planting conducted by NGOs.
Based on data from various sources, compiled and analyzed by WI-IP.

Note:
The number of seedlings planted through national NGOs is in reality much greater than that stated here, because most rehabilitation by international NGOs was in fact facilitated or implemented in the field by national NGOs. For example, the planting of 80% of the seedlings listed under WIIP was facilitated by around 60 local NGOs in Aceh, while the other 20% was facilitated by WI-IP directly with the community.

NO	Facilitator/Implementer	District/Subdistrict/Village	Species	Area (Ha)	Number of seedlings
	International NGOs				
1	Islamic Relief	Tibang, A. Besar	Rhizophora spp.	4	20,000
2	Livelihood Development	Cundien, A.Besar	Rhizophora spp.	-	800
3	(Conservation Program)		Rhizophora spp.	1	4,000
4	OXFAM	Lamsenia	Rhizophora spp.	22	110,000
5	OXFAM	Lhok Seudu	Rhizophora spp.	22	110,000
6	OXFAM	Pulot	Rhizophora spp.	22	110,000
7	OXFAM	Menasah Mesjid	Rhizophora spp.	22	110,000
8	OXFAM	Meunasah Ba'u	Rhizophora spp.	22	110,000
9	OXFAM	Daeah Mamplam	Rhizophora spp.	22	110,000
10	OXFAM	Lampulo malahayati	Rhizophora spp.	10	50,000
11	OXFAM	Alue Deah Tengoh	Rhizophora spp.	20	100,000
12	OXFAM	Deah Baro	Rhizophora spp.	10	50,000
13	OXFAM	Deah Glumpang	Rhizophora spp.	10	50,000
14	OXFAM	Ulee Lheu Mesjid	Rhizophora spp.	24	120,000
15	OXFAM	Lamteh	Rhizophora spp.	2	10,000
16	OXFAM	Tibang	Rhizophora spp.	2	10,000
17	OXFAM	Lam Batueng	Rhizophora spp.	75	373,000
18	OXFAM	Lam Prada	Rhizophora spp.	75	373,000
19	OXFAM	Man singet	Rhizophora spp.	75	373,000
20	OXFAM	Lam Seunong	Rhizophora spp.	75	373,000
21	OXFAM	Keude Aron	Rhizophora spp.	75	373,000
22	OXFAM	Gampong baru	Rhizophora spp.	14	70,000
23	ADB	Aceh Besar	Rhizophora spp.	20	?
24	GTZ-SLGSR	Aceh Besar	Rhizophora spp.	25	?
25	FAO	Paru Keude	Rhizophora spp.	89.5	?
26	FAO	Paru Cot	Rhizophora spp.	15	?
27	FAO	Meunasah &	Rhizophora spp., Nypa fruticans	8	?
28	FAO	Kiran Baroh	Rhizophora spp.	12	?
29	Wetlands International – Indonesia Programme (WI-IP) through Small Grants from Green Coast project[1]	A.Besar, B.Aceh, Semeulue, Nias, Pidie, Aceh Utara, Lhok Seumawe, Sabang.	Rhizophora spp.	200	1,100,000
	TOTAL (International NGOs)			973,50	4,109,800
	National NGOs *				
1	Yayasan Leuser Indonesia	Lambada, A.Besar	Rhizophora spp.	3	13,000
2	Yayasan Gajah Sumatera	Tibang, A. Besar	Rhizophora spp.	2	10,000
	TOTAL (National NGOs)			5	23,000

Table 4-3. Data on plans for or realization of planting of coastal vegetation by Government agencies and NGOs. Based on data from various sources, compiled and analyzed by WI-IP.

No	Facilitator/Implementer	District/Subdistrict/ Village	Species	Area (Ha)	Number of seedlings
Government					
	GERHAN BP-DAS	Aceh Besar	Ketapang & Sea pine	800	?
	Satker BRR Pesisir	Batee, Pidie	Ketapang, Sea pine, Mimba,Bunot	12	5,760
	Satker BRR Pesisir	Kota Sigli	Ketapang, Sea pine, Mimba,Bunot	18	8,640
	Satker BRR Pesisir	Simpang Tiga	Ketapang, Sea pine, Mimba,Bunot	9	4,320
	Satker BRR Pesisir	Keumbang Tanjong	Ketapang, Sea pine, Mimba,Bunot	8	3,840
	Satker BRR Pesisir	Lancak, Pasi Ihok, Jeumerang	Ketapang, Sea pine, Mimba,Bunot	6	2,880
	Satker BRR Pesisir	Bandar Baru	Ketapang, Sea pine, Mimba,Bunot	15	7,200
	Satker BRR Pesisir	Lancang Paru	Ketapang, Sea pine, Mimba,Bunot	6	2,880
	Satker BRR Pesisir	Pasi Pusong	Ketapang, Sea pine, Mimba,Bunot	9	4,320
	Satker BRR Pesisir	Pante Raja Mesjid	Ketapang, Sea pine, Mimba,Bunot	11	5,280
	Satker BRR Pesisir	Meue	Ketapang, Sea pine, Mimba,Bunot	6	2,880
	Satker BRR Pesisir	Cot Lheue	Ketapang, Sea pine, Mimba,Bunot	15	7,200
	Satker BRR Pesisir	Sagoe	Ketapang, Sea pine, Mimba,Bunot	7	3,360
	Satker BRR Pesisir	Meuraxa	Ketapang, Sea pine, Mimba,Bunot	17	8,160
	Satker BRR Pesisir	Aceh Jaya	Ketapang, Sea pine, Mimba,Bunot	200	96,000
	Satker BRR Pesisir	Bireuen	Ketapang, Sea pine, Mimba,Bunot	100	48,000
	Satker BRR Pesisir	Peukan bada	Sea pine, Ketapang, Mimba, Bunot	5	2,400
	Satker BRR Pesisir	Lhok Nga	Ketapang, Sea pine, Mimba,Bunot	84	40,320
	Satker BRR Pesisir	Wilayah Pante	Ketapang, Sea pine, Mimba,Bunot	31	14,880
	Satker BRR Pesisir	Mesjid Raya	Ketapang, Sea pine, Mimba,Bunot	30	14,400
	Note: Satker BRR Pesisir = BRR Coastal Work unit		TOTAL	1,389	282,720
NGO					
	Beach Care Programme, By Japan surf	Leupung-Lhok Nga	Sea pine	2	?
	Livelihood Development	Birek	Sea pine	2	20
	Livelihood Development	Karueng	Sea pine	1	40
	Livelihood Development	Baroh KK	Ketapang, Sea pine, Mimba	-	40
	Livelihood Development	Tanah Ano	Ketapang, Sea pine, Mimba	3	1,066
	Livelihood Development	Jantang	Coconut	4	800
	Livelihood Development	Paroy	Ketapang, Sea pine, Mimba	-	30
	Livelihood Development	Cot	Coconut	1	300
	Livelihood Development	Glee Bruek	Ketapang, Sea pine, Mimba	-	40
	Livelihood Development	Pudeng	Ketapang, Sea pine, Mimba,Bunot		
	Livelihood Development	Cundien	Coconut, Ketapang, Sea pine	3	415
	OXFAM	Alue Deah Tengoh	Coconut & Sea pine		1,100
	OXFAM	Deah Baro	Coconut & Sea pine		1,100
	OXFAM	Deah Glumpang	Coconut & Sea pine		1,100
	OXFAM	Lamteh	Coconut		5,000
	OXFAM	Tibang	Sea pine		600
	FAO	Bandar Baru, Pideie	Coconut, Sea pine, Ketapang	12	?
	Care International Indonesia & WIIP	Langi & Alus-alus villages in Simeulue district	Ketapang	20	10,500
	Wetlands International – Indonesia Programme through Small Grants from Green Coast project	A.Besar, B.Aceh, Semeulue, Nias, Pidie, Aceh Utara, Lhok Seumawe, Sabang.	Sea pine, Coconut, Bunot, Tamarind, Ketapang	152	109,000
			TOTAL	**198**	**131,151**
Note: Ketapang = *Terminalia cattapa* Mimba = *Azadirachta indica* Bunot = Punago = nyamplung = *Callophylum inophyllum*					

4.3 Level of success

To date, the degree of success achieved by rehabilitation work is not known with any certainty due to the lack of data on the percentage of seedlings that survived. Only a small proportion of the implementers possess data on the progress of their rehabilitation activities, including seedling survival rate in the field. Most do not do any monitoring, so do not know how many seedlings survive. This is one of the results of the fragmented nature of the activities, such that rehabilitation is considered to be finished as soon as the seedlings have been planted. Neither tending nor monitoring has been deemed necessary.

Rough calculations made during field observation suggest that the survival rate for mangrove (40%-60%) is considerably higher than for other coastal species (20%-50%). As time goes on, however, this percentage is certain to decrease for the following reasons:

- Some mangroves were planted using the propagule which, for a period of 1-2 months, gives the plant an excellent chance of living as the embryo is sustained by the nutrients contained in the hypocotyl. Only after this store is exhausted and the seedling has to depend upon nutrients in the soil can success or failure be determined.

- Seedlings still alive now will not necessarily continue to live. This will depend upon the conditions prevailing in the seedling's environment, such as drought, the action of the waves as tides ebb and flow, or being eaten by animals.

- The seedlings are not tended. Without proper maintenance, plants will be attacked by pests and diseases thus reducing the survival rate.

- Regional development involving the development of public facilities and infrastructure (such as roads) could destroy rehabilitation sites.

Box 4.2. Excerpts from press reports on Coastal Rehabilitation (translated from the Indonesian)

Tempo Interaktif, 4 January 2005
As part of the three stages of action following the earthquake and tsunami in Nanggröe Aceh Darussalam and Nias-Sumatera Utara (i.e. emergency stage, rehabilitation and reconstruction), the Ministry for the Environment (KLH) announced that they have mobilized a Commando Post (Posko) for the rehabilitation of Aceh. Coordinated by the secretary to the Minister for the Environment, the Posko has sent tens of KLH Ministry staff to inventorise data concerning the damage to nature. This team has also been instructed to calculate how much must be spent to repair the environment.

Bisnis Indonesia, 07 January 2005
The Forestry Department has allocated Rp 806 billion to re-establish 200,000 ha of mangrove forest along the coast of Nanggröe Aceh Darussalam (NAD) and its vicinity. This money will come from unused funds remaining from the 2003-2004 budget for the National Movement for Land and Forest Rehabilitation (GNRHL). It is envisaged that with this amount of money it will be possible to establish 150,000 – 200,000 ha of mangrove forest, calculated on an estimated cost of Rp 4-5 million per hectare, including labour costs.

Serambi Indonesia, 14 March 2005
Inhabitants of Leupung in the Aceh Besar district have begun rehabilitation along the coast and river by planting 85,000 mangrove seedlings in an effort to restore the coastal ecosystem destroyed by the Tsunami. These thousands of seedlings have been provided through the help of a leading member of the local community and distributed to the inhabitants of six villages for planting along the coast and riverside.

BRR Press announcement, 21 November 2005
The Agency for the Rehabilitation and Reconstruction of Aceh and Nias (BRR) on 21 November 2005 launched the Coastal Re-greening Project in collaboration with Wetlands International Indonesia Programme and WWF Indonesia. These latter two organisations are the primary implementers for the Green Coast Project in Indonesia which is funded by Oxfam Netherlands. This coastal reforestation program will focus on two areas: improving the livelihoods of coastal communities, and conserving the environment.

Serambi Nanggröe, 27 April 2006
The Forestry and Plantations Agency (Dishutbun) for Aceh Barat is currently developing 800 ha of mangrove forest in watersheds and swamps distributed through the sub-districts of Samatiga, Meurebo, Johan Pahlawan, and Arongan Lambelek. To achieve this target, Dishutbun has prepared 2 million mangrove seedlings, all of which have been donated by the Watershed Management Service (BP-DAS) for Krueng Aceh Pemprov NAD. The seedlings will be planted by the local communities. This forms part of the National Movement for Land and Forest Rehabilitation (Gerhan), which has a target of planting 1,000 hectares.

Serambi Nanggröe, 29 July 2006
A number of coastal inhabitants in the Syah Kuala sub-district of Banda Aceh have planted 200 thousand mangrove seedlings around newly renovated aquaculture ponds in order to reforest the coastal area devastated by the earthquake and tsunami on 26 December 2004. There are currently around 150 ha of aquaculture ponds that have been rehabilitated and are in need of mangrove because of the benefits these trees provide in preventing abrasion, especially abrasion to the community's ponds. The mangrove seedlings were donated to the community by the Agency for the Rehabilitation and Reconstruction of Aceh and Nias (BRR).

- Land owners may change their minds after their land has been planted with mangrove or coastal vegetation. Having initially agreed to the planting of these rehabilitation species, they subsequently pull them up because they want to use their land for another more economically advantageous purpose (e.g. aquaculture ponds, housing).

4.4 Limitations and constraints in the field

The coastal rehabilitation currently underway is still far from successful. This can be seen from the low percentage of seedlings still growing, both mangrove and terrestrial. Changing environmental conditions, mistakes in the choice of site, the implementers' lack of preparation, lack of experience, insufficient coordination, unclear spatial planning, and other constraints are all factors causing the low level of success in coastal rehabilitation.

Field observations identified several constraints or limiting factors which caused rehabilitation efforts to fail. These are described below.

4.4.1 No blueprint for coastal rehabilitation has yet been provided

It is essential to have a blue print for rehabilitation so that the activities are integrated and given direction. This is especially important considering how many stakeholders there are working on coastal rehabilitation. As well as providing a spatial plan, the blueprint should also provide information on important matters such as land suitability, land conditions and level of damage, the plans of parties concerned with the land's utilization, and land ownership status. Without this blueprint, rehabilitation activities will lack direction and run a serious risk of leading to conflict and other problems in the future.

Unfortunately, however, possibly because of complexities in the field, no such blueprint has yet been provided. Hence, every implementer freely chooses sites in a manner which appears to be unplanned, undirected and unorganised. It even happens that two or more different implementers find themselves planting on the same site. Lacking clear direction, planting is done without knowledge of who the site belongs to or what plans there may be for its development.

The Ministry of Forestry and the International Tropical Timber Organisation (ITTO) are drawing up a blueprint for rehabilitation, but it is not expected to be finished until the end of 2006 or early 2007. If this does in fact materialize, this document is likely to have been in vain as most field activities are by now well under way and in many cases already finished, and the rehabilitation stage is itself due to end in December 2006.

4.4.2 Most NGOs see coastal rehabilitation as a secondary activity

A large proportion of the facilitators, especially those who arrived shortly after the tsunami disaster, are primarily concerned with the emergency response, which is accompanied by the building of facilities such as houses, boats, roads and other infrastructure. Environmental rehabilitation is, for them, not a top priority. As a result, coastal rehabilitation is usually subject to the following constraints:

- **Inadequate funding**. It seems that funding is limited to the provision of seedlings and meeting the cost of planting. No funds have been made available for plant maintenance/ tending.

- **Inadequate manpower**. This has been the cause of many of the factors leading to failure, such as the selection of unsuitable sites, seedlings not ready for planting, planting at the wrong time, etc.

- **Inadequate preparation**. Because of the lack of preparation, several international NGOs often opted for the 'instant' step of contracting the planting to another party such as a local NGO or CBO which was not in practice monitored nor evaluated. A chief driver for this was the pressure from donors on international NGOs to show evidence of how their contributions had been spent.

Under such conditions, it is not surprising that planting did not go well and that it was prone to failure. Nevertheless, there are a few NGOs and projects that have coastal rehabilitation as their top priority, such as the Green Coast project (funded by Oxfam) whose implementation in Indonesia is managed by WI-IP.

4.4.3 The lack of preparation

Some of the rehabilitation activities were done in a sudden rush, and weaknesses were noted in the preparation of reliable implementers, the selection of good quality seedlings and suitable planting sites, and clarification of land ownership. An important driver towards undue haste was pressure to show results from the public and media in donor countries, applied to the organizations channeling funds (i.e. facilitators).

To achieve optimum success, the people doing the work must be properly prepared in advance. This can be done through a comprehensive training programme that includes practical training in how to select good seeds, prepare the seedlings in the nursery, choose suitable sites for planting and plant the seedlings there properly.

4.4.4 Failure in the nurseries

One of the keys to success in rehabilitation is an adequate supply of good quality seedlings that are ready for planting. Implementers should undertake seedling production on this basis. Unfortunately, they often run up against technical obstacles (e.g. seedlings die due to pests or lack of water) which reduce the number of seedlings available. Several other factors causing low success include the following.

a) Difficulties in seed procurement

The devastation of mangrove and other coastal vegetation resulted in the loss of seed stocks. Such seeds therefore became difficult to find in areas directly affected by the tsunami. Large stocks of mangrove seedlings were in fact still available in nearby districts, such as Aceh Timur and Aceh Tamiang whose coast had not been badly damaged, but this was not known to groups that were seeking to plant mangroves. Hence, several NGOs (also the Government) imported mangrove seeds and seedlings from distant places such as Banyuwangi in East Java and Cilacap in Central Java. Their shipment to Aceh took as much as 5 to 8 days, and the shock received during transport seriously weakened many seedlings. Some reports indicate that 35%-50% of mangrove seedlings imported from outside Aceh were dead on arrival at the planting site in Aceh, while the quality of the remainder had deteriorated to the point that most of them died after planting.

b) Poor seed quality

Seed quality is extremely important in the production of seedlings. If inferior quality seeds are used, fewer will sprout, and those that do grow will produce poor-quality plants, dwarfed or vulnerable to pests and diseases. This very often happens because unripe seeds are used, because the implementers do not understand how to identify ripe, mature seeds.

To prevent this from happening in future, information must be disseminated on how to identify good quality, mature seeds. This can be done in several ways, such as through training sessions and the distribution of instructions, leaflets and posters that give information on techniques for selecting seeds. Table 4-4 below lists the characteristics of matured seeds for several species of mangrove and coastal vegetation.

Table 4-4: Characteristics of seed maturity for mangrove and coastal species

Species	Characteristics of matured seed
Mangrove species:	
Rhizophora spp.	*R. mucronata*: yellowish cotyledon, minimum length of hypocotyl: 50 cm *R. apiculata* : Yellowish red cotyledon, minimum length of hypocotyl: 20 cm
Ceriops tagal	The cotyledon has grown to a length of 1-1.5 cm, minimum length of hypocotyl: 20 cm
Bruguiera gymnorrhiza	Reddish brown cotyledon, minimum length of hypocotyl: 20 cm
Sonneratia alba	Seed taken from fruit which has a minimum diameter of 40 mm and is floating in the water.
Avicennia marina	Yellowish green colour, weight: 1.5 gram
Coastal species:	
Callophyllum inophyllum	Yellowish brown colour. Diameter 2.5-4 cm.
Terminalia cattapa	Yellowish green colour
Casuarina equisetifolia	Yellowish green colour. Diameter 1+ cm.

c) Lack of skill and expertise

The field implementers' limited capacity and lack of experience are among the main causes of failure in seedling production. Without adequate knowledge, the process will be carried out haphazardly without proper heed to the principles and techniques of silviculture. The approach taken was frequently found to have been one of trial and error, with the implementers acting by guesswork and repeating activities that seemed to work and altering procedures that did not. This proved extremely inefficient, considering that rehabilitation activities require a guaranteed supply of good quality seedlings in large quantities and ready for planting at the time required by the project.

d) Inappropriate choice of nursery site

Mistakes were often made in selecting the site for a mangrove nursery, which requires special conditions. Among other things, it must be reached by high tide, have a muddy substrate, flat topography, and be near both to a source of media such as water and soil, as well as to the planting site. Field observations found several nurseries in unsuitable sites, where tidal inundation was too deep or the water currents too strong, or else the nursery was far from a source of suitable media because the area had been covered by tsunami deposits.

e) Mistakes in selecting media

Mangrove species prefer a muddy medium which is always wet with brackish water, whereas coastal species grow well in a medium of earth mixed with sand. However, it was found in the field that mistakes had often been made in the choice of media. The most common mistake was to use a sandy medium for mangrove, as a result of which the seeds could not grow properly and died.

Figure 4.5. Nursery failure due to mistakes in choice of media

f) No hardening off

In practice, seedlings were usually taken directly from the nursery for planting, without being given the chance to acclimatize. As a result, the seedlings became stressed and died. The implementers were generally unaware of this link, so the same mistake was made repeatedly.

Figure 4.4. Nurseries sited in unsuitable areas: site subject to heavy inundation and strong currents (left); site not subject to inundation (right). Both failed totally. Photographs taken in Lham Nga, Aceh Besar

To make seedlings ready for planting out in the field, they must go through a process of hardening or acclimatization of 1 – 2 months prior to planting out. For mangroves, this consists of gradually reducing the shade until they can survive without shade. For coastal species, it is not only the amount of shade that is reduced but also the intensity of watering. Thus the seedlings become ready to adapt to field conditions.

4.4.5 Planting in unsuitable locations

Many instances were found in the field where seedlings, both of mangrove and coastal species, had been planted in unsuitable sites and did not survive. In general, four important mistakes were made in selecting a planting site.

a)Planting mangroves in sandy areas

Generally, mangroves planted in sand will gradually show signs of stress and then die. If planted with its propagule, however, the seedling will at first appear to be growing normally as the embryo feeds off the nutrients in the propagule. This gradually runs out, as the plant's organs such as leaves and roots grow. When it has been completely exhausted, the seedling will have to depend on the nutrients in the soil. At this point, it will wilt and die.

Figure 4.6. Mangrove planted on sandy beach

As well as being poor in nutrients, sandy soil is unsuitable for mangrove seedlings because the sand absorbs and transmits heat from the sun thus burning the seedlings' roots.

b) Planting mangrove in dry mud

Although better than sandy soil, the planting of mangrove in dry mud is also not recommended because a supply of water is essential for the plant to grow. Mangrove planted on dry mud will not grow normally and may die.

Figure 4.7. Mangrove planted on permanently dry mud

c) Planting on open, labile sandy beach

Open sandy beach is very difficult to rehabilitate. Apart from being labile as the sand is easily eroded by the wind, it is highly saline and stores heat from the sun. It would seem obvious that such an area is unsuitable for planting as nothing is growing on it. Nevertheless, planting has been attempted on some sites of this nature and, as a result, most of the seedlings died.

Figure 4.8. Planting on open sandy beach

d) Planting coastal species in inundated areas

For terrestrial coastal species, inundation (especially by salt water) is most unsuitable and can result in plant death. However, this was frequently found to have happened. During orientation at several planting sites, many coastal species such as coconut *Cocos nucifera* and sea pine *Casuarina equisetifolia* were found to have been planted in places that were inundated. Close examination of these showed that all the inundated seedlings were dead.

Most inundated land is situated around estuaries, rivers, lagoons or seashores which from time to time receive overflow or are influenced by the tides. This must be taken into account when selecting suitable species for planting.

4.4.6 Problems concerning land ownership

The status of the planting site is of utmost importance as it relates to a person's rights and obligations regarding that land.

Several NGOs have had bitter experience regarding land status. In one case, hundreds of mangrove seedlings were pulled up from aquaculture ponds as they had been planted without the owner's permission. There were also owners who granted permission for the seedlings to be planted but then, a few months later, pulled them up because they wanted to reactivate the ponds.

4.4.7 Pressure for activities contrary to rehabilitation

Donor institutions (including Government) often find themselves in a difficult position because of the multitude of differing demands from the community. As a result, conflict of interest becomes unavoidable as the fulfilment of one group's aspirations through a particular activity is certain to disturb another group's programme.

Such a conflict of activities occurred in Lham Ujong village as a result of community pressure. Some of the aquaculture pond owners asked a donor to rehabilitate their ponds and irrigation ditches, although another community group had already planted mangrove around this area. The seedlings were already 4 months old. As a result, the rehabilitation work on the ponds and ditches (using excavators), damaged some of the mangrove seedlings, which subsequently died.

Figure 4.9. Coastal species planted on inundated land

Figure 4.10. Construction of ditches (pond rehabilitation) has damaged the mangrove already planted (Lham Ujong village, Aceh Besar)

There was a similar occurrence in Lham Dingin village, where the pond owners demanded that the government build a sea wall in front of their 140 ha of ponds to protect them from erosion and damage from the waves (see Box 4-3 below). Unfortunately, the building of the sea wall was not preceded by an environmental impact assessment, so there was a danger that the ponds behind the wall would be flooded at high tide. If, instead, part of the pond land had been planted with mangrove, according to the concept of silvo-fishery, the mangrove would be able to act as a natural defence and, at the same time, increase natural fishery productivity.

Box 4.3. SEA WALL IN LHAM DINGIN

From Suryadiputra (editor, 2006).

A sea wall approximately 16.2 m long and 2 m high is being built along the coast of Lham Dingin (from the mouth of the Krueng Aceh to the mouth of the Krueng Cut). The sea wall is located approximately 200 m from the aquaculture ponds.

The building of this sea wall requires deeper study [construction of the sea wall by the Department of Public Works began in July/August 2005 without a prior Environmental Impact Assessment (*AMDAL*); information obtained from staff of BRR during a donors meeting at the Embassy of Denmark in Jakarta]. The sea wall could create new problems including:

1. Such a large structure will likely restrict the discharge of fresh water during the rainy season or salty water during high tide (see this hypothesis in Figure 4-11). Because the wall will lead to retention of water behind the structure, in areas that are largely aquaculture ponds and homes, there is a risk of flooding. If there is flooding of the ponds, this places aquaculture activities at risk because fish and shrimp fry that are being cultivated would be released to the sea or nearby rivers (Krueng Aceh and Krueng Cut).

2. It is suspected that there will be an increased risk of sea water intrusion. If sea water is trapped behind the wall after high tide in the pond area, and the water remains there for a long period of time, there is the potential for recharging of sea water in the soil, meaning that sea water will intrude further inland.

3. The presence of the sea wall is also likely to change the patterns of currents and wave action, causing them to shift to other locations. If this happens, it could affect other coastal areas through, for example, erosion.

4. Sea water and water from the Krueng Aceh and Krueng Cut rivers have relatively high levels of suspended particles (clay particles, fine sand, among others), with a concentration ranging from 36 – 46 mg/l. If this water floods the area behind the sea wall there is a risk it will lead to sedimentation, and ultimately turn the aquaculture ponds to land (there is a risk it could be land heavy in salt if sea water is dominant and is not washed away for long periods of time). A salty substrate could be an obstacle to the vegetation rehabilitation program that is underway in the area of the sea wall.

5. The sea wall could also restrict washing away of organic material resulting from the tsunami, meaning that decomposing organic matter will collect in the ponds. This situation is already evident in the Gampong Jawa area, and is characterized by a rotten smell.

6. During the dry season the sea wall could prevent water from entering the area behind the wall, leaving it dry. This is evident in Tibang, Gampong Jawa, Lham Pulo and Dean Raya where there is a scarcity of water and seedlings are drying out and dying [note: the two pieces of information above were provided by the Head of the Provincial Environmental Agency of Aceh during a technical meeting at the Ministry of Environment in Jakarta in May 2006].

Based on the scenario outlined above, the following steps need to be taken:

- A detailed study of the hydro-oceanographic aspects (including the watersheds of the Krueng Aceh and Krueng Cut) and coastal areas near the sea wall. This should include an analysis of any potential changes in currents, water turbidity, ground water quality, potential for sea water intrusion and possibility of flooding behind the sea wall.
- Research on the ecological conditions (biodiversity and habitat for flora and fauna) in coastal parts of Lham Dingin and nearby areas. This should include research on the physical and chemical quality of the substrate/soil (including pond soil) behind the sea wall which could impact on the success of on-going rehabilitation activities and re-establishment of aquaculture activities (especially if the salt content is high).
- Socio-economic research to understand the impacts on the ponds and homes that are behind the sea wall.
- Research on possible alternatives to protect Lham Dingin (other than a large embankment built from rocks from the mountains), e.g. by mangrove planting.

Alternative to construction of sea wall. A protective barrier can be provided by coastal rehabilitation using mangroves and other coastal vegetation. There are examples from several coastal areas in Indonesia which show that mangroves trap mud naturally. Over time this mud increases the area for mangrove seedling growth, and a barrier is formed from dense and strong mangrove vegetation. Implementation of this concept will take time before it is functioning optimally, but the ecological advantages are many. In addition, it is most likely a less expensive option than constructing a stone sea wall.

4.4.8 Road construction from Banda Aceh to Meulaboh

There are fears that the highway construction work currently in progress (traversing the west coast from Banda Aceh to Meulaboh) could clash with the rehabilitation work being carried out by other agencies. In Pulot, for instance, the highway is planned to traverse the Pulot lagoon which is now in the process of being reforested (by WI-IP and UNEP). Similarly, in Lamno, the highway is expected to hit the aquaculture ponds already rehabilitated by BRR. To overcome such problems, the road construction agency needs to coordinate its activities with the agencies undertaking environmental rehabilitation.

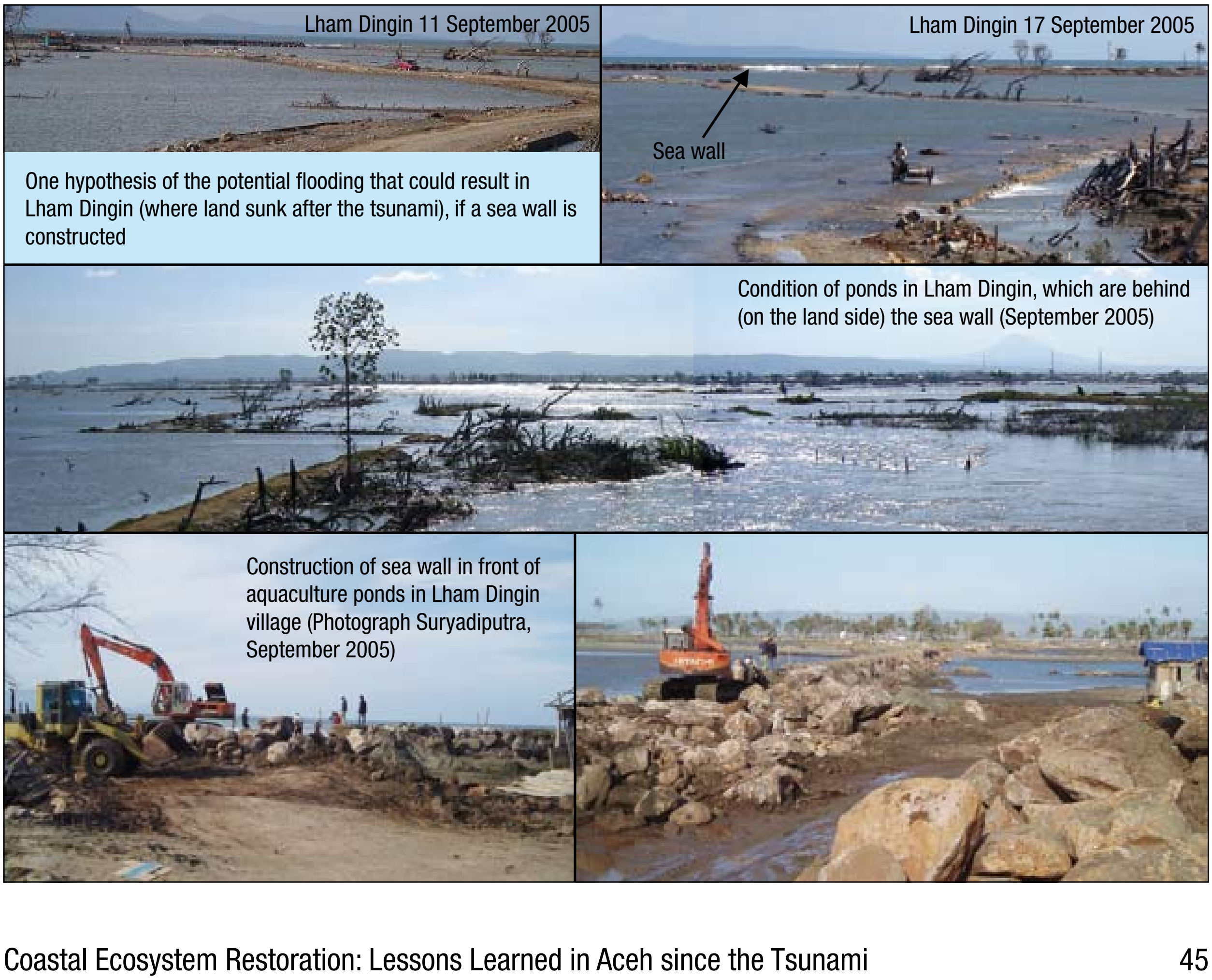
4.4.9 Aquaculture pond rehabilitation without mangrove

Following the tsunami, many ponds in Aceh Besar and Banda Aceh were rehabilitated by a variety of agencies, including ADB and BRR. Unfortunately, this was not done in the light of the silvo-fishery concept now being widely promoted in Aceh. Mangroves were not, therefore, planted around the ponds or ditches. Had this been done, especially on the dikes, the mangrove trees would not only have strengthened the ponds but also provided shade and, it is believed, been capable of increasing the productivity of natural fishery in the area. Table 3-2 above showed the area of ponds destroyed by the tsunami to be over 11,600 ha. Imagine how green Aceh's coast would be in years to come if mangrove could be planted along all the dykes and within some of the ponds.

4.4.10 Rehabilitation using a project approach

In a project, local residents are typically only involved as unskilled labour. This is not enough to awaken a psychological bond between them and the seedlings they have planted. Once the planting has been completed, the people's sense of responsibility ends and nobody cares about the result.

Figure 4.11. Lham Dingin flooded with sea and river water (Photograph WI-IP 11 & 17 September 2005)



Moreover, a single project is not sustainable. Once the project is over the rehabilitation activities are finished, and the seedlings are neglected and die. Also, a project tends to focus only on the immediate physical results, such as the number of seedlings planted, rather than the number that have actually survived after a longer period of time. In trying to achieve the physical target the activities are conducted haphazardly (without adequate preparation and without a clear system of planting). As a result, the survival percentage tends to be low.

Figure 4.12 (Top, Middle left) Pond dikes and land (empty land in centre) where mangrove could be planted (these ponds are in Ceunamprong and Kareng Ateuh villages in Jaya subdistrict of Aceh Jaya district, and have been rehabilitated by BRR).
(Middle right) One of these ponds has become little more than a buffalo wallow.
(Bottom) Pond on Lhoong coast in danger of abrasion. Mangrove needs to be planted along the shore in front.

4.4.11 Technical errors and mistakes in the field

Rehabilitation efforts often fail as a result of technical errors, for example, mistakes in the way seedlings are handled during transportation. Such mistakes are frequently encouraged by the desire to speed up or simplify the process, without considering the effect this will have. Seedlings must be handled carefully, so that they are not damaged (e.g. snapped off) or the media ruined. Other mistakes noticed during field observation included transporting seedlings unshaded during the heat of midday, and treating them carelessly during loading and unloading.

It was even found that seedlings had been removed from their polybags to make transportation and planting easier. This threatened the seedlings in at least two ways: the sun's heat shining directly on the roots, and damage to the roots as they were planted into the ground.

4.4.12 Conflict of Interest

The rehabilitation and reconstruction of a region involves a large number of different parties, each with their own point of view. These views often not only differ but may also conflict. Sadly, coordination among stakeholders is so weak that they can not reach agreement. Hence each goes his own way. Then, when one party's activities collide with those of another, a conflict of interest arises.

Figure 4.13. Seedlings taken out of the polybags to make work easier

Figure 4.14. Mangroves fall victim to rehabilitation of ponds

Figure 4.15. Barnacles attacking mangrove (top)
Figure 4.16. Coconut palms devastated by wild boar attack (bottom)

In Kahju village, for example, the rebuilding of pond dikes caused serious damage to the mangrove previously planted there. It is estimated that more than 1,000 one-year old seedlings were destroyed.

Conflict of interest is certain to continue at many other sites and claim more mangroves. Steps must therefore be taken to try to eliminate or at least minimize the impact of such conflicts of interest.

4.4.13 Pests

a) Pests attacking mangrove

Pests that attack mangrove include various barnacles, crabs (e.g. *Helice* spp., *Sesarma* spp., *Motapograpsus* spp.), and mud shrimps (*Alpheus* spp. and *Aulacaspis marina*). As far as possible, these must be avoided, controlled or exterminated. Barnacles pose the greatest threat to mangroves. They can spread rapidly and infest the trunk thus killing the tree. So far, no effective way has been found of eliminating them other than by hand.

It is therefore much better to avoid this pest in the first place rather than try to eliminate it. Mangrove should not be planted on a site where there are barnacles, however few there may be.

b) Pests attacking coastal species

Unlike the pests that attack mangroves, those which attack coastal vegetation tend to be livestock, such as goats, buffalo and cattle. They eat the leaves, trample on or pull up the plants. But their attack is nothing compared to that of the wild boar *Sus scrofa*, which wreaks havoc on all species of vegetation and is very difficult to control.

The worst area for wild boar attack is on the west coast of Aceh where there are still large tracts of forest which form their habitat, ad which may be very close to some of the planting sites.

A number of measures have been tried to protect the seedlings, such as fences, ditches and barbed wire, but none have had much effect. According to local NGO Gamma 9, heaping stones around a barbed wire fence protecting the seedlings is more effective. However, this is considered uneconomic as it requires large amounts of labour to pile the stones and money to buy the materials for the fence.

4.4.14 Lack of replacement planting and seedling maintenance

Most of the rehabilitation activities in Aceh lacked any provision for replacement planting or follow-up care. Field observations along the west coast

Box 4.4. The dilemma of pest protection; between effectiveness and extravagance

Along the western coast, most of the planting sites for coastal vegetation (especially coconut) are attacked by wild boar *Sus scrofa*. To protect against this pest, some NGOs and Government fenced every seedling. Ironically, the expenditure for fencing was much higher than the price of the seedlings. According to interviews, a fence cost Rp. 25,000 to Rp. 50,000 (made from wood and/or wire netting), while a coconut seedling cost no more than Rp. 7,500.

Figure 4.17. Various types of fence to protect seedlings

More saddening was the fact that the plants had not been tended. Dead seedlings had not been replaced, so fences were often found without a seedling. In some places, the fences were found broken, uncared for and falling apart.

Figure 4.18. Broken, useless and abandoned fences in Lhok Nga

Figure 4.19. Fence swallowed by climbing plants, and seedling eventually dies

from Leupung to Lhong village in Aceh Besar found no site where dead seedlings had been replaced. If this is not done, the reforestation will have a low success rate or may even fail. If dead seedlings are replaced with new healthy ones, there is a much better chance of success.

If, moreover, the seedlings are not tended, they are likely to die. According to field observations, many fences were found to have been covered by climbing weeds, which then covered the seedling and in many cases choked it to death.

Besides being killed by weeds, coastal vegetation can also suffer from livestock and strong winds. Livestock trample the growing seedlings, even eat them, while strong winds can blow away the substrate (such as sand) and uproot the seedlings.

4.4.15 Lack of monitoring and evaluation

Without monitoring and evaluation, the progress and success of plant rehabilitation cannot be known. Properly planned, routine monitoring and evaluation can help detect factors that cause failure early on, so that steps can be taken promptly to remedy the situation.

4.4.16 Poor coordination among stakeholders

This weakness was found not only in government agencies but also among implementers in the field and donor institutions involved in funding the rehabilitation and reconstruction of Aceh. This was obvious from the rarity of any meetings among stakeholders. If a meeting was held, only a few of the stakeholders attended, and it was not followed up by communication or coordination capable of reaching the implementers in the field. Everyone seemed to go their own way without caring about the interests or activities of the other stakeholders.

Without good coordination, activities will run in a manner which is sectoral, fragmented, directionless, overlapping or going in opposite directions. In contrast, with good coordination, although it will take more time, the activities carried out by various stakeholders can be harmonized and integrated so as to provide maximum benefit to the ecosystem and the community. Furthermore, the experience gained from the activities has not been well documented so as to provide valuable lessons for others to learn from in the future.

4.4.17 Inadequate spatial planning

Spatial planning in most of the areas affected by the tsunami is inadequate. It tends to have been done in a partial, fragmented manner, in accordance with the needs of the implementers and their partners in the field. It is not comprehensive and has not been formerly integrated into the spatial planning at district level. Each sector and institution plans its own programme, with little or no sharing or compromise with other stakeholders. As a result, there are both gaps and overlaps.

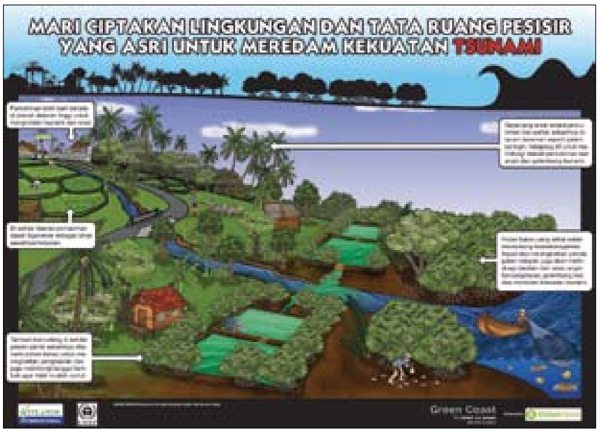
Inadequate spatial planning often ends in conflict of interest; for example, demolishing a rehabilitated site because the same site is to be used to construct a harbour, ditches for aquaculture ponds, or a highway. For this reason, the spatial planning must be discussed together by all the stakeholders, including the community. Once agreement has been reached on the spatial plan, all parties must use it as a fundamental reference document for action, and not contravene it.

4.4.18 Lack of environmental awareness

The community's poor environmental awareness is usually due to their ignorance of the environment's functions and benefits, including the benefit of mangrove and coastal vegetation. This is what makes them appear indifferent to the rehabilitation activity in their vicinity. Poor environmental awareness also causes them to get used to a lifestyle that is not clean.

Ironically, this lack of environmental awareness was found not to be limited to the community but also to be prevalent among government and other stakeholders. It is the reason why they have not considered the environmental impact of the activities they carry out. One example is the construction of a sea wall at Lham Dingin without first doing an Environmental Impact Assessment (EIA), with the result that water supply to the planting site was cut off (see Box 4-3 Sea wall in Lham Dingin).

A continuous effort must be made, therefore, to raise the environmental awareness of all parties, including community leaders, schoolchildren, government officials, members of the legislature, NGOs and the general public. Some of the ways this can be done include: environmental campaigns, showing films about the environment, and environmental education in schools. A variety of materials for environmental campaigns in Aceh have been published by various parties, but only on a limited range of themes. Among them are the posters, comics, leaflets/flyers published by UNEP in collaboration with WI-IP and the Green Coast Project. The following are examples of these:



4.4.19 Additional observations

Field inspection of mangrove and coastal vegetation planting sites in Aceh in early 2007 yielded the following observations concerning the failure of rehabilitation efforts.

a) Overlapping activities at planting sites

In Bireun-Pidie district, double planting occurred in the same pond at different times, using different methods and mechanisms without coordination or communication. In the first set of activities, local people used a small livelihood grant from the Green Coast (GC) project to plant mangroves successfully along the pond dikes and in the middle of the ponds. In the second intervention, a private company with funding from BRR offered a larger amount of money on a cash-for-work basis, asking the same community to plant mangroves in the same location. Since there was no space left for planting, the people were asked to inter-plant amongst the established seedlings. The community initially refused, but the company insisted they should do so, assuring them that they could remove them once they had been photographed. All these new seedlings died with a month or two, as they had been planted with their roots still in their polybags. Events of this kind have been seen in other locations in Aceh. The key to avoiding them lies in improving coordination and communication among donors and stakeholders.

b) Natural disasters.

Floods, extreme tides and storms have all caused damage to rehabilitation sites in Aceh. At Kahju beach, for example, more than a thousand seedlings were swept away by a high tide in 2005, while a flash flood in Pidie district in January 2006 caused damage across 15 sub-districts, including the loss of over 67,000 mangrove seedlings at one GC project site. The flash flood was attributed to severe degradation of the water catchment by illegal logging and land conversion. This illustrates how restoration and environmental protection efforts since the tsunami have focussed on coastal areas to the exclusion of vulnerable sites further inland. The flash-flood in Pidie has now drawn attention to the need to promote environmental security by protecting catchment forests. Necessary measures include:

- integrated watershed restoration with the participation of all stakeholders;
- suppression of illegal logging and land conversion; and
- rehabilitation of degraded areas.

Table 4-6. Suitability of seedling species for different types of site

Species	Substrate condition	Location	Hydrology	Salinity
Mangrove species				
Bakau *Rhizophora* spp.	Medium to deep mud	Along the dikes of fish ponds, along rivers, muddy beaches	Tidal	Moderate
Tengal *Ceriops* spp.	Medium to shallow mud	Muddy beaches	Tidal	Moderate
Tanjang *Bruguiera* spp.	Medium thickness of mud, shallow muddy soil	Near rivers	Tidal, but with fresh water inputs	Low
Pedada/Bogem *Sonneratia* spp.	Muddy sand, shallow muddy soil	Open muddy beaches, along rivers, around estuaries	Tidal	Moderate
Avicennia spp.	Muddy sand beach	Open beach	Always flooded by sea water	High
Coastal vegetation				
Sea pine *Casuarina equisetifolia*	Sandy soil	Sandy beach where *Ipomoea pes-caprae* is growing	Dry land	-
Nyamplung *Callophyllum inophyllum*	Sandy soil	Behind sandy beach	Dry land	-
Barringtonia	Sandy soil	Behind sandy beach	Dry land	-
Ketapang *Terminalia cattapa*	Sandy soil	Behind sandy beach	Dry land	-
Putat	Sandy soil	Behind sandy beach	Dry land	-

4.5 Recommendations

The obstacles, failures and experiences obtained from rehabilitation efforts during the two last years in Aceh and Nias have provided us with valuable lessons. These, it is hoped, can help to ensure that both on-going and future activities run better, are properly prepared, well coordinated, have direction, and are on target, thus leading to the success of the coastal rehabilitation effort.

4.5.1 Selection of appropriate species and planting sites

The species selected should be those best suited to the conditions prevailing at the planting site, priority being given to local species. Avoid introducing alien species as this can seriously disturb the equilibrium of the ecosystem.

If the planting site is muddy beach, mangrove seedlings should be selected, though the decision on which particular species of mangrove to plant will depend on the specific characteristics of the substrate, in particular the depth of the mud, the condition of the tides, the distance from a river, etcetera. On the contrary, if the planting site is sandy beach, other species of coastal vegetation species must be chosen.

4.5.2 Use of biological indicators when selecting planting sites

A species of plant or animal found on the site can be used as a biological indicator of the site's suitability for the purposes of rehabilitation.

- **Biological indicator for mangrove planting site.** The mud skipper (locally known as Glodok or Tembakul, *Periophthalmus* spp.) is an animal indicator of sites suitable for planting mangrove. This creature likes a muddy substrate with periodic flooding.

- **Biological indicator for coastal species planting site**. *Ipomoea pes-caprae* (locally known as Katang-katang or Galaran) is a herb that flourishes on sandy beaches. It is a pioneer species able to grow on open sandy substrate, and has high tolerance to salinity. Substrate (and also eventually the seedlings, such as sea pine) which is covered by this herb is protected from the sun's direct heat and does not become too hot. Moreover, it is also protected from the direct force of the wind, so is more stable and less susceptible to erosion. These conditions are usually accompanied by the appearance of micro-organisms and small creatures which slowly improve the carrying capacity of the substrate by, for example, enriching its organic and nutrient content.

Figure 4.20. Biological indicators of planting sites for mangrove and coastal vegetation: Ipomoea pes-caprae (left) and Mud skipper (right)

As a result, species such as sea pine and Callophyllum inophyllum can grow well.

- **Biological indicator for sites to avoid for mangrove planting.** Barnacles are a bad sign in a site planned for mangrove planting. Even though mud skippers are abundant, if barnacles are found, the site should not be used for mangrove. Just one single barnacle in the site will multiply very rapidly and become extremely difficult to exterminate.

4.5.3 Improving selection of rehabilitation sites

Mistakes in selecting the planting site are a major factor leading to the failure of rehabilitation work. They can be avoided by properly assessing a prospective site before deciding whether to use it for rehabilitation. A Decision Supporting System (DSS) is a tool which can be used to help make this decision. In this system, a number of parameters are used to assess the land's suitability and feasibility.

Although the land is bio-physically suitable, there may be other factors that make it an unfeasible site for rehabilitation. For example, it may be too remote from the community for rehabilitation work there to be effective or efficient.

Furthermore, all the potentials and constraints must be identified and analyzed to discover the possibility of success and the risk of failure. If the constraining factors are greater than the supporting factors, the activity should not be undertaken. If, on the contrary, the supporting factors outnumber the constraints, the activity has a good chance of succeeding and can therefore be undertaken.

4.5.4 Improving active community participation

The community is the spearhead in rehabilitation activity. Unfortunately, their role and participation is still very limited, appearing to be little more than a symbol that the rehabilitation work has involved the community. In all the various rehabilitation activities in NAD and Nias, the community has so far been involved only as planters and porters, and their involvement has automatically ceased when the planting and carrying is finished. Through this mechanism, they have no sense of ownership towards the seedlings they have planted, nor care whether or not the seedlings will survive. This is one of the factors leading to the failure of rehabilitation.

For rehabilitation to be successful, the community must be involved actively in the whole spectrum

Figure 4.21. DSS flow chart for selecting a rehabilitation site

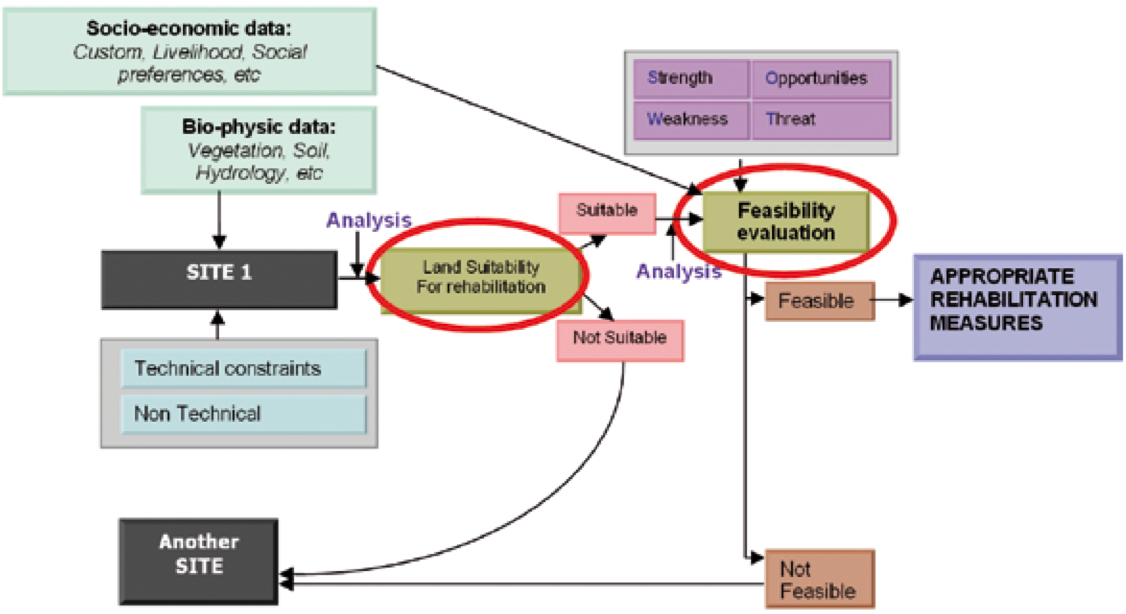
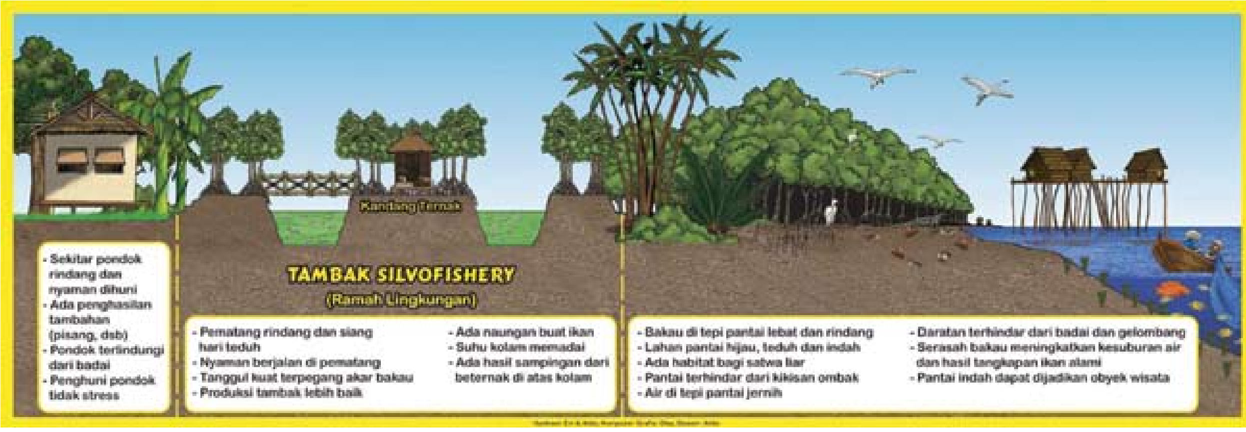


Figure 4.22. A recommended silvo-fishery system: planting mangrove around ponds



of activities, from planning to planting and then the other activities after planting. In this way, the community not only gets involved but can also develop a sense of ownership and an attitude of caring about the rehabilitation. They will also have acquired the range of skills needed to undertake the whole process of rehabilitation on their own, as they will have been involved from the beginning to the end of the activity. If this mechanism is managed well, the community will also function as warden of the growing trees. Nevertheless, this must continue to be supported by raised public awareness of the importance of coastal vegetation to the environment and to the community.

4.5.5 Capacity building through technical manuals and training

Based on field observation, it is known that very few field implementers have either the experience or skills needed to undertake coastal rehabilitation activities. As a consequence, rehabilitation programmes are not carried out properly and thus end in failure. By providing simple, clear manuals, it is hoped that field operators can be helped to understand the procedure through every stage of the activity, leading to much better performance. Other materials, such as posters and leaflets, can also help to improve the community's capacity.

However, for some field operators, particularly those with little or no formal education, a manual is not enough on its own as they may not be able to understand it. It needs to be interpreted through hands on training and demonstration by field instructors.

4.5.6 Development of silvo-fishery

Currently, almost all of the rehabilitation programs in NAD Province and Nias have the same planting pattern, i.e. they plant on empty coastal land. Unfortunately, the understanding of 'rehabilitation' is limited to the physical act of 'planting', lacking a basic understanding of the concept of conserving the coastal ecosystem in its entirety. To overcome this, reforestation should also be carried out in aquaculture territory (not just on empty land) by planting mangroves along the dykes and in some of the ponds. This concept is known as 'silvo-fishery', i.e. the combination of forestry through planting mangrove and fishery through the cultivation of shrimps or fish (see Figure 4-22).

4.5.7 Improving coordination among stakeholders

The poor coordination that prevails among stakeholders is in urgent need of improvement through better communication and information sharing. To do this, BRR should take the lead as both initiator and facilitator, by holding routine meetings that involve all the stakeholders and then distributing the results of each meeting to the various parties working in Aceh and Nias. For this purpose, BRR could be assisted by other institutions, such as the local environmental impact management agency (BAPEDALDA), the Forestry Agency and BP-DAS.

Furthermore, all the other stakeholders (including international donors and NGOs) should proactively coordinate their activities with BRR and inform the other parties, so that all can learn from one another. In this way, the development of each stakeholder's activities can be monitored and comprehensive data on their progress be made available. In addition, the stakeholders' activities will run better as a result of sharing experience and lessons.

4.5.8 The need for sustained tending, monitoring and evaluation

One of the keys to successful rehabilitation is the tending of the seedlings after they have been planted. The main tasks involved in tending include: replacement planting, pest and disease control, and weeding. If repeated replacement planting still results in failure, further enrichment should be discontinued. This is likely to occur when the substrate is unsuitable, for example as a result of tsunami deposits. Besides tending, both monitoring and evaluation need to be carried out.

BRR or government agencies should play a role in monitoring and evaluation so that all the activities carried out by all the various parties in Aceh are well looked after and properly documented. This step can also be an alternative way of solving problems when all the international NGOs and foreign donor agencies leave Indonesia.

4.5.9 The need for mangrove diversity

The current planting of mangroves in Aceh will, unawares, create a monoculture because almost all of the seedlings used are of only two species of a single genus, *Rhizophora*. Although these are local species, such homogeneity is not good for ecological balance.

For this reason, enrichment planting is essential. This can be done by planting other species of mangrove, such as *Avicennia* spp., *Bruguiera* spp. and *Ceriops* spp. on sites which suit each particular species. Thus the quality of the mangrove stand will improve along with its protective function and other benefits.

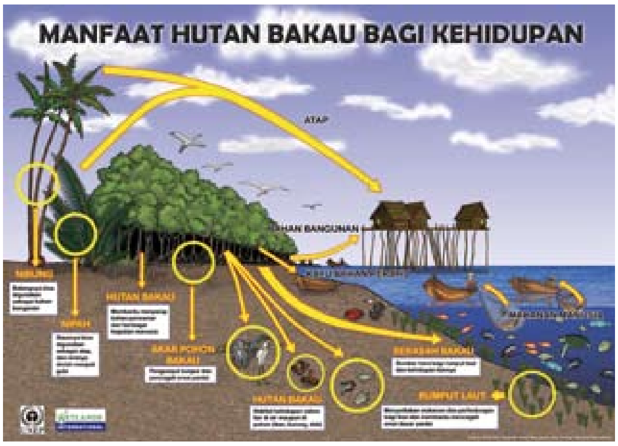
Figure 4.23. Incorrect planting strategy at Lhoong, Aceh Besar (from beach towards land), most of the sea pine seedlings (in wire cages) died from drought

4.5.10 Planting from the back of the beach towards the front

Beach vegetation should be planted starting from the land then moving towards the beach, so that the seedlings do not die as a result of inundation by sea water, nor wilt or die due to the hot sand substrate. In the field, however, it was frequently found that species such as casuarina and coconut had been planted starting from the sandy shore line then working inland. Perhaps this was done in the expectation that the shore line would quickly be protected from the action of the waves, but in fact many of these seedlings died from lack of water.

To improve the success rate further, planting should be done from the back (land) towards the beach, and should stop at the line where the sand is deep and there is no vegetation growing on it. The herb Katang-katang *Ipomoea pes-caprae* can be used as an indicator of where this line occurs.

Figure 4.24. Examples of environmental awareness posters



4.5.11 Improving awareness

Unless the community is environmentally aware, coastal rehabilitation runs a high risk of failure. One way of tackling this is through an environmental awareness campaign. This campaign can make use of a variety of methods, such as talks, discussions, documentary film shows, etc. It can include interactive events to attract the public, such as mangrove planting contests, environmental quiz competitions, etc., and the message can be consolidated through campaign materials like posters, leaflets, and billboards.

Environmental awareness must be instilled as early as possible in the community and must take into account the local culture and customs.

4.5.12 Exit strategies

Within the next few years, one by one the NGOs and donor agencies now working in Aceh will leave the province. At the end, only the residents and local government will remain. The withdrawal of the NGOs and donor agencies from Aceh will mean the end of their various programmes, the termination of employment they provided for local people, and the end of rehabilitation activities. This is certain to have a detrimental impact; there will be a large number of newly unemployed people, economic activity will decline, and there will be the question of the status of the activities that had been done (sustainability, maintenance, etc.).

As regards environmental rehabilitation, the end of the mission is certain to give rise to several problems for the future. One of these will be the abandonment of the mangroves and coastal vegetation planted; their status being unclear, there is a high risk that the rehabilitated sites could later be demolished.

For these reasons, measures are needed to prevent these problems from arising. These should be packaged together in an 'exit strategy' specifically designed to anticipate all the problems that could arise after the rehabilitation and reconstruction, when the donors and NGOs have left Aceh and Nias. Through this 'exit strategy' the negative impacts from the cessation of these activities can be eliminated, prevented, or reduced.

(Footnotes)

1 The Green Coast Project is a coastal rehabilitation programme which involves participation of the local community (facilitated by local NGOs), in which the community is given working capital (small grants) on the condition that they actively reforest the coast by planting mangrove and/or other species of coastal vegetation. This programme is coordinated by WI-IP with funding from Oxfam.

Further information

Further technical information may be obtained from the UNEP Post-Conflict Assessment Unit website at: http://postconflict.unep.ch/

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