3. Status of Coral Reefs in Indonesia After the December 2004 Tsunami

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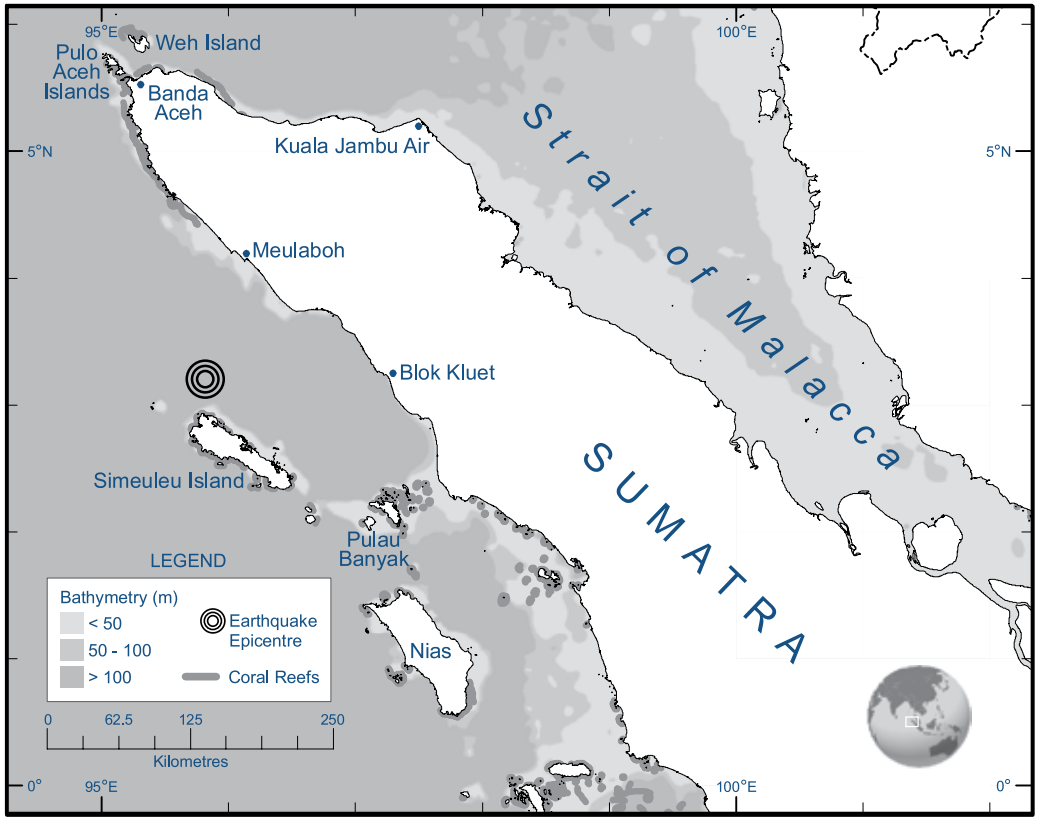
Summary

- The 2004 tsunami was the worst natural disaster in the history of Indonesia. More than 120,000 people died or are still missing; more than 500,000 people lost their homes; and more than 250,000 houses were destroyed or damaged; the total damage bill exceeds US$4.45 billion (approximately 97% of Aceh's GDP);
- Seawalls, flood control walls, irrigation canals and jetties have been severely affected with damage estimates in Aceh of US$72.1 million;
- The agriculture, aquaculture, fisheries and tourism sectors were seriously damaged, threatening food supplies and livelihoods. Fishing was the most important activity in the affected areas and 42,000 - 58,000 fishers and their families were affected, with the total damage estimated at US$52.0 million;
- Coral reef damage was assessed as 30% damage to 97,250 ha of reefs; damage varied greatly between sites, with some reefs structurally damaged by the earthquake while nearby reefs were minimally affected; most reefs showed moderate tsunami-related impacts and some reefs were entirely destroyed; and
- The most serious ongoing threats to the reefs are from debris washed into the ocean, and coastal pressures of over-fishing, pollution, and unsustainable development. Most reefs will eventually recover if not stressed further.

Introduction

The 2004 tsunami caused massive damage to Aceh Province, Northern Sumatra and killed more people and destroyed more property than any other event in the recorded history of Indonesia. The first waves struck Simeulue Island, 40 km from the epicentre, just minutes after the earthquake. The most damage on land was in nearby Aceh Province, with severe and widespread impacts found from Meulaboh to Banda Aceh, Aceh Besar and Aceh Jaya. Waves as high as 30 m hit the western and northern coasts of Sumatra, causing catastrophic damage to the coastline and its inhabitants. The tsunami wrapped around the island and waves flooded villages up to 500 m inland on the northeast coast of Sumatra. Flooding on the west coast reached at least 2 km inland and seawater surged as far as 6 km into rivers and estuaries.



The devastation in Indonesia was extensive: more than 120,000 people died or are still missing; more than 500,000 individuals were displaced from their homes and more than 250,000 houses were destroyed or damaged. Approximately 750,000 people were direct victims of the tsunami, but many more suffered indirectly by the loss of relatives, friends, livelihoods or other trauma. Estimates of the total damage exceeded US$4.45 billion (approximately 97% of Aceh's GDP) and economies in the affected regions are expected to shrink by approximately 14%, including $US1 billion in lost productivity.

Satellite images of the region show considerable changes to the coastline and sea bottom of surrounding waters. Seawalls, flood ways and jetties have been severely damaged. Damage to flood control and sea wall systems were estimated at $US72.1 million in Aceh alone. The loss of many beaches along the west coast will probably reduce the reproductive potential of hawksbill, leatherback and green turtles as these animals rely on these beaches for nesting. Two marine reserves, Pulau Weh Marine Reserve (3,900 ha) and Kapulauan Banyak Marine Recreation Area (227,500 ha), are located within the disaster zone, although detailed impact assessments on Indonesian MPAs have not been conducted.

The coral reefs and mangrove forests were also damaged during the tsunami. Direct and indirect damage to the coastline by the tsunami include solid waste runoff containing high concentrations of heavy metals, groundwater contamination and unstable coastal infrastructure.

The most serious ongoing threats to the coral reefs are from natural and man-made debris, such as vehicles, sediments, trees, coastal infrastructure, and other miscellaneous objects washed into the ocean. Approximately 5-7 million m^3 of debris accumulated in the affected areas and by mid-2005, it was estimated that 500,000 m^3 of mud and debris still covered the ground in Banda Aceh alone. The large amounts of remaining debris and sediment will continually abrade and smother the corals and prevent settlement of new coral larvae.

Status of Coral Reefs Pre-Tsunami

Many of the 17,500 islands in the Indonesian archipelago are surrounded by coral reefs. More than 590 hard coral species had been recorded prior to the tsunami, with many reefs containing more than 140 species. Coral reef monitoring has been coordinated by the Coral Reef Rehabilitation and Management Programme (COREMAP) since 1994 and they have established 648 permanent monitoring sites throughout Indonesia; almost double the 340 original sites. This program, together with international agencies including Reef Check throughout Indonesia, Project Wallacea in Wakatobi, The Nature Conservancy in Komodo, and WWF in Bali and Karimunjawa, stimulated local training and coordination across the archipelago.

Human impacts are the major causes of coral reef degradation in Indonesia. Coastal populations and development have increased pollution and deforestation, thus contributing to

AN EYEWITNESS ACCOUNT

"We lived on a river bend in the village of Lhoknga, Aceh and from our terrace we had a view through the trees of waves breaking on the offshore reef. Sunday morning, December 26, 2004, was sunny, with a light offshore and head high swell. At 8:00 am we felt the initial tremor and ran to the grass, well clear of trees, and crouched as the earthquake gained in intensity. The girls prayed to Allah, and their chanting grew faster as the power of the tremors increased. Then the tremors increased even more. The ground was rising and falling like a piston. After about 4 min, the earthquake slowed to a stop. My immediate thoughts were to get what we needed from the house between tremors before an even larger quake collapsed it. The tremors returned in bursts and we dodged in and out of the house, timing our runs between them. After about 20 min, we heard 3 loud, muffled booms coming from the ocean. This was accompanied by a roaring sound, like a high pitched jet plane. We ran towards the river to see through the trees and saw a 12 metre green wave with a lip of yellow foam rearing just off the reef near the river mouth. I knew that such a wave could easily wash over our property. The girls started screaming as the ocean began to push up the river with great streaks of yellow and white foam, rising rapidly up our 3 m embankment. We jumped in the car, and while my attention was focused ahead, my wife Nurma looked back to see Bebe, a 65 year old herbalist struggling up the road with her children and grand children around her. There was nothing we could do as the wave was only a couple of metres from them - they were seconds from death. There was nearly 80% loss of life in the kampungs (villages) of Monikuen and Weuraya with almost every house destroyed. Nothing was left except a few Casuarina trees stripped of their branches to the 10 m mark. My wife lost her mother, 2 brothers, and 30 members of her extended family" (from David Lines, wavelines@hotmail.com; full report on www.sifr.jcu.edu.au/ahb/dave.php).

The estimated damage and losses to the economy of indonesia illustrate the magnitude of the 26 December 2004 earthquake and tsunami (in US$ million, from BAPPENAS 2005).

	Total Impact			Property	
	Damage	**Losses**	**Total**	**Private**	**Public**
Social Sectors	1,674.9	65.8	1,740.7	1,440.6	300.1
Housing	1,398.3	38.8	1437.1	1408.4	28.7
Education	110.8	17.6	128.4	9.0	119.4
Health	82.5	9.4	91.9	23.2	68.6
Culture/Religion	83.4	-	83.4	-	83.4
Infrastructure	**636.0**	**240.8**	**876.8**	**325.9**	**550.8**
Transport	390.5	145.4	535.9	165.8	370.1
Communications	18.9	2.9	21.8	8.6	13.2
Energy	67.8	0.1	67.9	1.1	66.9
Water/sanitation	26.6	3.2	29.8	18.3	11.4
Flood control	132.1	89.1	221.2	132.1	89.1
Productive Sectors	**351.9**	**830.2**	**1,182.1**	**1,132.0**	**50.1**
Agriculture	83.9	140.9	224.8	194.7	29.9
Fisheries	101.5	409.4	510.9	508.5	2.5
Enterprises	166.6	280.0	446.6	428.9	17.7
Cross Sectoral	**257.6**	**394.4**	**652.0**	**562.9**	**89.1**
Environment	154.5	-	154.5	548.9	-
Governance	89.1	-	89.1	-	89.1
Bank/finance	14.0	-	14.0	14.0	-
Total Impact	**2,920.4**	**1,531.2**	**4,451.6**	**3,461.4**	**990.1**

sedimentation and pollution of the water discharging onto the coral reefs. Destructive fishing practices have also seriously damaged coral reefs, especially bomb and cyanide fishing which are widespread throughout Indonesia. The collection of fish for the live food fish and aquarium trades has resulted in significant damage which was clearly evident before the tsunami.

Several agencies are responsible for coral reef management: the State Minister for the Environment oversees environmental concerns; the Directorate General for Forest Protection and Nature Conservation, the Ministry of Environment, the Ministry of Forestry and the Ministry of Marine Affairs are all involved. Indonesia is currently implementing a decentralized Environmental and Natural Resources Management Programme to devolve responsibility for natural resources to regional and local governments.

Status of Coral Reefs Post-Tsunami

The initial assessment of coral reef damage by the Central Planning Agency BAPPENAS (Badan Perencanaan Pembangunan Nasional) estimated 30% damage to 97,250 ha of reefs at a net loss of US$332.4 million. Rapid assessments indicate that damage varied greatly between sites, although there was limited pre-tsunami coral reef information from northern Sumatra. Some reefs directly affected by the earthquake showed substantial mechanical damage, yet other reefs nearby were minimally affected. Most reefs showed moderate tsunami-related impacts and some reefs were entirely destroyed (see cover photograph).

Pulau Weh: The coral reefs surrounding Pulau Weh, just offshore from Banda Aceh, were less than 300 km from the earthquake epicentre. There were no significant changes to hard coral cover seen 100 days after the tsunami compared with 2003 surveys. The mean coral cover at 3 shallow water sites (< 2 metres) was approximately 43% in March 2003 and 47% in March 2005. Tsunami-related damage at other sites was patchy and directly linked to the sea bottom topography and shape and the structure of the reefs. Firmly attached corals on a solid base were largely unaffected by the tsunami with only occasional broken branches. Corals growing on loose sand or rubble suffered much greater damage, with many colonies overturned, buried or thrown across the reef. The increased sedimentation in some areas has caused some coral bleaching, probably due to decreased light levels. However, *Acropora* corals were still able to reproduce and these areas are expected to fully recover within a few years.

Further surveys at 15 sites around Pulau Weh in 2005 showed damage ranging from barely detectable breakage to severe impacts. The coral reef at Gapang Lagoon (also known as Lhok Weng Bay) was essentially destroyed and reduced to rubble, rock and detached mangrove trees. The sand in the lagoon was completely sucked out by the tsunami and washed into deeper water. Approximately 14 ha (60%) of mangrove forests fringing the bay were also destroyed. Almost 75% of the reefs near Iboih village were totally destroyed. There was a predictable pattern in the damage; shallow reef flats in bays or narrow channels suffered the greatest damage, while sites with a steep shoreline plunging into deep water were usually undamaged. More than 90% of the damage occurred at depths less than 10 m, and reefs sheltered from the open ocean were generally less affected. Lightly affected areas are expected to rapidly recover in a few years, although severely impacted sites (such as Gapang Lagoon) may take decades to fully recover.

Kuala Jambu Air: There was relatively little damage to this 10,000 ha estuary on the north coast of Sumatra which contains mangrove forests that support shrimp, crabs, fishes and many bird species. The forests are exploited for charcoal.

Blok Kluet: There was minor damage to the 200 ha of wetlands at Blok Kluet, 20 km south of Tapak Tuan. The wetlands include freshwater swamps and peat forests, and contain endangered fauna such as the Sumatran tiger, Muara crocodile, and hawksbill and leatherback turtles.

Simeulue Island: Although this island was heavily damaged by the tsunami, the local people retained traditional knowledge that allowed them to escape to higher ground immediately after the earthquake. The coastal wetland systems were in relatively good condition prior to the tsunami, and this added to the coastal protection. The coral reefs, seagrass beds and mangroves contain many endangered species, including 3 turtle species, dugong and many birds. While the eastern and southern coasts of Simeulue did not suffer major damage, the northwest coast

was heavily affected. The earthquake uplifted large areas of the reefs by 1-2 m above sea level, which killed the corals (see front cover). All the organisms on these exposed reefs are still in place, but have been bleached by the sun. Some large colonies of *Porites* were broken off and rolled ashore. The situation was similar on the northern island of Salaut Kecil, where the whole bedrock platform was uplifted and exposed, and there are numerous cracks in the platform caused by the earthquake. The submerged parts of the coral reefs remain alive, although many corals show mechanical damage and signs of disease. The branching *Acropora* corals were most affected, whereas the encrusting and massive growth forms (*Porites*, *Goniastrea*) appear to be intact. Many coral colonies were partially buried by sediments, and now have dead areas. This is particularly evident in reefs in front of rice paddies, where the tsunami penetrated more than 1 km inland and the backwash carried mud to the sea, which smothered the corals and made the water particularly turbid.

Pulo Aceh Islands: Previous bomb fishing had severely damaged the coral reefs of this group (Breueh, Nasi, Teunom, Batee, and several small islands), which stimulated the government to designate the Aceh Besar district as a conservation area. The tsunami seriously damaged the Pulo Aceh islands: coconut trees were uprooted; turtle nesting beaches completely destroyed; and seagrass beds were seriously damaged which may affect the dugongs in the future.

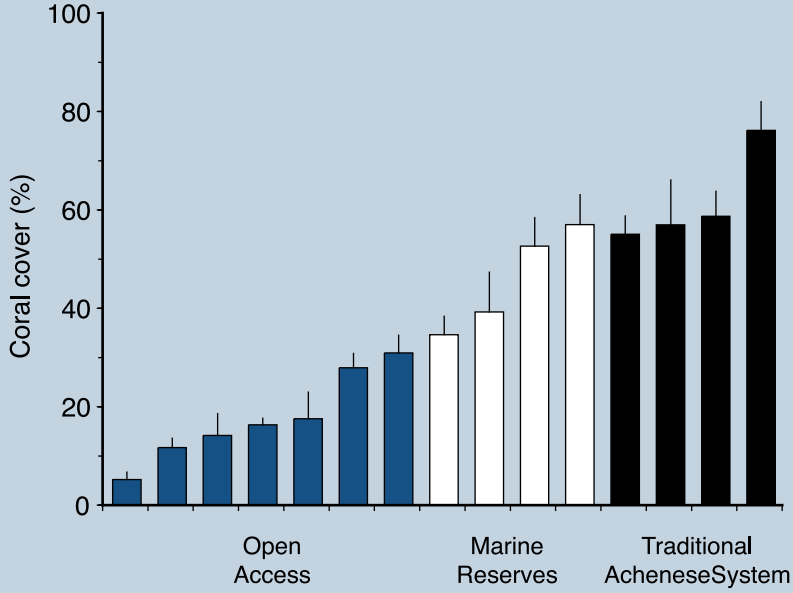
Impact on fish communities: The ratio of coral eating to algal eating fish changed at Simeulue Island, as a result of heavy siltation and mechanical damage to the corals (e.g. Langi Bay). The scarcity of coral eating fish (*Chaetodon trifasciatus, C. trifascialis, C. triangulum, C. ornatissimus, C. meyeri*) may be a direct consequence of the loss of corals. Now many algal eating fish (Acanthuridae, Scaridae and Siganidae) are grazing the green algae on rubble and dead coral. A good sign for the future is that there are many juvenile fish (70% of algal eaters and 80% of coral eaters are juveniles) in the sites most affected by siltation.

Seagrass damage: There are few data on the status of Indonesian seagrass beds either before or after the tsunami. There are significant seagrass beds around the Aceh Besar Island Group (Pulo Aceh), Weh Island group, Simeulue Island group and the Pulau Banyak group. Most damage to the seagrass beds was probably caused by the reverse currents which dragged large quantities of debris and sediment into the ocean, smothering or eroding significant areas of seagrass. BAPPENAS estimated a loss of approximately 600 ha, equivalent to a net economic loss of US$2.3 million. Based on the location of the islands and the damage caused by the tsunami on land, all of the seagrass beds around Pulo Aceh Islands and half of those around the Simeulue and Weh Islands are thought to have been destroyed.

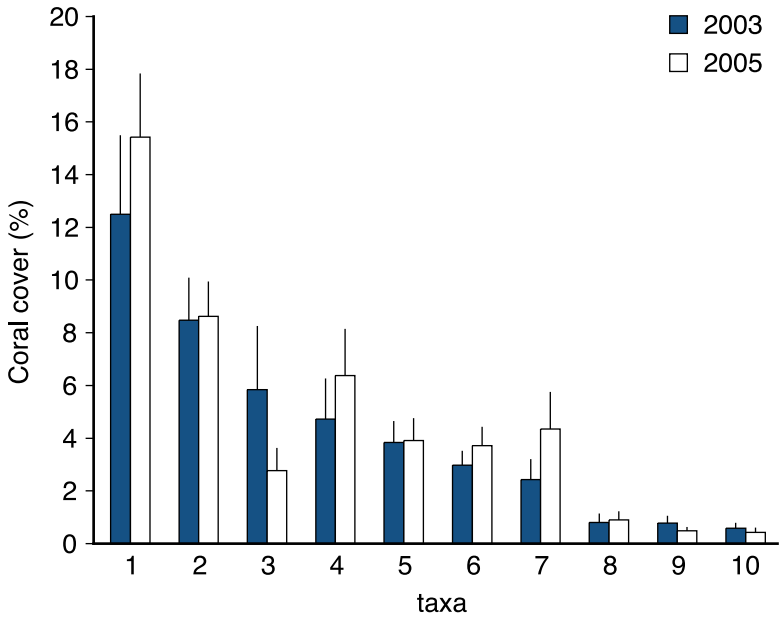
Mangrove damage: Only 10% of the 345,000 ha of mangrove forests in Aceh (predominantly on Simeulue Island) remain in good condition. Large areas of mangrove forests around Aceh were in serious decline prior to the 2004 tsunami, with estimates in 2000 indicating that more than 25,000 ha had been damaged, mostly due to increased coastal development. There are currently few data on the impact of the tsunami on Indonesian mangroves, but reports from residents and humanitarian organisations estimate that damage was localised to a few areas.

WERE HUMAN IMPACTS WORSE THAN THE TSUNAMI?

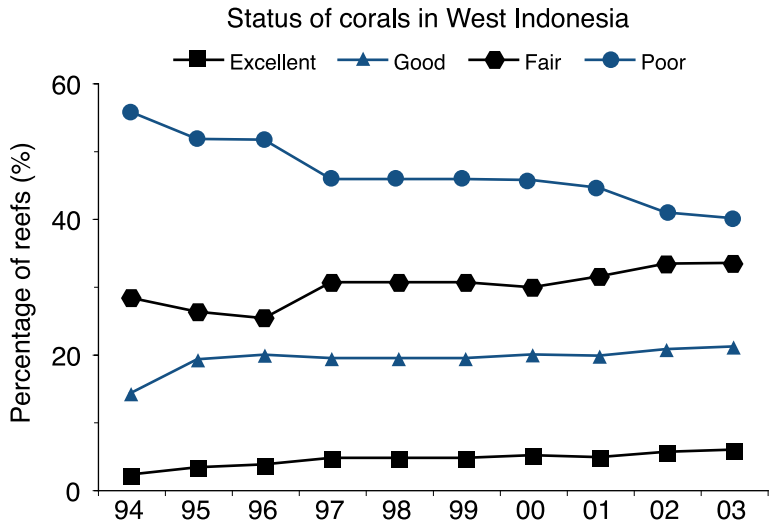
Although the Sumatra-Andaman tsunami was one of the greatest natural disasters in recorded history, the damage to corals on the northwest coast of Aceh, Indonesia was surprisingly limited, although some small areas were devastated. Prior reef condition varied widely within the region and was clearly correlated with human activities. The cover of live coral was high where fishing had been controlled, whereas there was low coral cover and high algal cover on reefs where there was considerable destructive fishing e.g. with bombs. The shift from coral dominated reefs to ones that are dominated by algae may be exacerbated by the tsunami because of an influx of sediments and nutrients. However, it appears that chronic human misuse has been more destructive to reefs in Aceh than this rare natural disturbance. The strength and height of the tsunami was so great that the waves washed straight over the reefs and the prior human damage to the reefs had no effect on the magnitude of damage on land (from Andrew Baird, andrew.baird@jcu.edu.au).



The influence of human activities on hard coral cover is clearly illustrated at these sites (measured on 8 replicate 10 m line transects from 0.5 to 2 m at 15 sites on Pulau Weh and Pulau Aceh in early 2005). The 'open access' sites had significantly lower coral cover due to destructive and damaging fishing than sites in 'marine reserves'. The sites managed under the traditional 'Acehnese system' of management had the highest coral cover.



The shallow hard coral communities in Aceh did not change significantly as a result of the tsunami. Bars are the mean percent cover of 5 morphological categories of Acropora (1 = table; 2 = finger like; 3 = branching; 4 = branching tables; 8 = corymbose), and 5 taxonomic groups of other hard corals (5 = Montipora; 6 = Faviidae; 7 = Porites; 9 = other Scleractinia; 10 = Pocilloporidae) on 8 replicate 10 m line intercept transects recorded at less than 2 m depth (from Andrew Baird).



These data on the status of West Indonesian coral reefs from the COREMAP project illustrate that there has been a slight improvement in coral cover over the last decade with improvement in the 'Excellent' and 'Good' categories (high and medium coral cover respectively). Most reefs, however, remain heavily degraded despite this slight improvement (from www.coremap.or.id/).

These estimates of mangrove damage in Indonesia due to the tsunami demonstrate that these forests absorbed a large amount of the wave force, possibly protecting infrastructure and people inshore (from WIIP 2005).

Area	Mangroves damaged (%)	Area of damaged mangroves (ha)
Aceh Besar	100	26,823
Banda Aceh	100	< 500
Pidie	75	17,000
Aceh Utara / Bireun	30	26,000
Aceh Barat	50	14,000

Socio-Economic Damage

Entire villages and communities along the west coast of Sumatra were destroyed with widespread associated damage to social and economic systems. The remoteness of many affected areas made assessments difficult, but the post-tsunami socio-economic impacts are now well documented. Survivors, government agencies, and international NGOs are working to address and rehabilitate the social and ecological systems damaged by the tsunami. The economic sectors most affected by the tsunami were aquaculture, fishing and small enterprises, such as rice cultivation. Aquaculture and rice cultivation were severely affected by damage to canal systems, pond dykes, contamination and flooding by salt water. Most of the damage to fisheries infrastructure was loss and damage to fishing boats, equipment and harbour facilities.

Agriculture: Vast areas of low lying and cultivated land remained completely submerged in seawater for months after the tsunami, with more than 40,000 ha of rice and other irrigated crops damaged. More than 80,000 wells will need to be repaired or replaced and the total irrigation infrastructure damage in Aceh Province was US$37.9 million. The FAO is providing seeds, fertilizers and tractors to 8,900 people to help restore food security and livelihoods amongst tsunami-affected farmers and other vulnerable groups.

Aquaculture: Aquaculture in Aceh Province formerly produced 20,000 tonnes of shrimp and fish annually. Tsunami damage to this sector has been estimated at US$51 million with an additional US$8 million damage to hatcheries and government facilities. Approximately 1,000 fish cage farms in Northern Sumatra were destroyed and 27,000 - 48,000 ha of aquaculture ponds in Aceh were seriously damaged, with most of the damage in Banda Aceh, Aceh Besar, Pidie, Aceh Barat, Aceh Jaya, Nagan Raya and Simeulue. The depth of existing ponds has been reduced due to sediment accumulation. Aceh provided a substantial proportion of the wild caught shrimp larvae (*Penaeus monodon)* for hatcheries; it is unclear what impact these losses will have on Indonesian shrimp farms. It will take 6-12 months to repair the ponds, with production expected to begin 2 years later.

Fisheries: The total damage to the fisheries sector was estimated at US$52.0 million; 65-70% of Aceh's small-scale fishing fleet was destroyed. Fishing was the main economic activity in the affected areas for 42,000 - 58,000 fishers and their families. There is also a major industry in Aceh in building boats for fishermen. France is funding trawler repairs and USAID is providing grants to build ice factories. Despite these successes, most fishermen have not returned to work, either because they still lack boats or because they are housed in displaced persons camps, which are too far from the ocean to allow them to resume fishing.

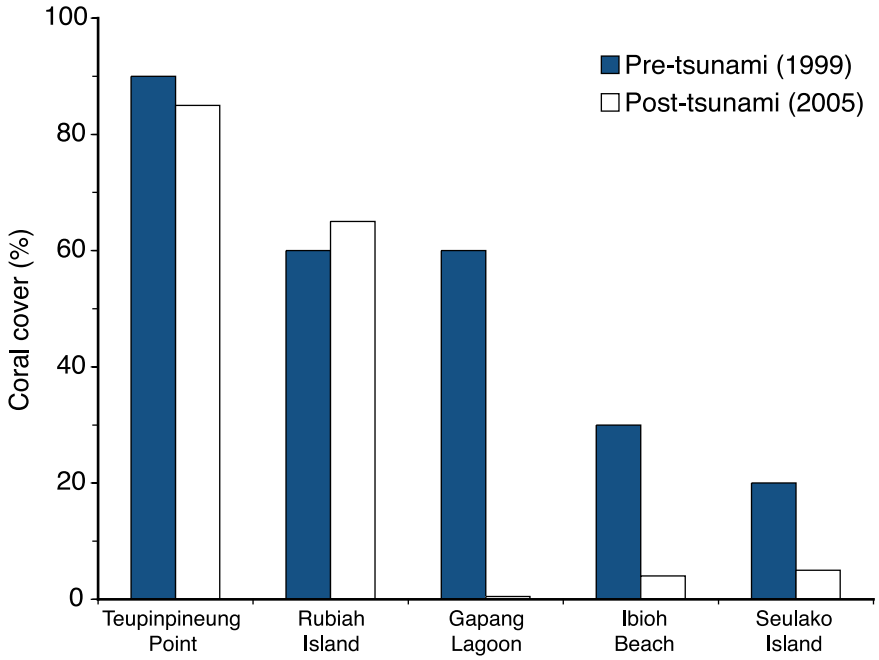
Tourism: The tourism industry in Aceh was not large; the hotel and restaurant sector contributed only 6.3% of the regional GDP. The businesses in the affected areas, however, have been destroyed and significant assistance is required to rehabilitate the industry.

Rehabilitation and Recovery Efforts

The massive devastation in Aceh Province provoked an urgent international response: more than 100 international NGOs and donors, 430 local NGOs and various government and intergovernmental agencies started rehabilitation and recovery. For example, the Government of Australia has promised US$800 million in assistance to Indonesia for rehabilitation.

Government activities: BAPPENAS has formed a unit for Aceh to coordinate the large amount of national and international assistance for rehabilitation and reconstruction. The Ministry of Environment is analysing problems related to pollution, water quality and damage to coastal resources and the Forestry Department is rehabilitating coastal forests and protecting the remaining forests from damaging human activities and harvesting for rebuilding materials.

Non-governmental activities: WWF is developing Green Reconstruction Guidelines for Aceh and is working with other NGOs to ship sustainably grown timber to the region for rebuilding. USAID is focusing on returning communities to their villages by rebuilding, and providing technical assistance for governance and reconciliation. Major projects include rebuilding more than 240 km of road, 110 bridges, numerous schools, a teacher training centre at Banda Aceh University, markets and sanitation systems. Approximately 200,000 people will also benefit from efforts to stimulate local economies by the provision of business loans and work-for-food programs.



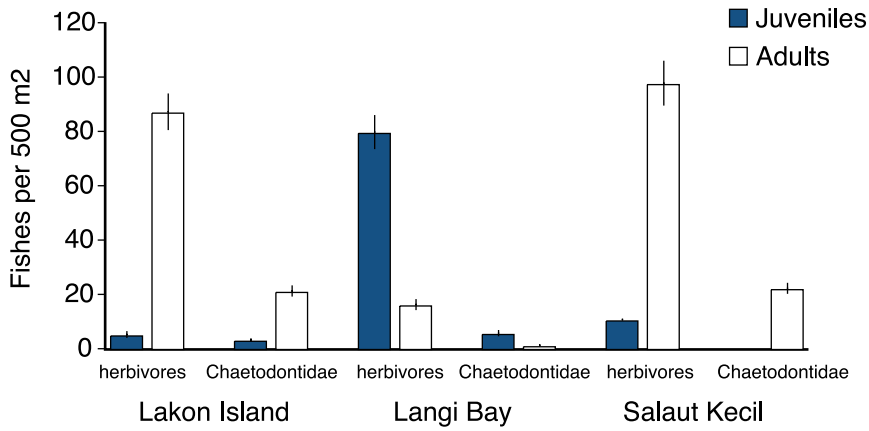
Coral cover before and after the tsunami varied greatly between sites at Weh Island. Coral reefs located in bays or channels between islands were most severely damaged (from Allen and Erdmann 2005).

CONSERVATION ORGANISATIONS TEAM UP TO ASSESS CORAL REEFS

A two-week survey of more than 660 kilometres of Aceh's southwest coast by the Khaled bin Sultan Living Oceans Foundation, Reef Check and IUCN - The World Conservation Union suggests that sedimentation (exacerbated by the tsunami), overfishing, and the use of destructive fishing methods may represent a greater threat to Aceh's reef ecosystems than the immediate impacts of the earthquakes and tsunami. A multinational team of 7 scientists and 3 support crew covered the area affected by the earthquakes and tsunami. Using the globally-standardised Reef Check protocol, the team recorded food fish sizes and abundance, as well as mobile and attached invertebrates including corals. A special survey was carried out to detect newly settled corals as a measure of recovery. There was relatively minor physical damage to coral reefs caused by the tsunami as compared with the well-documented devastation experienced on land. Tsunami damage included overturned corals and swathes of broken corals where large tree branches and tree trunks had been washed across the reef as the waves receded. Even in areas where severe tsunami damage was recorded, there were still large areas of intact, living coral reef present nearby. These areas may act as an important source of larvae for recolonisation of the damaged reefs. However, only 18 new coral recruits were recorded, with 15 in the Banyak Island group, on 5,280 quadrats surveyed for recruits. This low density of coral recruits indicates that recovery is proceeding very slowly and a longer-term, more insidious type of reef damage could occur if the observed turbidity and sedimentation continue. In addition to inhibiting coral settlement, sedimentation can directly injure and kill adult corals. A low abundance and small mean size of the 10 primary food fish families in Aceh was recorded suggesting that stocks of these fish are over-fished. There were many juveniles but very few large adult fish were seen. Evidence of destructive fishing practices was common. The earthquakes and tsunami have left the Acehenese more dependent than ever on their marine resources for survival. Coral reefs can recover relatively quickly following a reduction in fishing pressure. There is now an opportunity to invest in a long-term strategy to rehabilitate the marine resources of Aceh through education, coastal management, regular monitoring and the establishment and maintenance of marine protected areas (from Craig Shuman and Greg Hodgson, rcinfo@reefcheck.org; Foster et al. 2006).

Conclusions and Recommendations

One year after the tsunami, Indonesia is in transition from short-term relief efforts towards long-term recovery of livelihoods, communities and economies. However, the same pre-tsunami threats to the coastal environment remain and should be addressed to accelerate recovery. Large human pressures that previously degraded Indonesian coral reefs and their associated resources still remain. The international support provides an opportunity to reduce the ongoing coastal pressures of over-fishing, poor water quality, and inappropriate development, and thus increase the health and resilience of Indonesian coral reefs. Financial resources should be focused on the root causes of persistent degradation of Indonesian coral reefs, rather than being diverted into short-term projects. The focus should be on the long-term, large-scale rehabilitation of coral reefs to ensure that these resources, and the communities reliant upon



The numbers of herbivore (Acanthuridae, Scaridae, Siganidae) and corallivore fishes (Chaetodontidae) per 500 m² (average ± SE) at 2 sites on northern Simeulue and in Salaut Kecil show that there are many more juvenile fishes (white bars) than adults (black bars) at most sites (from Giorgio Bavestrello).

them, are sustained through time. The following recommendations are proposed to address these ongoing threats and stimulate recovery after the tsunami disaster:

- reconstruction materials such as timber, rock and sand should be drawn from sustainable sources and not from local protected forests and reef areas;
- there should be increased monitoring and prevention of destructive fishing practices to facilitate reef recovery;
- vulnerability mapping of coastal areas is needed to assist resources managers determine which are the most hazardous areas and designate these as exclusion zones for development;
- communities should be involved in rehabilitation decision making and in policy and legislation development to assist in the successful recovery of coastal resources;
- fishing communities should be advised on sustainable fishing practices and provided with economic incentives to reduce illegal and damaging activities;
- more emphasis would be appropriate on improving legislation to protect coral reefs and improving MPA design to ensure better coral reef protection, preferably within an expanding network of MPAs; and
- the development of stronger community and government partnerships will improve coral reef monitoring, data management systems and conservation of coral reefs with better sharing of information to improve awareness within communities of the need for resource conservation.

Reviewers

Karenne Tun, Kristian Teleki and Joanna Ruxton.

Acknowledgements

Data and information for this report were drawn from various internet pages such as:
The New England Aquarium (2005), (www.neaq.org/temp/tsunami_report.pdf); FAO (2005),

DID THE TSUNAMI AID CROPS IN INDONESIA?

From atop a coconut tree where he fled to escape the onrushing water, Muhammad Yacob watched the tsunami turn his rice paddy into a briny, debris-strewn swamp; but 9 months later, they are harvesting their best-ever crop. They initially feared that salt water had poisoned the land. "The sea water turned out to be a great fertilizer, and we are looking at yields twice as high as last year" said Yacob, 66. Rice is the staple food and is not the only crop thriving on tsunami-affected land in Aceh. Farmers say vegetables, peanuts and fruit are also growing well, spurring hopes that agriculture will recover faster than expected. But bumper harvests for some are misleading; UN surveys indicate that 81% of the agricultural land damaged by tsunami in Indonesia, Sri Lanka, Maldives, India and Thailand is again cultivable. However, much fertile land remains contaminated with seawater or marine sand. Recovery in the worst-hit areas may take 3 - 5 years. The tsunami and mud have destroyed or clogged countless drainage systems, and there are few people left to clear the land and replant. Yacob, a father of 8, has received no tsunami aid from the government, and points to a rusting threshing machine, mangled by the tsunami. He lost 1,000 cocoa plants and has no money for seedlings. The preliminary estimates were that half of the land would be lost, but now fields of lush, green rice paint a more optimistic picture. High rainfall in most Indian Ocean countries washed the salt out more quickly than expected and the higher yields may be due to new, rich top soil and compost dumped by the tsunami. The rice harvest is helping to restore some of the pre-tsunami rhythms of life to the countryside, which is still littered with damaged buildings and tent camps housing tens of thousands of survivors. The UN World Food Program expects to be feeding 750,000 tsunami victims well into 2006, and life remains tough even for farmers with good crops. Sur Salami has never grown corn so high, but any heavy rain combined with a high tide, will flood half of his land. The earthquake dropped his land bringing the sea 50 m closer to his fields. "But we cannot lose hope. Whom can I complain to?" (from Chris Brummitt, Associated Press).

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