Rapid Assessment of Tsunami Damage to Coral Reefs in Sri Lanka

Interim Report No. 1

20 January 2005

NARA, CORDIO/IUCN/GCRMN, SLSAC

Participating organizations and programmes

NARA	**National Aquatic Resources Research and Development Agency**
CORDIO	**Coral Reef Degradation in the Indian Ocean**
IUCN	**The World Conservation Union**
GCRMN	**Global Coral Reef Monitoring Network**
SLSAC	**Sri Lanka Sub-Aqua Club**

List of participants

Arjan Rajasuriya	NARA
Chaminda Karunarathna	NARA
Jerker Tamelander	CORDIO/IUCN/GCRMN
Nishan Perera	SLSAC
Malik Fernando	SLSAC

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Cover		Arjan Rajasuriya
Figure 1	(a,b)	Arjan Rajasuriya
Figure 3	(a)	Arjan Rajasuriya
	(b,c)	Jerker Tamelander
	(d,e)	Arjan Rajasuriya
	(f,g)	Nishan Perera

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This report was produced jointly by NARA[1], CORDIO/IUCN/GCRMN[2], and SLSAC[3]
1. National Aquatic Resources Research and Development Agency, Colombo 15, Sri Lanka
2. CORDIO/IUCN Regional Marine Programme, 53 Horton Place, Colombo 7 Sri Lanka
3. Sri Lanka Sub Aqua Club, Colombo 7, Sri Lanka

Summary

Coral reefs at five sites in south and southwest and one site in the east of Sri Lanka were surveyed. Impact of the tsunami was highly varied, and the areas range from almost unaffected to extremely damaged. Almost total destruction of a reef was seen at Dutch Bay off Trincomalee town in eastern Sri Lanka. Most damage observed was mechanical, with breakage of fragile corals, notably *Acropora* and *Montipora* spp., and larger massive colonies toppling over. Impact on fish population seems correlated with reef damage, most likely due to loss of fish habitat. The impact on larger reef fish species such as groupers (Serranidae), snappers (Lujanidae), sweetlips (Haemulidae), emperors (Lethrinidae) seemed low whilst smaller reef dwelling species such as damselfish (Pomacentridae), butterflyfish (Chaetodontidae), gobies (Gobiidae) and wrasses (Labridae) seemed high in damaged areas. A negative impact on the marine aquarium fishery can be expected as a result of a reduction in the populations of smaller reef dwelling species and loss of habitats. Some smothering has been observed, but it appears primarily from resuspended marine sediments rather than terrigenous matter. Litter and debris were abundant, although it is expected a lot of the debris from land has actually been washed further out than the near-shore shallow reefs visited. Much of the rubble formed after the coral mass mortality in 1998 has shifted and in some locations had damaged live corals. Damage to seagrass beds was minor and where present mostly due to shifting rubble. Hardly any uprooting was observed. Severe beach erosion was observed both in the east and southwest, but impact was patchy. Severe damage on the coast was observed where coral mining in the sea has been rampant. While there are signs of absorbed impact and less damage in healthier vegetation and less disturbed ecosystems, more information on how the tsunami has been shaped, deflected, weakened or focused by bathymetry and shore profile is essential to draw more detailed conclusions.

Methodology

A method detailed in the document "Tsunami Damage to Coral Reefs – Guidelines for Rapid Assessment and Monitoring" has been developed for ICRI and ISRS by a contact group comprising of the GCRMN, CORDIO, Reefbase Reefcheck and IUCN networks and individual reef scientists. It combines standard coral reef assessment techniques (e.g. English et al.1997) adapted to the needs of the situation. The method covers broad areas, assessing main benthic cover categories, sources and intensity of damage and other conditions.

Additional protocols have been borrowed from Technical Manual for Post-disaster Rapid Environmental Assessment (Ecoengineering Caribbean Limited 2003), particularly for coastal ecosystems other than coral reefs. This method classifies various damages by intensity and spatial extent.

Sites

Southern and Southwestern Sri Lanka: Kapparatota/Weligama, Polhena, Unawatuna, Hikkaduwa, Rumassala.

With the exception of Rumassala all sites are shallow inner fringing coral reefs with a crest depth of less than one meter, a narrow shallow lagoon on the landward side and an outer slope down to c 10m. Rumassala is sheltered behind a rocky headland with a lower wave energy regime. The coral community is mostly on limestone and rock habitats (Rajasuriya, et al 1995).

Prior to 1998 all sites except Unawatuna were dominated by branching *Acropora* and foliose *Montipora* species. Unawatuna had large stands of tabulate *Acropora* as well as *Pocillopora*. Massive corals were also common. All sites were severely affected by the coral bleaching and mortality in 1998, which has left the areas with a relatively low coral cover and large amounts of loose rubble.

Recovery of corals after the bleaching event varied among the southern and southwestern reefs. At Kapparatota/Weligama there was rapid growth of branching *Acropora* and increased colonization by *Montipora* that had survived the bleaching. There was little recovery at Polhena and Unawatuna. At Rumassala there was rapid recolonization by *Porites rus* and *Pocillopora damicornis*. At Hikkaduwa, foliose *Montipora* has begun to recolonize much of the reef that was previously dominated by branching *Acropora* species (Rajasuriya 2002).

Northeastern Sri Lanka: Dutch Bay, Trincomalee

There are scattered coral reef patches along the eastern coast, including around Trincomalee town and Pigeon Island and Coral Island at Nilaveli, 15 km further north. All of these reefs were dominated by branching *Acropora* and foliose *Montipora* species. *Pocillopora* species, *Porites* and massive Favids were also common on all of the reef habitats. Coral reefs dominated by *Porites* and other massive species (Mussidae, Caryophyllidae) are present within the Trincomalee Bay (harbour area). However, this area was not surveyed due to access restrictions imposed by the Sri Lanka Navy.

Rough seas due to the northeast monsoon prevented reef assessments at all eastern sites except Dutch Bay. Prior to the tsunami Dutch Bay had a coral cover of about 50%, mostly made up of branching *Acropora* and foliose *Montipora*, and interspersed with massive Faviids and Poritid colonies.

Resources use

Fishing pressure and other, often destructive, resource extraction is high at all sites, with the exception of Hikkaduwa, which is a Marine Protected Area (Hikkaduwa National Park). Urban and coastal development has to a varying degree impacted on all of the sites. In Trincomalee the main stresses are fishing, including destructive fishing practices such as blast fishing and the use of bottom set nets.

Results and Observations

Southern and Southwestern Reefs

- Most damage observed was mechanical, caused by rubble movement and breakage, as well as boats or pieces of debris scouring the reef.
- Damage was very patchy, with scars ranging from less than one to several meters across, but many times far apart. Where damage was observed it was frequently quite severe, e.g. blocks of over 1 meter across turned over (mostly large colonies killed in during the 1998 coral bleaching event).
- Damage to reefs frequently seemed uncorrelated with damage on land. For example, in Weligama, where the beach had visibly shifted, with plenty of erosion and high impact on infrastructure and vegetation 500m inland, large stands of undamaged *Montipora* were present less than half a meter under the water surface.
- Some large areas of *Acropora* have been overrun by rubble and suffered a lot of breakage.
- Many live branching and massive coral colonies (up to c. 50 cm) have been turned over.
- Large quantities of rubble formed after the mass mortality in 1998 has shifted, sometimes forming very large heaps and covering reef biota.
- Seagrasses, while found only to a limited extent in the areas visited, seemed almost undamaged. Some areas had been covered by moving coral rubble.
- Virtually no smothering from terrigenous sediment was recorded, and turbidity was within normal limits.
- Corals within reef lagoons at Polhena, Kapparatota/Weligama, Unwatuna and Hikkaduwa have been buried due to sand accumulation.
- Large quantities of debris were observed especially at Unawatuna and Hikkaduwa, mainly textiles, tree branches and logs, parts of boats, and household items. However, no area was extremely affected and impact was mostly low to moderate. It is possible the amount of water leaving land after the tsunami has carried a lot of debris beyond the shallow reefs near to the shore.
- The fish populations in many sites depleted by overexploitation, showed varying levels of impact. In some instances habitat destruction has led to reduced abundances, particularly species associated with coral substrates such as damselfish, butterflyfish gobies and wrasses.

- Initial observations of beaches and adjacent land in the southwestern parts of Sri Lanka (Seenigama, Telwatte, Peraliya) indicate worse damage on land where reefs have been mined for coral lime. Although illegal this practice is rampant.

a)  b) 

b) **Figure 1.** (a & b) Overturned coral and tree trunks underwater at Unawatuna

Eastern Reefs – Dutch Bay, Trincomalee

- Extreme mechanical damage, with nearly half of the coral reef area ripped off, including the reef base (limestone substrate) in some places, turning the reef into fields of rubble and sand. Three quarter or more of the remainder has also been severely damaged.
- The severely damaged areas have been covered by a layer of sediment and sand.
- Large coral blocks and dead coral have been moved over the reef, tearing off the live coral and also the reef base. The southern reef margin has been restructured and severely eroded.
- Granite rocks and boulders 20-50 cm in diameter have been shifted, particularly around a rock patch near the shore.
- Virtually all remaining live corals had been damaged, and many *Acropora* colonies have been sheared. Among standing thickets most branches were loose and moved with the swell. Many table corals had been uprooted and toppled over.
- Many massive coral colonies have been toppled, including some *Porites* domes over 2m in diameter, and many colonies of c 50 cm have shifted large distances.
- A lot of broken branches of live coral are being abraded in moving rubble beds. Many coral colonies were partially or entirely buried in rubble and sand.
- There were also signs of paling and bleaching in remaining massive colonies, most notably *Goniastrea* sp., *Porites* sp. and *Favia* sp. This may be caused by sediment stress and abrasion.
- Many soft corals were found ripped off the reef substrate and with severe tissue damage.
- There was very little evidence of terrigenous litter, debris and sediment.
- Figure 2 compares major benthic cover categories at Dutch Bay in 2003 and 2005. Figure 3 illustrates the change in reef coral cover and structure.

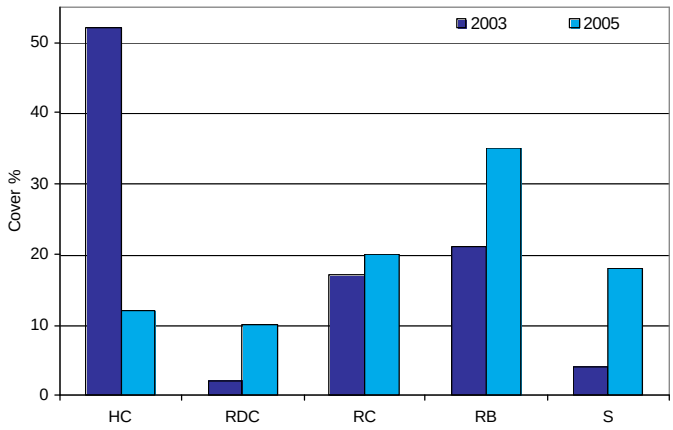


Figure 2. Benthic cover at Dutch Bay, Trincomalee, in 2003 and 2005 (HC Live Coral; RDC Recently Dead Coral; RC Bare substrate with or without algal turfs; RB Rubble; S Sand).

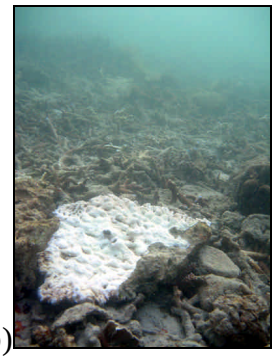
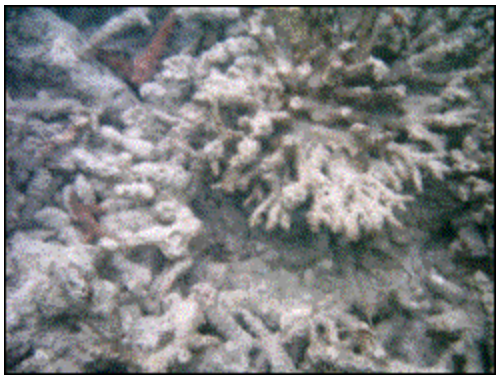
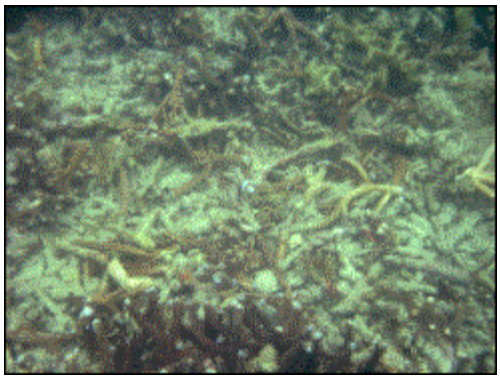
a)  b)  c) 

Figure 3. The healthy coral reef at Dutch Bay, Trincomalee in 2003 (a). Bleached and overturned corals, Trincomalee (b and c) 2005.

d)  e) 

Lianas and other debris on live coral, Trincomalee (d). Large corals have been shifted causing extensive damage to the reef, Trincomalee (e).

f)  g) 

Corals covered in sediment and sand, Trincomalee (f). Sheared and broken corals, Trincomalee (g).

Table 1 outlines the mechanical damage sustained by coral reefs as well as impacts on fish community. High levels of extraneous matter on the reefs was recorded only at Unawatuna and Hikkaduwa, and the same sites, together with Dutch Bay, also exhibited high levels of smothering. Other sites exhibited mostly low and in some cases moderate levels of extraneous matter and smothering

Table 1. Damage to coral reef and fish community caused by the tsunami on 26 December 2004 (damage categories, relative scale: None 0; Low 0 to 0.1; Moderate 0.1 to 0.25; High 0.25 to 0.66; Extreme 0.66 to 1.0).

		Mechanical Damage		**Fish Community**	
Site	**Area**	**Intensity**	**Spatial Extent**	**Impact**	**Comments**
Polhena	S	Moderate	Moderate	Moderate-High	Mainly loss of small reef fishes (e.g. damsels, butterflyfish and wrasse) where the reef substrate and habitat have been lost
Kapparatota/ Weligama	S	High	Moderate	Moderate	Loss of fish life was evident where there was severe damage to coral patches. The site was degraded by over and destructive exploitation of resources, compounded by bleaching in 1998.
Hikkaduwa	SW	High	Moderate	Low	Fish life seems relatively unaffected but some habitat destruction was observed. The site, an MPA, had the most abundant populations of larger fish species such as sweetlips, rabbitfish and parrotfish both before and after the tsunami. Butterfly fish and damselfish populations were already low after the bleaching in 1998
Rumassala	SW	None	None	None	Adverse impacts due to the tsunami cannot be seen but damage due to blast fishing was evident. Fish life was reduced after the bleaching event and ongoing blast fishing continues to reduce fish populations
Unawatuna	SW	High	High	High	Most groups, in particular surgeon fishes and damsel fishes have been reduced. While a lot of the fish on this reef was lost with the coral during the 1998 bleaching, there is a further reduction as a result of the tsunami

Dutch Bay	E	Extreme	Extreme	High-Extreme	Fish life reduced drastically due to extreme reef damage caused by the tsunami, especially damselfish, butterfly fish, gobies wrasses etc.

Beaches

Several beaches experienced loss of width as well as significant sand migration, most notably Unawatuna in the southwest and Gopalapuram/Nilaveli in the east (see Table 2). The latter had lost at least 30 meters in width over a long stretch of beach, and much sand had been swept away from among buildings and beach vegetation, causing coconut palms to fall and buildings to collapse.

Change in beach composition was low in all areas in the southwest, and moderate to high on all beaches visited in the Trincomalee area. This was mostly caused by rubble washed ashore. Some moderate contamination of beaches was seen at Unawatuna, Hikkaduwa and Polhena, mostly due to sewage from land, broken toilet pits etc. Littering was moderate to high in all areas, with a combination of both man-made artifacts such as pieces of boats, furniture, machinery, building materials etc, and plant materials.

Table 2. Damage to sandy beaches caused by the tsunami 26 December 2004 (damage categories, relative scale: None 0; Low 0 to 0.1; Moderate 0.1 to 0.25; High 0.25 to 0.66; Extreme 0.66 to 1.0).

Site	Area	Loss of beach width	Sand Migration
Polhena	S	High	High
Kapparatota/Weligama	S	Moderate-High	High
Hikkaduwa	SW	Low-Moderate	Moderate-High
Rumassala	SW	Low	Low
Unawatuna	SW	Extreme	High
Clappenberg Bay	E	None	Low
Cod Bay	E	Low-Moderate	Unknown
Dutch Bay	E	Moderate-High	Moderate-Low
Erakkandy	E	Moderate-High	Moderate-High
Gopalapuram/Nilaveli	E	Extreme	Moderate-High
Uppuveli	E	High	High

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