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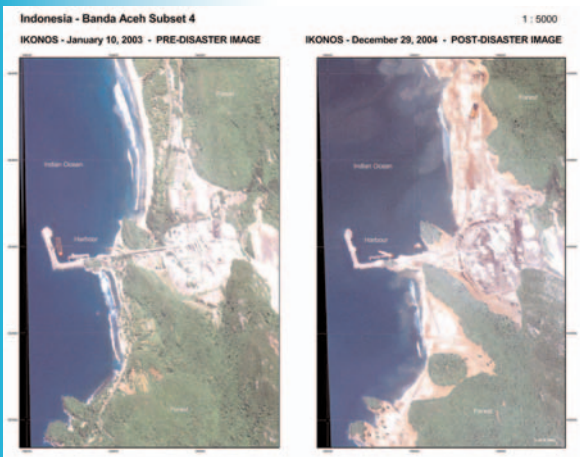
Coral Reef Targeted Research & Capacity Building for Management

ADVISORY BRIEF

Reef restoration following the Asian tsunami tragedy

Recommendations

In the short-term the primary concern in Indonesia, Thailand, Sri Lanka, India, Maldives and other affected nations is the human toll, the health and sustenance of survivors, and the rebuilding of livelihoods for those coastal communities devastated by the 26 December 2004 tsunamis. However, longer term reconstruction efforts will need to examine requirements for rebuilding damaged economic sectors, such as fisheries and tourism, and rehabilitating the natural systems on which they depend.



Source: ReefBase

Studies of coral reefs following hurricanes and typhoon impacts suggest that, in general, natural recovery processes work well and, given limited resources, restoration should be considered with circumspection. The cost effectiveness of restoration interventions will depend on a number of factors, including the source and extent of damage, the extent to which these reefs underpin the health and livelihoods of heavily affected local communities, such as artisanal fishers and those dependent on local tourism, and the estimated time lags for natural recovery. In the light of these considerations, we make some general recommendations concerning reef restoration targeted at enhancing natural recovery.

From the evidence we have seen, quite extensive areas of coral reef have been damaged with some 13% of 174 representative sites surveyed in detail in Thailand deemed to be heavily impacted. On the other hand, almost 80% of sites were found to have been little impacted. Further, aerial images show that coral reefs (and mangroves) provided significant protection to coastlines, with damage being greater where these were absent or degraded. Interestingly, reef damage was often localised. For example, the coral reef in the north of Patong Bay in Phuket, Thailand was almost undamaged whereas that in the south part of the bay was severely impacted. Similarly, in Sri Lanka some sites showed no detectable impact whereas others (e.g. Dutch Bay, Trincomalee) were devastated. Even so, with present techniques it would be very costly to restore all areas and some are likely to recover naturally. Impacted areas will need to be carefully prioritised and scarce resources focused to assist recovery in those areas which will benefit most from both a biological and economic viewpoint.

Before any restoration is undertaken, the damage caused to reefs by the tsunami needs to be assessed in detail. Assessments should not only evaluate the extent of damage but also the potential for natural recovery at each impacted site. In some countries (e.g. Thailand, Sri Lanka, Maldives) a preliminary or detailed assessment has already been done. Standard rapid reef assessment techniques are ideal for this. Unless detailed baseline data are available, the difficulty lies in determining what damage was caused by the tsunami and what damage existed before. However, certain impacts such as presence of large debris (trees, doors, cars, etc.) on the reef and large chutes of sand and mud swept off coastal areas and smothering the reef are likely to be tsunami-related. Other common tsunami impacts are huge massive corals broken or overturned. Damage due to anthropogenic impacts such as dynamite fishing, sewage discharges, etc. needs to be distinguished from that due to the tsunami. Reefs are more likely to recover from impacts due to natural disturbance than from human impacts and the former may also be more amenable to restoration efforts. Impacts due to anthropogenic causes cannot easily be remedied unless coastal management measures have also been introduced to eliminate the source of stress. In the absence of such measures, restoration should not even be considered.

Construction in coastal areas often generates sediment which damages near-shore reefs. Thus coastal reconstruction, if not carried out sensitively, may exacerbate damage to reefs caused by the tsunami or kill corals that survived the tsunami. During reconstruction the opportunity should be taken to reduce any anthropogenic stresses that may be impacting the natural reefs. This is extremely important to ensure the recovery of the reefs. Such stresses might include sewage pollution, anchor damage, diving pressure, over-fishing, sedimentation, etc. Overfishing is suspected to be a key factor in reducing the recovery potential of reefs to various impacts, leading in some cases to phase-shifts from highly productive, biodiverse, coral-dominated communities to relatively unpro-

ductive, less biodiverse, algal-dominated communities. As cogently argued by Daniel Pauly in *Nature*, re-investing in boats and gear to rebuild local fisheries to pre-existing levels in areas, which in general are already grossly overfished, will not provide a long-term sustainable solution (*Nature*, Vol. 433, February 2005). Where feasible, the opportunity should be taken to develop exit strategies and alternative livelihoods for fishers who wish to leave the sector, thus reducing overcapacity and fishing pressure, and increasing the resilience and recovery potential of the coral reefs. Coastal managers should also take this opportunity to correct land-based pollution and other sources of stress on their precious coral reef resources.

There is a range of reasonable actions which can be undertaken to aid recovery. Where there is foreign debris (e.g. tree trunks) on the reef, which is moving around and causing further damage by breaking corals, this should be removed as soon as possible. Where there are large chutes of sediment, these may be relatively quickly swept off by normal currents and wave action in exposed areas but may require mechanical removal in protected embayments. Corals buried for a month are likely to be dead and so such chutes are primarily of concern if they are creating turbidity which is impacting surviving corals or retarding natural recovery in adjacent areas. An attempt to estimate the natural rate of sediment loss from chutes should be made during the assessment phase. If natural sediment removal is relatively fast and not causing collateral damage then such chutes are best left alone. Where necessary chutes can be sucked off the reef using a suction dredge but care must be taken that dredged sediment does not cause problems elsewhere.

If large areas of coral rubble have been generated by the tsunami, these are unlikely to recover naturally if the rubble is unstable and moved around by waves and currents. Rehabilitation of such areas can be assisted by deposition of large limestone boulders which stabilise the substrate and allow natural recolonisation. Such techniques have been used successfully to rehabilitate areas impacted by dynamite fishing in Indonesia. Costs and priorities need to be determined locally as any such intervention demands considerable funding. An alternative, if the areas are small, is to remove the loose rubble. Diver operated suction dredges driven by compressed air from a surface compressor can be used to remove small patches.

Good scientific approaches to reef restoration can enhance its cost-effectiveness. For example, studies of local currents can identify reefs which are likely to act as sources of coral larvae and others which are likely only to be sinks. Restoration interventions at source reefs are likely to be more effective than restoration at sink reefs.

Some species of branching coral form thickets on sand (e.g. *Acropora formosa*). These are likely to have been severely impacted by the tsunami. To restore these communities one can anchor small clusters of those acroporid branching coral species, which live naturally on sand to the seabed. If one tries to stabilize such sand environments with artificial structures, there is a risk of upsetting the local hydrodynamics. Also, introducing artificial structures will almost certainly lead to coral communities being established (seeded from nearby reefs) that are different to those that existed on the sand prior to the tsunami. This may result in unwanted changes in community structure.

As soon as possible after assessment, various non-controversial steps can be taken at sites prioritised for rehabilitation. These fall under the heading of "triage" (i.e. stop the bleeding) and involve trying to limit damage. Volunteer divers can assist in this work:

- Returning overturned colonies to original positions, repairing cracked massive colonies, and reattaching detached coral colonies directly with epoxy compounds or cement. This is perhaps most important for large slow-growing massive corals, but also for branching corals and sea-fans.
- Broken branches and fragments of branching corals, for species which do not naturally reproduce by fragmentation, can be rescued and reattached or moved to safety in *in-situ* nurseries for later reattachment. These are likely to die if left where they are.

Beyond triage, there are various techniques like coral culture, coral transplantation, etc. that can be used to assist or kick-start natural recovery. For example, broken branches can be cut into small fragments a few polyps in size (called "nubbins") and these can be cultured in nurseries to produce thousands of small colonies which can then be planted out on the reef. Such techniques are expensive, time-consuming, require expert advice and have had limited testing in the field. Local needs and priorities will dictate whether they might be considered.

Above all it must be stressed that restoration has only ever been attempted on the scale of a few hectares, whilst the areas impacted by the tsunami far exceed this.

Every restoration project can potentially contribute lessons from which future projects can learn. Unfortunately, few do, because monitoring of the progress of recovery is seldom carried out systematically; this is because funding is generally short-term and focused on doing restoration rather than evaluating its success in the long term. *The importance of systematic long-term monitoring of any restoration attempted cannot be overemphasised.*

In general, restoration actions should be well-considered and thoroughly costed. They should only be undertaken once the source of stress is removed, and should be conservative in scope. We would urge those considering reef restoration to keep the lines of communication open with this and other groups of practitioners and to share the results of assessments and monitoring so that all can benefit from lessons learned.

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