

In the front line



Shoreline **protection** and other **ecosystem services**
from **mangroves** and **coral reefs**



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Front cover photos: Y Yusuf; UNEP/Topham;
E Clua/CRISP, 2005; S Wells; UNEP-WCMC World
Atlas of Coral Reefs.
Back cover photo: S Wells

Citation: UNEP-WCMC (2006) *In the front line: shoreline protection and other ecosystem services from mangroves and coral reefs*. UNEP-WCMC, Cambridge, UK 33 pp

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A Banson production
Printed in the UK by Cambridge Printers

ACKNOWLEDGEMENTS

We gratefully acknowledge the many partners and institutions who contributed to this publication, in particular the following individuals who provided information and comments on early drafts: John Agard, Tundi Agardy, Jackie Alder, Daniel Alongi, Andrew Baird, Nicola Barnard, Juan Bezaury, Simon Blyth, Barbara Brown, Marion Cheatle, Isabelle Côté, Salif Diop, Alasdair Edwards, Norberto Fernandez, Harinda Fernando, Phil Fox, Alison Glass, Stefan Hain, Mark Huxham, Val Kapos, Carmen Lacambra, Ian May, Nick Nuttal, Pascal Peduzzi, Pasi Rinne, Toby Roxburgh, Charles Sheppard, Jerker Tamelander, Kristian Teleki, Ruben Torres, Collette Wabnitz, Alan White, Victoria Wood and Kaveh Zahedi.

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Introduction

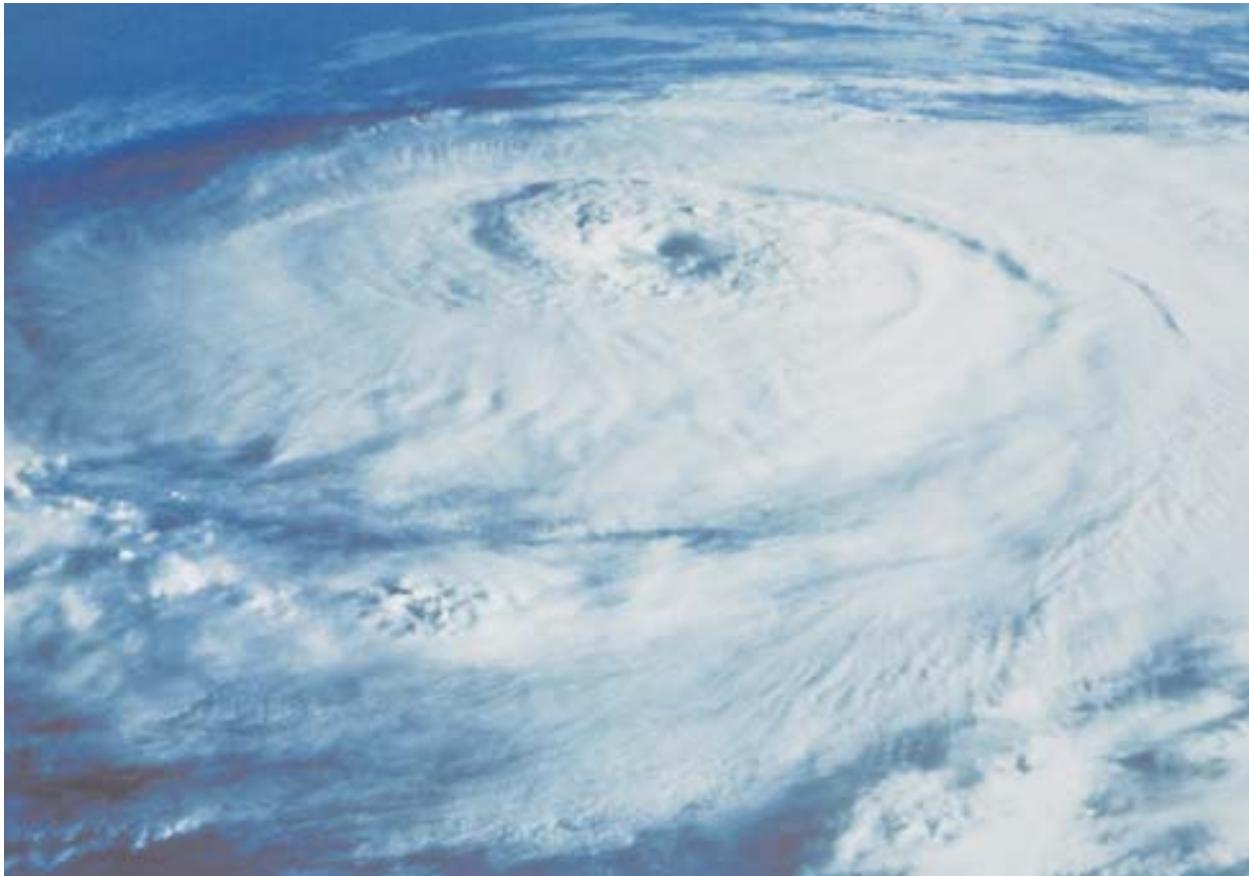
The Indian Ocean tsunami of 26 December 2004 and its tragic and devastating consequences were a wake-up call for the global community, dramatically drawing attention to the vulnerability of tropical coastal ecosystems and the dangers of undermining the services they provide to humankind. This was further emphasized by the catastrophic hurricane season in the Gulf of Mexico in 2005 when Hurricanes Katrina, Rita and Wilma caused much publicized and extensive damage to coastal areas. The numerous other tropical storms that affected coastal communities and ecosystems in other parts of the world in the same year received much less attention, but were also notable.

The lessons learnt in terms of loss of life, damage sustained, and approaches to reconstruction and mitigation are critically relevant to future management of the coast in a context of increasing severe weather events such as

hurricanes and typhoons, and other potential consequences of global warming. More than ever, it is essential to consider the full value of 'ecosystem services' (the benefits that people obtain from ecosystems) when making decisions about coastal development.

The aim of this publication is to help decision makers and policy makers around the world understand the importance of coastal habitats to humans, using coral reefs and mangroves as an example. It looks at the role of these ecosystems in protecting the coast, and takes into account new studies of this complex topic triggered by the tsunami and tropical storms. The publication also addresses the huge range of other benefits provided by these ecosystems and the role that they can play in coastal development and in restoring and maintaining the livelihoods of those who have suffered from extreme events, whether natural or induced by human activity.

NASA/Still Pictures



Key messages

GLOBAL STATUS OF CORAL REEFS AND MANGROVES

Coral reefs and mangroves are two of the world's rarest ecosystems, covering an area that is an order of magnitude less than that of tropical and subtropical forests. Both ecosystems are under serious threat.

- ❑ Some 30 per cent of reefs are already seriously damaged and 60 per cent could be lost by 2030. Threats include overfishing, use of destructive fishing methods, coral mining, pollution, sedimentation, anchor damage and tourism, as well as coral bleaching, disease and tropical storms. This combination of impacts is causing a shift, on many reefs, from a coral-dominated ecosystem to one dominated by algae.
- ❑ An estimated 35 per cent of the world's original mangrove cover has already gone, with some countries having lost up to 80 per cent. Mangroves have been degraded by conversion to aquaculture, timber extraction, use of wood for fuel and charcoal production, diseases and storms.

ECOSYSTEM BENEFITS

Coral reefs and mangroves provide benefits under the four categories of ecosystem services defined by the 2005 Millennium Ecosystem Assessment:

- ❑ Regulating – e.g. protection of shores from storm surges and waves; prevention of erosion.
- ❑ Provisioning – e.g. fisheries, building materials.
- ❑ Cultural – e.g. tourism, spiritual appreciation.
- ❑ Supporting – e.g. cycling of nutrients, fish nursery habitats.

They are among the most valuable ecosystems in terms of their benefits to humankind:

- ❑ Economic valuation of ecosystems needs to be treated with caution but annual values per km² have been calculated at US\$100 000-600 000 for reefs and US\$200 000-900 000 for mangroves.
- ❑ The small total area of coral reefs and mangroves belies their importance in terms of fisheries, other extractive uses, shoreline protection and, in the case of reefs, tourism and recreation.
- ❑ Both ecosystems contribute significantly to national economies, particularly those of small island developing states (SIDS), 90 per cent of which have coral reefs and over 75 per cent of which have mangroves.

Ecosystems that can no longer provide their full ecological services have a social and economic 'cost' that can be felt locally and many miles away. Degradation of coral reefs and mangroves may, and in some cases already does, cause:

- ❑ Reduced fish catches and tourism revenue in coastal communities, and potentially even loss of food security and malnutrition due to lack of protein.
- ❑ Loss of export earnings and decline of the tourism industry.
- ❑ Increased coastal erosion and destruction from storms and catastrophic natural events, which affects coastal residents, tourism operations and many other economic sectors.

SHORELINE PROTECTION

Reefs and mangroves naturally form barriers and thus inevitably provide some shore protection, a fact long recognized by coastal communities, fishers and vessels which use the sheltered waterways behind these ecosystems. Both reefs and mangroves can themselves be damaged by strong winds and waves, and so their buffering capacity is a balance between their resilience and their vulnerability. The current consensus is that:

- ❑ Reefs and mangroves play an important role in shore protection under normal sea conditions and during hurricanes and tropical storms. At least 70-90 per cent of the energy of wind-generated waves is absorbed, depending on how healthy these ecosystems are and their physical and ecological characteristics.
- ❑ In a tsunami, the buffering capacity of reefs and mangroves is more variable and often reduced because of the different structure and form of the waves and their much greater force. Distance from the earthquake epicentre, the presence of inlets and headlands, the gradient of the continental slope, shoreline elevation, the presence of dunes and other vegetation, and density of habitation and infrastructure seem to explain most of the variation.

PROS AND CONS OF REHABILITATION AND RESTORATION

Both reefs and mangroves will recover naturally once a stress has been removed, but this can be slow; for example, the reefs most seriously damaged by the tsunami may take five to ten years to recover. New growth of coral colonies and

mangrove trees, and recruitment of coral larvae and mangrove seedlings, is balanced by erosion and breakdown from both human-induced and natural stresses. The chronic human impacts faced by these ecosystems are tending to slow recovery, and the highest priority is to reduce and eliminate these stresses. It is tempting to try to speed recovery of an ecosystem by active restoration, or repair. However, this is rarely totally successful because of the difficulties involved in re-establishing full biodiversity and ecological processes:

- ❑ Mangrove restoration is relatively simple and large areas of new forest are being created using volunteers and local labour. However, achieving a mangrove forest with a full complement of biodiversity is a more complex and long-term process, and it is questionable whether any programmes have yet achieved this.
- ❑ Reefs, involving numerous species with very different life histories and poorly understood growth and reproductive characteristics, are more difficult to restore. Many attempts have been made using a variety of techniques. Most methods are costly and require considerable skill, and there are few examples of successful sustainable reef restoration over large areas.

CORAL REEF AND MANGROVE MANAGEMENT IN THE FUTURE

Investing in environmentally sustainable management and development of the coast will be more cost effective than restoring human livelihoods and ecosystems after a catastrophe. The relatively small amount of damage inflicted on coral reefs and mangroves by the 2004 tsunami demonstrated the resilience of these ecosystems to natural disturbance, but the worldwide public concern generated also revealed our awareness of their vulnerability.

- ❑ The devastation recently wrought by hurricanes and tropical storms testifies to the priority that must be accorded to the maintenance and enhancement of the resilience of natural coastal barriers such as reefs and mangroves.
- ❑ Post-tsunami and hurricane reconstruction efforts provide an opportunity to introduce and expand good coastal management practices. These may indeed help to mitigate damage from future tsunamis but, since these are infrequent events, the more important consequence is mitigation of the impacts of the more certain, but gradual, changes due to global warming.
- ❑ Short-term, small-scale rehabilitation programmes should not take precedence over activities directed at the root causes of the decline in reef and mangrove health. Key tools include integrated coastal management, marine protected areas, and monitoring and assessment for adaptive management.
- ❑ Governments, civil society and the private sector must recognize that, as with other benefits, there is a price to pay for maintaining these ecosystems. However, this is much lower than the benefit received. For example, the estimated average operational management cost of a marine protected area is US\$775 per km², or less than 0.2 per cent of the estimated global value of a square kilometre of reef or mangrove.
- ❑ Many of the world's wealthiest nations have jurisdiction over these ecosystems – more than 30 per cent of reefs are in countries classified as highly developed. They also have strong links with less developed countries struggling with their management. Political will and concerted action are needed – coral reefs and mangroves are in the front line, and calling for attention.

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