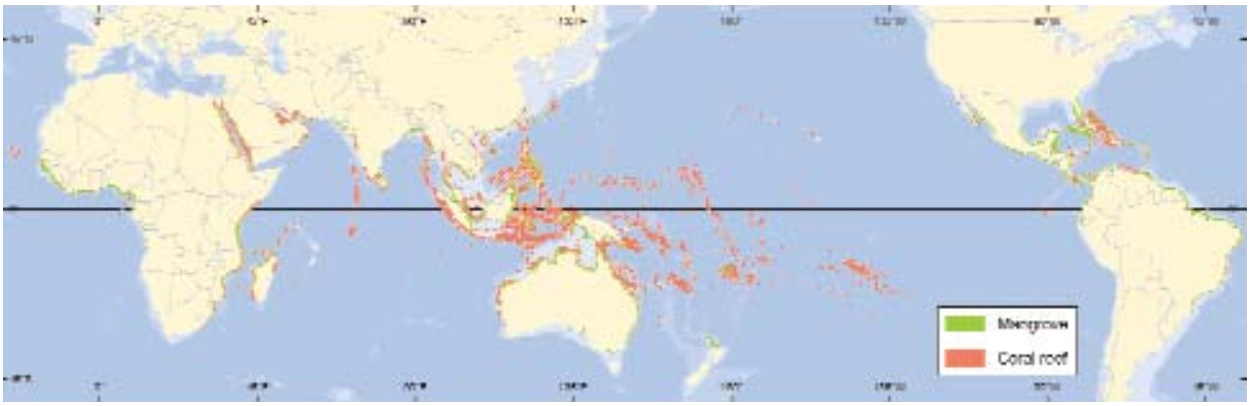
Global status of reefs and mangroves



Mangroves and tropical coral reefs

DISTRIBUTION

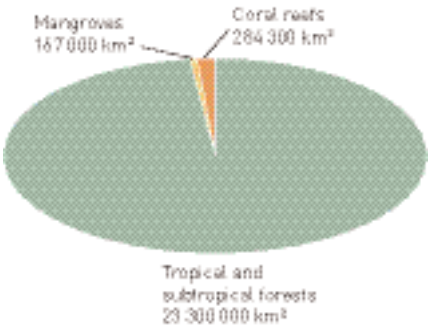
Of the 177 countries in the world, rather less than half (44 per cent) have tropical coral reefs and about half have mangroves. Our knowledge of the distribution of coral reefs and mangroves is now relatively good, as a result of regional and global mapping programmes using navigational charts, satellite imagery and aerial photography, as well as more detailed field surveys.

Both ecosystems occur principally in the tropics, with South-East Asia a major centre. Distribution between countries is very unequal. Australia and Indonesia each have about 50 000 km^2 of reef and account for nearly 35 per cent of the world's reefs, and Indonesia alone has 23-25 per cent of the world's mangroves. In general, other countries have less than 10 000 km^2 of reef and less than 1 000 km^2 of mangroves (Spalding et al., 1997; 2001).

STATUS

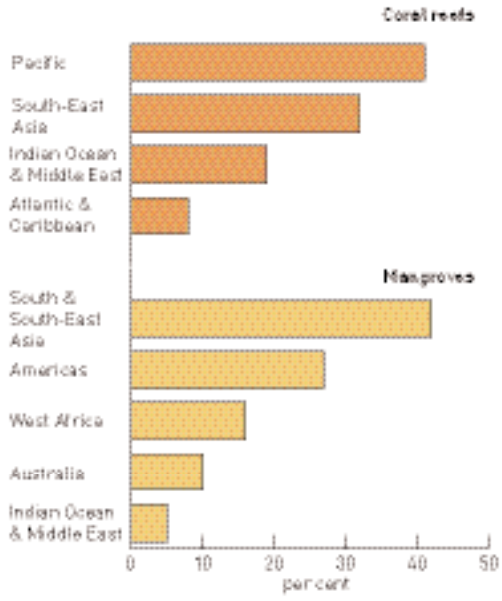
The coastal biome, which makes up only 4 per cent of the

Fig. 1: **Area of coral reefs and mangroves**



Coral reefs and mangroves are among the world's rarest ecosystems. Reefs cover an estimated 284 300 km^2, or just 1.2 per cent of the world's continental shelf area (Spalding et al., 2001). The total area of mangrove forest is less certain but is even smaller, estimated at between 167 000 km^2 (Valiela et al., 2001) and 181 000 km^2 (Spalding et al., 1997). As a comparison, tropical and subtropical forests cover 23.3 million km^2, an order of magnitude larger (Millennium Ecosystem Assessment, 2005).

Fig. 2: **Distribution of tropical coral reefs and mangroves**

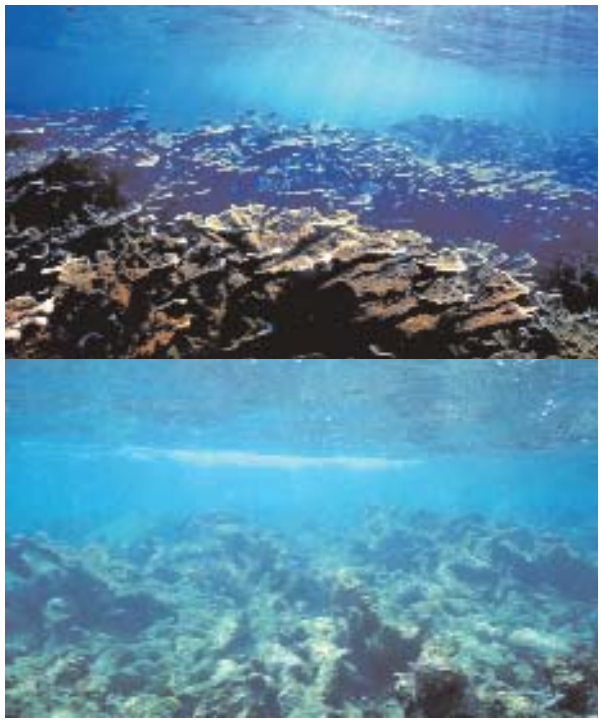


planet's total land area, is home to one-third of the world's population, and this population is predicted to double over the next 15 years. In many countries, such as island nations and those with inhospitable and arid interiors, humankind lives almost entirely on the coast. With the exception of some isolated atolls, all reefs and mangroves lie adjacent to the coast; more than half these ecosystems occur within 25 km of urban centres inhabited by 100 000 or more people (Millennium Ecosystem Assessment, 2005). Not surprisingly, the health and extent of both reefs and mangroves have declined dramatically over the last century.

Trends in reef health are well documented as assessments are carried out at regular intervals, through numerous monitoring programmes, the results of which are published in the biennial *Status of the World's Reefs Reports* (Wilkinson, 2004), the regional World Resources Institute's *Reefs at Risk* reports (Burke and Maidens, 2004; Burke et al., 2002) and many national reports.

Results from monitoring programmes indicate that about 30 per cent of the world's reefs are seriously damaged, with possibly no pristine reefs at all remaining, and it has been predicted that 60 per cent of reefs will be lost by 2030 (Wilkinson, 2004). Using information on existing and potential threats to reefs in 1998, the World Resources Institute suggested that 27 per cent of all reefs are potentially at high risk and a further 31 per cent are at medium risk of damage (Bryant et al., 1998). More recent regional predictions, using the same method, paint an even more disturbing picture. A 2000 analysis estimated that human activities potentially threaten 88 per cent of the reefs of South-East Asia, with 50 per cent at 'high' or 'very high' risk and only 12 per cent at low risk (Burke et al., 2002).

As yet there are no equivalent global mangrove



P Dustan

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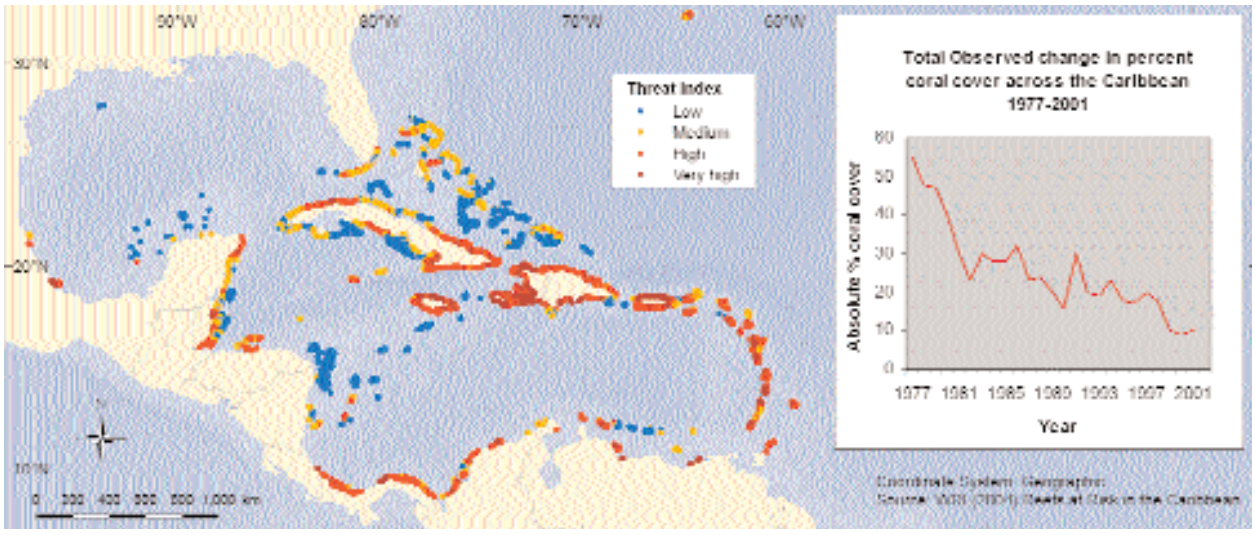
Carysfort Reef, the largest and most luxuriant reef in the Florida Keys, United States, in 1975 (higher) and 2004 (lower) showing the catastrophic decline of living coral cover.

Reefs at risk in the Caribbean

*Nearly two-thirds of reefs in the Caribbean are potentially at risk from human activities, according to a 2004 report, with over 40 per cent at 'high' or 'very high' risk, and about 28 per cent at low risk (Burke and Maidens, 2004). In this region, elkhorn (*Acropora palmata*) and staghorn (*A. cervicornis*) corals have undergone massive die-offs (Gardner et al., 2003).*



assessments, but several studies have shown this ecosystem to be as much at risk as coral reefs. The amount of mangrove lost varies widely among countries but, where data are available, mangroves are on a declining trend. An estimated 35 per cent of mangrove forest has disappeared in the last two decades (Valiela et al., 2001), and some countries have lost 80 per cent of cover (Spalding et al., 1997). The average annual rate of disappearance (or conversion to other forms of land use) is estimated at 2.1 per cent, with the greatest rate of loss in the Americas (3.6 per cent). The annual rate of loss of mangroves thus exceeds the rate of disappearance of tropical rainforests (0.8 per cent) (Valiela et al., 2001). Estimates for some locations suggest that rates of mangrove loss may be as high as 50 per cent a year (Alongi, 2002).

Over the last few decades there have been major changes in the appearance and quality of reefs and mangroves, the result of a combination of many 'drivers' or threats. These have both direct and indirect impacts that often trigger an escalating series of problems.

Many reefs, for example, are undergoing a shift from a coral-dominated to an algal-dominated state. Corals have been disappearing as a result of bleaching, disease, storm damage and a range of human activities, including overfishing, use of destructive fishing gear, anchor damage and pollution. At the same time, algae have increased as herbivores and grazers, such as sea urchins and some fish species, that keep them in control have declined through disease and overfishing. Algae have further increased as a result of nutrient pollution. Where coral cover has started to increase there are indications that the so-called framework-building corals (e.g. *Acropora, Montastrea*) that once dominated are being replaced by corals that contribute little to the main structure of the reef (e.g. *Agaricia*) (Hughes et al., 2003; Knowlton, 2001).

The brown seaweed Chnoospora *overgrowing branching corals.*

Y Latypov

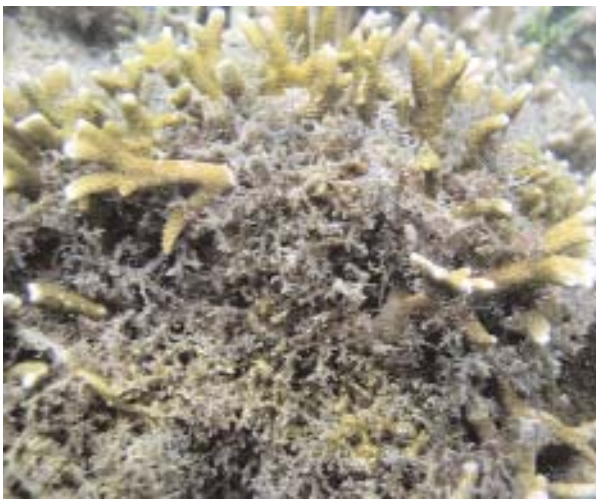
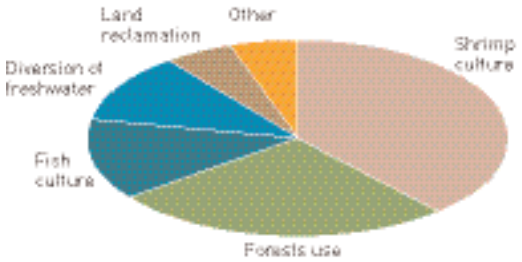


Fig. 3: **Area of mangrove lost to human activities** (per cent)



Source: Valiela et al., 2001

Degradation of mangroves leads to long-term changes in the ecology of large areas of coastline. In particular, conversion of mangroves to shrimp farms, and the subsequent aeration and use of fertilizers, alters the composition and structure of the soil. Eventually ponds are abandoned, sometimes after only two to ten years, as they are no longer suitable for production (Stevenson, 1997). There is little chance of mangrove regeneration in the remaining barren lands. Leading causes of mangrove forest loss and degradation are conversion for aquaculture, use of mangroves for timber for construction and other functions, and for fuelwood and charcoal, conversion to rice paddies, and freshwater diversion and coastal development for tourism and other purposes (Valiela et al., 2001).

THREATS

Overexploitation and destructive fishing

Many commercial fish species, such as rabbitfish (Siganidae), feed on algae, and their removal can result in excessive algal overgrowth of corals. Removal of 'keystone' species (those that play a particular role in an ecosystem) – such as triggerfish which prey on sea urchins – may be the cause of urchin population out-breaks which further degrade corals through bioerosion. Dynamite, small-mesh nets and nets that are dragged over the seabed, although illegal in many countries, are still used and cause widespread physical damage as well as removing or killing immature fish and other species of no commercial value.

Habitat loss

Mangroves can be completely wiped out when forests are cleared for salt production operations, for industrial, residential and tourism development, or, particularly, for aquaculture. In contrast, coral reefs generally suffer from

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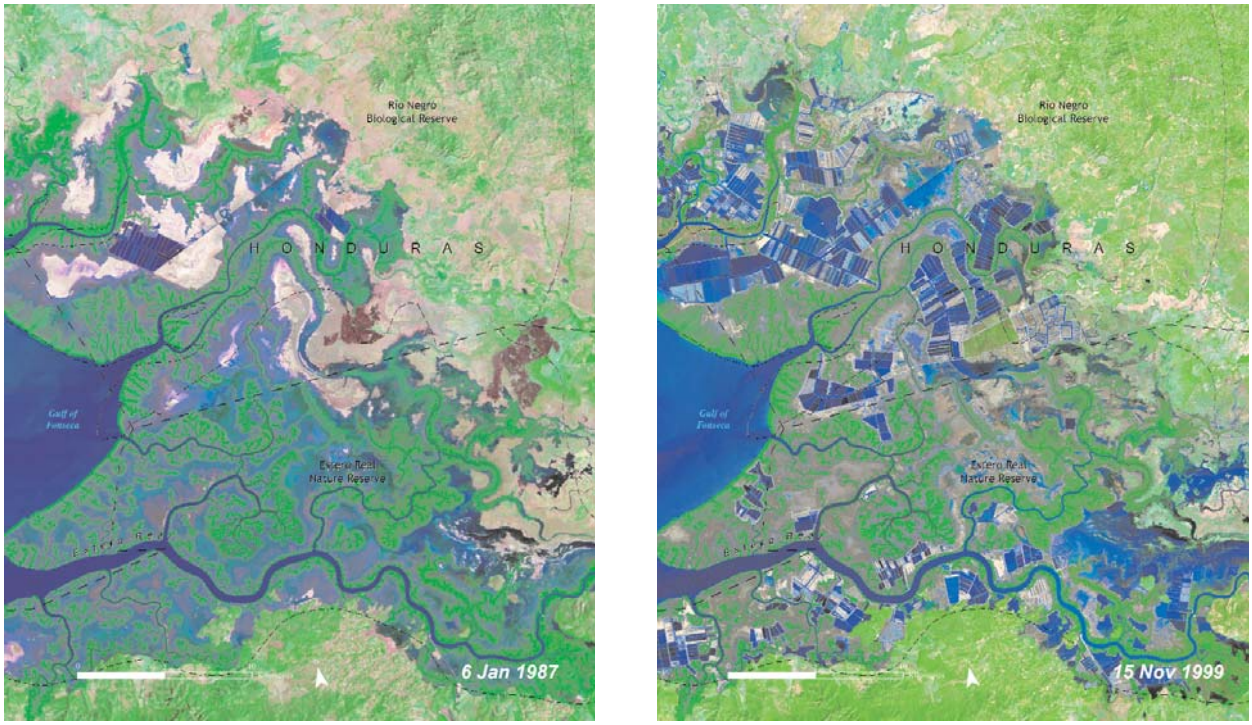


In Honduras, shrimp farms have progressively transformed the coast of the Gulf of Fonseca since the early 1970s. Although there were still large areas of mangrove in 1987, by 1999 the only substantial forests were in protected areas such as Estero Real Nature Reserve (UNEP, 2005a).

a gradual decline in quality rather than a sudden disappearance. However, mining for corals for use as building materials can eliminate, or reduce to rubble, large areas of reef. Although coral mining is illegal or regulated in most countries, it is still having a major impact in India, the Maldives, Sri Lanka and Tanzania (Wilkinson, 2004).

Land-based sources of pollution

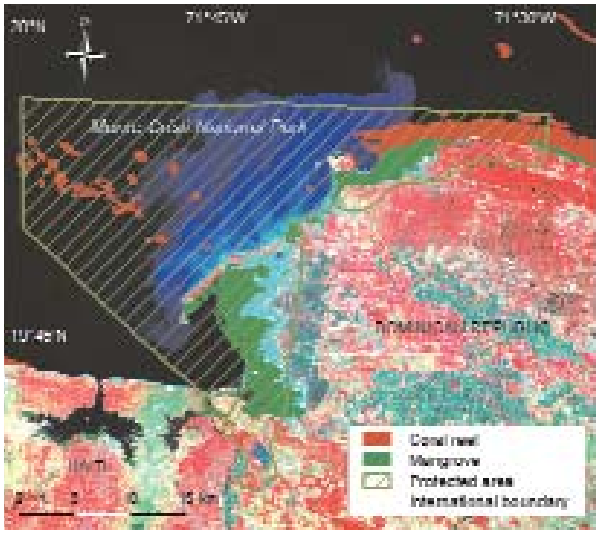
More than 77 per cent of the pollutants entering the oceans originate on land, and 44 per cent of these pollutants come from improperly treated wastes and run-off (Cicin-Sain et al., 2002). The nutrient content of the oceans has increased dramatically in recent years as a result of fertilizer and other agricultural run-off, sewage and aquaculture waste. Nutrients such as nitrogen and phosphorus deplete oxygen in the water and promote the growth of algae on reefs (Hughes et al., 2003).

Many coastal development activities, such as residential, tourist, industrial and port development, involve land reclamation and dredging which invariably results in sediment being stirred into the water column. This reduces light penetration, may directly smother corals and can damage mangroves. Construction activities inland, agriculture and deforestation, and poor management also contribute to increased sediment.

Disease

Coral diseases, rarely recorded until the 1970s, have had a catastrophic effect on reefs, particularly in the Caribbean, affecting 100 hard and soft coral species in 54 countries. The cause is still largely unknown, although

Sediment plume in Monte Cristi National Park, Dominican Republic. Inland deforestation is causing sediment run-off on to nearby coral reefs. As a result, coral cover tends to be low compared with other less impacted areas.



UNEP-WCMC

A W Bruckner

Coral attacked by black-band disease.

Thomas Heeger

Fishing with dynamite in the Philippines.

both fungi and bacteria have been identified as pathogens in two cases (Porter, 2001; UNEP-WCMC, 2003). There are indications that abrasion of massive corals through tourist activities may make corals more susceptible to disease (Hawkins et al., 1999).

Climate change

There is now general consensus that extreme storm events are becoming more frequent, and sea levels and sea surface temperatures are rising as a result of global warming. Reefs are already suffering from bleaching events that have increased significantly since 1975. In the Caribbean bleaching events are predicted to become an annual event as current sea surface temperatures are in the upper temperature threshold for coral survival (Gardner et al., 2005; Hughes et al., 2003). Tropical storms are forecast to become even more frequent and/or more intense (Trenberth, 2005), and this will compound the problem, causing more damage to both reefs and mangroves and resulting in shorter recovery times between events (Hughes et al., 2003).

The change on reefs from coral to algal dominance, and from framework-building species to non-framework species, may also compromise their ability to keep pace with rising sea levels (Bellwood et al., 2004; Gardner et al., 2003).

Furthermore, by 2100, rates of calcification (the process by which calcium is formed) on reefs may have decreased by 17-35 per cent of pre-industrial levels as a result of high levels of dissolved carbon dioxide in the oceans (these are now 380 parts per million (ppm), compared with 280 ppm two centuries ago). This will cause weakening of coral skeletons and slower growth rates, making reefs even less effective as breakwaters (Feeley et al., 2004; Kleypas et al., 1999).

Other threats

Individual tourists, tourist boats and anchors may have only a minor impact, but over time and in large numbers the impact becomes significant (Hawkins et al., 1999; Zakai and Chadwick-Furman, 2002). Spills of oil and toxic chemicals, and dumping of other wastes, cause localized impacts to both reefs and mangroves. The introduction of alien species is a threat to marine ecosystems that is growing rapidly with increased shipping and susceptibility in systems degraded by other stresses. Marine plants and animals can be transported immense distances on the hulls of vessels or in ballast water. Non-indigenous sessile species have been introduced to reefs in Guam via ships' hulls, and other alien species are spreading on the reefs of Hawaii, outcompeting native species (Eldredge, 2003).