

CORAL REEFS: ARE THEY THREATENED BY MASS EXTINCTION?

by Robert Morris

CORAL REEFS ARE among the most biologically rich ecosystems on Earth. They are also one of the most threatened. They have very high levels of biodiversity (a large number of species) with about 5,000 species of fish and 800 species of reef-building coral. They are also of huge economic value, from fishing and as a source of materials for jewellery manufacture and construction. For these reasons, and because of the effects of global warming, they are massively under threat.

This unit deals with the threats to coral reefs in the Coral Triangle region (Figure 1) as this is where the greatest concentration of reefs in the world is found. It also looks at measures put into place to protect the reefs. More details on the formation and the value of coral reefs can be found in *GeoActive* 392 'Caribbean Coral Reefs: an Ecosystem Under Threat' (April 2008) – ask your teacher for this.

Coral reefs in the Coral Triangle

Spanning parts of Southeast Asia and the western Pacific, the Coral Triangle is recognised as the global centre of marine biological diversity, with the highest coral diversity in the world (76% of all coral species) and the highest diversity of coral reef fishes (37% of all species). The area within the boundary of the Coral Triangle (shown on Figure 1) covers nearly 73,000 km² of coral reefs (29% of the global total) and spans parts of six countries: Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands, and Timor-Leste.

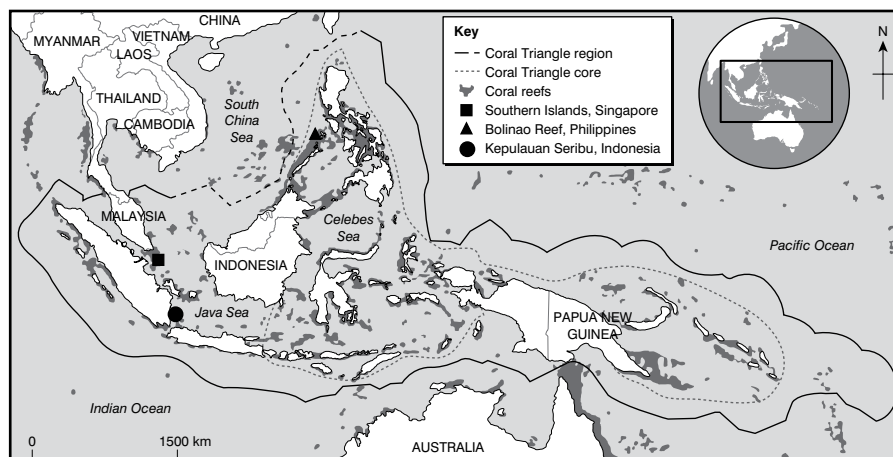


Figure 1: The Coral Triangle

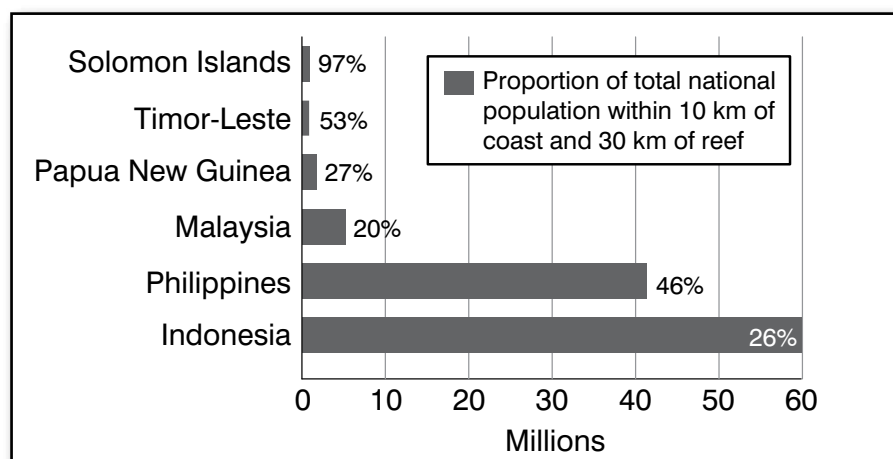


Figure 2: People in the Coral Triangle living near coral reefs, 2007

Source: World Resources Institute

Over 80% of the reefs in this region are under threat, with 56% at high risk. The major threats to reefs in the Coral Triangle are both local (development of urban areas and ports, overfishing, destructive fishing practices, pollution, sedimentation) and global (coral bleaching and ocean acidification). More than 70% of the region's people live within the coastal zone (Figure 2), putting pressure on nearby marine resources. Southeast Asia contains one-quarter of the world's reefs. Indonesia and the

Philippines account for a major portion of these habitats.

Local threats

There are a number of local threats affecting coral reefs within the Coral Triangle.

- **Coastal development** has generated a range of threats to nearby coral reefs. Where space is limited, construction projects such as hotels are built upon reef communities. Dredging of harbours and shipping channels results in destruction of these habitats. In many areas, coral is mined for limestone and sand to be made into cement. Shoreline

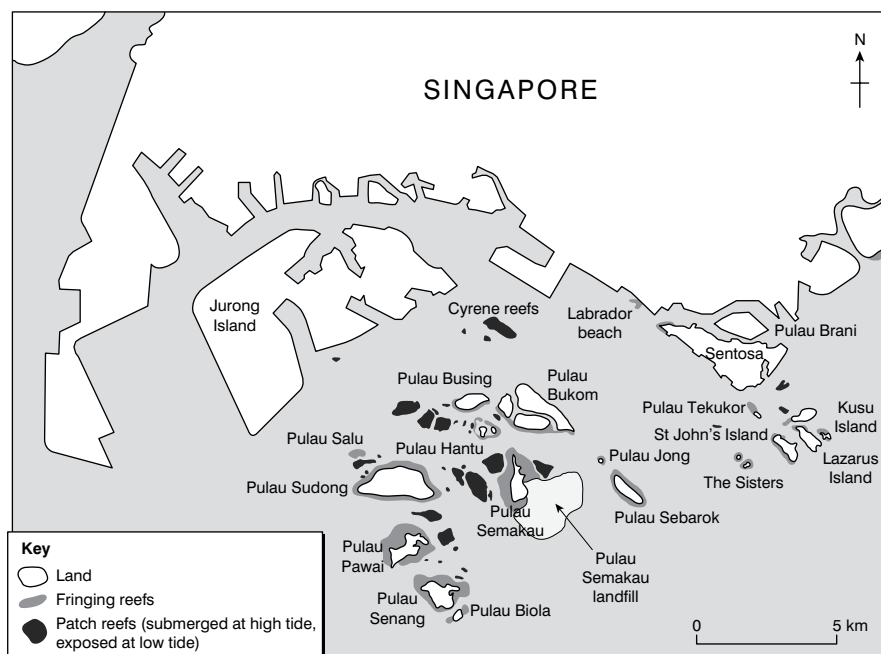


Figure 3: Singapore's coral reefs

Source: <http://coralreef.nus.edu.sg/map.htm>

construction disturbs sediments, which smother corals. Runoff from farming causes the growth of algae which interferes with coral reproduction. Other threats include hot-water discharge from power stations, mine runoff and toxic waste which poisons coral reefs.

- **Overfishing** affects most of the world's reefs. At a basic level, overfishing results in changes in fish size and reduction in the numbers of fish and of species within coral reefs. The removal of certain species may have a serious impact on ecosystems and result in wholesale changes as some species increase rapidly in numbers if they have no natural predators.
- **Destructive fishing** – fishing using improvised explosives or using cyanide and other poisonous chemicals, pounding reefs with weighted bags to scare fish out of crevices and, in deeper waters, trawling, all damage corals. Large numbers of other species, along with undersized target species, may be swept up in nets or killed by poisons or explosives in the process. Most of these methods are actually illegal but often cannot be fully enforced by law enforcement agencies. As not all fishing methods are destructive, this is a lesser threat than overfishing.
- **Impact from inland pollution and erosion** – sediment, pesticides, and pollution from human activities

inland can damage coral reefs when they are transported by rivers into coastal waters. This results in the smothering of corals, reducing light levels and affecting growth, and over-nutrication of coral reefs. Pollution is a particular threat to coral reefs near the mouths of many smaller rivers, as the high volume of sediment and freshwater flow naturally inhibits coral growth.

- **Deforestation** can also affect the development of coral reefs. River basins cleared of their forests and other vegetation cover are vulnerable to erosion and flooding. During flooding events, silt and other pollutants within these basins are carried out to sea, affecting the offshore reefs.
- **Marine-based pollution** – in comparison with the other stress factors, oil spills and the deliberate discharge of oily ballast water by passing ships pose an unknown, but probably less significant, threat to coral reefs.

Global threats

The two main global changes affecting coral reefs are largely driven by human development.

- **Coral bleaching** – when corals undergo certain kinds of stress, much of the zooxanthellae (the symbiotic algae that provide coral polyps with nutrients) are expelled from the coral tissue and the coral

turns white. Ultimately, weakened corals may die. Bleaching is a frequent symptom of pollution-induced stress, as well as a response to natural factors such as changes in water temperature, salinity levels, and ultraviolet light. During El Niño events, large areas of coral reef in the Coral Triangle are severely damaged by high water temperatures, resulting in coral bleaching. Scientific studies have linked bleaching events to temporary 'hot spots' – local areas of unusually high temperatures possibly caused by climate change.

- **Ocean acidification** – the oceans absorb about 25% of the carbon dioxide we release into the atmosphere every year. As the carbon dioxide levels increase with global warming, so do the levels in the ocean. Scientists originally focused on the benefits of the ocean removing this greenhouse gas from the atmosphere. However, research has shown that there is also a downside: the carbon dioxide absorbed by the ocean is changing the chemistry of the seawater by becoming carbonic acid. This has affected corals and other crustaceans as they are then unable to take calcium from the water to help them grow.

Case Studies

The following case studies illustrate the range of threats to coral reefs in the Coral Triangle and how, in some cases, they are being resolved.

The Southern Islands, Singapore

Most of Singapore's reefs lie off the Southern Islands in close proximity to Singapore city's marina (see Figure 3). This area is home to nearly 200 species of hard corals. It has a large tourist industry, as well as some commercial and sport fishing.

The Southern Islands reefs lie within the port limits of the world's busiest harbour, while the islands themselves support oil refineries and petrochemical plants. Massive land reclamation programmes since the 1960s

(resulting in nearly 1,700 hectares of new land), along with regular dredging of shipping channels, has resulted in widespread sedimentation of the reefs. Underwater visibility was reduced from 12 metres in the 1960s to 2 metres in 2000. The active growth zone of corals is now confined to the topmost 5–6 metres of the sea compared with 20 metres elsewhere. However, strict controls on sewage and industrial waste treatment mean that these coral communities do still survive despite their proximity to one of the most densely populated countries on Earth.

The Bolinao Reef, Luzon Island, the Philippines

Although the population of Bolinao is around 75,000, only a few thousand actually fish the 200 km² of reefs, but the reefs support another 20,000 people who work in fishery-related occupations. Sea urchins are a popular delicacy in some parts of the world and are caught here in large numbers. Increasing numbers of Filipinos have migrated into reef areas, due to loss of farmland to development and land reform. They now harvest fish and other reef resources, increasing the threats. Greater competition has led to widespread destructive fishing. While fishermen in more pristine reefs in other areas can harvest up to 30 kg of fish per day, the Bolinao fishers have had their catches reduced to an average of about 1 kg per day.

Beginning in 1986, programmes were established by the University of the Philippines to help the Bolinao municipality. Various projects to introduce small-scale mariculture of seaweed and invertebrates (shrimp farming) were supplemented by community activities. Public education and improved law enforcement have led to a reduction in destructive fishing, and coral cover and

fish numbers both seem to be increasing.

Despite this, the reef remains in a critical state; coral bleaching and ocean acidification remain threats. Fish farming is also causing problems with pollution, water stagnation, and public access to reef resources. Incomes in the area are low, and many resources on land and sea are seriously overused by the dense population. Ultimately, the greatest challenge is that the population of Bolinao is increasing by 2.5% a year and is expected to double in the next 30 years.

Kepulauan Seribu, Java Sea, Jakarta, Indonesia

The Kepulauan Seribu reefs cover 108,000 hectares. This area, whose name means ‘Thousand Islands’, is noted for its tropical islands, attractive beaches and coral reefs. If you look up the following link, you can explore for yourself the kind of tourist attractions that have led to the rapid growth in tourism detailed below: www.indonesia.travel/en/destination/240/the-thousand-islands

In 1995, the islands were declared a marine national park. Consequently, tourism has grown rapidly from one operator on a single island in 1982 to 11 operators working out of 18 islands by 1992. There were approximately 8,000 visitors in 1991 rising to 187,000 in 2007. Some islands have long been inhabited by villagers who depend on reef and island resources, with the tourism industry employing an increasing percentage of the local population.

Domestic sewage and industrial waste from Jakarta threaten the area and rubbish floating on the sea is a particular problem. Ballast water discharges from boats result in tar being

washed up on local beaches. Dynamite fishing, although outlawed nationally since 1920, still occurs, as well as heavy ornamental fish collecting and subsistence fishing. The islands are under pressure from developers seeking more tourism and recreational facilities. There is no strategy to promote a sustainable expansion of the tourist industry. Boat anchoring and diving are damaging coral reefs.

The global recession has seen visitor numbers plummet to only around 50,000 a year in 2011 and this has led to a number of island resorts closing down, so less pressure is put on the fragile ecosystem by visitor numbers. Most visitors are now wealthy Jakartans, who mainly visit at the weekends. Oil and gas exploration, taking place close to the park, could pose a potential future threat.

Conclusion

Although there are no internationally binding conservation targets or treaties related specifically to coral reefs, a range of agreements are in place that have helped focus attention on these ecosystems. These include The International Coral Reef Initiative (ICRI), which promotes the sustainable management and use of coral reefs and related ecosystems (mangroves and sea grass beds) through a range of actions. These have included:

- The International Year of the Coral Reef (1997)
- The International Year of the Ocean (1998).

Both of these were used to raise awareness of the threats to coral reefs. Until there are any internationally binding conservation targets or treaties, coral reefs all over the world will continue to be under serious threat.

Activities

1 Define the following terms:

ecosystem
biodiversity
overfishing
destructive fishing
coral bleaching
ocean acidification
mariculture.

2 Study Figure 2.

(a) What percentage of people in the Philippines live within 10 km of the coast and 30 km of coral reefs?

(b) What percentage of Indonesia's population live within 10 km of the coast and 30 km of coral reefs?

(c) Calculate the approximate overall population of the Philippines and Indonesia from the information given in Figure 2. (Your teacher should be able to help you with this activity.)

3 Study Figure 4.

(a) The Coral Triangle is a part of which three regions (including seas/oceans)?

(b) Draw a bar graph to display the information shown in Figure 4.

Figure 4: World distribution of coral reefs

Region	Area (km ²)
Middle East	20,000
Caribbean and Atlantic Oceans	23,100
Indian Ocean	36,100
Southeast Asia	68,100
Pacific Ocean	108,000
Total	255,300

4 Explain the differences between local and global threats to coral reefs.

5 (a) Using Figure 5, identify all the countries listed and locate them on a base map of the region. Label and colour each country on your map.

(b) Draw pie charts for each country on your map, showing the percentage of coral reefs

Region	Reef area (km ²)	Reef area as % of global reefs	Threat – medium or higher (%)	Severe thermal stress 1998–2007 (%)	Coastal population within 30 km of reef ('000s)	Reef area in MPAs (%)
Brunei Darussalam	109	<1	100	49	323	<1
Indonesia	39,538	16	93	16	59,784	29
Malaysia	2,935	1	99	9	5,065	7
Papua New Guinea	14,535	6	55	78	1,570	5
Philippines	22,484	9	98	99	41,283	7
Singapore	13	<1	100	100	4,497	6
Solomon Islands	6,743	3	71	82	540	6
Timore-Leste	146	<1	100	100	564	0
Coral Triangle region	86,503	35	86	92	113,626	16

Figure 5: Threats to the countries of the Coral Triangle

MPA = Marine Protected Area

Source: World Resources Institute

**1 Any Road
Anytown
AN1 1YT
[Date]**

**The Minister
[Address of government minister]**

Dear [?]

Figure 6: Template for letter to a government minister

that are under threat – use the 'Threat – medium or higher' column for your data. Your teacher should advise you what radius to draw your circles for the pie charts.

(c) Give your map a key and a suitable title.

6 Why are so few areas of coral reef in the Coral Triangle part of Marine Protected Areas? *Hint:* Think about the levels of development in these countries.

7 Using the internet, do some research on how people are protecting coral reefs. You will use this research to write an extended piece of writing in Activity 8.

8 Using your research in Activity 7, and the information in this unit, answer the following question:

Why do we need to prevent the extinction of coral reefs?

9 Write a letter to the Prime Minister or a government minister, explaining why it should be a priority for the government to implement a worldwide treaty protecting coral reefs from further damage. Use the information from your research (Activity 7) and in this unit. The format for your letter is set out in Figure 6.