Water quality and the Great Barrier Reef

What is the role of water quality in coral loss on the Great Barrier Reef?

The Great Barrier Reef lost half its coral cover between 1985 and 2012. The known causes of this decline in coral cover since 1985 were storm damage (48%), crown-of-thorns starfish (42%), and bleaching (10%) caused by extended periods of increased sea temperature.

We can't stop the storms, and we can't stop the warming of the oceans. We can, however, act to reduce the impact of crown-of-thorns starfish and to tackle other stresses that affect the capacity of coral reef communities to repair themselves.

Water quality is implicated in crown-of-thorns outbreaks. Water quality and sediments are also important factors in the health of the inner-Reef.

Historically the focus on Great Barrier Reef monitoring was on the mid- and outer-reef systems so we know less about the changes on the inner Reef and their causes. However, over the past decade much work has gone into measuring and improving water quality.

Reef Plan (the Reef Water Quality Protection Plan) was established in 2003 and updated in 2009 and 2013. It has the goal that by 2020 the quality of water entering the Great Barrier Reef from broadscale land use will have no detrimental impact on the health and resilience of the Reef. Farmers, land managers, scientists and governments are working together to achieve this goal.

Water quality is the number one suspect for crown-of-thorns starfish outbreaks

We don't know precisely what causes the periodic crown-of-thorns outbreaks but water quality is the number one suspect. River floods and associated sediment and nutrient run-off are thought to increase the amount of plankton for the larvae of crown-of-thorns starfish to feed on.

The four outbreaks of crown-of-thorns starfish outbreak waves on the Reef since the 1960s all followed extreme floods of the Burdekin River and the rivers along the Wet Tropics coast.

The larvae feed on plankton which may also undergo a population boom when increased nutrients are available when, for example, storms wash sediment and nutrients into the ocean. Field data and population models suggest that river floods and regional differences in plankton availability are strongly related to patterns of starfish outbreaks on the Reef.

Three times the sediment, at least double the nitrogen and phosphorus

The evidence of declining water quality on the Great Barrier Reef is extensive. In 2013 the Queensland government commissioned a Scientific Consensus Statement on land use impacts on Great Barrier Reef water quality and ecosystem condition. It concluded that key Great Barrier Reef ecosystems are showing declining trends in condition due to continuing poor water quality, cumulative impacts of climate change and increasing intensity of extreme events.

The development of agriculture within the Great Barrier Reef catchment since European settlement has resulted in increased sediment and nutrient loads being washed into the Great Barrier Reef lagoon. The lagoon is receiving three to five times the suspended solids, at least double the total nitrogen, and between two and nine times the total phosphorus. Most of this increase is in rivers in the central and southern Great Barrier Reef.

Seventy per cent of the additional suspended solids come from the Fitzroy and Burdekin catchments and most of that is from grazing lands. It's estimated that over 16 tonnes of herbicides are also carried annually to the Reef lagoon with 80 per cent of that coming from cane fields.

Sediment

Excess sediment increases the turbidity (opacity) in waters of the GBR. When more particles are in the water, light intensity can drop significantly, creating a problem for photosynthesising organisms such as corals and seagrass. Benthic (bottom-dwelling) organisms can also be smothered under layers of silt, blocking photosynthesis and filter feeding.

Nutrients

Increased nutrient availability from eroded soils and fertilisers favours the growth of macroalgae that can outcompete and displace corals on inshore reefs. Phytoplankton can form blooms, contributing to reductions in light intensity and potentially favouring Crown-of-thorns starfish outbreaks.

Contaminants

Chemicals used in agricultural, industrial and urban environments can affect marine organisms. Pesticides, oils and industrial waste amongst others, can affect various biological functions such as photosynthesis, reproduction and larval settlement. These contaminants weaken the ecosystem, reducing its resilience against disease, physical disturbance and climate change.

Reducing the impact of agriculture

Reef Plan is helping to reduce the impact of agriculture. By June 2013 49 per cent of sugarcane growers, 59 per cent of horticulture producers and 30 per cent of graziers had adopted improvement management practices. Sediment loads had dropped by 11 per cent and pesticide loads by about 28 per cent.

AIMS surveys indicate that over the past two years, coral decline on the inner Reef has paused but its condition is still 'poor'. In a parallel study, James Cook University researchers found that inshore seagrass has started to recover. These results may indicate that land management changes are working, or it may reflect that recent low rainfall years led to reduction in the amount of runoff of sediments and nutrients to the Reef. Seagrass is also recovering from Tropical Cyclone Yasi in 2011 which destroyed many seagrass beds.

What about dredging?

The expansion of ports on and near the Great Barrier Reef has led to much debate about the impact of dredging on the Reef. In 2015 an expert group convened by AIMS and the Great Barrier Reef Marine Park Authority wrote a 'Dredging Synthesis Report'. It concluded that under the current rules that Reef-wide impact of dredging is much less significant that run-off from rivers. However, the report also identified "significant areas of insufficient knowledge" including sediment dynamics, monitoring, and sensitivity of coral and seagrass to increased sediment exposure.

AIMS research into water quality

AIMS is filling our gaps in knowledge about the impacts of water quality and sediment

From 2000 to 2006 AIMS, together with the then Reef Cooperative Research Centre, undertook major research into the effects of water quality on coral reefs. That contributed to the creation of Reef Plan.

AIMS continues to run a series of long-term studies into the impact of water quality on the Reef:

- assessing the resilience of Great Barrier Reef inshore ecosystems in response to water quality
- developing regional models of coastal environmental condition and function
- determining the impacts of known and emerging contaminants
- identifying zones of influence of, and biological responses to, dredging activities.

The AIMS research aquarium SeaSim is playing an important role in this research – allowing researchers to look at individual and combined impacts of sediment, storm plumes, temperature, ocean acidity and other factors.

Our aim is to enhance capacity within government and the private sector to predict and manage the environmental impacts of water quality, sediment and dredging, and to facilitate more informed environmental decision-making.

This work is relevant not just to the Reef but also to ports and ecosystems across northern Australia.

Further reading and references

eReef: Reef Plan monitoring of inshore water quality, Great Barrier Reef at:
http://data.aims.gov.au/metadataviewer/uuid/a5a02dc8-16b4-4b50-abad-af4a1c1e9c49

Reef Plan report cards: http://www.reefplan.qld.gov.au/measuring-success/report-cards/2012-2013-report-card/

Reef Plan Scientific Consensus Statement 2013: http://www.reefplan.qld.gov.au/about/scientific-consensus-statement/

Note: the individual Consensus Statement chapters include extensive lists of references.