GREAT BARRIER REEF: Resilience and change

Editor Lorraine Chaffer

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INTRODUCTION

Webinar

In a recent University of Sydney, Lunchbox Science webinar, Associate Professor Jody Webster explained the use of fossil reef cores to learn about past sea level, climate and environmental change and responses of the Great Barrier Reef. The webinar is based on a study led by Jody and published in **Nature Geoscience:** *'Rise and fall of the Great Barrier Reef over 30,000 years'*

This webinar would make great teacher professional learning and provide an opportunity to differentiate content and challenge more capable HSC students.

Link to webinar
https://www.sydney.edu.au/science/news-and-events/events/lunchbox-science/lunchbox-science-with-jody-webster.html

Link to Nature Geoscience

Rise and fall of the Great Barrier Reef over 30,000 years'
https://rdcu.be/Prgb

Blog entry

Associate Professor Webster summarised key highlights from the paper *Rise and fall of the Great Barrier Reef over 30,000 years'* in a blog entry on his research group's website Coastal Research Group. Selected highlights relevant to Ecosystems at Risk include:

- The GBR had a complex and dynamic history of reef growth and demise over the past 30,000 years, characterised by five distinct reef sequences.
- Each reef sequence consists of shallow and deep reef habitats that can be traced in space and time.
- The GBR shows a remarkable capacity to laterally migrate as it tracked falling and rising sea levels.
- We identified two different types of reef death/demise events, one caused by subaerial exposure during falling sea level and the another caused by drowning as sea level rose beyond the capacity of the reef to keep up.
- As an ecosystem the GBR has been more resilient to past sea-level and temperature fluctuations than previously thought, but it has been highly sensitive to increased sediment input over centennial–millennial timescales.

Link to blog entry
https://grgusyd.org/2018/05/29/hot-off-the-press-the-rise-and-fall-of-the-great-barrier-reef-over-the-past-30000-years/

Note: The Coastal Research Group website Coastal research Group at https://grgusyd.org maintains a lot of interesting articles, multimedia, resources and blogs and links to original research papers that might be of interest to teachers and students with an interest in Geoscience topics.

News item

The item below from Sydney University News summarises the study led by Associate Professor Webster. The study reveals how the reef migrated laterally, landward or seaward, in response to sea level changes over a period of 30,000 years.

Link to USYD news item
https://www.sydney.edu.au/news-opinion/news/2018/05/29/rise-and-fall-of-the-great-barrier-reef-over-30-000-years.html

Rise and fall of the Great Barrier Reef over 30,000 years

University of Sydney News

World's largest reef system has suffered five death events

An international study led by Associate Professor Jody Webster has shown the reef is resilient to major environmental changes but is highly sensitive to increased sediment input and poor water quality.

A landmark international study of the Great Barrier Reef has shown that in the past 30,000 years the world's largest reef system has suffered five death events, largely driven by changes in sea level and associated environmental change.

Over millennia, the reef has adapted to sudden changes in environment by migrating across the sea floor as the oceans rose and fell.

The study published today in Nature Geoscience, led by University of Sydney's Associate Professor Jody Webster, is the first of its kind to reconstruct the evolution of the reef over the past 30 millennia in response to major, abrupt environmental change.

The 10-year, multinational effort has shown the reef is more resilient to major environmental changes such as sea-level rise and sea-temperature change than previously thought but also showed a high sensitivity to increased sediment input and poor water quality.

Associate Professor Webster from the University's School of Geosciences and Geocoastal Research Group said it remains an open question as to whether its resilience will be enough for it to survive the current worldwide decline of coral reefs.

"Our study shows the reef has been able to bounce back from past death events during the last glaciation and deglaciation," he said. "However, we found it is also highly sensitive to increased sediment input, which is of concern given current land-use practices."

The study used data from geomorphic, sedimentological, biological and dating information from fossil reef cores at 16 sites at Cairns and Mackay.

The study covers the period from before the "Last Glacial Maximum" about 20,000 years ago when sea levels were 118 metres below current levels.

History of death events

As sea levels dropped in the millennia before that time, there were two widespread death events (at about 30,000 years and 22,000 years ago) caused by exposure of the reef to air, known as subaerial exposure. During this period, the reef moved seaward to try to keep pace with the falling sea levels.

During the deglaciation period after the Last Glacial Maximum, there were a further two reef-death events at about 17,000 and 13,000 years ago caused by rapid sea level rise. These were accompanied by the reef moving landward, trying to keep pace with rising seas.

Analysis of the core samples and data on sediment flux show these reef-death events from sea-level rise were likely associated with high increases in sediment.

The final reef-death event about 10,000 years ago, from before the emergence of the modern reef about 9000 years ago, was not associated with any known abrupt sea-level rise or "meltwater pulse" during the deglaciation. Rather it appears to be associated with a massive sediment increase and reduced water quality alongside a general rise in sea level.

The authors propose that the reef has been able to re-establish itself over time due to continuity of reef habitats with corals and coralline-algae and the reef's ability to migrate laterally at between 0.2 and 1.5 metres a year.

Future survival

However, Associate Professor Webster said it was unlikely that this rate would be enough to survive current rates of sea surface temperature rises, sharp declines in coral coverage, year-on-year coral bleaching or decreases in water quality and increased sediment flux since European settlement.

"I have grave concerns about the ability of the reef in its current form to survive the pace of change caused by the many current stresses and those projected into the near future," he said.

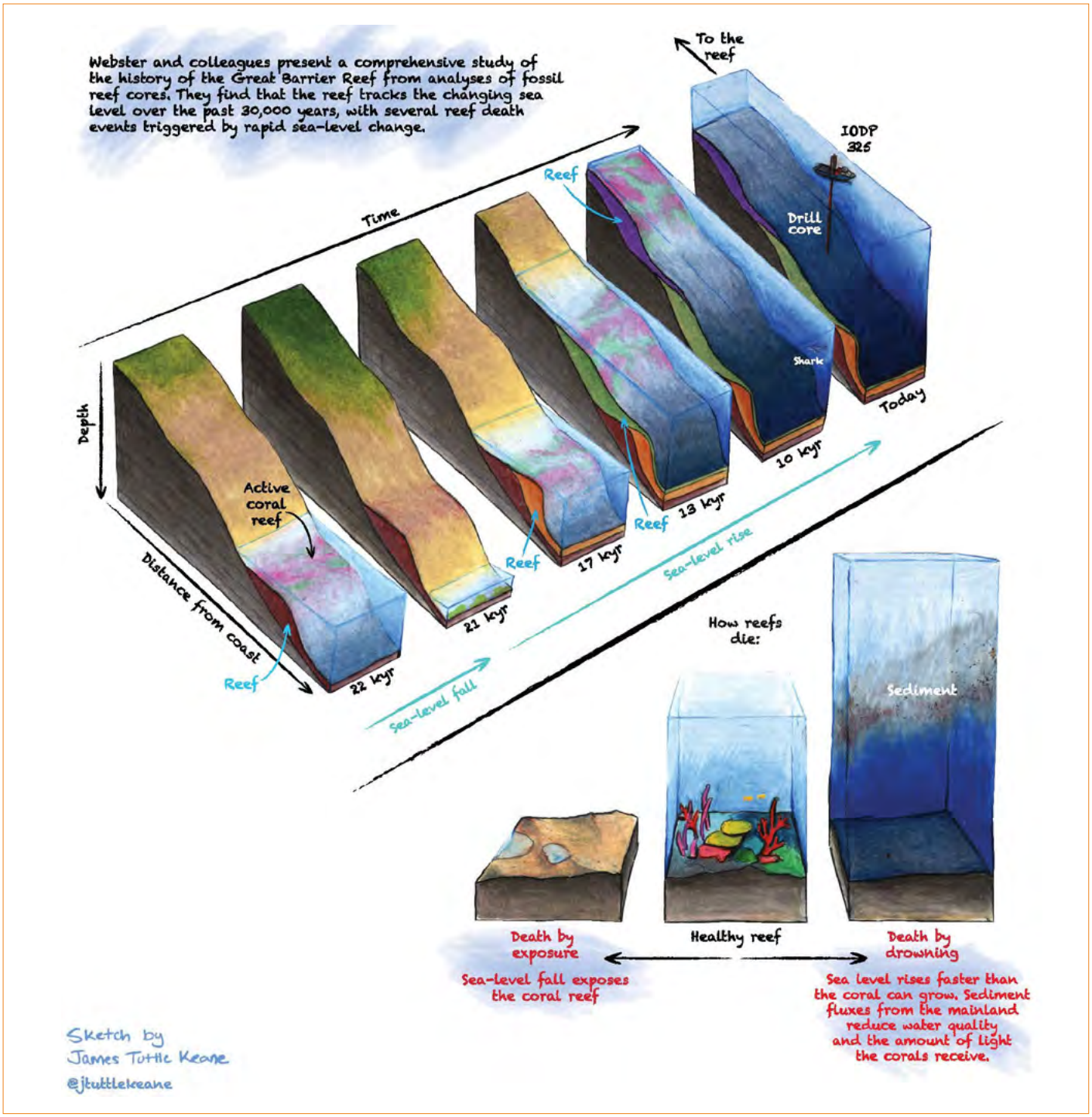
Associate Professor Webster said previous studies have established a past sea surface temperature rise of a couple of degrees over a timescale of 10,000 years.

Rise and fall of the Great Barrier Reef over 30,000 years

However, current forecasts of sea surface temperature change are around 0.7 degrees in a century.

"Our study shows that as well as responding to sea-level changes, the reef has been particularly sensitive to sediment fluxes in the past and that means, in the current period, we need to understand how practices from primary industry are affecting sediment input and water quality on the reef," he said.

Great Barrier Reef: Spatial and temporal change



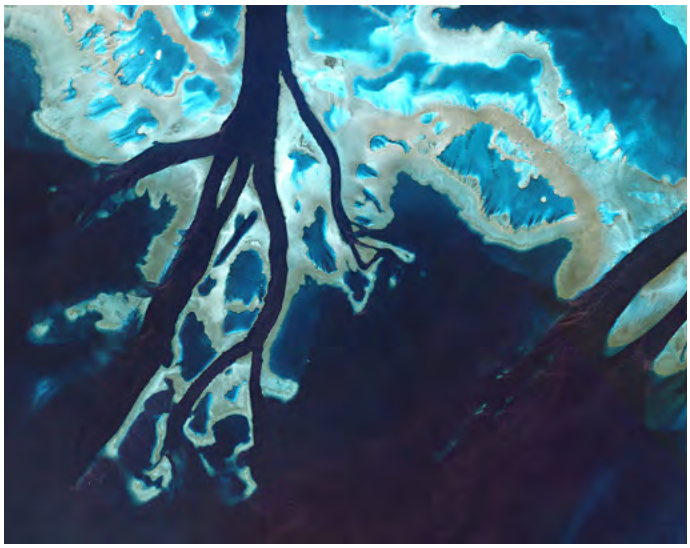
The reef has died five times in the past 30 millennia, largely in response to sea-level change caused by glaciation and deglaciation. A death event about 10,000 years ago looks more associated with high levels of sediment. Graphic by James Tuttle Keane and courtesy of Nature Geoscience

References

Webster, J.M., Braga, J.C., Humblet, M. et al. Response of the Great Barrier Reef to sea-level and environmental changes over the past 30,000 years. *Nature Geosci 11*, 426–432 (2018). https://doi.org/10.1038/s41561-018-0127-3

Rise and fall of the Great Barrier Reef over 30,000 years. Retrieved from University of Sydney News August 4, 2020. https://www.sydney.edu.au/news-opinion/news/2018/05/29/rise-and-fall-of-the-great-barrier-reef-over-30-000-years.html

Hot off the press! The rise and fall of the great barrier reef over the past 30,000 years. Retrieved from Coastal Research Group Blog, August 4, 2020. https://grgusyd.org/2018/05/29/hot-off-the-press-the-rise-and-fall-of-the-great-barrier-reef-over-the-past-30000-years/ .



Further reading

Mapping the fate of our reefs University of Sydney News, 29 March 2017 . Global warming and coral bleaching in the Great Barrier Reef. https://www.sydney.edu.au/news-opinion/news/2017/03/29/mapping-the-fate-of-our-reefs.html

How the great barrier reef sculpts underwater landscapes, July 20, 2020 by Geocoastal Research Group. https://grgusyd.org/2020/07/20/how-the-great-barrier-reef-sculpts-underwater-landscapes/

ABOVE: Envisat satellite image of a section of the Queensland coast and reef near Cape Melville NP. Source: https://commons.wikimedia.org/wiki/File:The_Great_Barrier_Reef,_Australia_-_Envisat.jpg

LEFT: Tidal channels cut through unnamed reefs off the coast of Queensland. Source: https://commons.wikimedia.org/wiki/File:Great_Barrier_Reef,_Australia_by_Planet_Labs.jpg

Recommended resources for teaching about coral reef resilience

Reef Resilience Network

Includes

- Ecological resilience
- Coral reef resilience including natural mechanisms such as recruitment and herbivory
- Resilient based management
- Reef resilience in practice – including GBR case study.

https://reefresilience.org/resilience/what-is-resilience/

Reef Blueprint: GBRMPA

http://www.gbrmpa.gov.au/our-work/reef-strategies/managing-for-a-resilient-reef