

After studying more than 1,500 coastal ecosystems, researchers say they will drown if we let the world warm above 2C

September 3 2023, by Neil Saintilan

Credit: Simon Albert

Much of the world's natural coastline is protected by living habitats, most notably mangroves in warmer waters and tidal marshes closer to the poles. These ecosystems support fisheries and wildlife, absorb the impact of crashing waves and clean up pollutants. But these vital services are threatened by global warming and rising sea levels.

Recent research has shown wetlands can respond to [sea level](#) rise by building up their [root systems](#), pulling [carbon dioxide](#) from the atmosphere in the process. Growing recognition of the potential for this "blue" carbon sequestration is driving mangrove and tidal marsh restoration projects.

While the resilience of these ecosystems is impressive, it is not without limits. Defining the upper limits to mangrove and marsh resilience under accelerating sea level rise is a topic of great interest and considerable debate.

Our new research, [published in the journal *Nature*](#), analyzes the vulnerability and exposure of [mangroves](#), marshes and coral islands to sea level rise. The results underscore the critical importance of keeping [global warming](#) within 2 degrees of the pre-industrial baseline.

What we did

We pulled together all the available evidence on how mangroves, tidal marshes and coral islands respond to sea level rise. That included:

- delving into the geological record to study how [coastal systems](#) responded to past sea level rise, following the last Ice Age
- tapping into a global network of [survey benchmarks](#) in mangroves and tidal marshes
- analyzing [satellite imagery](#) for changes in the extent of wetlands and coral islands at varying rates of sea level rise.



Coral islands are contracting, causing habitat loss in the Solomon Islands. Credit: Simon Albert

Altogether, our international team assessed 190 mangroves, 477 tidal marshes and 872 coral reef islands around the world.

We then used computer modeling to work out how much these coastal ecosystems would be exposed to rapid sea level rise under projected warming scenarios.

What we found

Mangroves, tidal marshes and coral islands can cope with low rates of sea-level rise. They remain stable and healthy.

We found most tidal marshes and mangroves are keeping pace with current rates of sea level rise, around 2–4mm per year. Coral islands also appear stable under these conditions.

In some locations, land is sinking, so the relative rate of sea level rise is

greater. It may be double this 2–4mm figure or more, comparable to rates expected under future climate change. In these situations, we found marshes failing to keep up with sea level rise. They are slowly drowning and in some cases, breaking up. What's more, these are the same rates of sea level rise under which marshes and mangrove drown in the geological record.



Eroding wetland at Towra Point in Sydney. Credit: Neil Saintilan

These cases give us a glimpse of the future in a warming world.

So if the rate of sea level rise doubles to 7 or 8 millimeters a year, it becomes "very likely" (90% probability) mangroves and tidal marshes will no longer keep pace, and "likely" (about 67% probability) coral islands will undergo rapid changes. These rates will be reached when the 2.0°C warming threshold is exceeded.

Even at the lower rates of sea level rise we would have between 1.5°C and 2.0°C of warming (4 or 5mm a year), extensive loss of mangrove and tidal marsh is likely.

Tidal marshes are less exposed to these rates of sea level rise than mangroves because they occur in regions where the land is rising, reducing the relative rate of sea level rise.

Let's give coastal ecosystems a fighting chance

We know mangroves and tidal marshes have survived rapid [sea level rise](#) before, at rates even higher than those projected under extreme climate change.

Ecosystem	Proportion likely lost under each warming scenario			
	1.5°C	2.0°C	3.0°C	4.0°C
Tropical coral reefs	75%	99%	100%	100%
Mangrove	81%	99%	100%	100%
Tidal marsh	34%	65%	67%	70%
Coral island	1%	4%	99%	100%

This is the proportion of existing habitat we stand to lose at various levels of warming above the pre-industrial baseline. Figures are best estimates, based for tropical coral reefs on global temperature changes (IPCC 1.5°C special report) and for mangrove, tidal marsh and coral islands, on rates of relative sea level rise (Saintilan et al., 2023, Nature)

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They won't have long enough to build up root systems or trap sediment in order to stay in place, so they will seek higher ground by shifting landward into newly flooded coastal lowlands.

But this time, they will be competing with other land uses and increasingly trapped behind coastal levees and hard barriers such as roads and buildings.

If the global temperature rise is limited to 2°C, coastal ecosystems have a fighting chance. But if this threshold is exceeded, they will need more help.

Intervention is needed to enable the retreat of mangroves and tidal [marshes](#) across our coastal landscapes. There is a role for governments in

designating retreat pathways, controlling coastal development, and expanding coastal nature reserves into higher ground.

The future of the world's living coastlines is in our hands. If we work to restore mangroves and [tidal marshes](#) to their former extent, they can help us tackle climate change.

More information: Neil Saintilan et al, Widespread retreat of coastal habitat is likely at warming levels above 1.5 °C, *Nature* (2023). [DOI: 10.1038/s41586-023-06448-z](https://doi.org/10.1038/s41586-023-06448-z)

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