Wetlands and climate change

Coastal wetlands help us adapt to sea-level rise

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The Fifth Assessment Report of the Intergovernmental Panel on Climate Change projects a rise in global mean sea level of between 0.40 metres and 0.63 metres by 2100.

Limited recognition of the dynamic nature of our coastlines has left us with a legacy of existing assets and infrastructure being vulnerable to erosion and inundation. We do have the capacity to adapt to this challenge, but there are financial, technological and cultural limits to our capacity to adapt. Delaying action increases the eventual cost of intervention. We need a new approach to coastal climate change adaptation, and scientific evidence indicates that coastal wetlands are crucial to sustainable coastal adaptation.

The value of working with coastal wetlands is being recognised by coastal engineers, particularly in the USA and Europe, who are harnessing the capacity of coastal wetlands to increase the resilience of shorelines undergoing erosion and to accommodate inundating floodwaters. Known as 'living shorelines', coastal wetlands are being constructed as an alternative to traditional engineering structures such as seawalls. The cost of living shorelines is estimated to be approximately 30–80 per cent lower than hard structures, and once established, living shorelines are a cost effective mechanism for protecting shorelines that have minimal ongoing maintenance costs.

There may also be significant economic gains in facilitating coastal wetlands to retreat and accommodate sea-level rise. The tidal wetlands of the Hunter River in New South Wales, where floodgates once held back tidal waters from coastal floodplains, are a beacon for sustainable coastal adaptation. Tidal exchange is being reinstated to the coastal floodplain resulting in the conversion of marginal farmland and freshwater wetlands to mangrove and saltmarsh. This will provide considerable gain in fish nursery habitat which may contribute over $14 000 per hectare per annum to commercial fisheries, and waterbird habitat for an internationally recognised wetland (Hunter Estuary Wetlands Ramsar site). In addition, as coastal wetlands are also amongst the most efficient ecosystems at sequestering carbon from the atmosphere, expansion of coastal wetlands across the floodplain will contribute to Australia's climate change mitigation efforts.

Rogers et al. (2014) estimated that an additional carbon sequestration of up to 280 000 tonnes by 2100 may occur on the Lower Hunter River when floodgates are open and coastal wetlands are able to adapt to sea-level rise by building accommodation and retreat strategies. Based on the historic carbon price of the European Union Emissions Trading Scheme, which has fluctuated between €5 (AU$7.73) and €30 (AU$46.40) per tonne of carbon since 2008, the carbon sequestered in the Hunter wetlands by 2100

could have a current value ranging between AU$2 million and $13 million in a carbon sensitive economy. Irrespective of a mandated emissions trading scheme, this sequestered carbon may potentially provide financial incentives for coastal wetland restoration and conservation through programs such as REDD+ and voluntary carbon markets like Voluntary Carbon Standard (VCS).

Sustainable coastal zone planning is essential if we are going to maximise the benefits gained from coastal wetlands. Appropriate planning would acknowledge the multiple benefits that coastal wetlands provide. It is imperative that local, state and federal governments begin discussions on protecting land that will accommodate the migration of natural coastal wetlands in the future. Natural coastal wetlands exist in four dimensions that include a location and elevation, and a trajectory through time. Planning needs the vision to encompass the changing boundaries coastal wetlands will have over time. Importantly, coastal zone planners, managers and researchers need to recognise that coasts are dynamic and that our coastal future will be different to the status quo. Working with coastal wetlands to adapt to sea-level rise is not only cost effective, but may also provide multiple economic gains for Australia.

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Example of a living shoreline along Haslams Creek, Homebush Bay, Australia. The revetment was revegetated with coastal saltmarsh in 2006 (top image), and by 2013 (bottom image) the area was supporting a range of saltmarsh species including the threatened Wilsonia backhousei

References

Kerrylee Rogers, Neil Saintilan and Craig Copeland (2014) 'Managed Retreat of Saline Coastal Wetlands: Challenges and Opportunities Identified from the Hunter River Estuary, Australia', *Estuaries and Coasts*, January 2014, Vol 37(1), pp 67–78 doi: 10.1007/s12237-013-9664-6

Staged opening of floodgates has commenced at Tomago Swamp (foreground) to reinstate tidal exchange between the swamp and the Hunter River estuary (background) (© Copyright, Doug Beckers, New South Wales National Parks and Wildlife Service)

Riparian restoration mitigates the impacts of climate change

Chrystal Mantyka-Pringle, ARC Centre of Excellence for Environmental Decisions

Freshwater habitats are critically important to a broad range of animals and plants, and they are in trouble.

Globally, these habitats are experiencing declines in biodiversity far greater than those being experienced in other terrestrial and marine ecosystems. New research involving the Australian Research Council's Centre of Excellence for Environmental Decisions (CEED) aim to help managers identify how this decline might best be dealt with.

Freshwater habitats face many problems. A combination of multiple stressors in freshwater ecosystems have resulted in population declines and range reductions of freshwater species all around the world, yet our understanding of the combined effects of climate change and land-use change on freshwater biodiversity is limited. For example, large uncertainties remain regarding which processes (such as biophysical processes like water temperature or nitrogen enrichment) will have the greatest impact on biodiversity in freshwater ecosystems and whether the sum of the individual stressor effects are greater than any stressor alone.

Working with the University of Queensland, CSIRO, Griffith University and the Queensland Government, CEED researchers modelled the independent and combined effects of climate change and land-use change on freshwater macroinvertebrates and fish using South East Queensland and the Ecosystem Health Monitoring Program as a case study (Mantyka-Pringle *et al.* 2014).

The first step involved building a conceptual model to identify the major causal links between land-use (for example, the amount of hard impervious surfaces and the amount of riparian vegetation) and climate (for example, air temperature, precipitation and rainfall variability) on freshwater biodiversity. The team then used this conceptual model to build a Bayesian Belief Network enabling the researchers to predict the effect of future land-use and climate change on the richness of macro-invertebrates and fish.

One of the key effects they identified through this modelling was that high nutrients and high runoff from urbanisation interacted with higher water temperatures as a result of climate change. This was the leading driver of potential declines in macro-invertebrates and fish at finer scales.

By identifying the mechanisms behind biodiversity loss, the researchers were able to identify management strategies that can simultaneously tackle both climate change and land-use change. The good news coming out of this study is that the restoration of riparian vegetation was identified as an important tool for adaptation that can mitigate the negative effects of climate change and land-use change on freshwater biota.

Riparian restoration has been transformed over the last few decades from engineer-based to ecosystem-based approaches. As a result, planting of native riparian buffers has become a priority for restoration projects as it improves ecological conditions in streams without negatively impacting riparian soils.

For more information on the research, please contact Chrystal Mantyka-Pringle (c.mantykapringle@uq.edu.au).

Reference

Mantyka-Pringle CS, TG Martin, DB Moffatt, S Linke and JR Rhodes (2014), 'Understanding and Predicting the Combined Effects of Climate Change and Land-Use Change on Freshwater Macroinvertebrates and Fish', *Journal of Applied Ecology*, March 2014 doi: 10.1111/1365–2664.12236

New research is showing that riparian restoration is an important buffering tool for reducing the negative effects of climate change and land-use change on freshwater biodiversity (© Copyright, David Salt, Environmental Decisions Group)

CSIRO's Coastal Carbon Cluster project

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Coastal wetlands cover less than 0.5 per cent of Australia's land surface, yet provide vital services to humans and associated ecosystems.

The mangroves, tidal marshes and seagrass that make up a coastal wetland provide habitat for water birds and fish, protect our coasts from flooding and erosion, and create a natural form of carbon sequestration.

Over the last year CSIRO's Coastal Carbon Cluster have collected sediment samples from over 120 sites (40 tidal marsh, 30 mangrove, and 50 seagrass sites), and made many important discoveries. The samples gathered and subsequent testing suggests that Australia's coastal wetlands have carbon sequestration rates that are 60 times greater than terrestrial forests.

The $3 million Cluster began in early 2013 and combines multidisciplinary expertise from CSIRO, the Australian Institute of Marine Science, and nine Australian universities. The aim of the Cluster is to determine the role coastal wetlands play in the storage of carbon across Australia, quantifying the capacity of these wetlands to trap and store carbon. The enormous potential of coastal wetlands to store carbon in sediments for millennia, termed 'blue carbon', provides prospects and opportunities to help mitigate human-induced climate change.

The Cluster is measuring the carbon content of sediments collected from coastal wetland sites across the whole of Australia. As part of the surveying and sampling, the researchers are refining area estimates for each coastal wetland type with the goal of producing detailed continental coastal maps. This information is critical for coastal managers and governments tasked with making decisions about the future of Australia's coastal wetlands.

Globally, coastal wetlands are being removed (for industrial and community development) four times faster than tropical forests. It is hoped that the research outcomes of the Cluster will assist coastal managers and governments to support the sustainable management of wetlands.

For further information on the project, please visit www.csiro.au/Coastal-Carbon-Cluster or contact the following project members:

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Mangrove-salt marsh interface at Amity Point on Stradbroke Island, Queensland (© Copyright, Trisha Atwood)

Jeff Kelleway conducts sediment sampling in mangroves at Towra Point Nature Reserve, New South Wales (© Copyright, Trisha Atwood)