Monitoring sea-level response and carbon sequestration in Australian supratidal forests

Coastal wetlands are dynamic ecosystems which are susceptible to shifts in vegetation structure, surface elevation and ecosystem service provision in response to sea-level rise. Research conducted over recent decades has demonstrated that some coastal wetland ecosystems, such as saltmarshes and mangroves, have a degree of resilience to sea-level rise. That is, in addition to wetlands migrating to higher grounds, they may also build their elevation capital in situ through the preservation of carbon-rich root material and/or the trapping of sediments. While such findings have been described for *intertidal* mangroves and saltmarshes, there is a critical knowledge gap regarding the response and tolerances of Australian forests positioned in the higher elevation '*supratidal'* zone, where sea-level rise impacts might be severe (Figure 1).

Figure 1 – Supratidal forests (right of image) typically occur at slightly higher elevations than adjacent intertidal saltmarsh (centre) and mangrove (left), and may be susceptible to impacts of sea-level rise

In Australia, supratidal forests are dominated by trees and shurbs of the genera *Melaleuca* (paperbark and tea-tree swamps) and *Casuarina* (swamp oak forests). Together, these genera cover more than 90,000 km^2 of Australia's land area, a significant portion of which is wetland habitat. *Melaleuca*-dominated forests or shrubs occur across the tropical north of the country, as well as Australia's southern temperate coastlines (Victoria to southern Western Australia). Coastal Swamp Oak Forest dominated by *Casuarina glauca* forms the landward border of intertidal saltmarshes and/or mangroves, particularly along the east coast of Australia (southern NSW to central QLD). Significant historic decline in swamp oak forest extent has led to their listing as 'Endangered Ecological Communities' under NSW and Commonwealth legislation. Understanding the response of these ecosystems to changing inundation regimes is critical, especially in a time of

Figure 2 – First measurements of a rod Surface Elevation Table – Marker Horizon (rSET-MH) instrument in an Australian supratidal forested wetland

accelerating global sea-level rise, and growing interest in the managed re-introduction of tidal flow to disturbed coastal landscapes to restore wetland services such as carbon storage, biodiversity and fisheries production (https://www.sciencedirect.com/science/article/pii/S0959378019304017).

The rod surface-elevation table–marker horizon (rSET-MH) approach to monitoring surface elevation change is a relatively simple, yet high-precision tool for quantifying surface dynamics and processes in coastal wetlands (Figure 2). This approach is the global standard for monitoring sea-level rise vulnerability in coastal wetlands. The rSET-MH technique provides information on below-ground processes that influence surface elevation and rates of elevation change and provides crucial data for the calculation of the 'blue carbon' value of wetlands (https://youtu.be/4fNW8spFS_o).

Figure 3 - Water level and salinity loggers in a supratidal forest are submerged following Spring tide and rainfall events

Funding from the GeoQuEST Research Centre has supported the construction and installation of rSET-MH stations in a number of sites along the temperate coast of SE Australia (Figure 2). While monitoring of rSET-MHs is in the early stages, data collected from complimentary approaches – including analyses of sediment cores, measurement of surface and groundwater inundation, and belowground decomposition experiments are presenting some important findings. Together, these data suggest that Australian supratidal forested wetlands are locations of high carbon preservation and storage, and may be subject to large variations in inundation and salinity due to extreme tides and flooding events (Figure 3).

Long-term monitoring of the rSET-MH network will enable the first comprehensive quantification of surface elevation change and sediment accretion dynamics for Australian supratidal wetlands. When combined with sediment core analyses (Figure 4), the rSET-MH network will also provide site-scale data crucial for quantification of carbon sequestration by these ecosystems, with implications for carbon accounting and climate change mitigation opportunities in Australia and globally.

Figure 4 - Collecting soil samples from Swamp Oak Forest wetlands as part of a citizen science program (https://www.earthwatch.org.au/news/blue-carbon-program-receives-higher-education-award) (left); the carbon-rich soil profile of a Swamp Oak Forest wetland (right)