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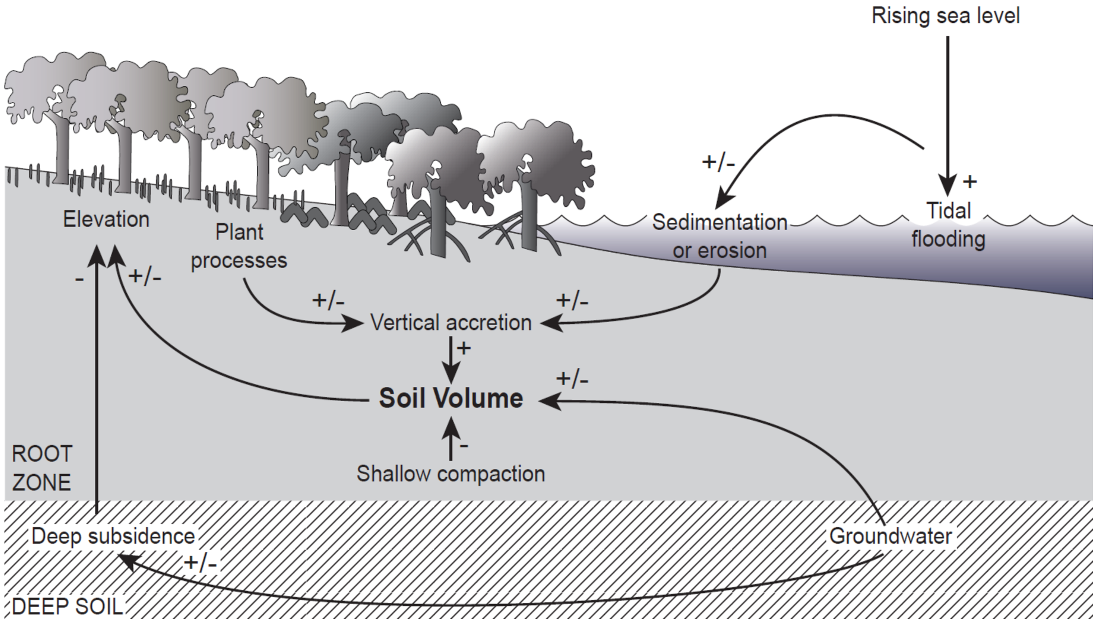
Indicator based modelling of the response of mangrove and saltmarsh to climate change and climatic variability on the Hunter River

Background

- Mangrove and saltmarsh are at the interface between the land and the sea. Changes in their elevation and distribution may be an indicator of changes in the relationship between the land and sea.



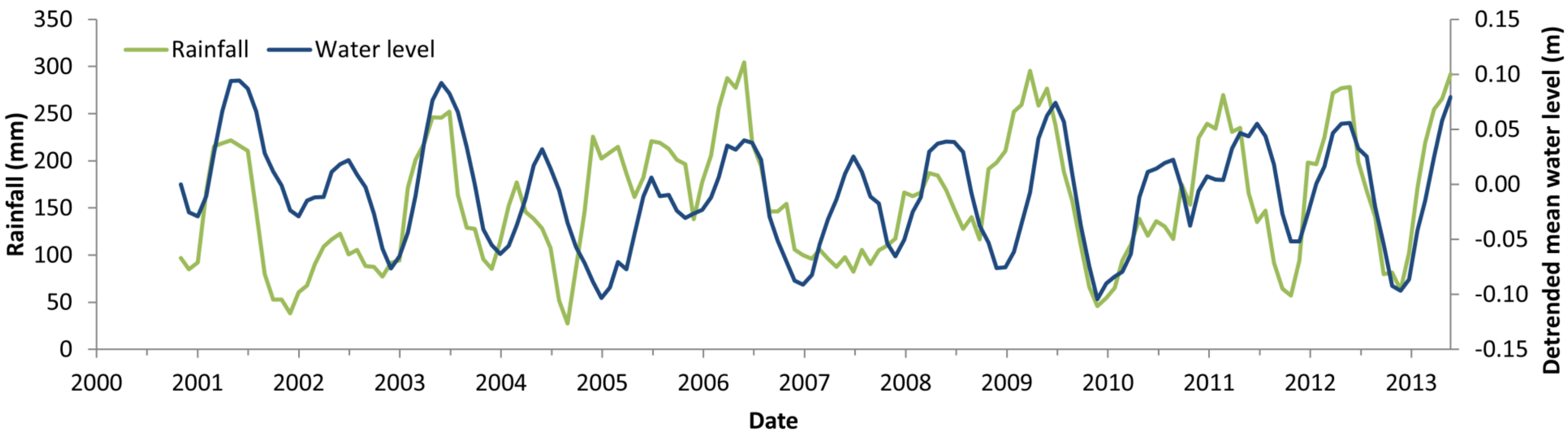
- Many biophysical factors influence the elevation of mangrove and saltmarsh including water level, inundation depth, duration and frequency of inundation, groundwater levels, sedimentation, plant productivity and organic matter decomposition (Woodroffe et al. 2014).

Background

- The difference between the degree of elevation change in a wetland and sea-level rise, commonly referred to as an elevation deficit, is used an indicator of the pending fate of coastal wetlands to sea-level rise.
- Over millennial and decadal timescales coastal wetlands have been found to adjust their elevation according to the degree of tidal inundation; a factor which correlates with sea-level rise.
- Over shorter time scales of up to a few decades there appears to be greater variability in the response of coastal wetlands to sea-level rise. Elevation adjustments at this scale may be preferentially influenced by short-term perturbations operating at inter-annual and inter-decadal timescales.
- Surface Elevation Tables and Marker Horizons are an ideal technique for exploring accretion and elevation adjustments over periods of years to decades.

Background

- The El Nino-Southern Oscillation (ENSO) is the dominant climatic perturbation operating in eastern Australia and has been correlated with rainfall (Allan 1988) and sea level (Zhang and Church 2012; Nerem et al. 1999).
- Recent changes in the distribution of coastal wetlands in southeastern Australia has been linked to both sea-level rise (Rogers et al. 2006) and rainfall (Eslami-Andargoli et al. 2009), and warrants further investigation.
- However, ENSO, rainfall and sea level are cross-correlated. Rogers et al. (2014) demonstrated that mean monthly water level variability on the Tweed River and total monthly rainfall were correlated.



Aim

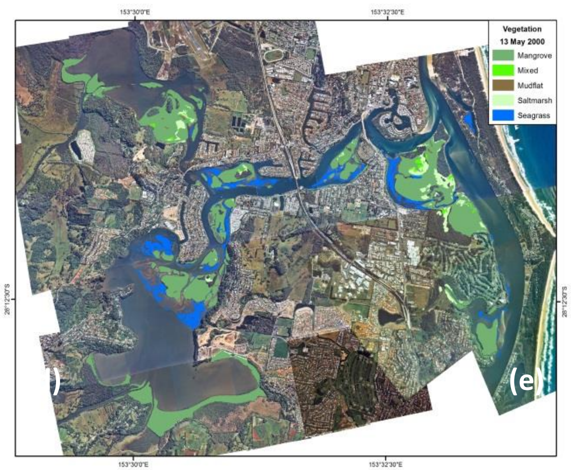
To determine whether surface elevation trends and the variability around trends are primarily influenced by climatic or hydrological variables

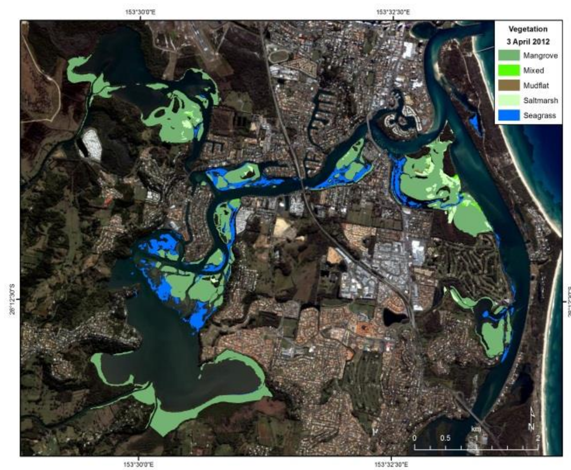
Methods

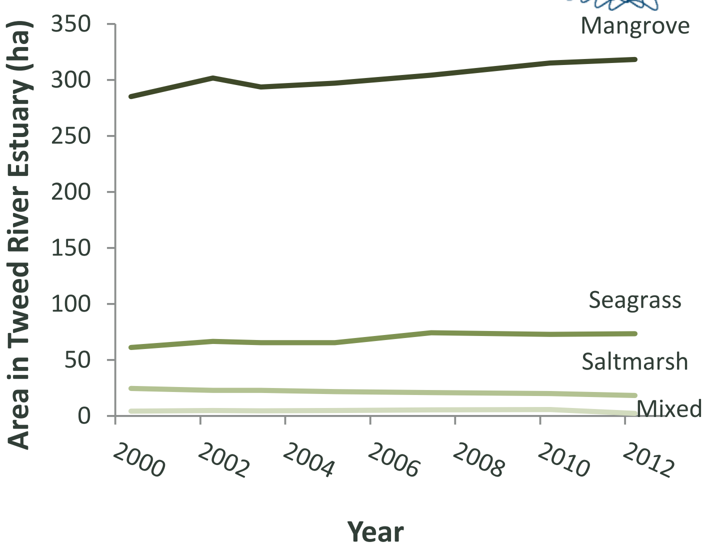
- Estuarine vegetation distribution mapping was undertaken using aerial photography from Pacific Wetlands (2012). This built upon the existing mapping undertaken by Saintilan (1998) and Wilton (2002).
- We used Surface Elevation Tables established in 2000 to identify surface elevation dynamics.
- Linear regression analyses were used to identify the overall trend in surface elevation change.
- Surface elevation change was detrended by subtracting the linear trend from each measurements to identify surface elevation variability.
- Stepwise linear regression analyses were used to identify drivers of the surface elevation trends and variability, and establish relationships between possible drivers, such as rainfall, SOI, water level, distance to the nearest shoreline and inundation depth.

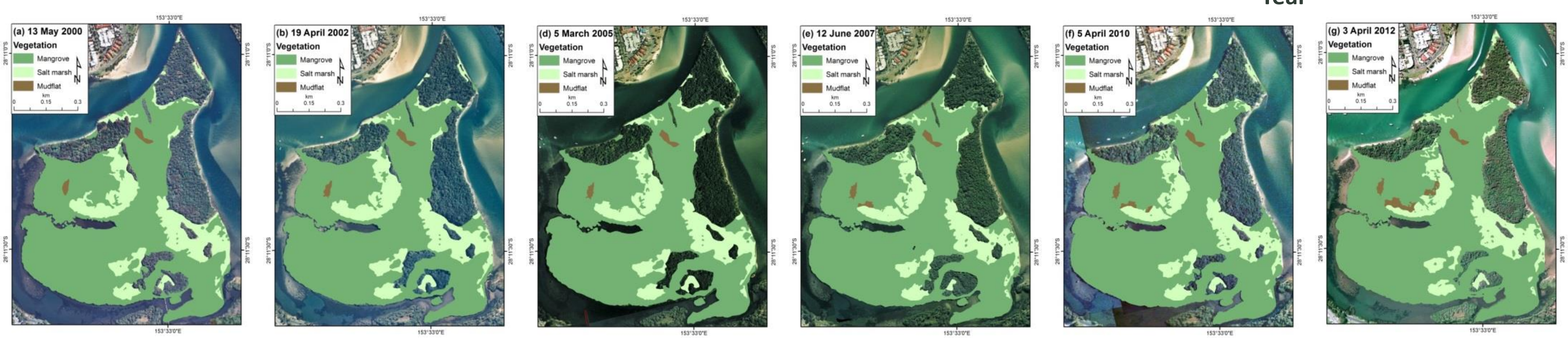
Results

- The study was undertaken at the Hunter River and focussed on Ukerebagh Island.
- Vegetation mapping indicated a continuing trajectory of mangrove expansion and a slight loss of saltmarsh over the study period.



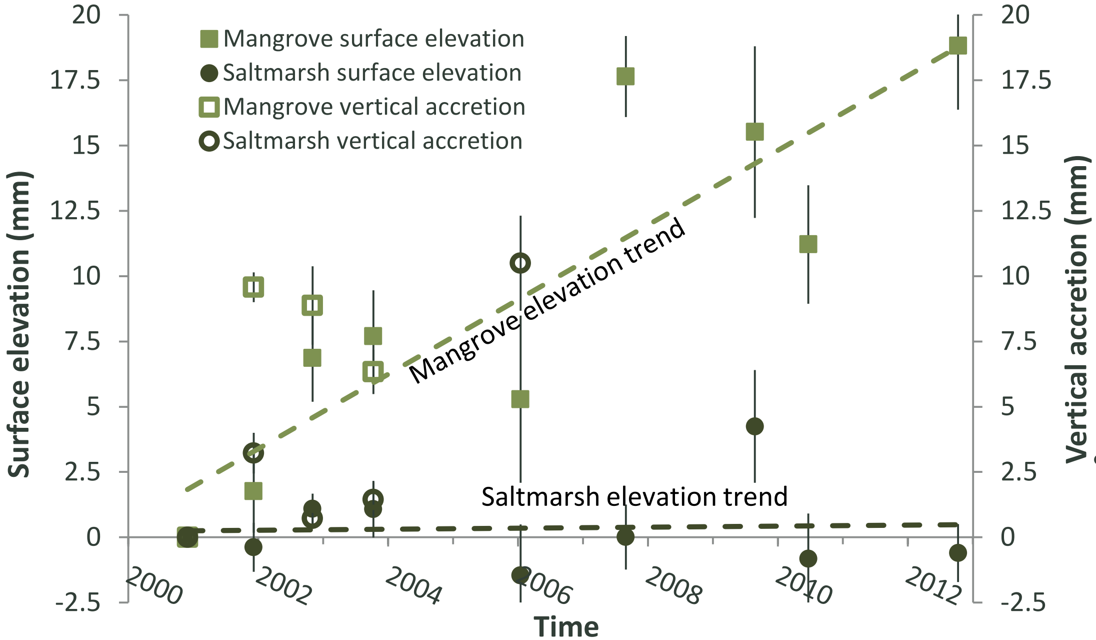


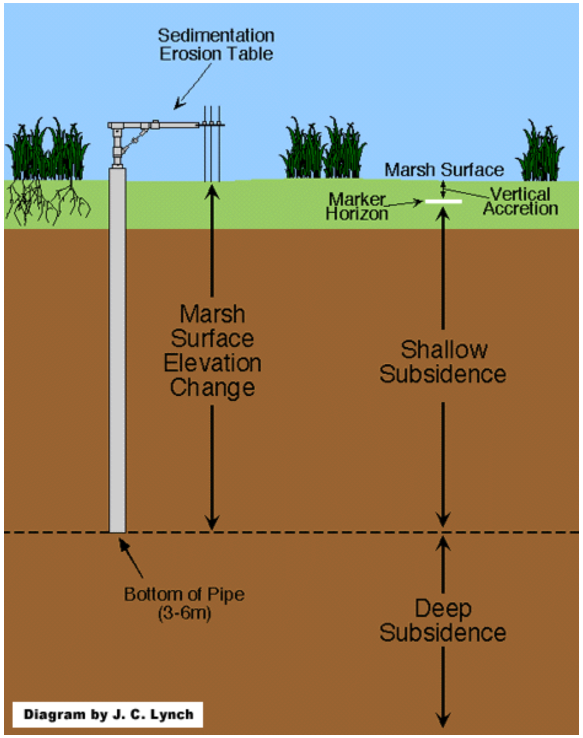




Results

- Using Surface Elevation Tables it was found that surface elevation gain was greater in the mangrove than the saltmarsh.
- Significant elevation deficits were evident in the mangrove and salt marsh based on long-term water level trends in the estuary.





- Factors driving elevation trends were related to position within the tidal prism and the influence this has on feedbacks between water level and elevation.

Important Rates of Change

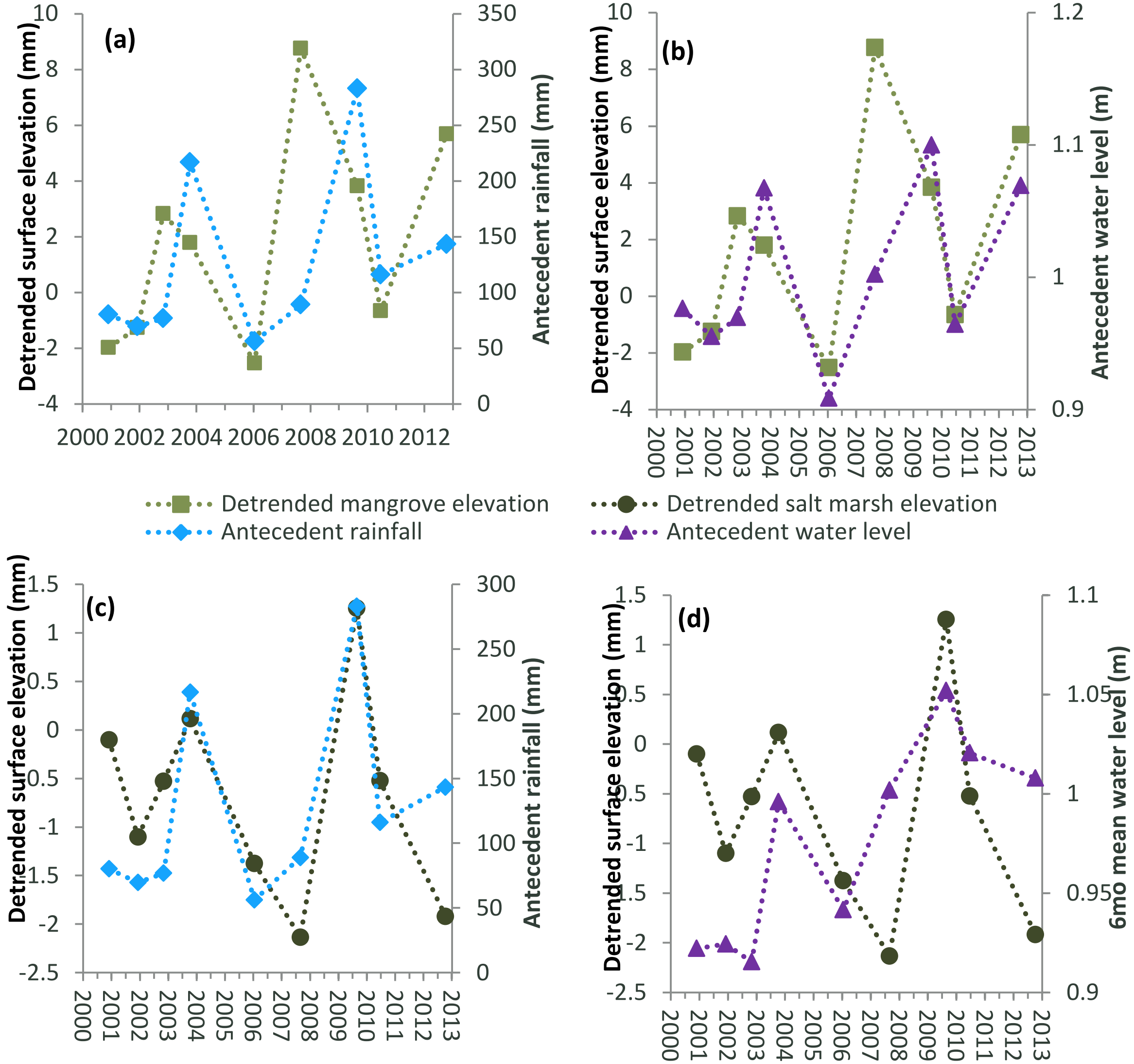
Long-term water level rise = 4.24 ± 0.16 mm/y
Global SLR (1993-2010) = 3.2 mm/y
Mangrove increase = 1.40 ± 0.03 mm/y
Saltmarsh increase = 0.17 ± 0.09 mm/y
Mangrove elevation deficit ~ -2.84 mm/y
Saltmarsh elevation deficit ~ 4.07 mm/y

- Significant factors influencing surface elevation trends in the mangrove and saltmarsh were:
  - Inundation depth (p=0.0009),
  - SOI (3 mo mean) (p=0.0147),
  - Hydrological distance (0.0398), and
  - Water level (6 mo mean) (p=0.0779)
- Rainfall did not significantly influence elevation trends (p=0.3760).

Results

Strong correlations were identified between surface elevation variability and environmental variables.

Variability in the mangrove and saltmarsh zone appears to be strongly influenced by climatic perturbations and their influence on antecedent rainfall and estuary water levels.



Conclusions

Surface elevation deficits may relate to a temporal lag between drivers of elevation gain and the elevation response. Elevation deficits may be a precursor to impending systemic change.

Vegetation changes may occur in response to long-term geomorphic change or short-term climatic perturbations.

Surface elevation trends appear to relate to position within the tidal prism and the influence this has on feedbacks between water level and elevation. Deviations from the long-term elevation trend was attributed to short-term climatic perturbations.

Management actions that increase the delivery of sediment to coastal wetlands, increase the capacity of vegetation to sequester sediment, and increase primary productivity and the contribution of organic matter to soil volume may ease the threat of systemic change to coastal wetlands as sea-level rise accelerates in the 21st century.

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Thank you

From the East Coast Cluster