Impacts on Mangrove Distributions in the Firth, and Implications

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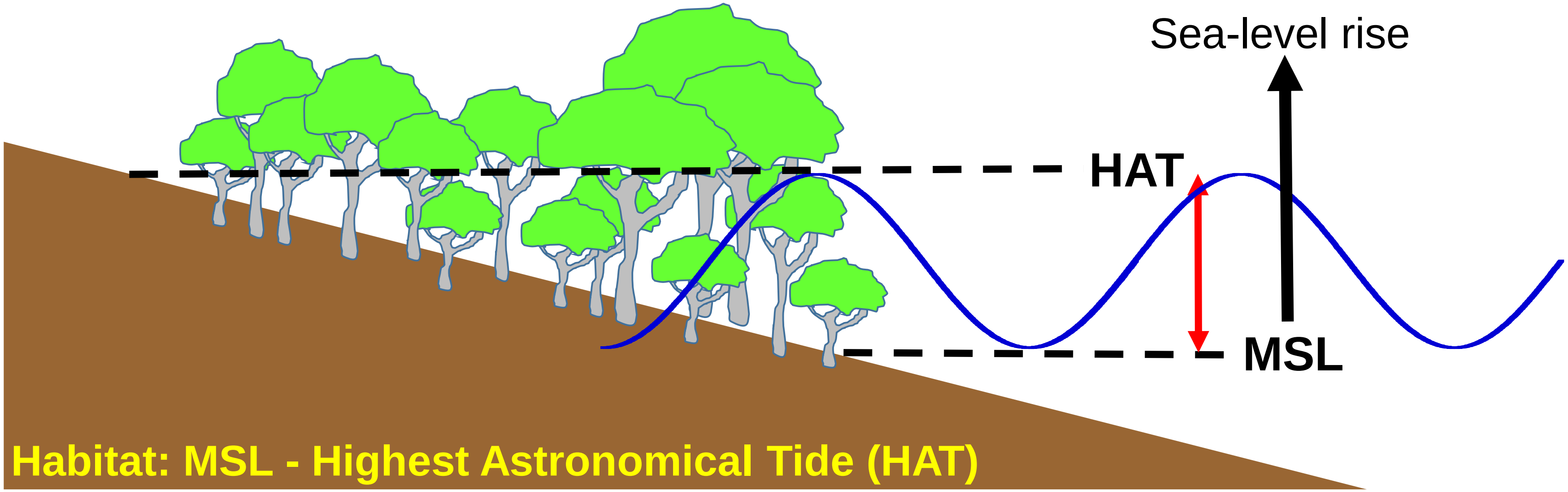
What are projected changes in mangrove distributions in the Firth of Thames?

- Climate Change likely to result in changes in:
  - Sedimentation rates
  - Sea level rise
  - Wave/storm frequency
  - Wind direction and strength
- Key driver of change in mangrove distribution is change in bed level height
- What is the likely impact on distributions of coastal habitats (mangroves, salt marsh) of these combined influences?

Study area: Firth of Thames/Waihou R/Gulf

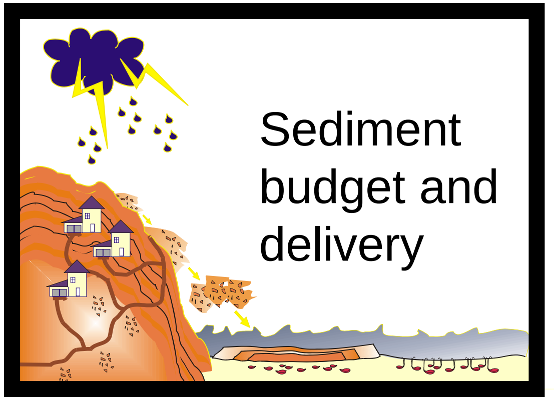
NZ Mangroves

- Mangrove forests (*Avicennia marina)* occur in upper North Island estuaries
- **Modern forests** developed over last ~150 yr = period of increased catchment erosion & accelerated estuary infilling
- M**angrove-habitat expansion** averaging **4% yr^{-1}** (last ~70 yr) = **displaced** other habitats
- **Intertidal zone** above mean sea level (**MSL**) = physiological tolerance to immersion
- **Must maintain position relative to MSL** as sea-level rises (surface elevation gain)



Key stressors: impacts, tipping points and implications for policy and management

- Climate changes
  - Temperature
  - **Sea Level Rise**
  - **Storm/Wave/Wind Climate**
  - **Rainfall**
  - **Catchment Sedimentation**



- Changes in bed level height through sediment deposition and/or erosion

- Changes in biological habitat distribution (and Ecosystem Services provided by them)

Model scenarios

- 3D **Deltares model**
- **Water Column sediment deposition model**

Projected changes in high tide water depth for:

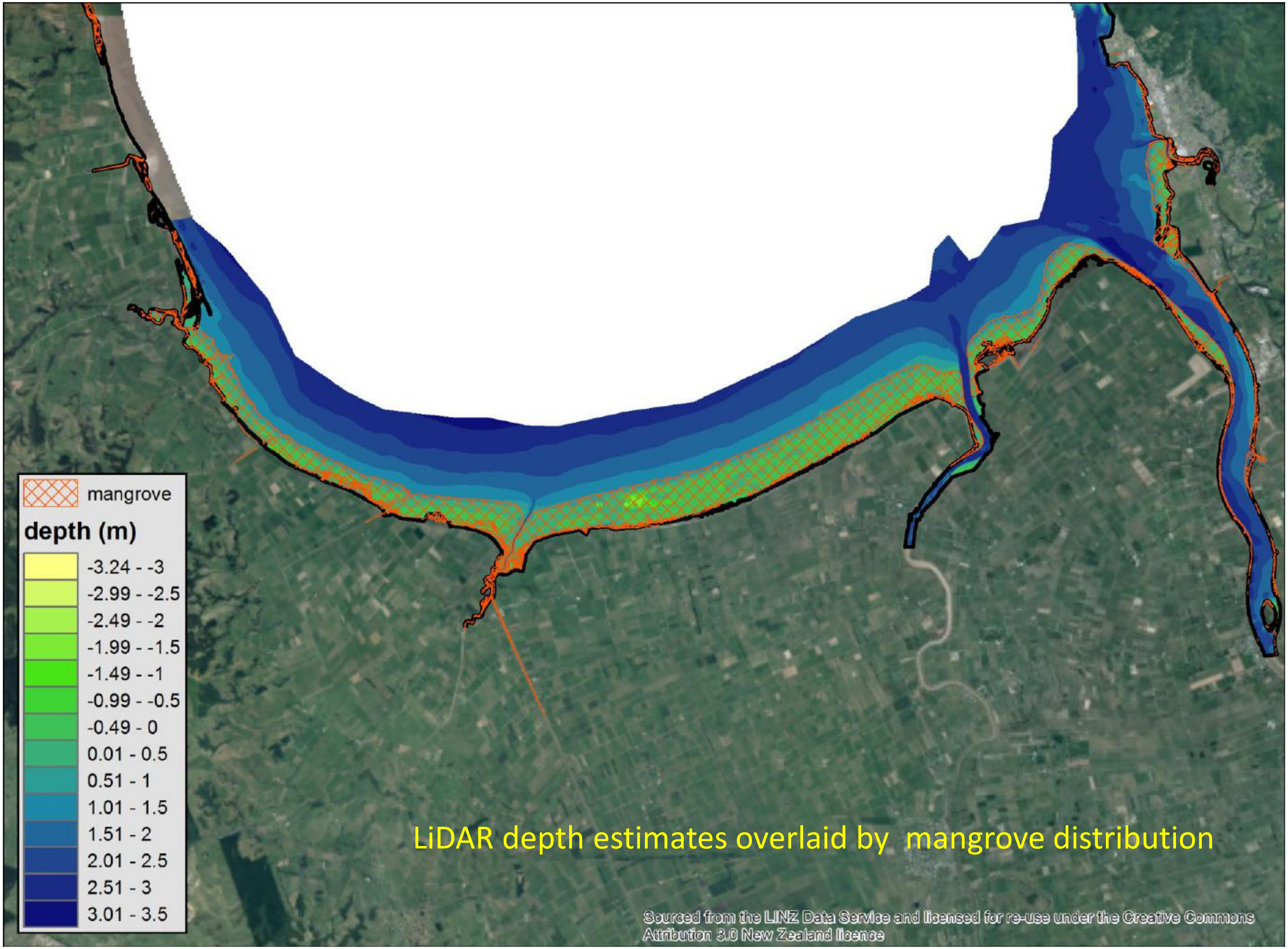
- 3 'positions'
  - intertidal wetting and drying;
  - edge of intertidal zone;
  - subtidal platform
- 4 RCPs (W/m^2)
  - 2.6
  - 4.5
  - 6.0
  - 8.5
- 3 sedimentation rates
  - 300 g/m^3 (in deep water)
  - 20% increase
  - 20% decrease

Convert projected changes in water depth to mangrove distribution

Projected changes in high tide water depth

→

- LiDAR to determine area in each depth band for 25cm increments from 3m above to 3m below '0 m' water depth
- Convert model projections of high tide water depth to LiDAR 'depths'
- Determine depth bands relative to mangrove ecological values;
  - Saltmarsh band
  - High suitability for mangroves (~80% in current FoT mangrove distribution)
  - Low suitability (above mean water depth, but typically low colonisation success by mangroves) (~10% colonised in current FoT mangrove distribution, though biology suggests these are potentially suitable for mangroves)
  - Subtidal - unsuitable
- Calculate revised depth bands and area covered after conversion using projected changes in high tide water depth


mangrove
depth (m)
-3.24 - -3
-2.99 - -2.5
-2.49 - -2
-1.99 - -1.5
-1.49 - -1
-0.99 - -0.5
-0.49 - 0
0.01 - 0.5
0.51 - 1
1.01 - 1.5
1.51 - 2
2.01 - 2.5
2.51 - 3
3.01 - 3.5
LiDAR depth estimates overlaid by mangrove distribution
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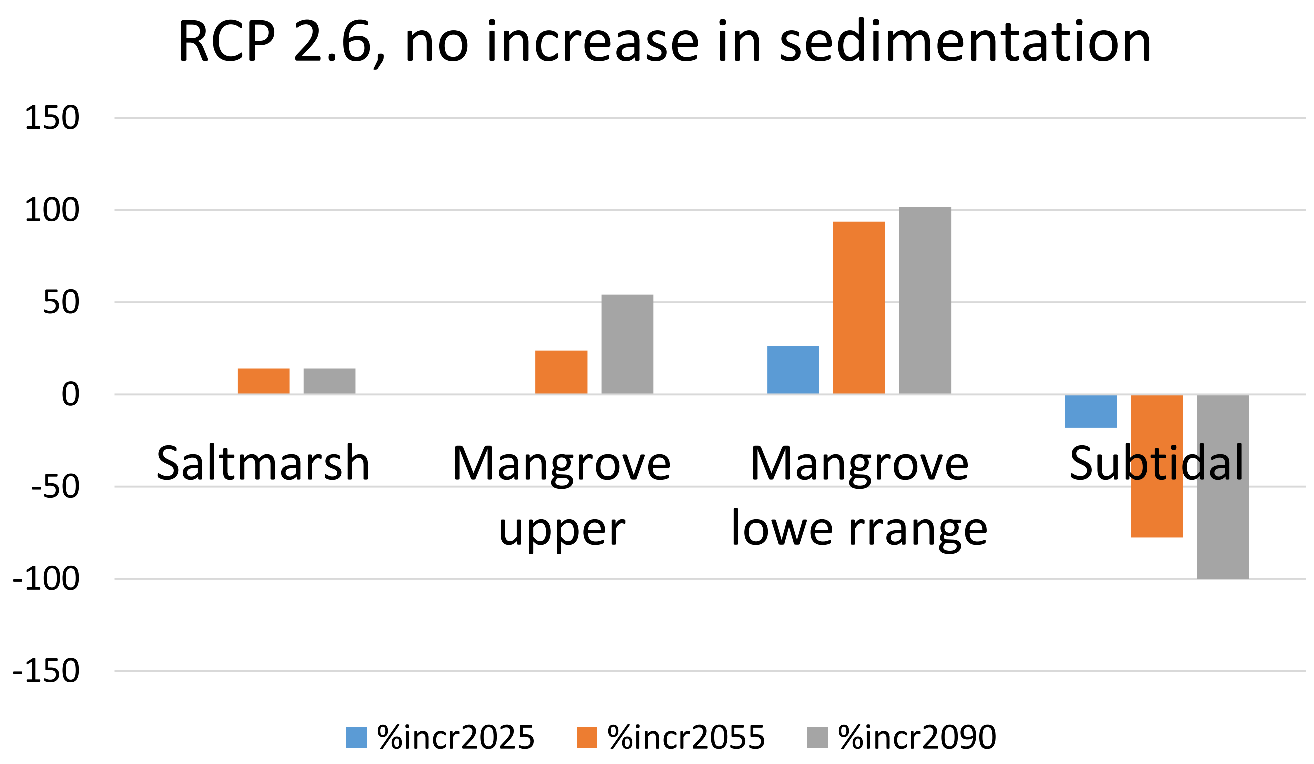
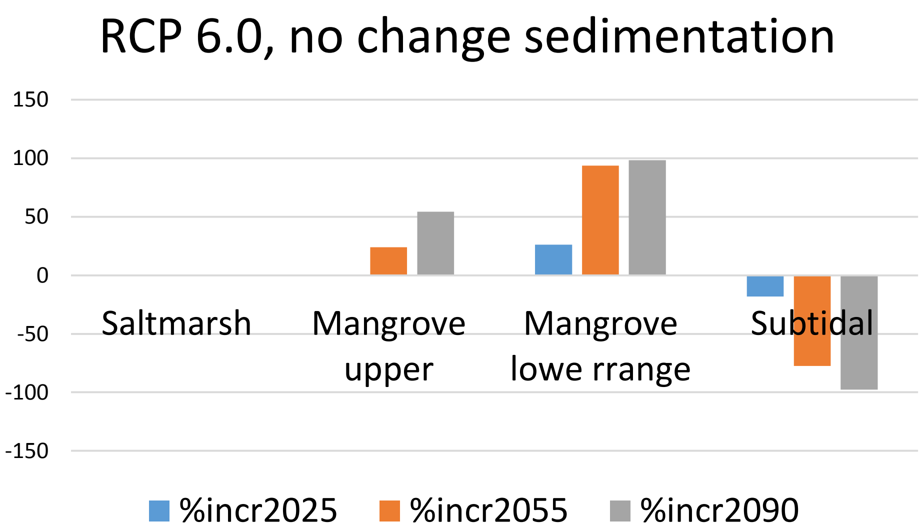
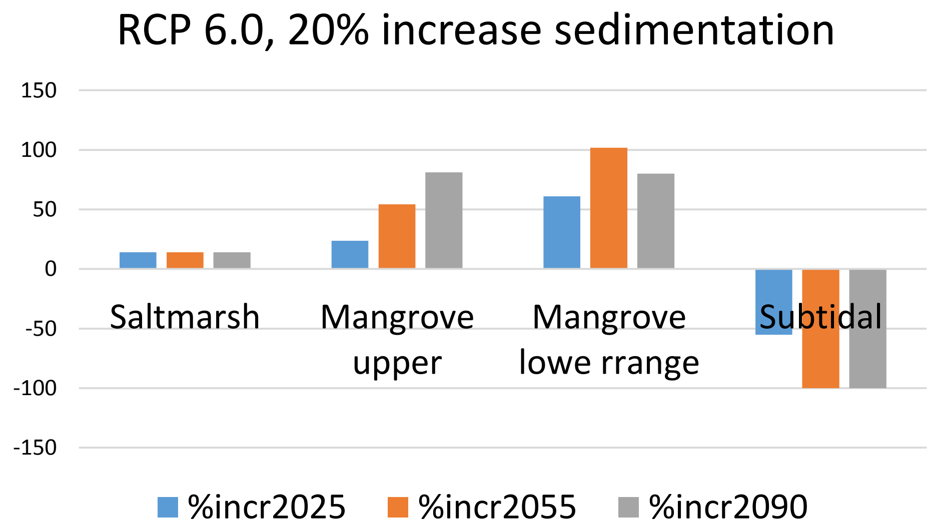
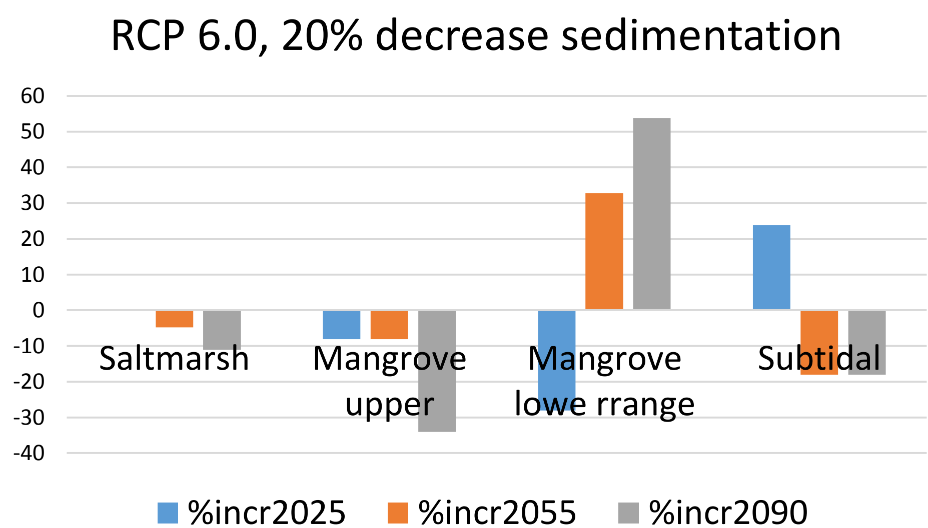
Example: change in mangrove distribution



Interactions between sedimentation and sea level rise







Summary of results

- Sedimentation and sea level rise interact to determine changes in coastal habitat distributions under different climate change scenarios
- In some scenarios, sedimentation is not sufficient to maintain mangrove distributions
- In other scenarios, increased sedimentation builds up bed level height resulting in increased mangrove distribution, likely at expense of saltmarsh and shallow subtidal habitats

Implications

- Landuse policies and practice need to be cognisant of the *primary role played by sediment runoff* on the evolution of bathymetry and water depth in the Firth over the next 100 years.
  - o In contrast to the Waihou River study where SLR is rather dominant
  - o SLR and sedimentation show signs of being in a state of equilibrium (differences between RCPs generally small)
- Nonetheless, water levels will rise of course, so waters' edge activities and infrastructure could be impaired (roads, railways,…).
- Further work needed to:
  - o analyse effect of various land use policies
  - o project changes in fisheries distribution, spawning, land flooding, storm surges

Next steps

- Sedimentation is important to maintain mangroves with respect to sea level rise.
- Barriers to seaward migration?
- Impacts on ecosystem services provided by coastal habitats?