Universiteit Utrecht

Faculty of Geosciences
River and delta morphodynamics

Bio-morphodynamics of coastal wetlands with mangrove vegetation

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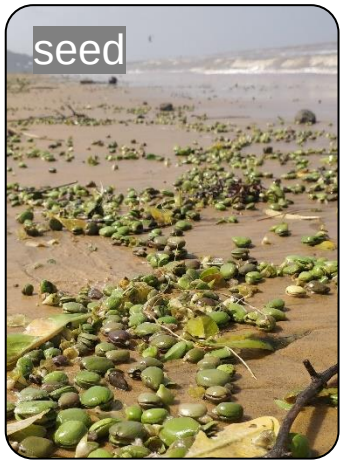
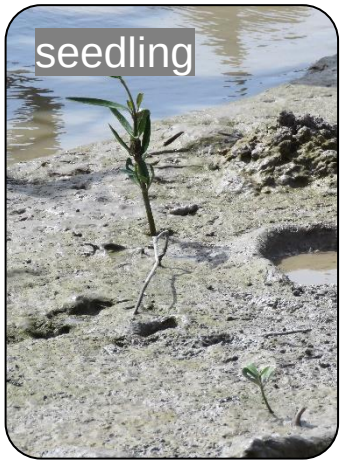
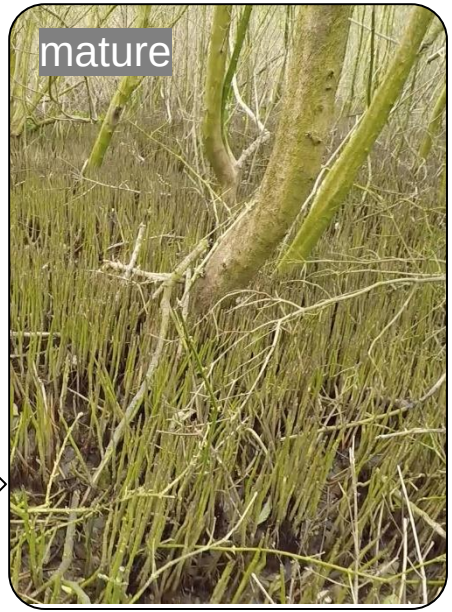
Life stages of mangrove forests





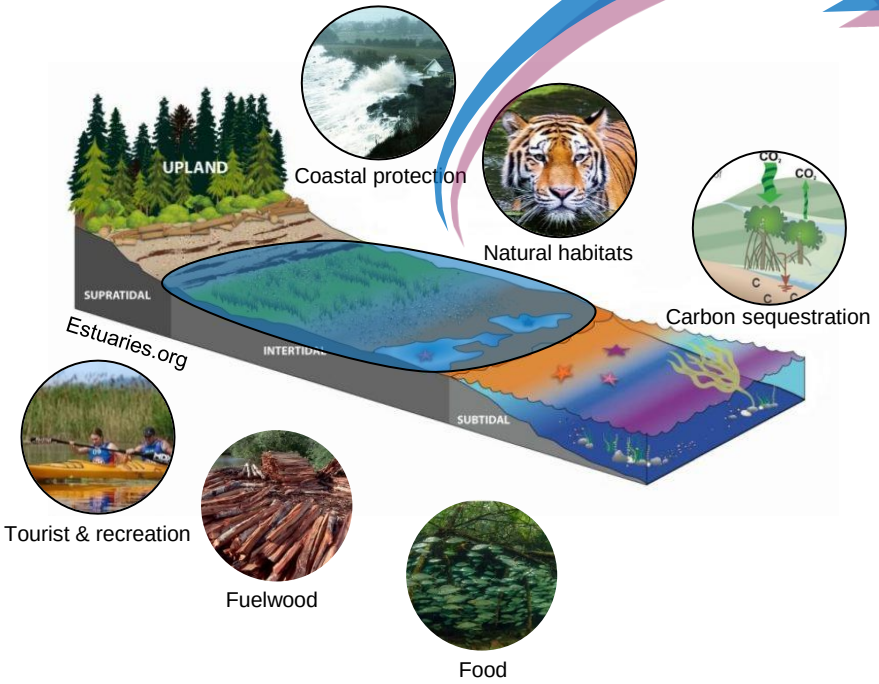


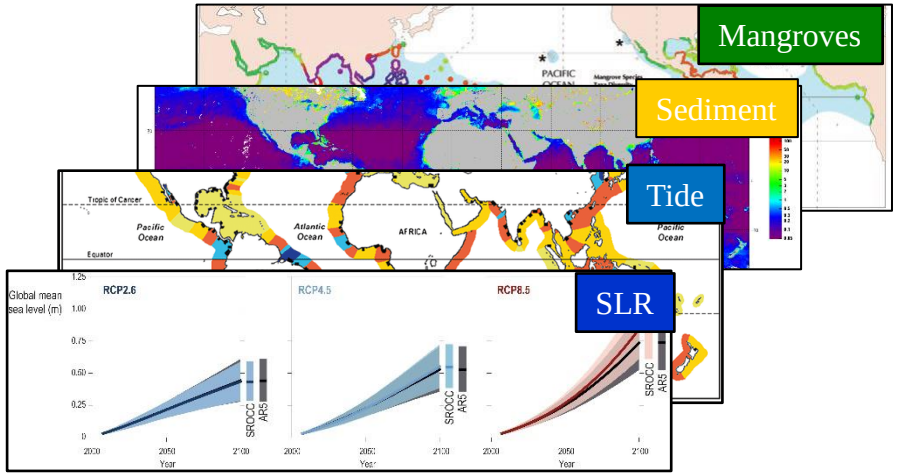
Causes:

- Prolonged inundation
- Lack of tidal flow
- Competition
- Human removal
- Others

Mangrove habitats

A multifunctional coastal ecosystem:



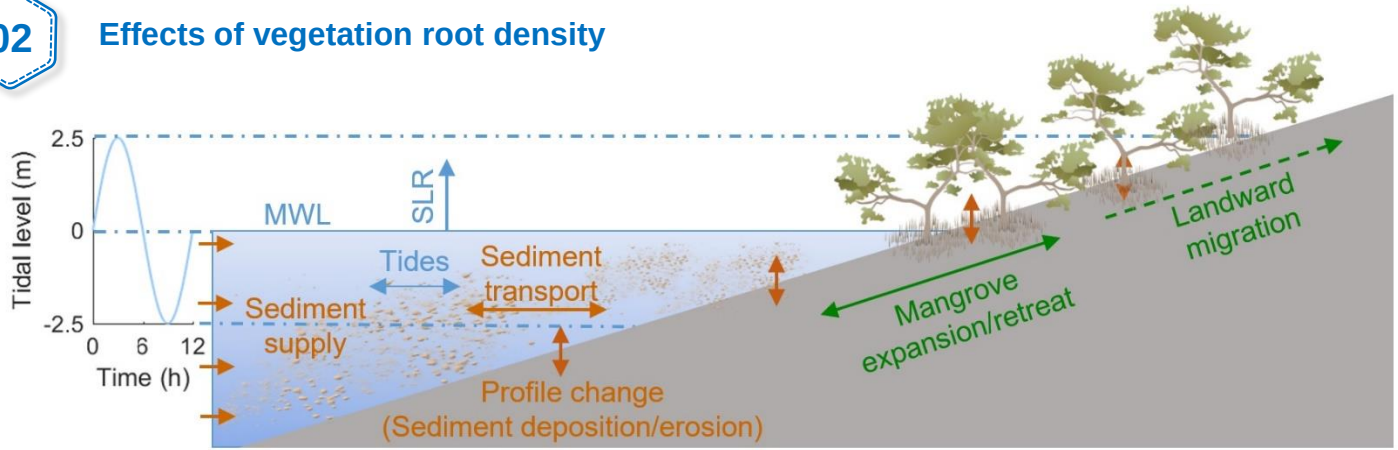


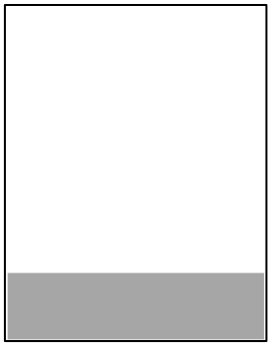
How do mangroves respond to accelerating sea-level rise under different coastal conditions?

Bio-morphodynamic model development

01 One or multiple vegetation species

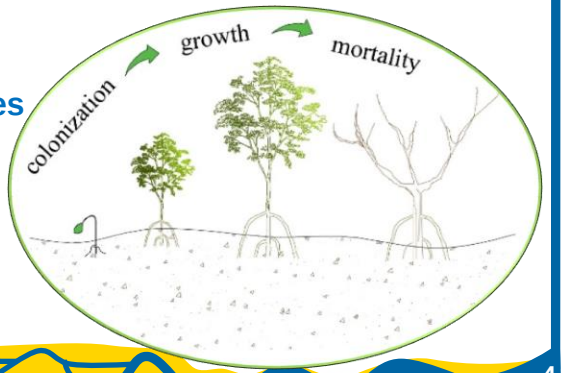
02 Effects of vegetation root density





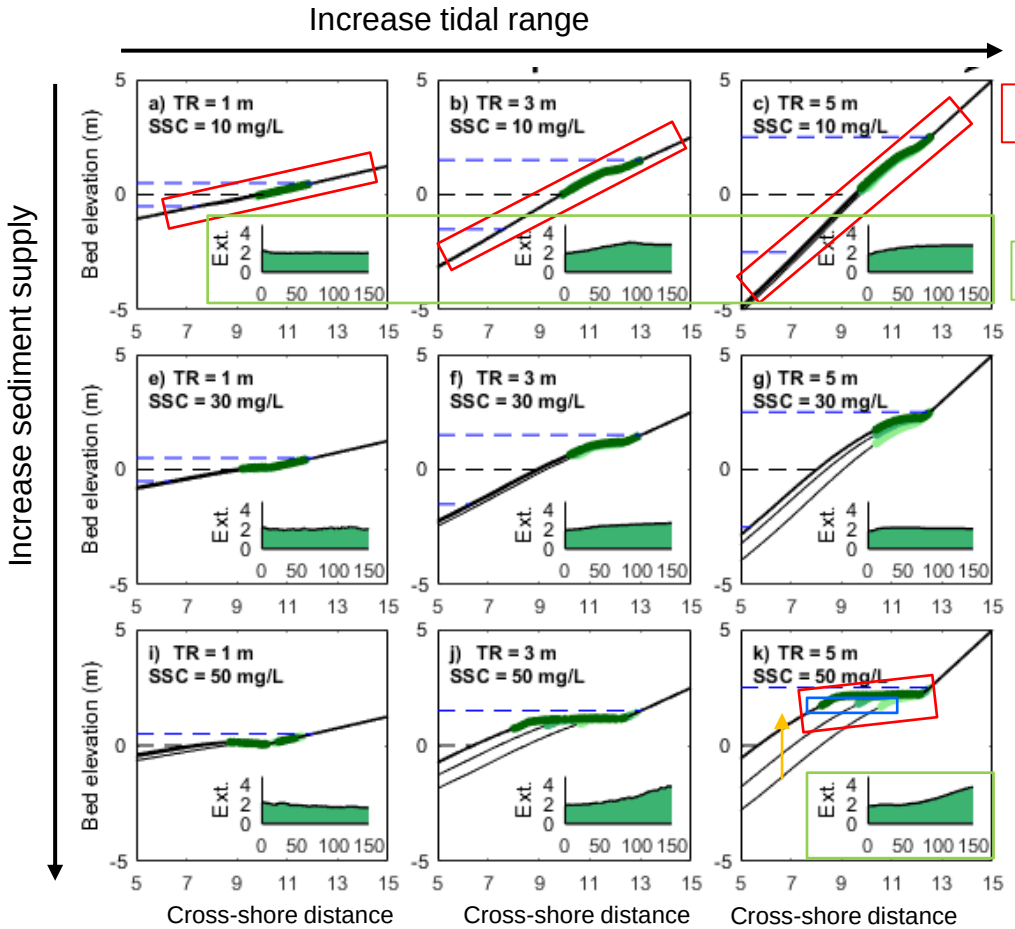
03 Tides, waves & sea-level rise

05 Dynamic vegetation processes



04 Comprehensive treatment of sediment process

Impacts of varying environmental conditions: *without* SLR



Stable profile & vegetation

Comparable vegetation extent

More accretion

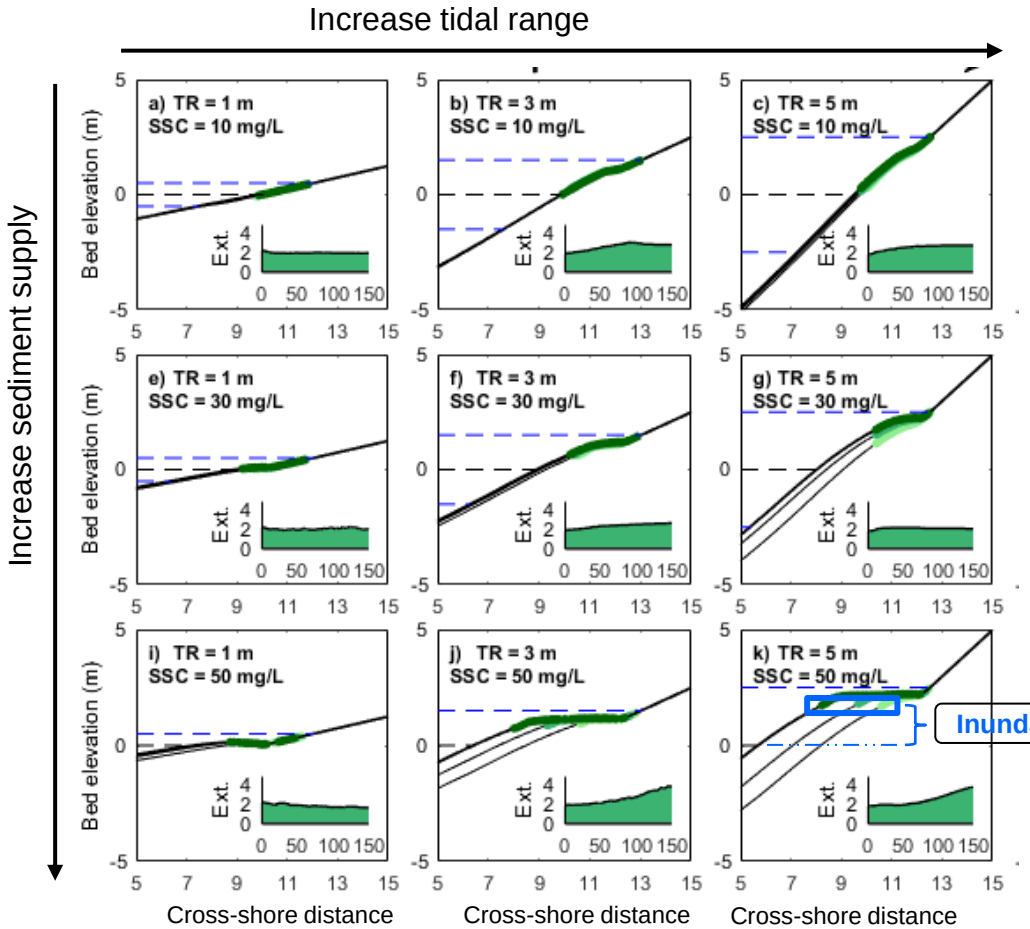
Gentler slope

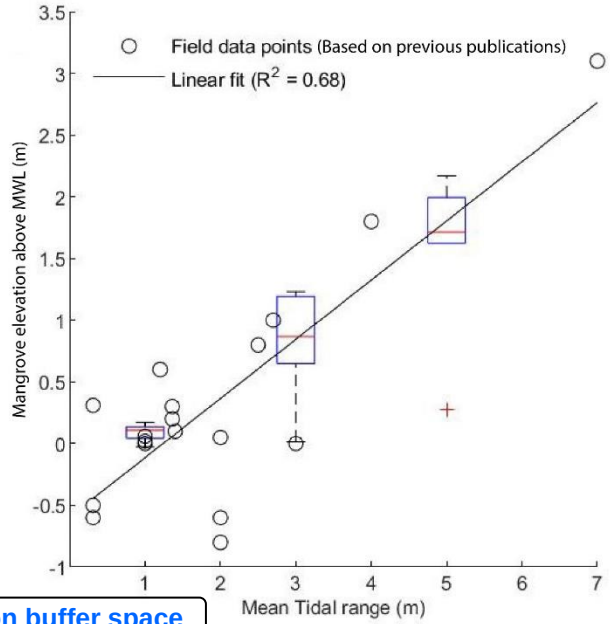
Vegetation extent increases

Mangroves colonize at higher elevation

Xie et al., 2022 Journal of Geophysical Research: Earth Surface

Impacts of varying environmental conditions: *without* SLR





Inundation buffer space

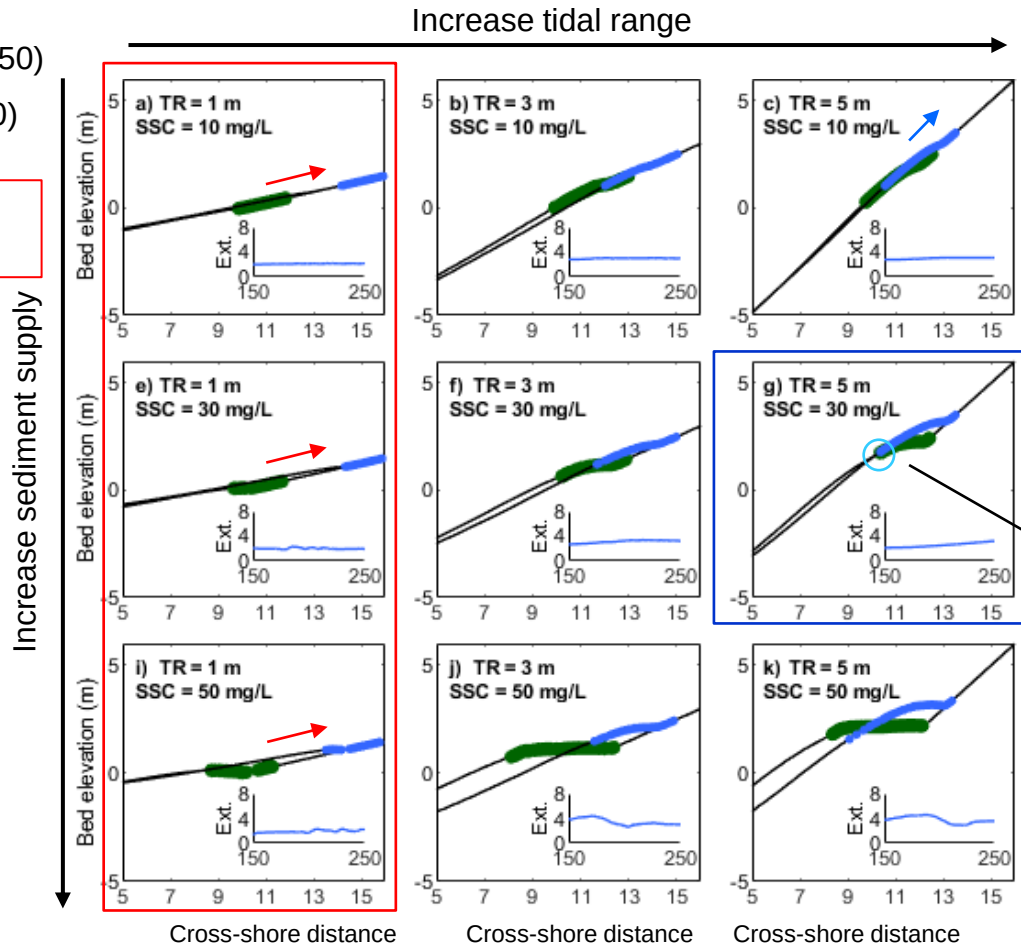
Limitation of mangrove seaward colonization increases with tidal range.

Xie et al., 2022 Journal of Geophysical Research: Earth Surface

Impacts of varying environmental conditions: *with* SLR

- Before SLR (year 150)
- After SLR (year 250)

Mangrove development: SLR dependent



Little landward retreat

Stable vegetation seaward

Mangroves initially colonize high such that increasing sea level doesn't inundate mangroves immediately within the study period.

Xie et al., 2022 Journal of Geophysical Research: Earth Surface

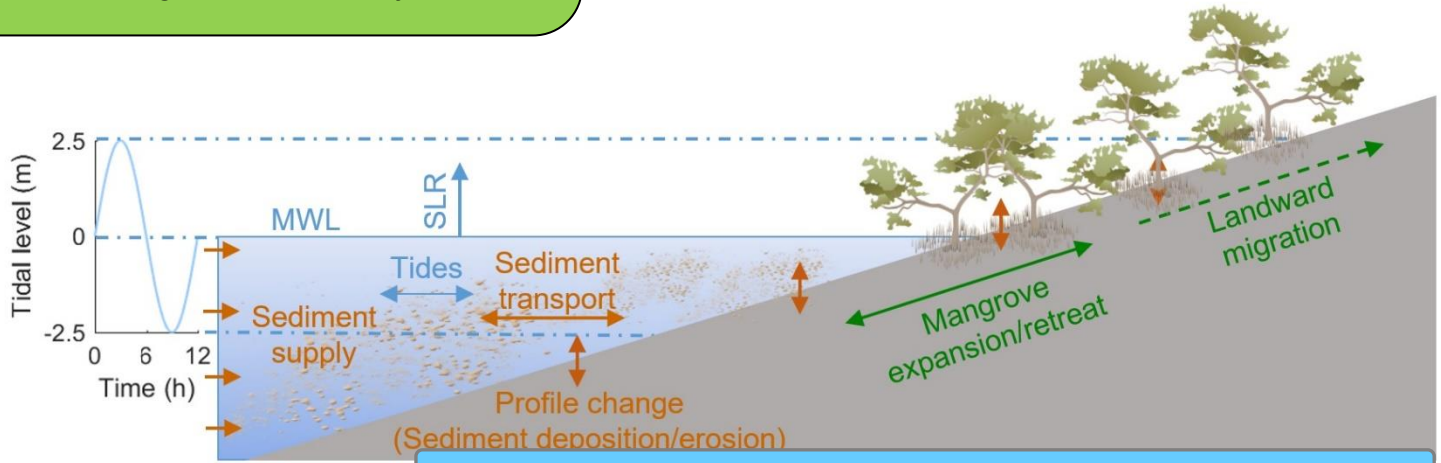
Key messages

Different mangrove responses due to physical settings:

1- Similar mangroves extent among different tidal ranges

2- Stable mangrove seaward edge with SLR

3- Mirco-tidal system exhibited highest vulnerability

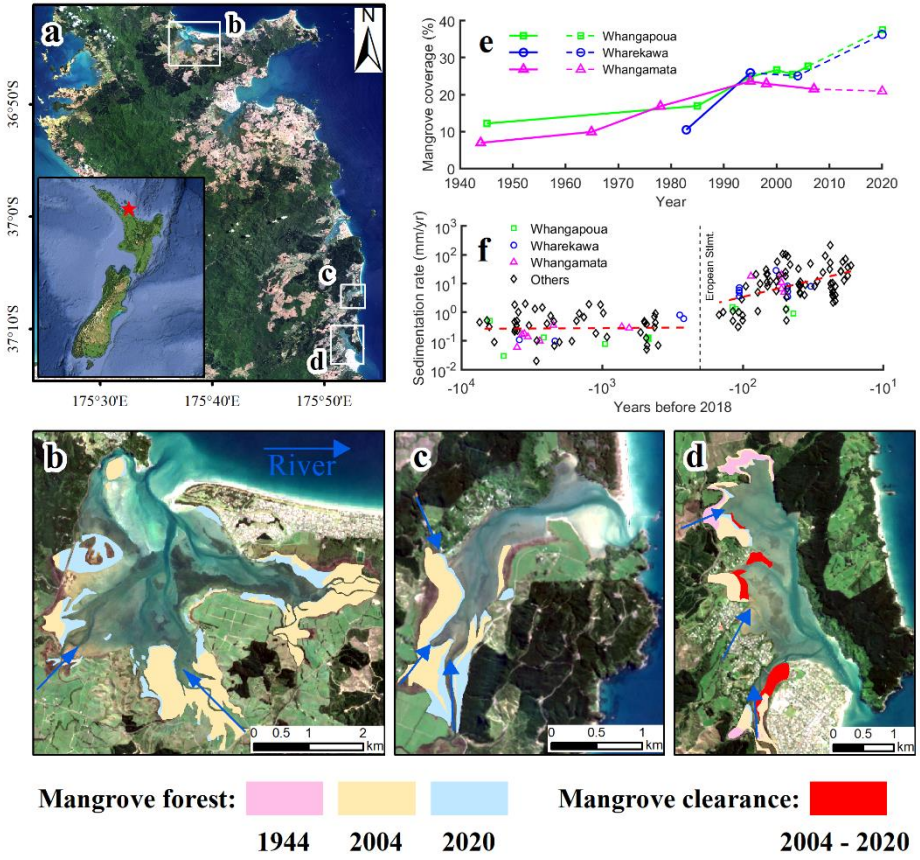


New mangrove model accounting for bio-morphodynamic interactions

Xie et al., 2020 - Mangrove diversity loss under sea-level rise triggered by bio-morphodynamic feedbacks and anthropogenic pressures, *Environmental Research Letters*, *15*(11), 114033.

Xie et al., (2022) - Implications of Coastal Conditions and Sea-Level Rise on Mangrove Vulnerability: a Bio-morphodynamic Modelling Study, *Journal of Geophysical Research: Earth Surface, 127(3), e2021JF006301*.

Impacts of upstream land-use change and mangrove removal

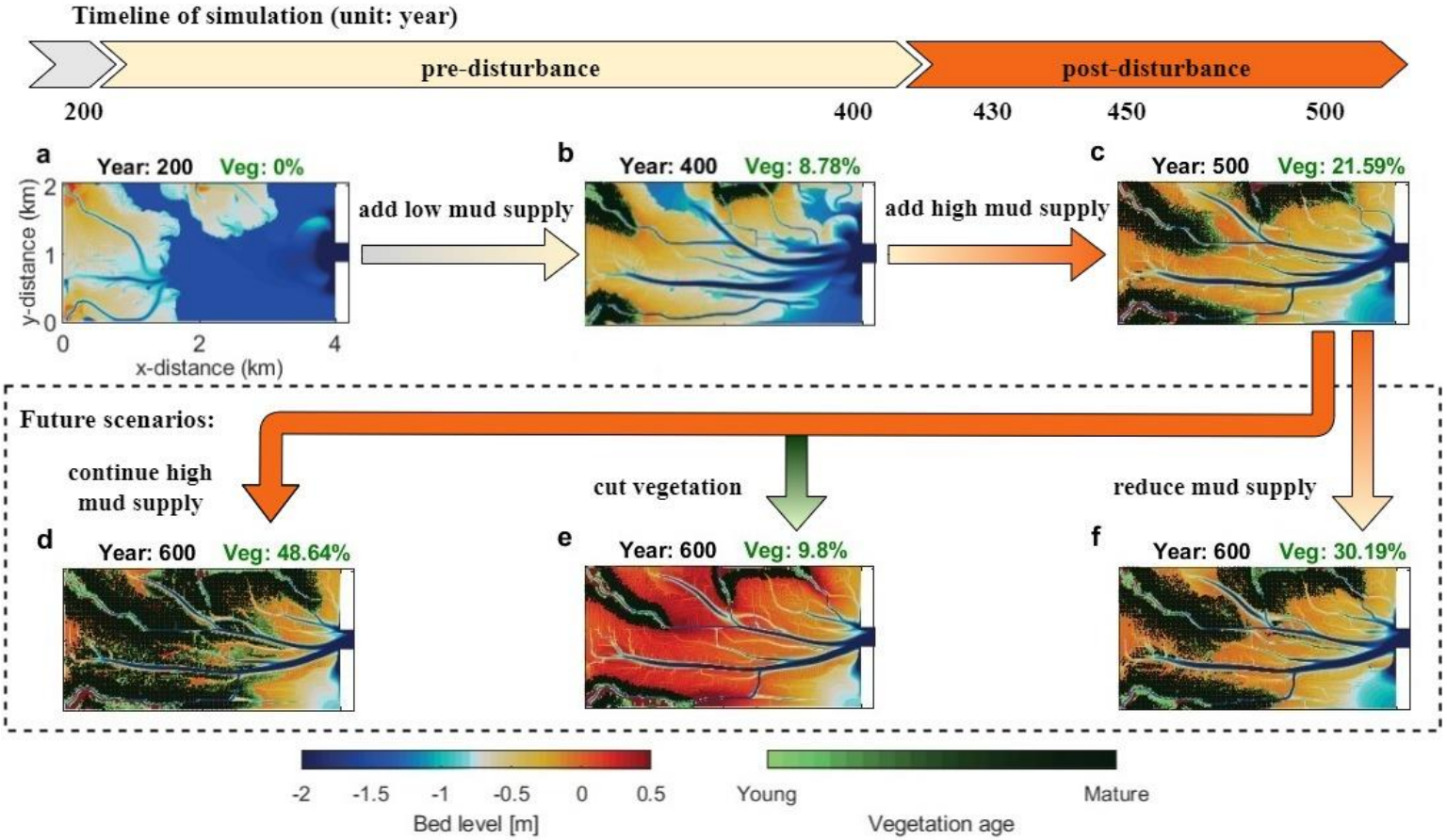


Mangrove expansion with increasing muddy sediment input

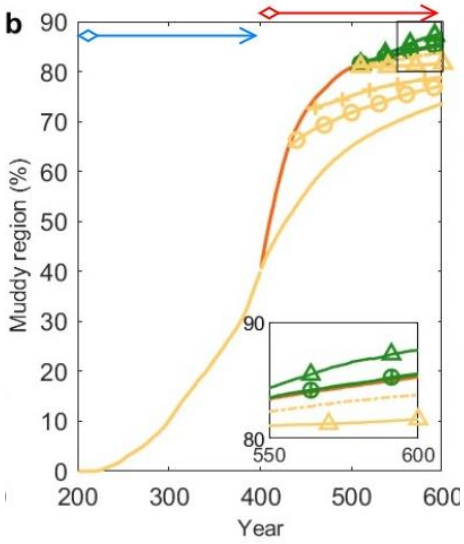
Mangrove clearance in New Zealand: mechanical clearance

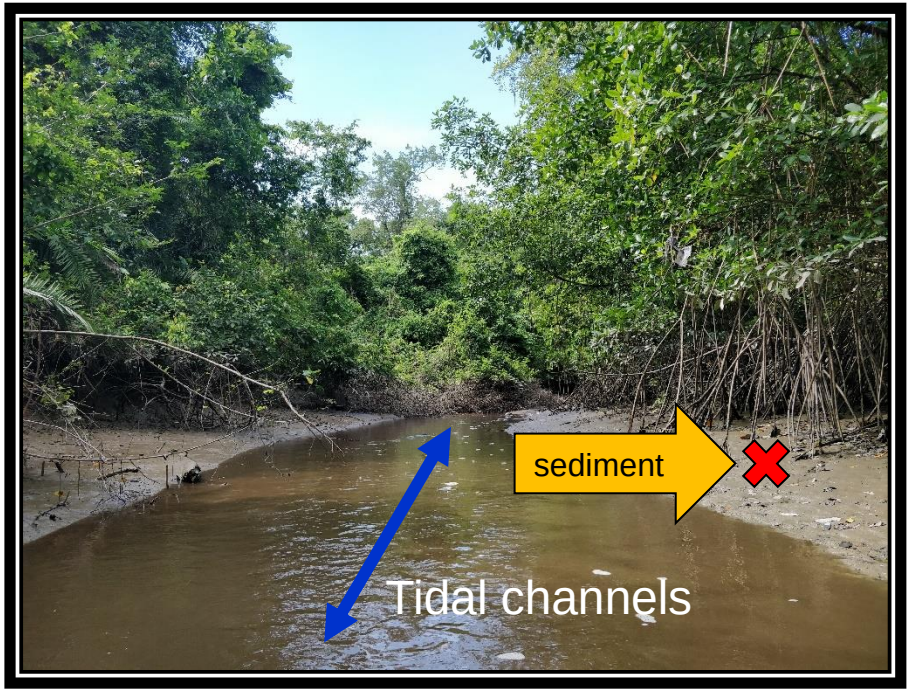
Is cutting off mangroves an effect way?

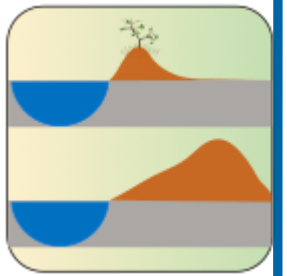
Impacts of upstream land-use change and mangrove removal



Impacts of upstream land-use change and mangrove removal



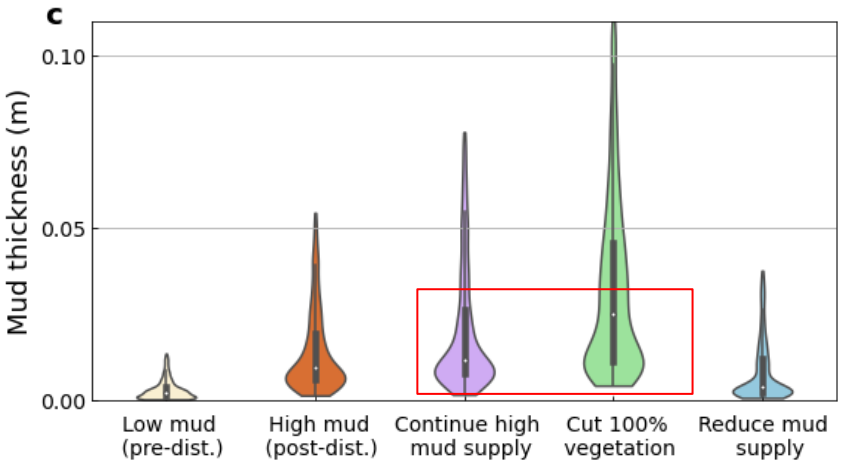




Low mud
High mud
Cut 25% vegetation
Cut 50% vegetation
Cut 100% vegetation
Intermediate mud
Low mud after 30-yr high mud
Low mud after 50-yr high mud
Low mud after 100-yr high mud

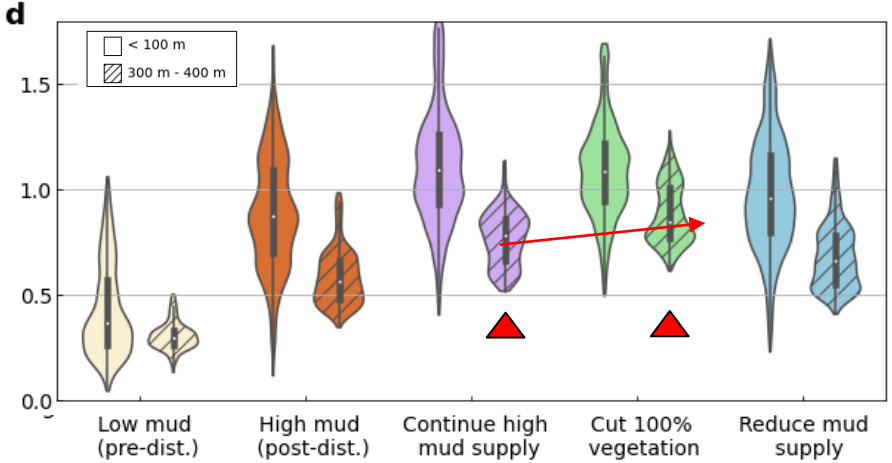
Impacts of upstream land-use change and mangrove removal

Channelized area



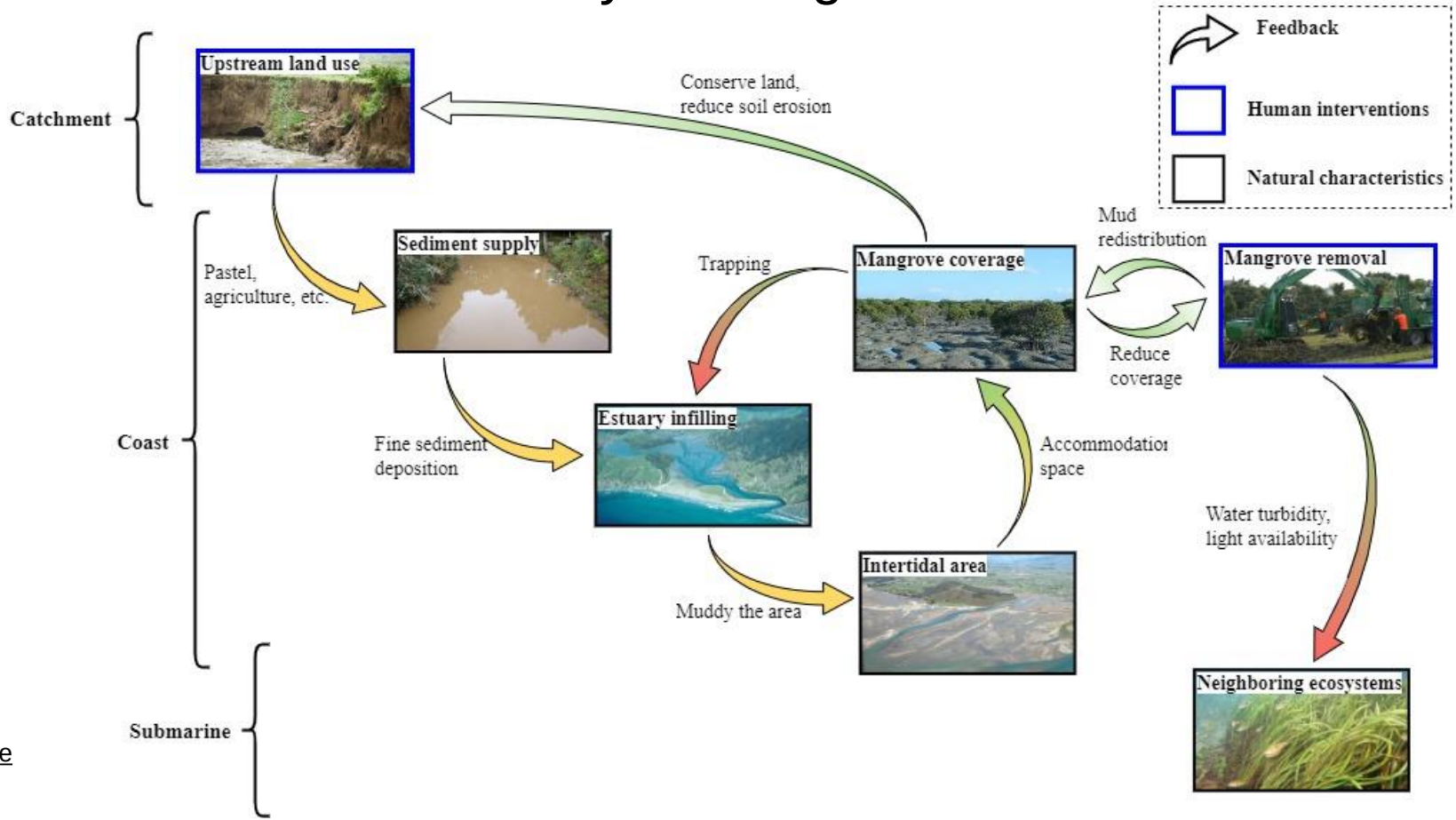
More Mud in the channels

Flats area



Mud redistributes further away from the channels

Key messages



code

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Stop cutting off mangroves, but please manage the upstream land use