



CSDMS
community surface
dynamics modeling system

**BOSTON
UNIVERSITY**

Universiteit Utrecht

Faculty of Geosciences

River and delta morphodynamics



Responses of mangrove forests to sea-level rise and human interventions: a bio-morphodynamic modelling study

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Life stages of mangrove forests

seed



seedling



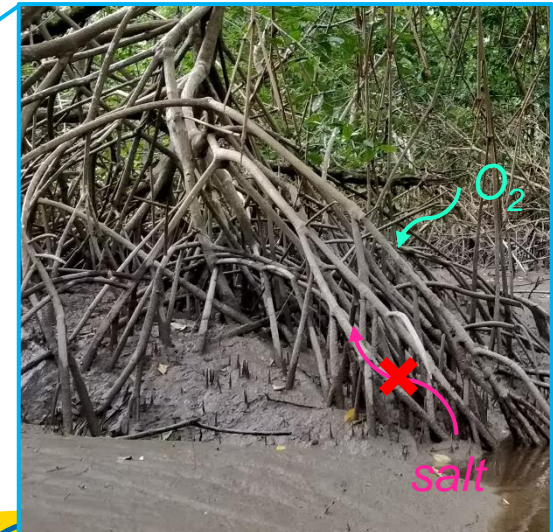
young



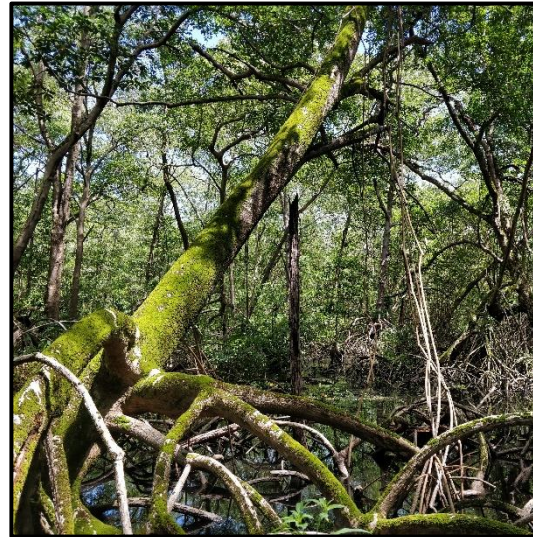
mature



Sedimentation in mangrove forests



Complex root systems of mangrove forests



Mortality of mangrove forests



Fate of mangroves?

REPORT **Sedimentary archives**

Thresholds of mangrove survival under rapid sea level rise

Original Paper | Published: 20 October 2015

Meta data

Can mangroves keep pace with contemporary sea level rise? A global data review

Sigit D. Sasmito, Daniel Murdiyarso, Daniel A. Friess

Wetlands Ecology and Management 24, 263–278 (2016)

Google Scholar mangrove, numerical model

Articles About 43,600 results (0.10 sec)

Google Scholar salt marsh, numerical model

Articles About 71,000 results (0.04 sec)

Assessment of Mangrove Response to Projected Relative Sea-Level Rise And Recent Historical Reconstruction of Shoreline Position

Geo-imagery analysis

Eric Gilman, Joanna Ellison & Richard Coleman

Environmental Monitoring and Assessment

The vulnerability of Indo-Pacific mangrove forests to sea-level rise

Field observation and model

Catherine E. Lovelock, David Reef, Kerrylee Rogers, Megan Tran Triet

Nature 526, 559–563 (2015)

Global Change Biology

PRIMARY RESEARCH ARTICLE | Open Access | Remote sensing

Global declines in human-driven mangrove loss

Liza Goldberg, David Lagomasino, Nathan Thomas, Temilola Fatoyinbo



How do mangroves respond to accelerating sea-level rise and human interventions?



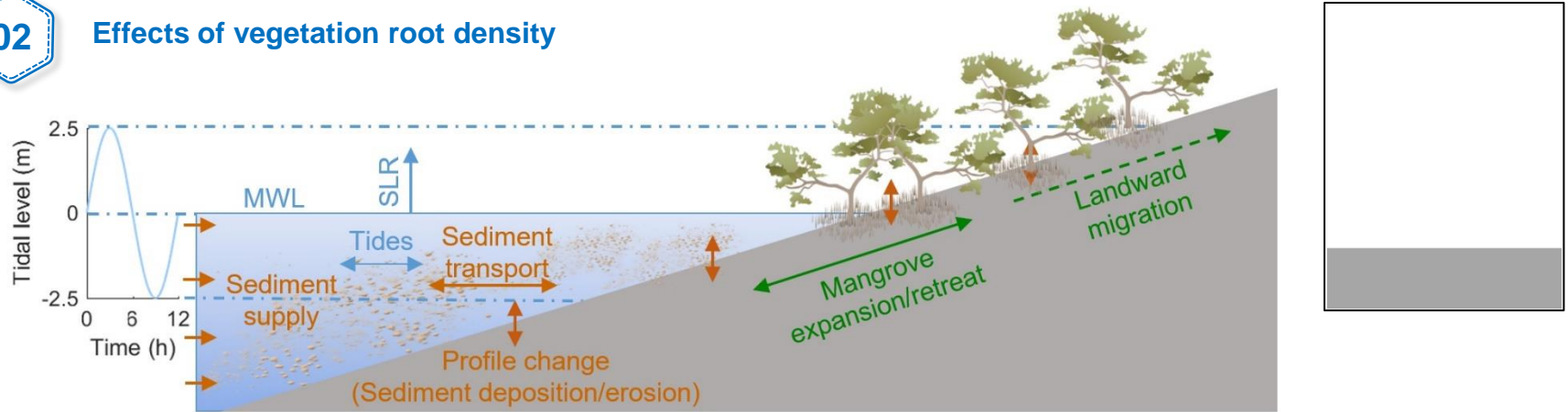
Bio-morphodynamic model development

01

One or multiple vegetation species

02

Effects of vegetation root density



03

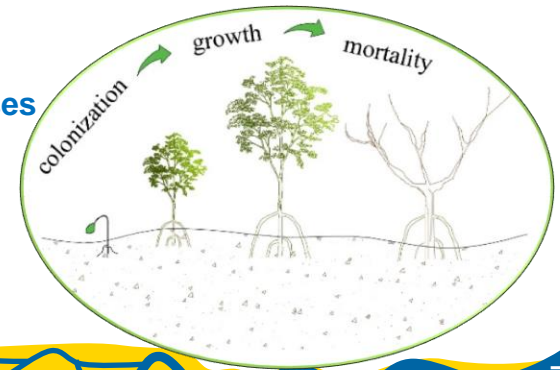
Tides, waves & sea-level rise

05

Dynamic vegetation processes

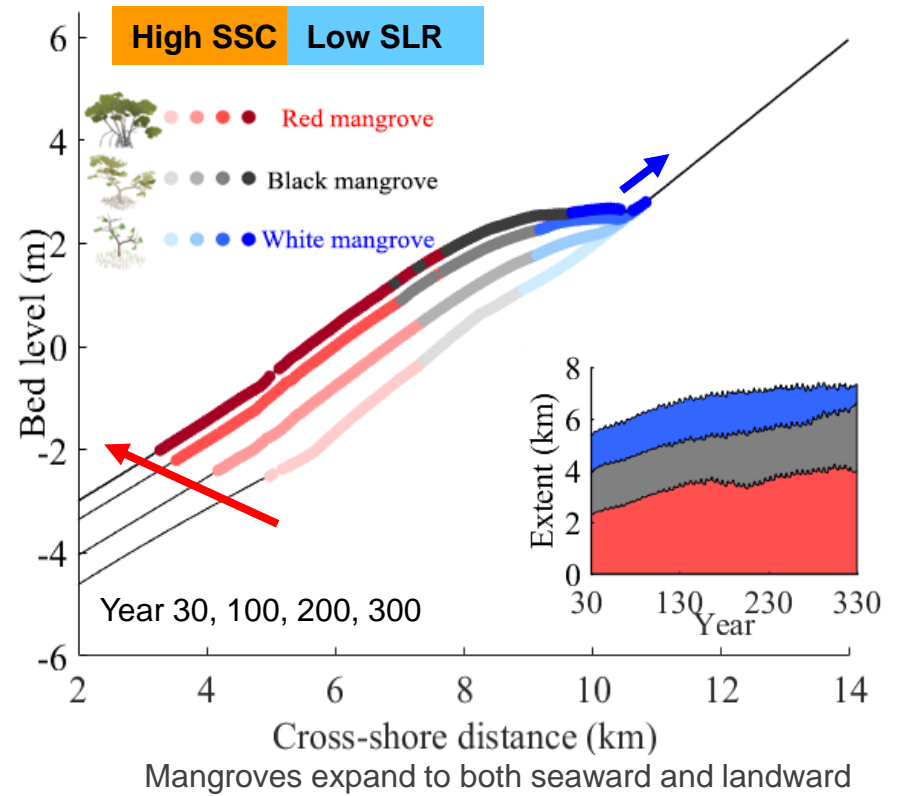
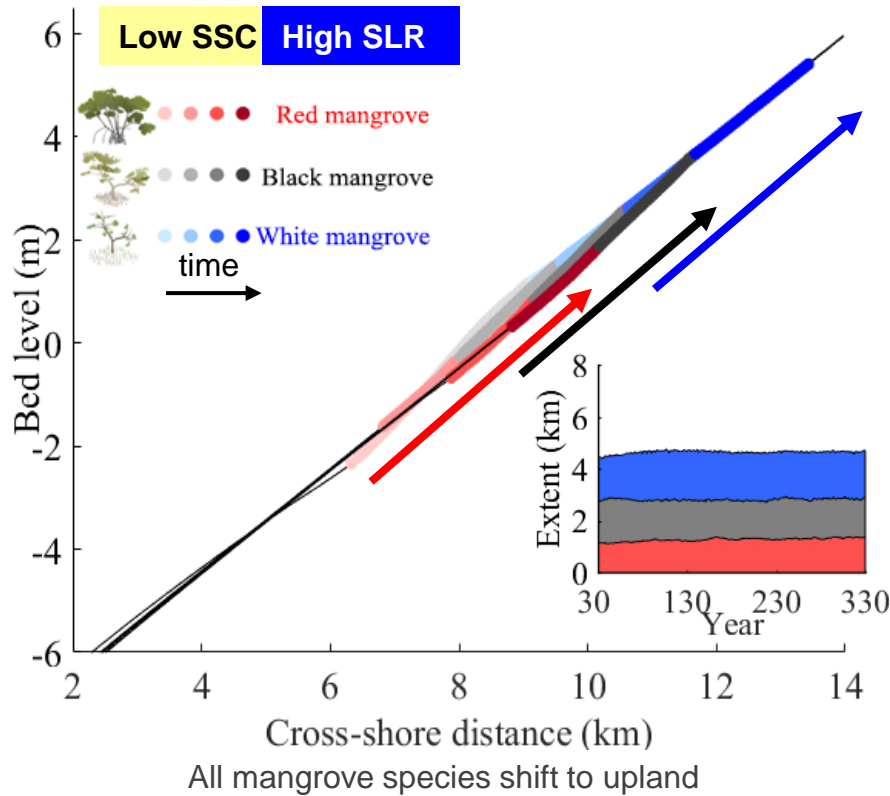
04

Comprehensive treatment of sediment process



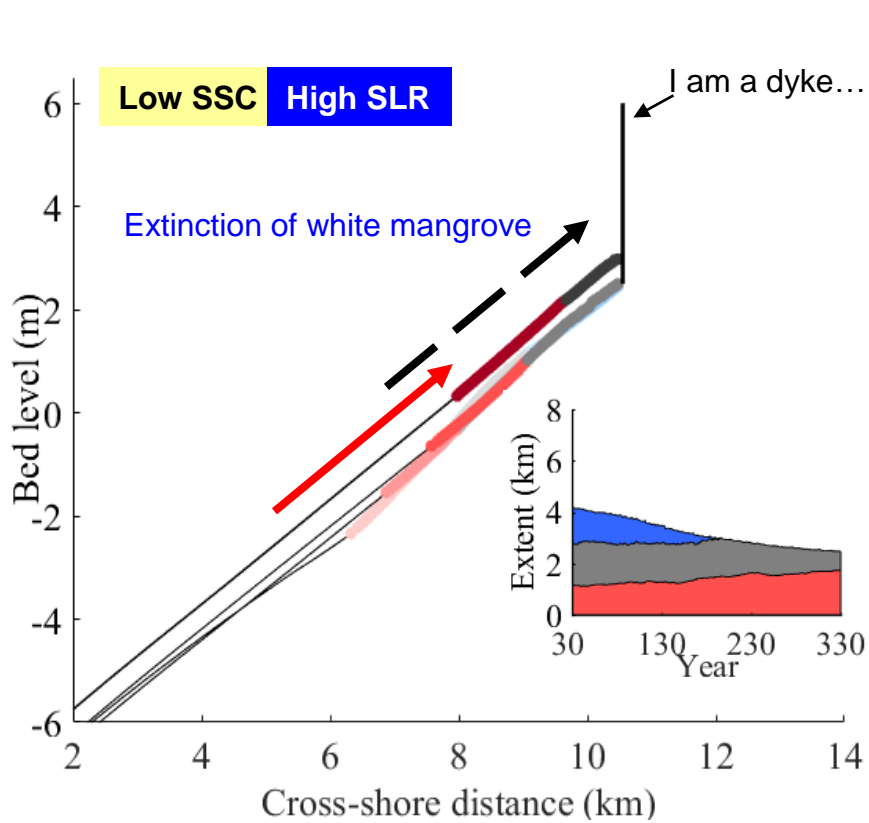
Impacts of sediment supply concentration and sea-level rise

Tidal range = 5 m (M2)

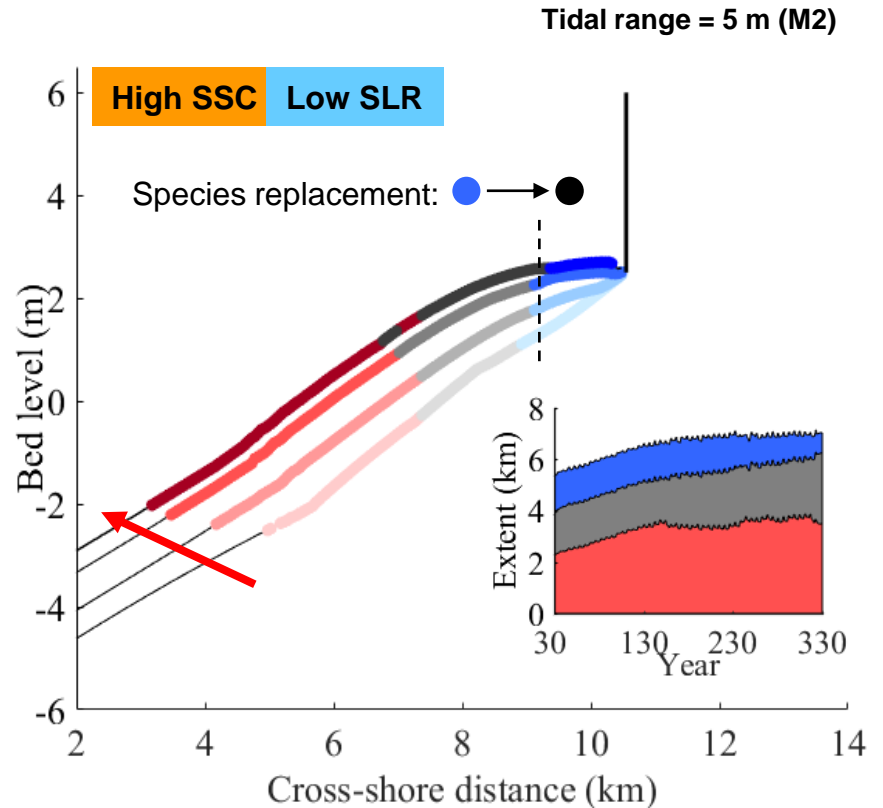


* **SSC**= Sediment supply concentration; **SLR**=sea-level rise

Impacts of human barriers

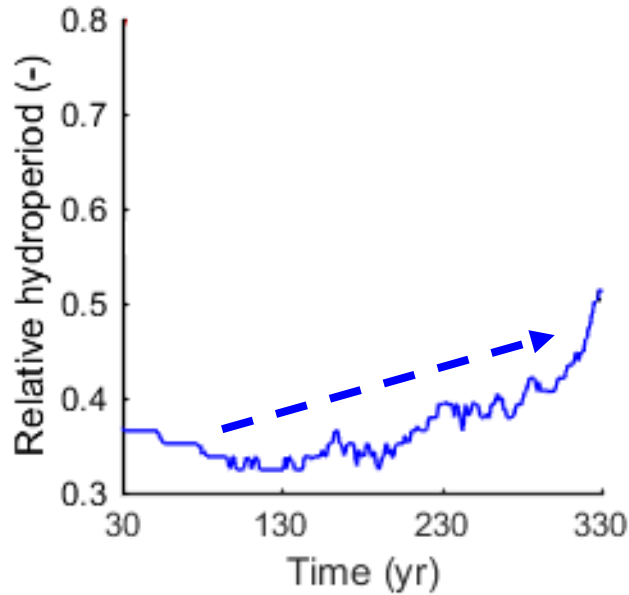


All mangrove species shift to upland, extinction happens

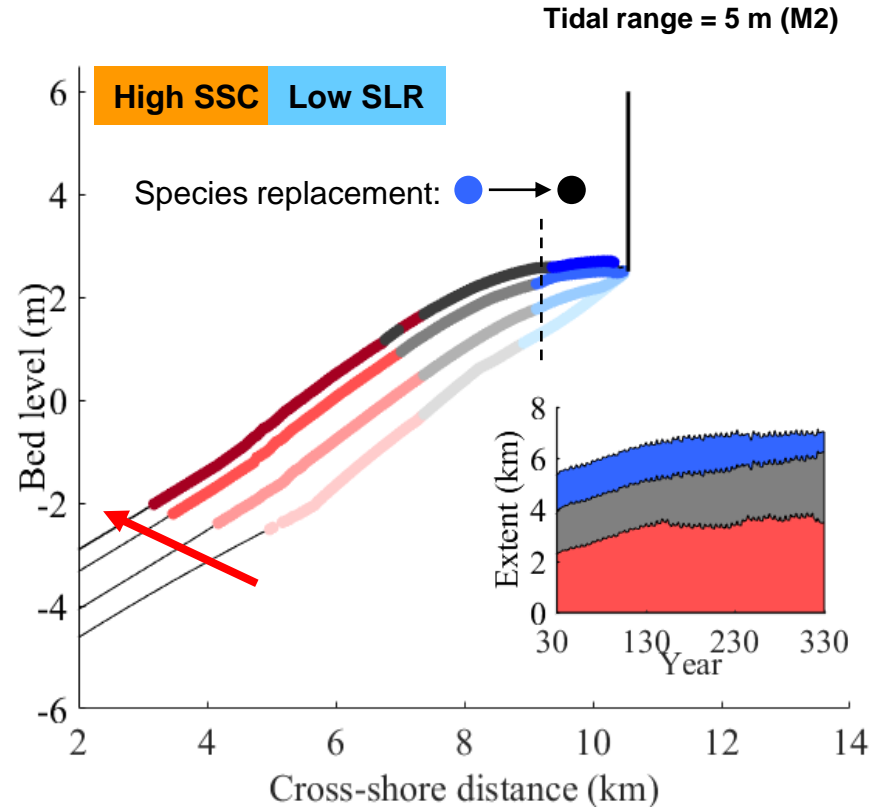


Mangroves expand to seaward but blocked on upland

Impacts of human barriers

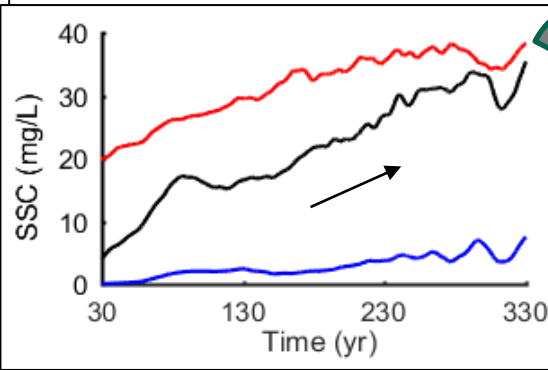
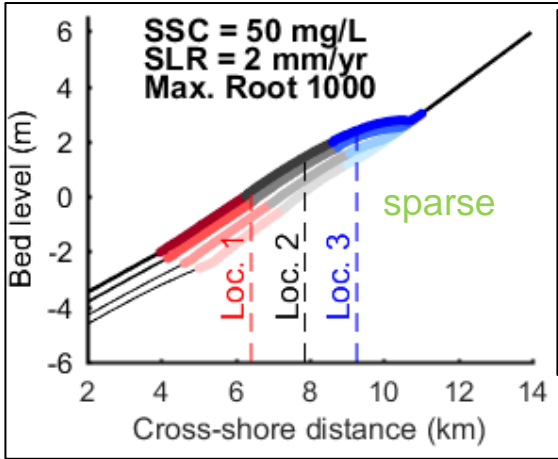


Inundation period increases → species replacement



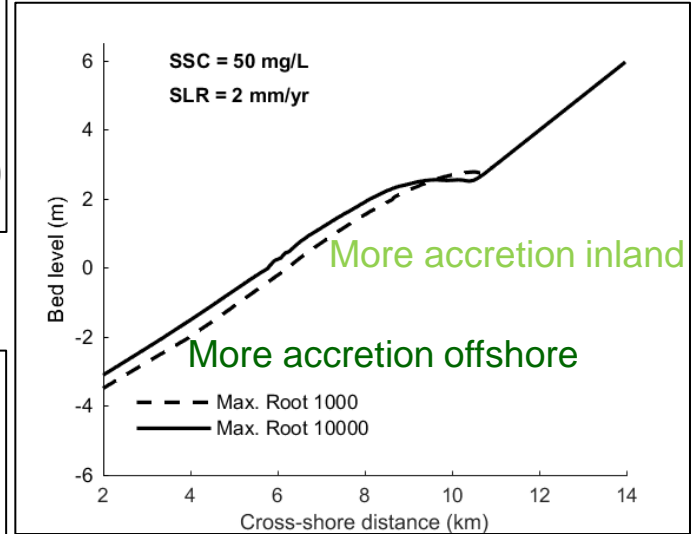
Mangroves expand to seaward but blocked on upland

Impacts of root density

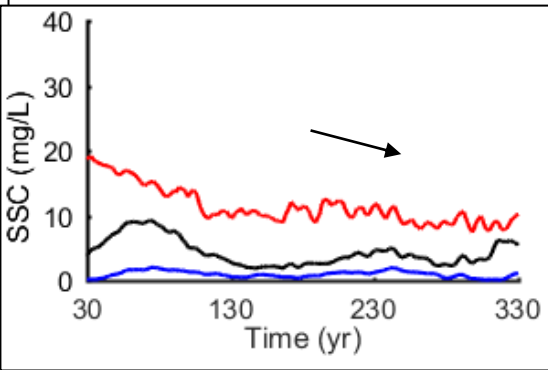
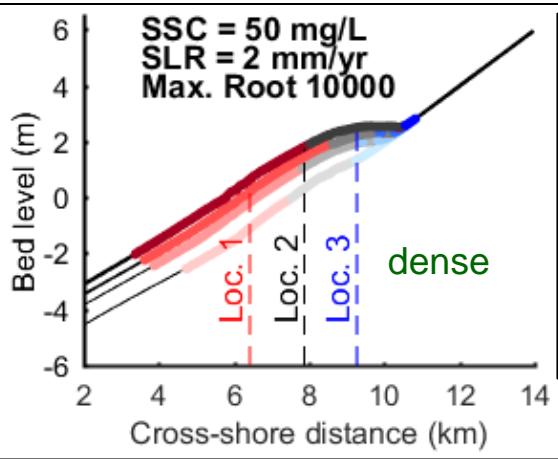


Vegetation diversity remains stable

More sediment move inland

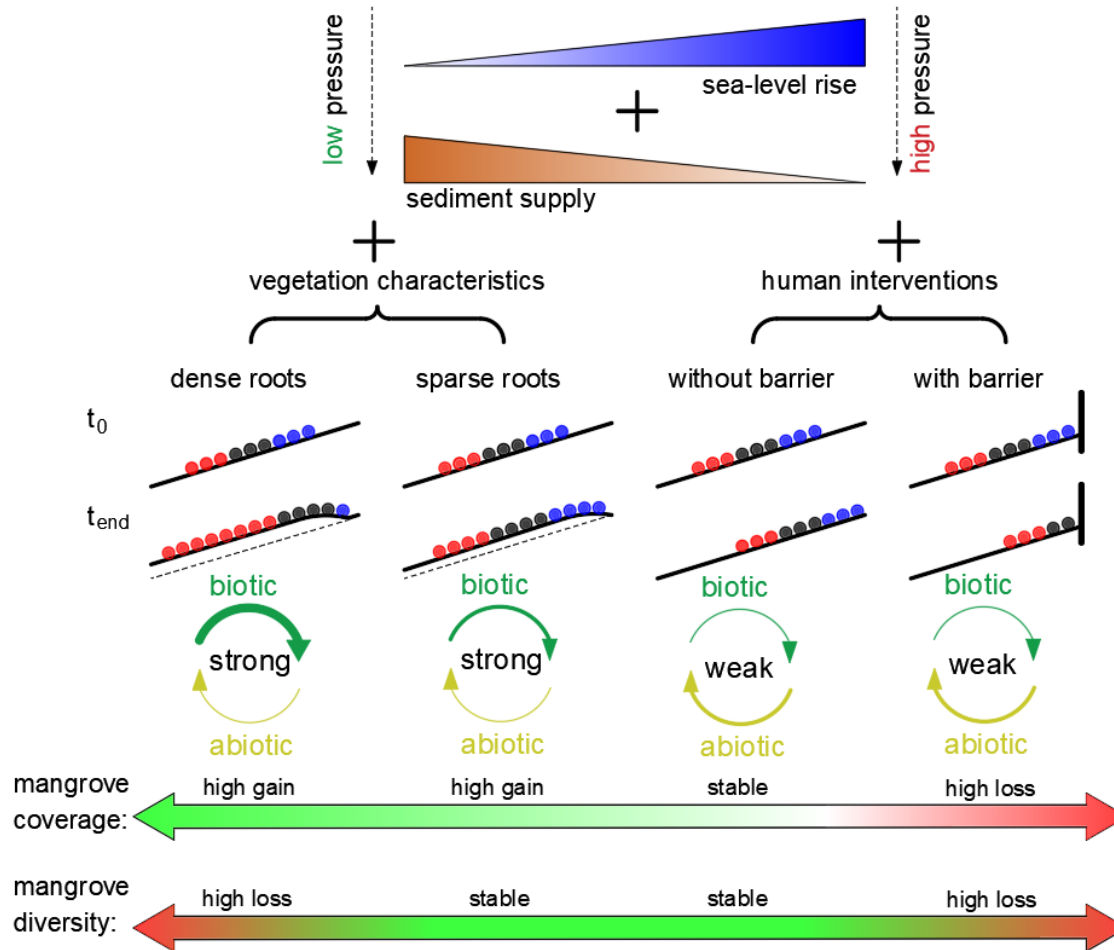


Species replacement occurs

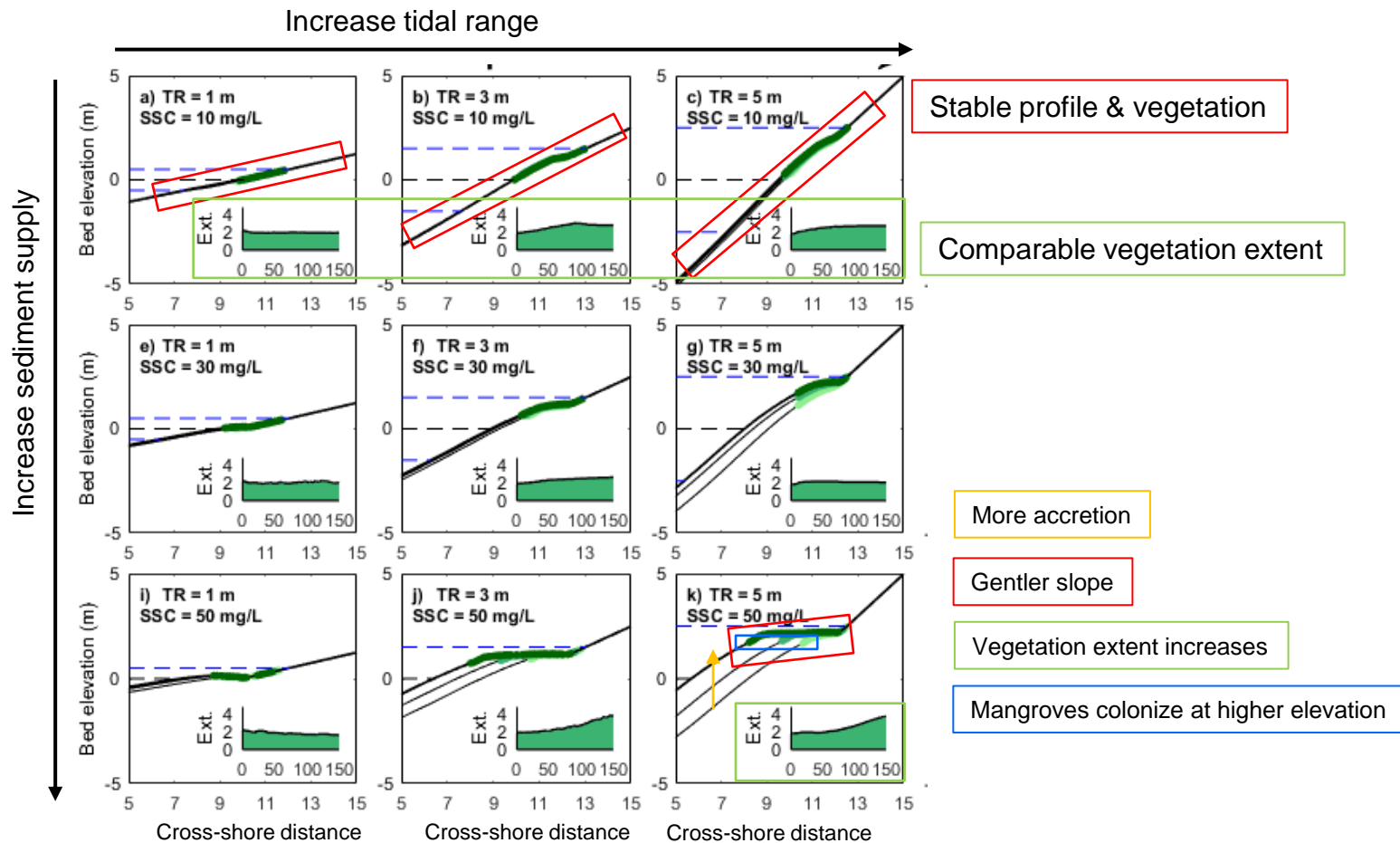


Less sediment move inland

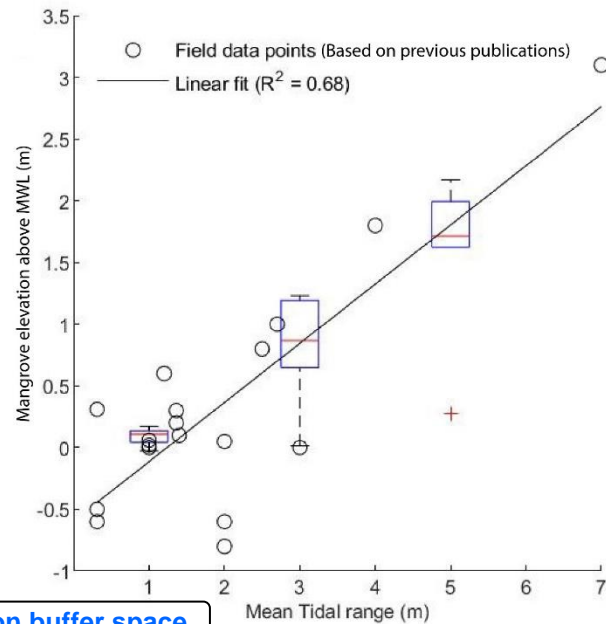
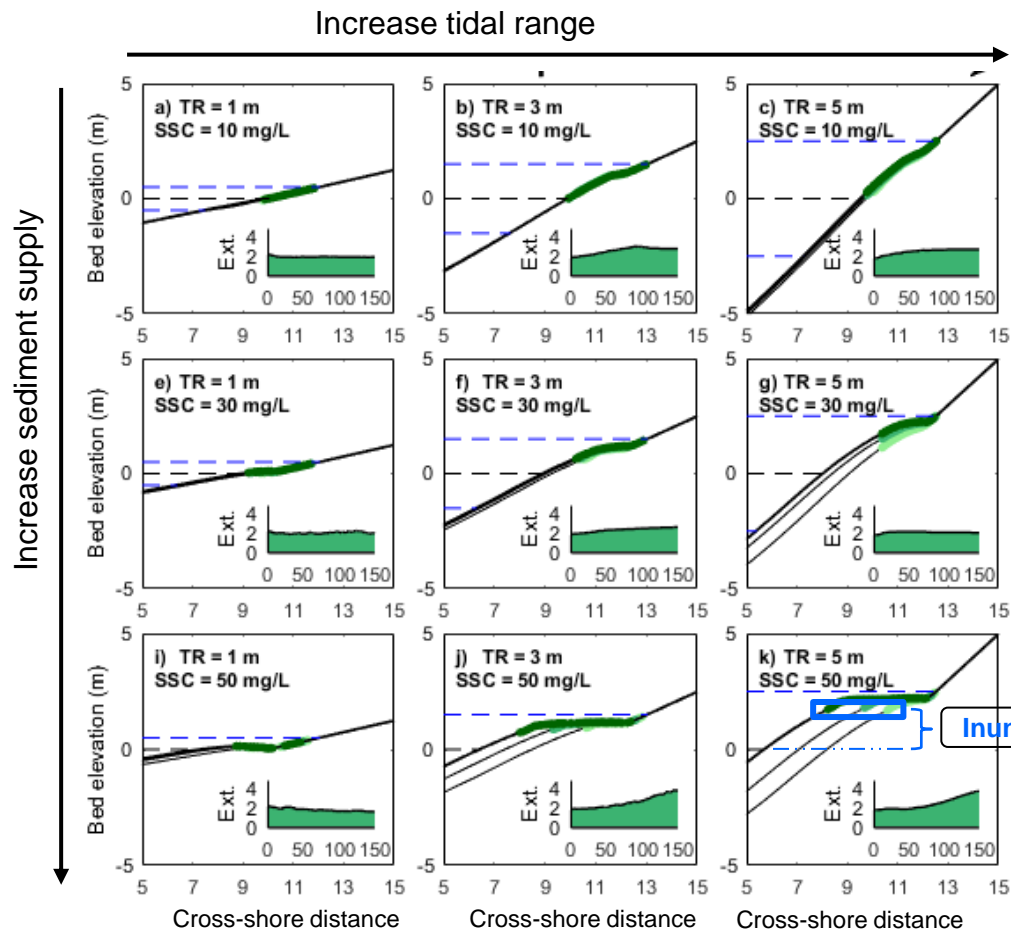
Responses of mangroves to SLR



Impacts of varying environmental conditions: *without* SLR



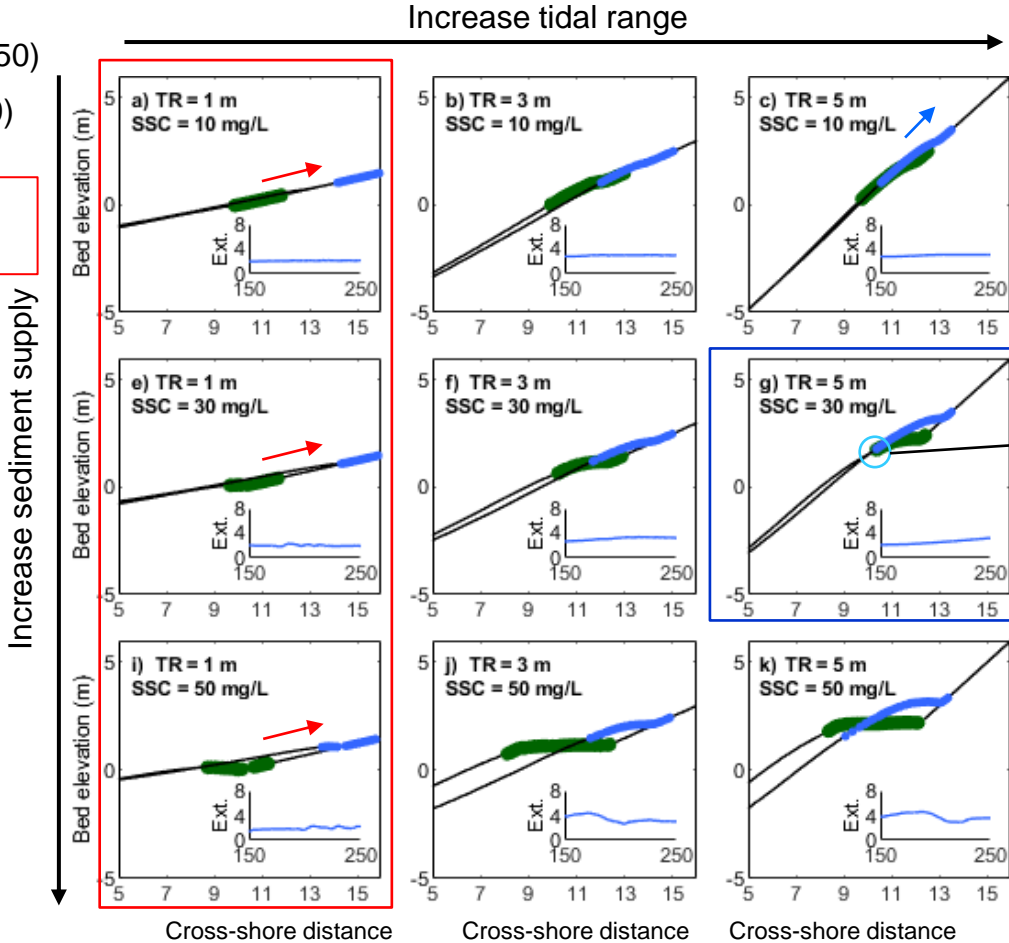
Impacts of varying environmental conditions: *without* SLR



Limitation of mangrove seaward colonization increases with tidal range.

Impacts of varying environmental conditions: *with* SLR

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

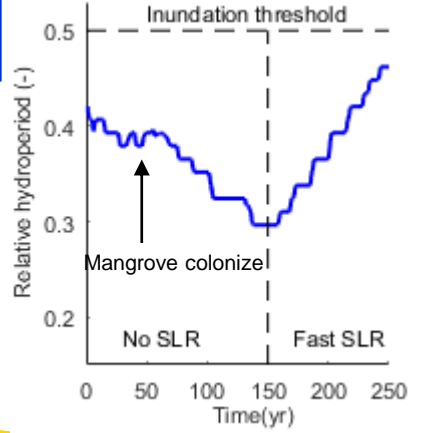


Mangrove development: SLR dependent

Less landward retreat

Stable vegetation seaward

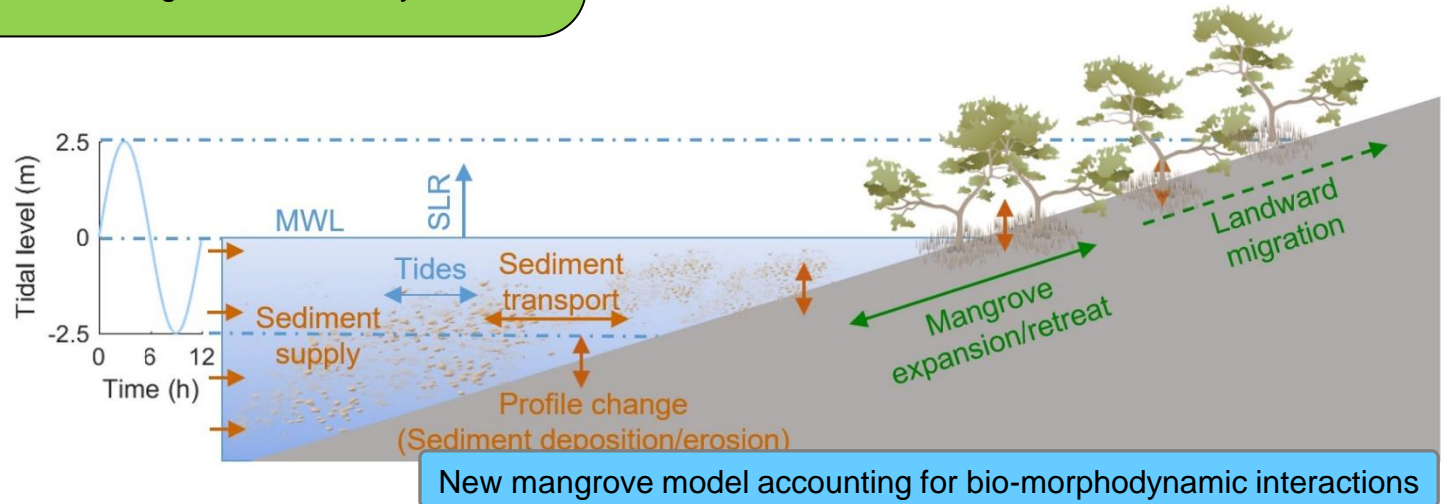
Mangroves initially colonize high such that increasing sea level doesn't inundate mangroves immediately within the study period.



Key messages

Different mangrove responses due to physical settings:

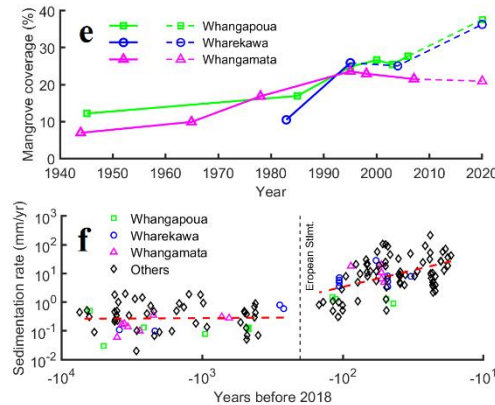
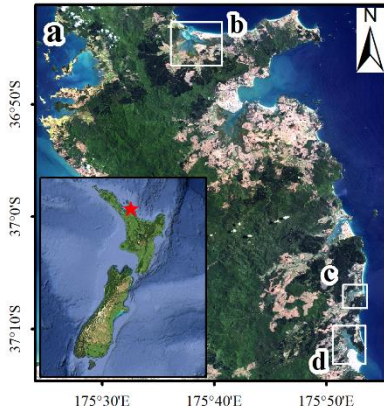
- 1- Similar mangroves extent among different tidal ranges
- 2- Stable mangrove seaward edge with SLR
- 3- Micro-tidal system exhibited highest vulnerability



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.

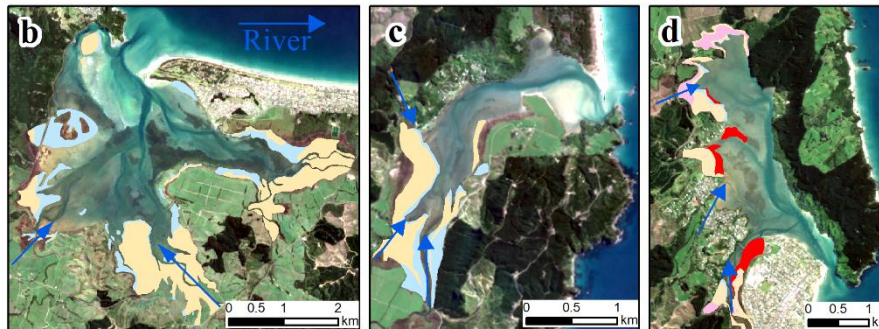
Impacts of upstream land-use change and mangrove removal



Mangrove expansion with increasing muddy sediment input



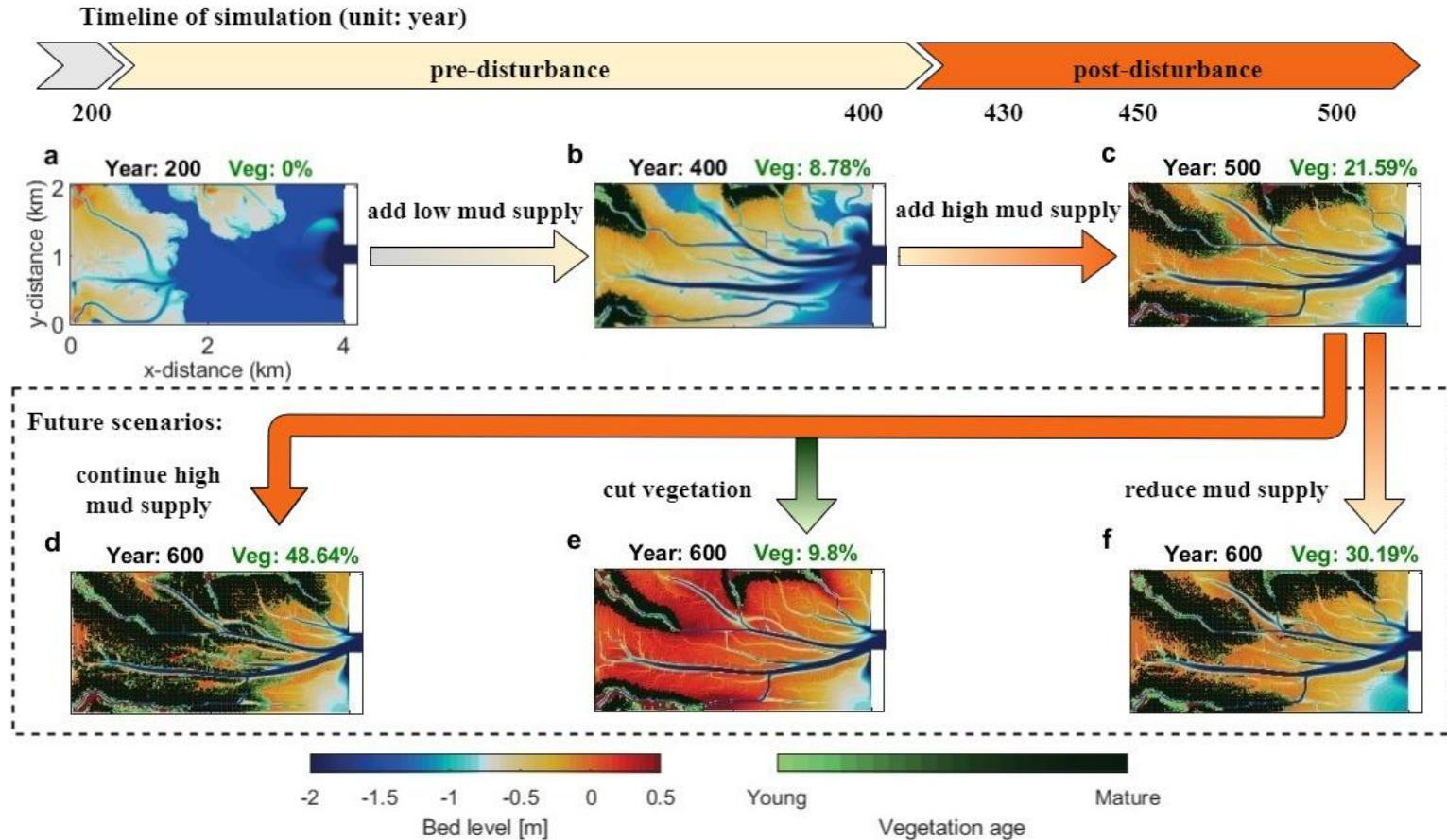
Mangrove clearance in New Zealand: mechanical clearance



Mangrove forest: 1944 (pink), 2004 (yellow), 2020 (light blue) Mangrove clearance: 2004 - 2020 (red)

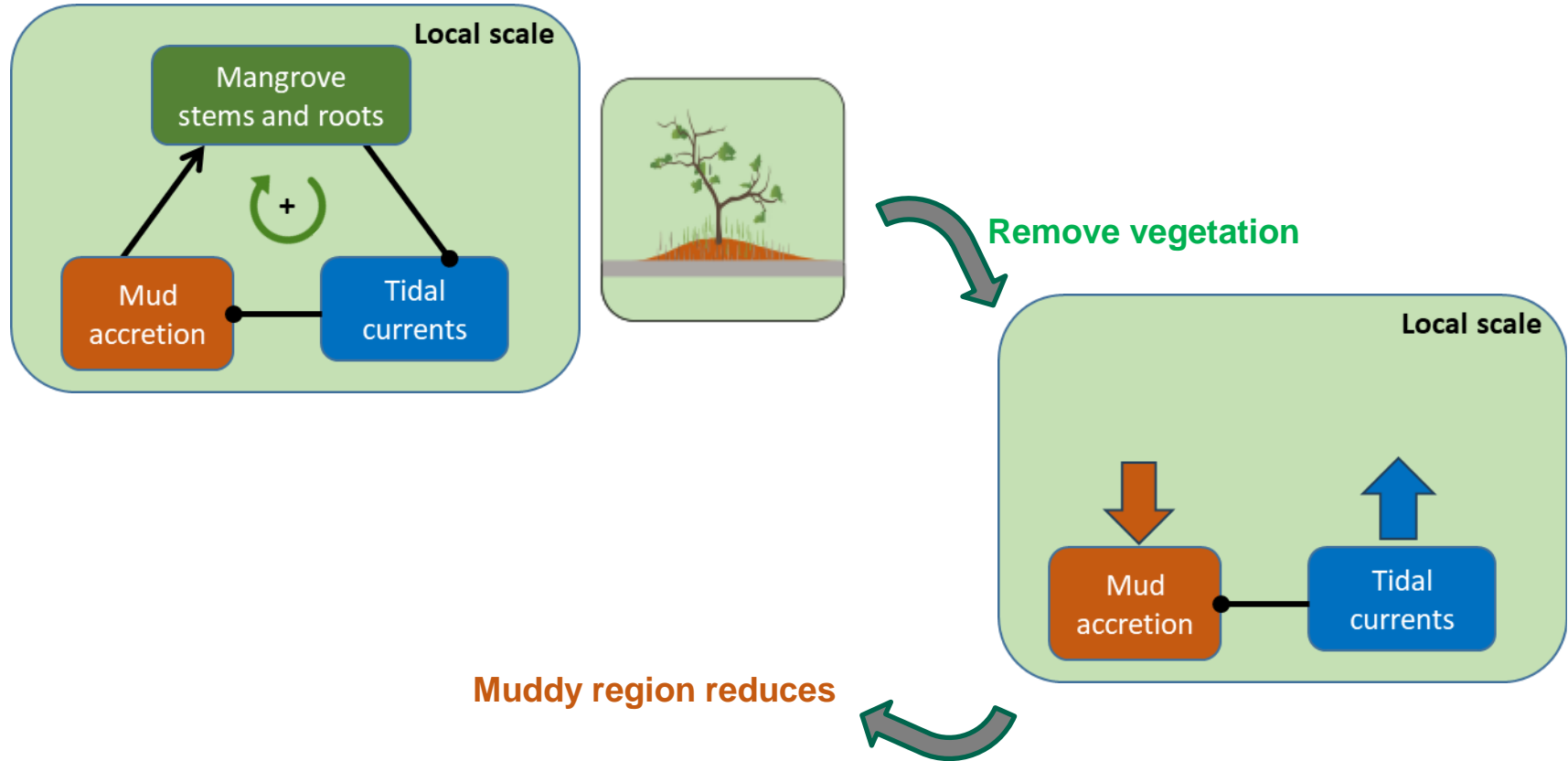
Is cutting off mangroves an effect way?

Impacts of upstream land-use change and mangrove removal

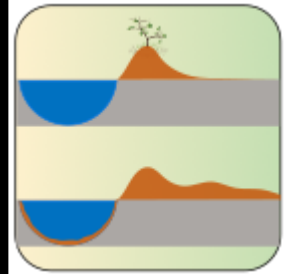
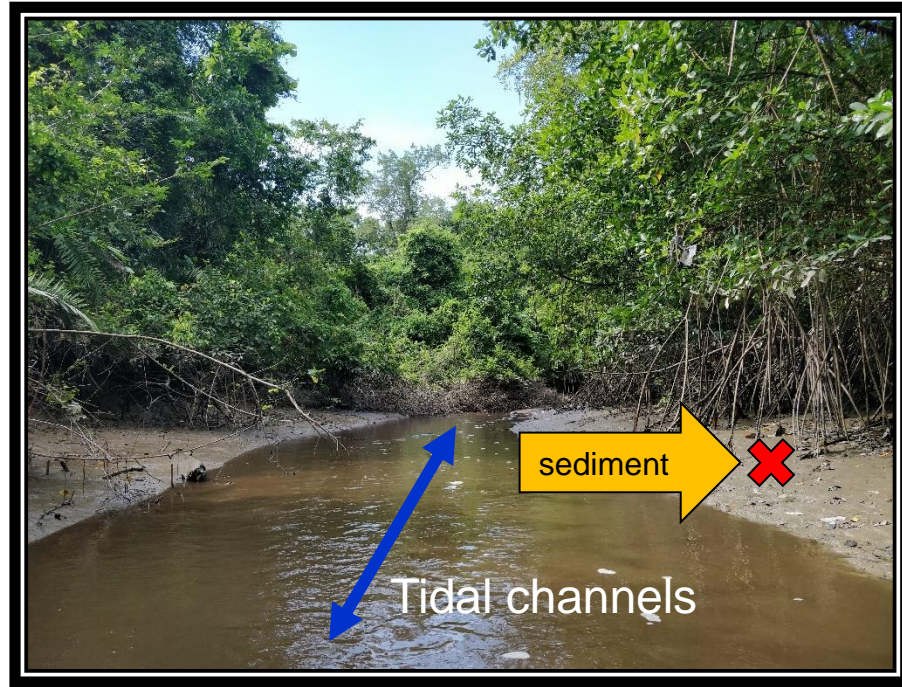
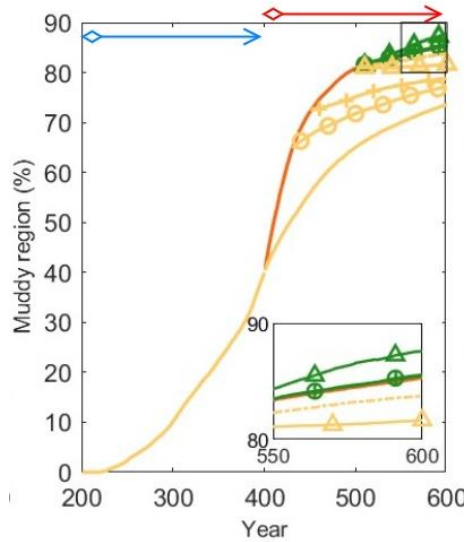


Impacts of upstream land-use change and mangrove removal

Local scale bio-morphodynamic feedbacks:

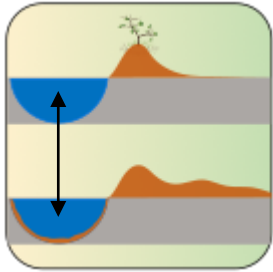


Impacts of upstream land-use change and mangrove removal

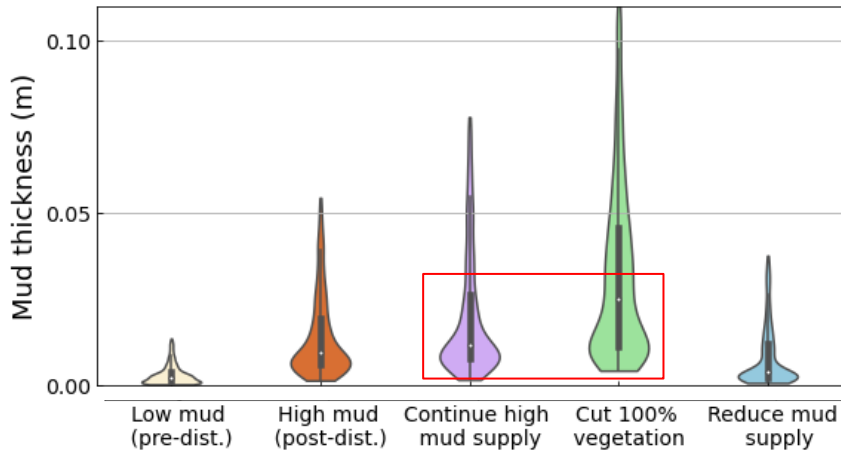


- Low mud
- High mud
- Cut 25% vegetation
- +— Cut 50% vegetation
- △— Cut 100% vegetation
- Intermediate mud
- Low mud after 30-yr high mud
- +— Low mud after 50-yr high mud
- △— Low mud after 100-yr high mud

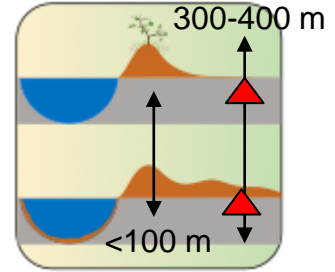
Impacts of upstream land-use change and mangrove removal



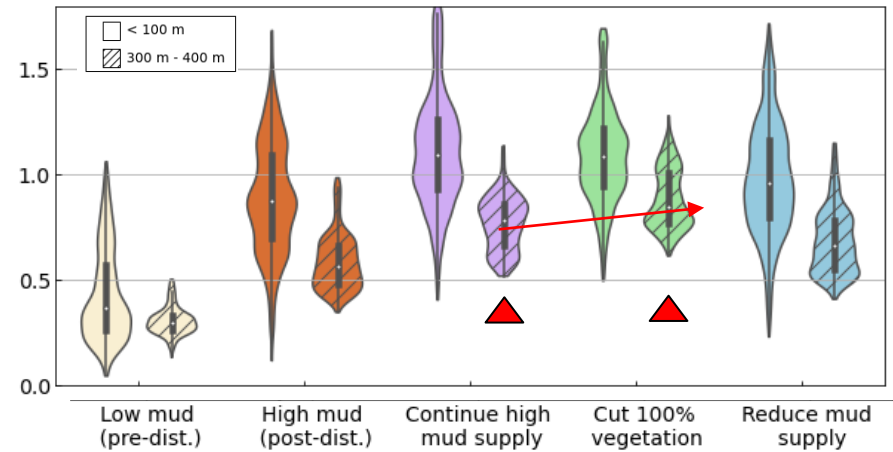
Channelized area



More Mud in the channels

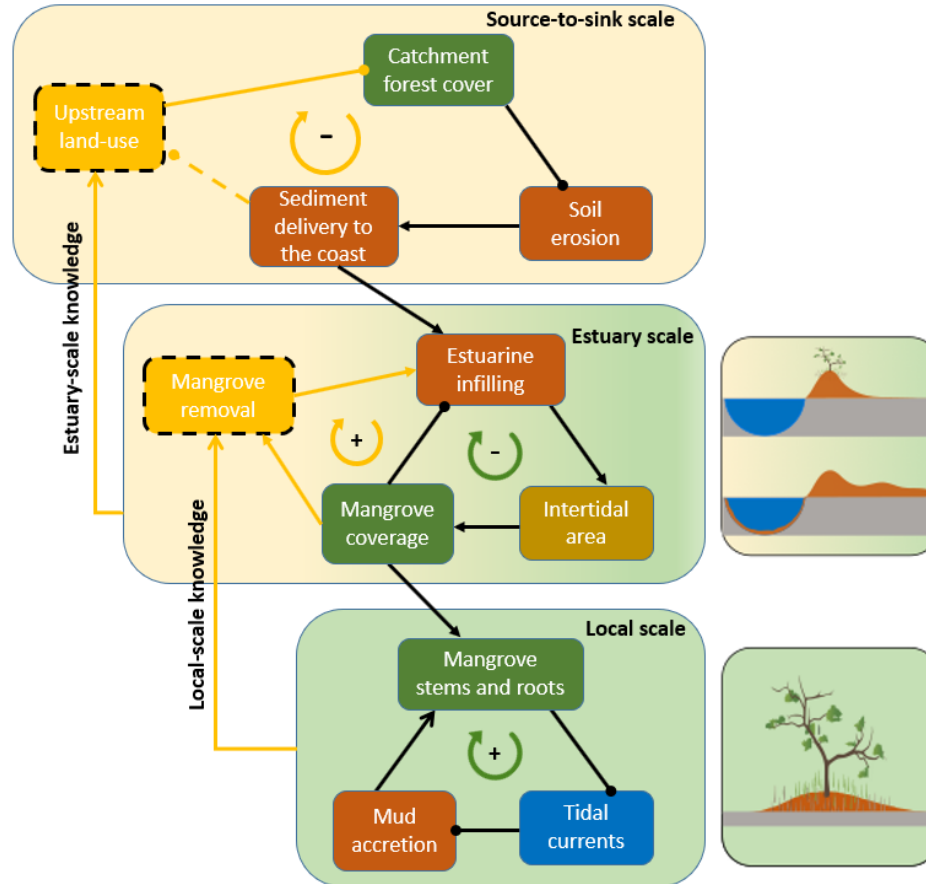
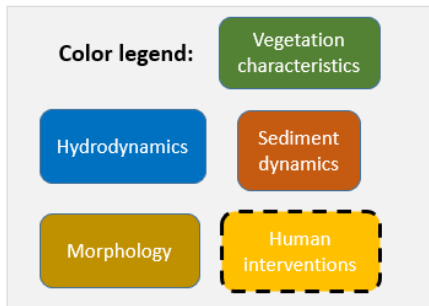
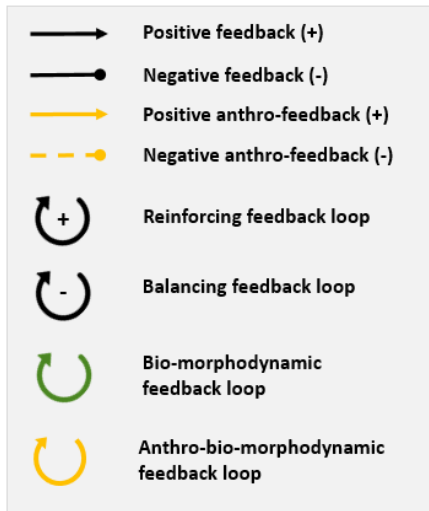


Flats area



Mud redistributes further away from the channels

Anthro-bio-morphodynamic feedbacks



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

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Get the code here

[code](#)



The screenshot shows a GitHub repository page for 'EstuarineMangroves' by user 'xiedanghan'. The repository is public and has 1 star, 0 forks, and 1 watch. The main branch is 'main'. The repository contains several files and folders, including 'Code/3riversQ18EquSandMud30', 'figs', 'LICENSE', 'README.md', and 'Xie_TechnicalDocuments_EstuarineM...'. The 'README.md' file is selected, showing the title 'Estuarine Mangroves' and a description: 'Estuarine Mangroves is a modelling study investigating the long-term effects of anthro-bio-geomorphic feedback on estuarine landscape development where mangroves are present. The research is still in preparation so the detailed results regarding this research will be updated soon. To use the model, please follow the instructions on the [Technical Document](#). Below are some highlights of this model.'

File/Folder	Commit Message	Time
Code/3riversQ18EquSandMud30	Add files via upload	8 months ago
figs	Add files via upload	8 months ago
LICENSE	Initial commit	8 months ago
README.md	Update README.md	8 months ago
Xie_TechnicalDocuments_EstuarineM...	Add files via upload	8 months ago

About

- Numerical Model for Estuarine Mangroves
- Readme
- MIT license
- Activity
- 1 star
- 1 watching
- 0 forks

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No releases published
[Create a new release](#)

Packages

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