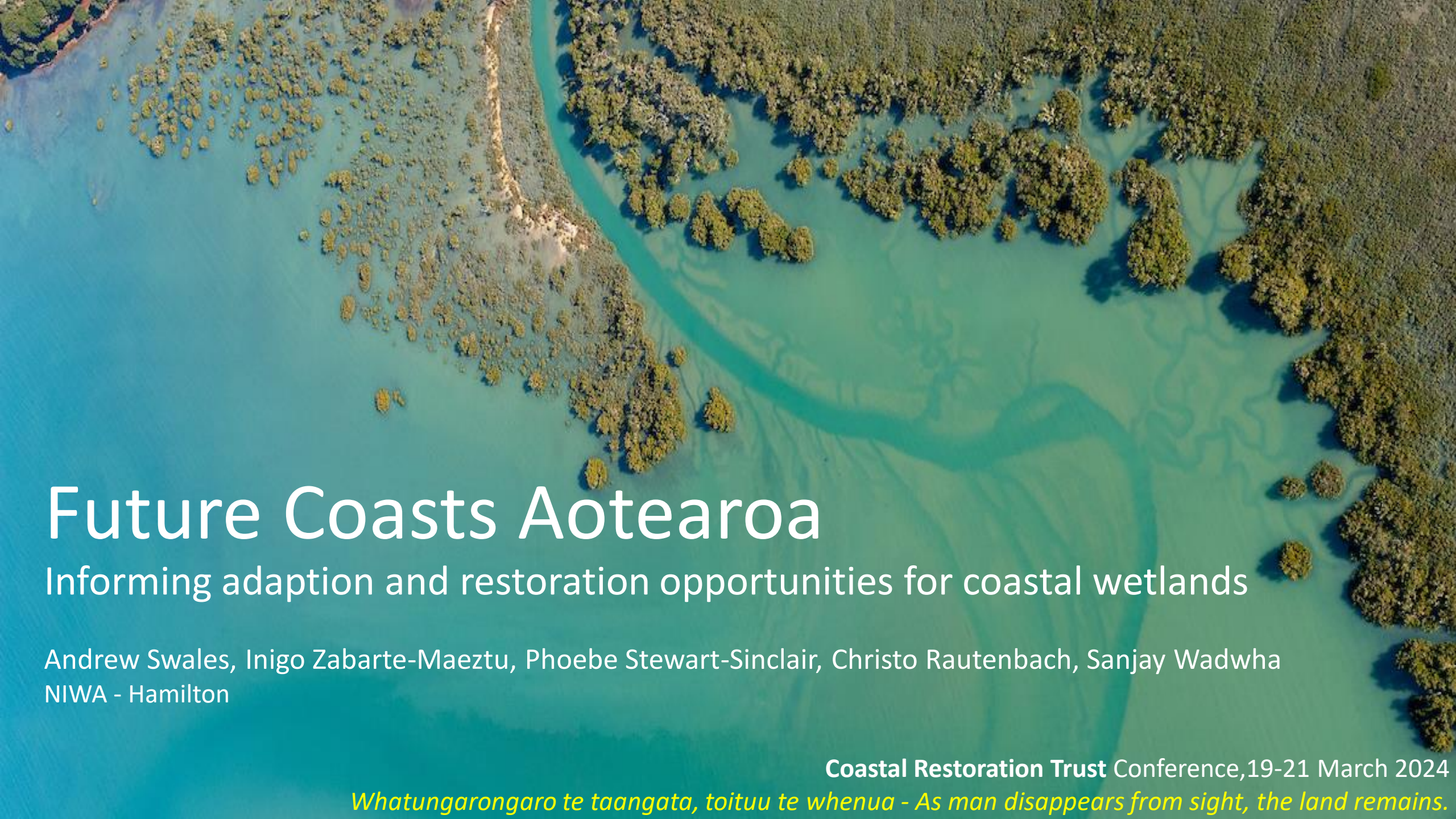


Future Coasts Aotearoa

Informing adaption and restoration opportunities for coastal wetlands

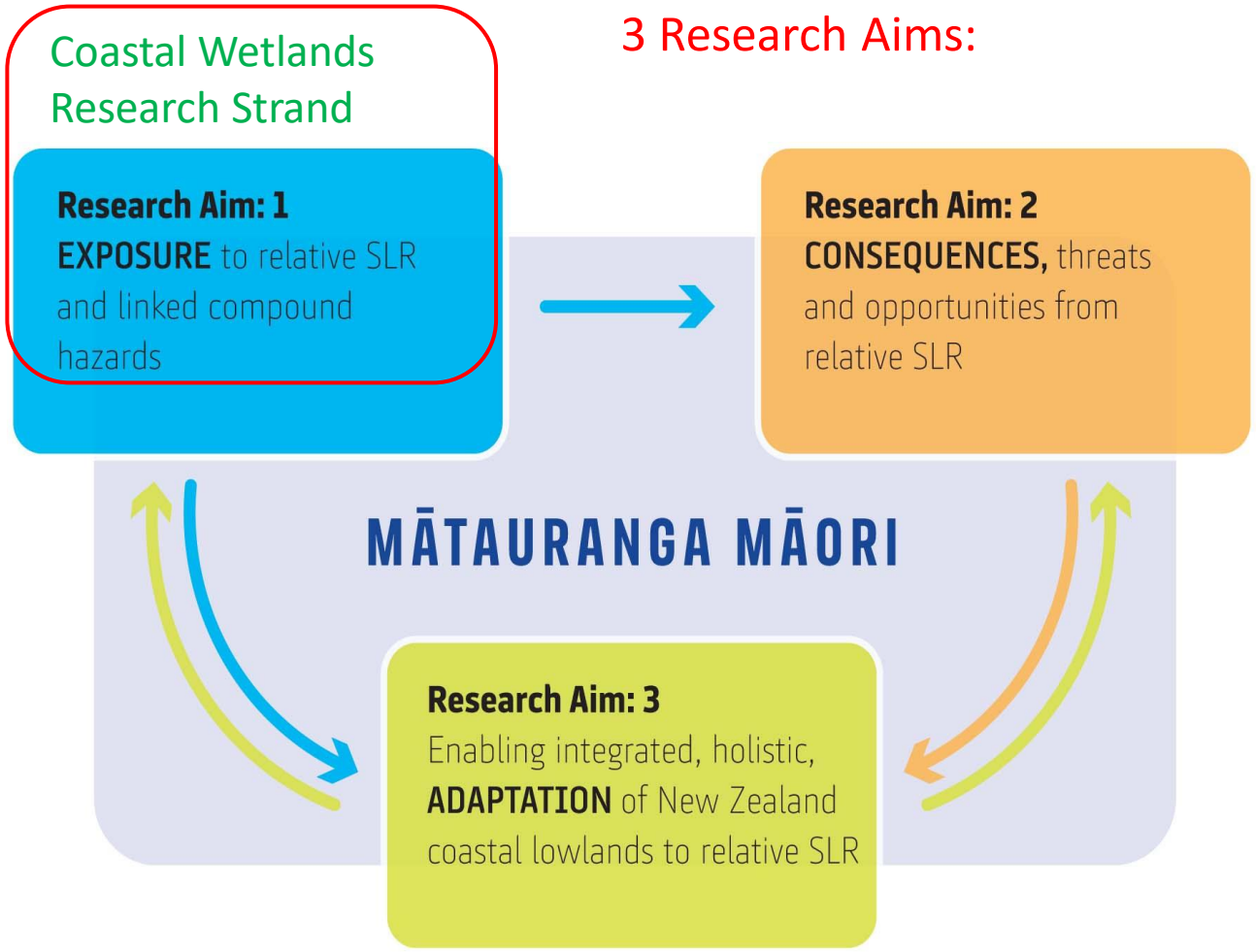
Andrew Swales, Inigo Zabarte-Maeztu, Phoebe Stewart-Sinclair, Christo Rautenbach, Sanjay Wadwha
NIWA - Hamilton

Coastal Restoration Trust Conference,19-21 March 2024

Whatungarongaro te taangata, toituu te whenua - As man disappears from sight, the land remains.

Future Coasts Aotearoa

5-yr Endeavour programme



Climate, Freshwater & Ocean Science

SLR is already causing irreversible changes:

- Salinisation – low lying land
- Inundation

FCA objective : *Provide knowledge & tools to transform coastal lowlands threatened by SLR in most effective way*.

Focus on coastal lowlands because:

- Where people live
- Highly productive land
- Important wetlands & ecosystem services

Coastal wetland research partners:

Ngāti Manuhiri, Ngāi Takoto, Ngāti Kahu

USGS science for a changing world

THE UNIVERSITY OF WAIKATO Te Whare Wānanga o Waikato

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

BAY OF PLENTY REGIONAL COUNCIL TOI MOANA

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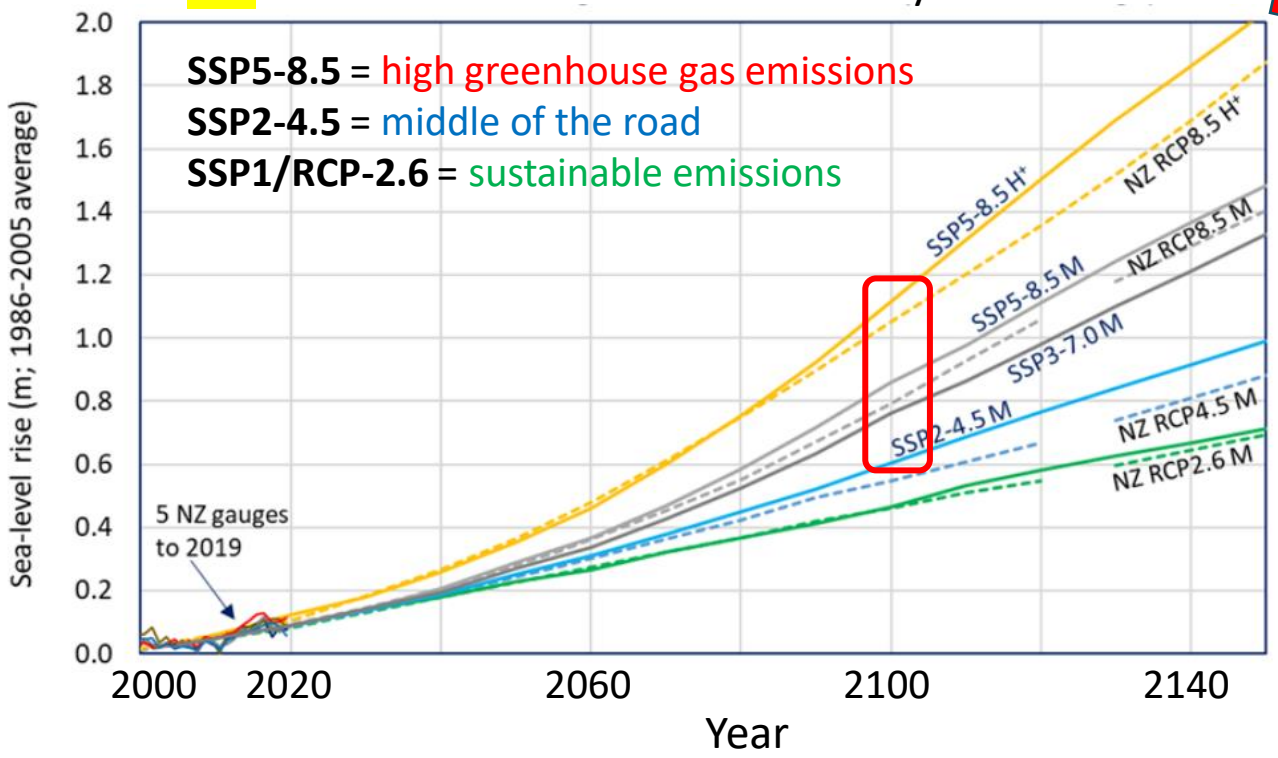
Sea level rise - Aotearoa



World presently on SSP5-8.5 pathway !

MfE (2024) – updated interim guidance (solid lines)

SLR projections exclude vertical land motion (VLM) = Relative SLR (RSLR)

Middle of road/high emissions = 0.6 – 1.1 m SLR by 2100

Most at risk natural environments: estuaries, intertidal habitats, dunes, coastal lakes and wetlands (MfE, 2020)

Sources:

MfE (2024) Interim guidance on the use of new SLR projections

MfE (2020) National Climate Change Risk Assessment for NZ

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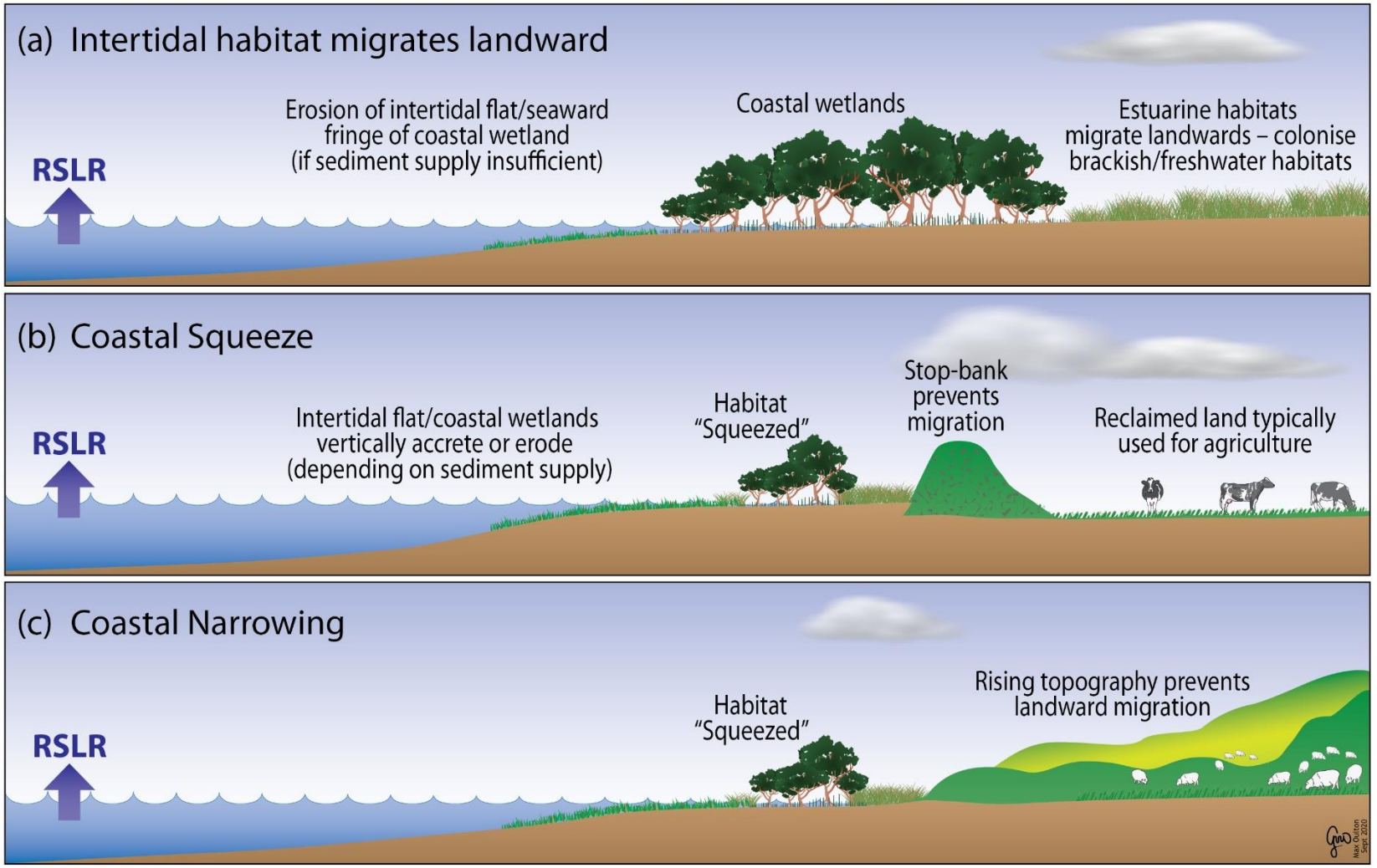
SLR – coastal wetland response



Potential scenarios & estuarine habitat responses to RSLR:

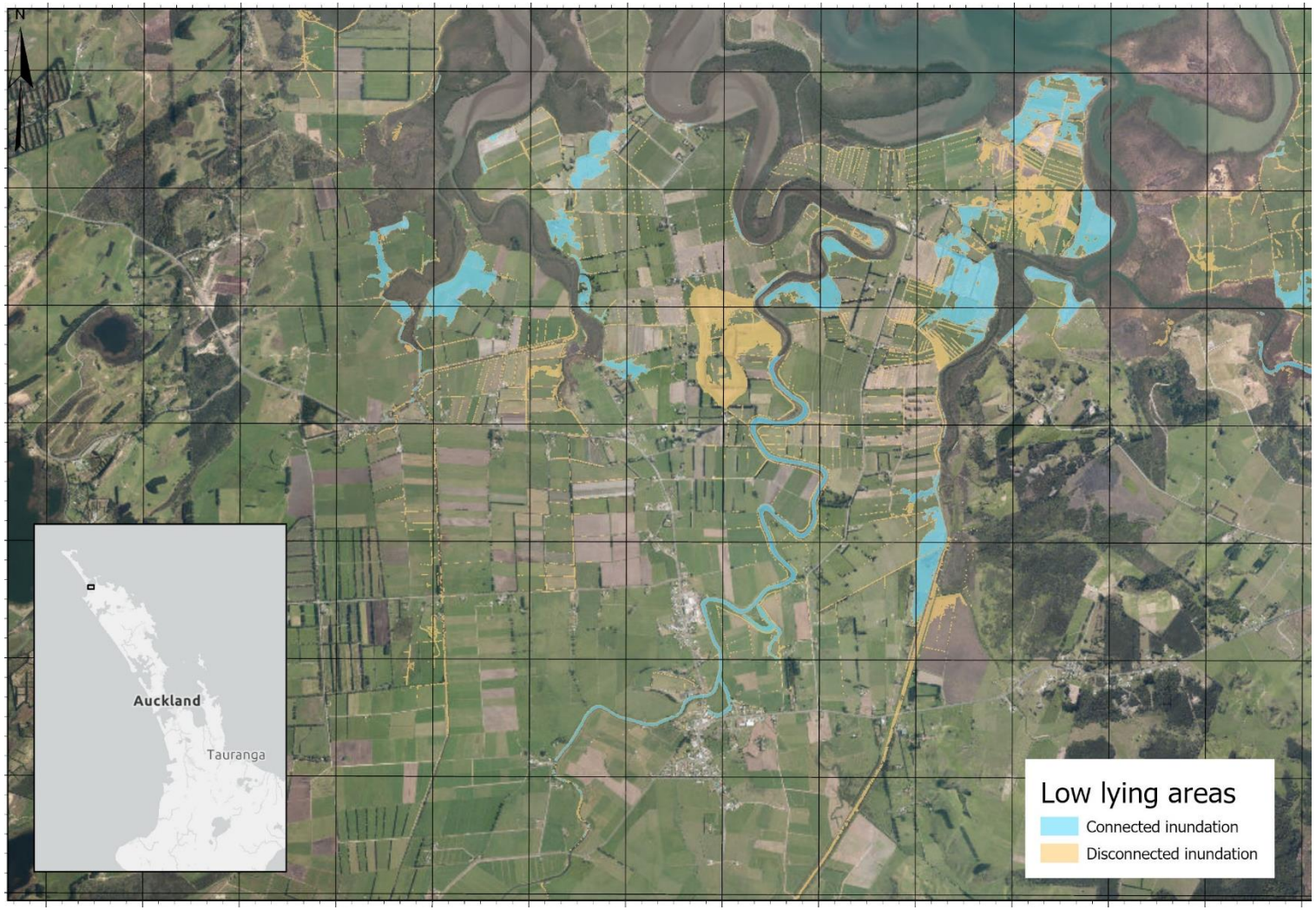
(a) habitats can naturally migrate landward - **no physical barriers** (rare)

(b) coastal squeeze - landward migration of CW prevented by **structures** (common)

(c) Coastal narrowing - migration prevented by **natural topography** (common)

SLR – MSL +0.6 m

Year: 2100



Rangaunu Harbour (Northland)

0.6 m SLR (Middle of road – 2100)

Inundation – entire shoreline:

- Tidally connected 187 ha
- Not tidally connected: 185 ha

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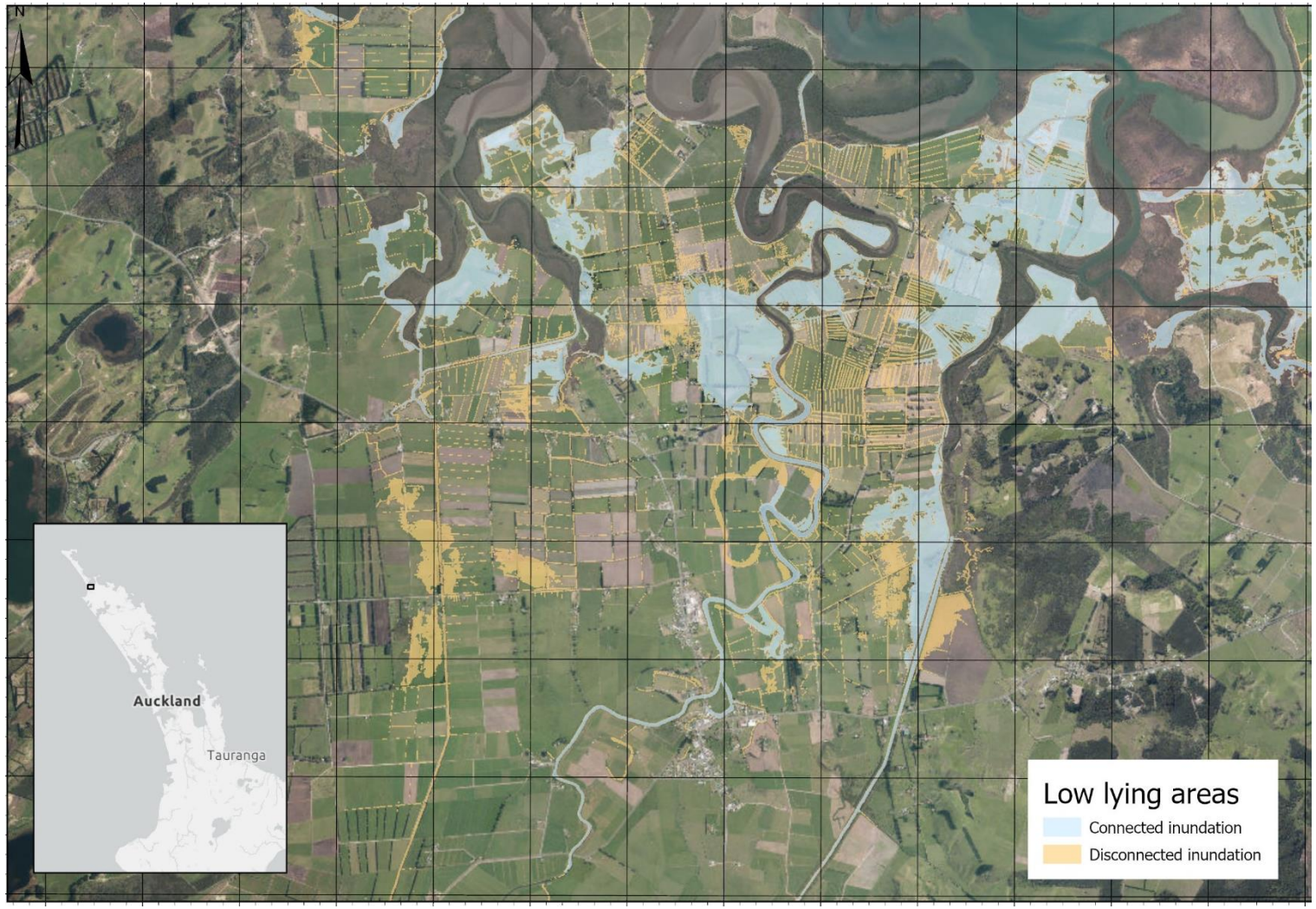
SLR – MSL +1 m

Year: 2100



Rangaunu Harbour (Northland)

1 m SLR (High emissions– 2100)

Inundation – entire shoreline:

- Tidally connected: 648 ha
- +350% increase (c.f. 0.6 m SLR)
- Not tidally connected: 115 ha

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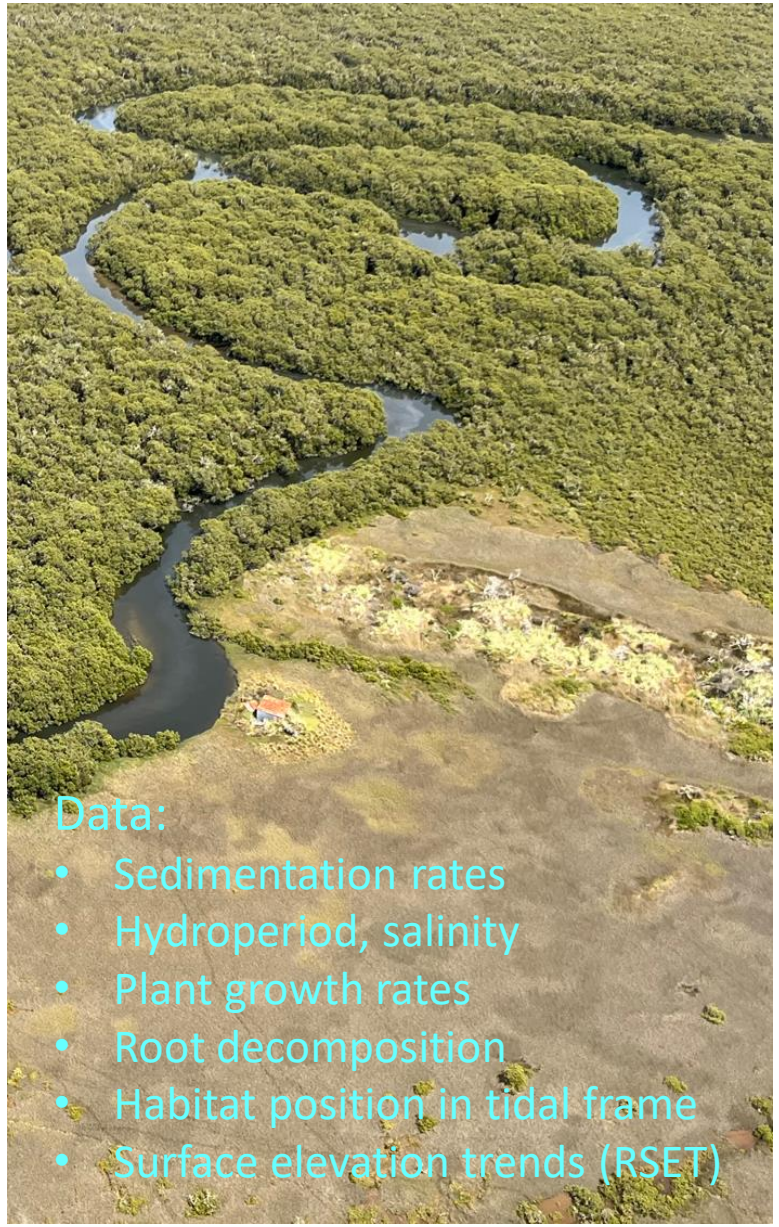
Storm tides

Storm tides will exacerbate SLR impacts

Firth of Thames – RSLR ~ 1 cm/yr (Subsidence)

- **1938** storm tide (+3m aMSL) – stop bank over-topped (Pre-mangrove forest)
- **2018** storm tide - similar to 1938 event (mangrove forest = hazard mitigation)

Coastal Wetlands research -tasks



Maps & databases

- National GIS layers: environmental, land use and asset exposure
- Identify coastal squeeze & coastal narrowing bottlenecks
- Identify areas likely to be inundated (repurpose land use, habitat restoration)

Models

- Simulate coastal wetland responses to **RSLR** scenarios & vulnerability
- Inform national up-scaling evaluation.

Data

- Biophysical data collected from range of habitat types & conditions to inform model set-up
- Model validation – Rod Surface Elevation Tables (RSET)

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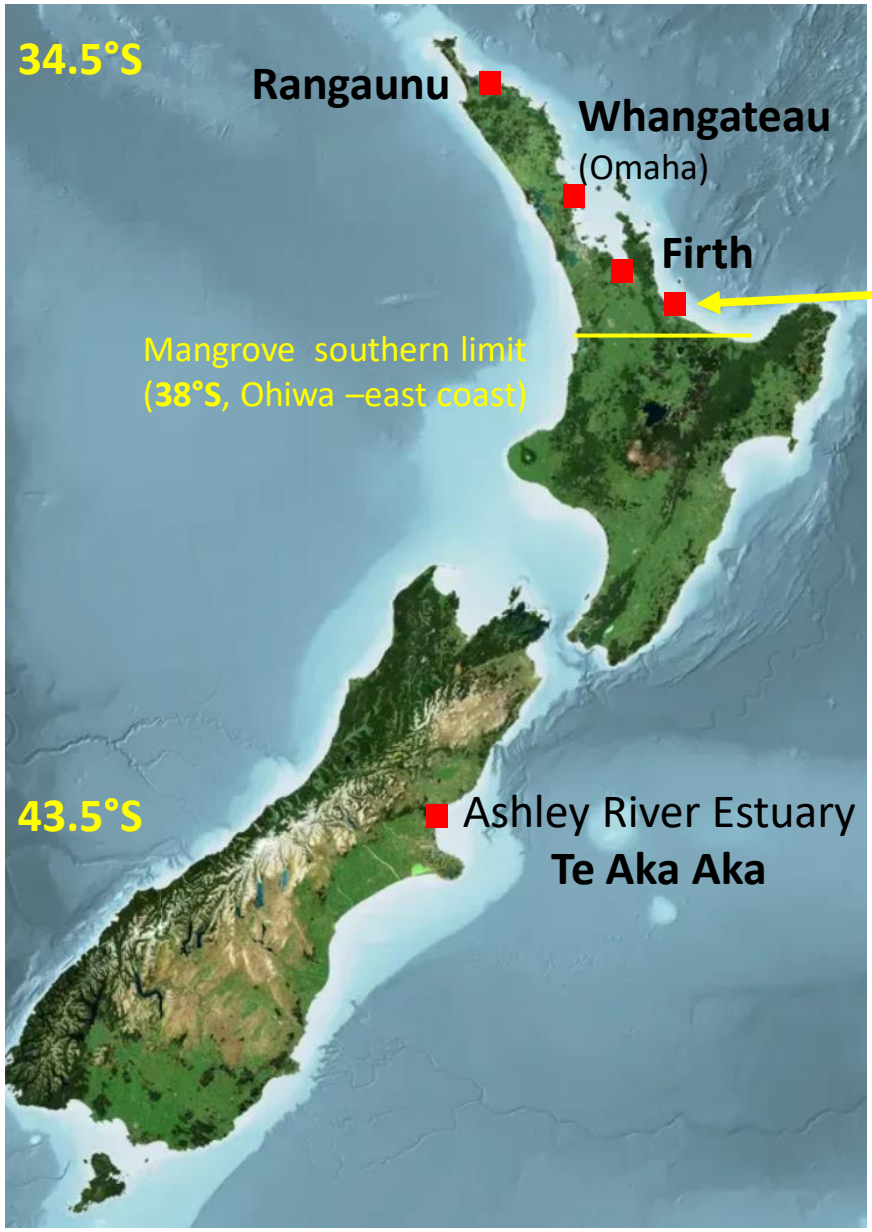
Study sites

Coastal wetlands

- Rangaunu (Northland)
- Whangateau (Omaha-Taniko)
- Firth of Thames (2007 - present)
- Bay of Plenty (Athenree, Ohiwa)
- Ashley River Estuary/Te Aka Aka



Bay of Plenty (**BoP**) Estuaries

- Tauranga Harbour (Athenree)
- Ohiwa

*BoPRC funded installation of RSETs in Athenree & Ohiwa.

Basemaps | Land Information New Zealand (LINZ)

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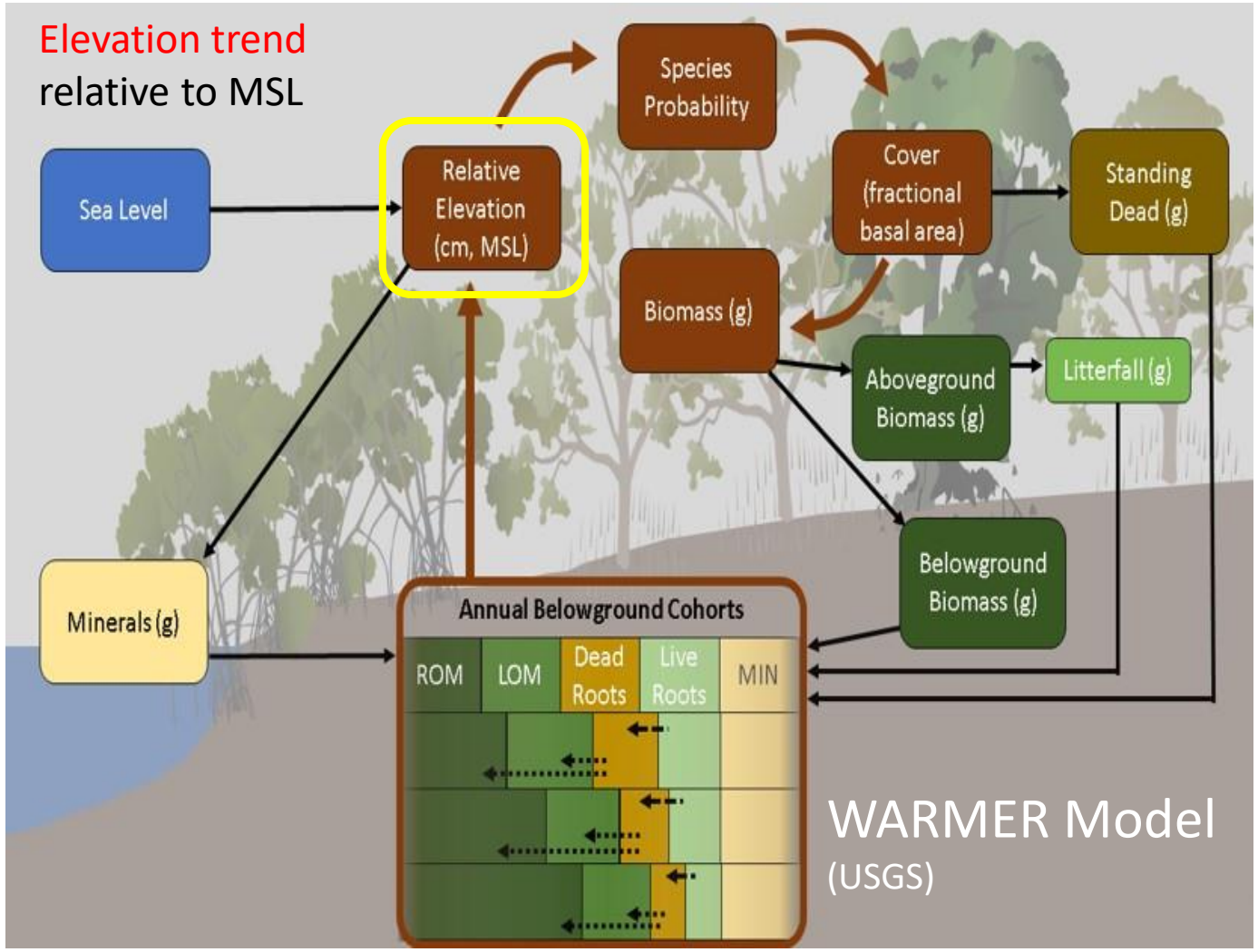
Wetland model



WARMER Model: US Geological Survey

Simulate:

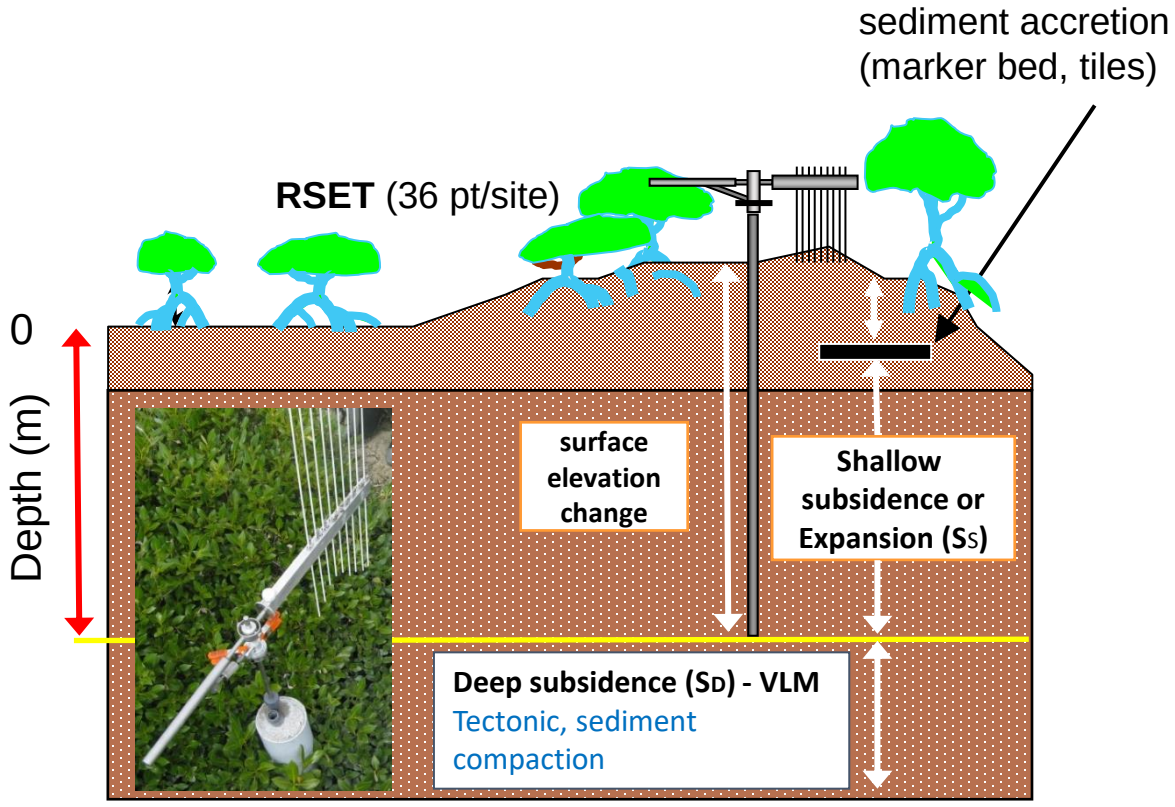
- Sediment accretion = sediment from rivers & organic matter (wetland plants) = elevation trend
- Plant community evolution (10s – 100's yr)

Use to:

- Understanding **when & where** wetlands most vulnerable to SLR
- **What** can be done to adapt (scenario modeling with management)
- inform opportunities for blue carbon to offset adaption costs

RSET

Rod Surface Elevation Tables



Elevation change = f(sediment accretion + sub-surface processes)

Long-term survival of coastal wetlands: must maintain elevation relative to sea level (mid-upper intertidal)

How: vertical sediment accretion &/or migrate upslope

RSET: key monitoring infrastructure

- Surface elevation trends & processes in wetlands
- Validate WARMER model simulations
- 2000+ sites globally
- Firth of Thames 2007 – present (NIWA-WRC)
- RSET being installed at FCA study sites

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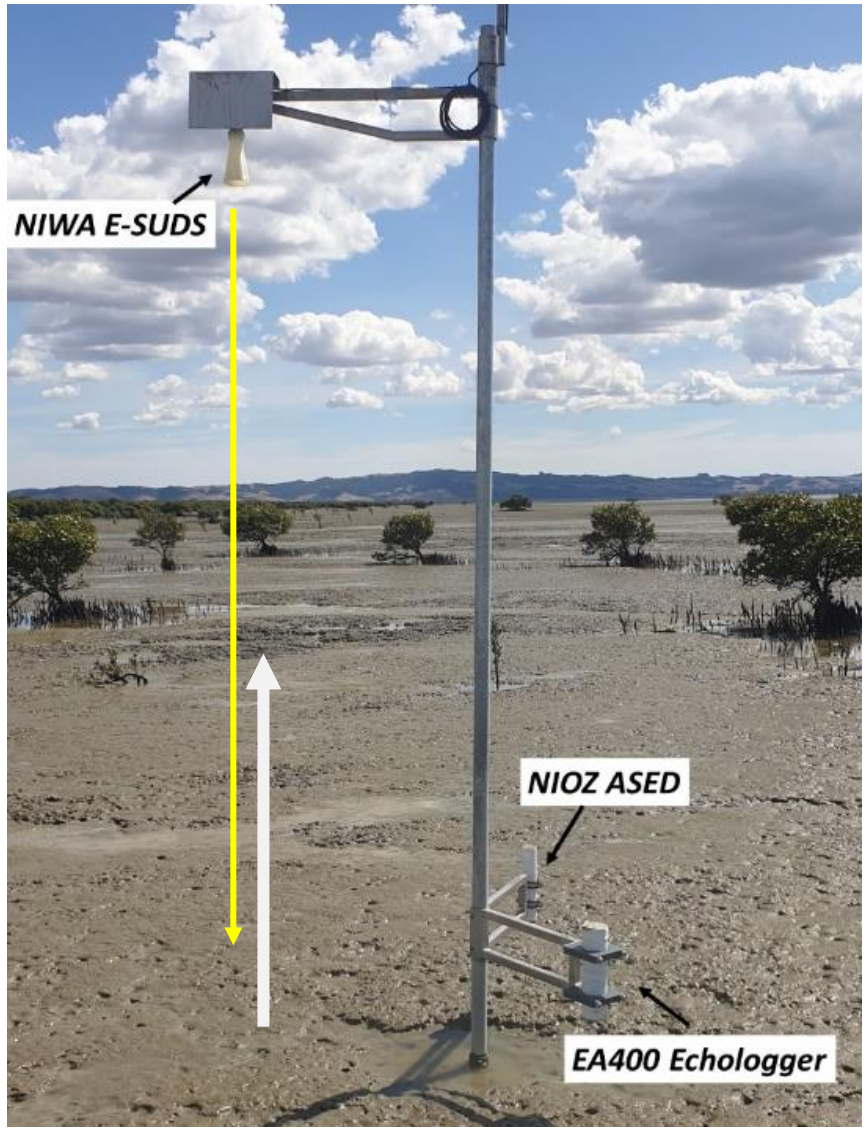
E-SUDS

Firth of Thames

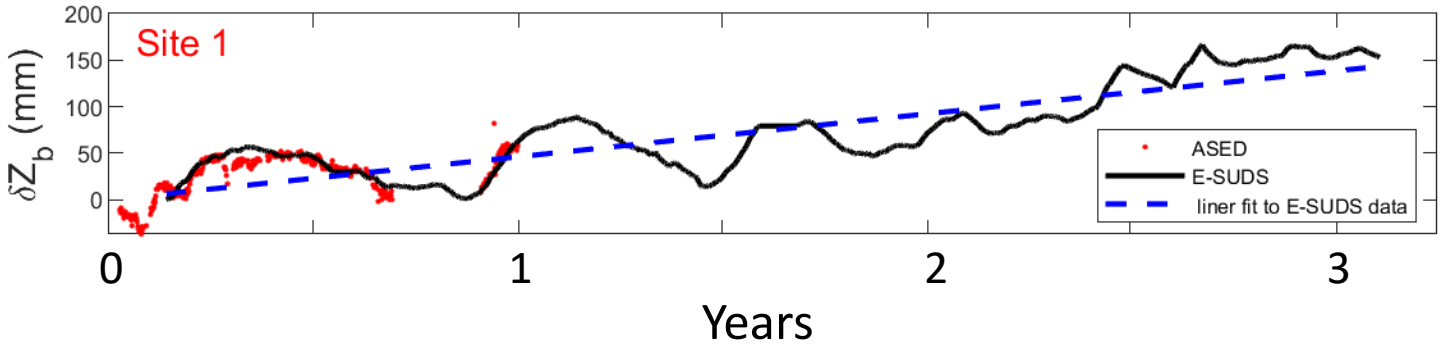


New tool for estuary & coastal wetland monitoring

E-SUDS (**E**stuary-**S**urface **U**ltrasonic **D**istance **S**ensor)

- Acoustic sensor + camera
- Continuous measurements: sedimentation, water levels & waves
- High freq (6 Hz) recording every 15 min
- Telemetered data
- Validated - independent acoustic and wave data
- Deploy at FCA sites

Sedimentation record = 46 mm/yr (average)



Restoration

BoPRC Wainui saltmarsh restoration project

Tauranga Harbour

Project aim: create habitat connection from wetland to harbour & river. Address habitat fragmentation

- Increase tidal flows & water levels - additional **culverts.**
- Stopbanks rebuilt landward.
- Revegetation: 20 ha planted (Oioi, *Juncus, Saltmarsh ribbonwood*)

BoPRC – key player in SLR adaption, saltmarsh restoration & exploring blue carbon opportunities

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Summary

Sea Level Rise

- Unavoidable & already causing irreversible changes
- Most at risk environs inc: estuaries, intertidal habitats & wetlands

FCA programme: provide knowledge & tools to transform coastal lowlands in most effective way.

More info:

- FCA programme : Christo.Rautenbach@niwa.co.nz
- Coastal wetland research: Andrew.Swales@niwa.co.nz
- Web: https://niwa.co.nz/natural-hazards/research-projects/future-coasts-aotearoa

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EXTRA SLIDES

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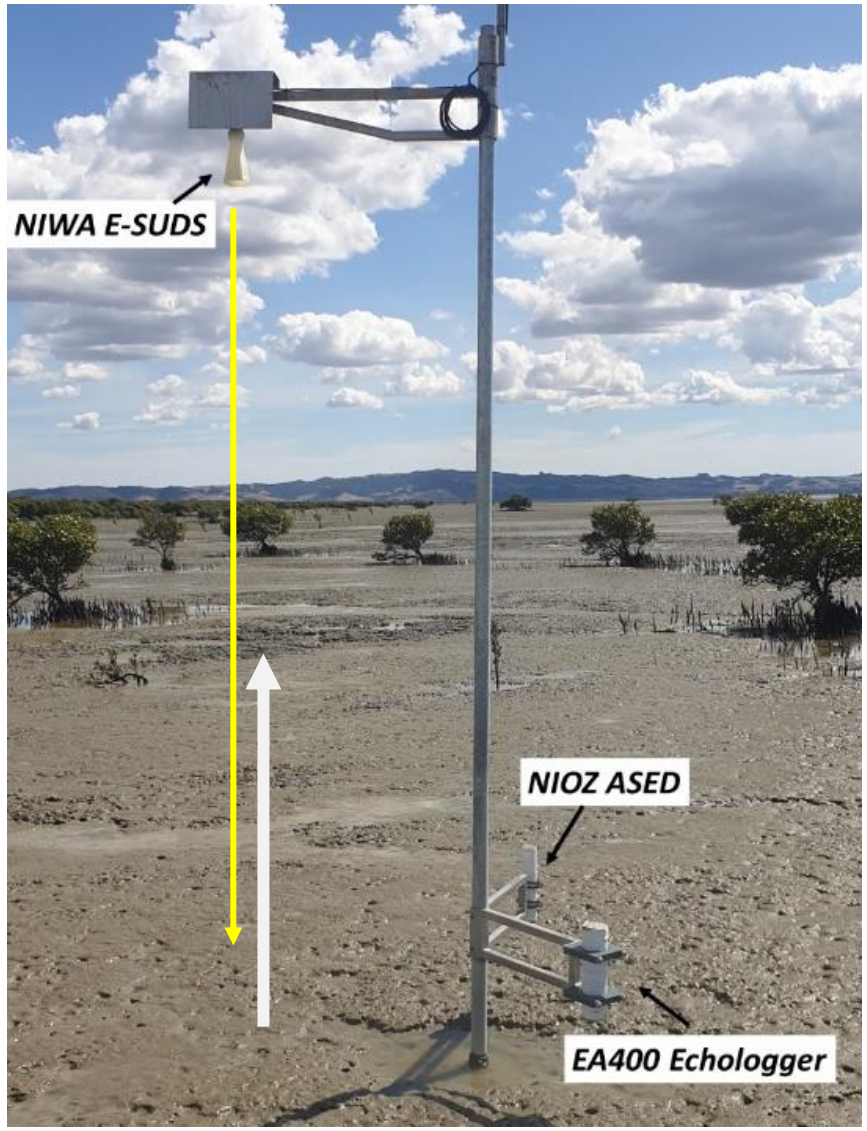
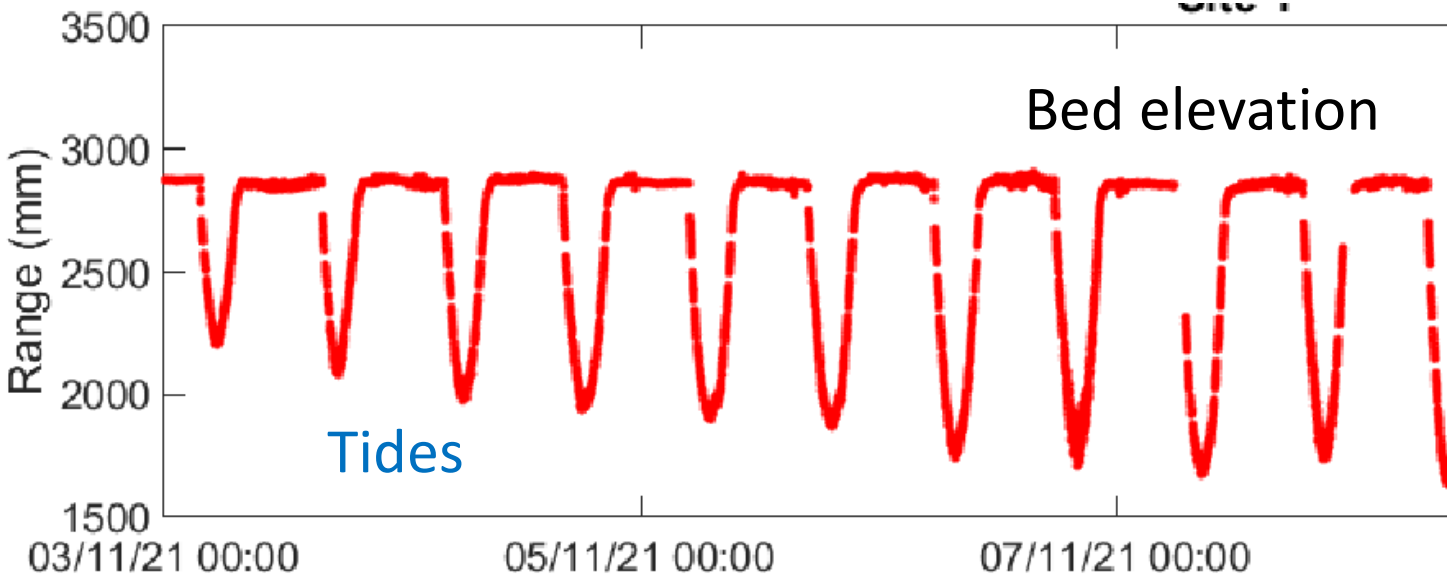
E-SUDS

Firth of Thames





E-SUDS (**E**stuary-**S**urface **U**ltrasonic **D**istance **S**ensor)

- Telemetered continuous measurement - tidal-flat elevation, tides & waves
- High freq 42kHz, recording @ 6 Hz, 10-min burst every 15 min + camera
- Validation - independent data (ASED, Echologger, 3 yr)
- Cost-effective tool for monitoring events & long-term trends

Salinisation

- Tauranga Harbour, Aongatete
- Tidally connected: 0.6 - 1.2 m above MSL

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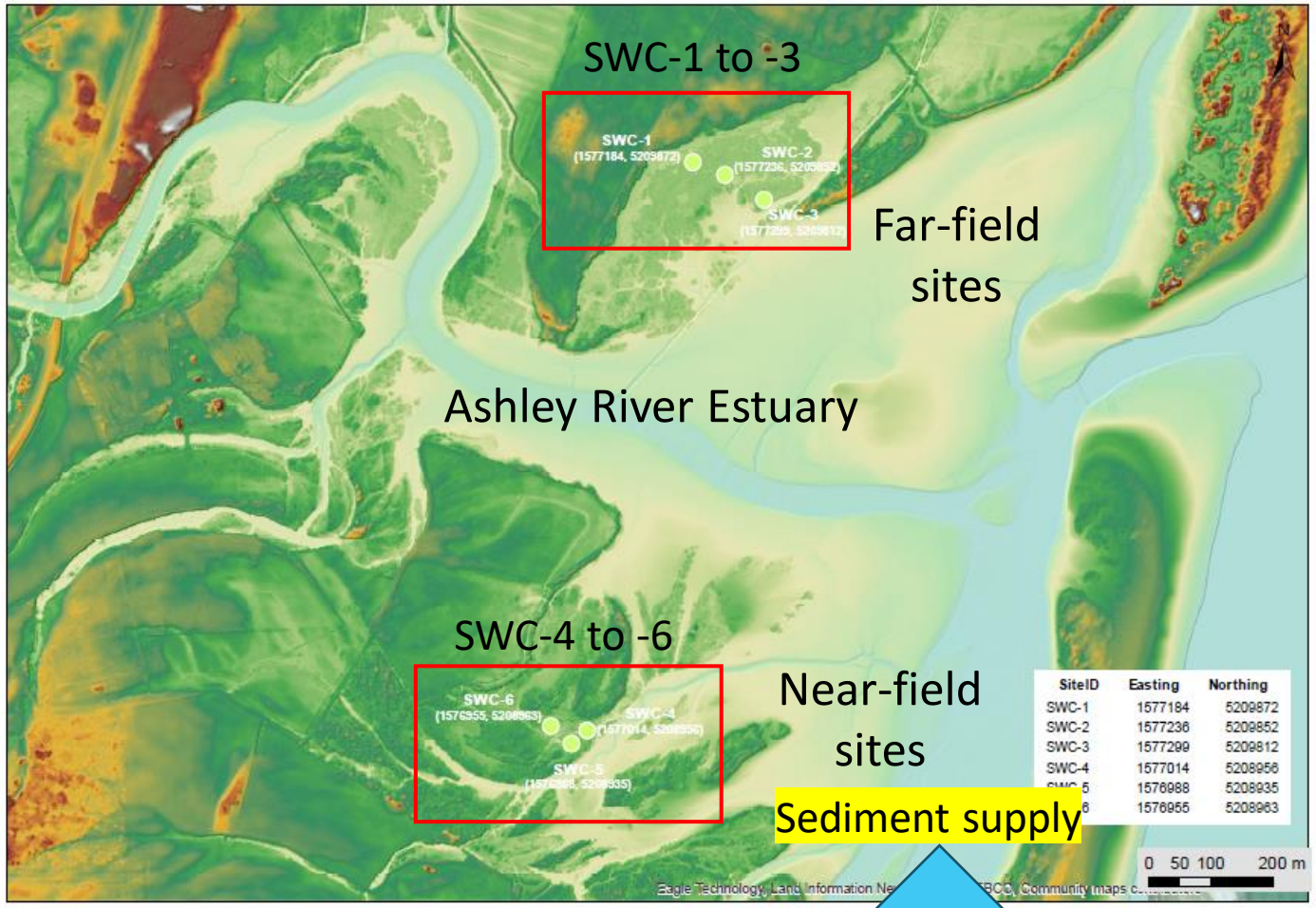
Ashley River – saltmarsh



Initial results

Blue Carbon (*Juncus kraussii*, 1 m cores)

- Inventories unexpectedly high
- 38 - 94 tC/ha (ave: 52 tC/ha)
- 38 - 57 tC/ha (NZ: Ross et al., 2023)

^{210}Pb SAR (40 - 150 yr)

- Near-field: 2.6 - 4.6 mm/yr
- Far-field: 1.4 - 2.0 mm/yr
- RSLR 1.9 mm/yr (Lyttleton 1900- , Denys et al., 2020)

RSET trends (4 surveys – 1 yr)

- Near-field: 1 - 8.1 mm
- Far-field: -0.2 - 4 mm

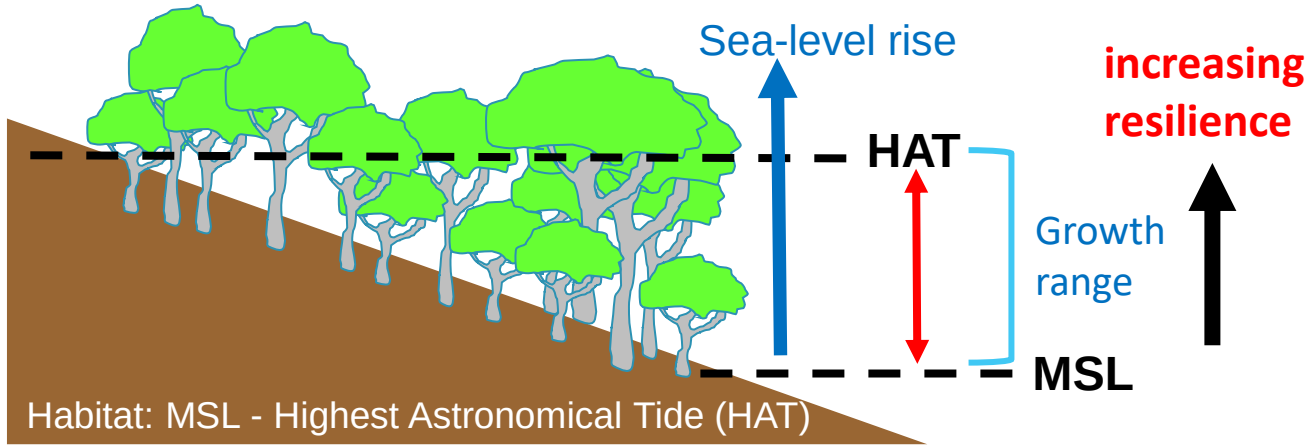
Ross et al (2023) A preliminary estimate of the contribution of coastal blue carbon to climate change mitigation in New Zealand. *NZ Journal Marine & Freshwater Research* https://doi.org/10.1080/00288330.2023.2245770

Elevation Capital - resilience to RSLR

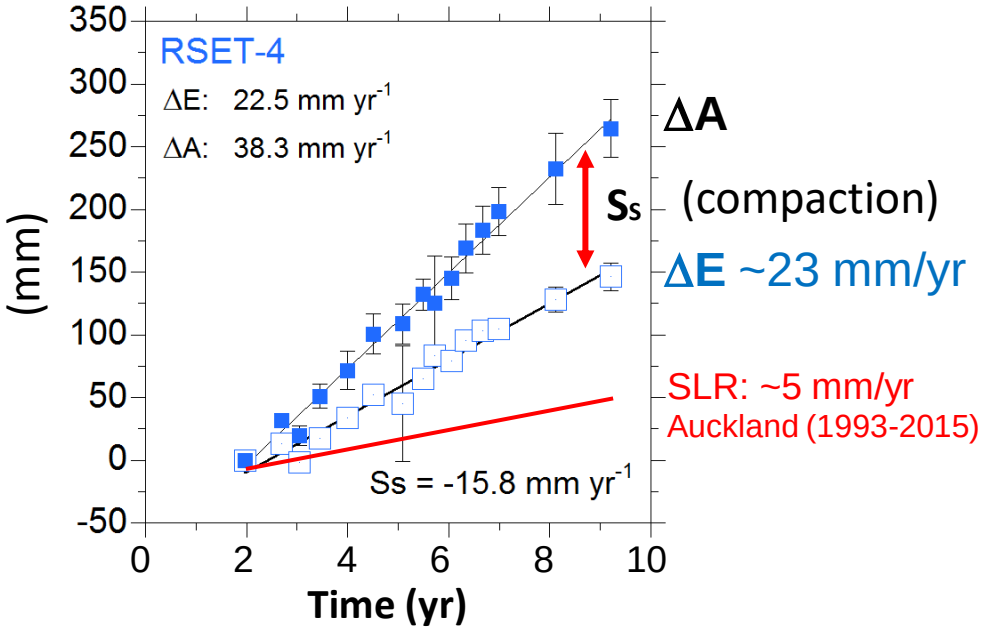
(1) **Elevation Capital** = elevation of a coastal wetland relative to **lowest viable elevation** in growth range

(~ MSL)

Drivers: tidal range (micro –mesotidal) & sediment supply (*Cahoon & Guntenspergen, 2010*)



(2) **Net Surface Elevation Trend (ΔE)** = Sediment accretion (**ΔA**) – shallow subsidence (**Ss**)



ΔA (compaction)

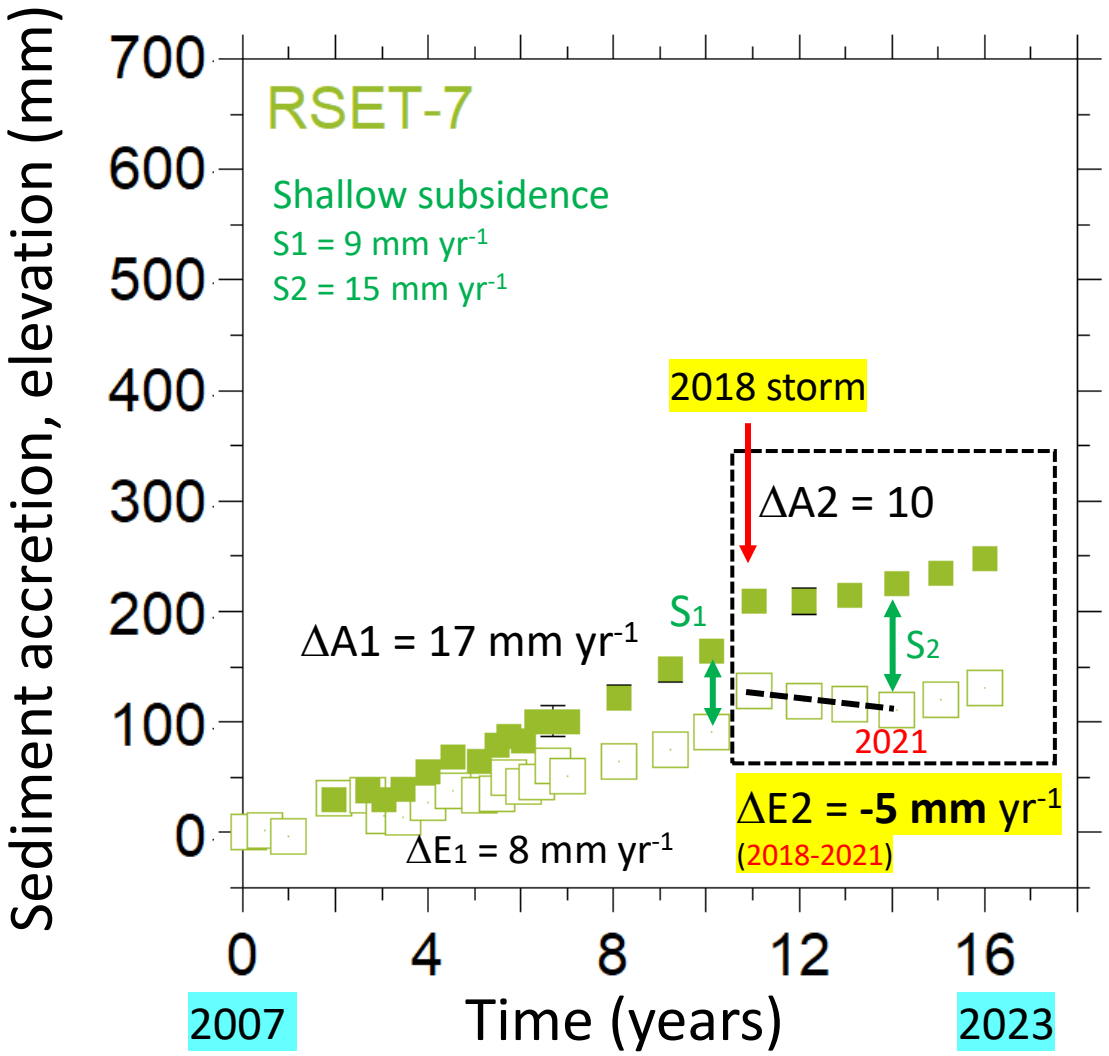
ΔE ~23 mm/yr

SLR: ~5 mm/yr
Auckland (1993-2015)

Elev. capital + (ΔE)

= resilience to RSLR

Response – post storm



Relict-fringe forest (RSET-7 – RSET-9):

- **4-cm sediment deposited** in landward most forest
- **Elevation loss** at all sites: 5 - 6 mm yr^{-1} (2018-2021)
- Storm sediment loading = 2 x increase in compaction rate
- Elevation recovery from 2021 – BUT 2023 elevation ~16 mm < pre-storm trend
- **Day-to-day processes** drive **long-term** surface-elevation dynamics Not episodic storms
- Sediment-rich systems - resilient

Mangrove invasion

2018 storm-tide: delivered mangrove propagules to saltmarsh & supra-tidal zone – on scale not observed before

- mangroves habitat replacing these communities
- SLR & storm tides = NZ saltmarsh loss without landward migration?

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National-scale mapping – RSLR impacts

Data sets & methods

- LiDAR - DEM — FCA GIS Database
- Present-day coastal wetland extent
- Land use
- Infrastructure (e.g., stop banks, roads, rail)

- SLR projections X 5 (IPCC –AR6), >> MfE (2022) 0.6-1.6 m by 2130 AD 5-10 yr increments
- Tidal levels & ranges - **NZ Tide Model** (NZTM), includes estuaries, spatial resolution 10-100s m
- **NZTM + SLR** projections = map relevant tidal envelopes relative to MSL = proxy for vegetated & unvegetated (< MSL) intertidal habitats.
  (e.g., MSL – HAT, Mean Neap & Spring (low-high) etc)
- **VLM** (local estimates where available)
- Identify areas potentially suitable for restoration & barriers = connected/disconnected

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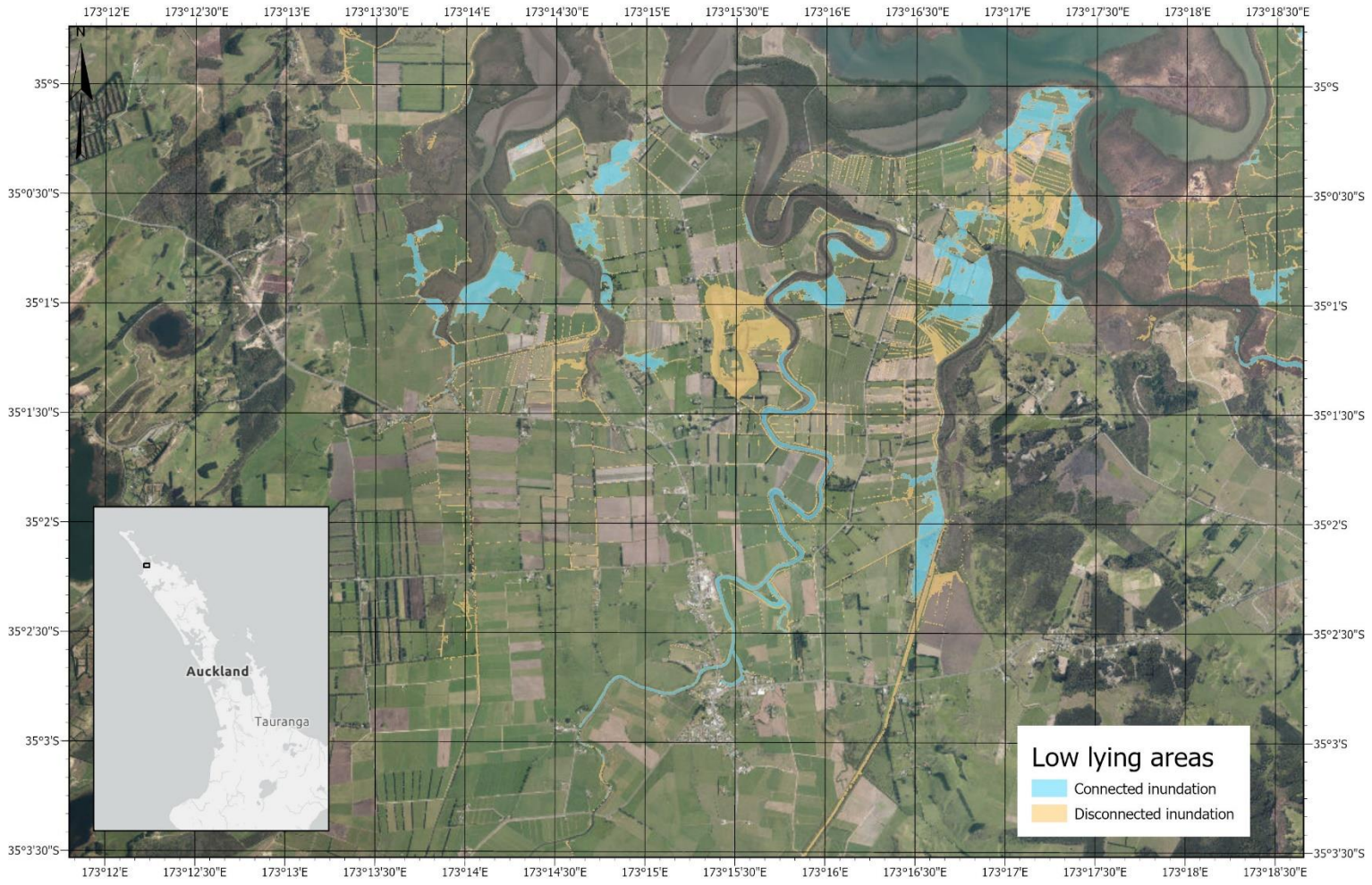
SLR – MSL +0.6 m



Rangaunu Harbour (Northland)

0.6 m SLR (middle of road – 2100)

- Inundation – tidally connected 187 ha
- Not tidally connected: 115 ha

Rangaunu Harbour	
SLR	Area_ha
MSL060_All	307.4054
MSL060_Connected	186.7376
MSL100_All	833.0527
MSL100_Connected	647.5911
MSL160_All	2627.459
MSL160_Connected	2422.299
Clipped to View extent	
SLR	Area_ha
MSL060_All_clip	245.9376
MSL060_Connected_clip	152.1475
MSL100_All_clip	634.9618
MSL100_Connected_clip	486.1845
MSL160_All_clip	1997.124

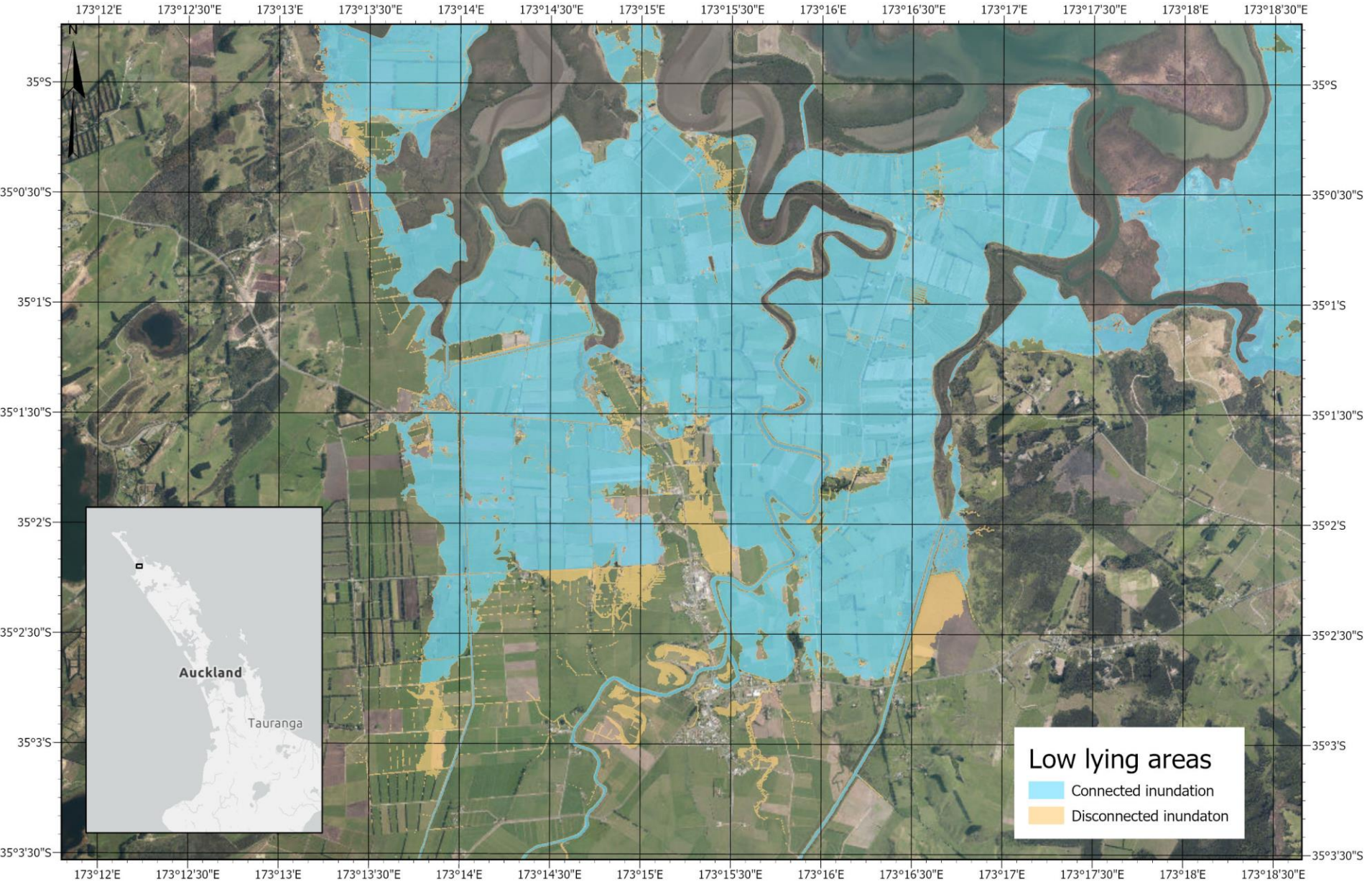
Future Coasts Aotearoa – informing adaption and restoration opportunities for coastal wetlands

Andrew Swales, Inigo Zabarte-Maeztu, Phoebe Stewart-Sinclair, Christo Rautenbach

National Institute of Water and Atmospheric Research, Hamilton

Abstract

Future Coasts Aotearoa (FCA) is a five-year research programme that aims to inform how the lowland rural communities and environments of Aotearoa New Zealand can adapt and prosper despite unavoidable sea level rise (SLR) over the coming decades. FCA is exploring the environmental, social, economic, and physical changes that lie ahead and how we can most effectively respond. Biophysical models of inundation and salinisation and coastal wetland evolution, underpinned by measurements, can inform land-use change decisions sensitive to flooding and salinisation at a national scale. Mana whenua research aspirations and world views are also interwoven into research activities through partnerships at case study sites. This presentation provides an overview of the research being undertaken to understand, and simulate, how coastal wetlands will respond under a range of possible SLR scenarios, their capacity to adapt and key environmental drivers. The insights flowing from this work will inform opportunities to restore coastal wetland ecosystems that have been degraded or largely lost due to reclamation and infrastructure development on estuarine margins as well as land clearance and development of pastoral agriculture in lowland catchments over the last 170 years.



SLR: MSL + 1.6 m

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