

Dunelands of the southwest North Island

DRIVING FORCES, DEVELOPMENT, AND FUTURE SCENARIOS



Dr Alastair Clement

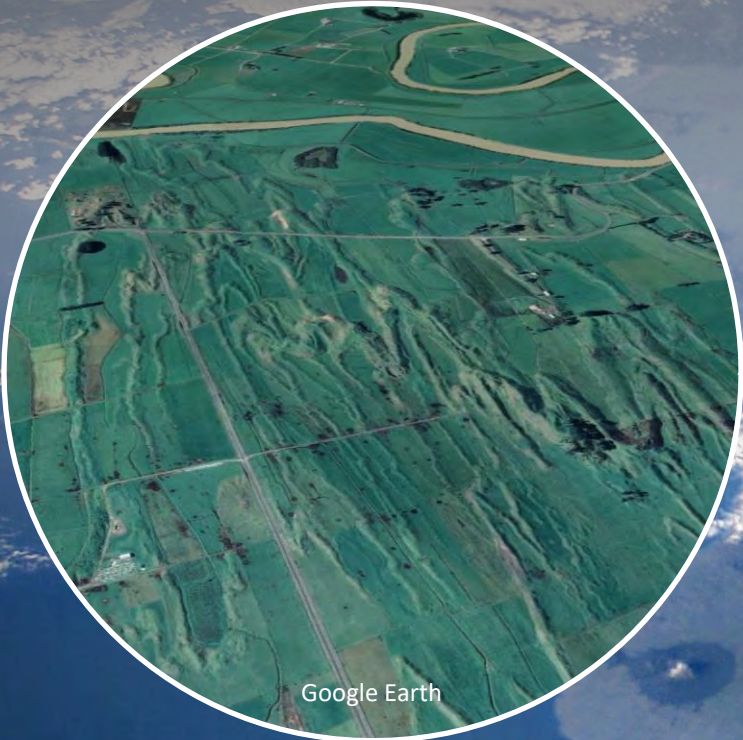
School of Agriculture and Environment, Massey University, Palmerston North



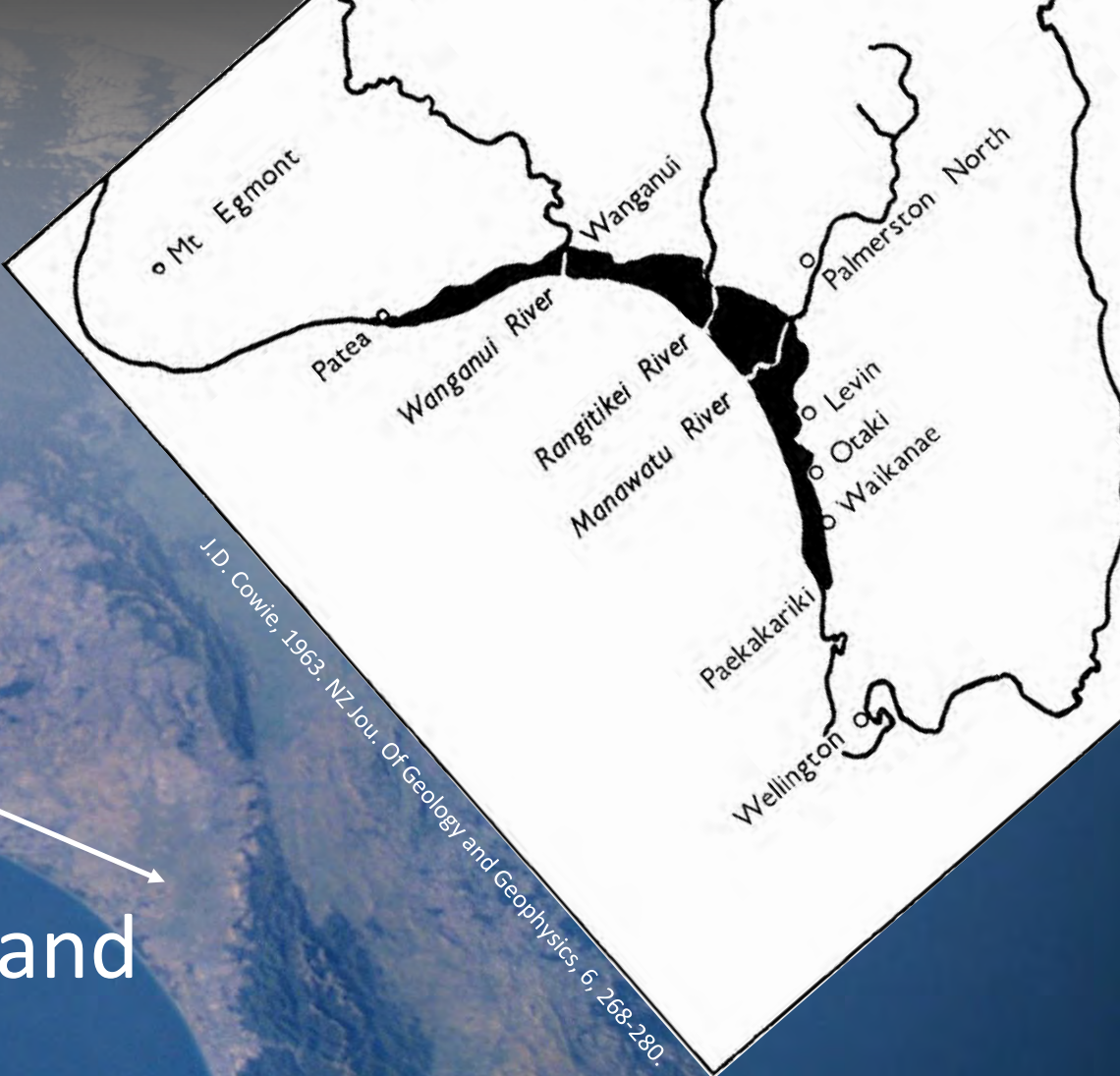
Dunelands of the southwest North Island

- Context: space, morphology, and time
- Physical setting + geomorphic controls on dune development
- Chronology of dune activity + evolution of our understanding
- Future scenarios

Broad spatial extent



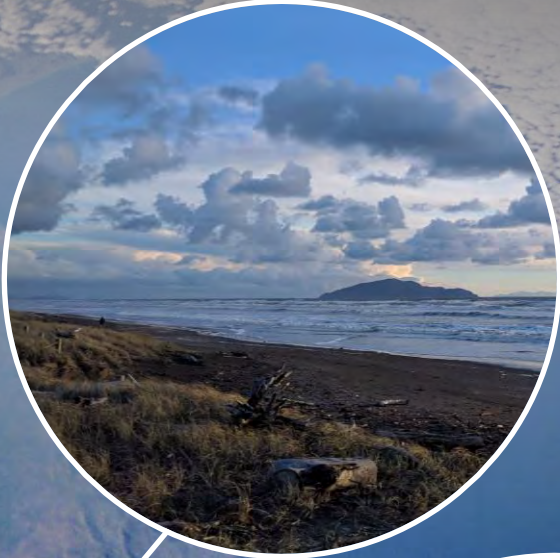
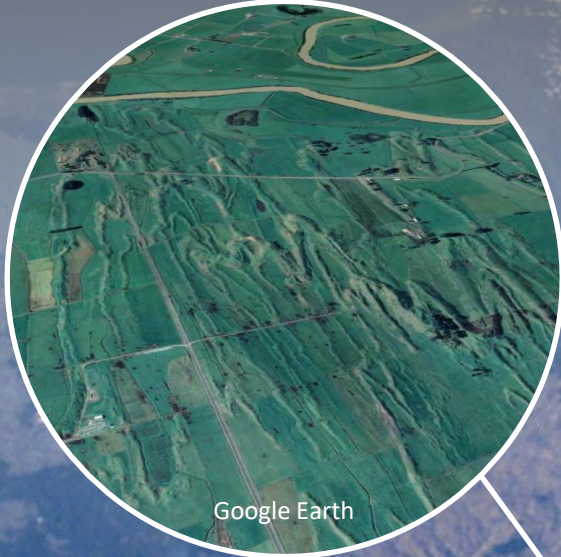
Google Earth



Up to 18 km inland

Found along 180 km of coastline

A variety of settings



Whanganui
Manawatu
Otaki
Paekakariki

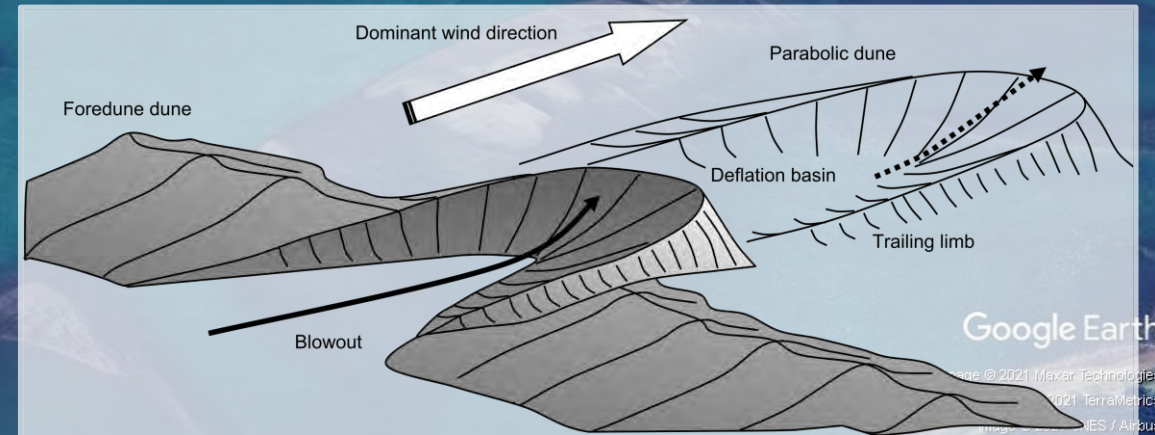
Patea

Parabolic dunes

- Evolved from sand sheets
 - Lobes of sand migrating into vegetation evolve to become parabolic dunes
 - Disturbance of a sand sheet stabilised under vegetation



Sand sheet at Aotea Harbour



Google Earth

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Time-transgressive landforms

- Diachronous
 - Vary in age across space

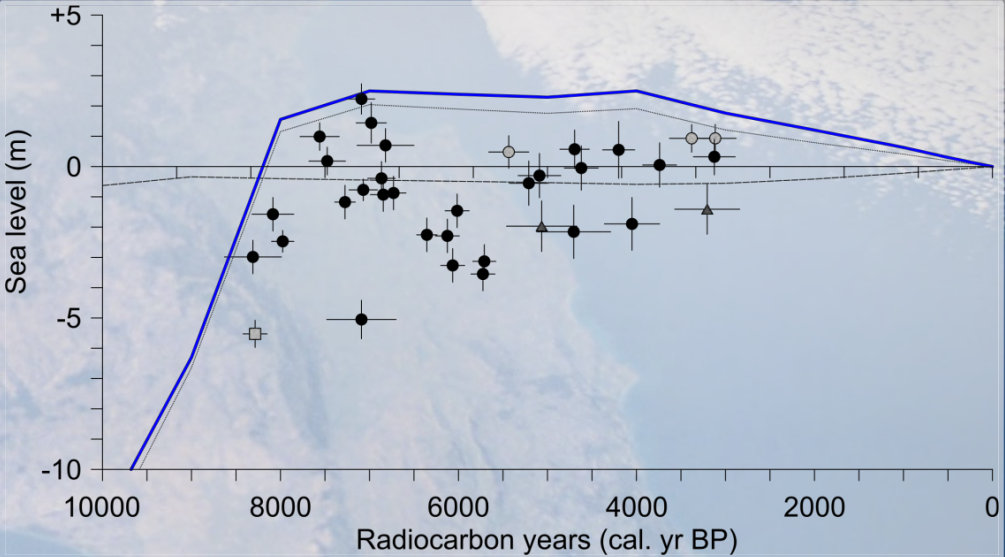
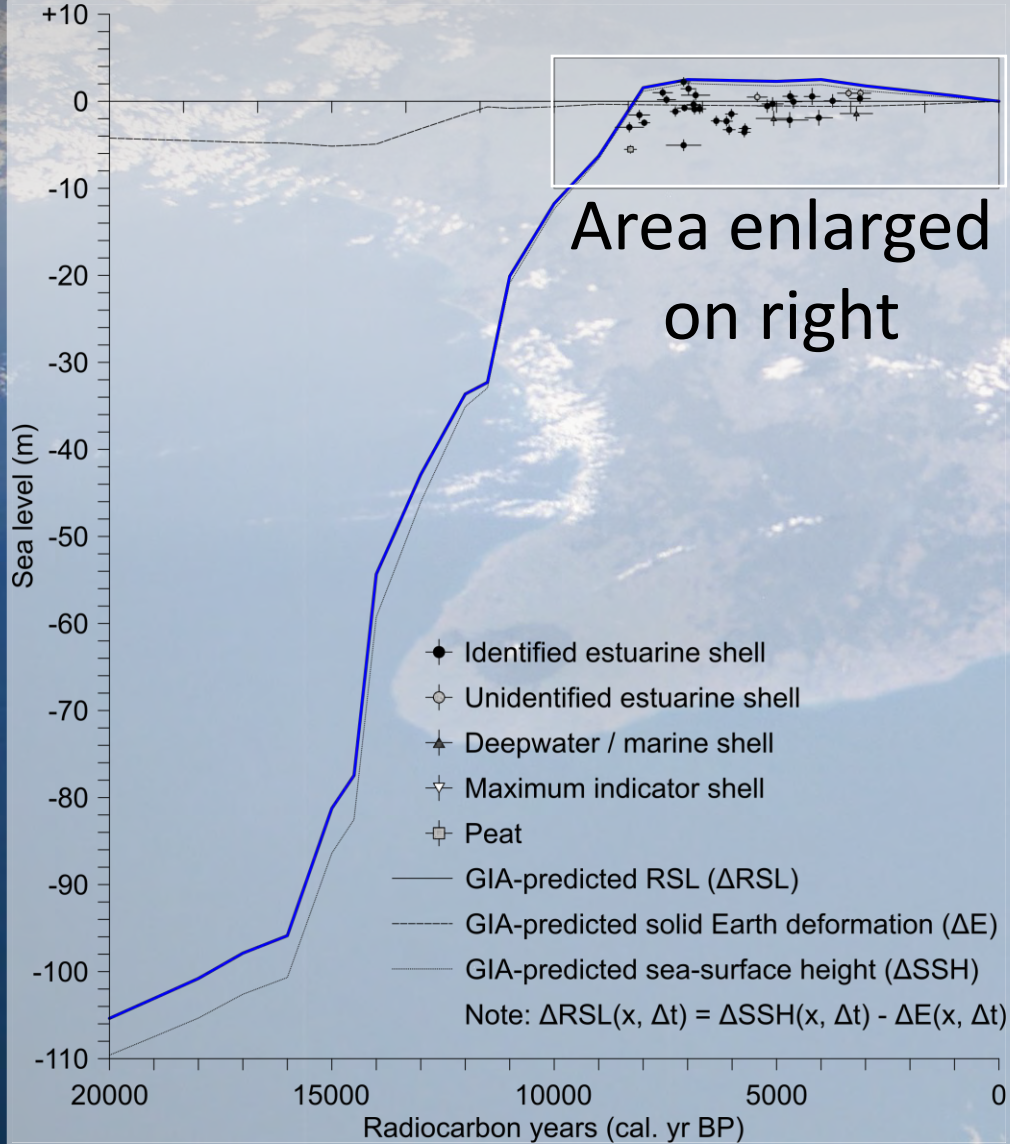


Rangiotu, Manawatu

Google Earth

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Image Landsat / Copernicus
Image © 2021 CNES / Airbus
Image Horowhenua District Council

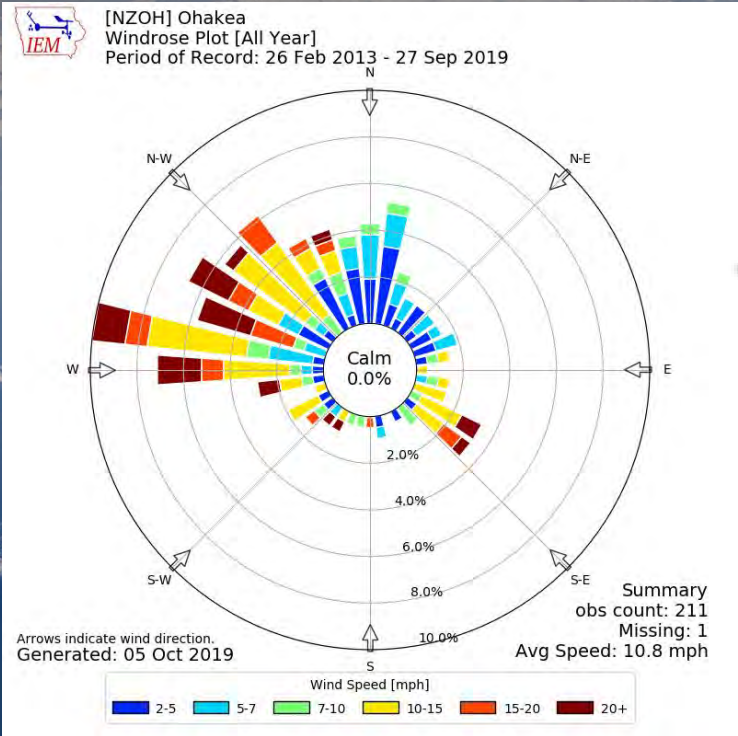
Looking back over the past 10,000 years



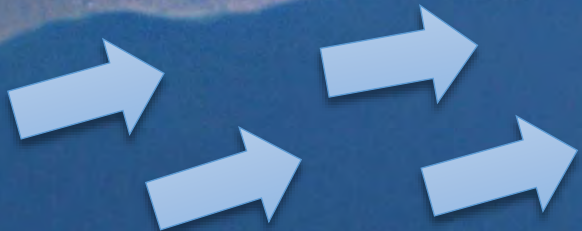
Physical setting + geomorphic controls



Wind regime

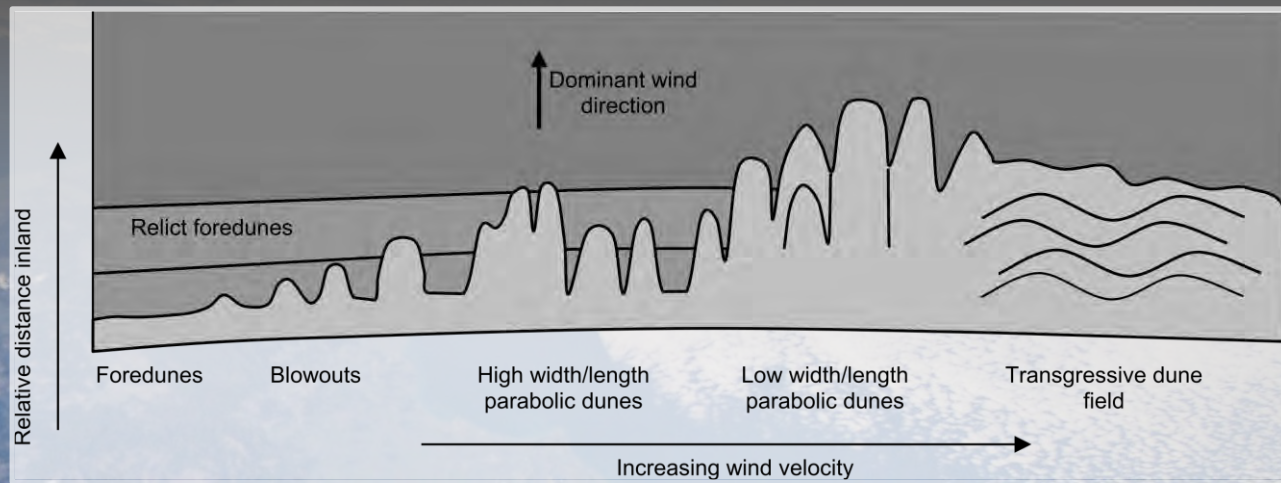
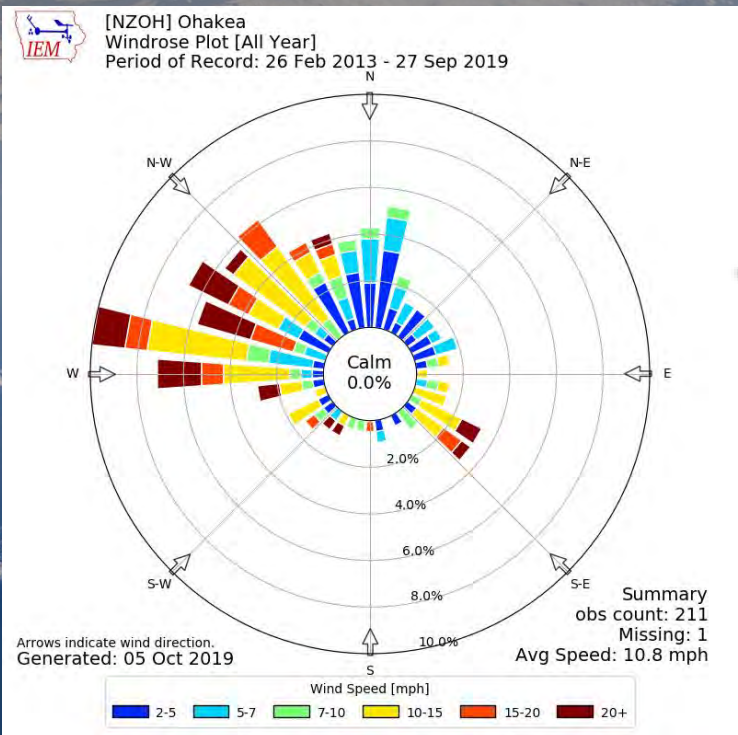


Iowa State University Environmental Mesonet



- Southern Hemisphere westerly winds
- New Zealand topography - Cook Strait

Wind regime



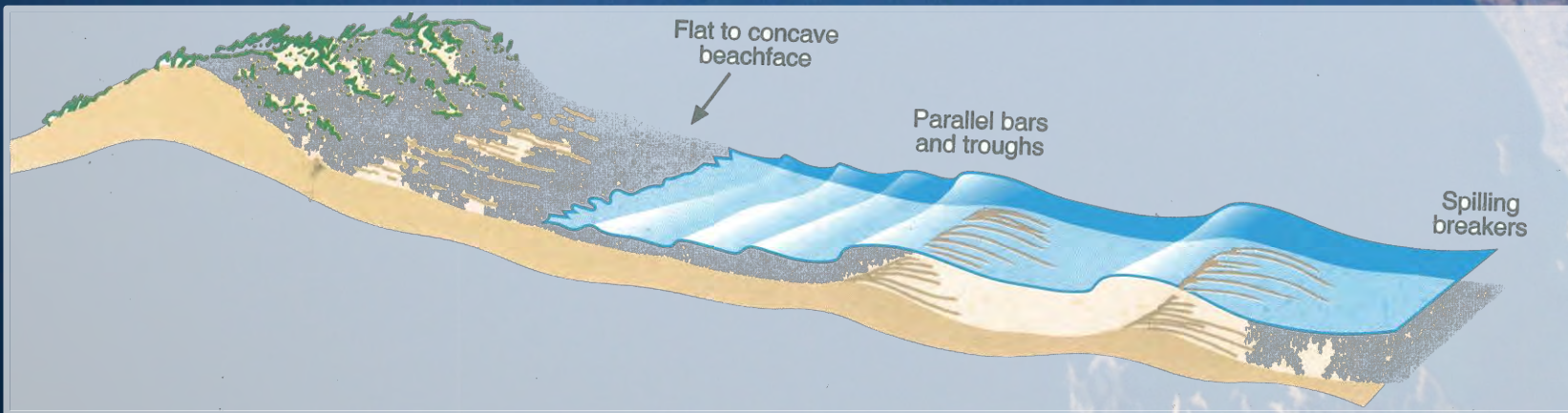
Iowa State University Environmental Mesonet



- Southern Hemisphere westerly winds
- New Zealand topography - Cook Strait

Wave climate + beach morphology

- Low gradient beaches conditioned to high wave energy

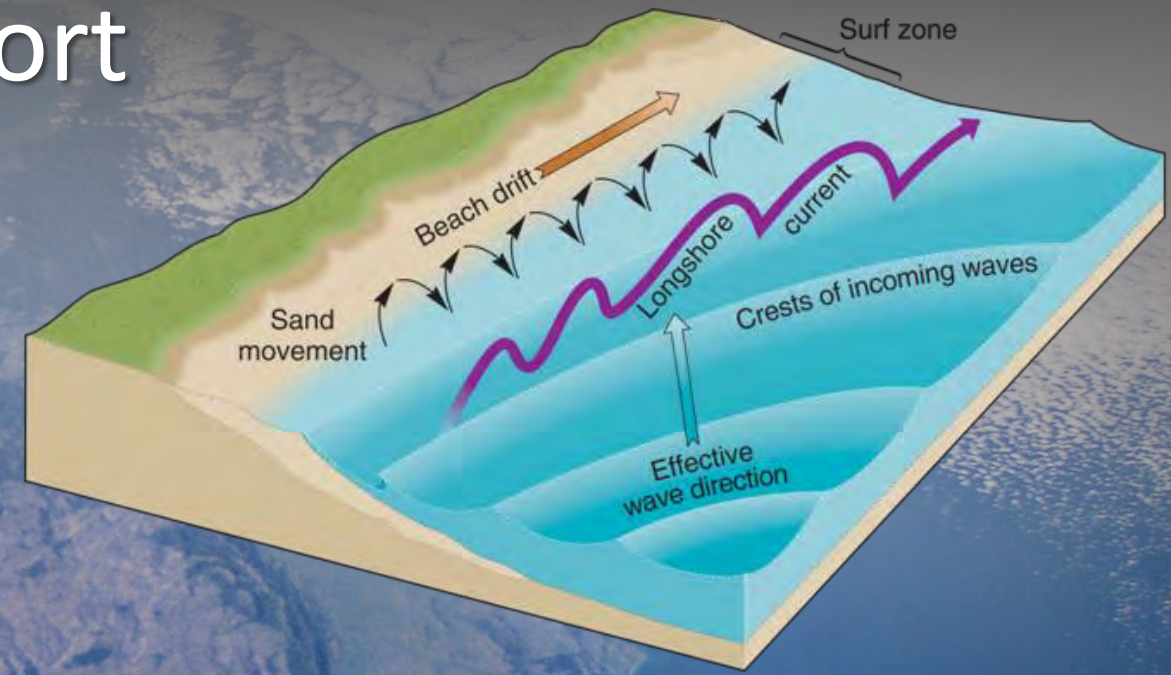


Rivers and sediment supply

- Whanganui – 4.70 Mt/y
- Whangaehu – 0.69 Mt/y
- Rangitikei – 1.10 Mt/y
- Manawatu – 3.74 Mt/y
- Otaki – 0.17 Mt/y

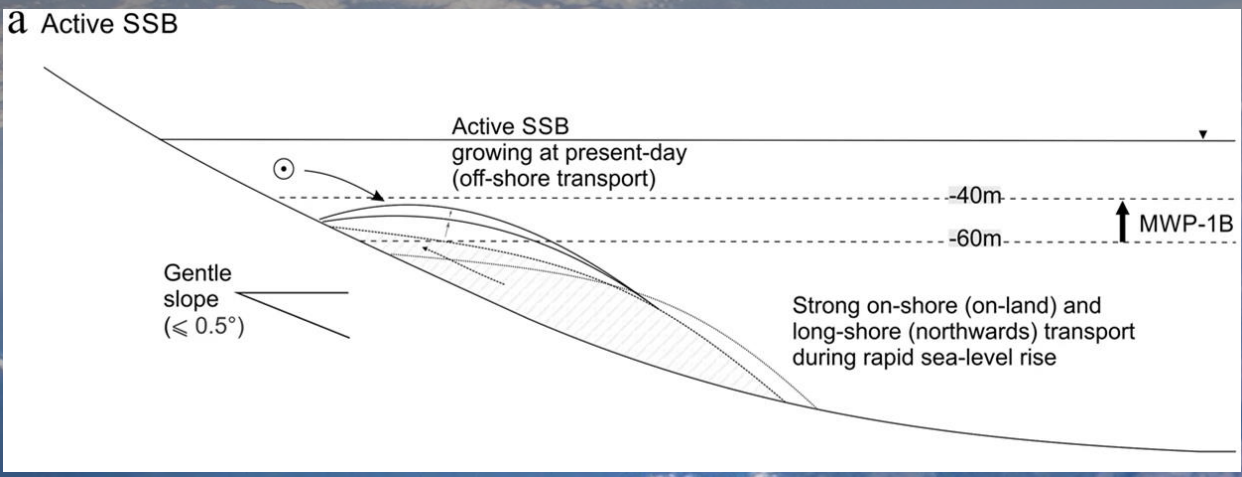


Longshore sediment transport

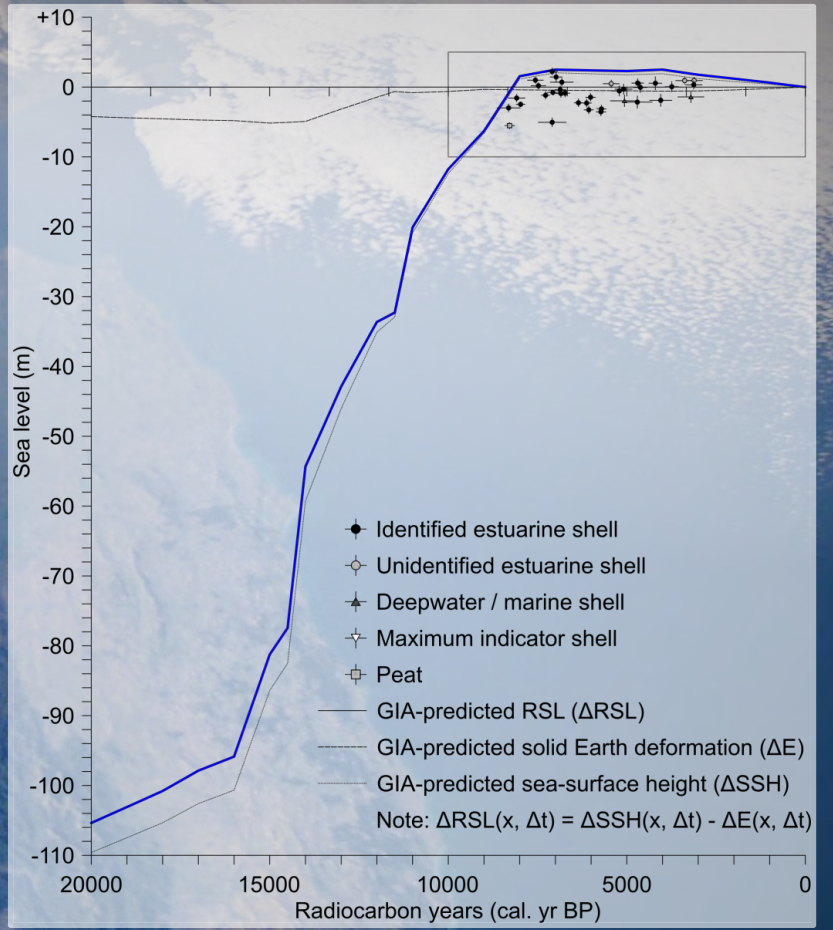


- North to south
- Peaks along the Manawatu coast
- Declines significantly towards Kapiti coast

Sediment from the continental shelf



M. Ribo et al. 2020. Sci. Reports, 10, 462.



- Rapid sea-level rise
- Shallow marine processes eroding sediment
- Landward migration of sediment

Flat back-beach topography

- Cliff-top dunes discussed later...

Mouth of the
Manawatu River

Google Earth

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Data SIO, NOAA, U.S. Navy, NGA, GEBCO



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How did the dunefield develop?

How did our understanding of the dunefield develop?

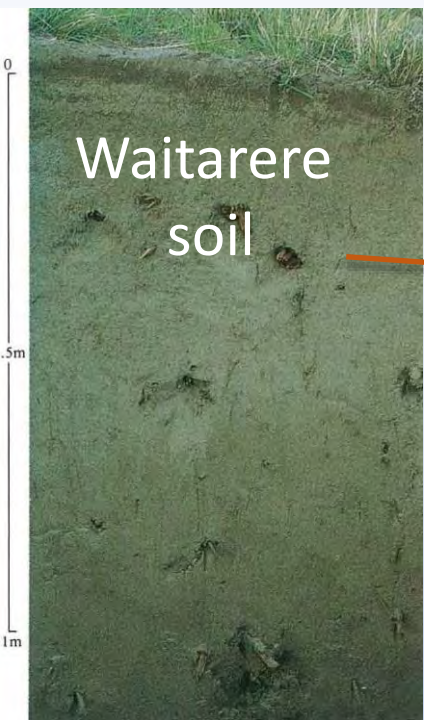
Horowhenua coast

Google Earth

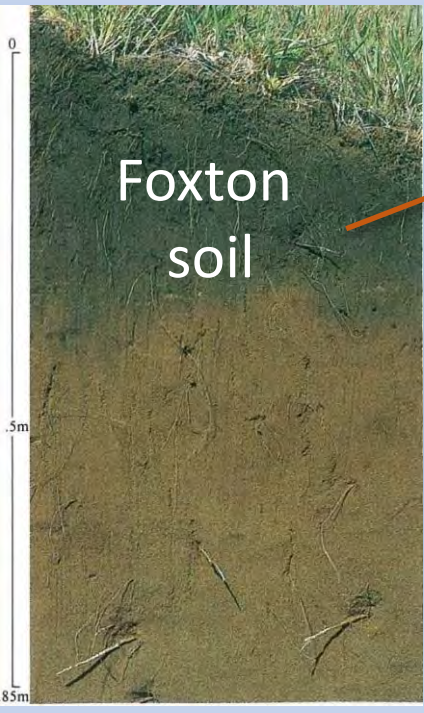
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Pedological studies

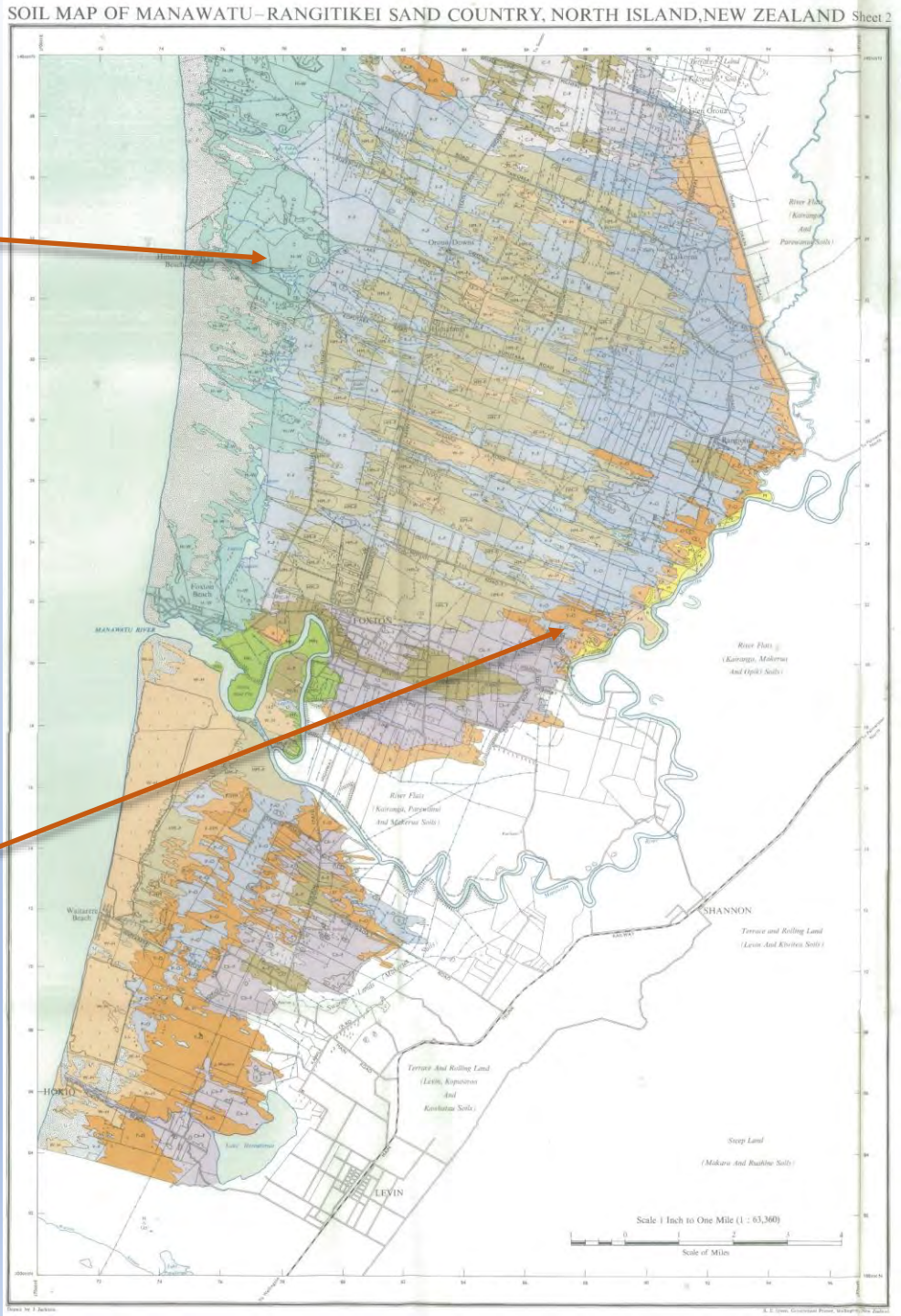
- Various works by J.D Cowie
- “Assessment of the soil resource... as a basis for further development ...”



Waitarere soil

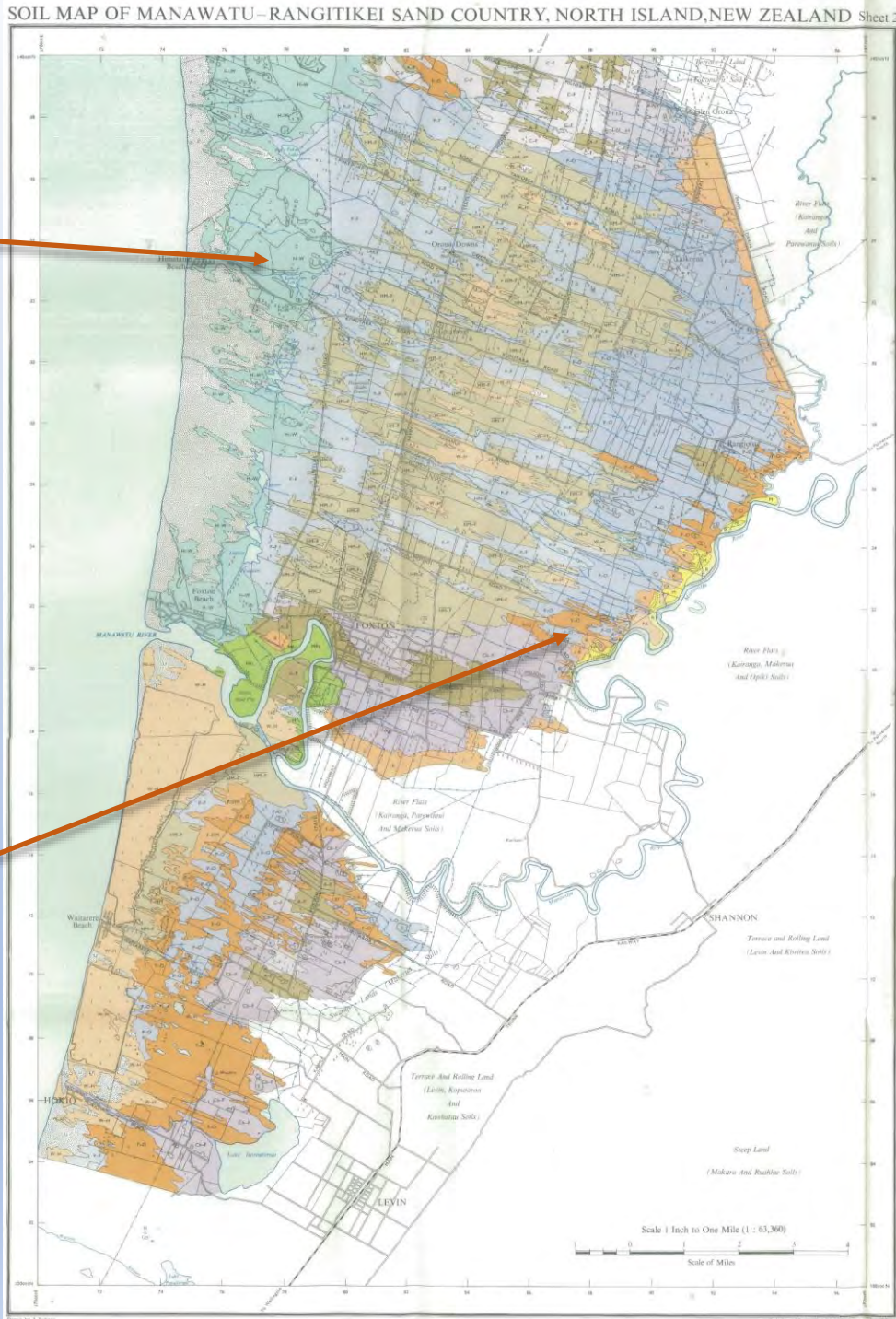


Foxton soil



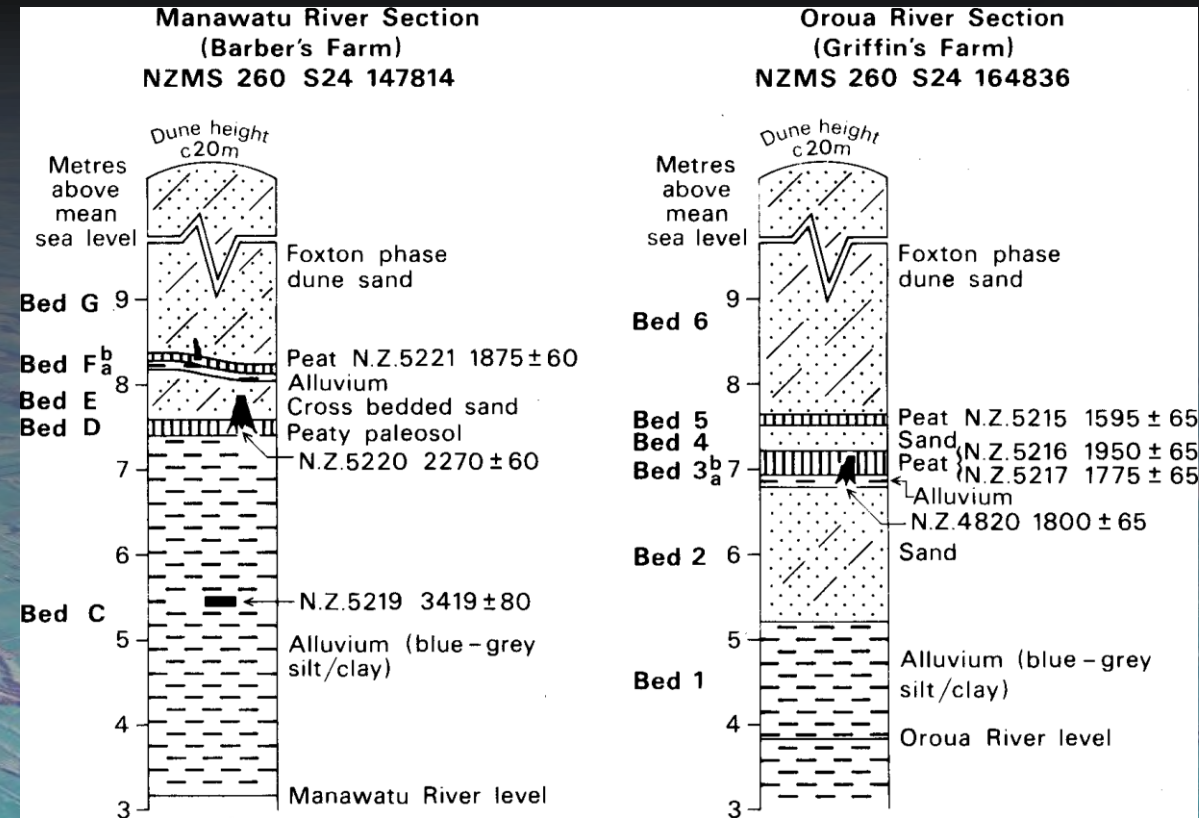
Soil studies

- Foxtton phase
 - 4,000-2,000 years BP
 - Up to 18 km inland
- Motuiti phase
 - 1,000-500 years BP
- Waitarere phase
 - Active and stabilised dunes extending up to 4 km
 - Less than 100 years old



Radiocarbon dating

- Dunes reached Rangiotu 2,300 years BP
- Continued until 1,600 years BP
- Advance estimated at 5 m per year
- Dunes initiated at the coast 6,000 years BP



New Zealand Journal of Geology and Geophysics, 1987, Vol. 30 : 175–187
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Holocene alluviation and transgressive dune activity in the lower Manawatu Valley, New Zealand

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Massey University
Palmerston North, New Zealand

Rangiotu, Manawatu

Google Earth

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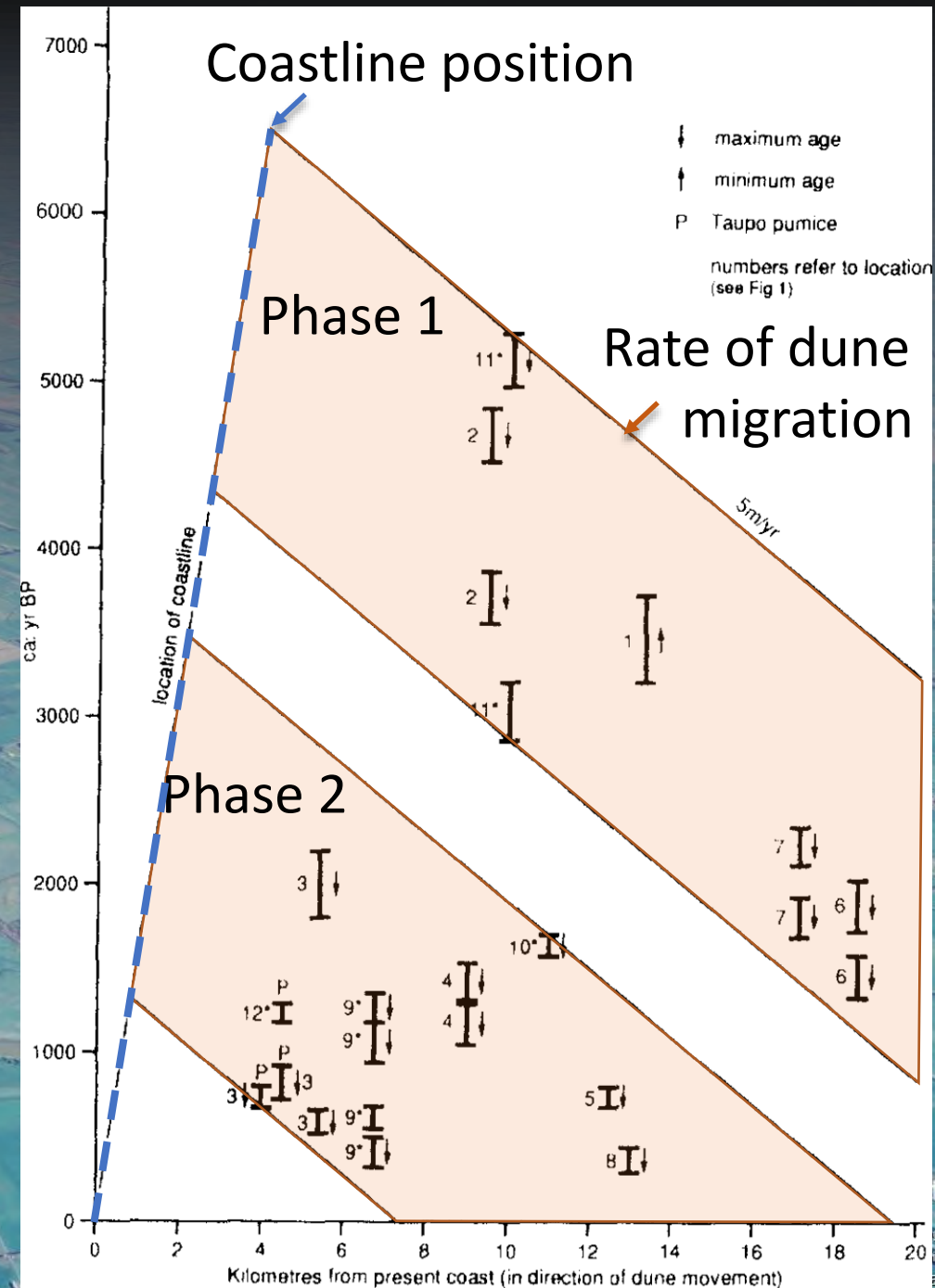
Radiocarbon dating

- First phase initiated ~6,500 years BP
 - Ceased at the coastline 4,500 years BP
 - Dunes continued to migrate inland until 1,600 years BP
- Second phase of dune activity at the coast beginning 3,500 years BP
 - Some dunes still active 400 years BP
- Possible Maori and European phases

DUNE PHASES AS TIME-TRANSGRESSIVE PHENOMENA, MANAWATU, NEW ZEALAND

C. Muckersie and M.J. Shepherd

Department of Geography, Massey University, Private Bag 11222, Palmerston North, New Zealand



OSL dating

- Optically stimulated luminescence
- Swamp road dunes
 - Leading edge of the Foxton phase
 - ~3,700-4,100 years BP
- Foxton phase
 - Landward 2,900 years BP
 - Seaward 1,800 years BP
- Motuiti phase
 - 700 years BP
- Waitarere phase
 - 500 years BP

Dune phases in the Otaki-Te Horo area (New Zealand): a geomorphic history

R. M. Hawke* and J. A. McConchie
School of Earth Sciences, Victoria University, PO Box 600, Wellington, New Zealand

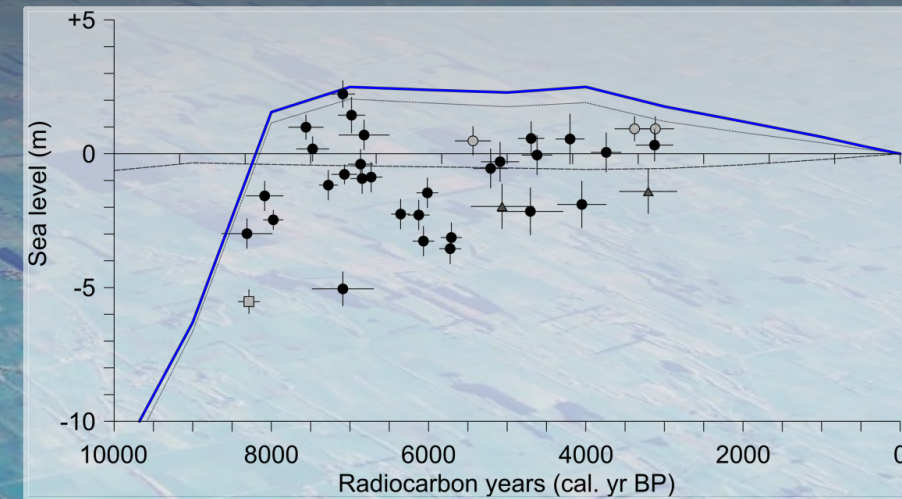


Summary of phases

- Dune activity initiated ~7,500 years BP
 - Dunes generated until 4,500 years BP
 - Transgressing inland up to 15 km
 - Fully stabilised by 1,600 years BP

The Manawatu Dunefield: Environmental Change and Human Impacts

PATRICK A. HESP



Rangiotu, Manawatu

Google Earth

Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Horowhenua District Council
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Summary of phases

- Second phase initiated 3,500 years BP
 - Continued until Maori occupation
 - First and second phases active concurrently, semi-continuously
 - Second phase likely initiated by a climatic driver
 - Hiatus between phases unclear

The Manawatu Dunefield: Environmental Change and Human Impacts

PATRICK A. HESP

Whirokino, Foxton

Waitarere

Google Earth

Summary of phases

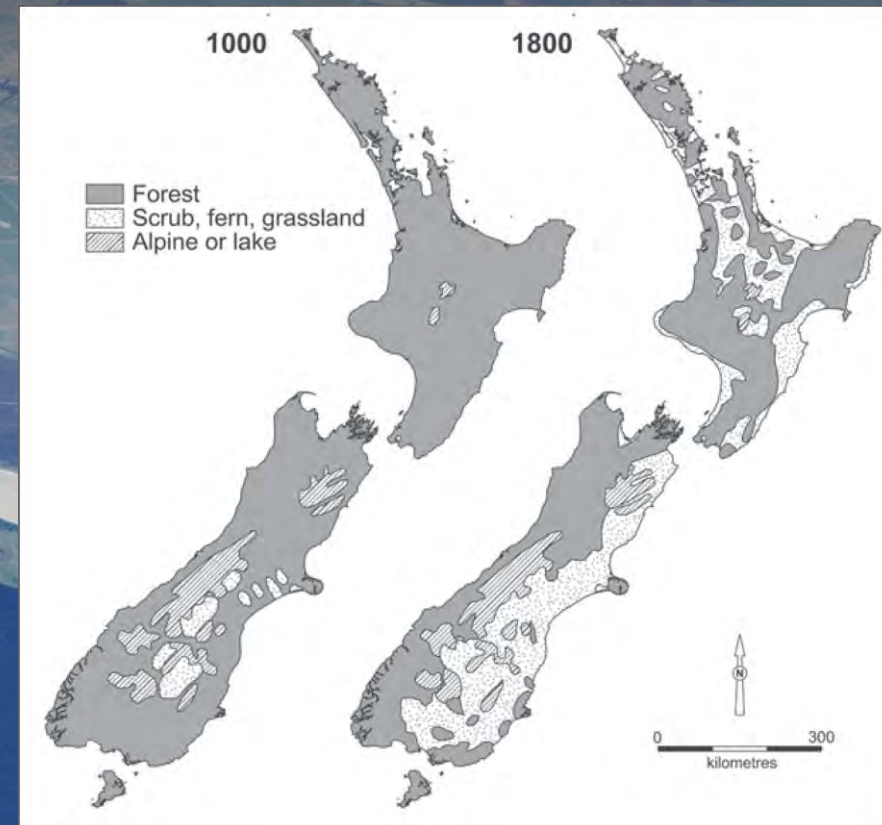
- Third phase initiated by Maori
 - Reactivation of older dunes
- Continued by Europeans
 - Stocking
 - Introduced plants
 - Pasture conversion

Whirokino, Foxton

Waitarere

The Manawatu Dunefield: Environmental Change and Human Impacts

PATRICK A. HESP



Summary of phases

The Manawatu Dunefield:
Environmental Change and Human
Impacts

PATRICK A. HESP

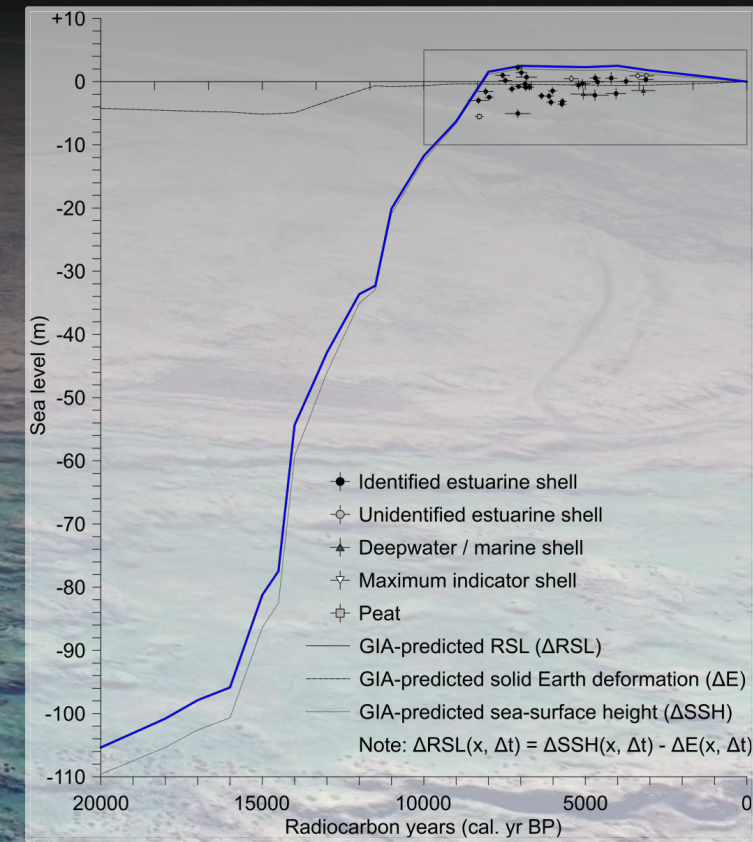
- Fourth phase 1940-1990

- Foredune stabilisation through introduced grasses
- Blowouts and parabolic dunes formed

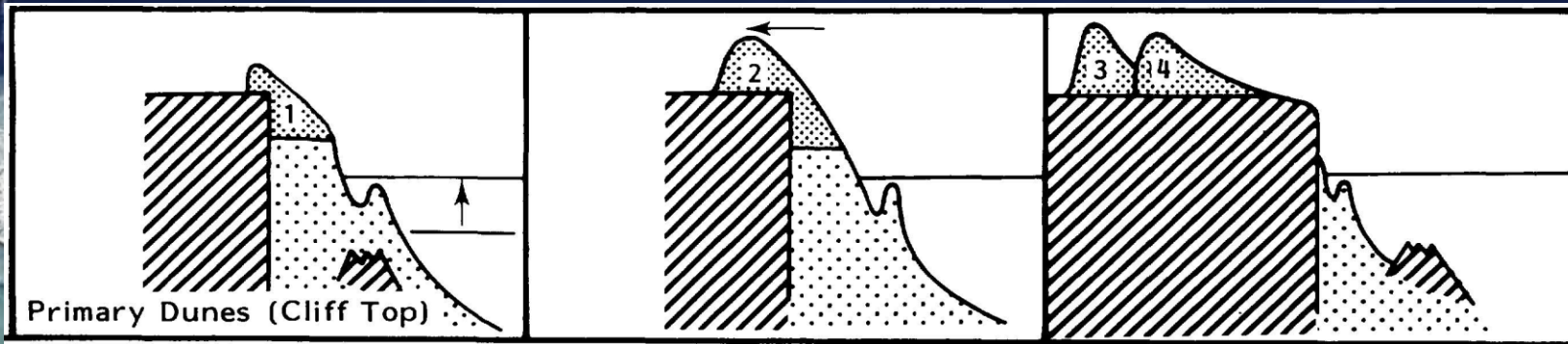
Himitangi

Cliff-top dunes

- Sand ramps formed prior to 7,000 years BP
- Sand supply decreases
- Ongoing dune activity drives shoreline recession
- Sand ramp eroded, dunes perched



South of Patea



Future scenarios

- Much of the coast is prograding
 - Waitarere Surf Lifesaving Club
 - 80 m between 1953-2021



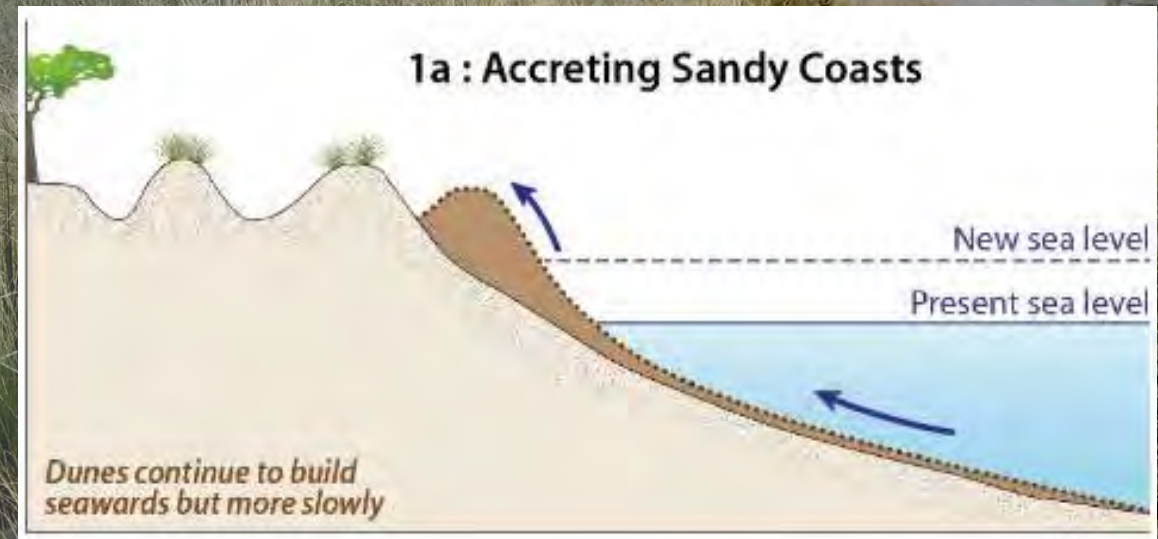
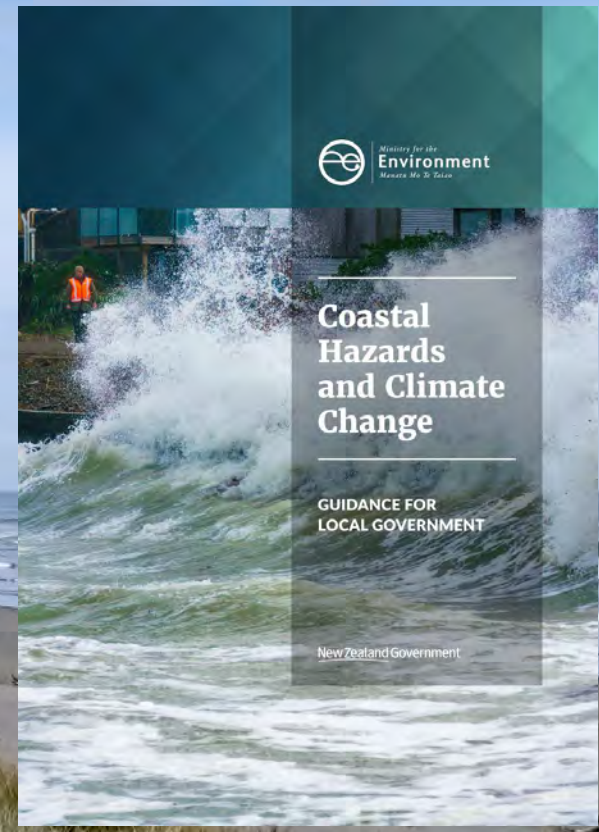
Future scenarios

- Much of the coast is prograding
 - Foxton Surf Lifesaving Club carpark foredune



Future scenarios

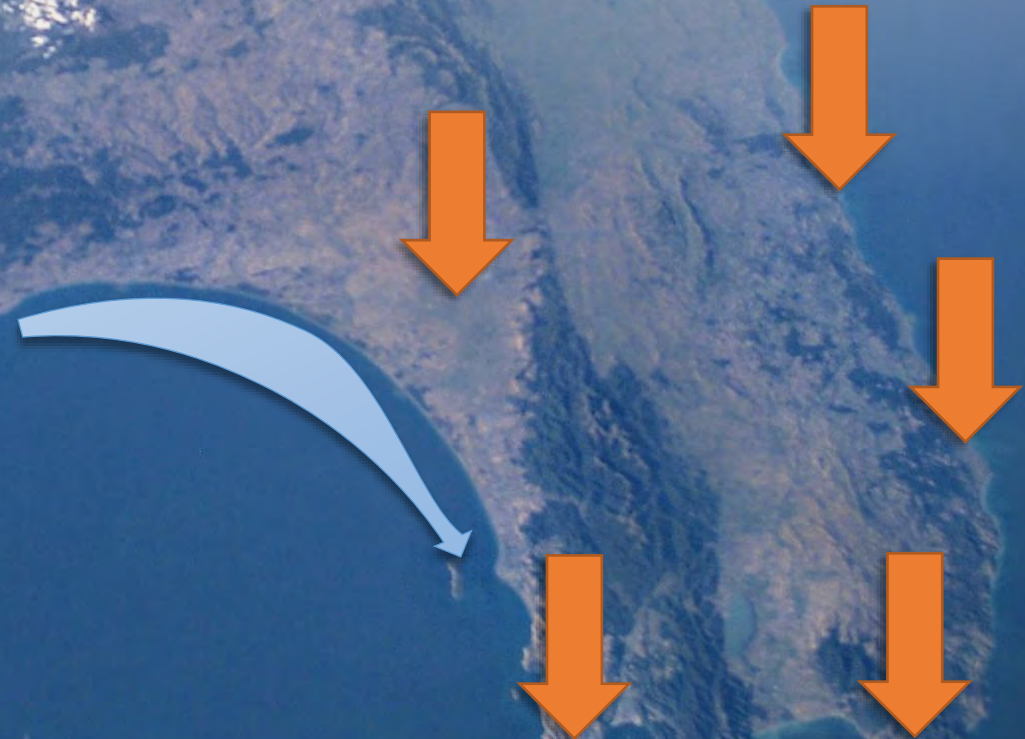
- Much of the coast is prograding
 - Foxton Surf Lifesaving Club carpark foredune
- Lots of sediment is available
- Dunes can be resilient to climate and sea-level changes



Future concerns – southern Kapiti Coast



- Highly modified dunes
- Low sediment supply
- Land subsidence
- Sea-level rise



Future concerns – Manawatu River mouth

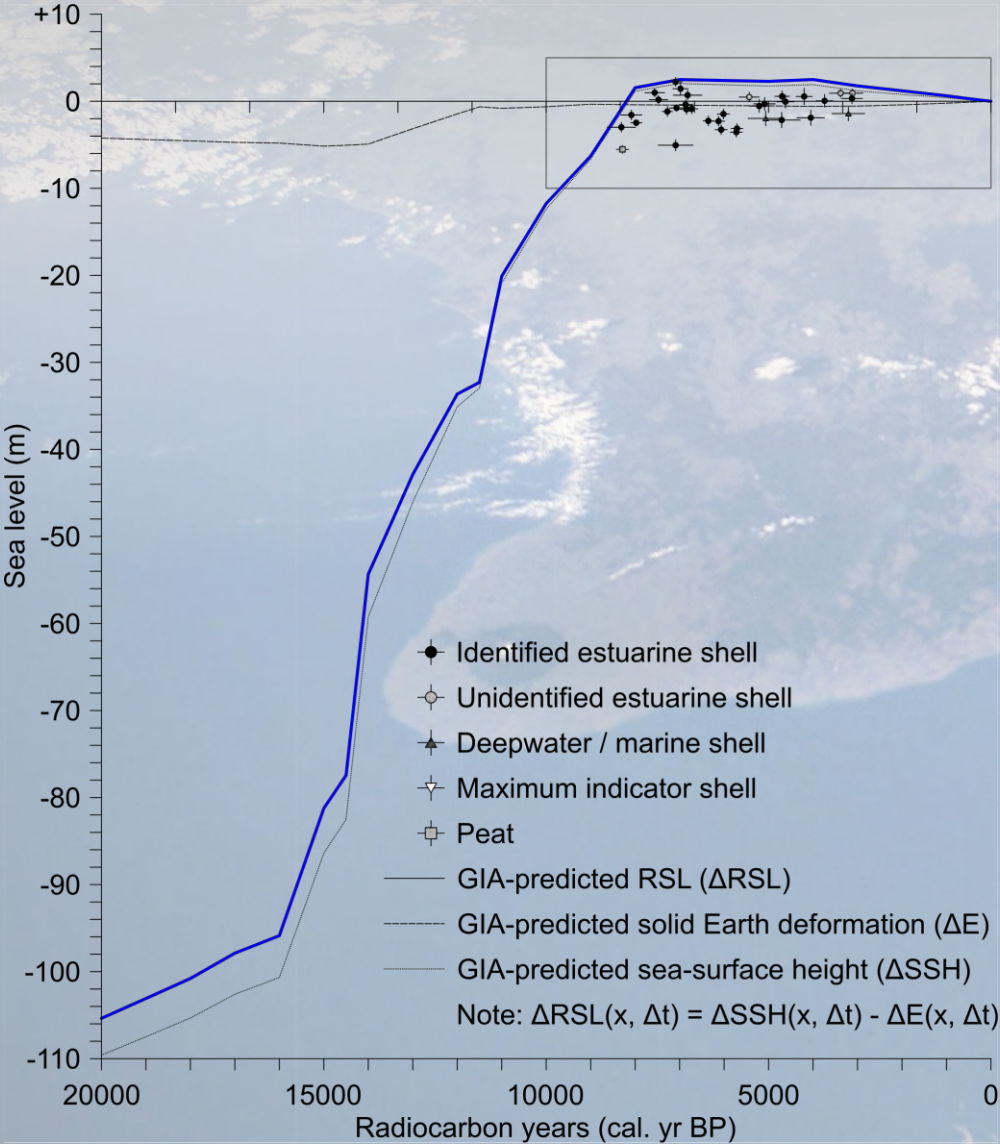
- Dunes are accreting, the coast is prograding
- But what about the coast away from the beach?



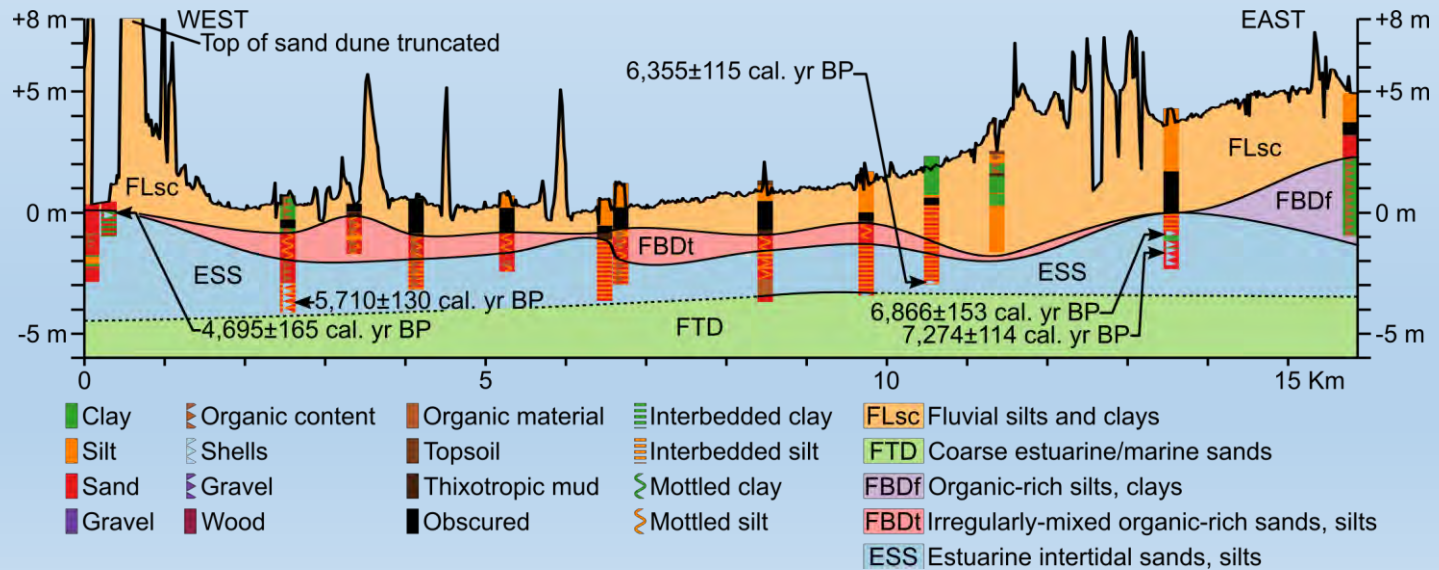
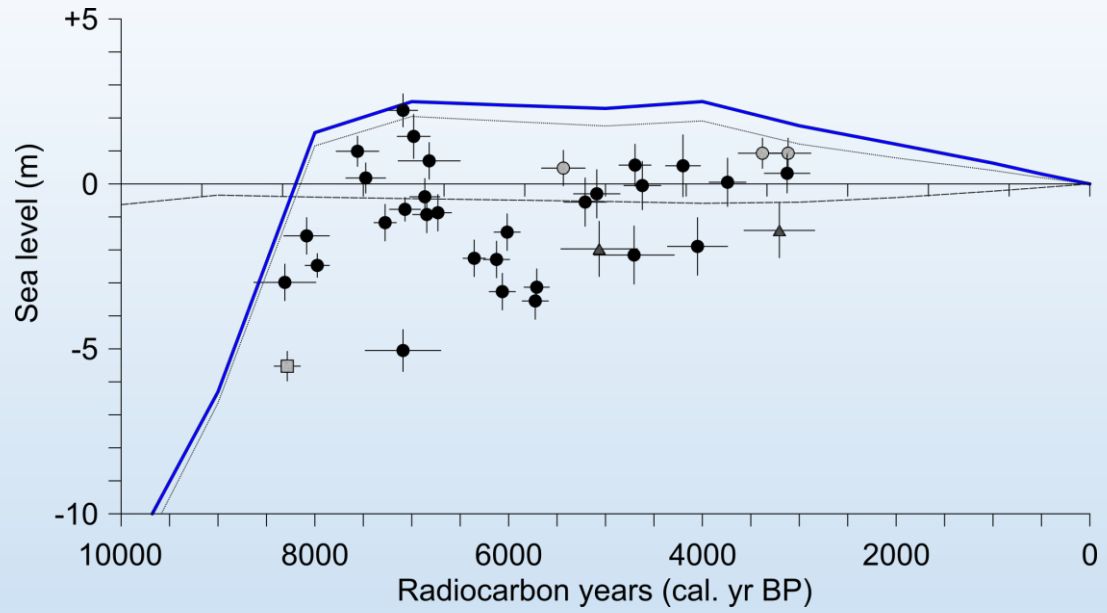
Thank you



Looking back over the past 10,000 years

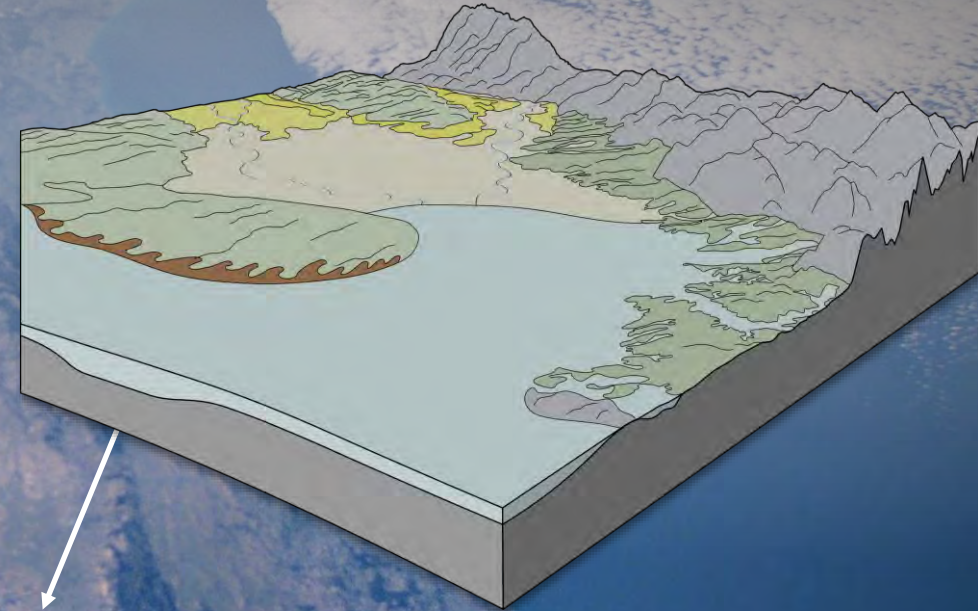


Te Ara Encyclopaedia of New Zealand

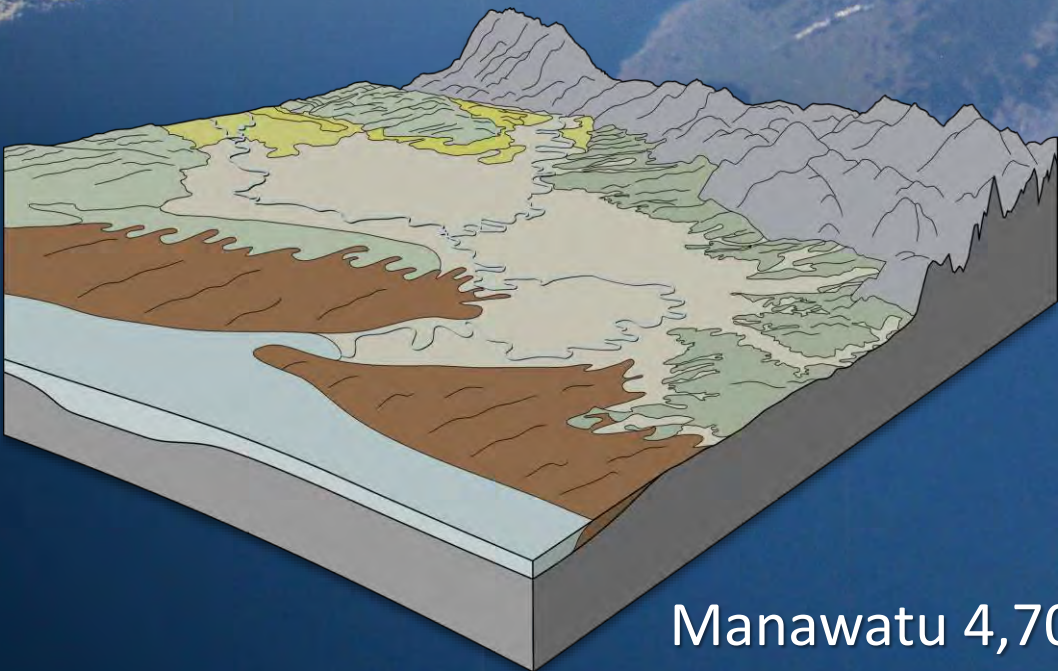


Geomorphic controls on dune development

- Sediment supply
 - Very high prior to 10,000 years BP
 - Still quite high in the Manawatu
 - Low to the north and south



Manawatu 7,700 years BP



Manawatu 4,700 years BP