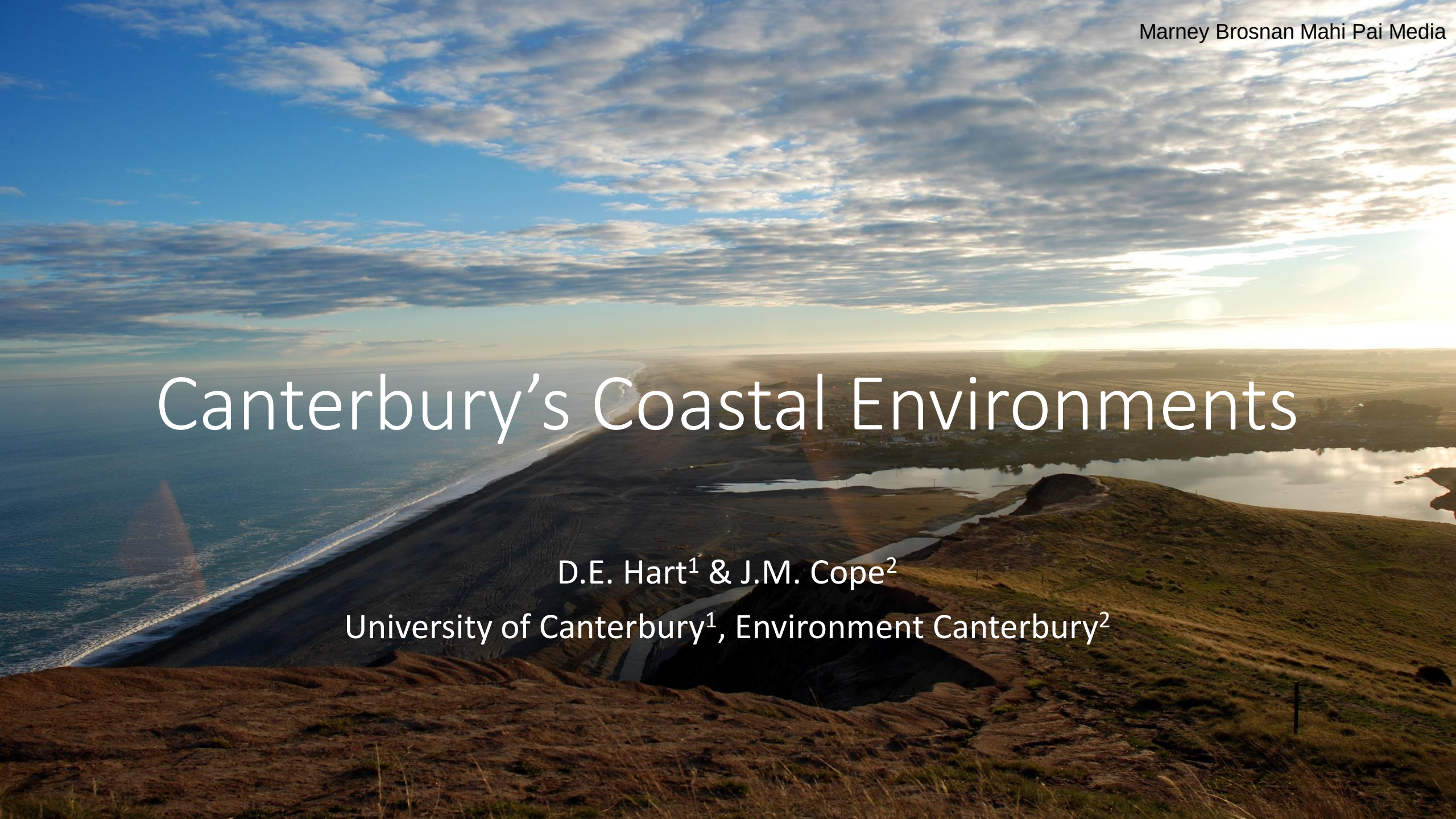


Canterbury's Coastal Environments

D.E. Hart[1] & J.M. Cope[2]

University of Canterbury[1], Environment Canterbury[2]

Outline

1. Present day diversity of Canterbury's coasts

2. Past formation of the local coastal environments

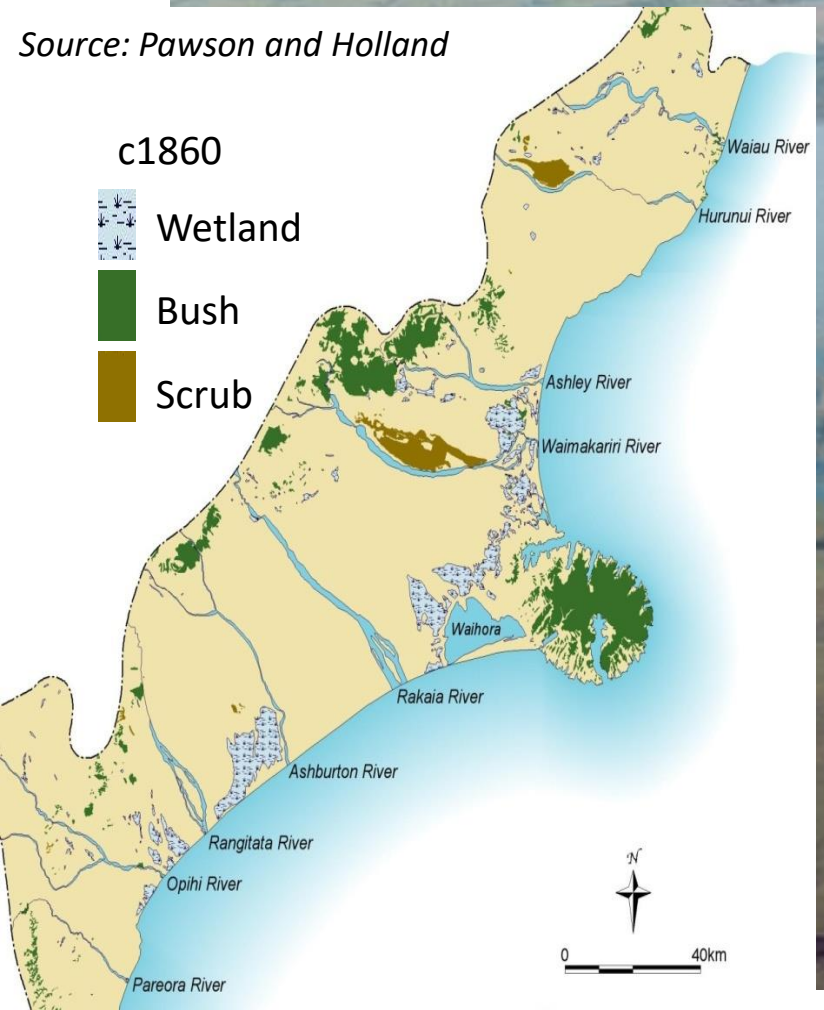
3. A diversity of coastal processes
    1. Mixed sand and gravel & composite beach science
    2. Sandy beach science/Southern Pegasus Bay coast

Canterbury’s Coastal Diversity

Slide Credit: Murray Hicks, NIWA

Wainono Lagoon after coastal storm

Source: Pawson and Holland



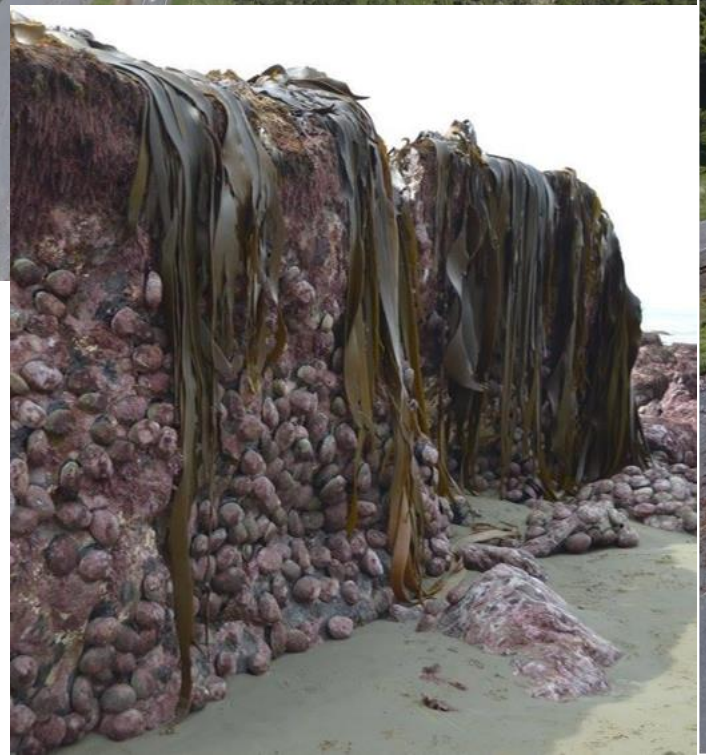
Caroline Bay 1930s

Caroline Bay dune ‘creation’

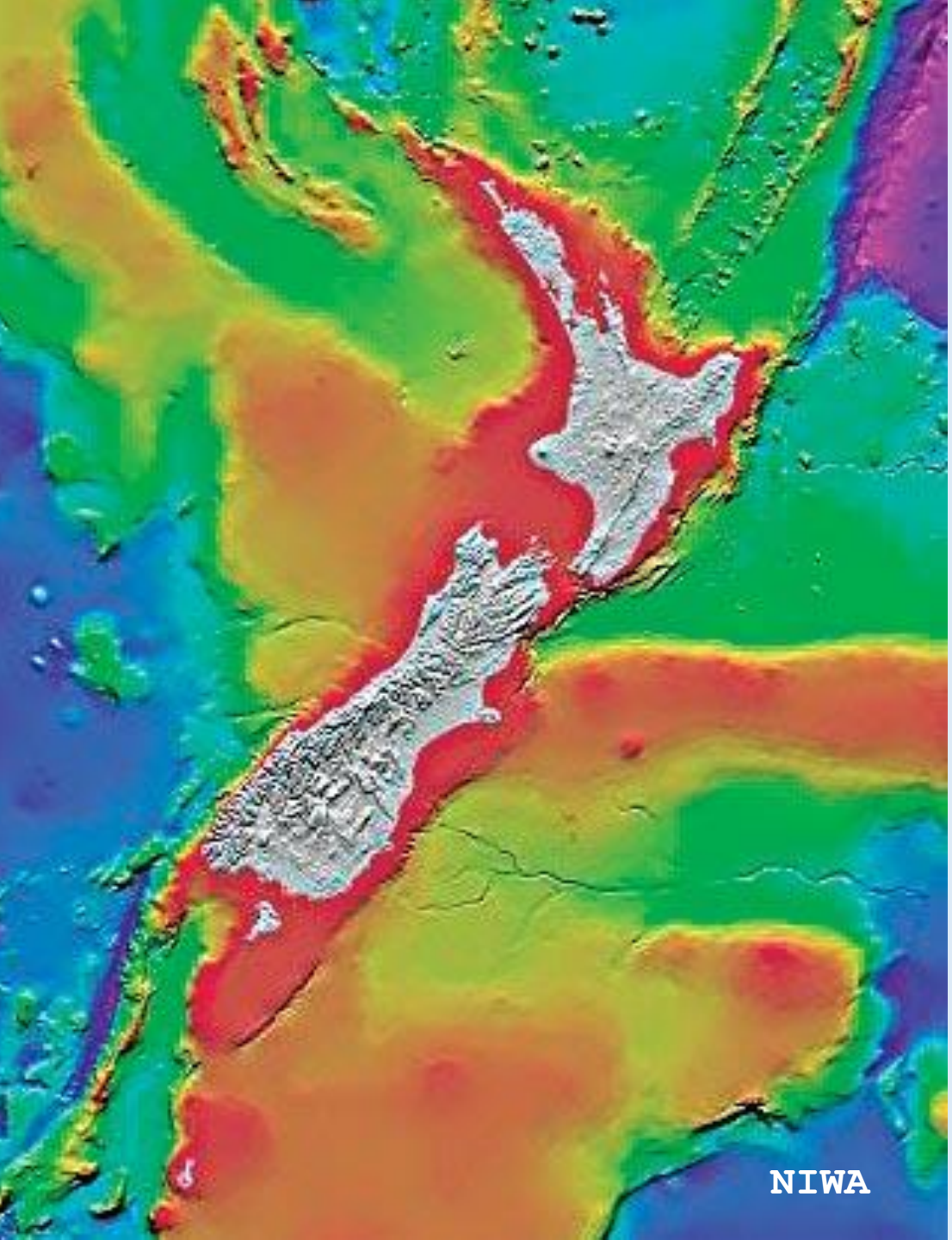

Whakaora Te Waihora Wave Barrier
Photo credit: NIWA

Amberley Beach

Kaikoura



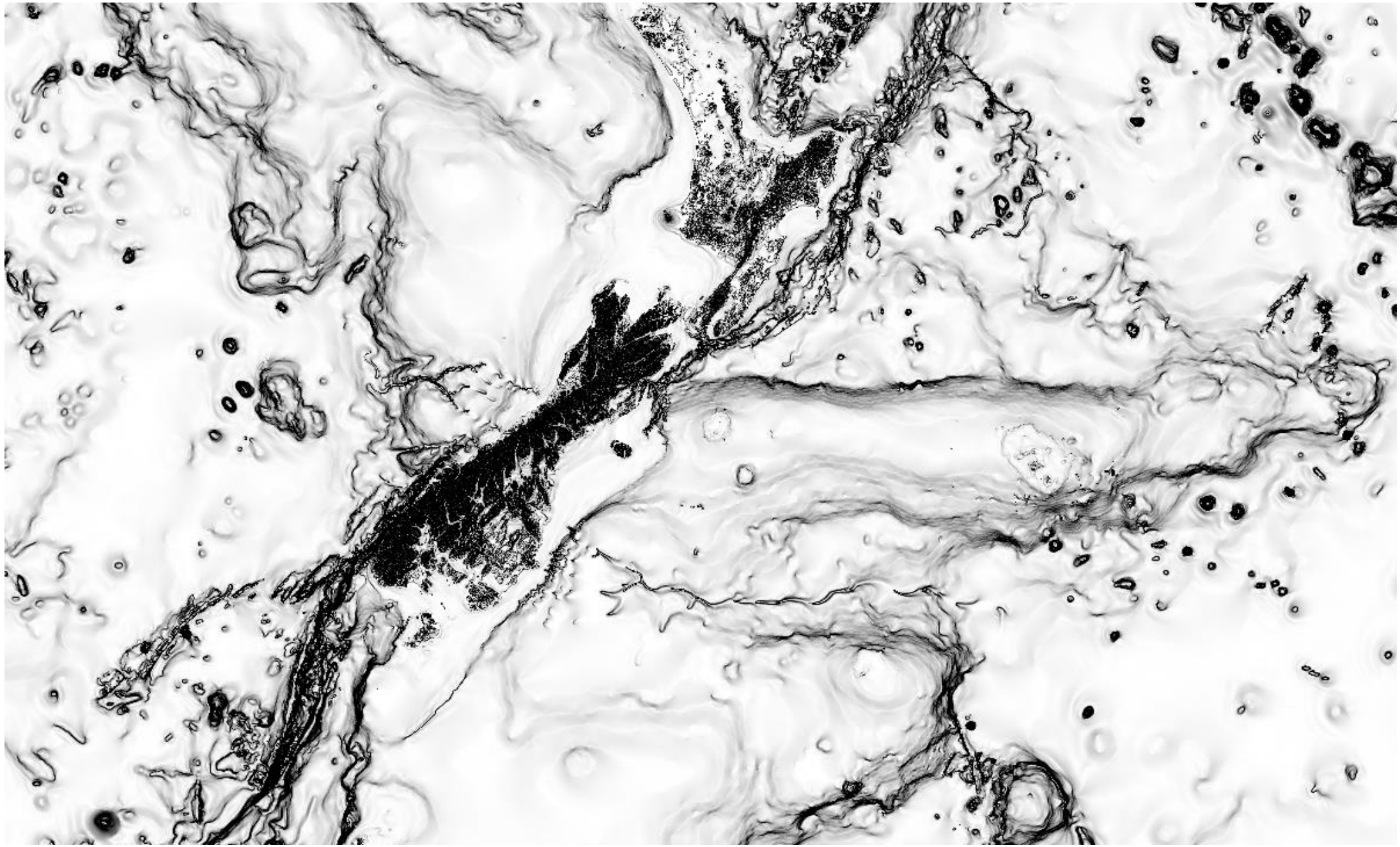
How did we get here?



Last glacial max ~ 20,000 years ago, sea levels ~130 m lower than today, coastline near the location of today's continental shelf edge

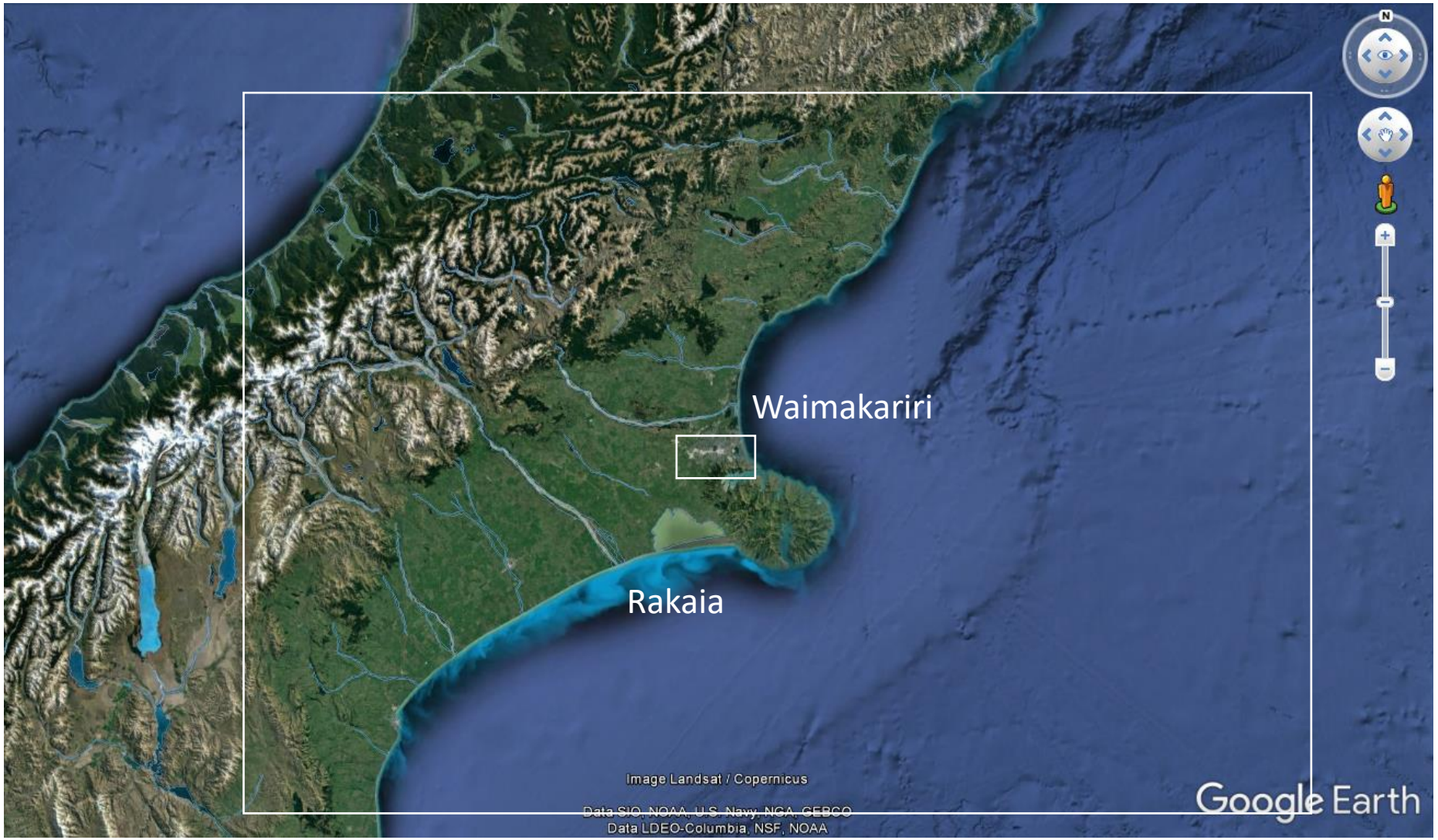
Left image: today's bathymetry by NIWA
Right image: glacial max, by Te Ara.

Canterbury's 'NZ record' flatness

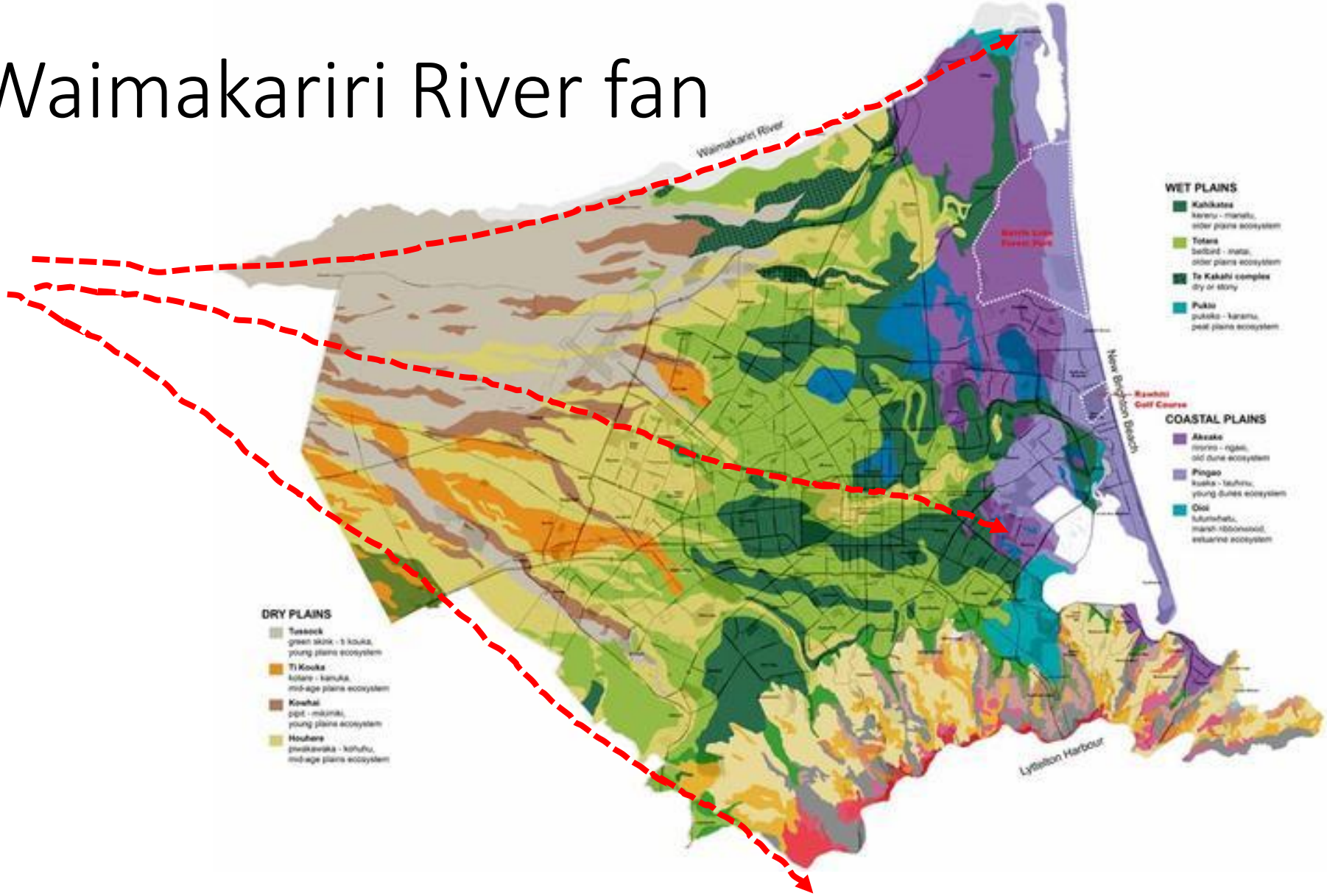


http://blog.mastermaps.com/2012/09/creating-seafloor-map-using-shaded.html

Formation of Canterbury Plains

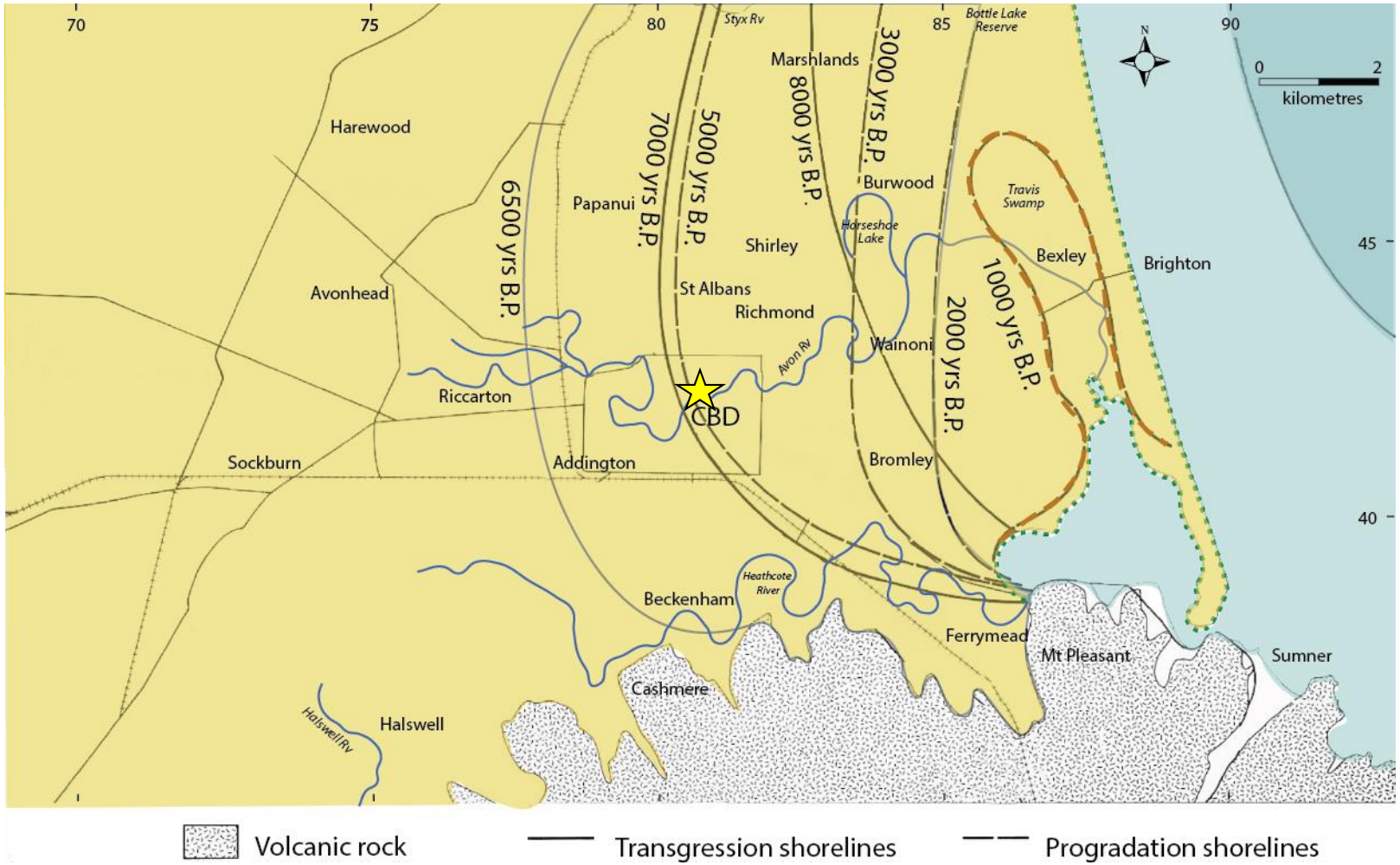


Waimakariri River fan



Christchurch 1856 Landcover derived from the ‘Blackmaps’ held by Archives NZ
Source: Di Lucas http://architecturenow.co.nz/articles/framing-the-central-city-again/

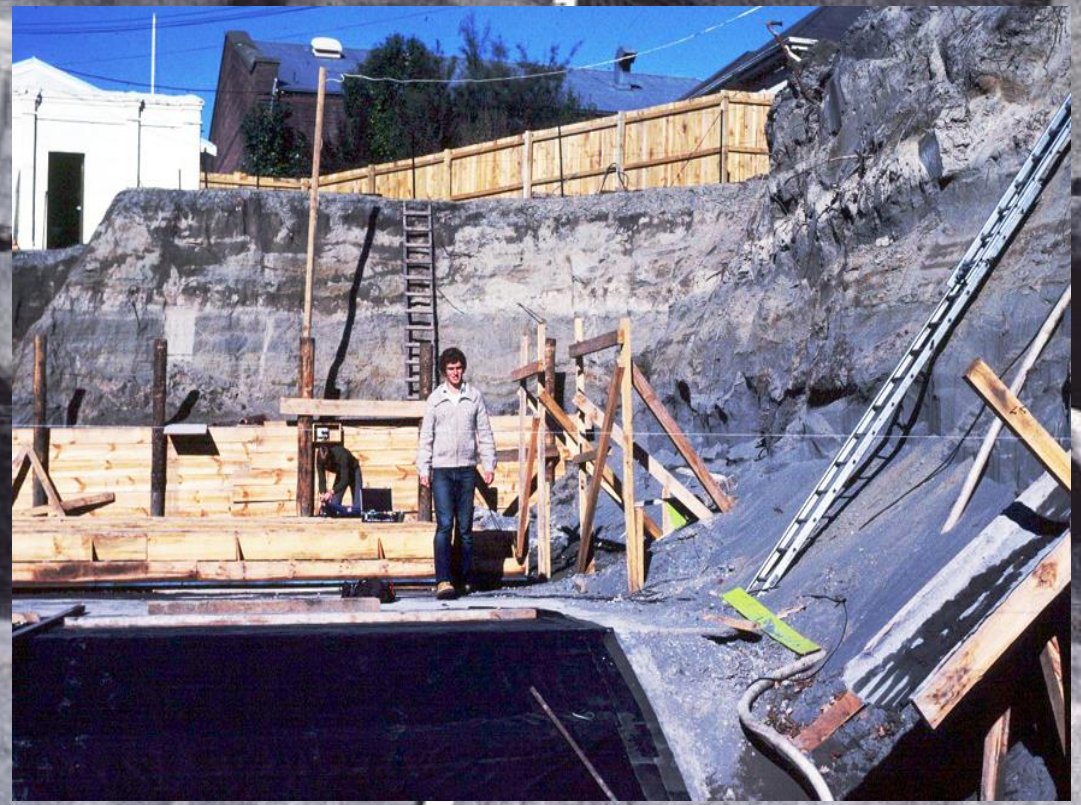
Christchurch Holocene shorelines



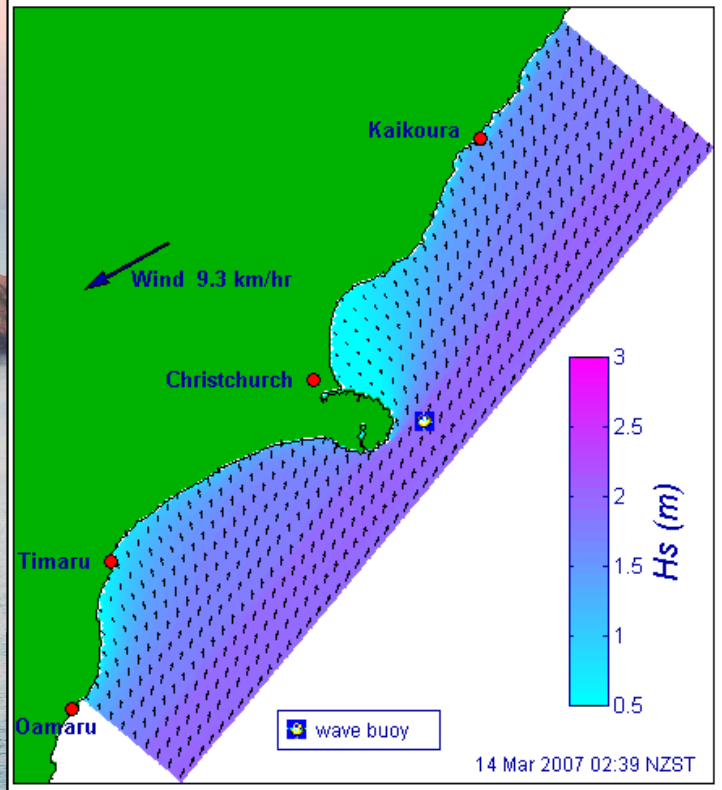
Brown & Weeber 1992, adapted by Marney Brosnan Mahi Pai Media

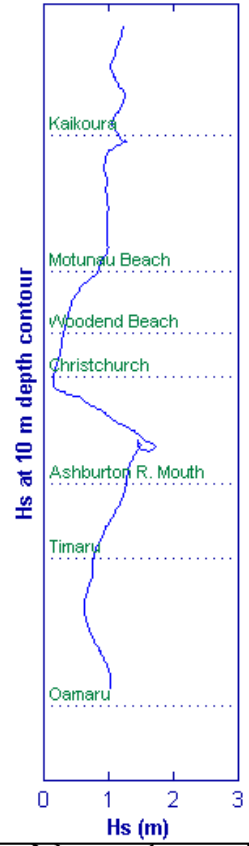
Photos: RM Kirk

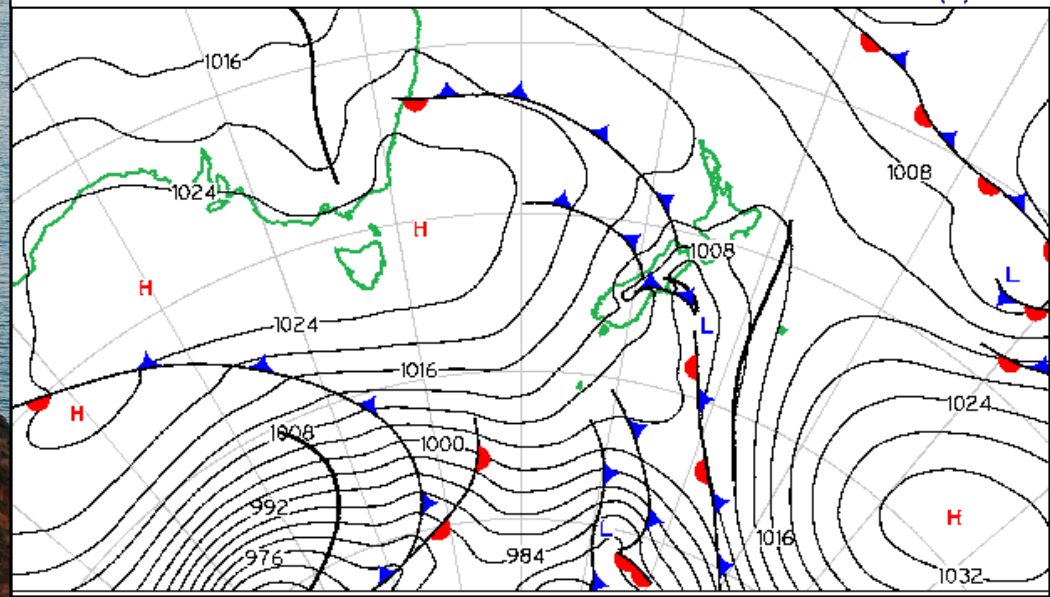
Beneath central Christchurch today,
shoreline ~5000 y BP (before present)



‘The Big Breakwater’ Banks Peninsula

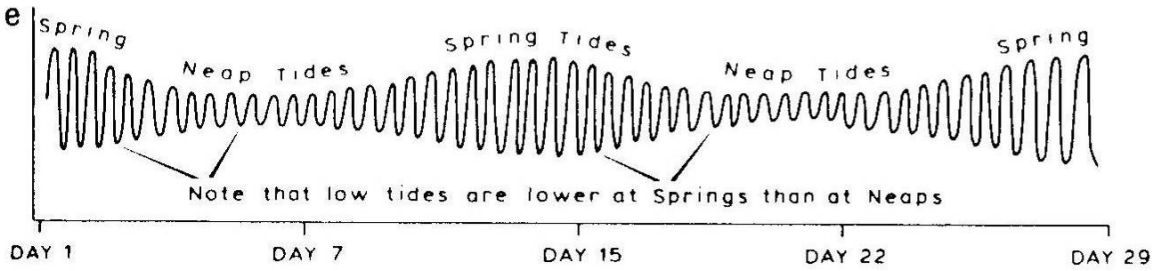


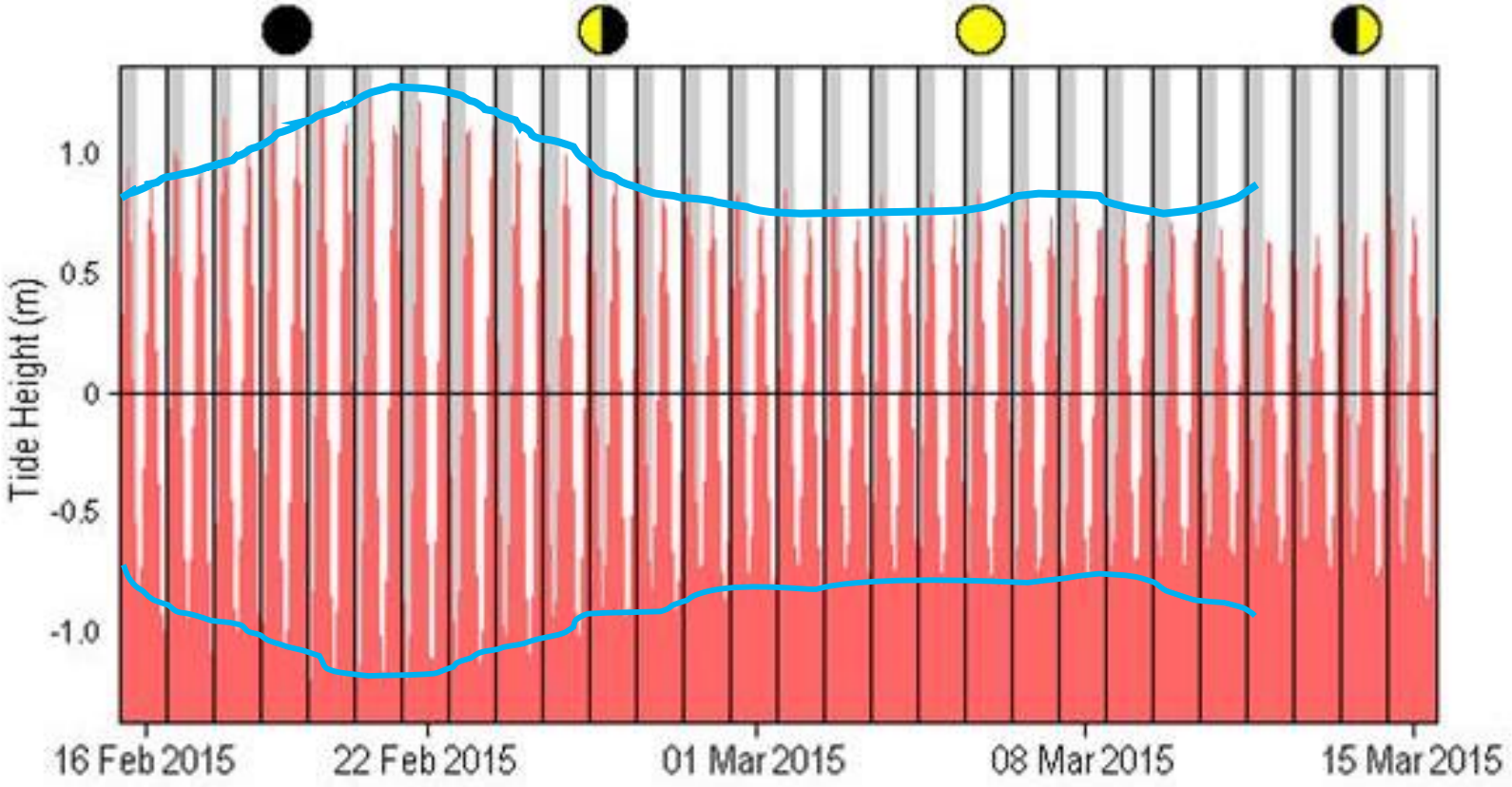




Marney Brosnan

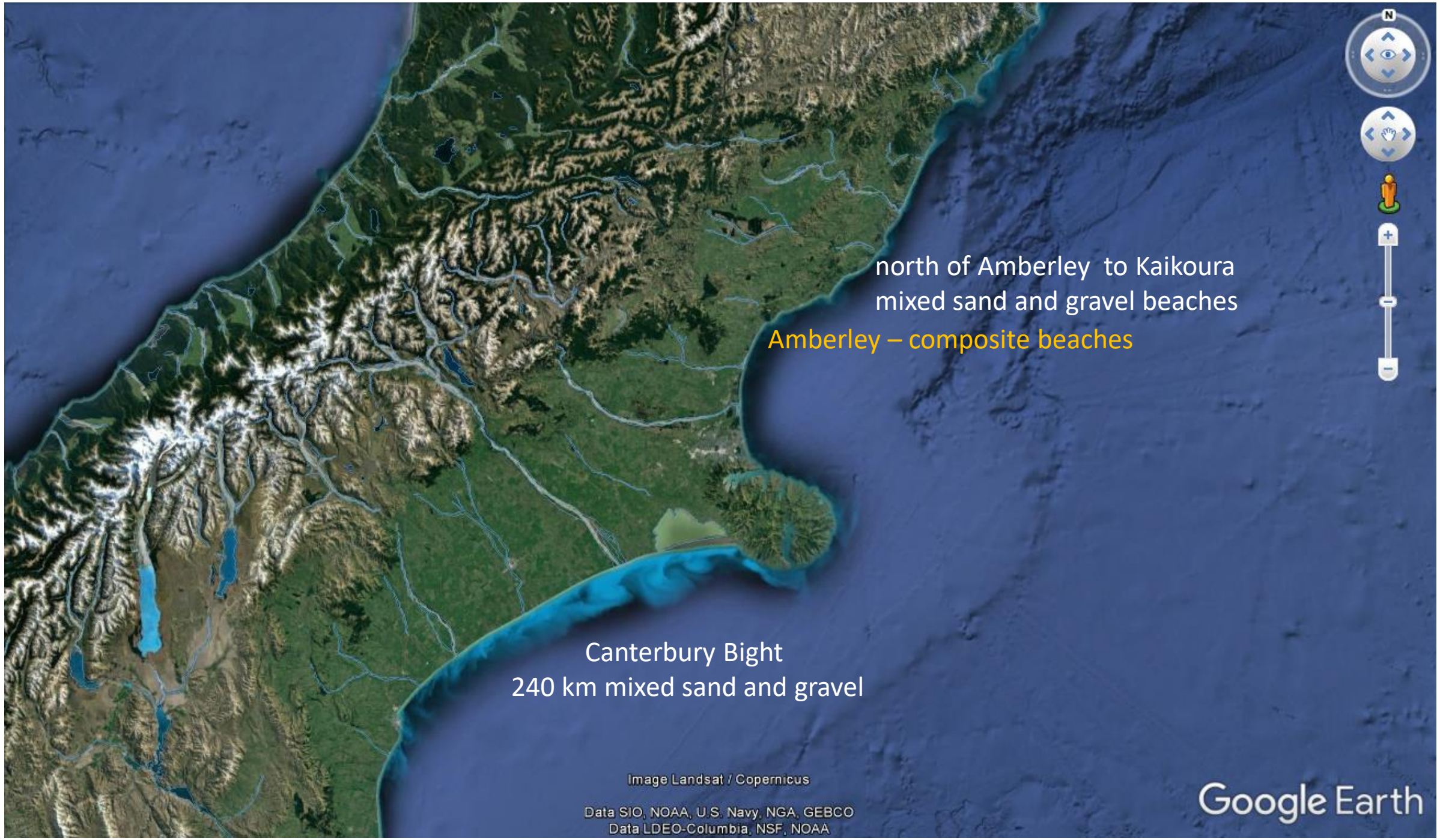
Tides in Canterbury



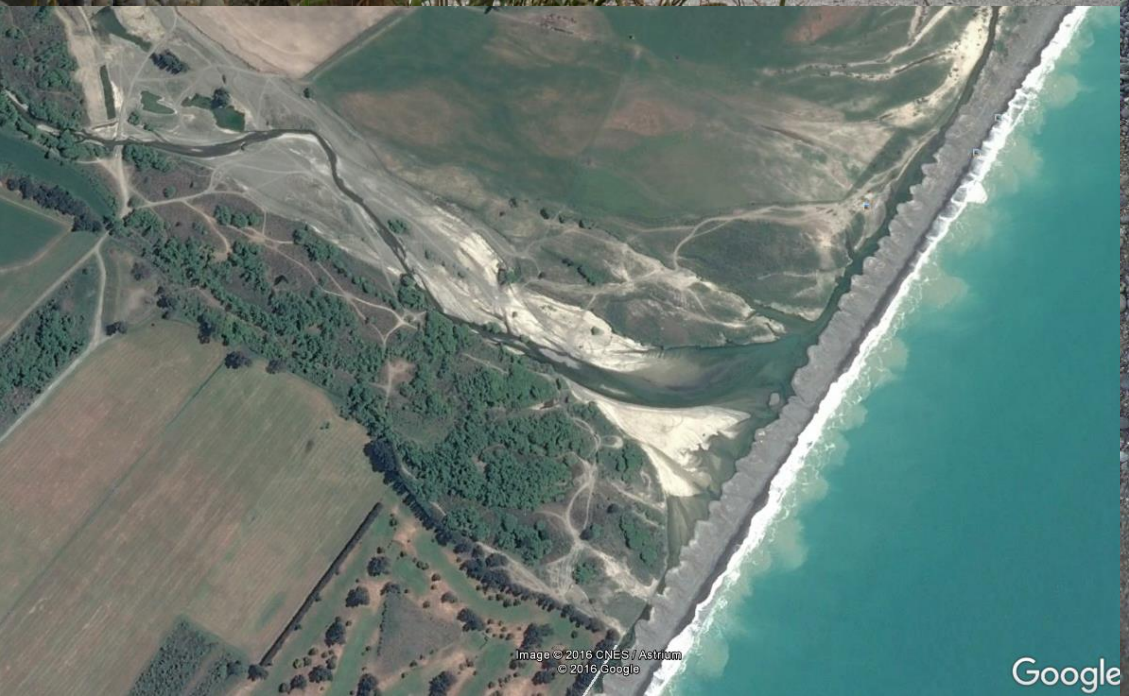


Tidal range across 28 days
https://www.niwa.co.nz/services/online-services/tide-forecaster

Mixed Sand and Gravel Beaches

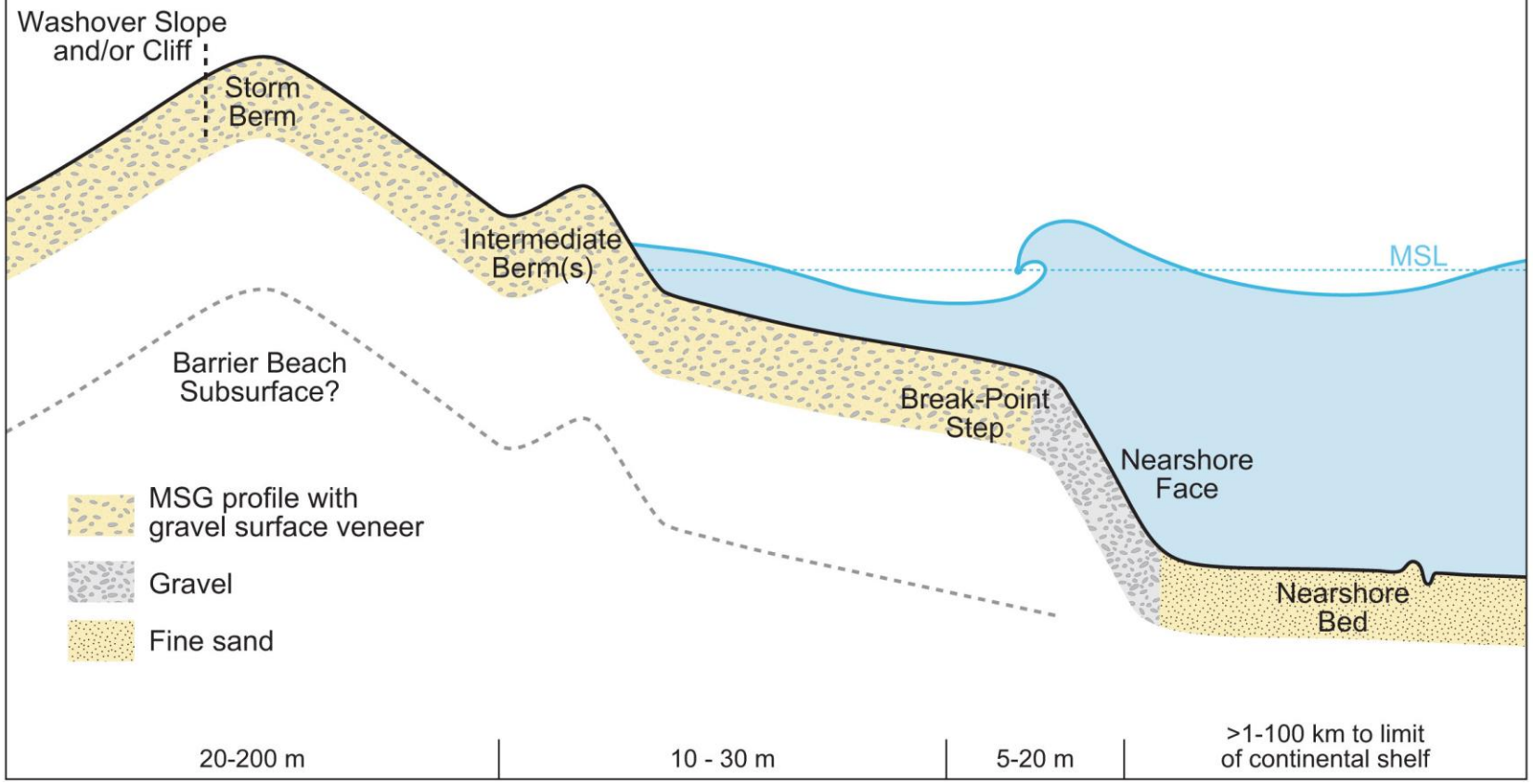

north of Amberley to Kaikoura
mixed sand and gravel beaches
Amberley – composite beaches
Canterbury Bight
240 km mixed sand and gravel
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data LDEO-Columbia, NSF, NOAA
Google Earth

- Globally rarely reported (not necessarily rare)
- Common in NZ on east & south coasts (Hastings, Kaikoura, Hurunui, Canterbury Bight)
- High wave-energy coasts, wave dominated
- Coarse sediment supply: leeward margins of Pleistocene fluvio-glacial outwash fans & paraglacial coasts



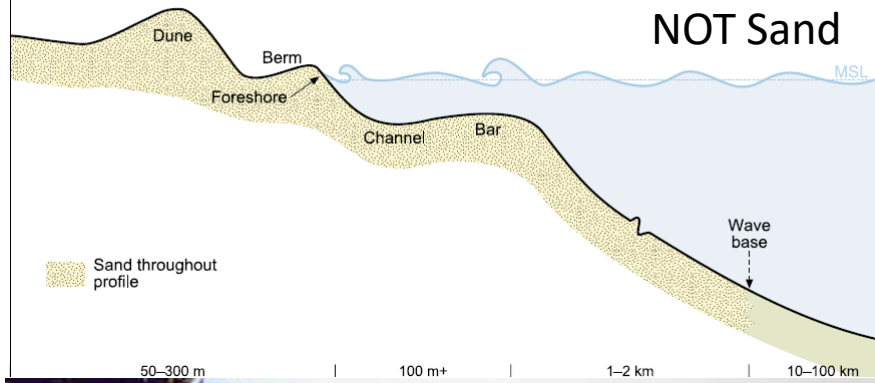
Mixed sand & gravel beach

Morphology	Backshore	Foreshore	Break Point	Nearshore	Continental Shelf
Wave Process	Storm Wave Washover	Swash Zone 'Engine Room'	Plunging Breaker	Wave Shoaling	

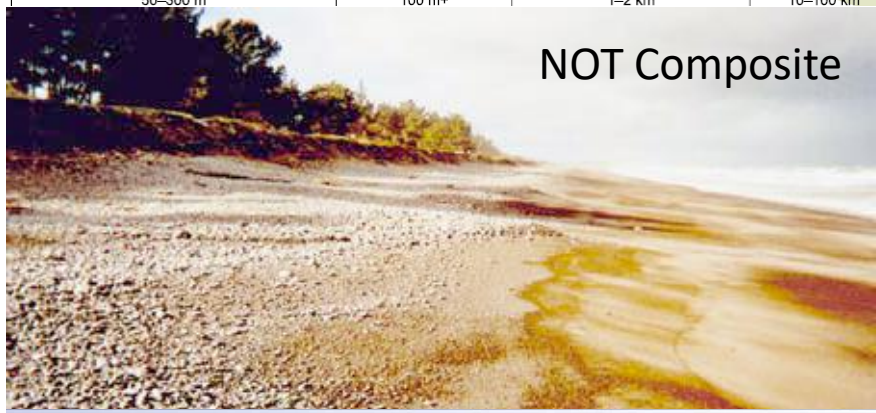


Morphology	Subaerial beach dune/berm	Surf zone	Nearshore zone	Continental Shelf
Process	Aeolian/swash	Wave breaking	Wave shoaling	

NOT Sand



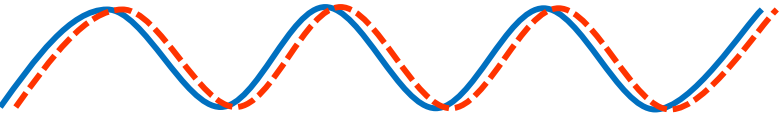
NOT Composite



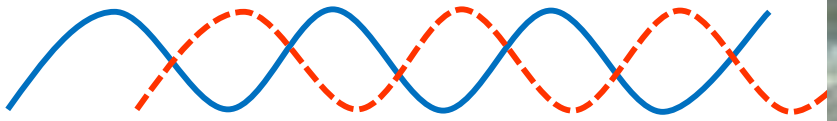
NOT Gravel


Marney Brosnan

Swash, the beach ‘engine room’



Waves in phase = accretionary



Waves out of phase = erosional

Different to sand beach, where wave shape is key.

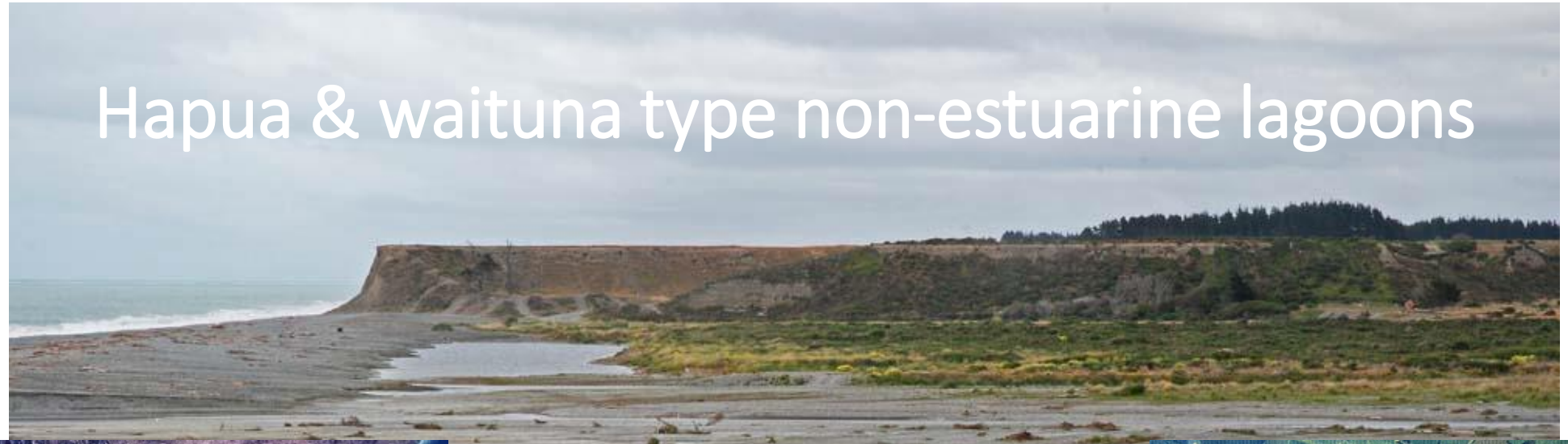
Mixed sand and gravel beaches :

- Typically micro-tidal to lower meso-tidal
- Typically erosional: 0.3-5.5 m y^{-1}
- in Canterbury, they have cliff hinterlands, except around lagoons (Kirk 1980)

Their rivers:

- Big braided Southern Alps rivers, plus smaller foothills and plains rivers
- Sediment supply is ‘huge’ BUT insufficient coarse enough material to stop erosion in the face of very high wave energies (Kirk 1991)

Hapua & waituna type non-estuarine lagoons



More info, see Hume et al. 2017

Coastal Hydrosystems

2. *Waituna-type lagoons*

3. *Hāpua-type lagoons*

5. *Freshwater river mouths*

6. *Tidal river mouths*

7. *Tidal lagoons*

8. *Shallow drowned valleys*

9. *Deep drowned valleys*

10. *Fjords*

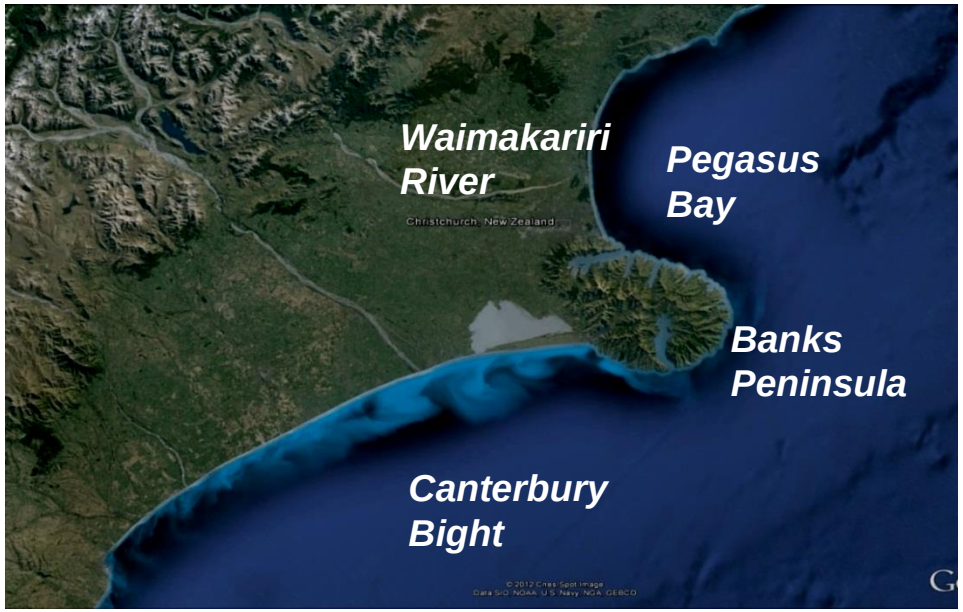
11. *Coastal embayments*

Hume et al. 2017. *A classification of New Zealand's coastal hydrosystems*. http://www.mfe.govt.nz/publications/marine/classification-of-new-zealands-coastal-hydrosystems

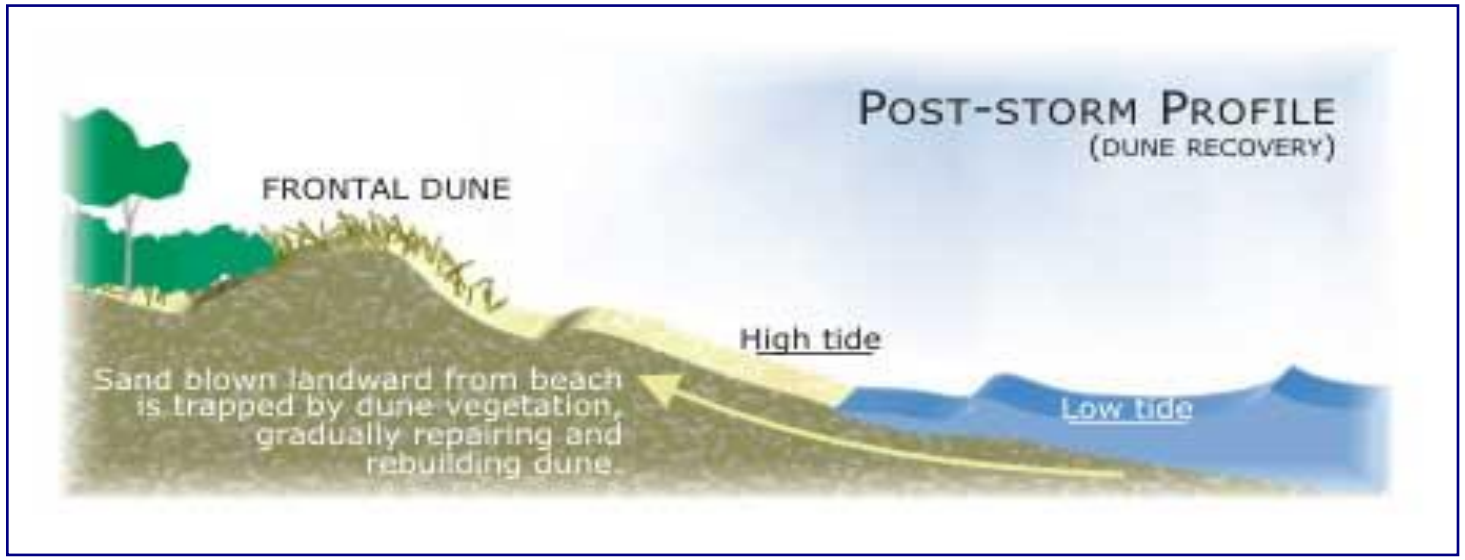
Composite beaches

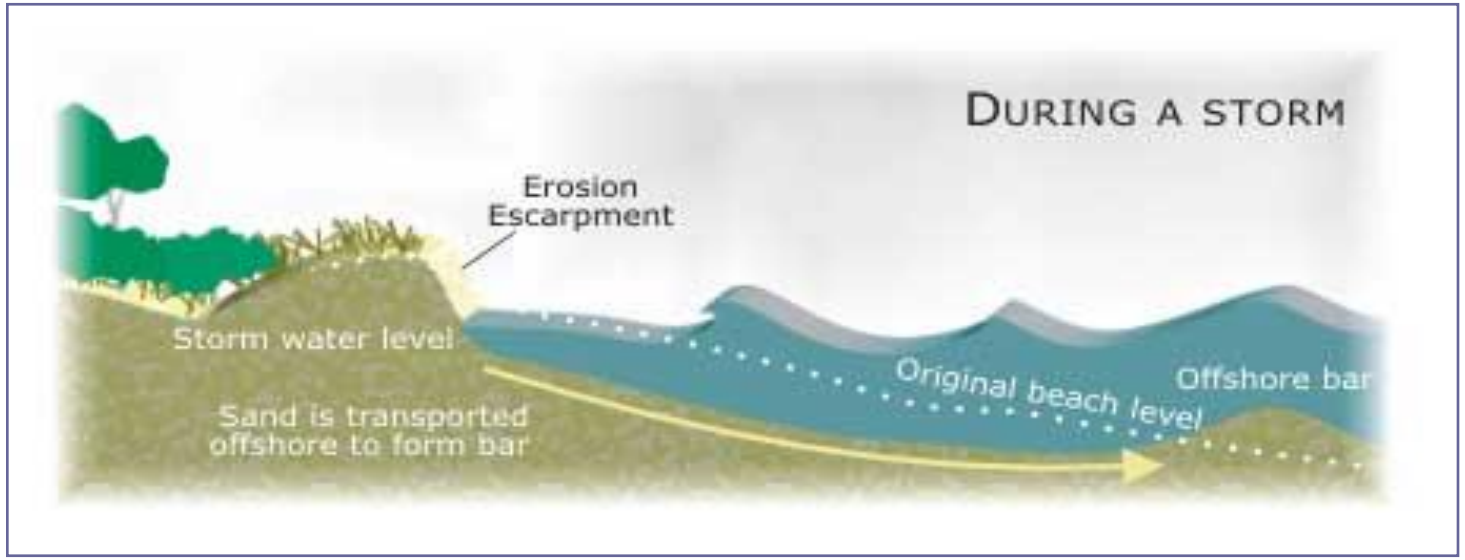
Sand Beaches

Southern Pegasus Bay today



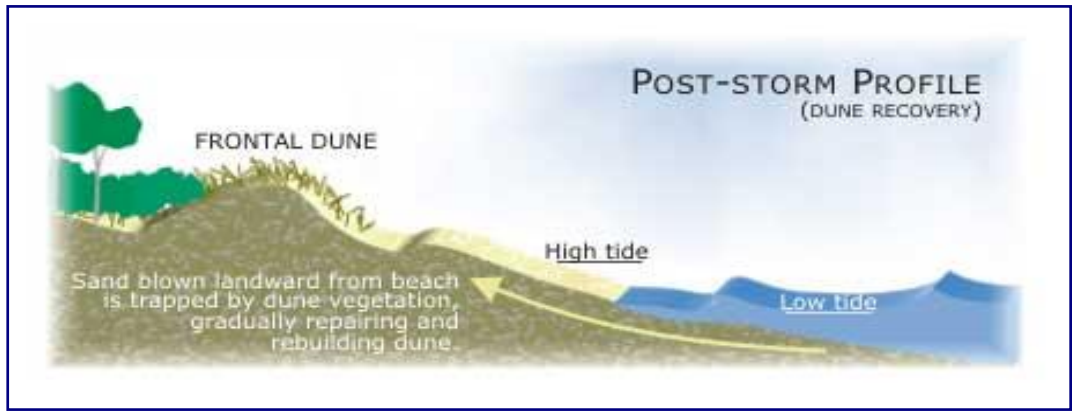
- Moderate wave climate: Banks Peninsula shelters from high-energy Pacific east coast swell environment
- Sandy beaches ‘nourished’ by rivers : Waimakariri, Ashley, Kowai, Wairau [versus mixed sand and gravel Canterbury Bight]


POST-STORM PROFILE
(DUNE RECOVERY)
FRONTAL DUNE
High tide
Low tide
Sand blown landward from beach is trapped by dune vegetation, gradually repairing and rebuilding dune.


DURING A STORM
Erosion Escarpment
Storm water level
Original beach level
Offshore bar
Sand is transported offshore to form bar

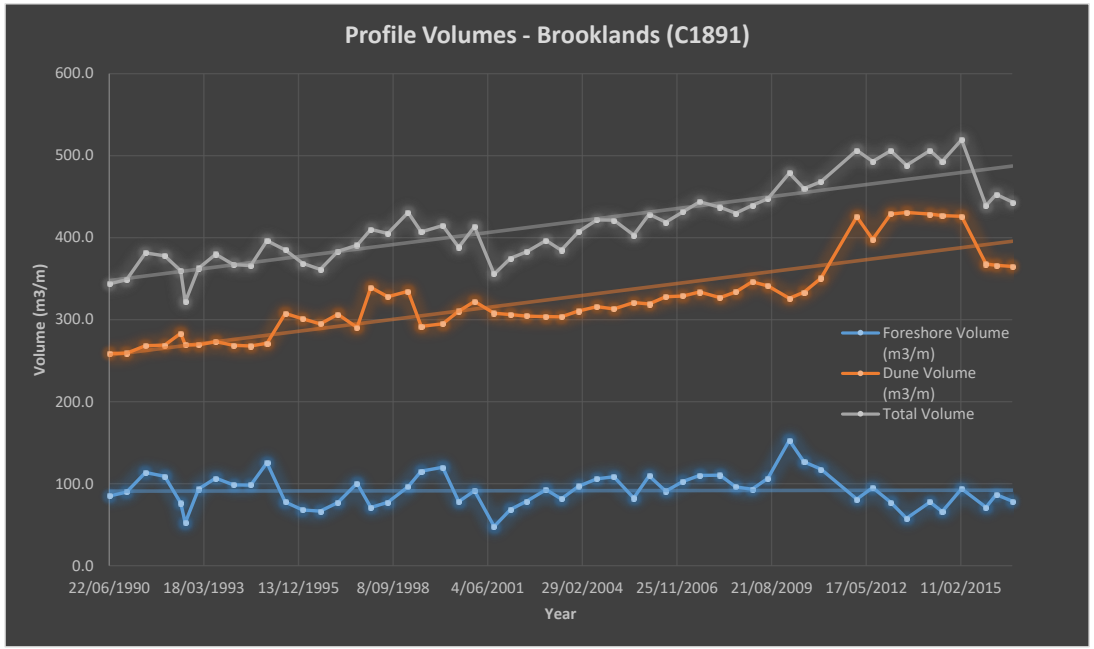
Slow post-storm dune recovery

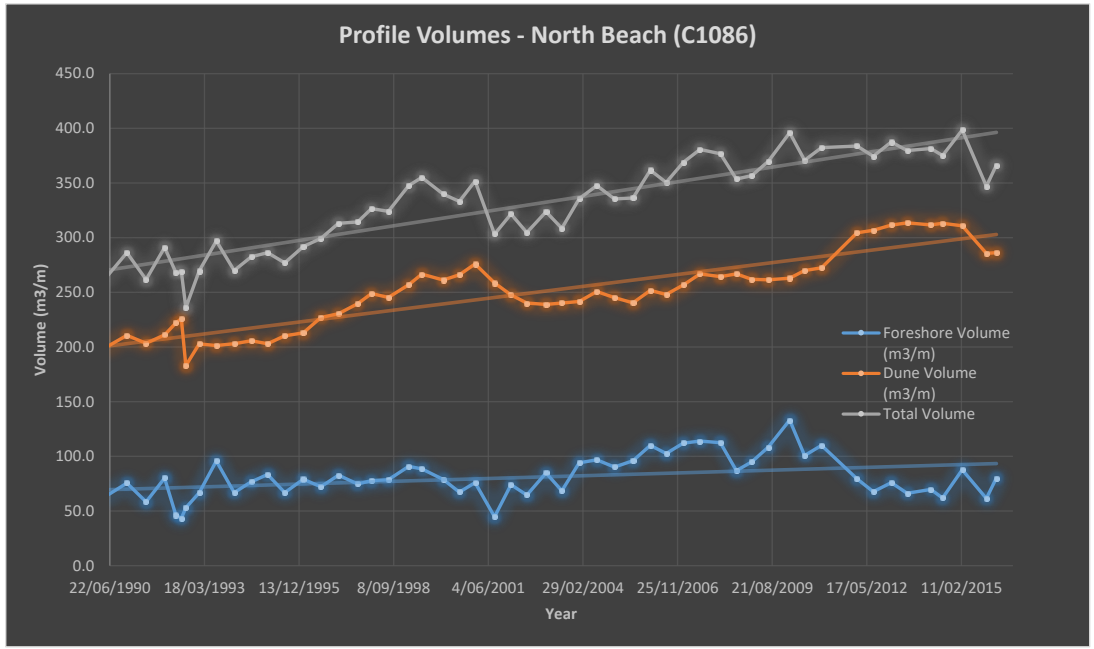
Southern Pegasus Bay today

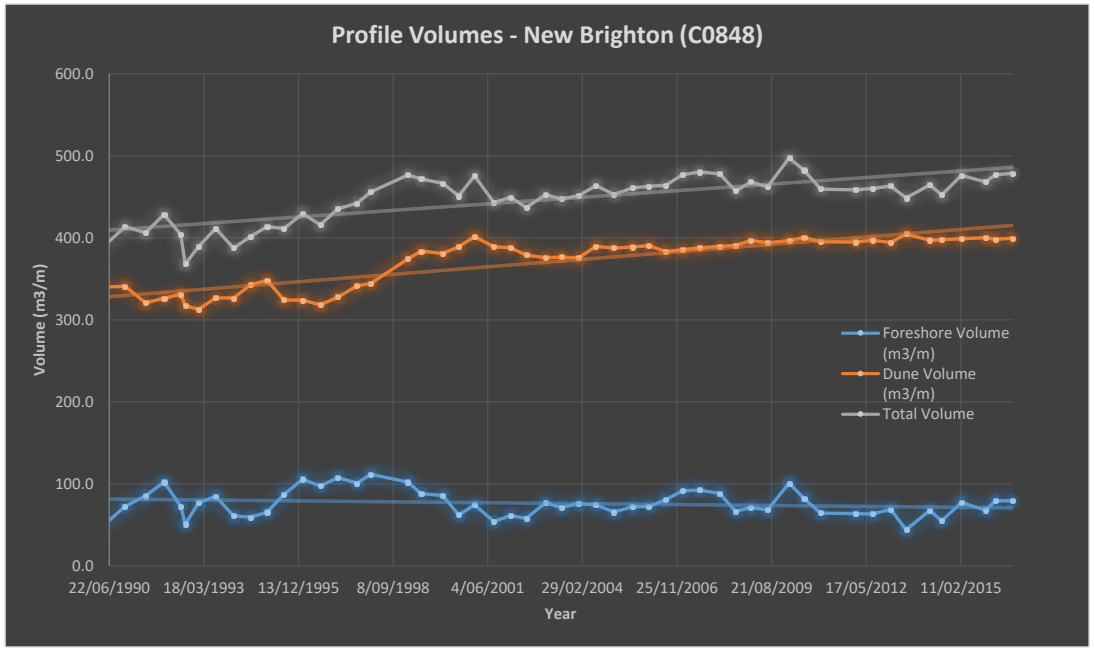


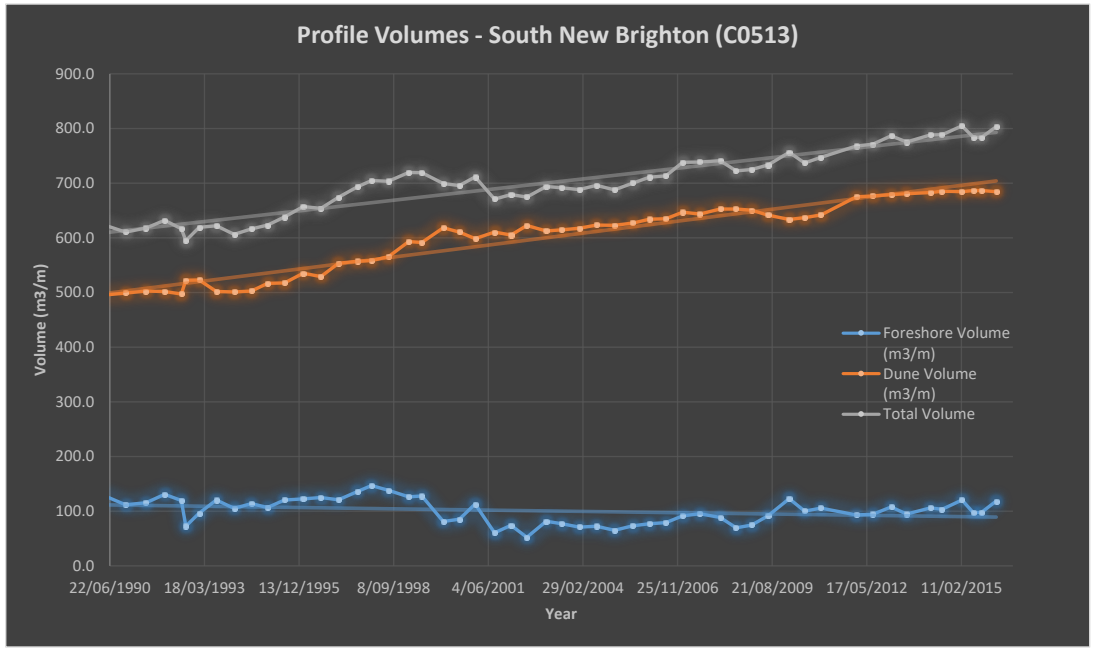
- Looking at a beach in profile only some of the story. Consider alongshore sand movement too
- Sandy beaches ‘nourished’ by rivers (Waimakariri, Ashley, Kowai, Wairau [versus mixed sand and gravel Canterbury Bight]
- **30 year dune accretion from management versus beachface which is, at best, stable**

Beach Profile Volumes Christchurch Coast – North to South





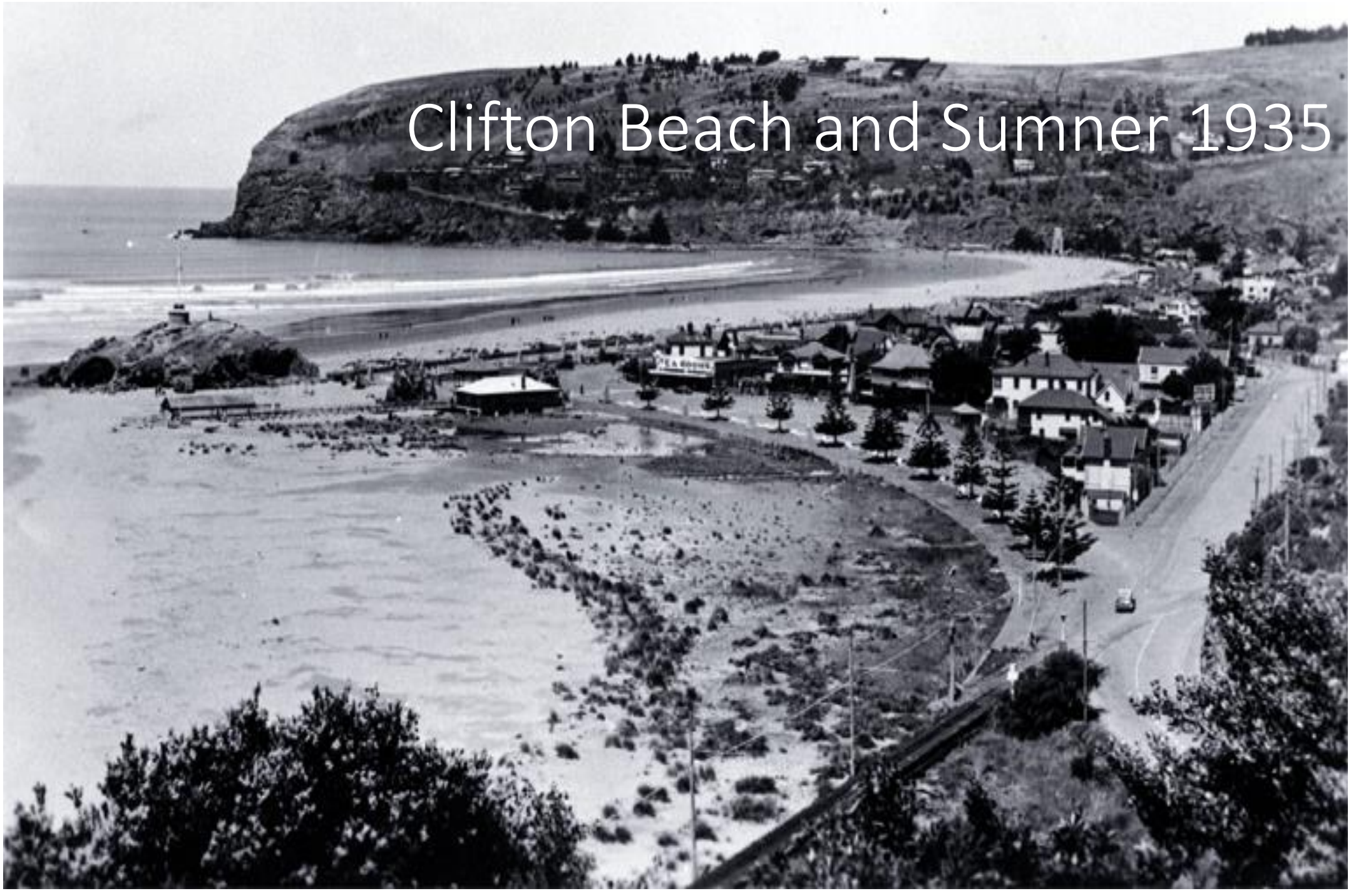




Southern Pegasus Bay is a modified coastal environment

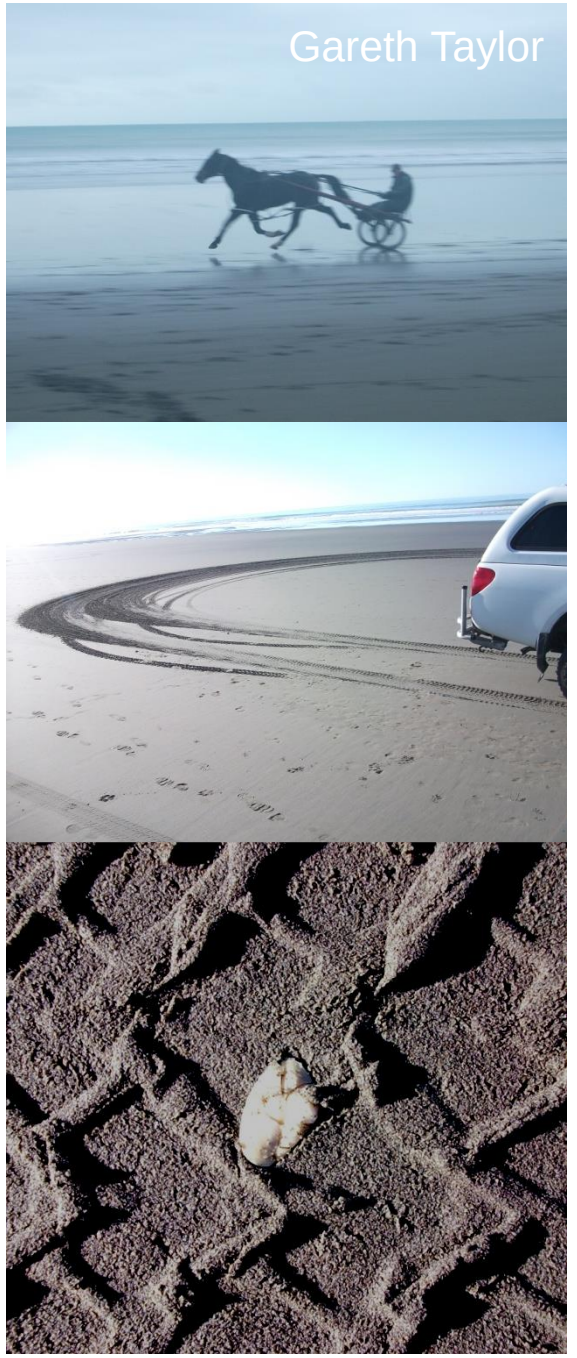
1920s South New Brighton 2016

Dune Reconstruction


Clifton Beach and Sumner 1935

Sumner

South Brighton surf clam bed (nearshore habitat) lies exposed on the foreshore after a storm (Hart, Nov 2012)



For more information

- Hume et al. 2017. A classification of New Zealand's coastal hydrosystems. Report for MfE, NIWA HAM2016-062. http://www.mfe.govt.nz/publications/marine/classification-of-new-zealands-coastal-hydrosystems
- Te Waihora Cultural and Ecological Restoration – Whakaora Te Waihora www.tewaihora.org
- Hart et al. 2008. Coastal systems. In: Winterbourne, M; Knox, G; Burrows, C; Marsden I (2008) The Natural History of Canterbury. Christchurch, NZ: Canterbury University Press.