Rising sea-level impacts on braided river mouths (hapua)

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Outline

- Hapua features & behaviour
- Hapua hydraulics 101
- SLR response with
  - ➢ cliff-backed hapua
  - ➢ lowland-backed hapua

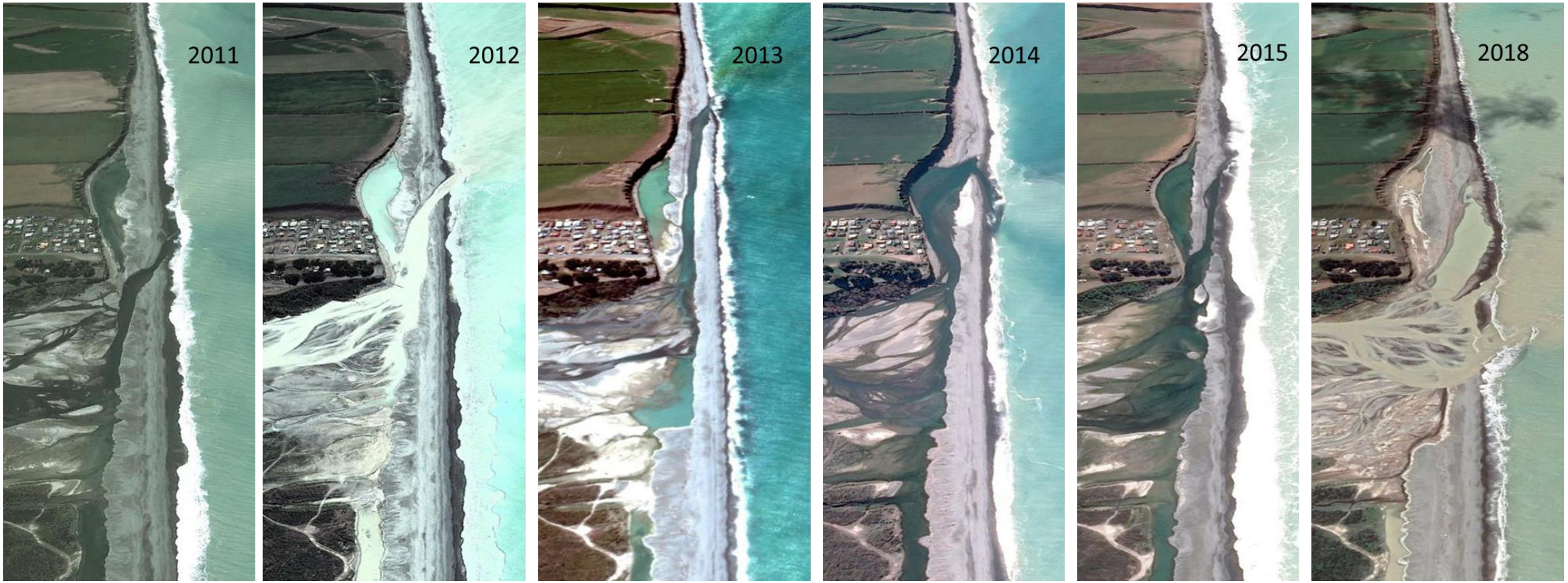
Hapua features:

- Skinny lagoons
- Mouths of braided rivers (steep, floody, high bedload)
- High wave-energy, retreating coasts
- Often cliffed backshore
- Highly dynamic gravel barriers, with typically constricted, elongated, migrating outlet channels, blown out by floods
- Not estuaries: freshwater (mostly), no reversing tidal flows – so specialised ecosystems

Form and behaviour controlled by:

- River flows
- Waves
- Tide
- Mean sea level
- Backshore character

A running battle between controls, with rapid morphological adjustment



Key point: Extensive morphological “turnover” on a year-by-year basis

What will happen to barrier size with sea level rise?

- Barrier height determined by:
  - storm waves
  - sea level
  - time between turnover events
- Rapid turnover, therefore expect average barrier height to keep pace with rising sea-level
- Assuming plenty of barrier gravel stock from river and adjacent coast

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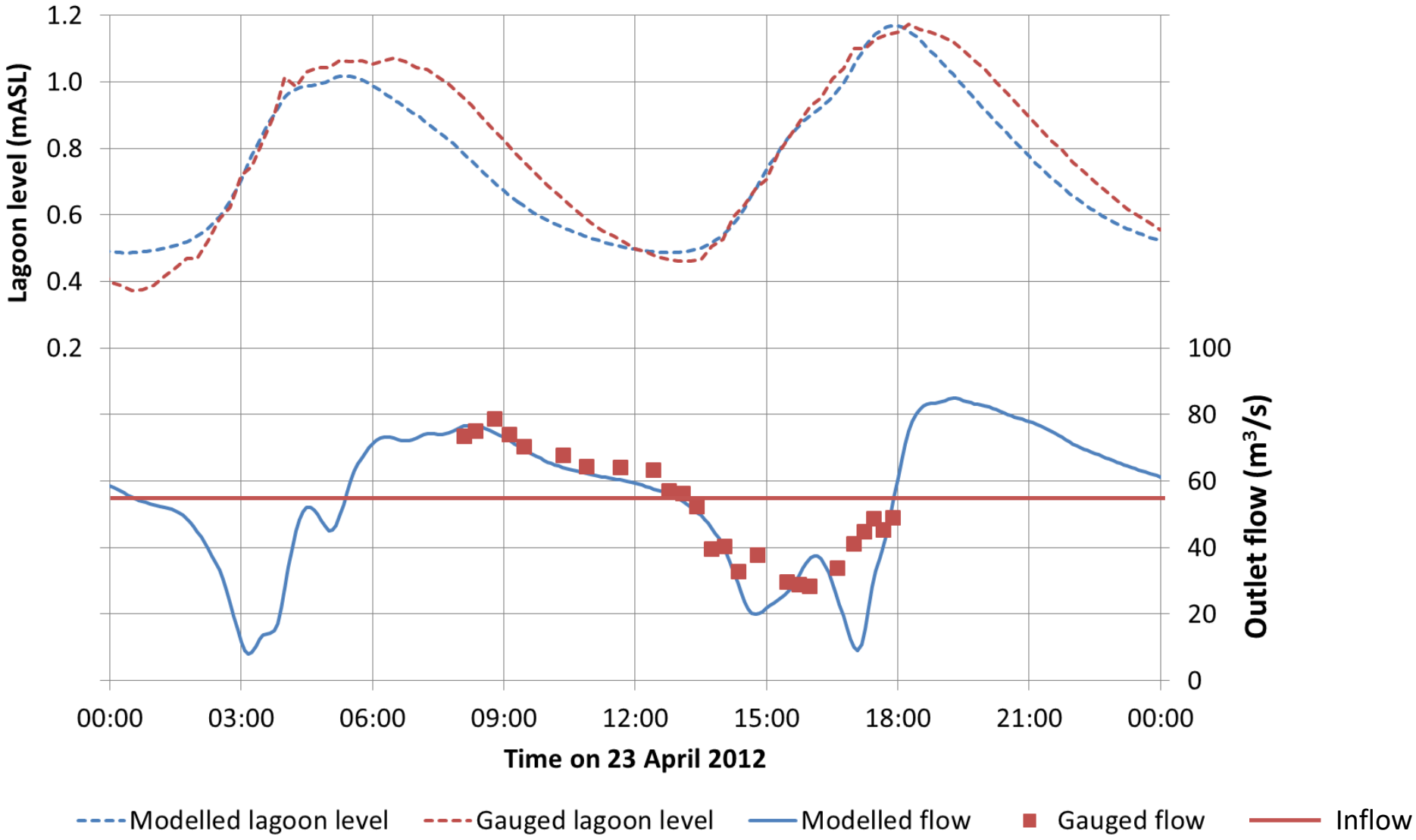
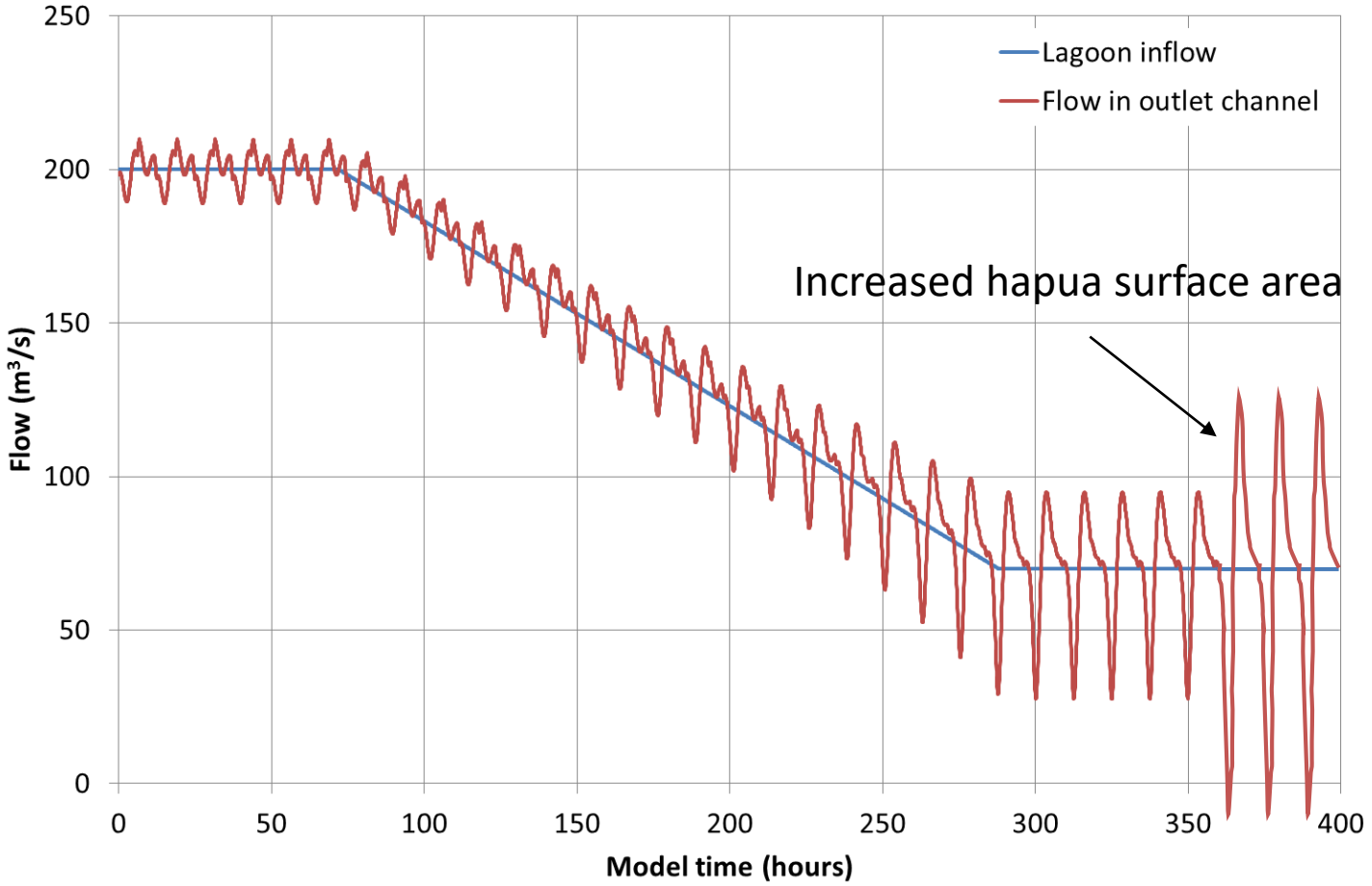
April 2012 study

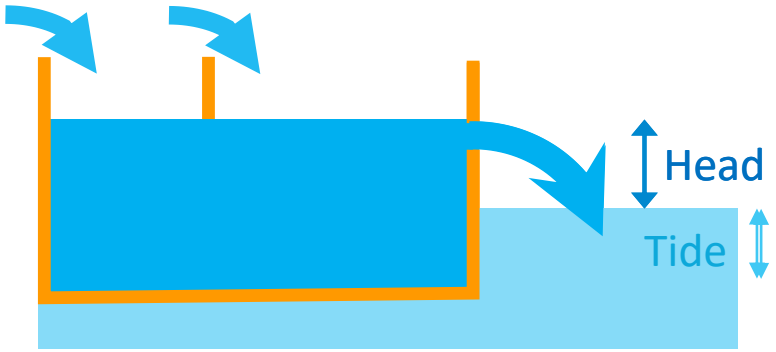
- Outflow gauging over 1 tidal cycle
- Survey of lagoon bathymetry, barrier crest
- Cross-section of outlet channel
- Numerical models of hapua outflow, water level


Lagoon level (mASL)
1.2
1.0
0.8
0.6
0.4
0.2
Outlet flow (m³/s)
100
80
60
40
20
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time on 23 April 2012
Modelled lagoon level
Gauged lagoon level
Modelled flow
Gauged flow
Inflow



Amplitude of outflow fluctuations increases as:

- River flow decreases
- Outlet less constricted
- Area of hapua increases



- If sea-level rise increases hapua size by flooding backshore, could potentially turn hapua estuarine
- Controlled by backshore character

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Cliffed coasts: What will happen to hapua plan form with sea level rise?

- Planform pinned by adjacent cliffed shore
- Cliff retreat ~ 100 m/ 100 yr
- With 1 m SLR over 100 yr, riverbed edge retreats 125 m (up 8 m/km slope)
- Therefore, little change in hapua size

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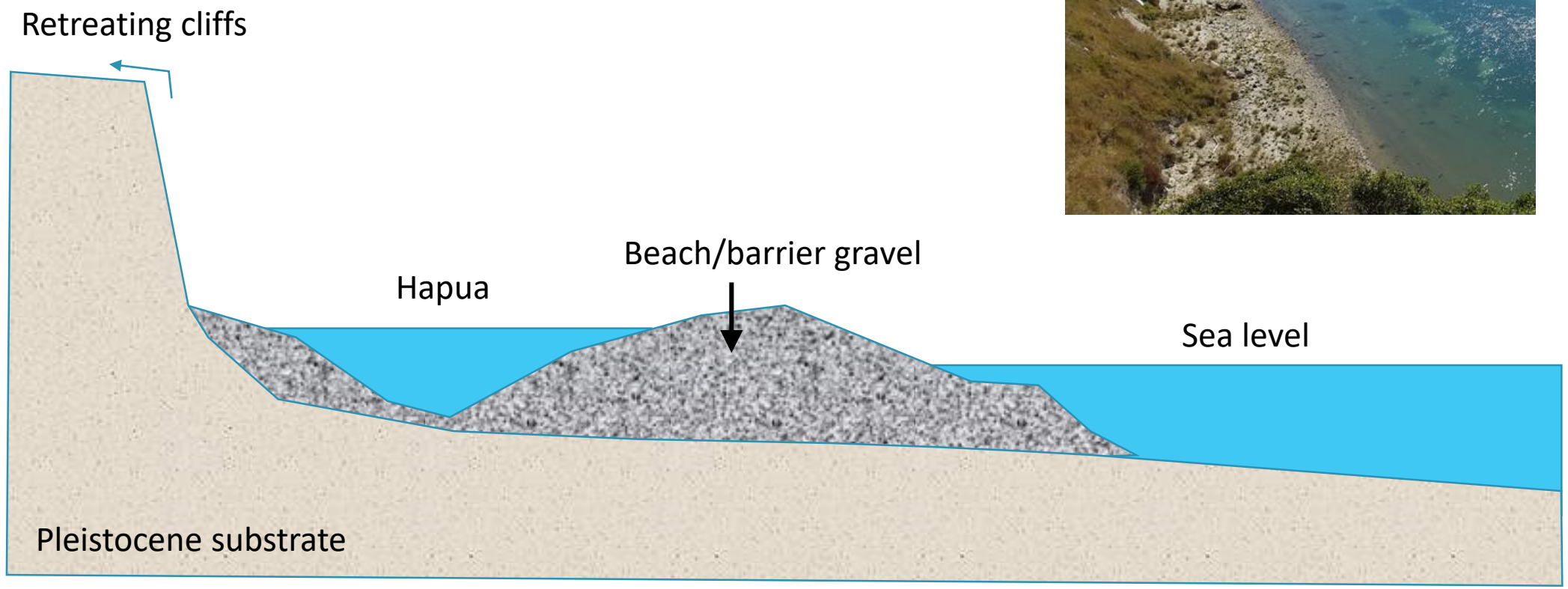
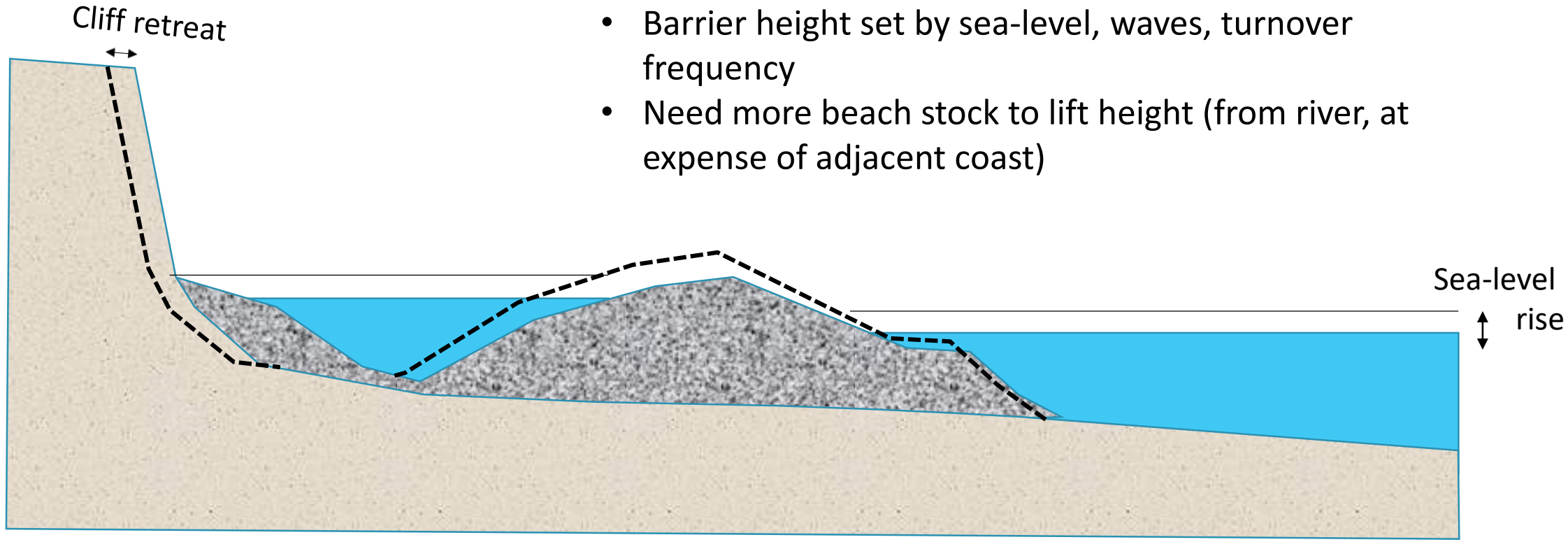
Cliff-backed hapua
(e.g. Ashburton, Hurunui, Waitaki)

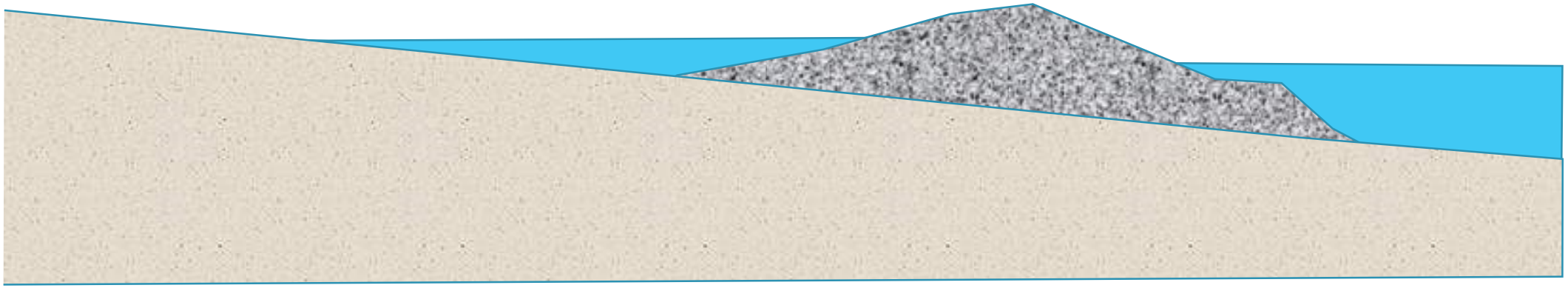


Cliff-backed hapua with rising sea level

- Hapua location controlled by cliff retreat
- Hapua width stays in dynamic equilibrium with floods, waves
- No change in hapua area, so no change in hydraulics, salinity regime
- Barrier height set by sea-level, waves, turnover frequency
- Need more beach stock to lift height (from river, at expense of adjacent coast)

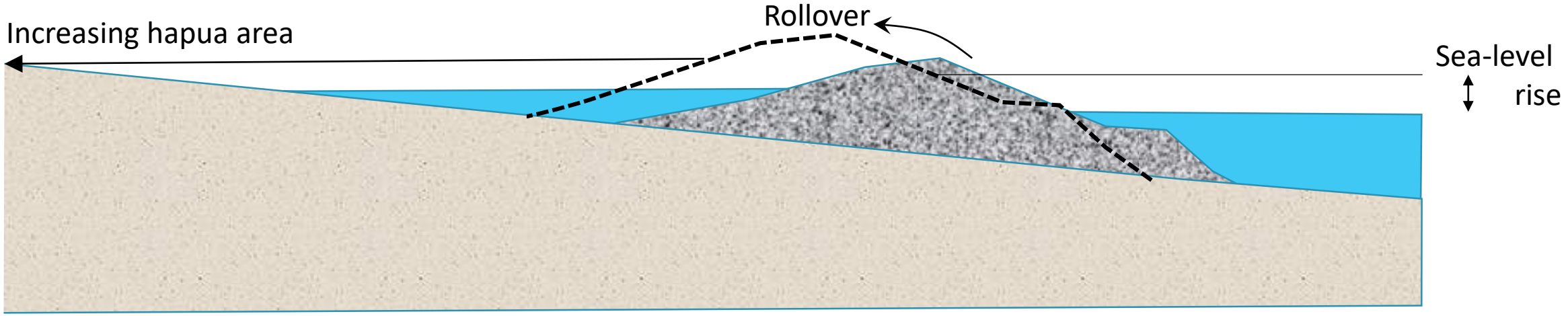


Lowland-backed hapua/barrier
(e.g., Rakaia)



Lowland-backed hapua/barrier with rising sea level

- Barrier height lifts with sea-level
- May need more beach stock to lift height (from river, at expense of adjacent coast) – depends on substrate slope
- Lagoon seaward edge controlled by net barrier rollover
- Backshore shifts landward due to flooding
- Increase in hapua area, so change in hydraulics, may become estuarine (particularly if baseflows are minimised)



Summary:

- On cliffed coasts, expect little change in hapua form and morphodynamic and hydraulic behaviour
- With lowland backshores, hapua may get bigger, with risk of becoming estuarine (with impacts on ecosystem)

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Thanks!