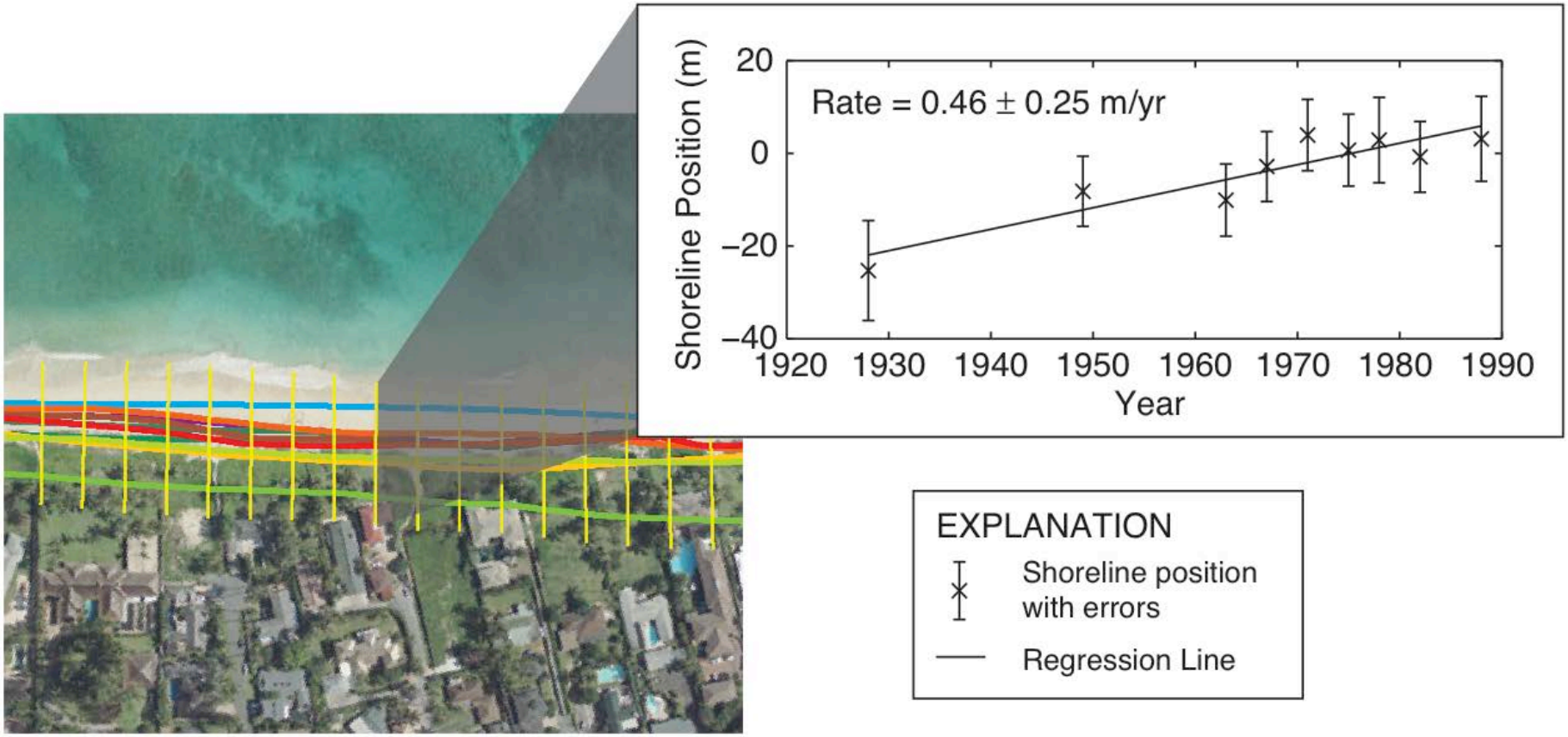
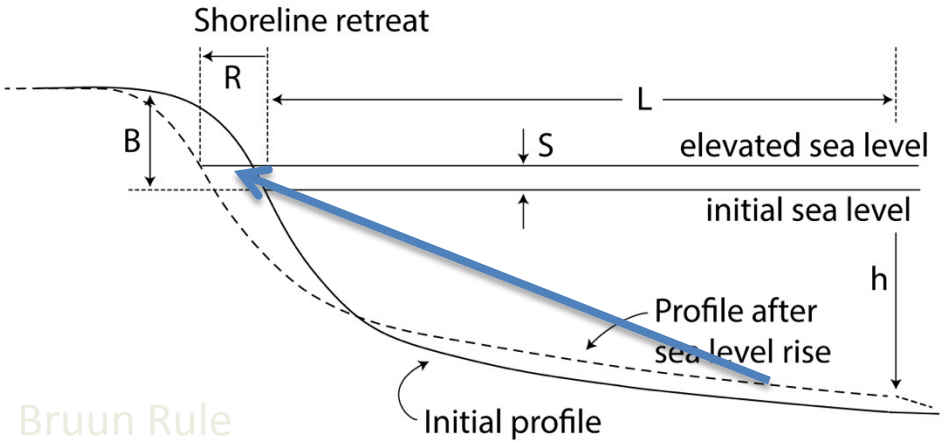
Future erosion hazards?

Simply extrapolating the trend is not sufficient

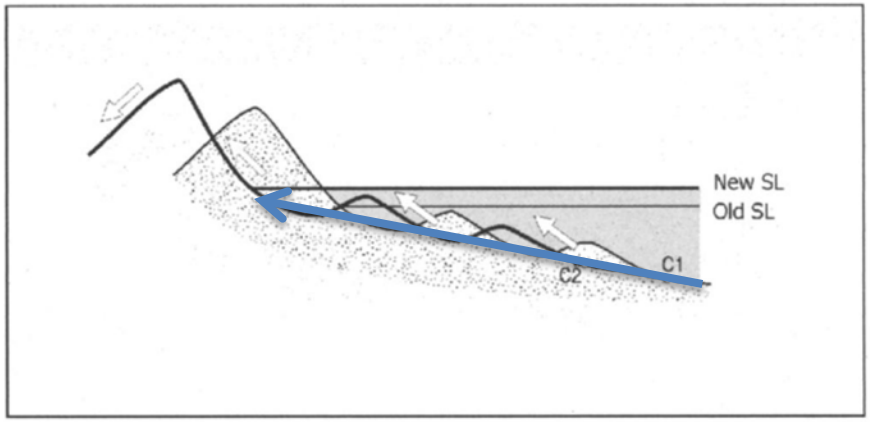


Modeling sea level rise impacts?

- Process-based models
  - i.*e.* SBEACH, Xbeach, Delft3D
- Geometric models
  - *i.e.* Bruun Rule (Bruun, 1962), Davidson-Arnott (2005)
  - Simple, minimal data
  - Limited applicability
    - closed sediment system

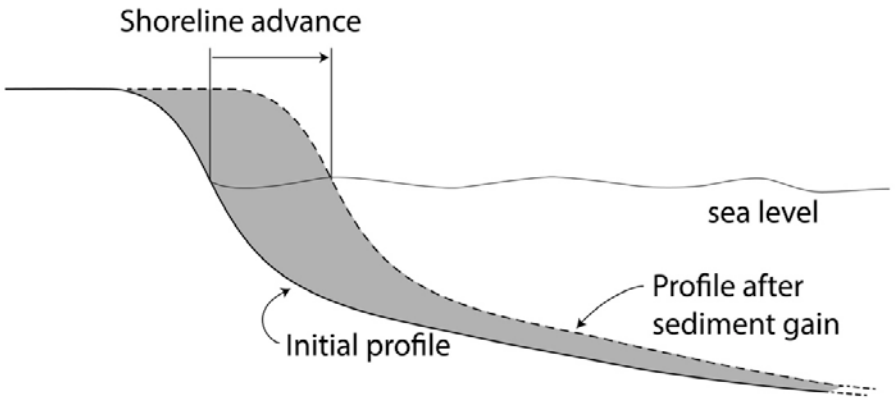


Bruun Rule

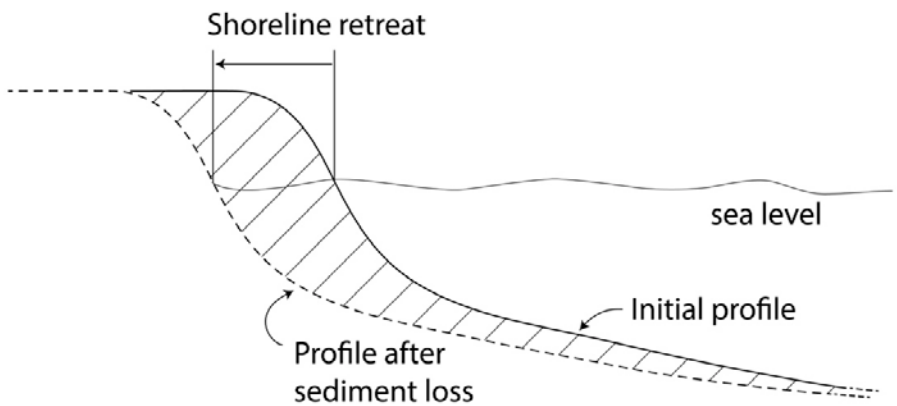


From Davidson-Arnott, 2005

Shoreline change due to sediment gain/loss

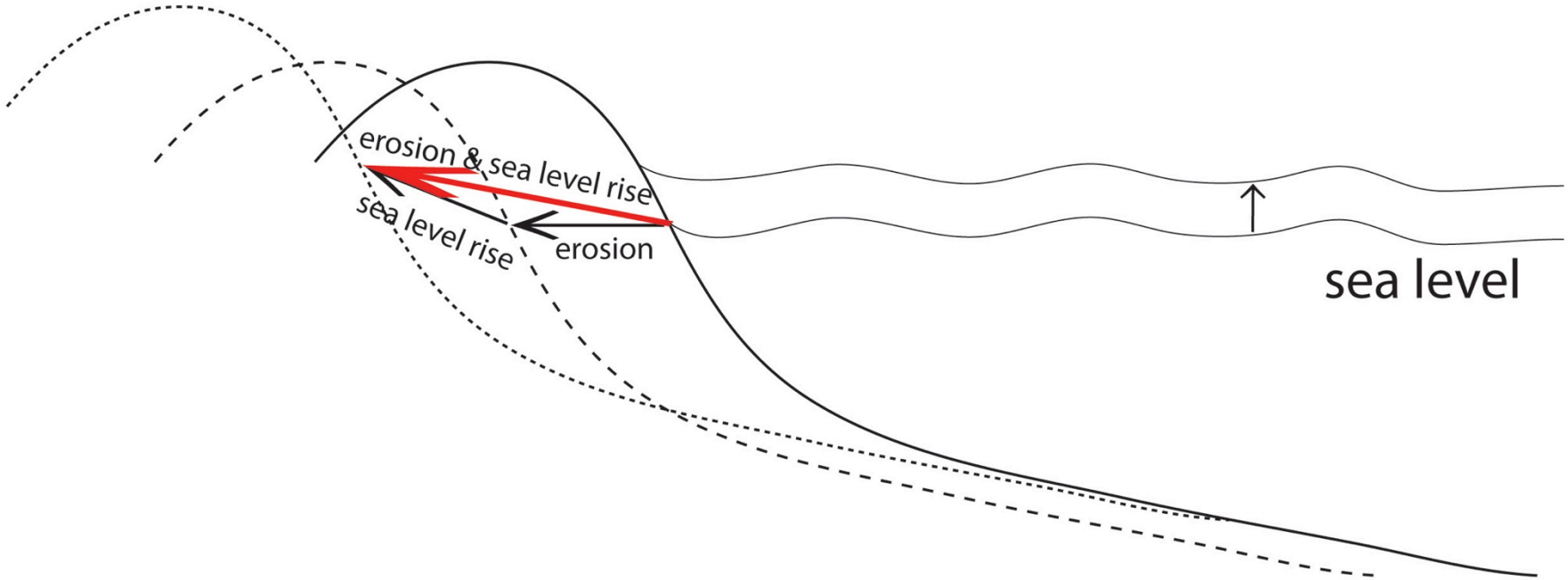


Gain ⇒ **Seaward migration**

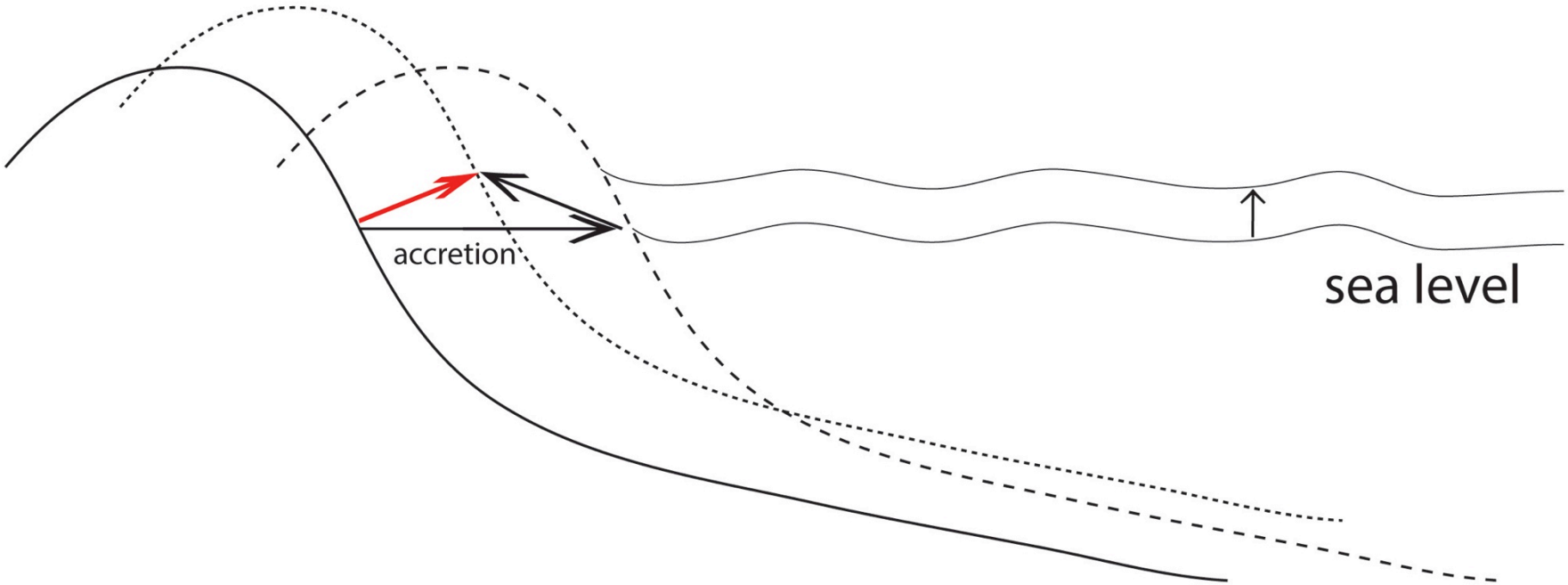


Loss ⇒ **Landward migration**

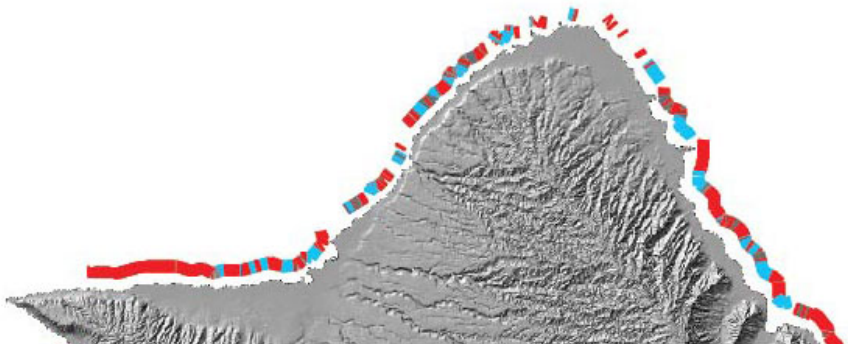
Sediment loss and sea level rise

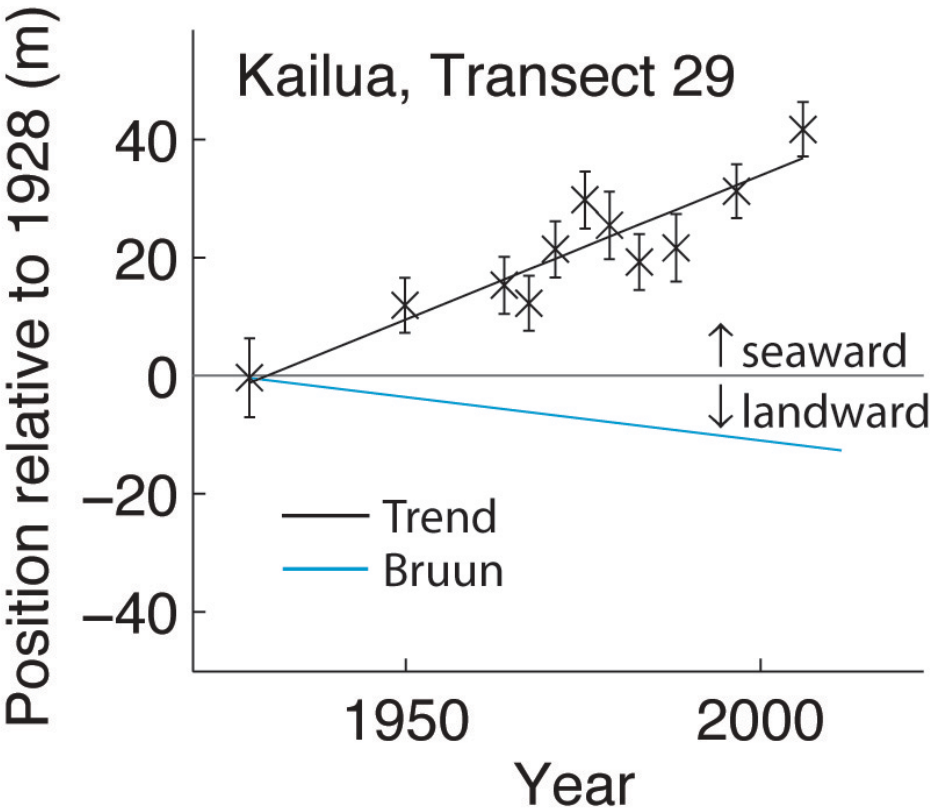


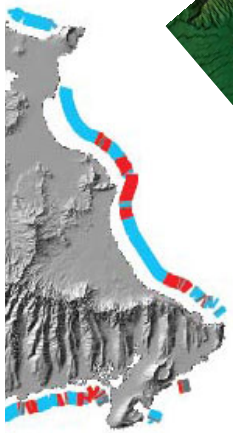
Sediment gain and sea level rise

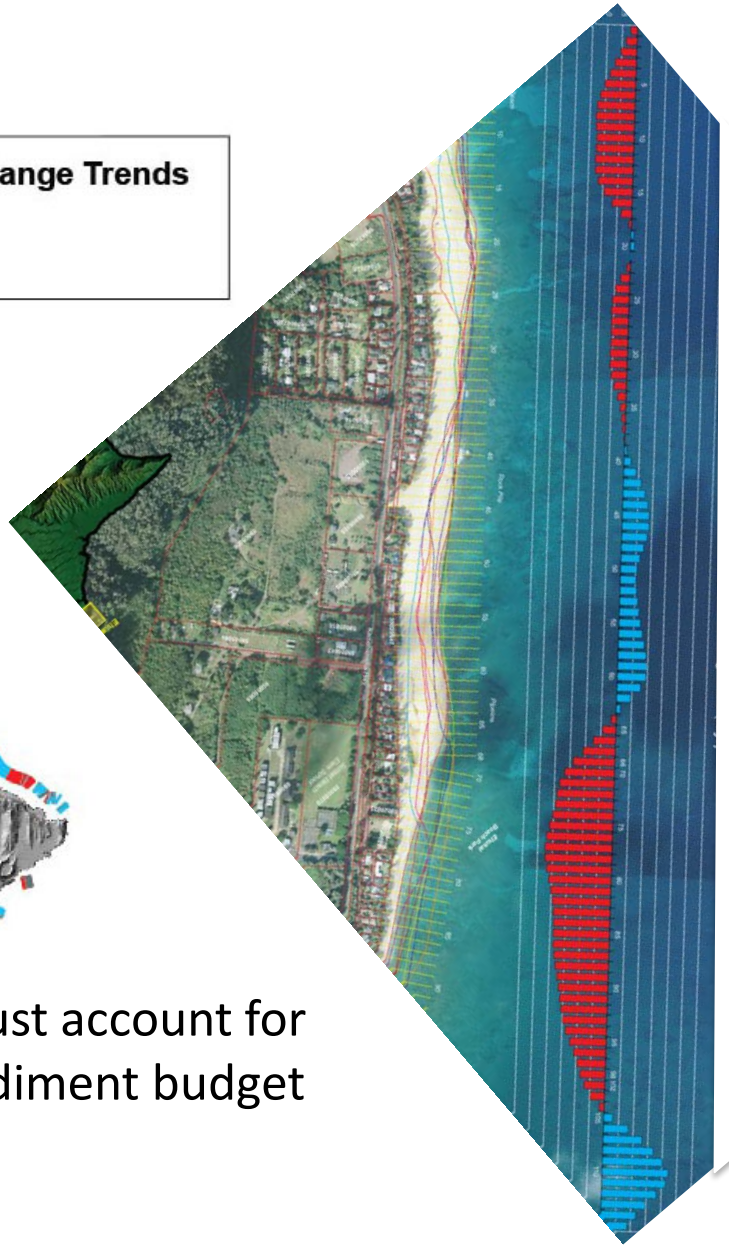


Spatial patterns in littoral transport









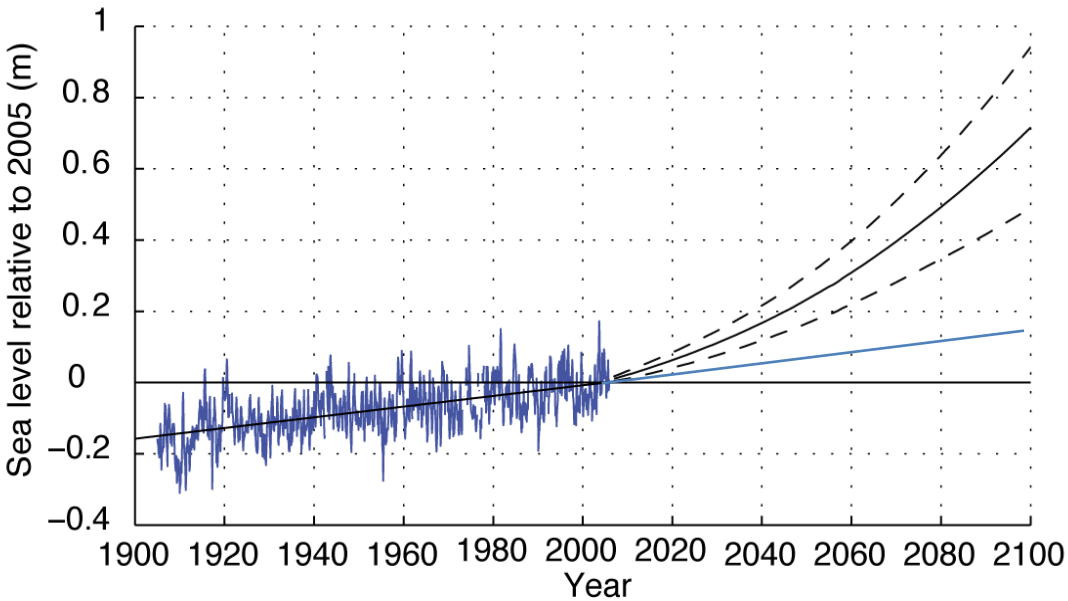
Must account for sediment budget

Hybrid model concept

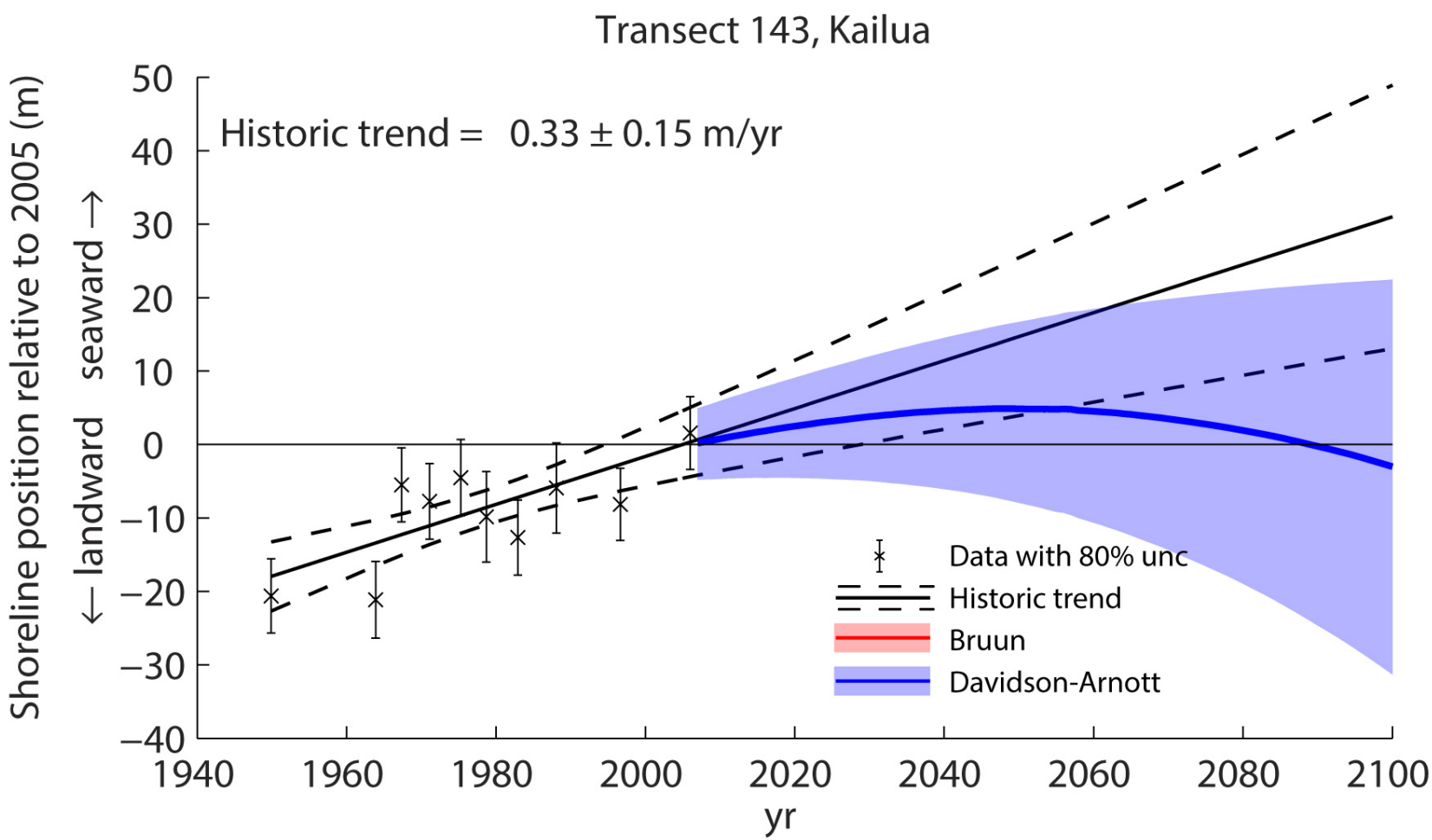
- Use historical shoreline change rates to capture variations in shoreline change due to sediment availability
- Use a geometric model to estimate shoreline response to increased rates of sea level rise.
- Add the two together

Sea level projection

- IPCC AR5 global mean sea level, scenario RCP 8.5
  - Shown with “likely” interval
- Honolulu tide gauge (1905-2006)
  - Assume no island subsidence/lift



Example: Accreting shoreline



Kailua Beach - South

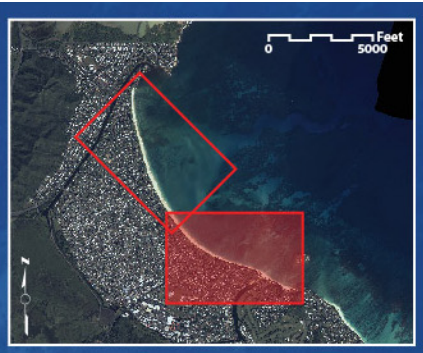
Modeled vegetation line (veg) using AR5, RCP8.5

Area Description

Historically (1949-2005), the southern portion of Kailua Beach experienced net accretion at an average rate of 0.6 ± 0.2 ft/yr. However, over the same period, net erosion occurred at Kailua Beach Park [see map] at an average rate of -0.4 ± 0.2 ft/yr. Model results indicate that by 2050, 72% of the map area will be eroding at an average rate of -0.3 ± 0.2 ft/yr. By the year 2100, 100% of the map area is predicted to be eroding with an average rate of -1.1 ± 0.2 ft/yr.

Modeling Beach Change

Future sea level predictions using the RCP 8.5 scenario (ICPP AR5, 2014) are converted to shoreline recession distances using the Davidson-Arnott geometric model (Davidson-Arnott, 2005). Recession values are adjusted to reflect local sea level and sediment availability using tide gauge records and historical shoreline change rates (Fletcher et al., 2013).



Davidson-Arnott (hybrid)

- 2050 veg
- 2100 veg

Sea level rise scenario - above MHHW

- 1 ft
- 2 ft
- 3 ft

1:5000

0 500 1000 1500 2000 Feet

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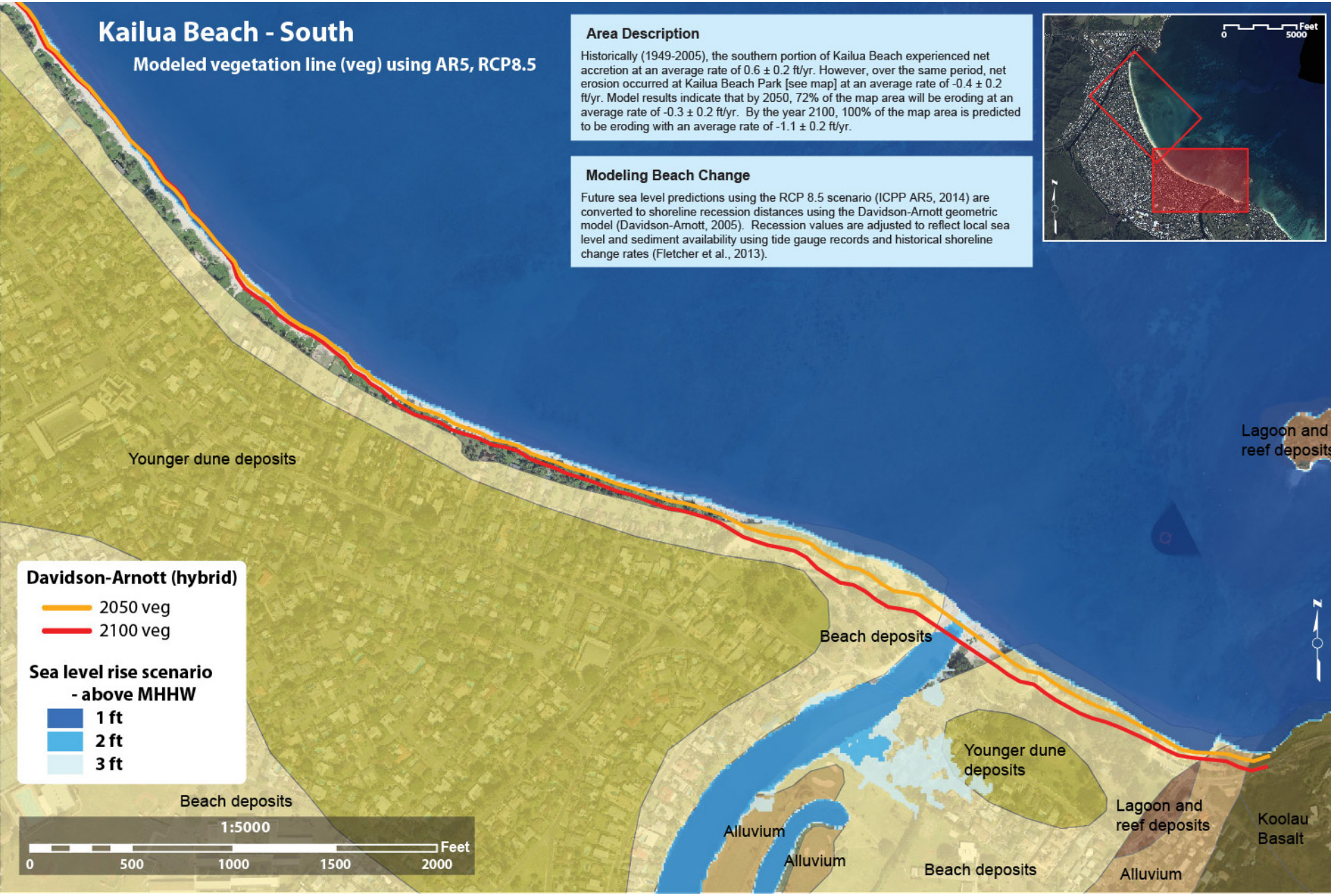
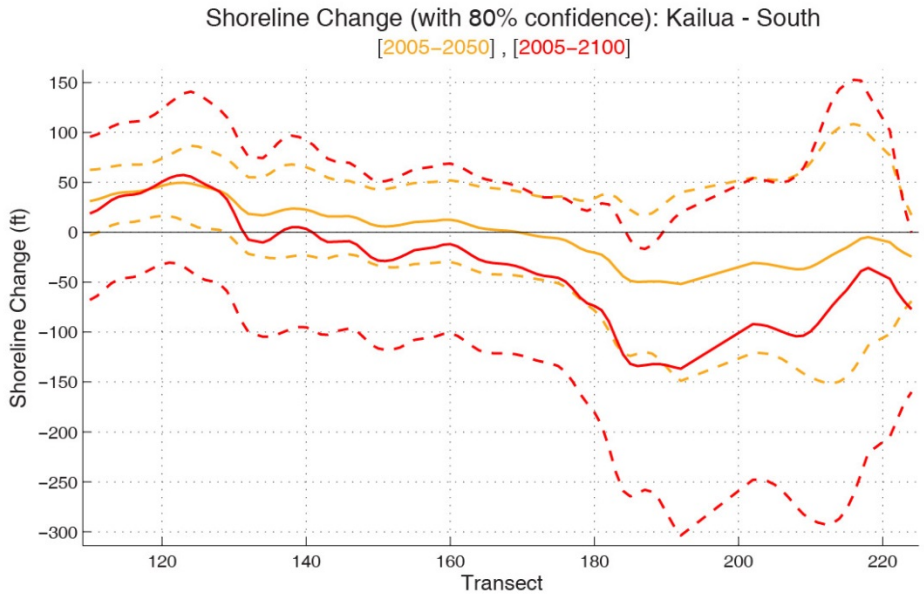
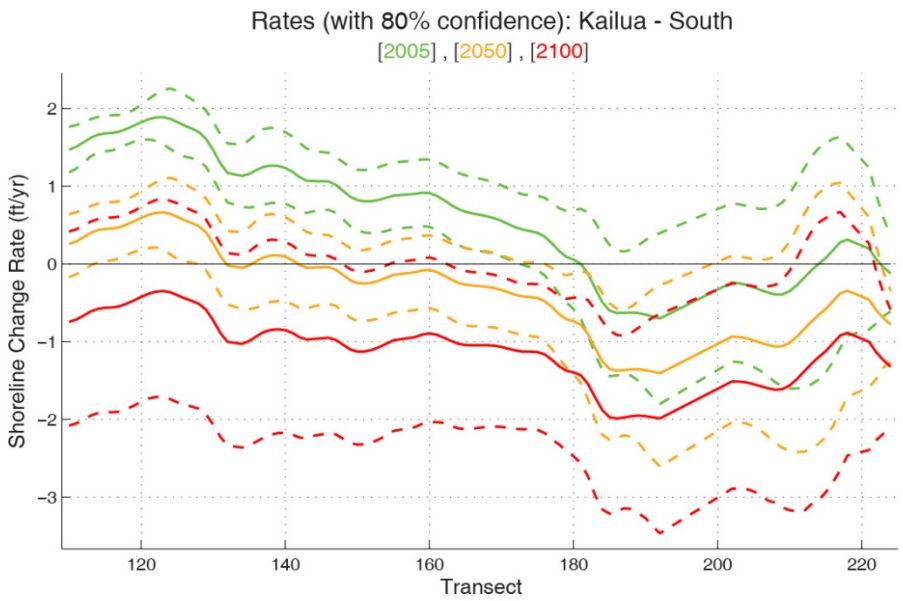
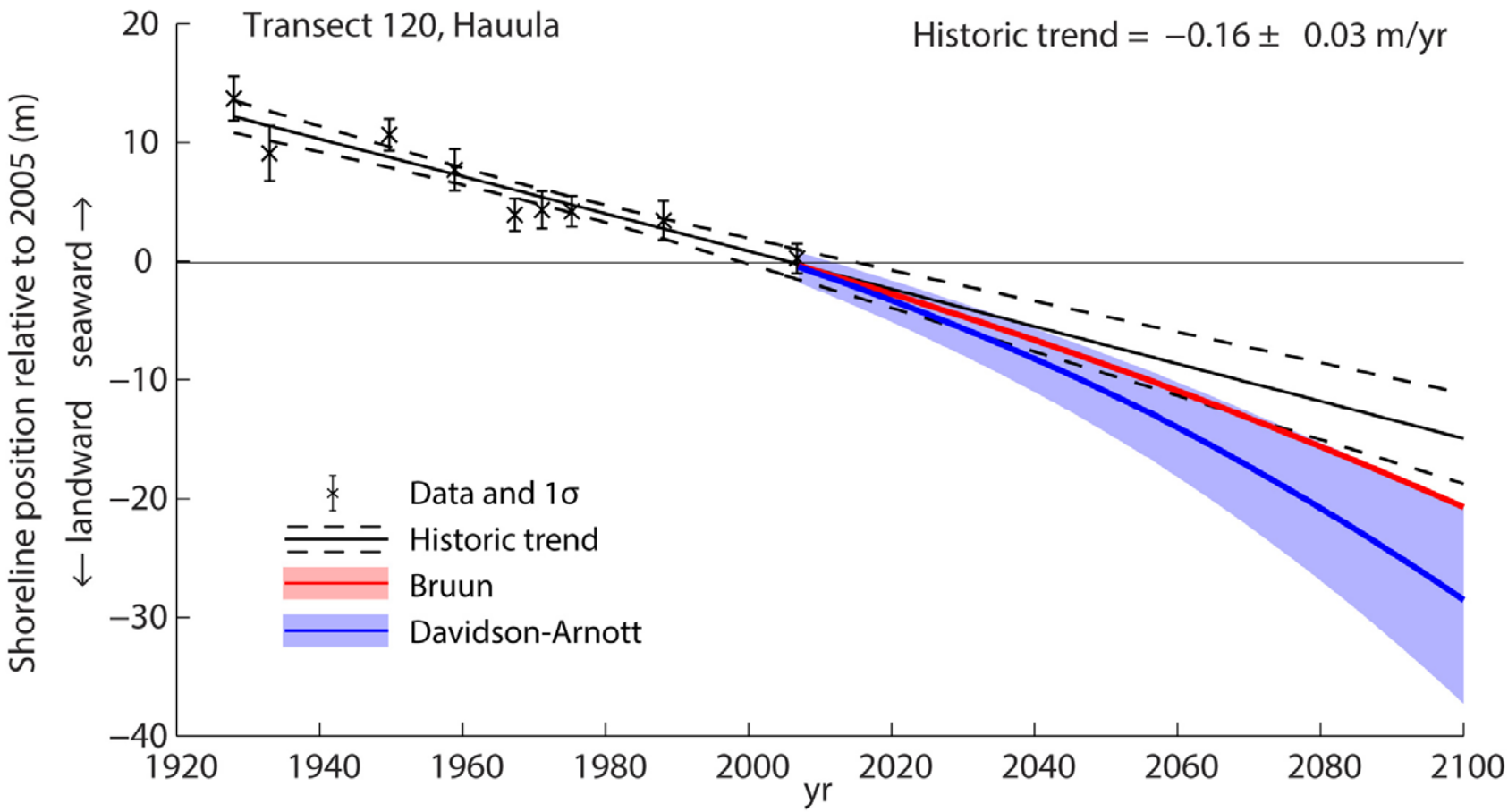



Shoreline Change (with 80% confidence): Kailua - South
[2005–2050] , [2005–2100]
Shoreline Change (ft)
150
100
50
0
−50
−100
−150
−200
−250
−300
120
140
160
180
200
220
Transect


Rates (with 80% confidence): Kailua - South
[2005] , [2050] , [2100]
Shoreline Change Rate (ft/yr)
2
1
0
−1
−2
−3
120
140
160
180
200
220
Transect

Example: Eroding shoreline



Hauula - South

Modeled vegetation line (veg) using AR5, RCP8.5

Area Description

From 1928 to 2007, South Hauula experienced net erosion with 97% of the beach eroding at an average rate of -0.3 ± 0.0 ft/yr. Modeled response to sea level rise indicates 100% of the beach will erode at an average rate of -0.7 ± 0.0 ft/yr by 2050 and -1.1 ± 0.1 ft/yr by 2100. An average beach recession of -24.3 ± 2.9 ft is estimated by 2050 and -68.7 ± 5.3 ft by 2100.

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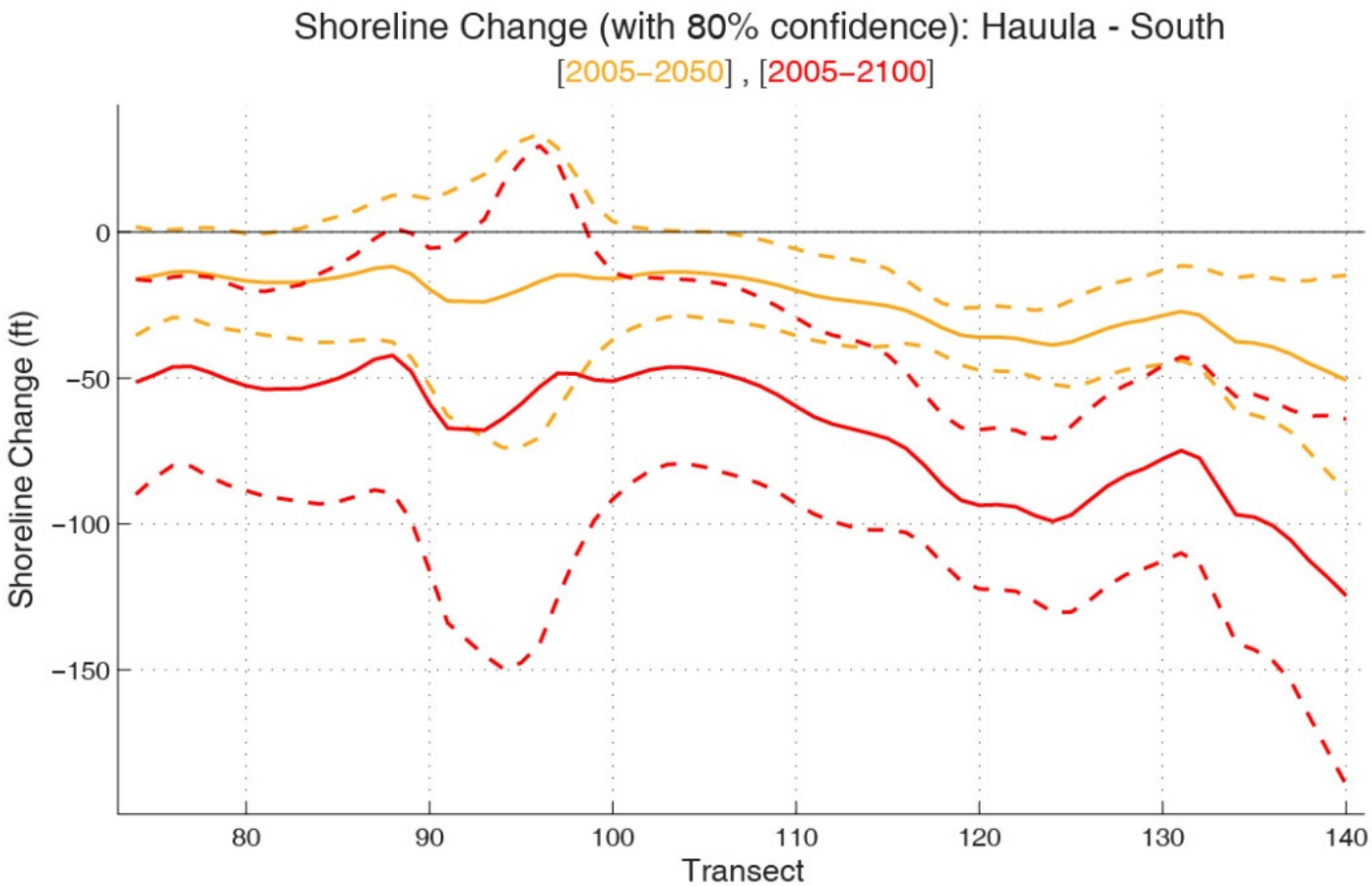
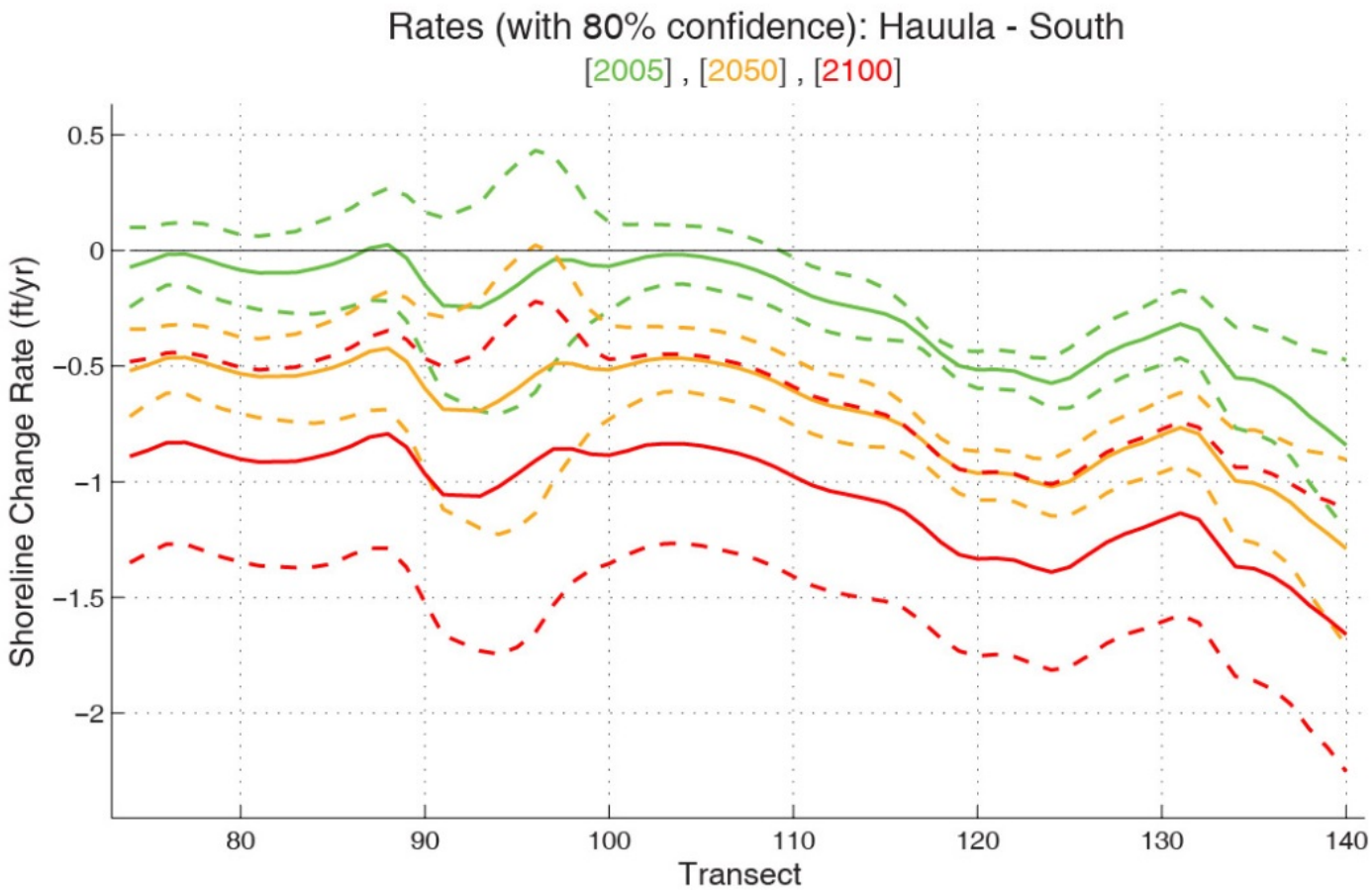

Shoreline Change (with 80% confidence): Hauula - South
[2005–2050] , [2005–2100]
Shoreline Change (ft)
0
−50
−100
−150
80
90
100
110
120
130
140
Transect


Rates (with 80% confidence): Hauula - South
[2005] , [2050] , [2100]
Shoreline Change Rate (ft/yr)
0.5
0
−0.5
−1
−1.5
−2
80
90
100
110
120
130
140
Transect

Mahalo for your time