Coastal Re-alignment. North Devon

What options for the future of the estuary?

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- A few basics about coastal change
- Historic Change
- Future Scenarios
- Conceptual Model

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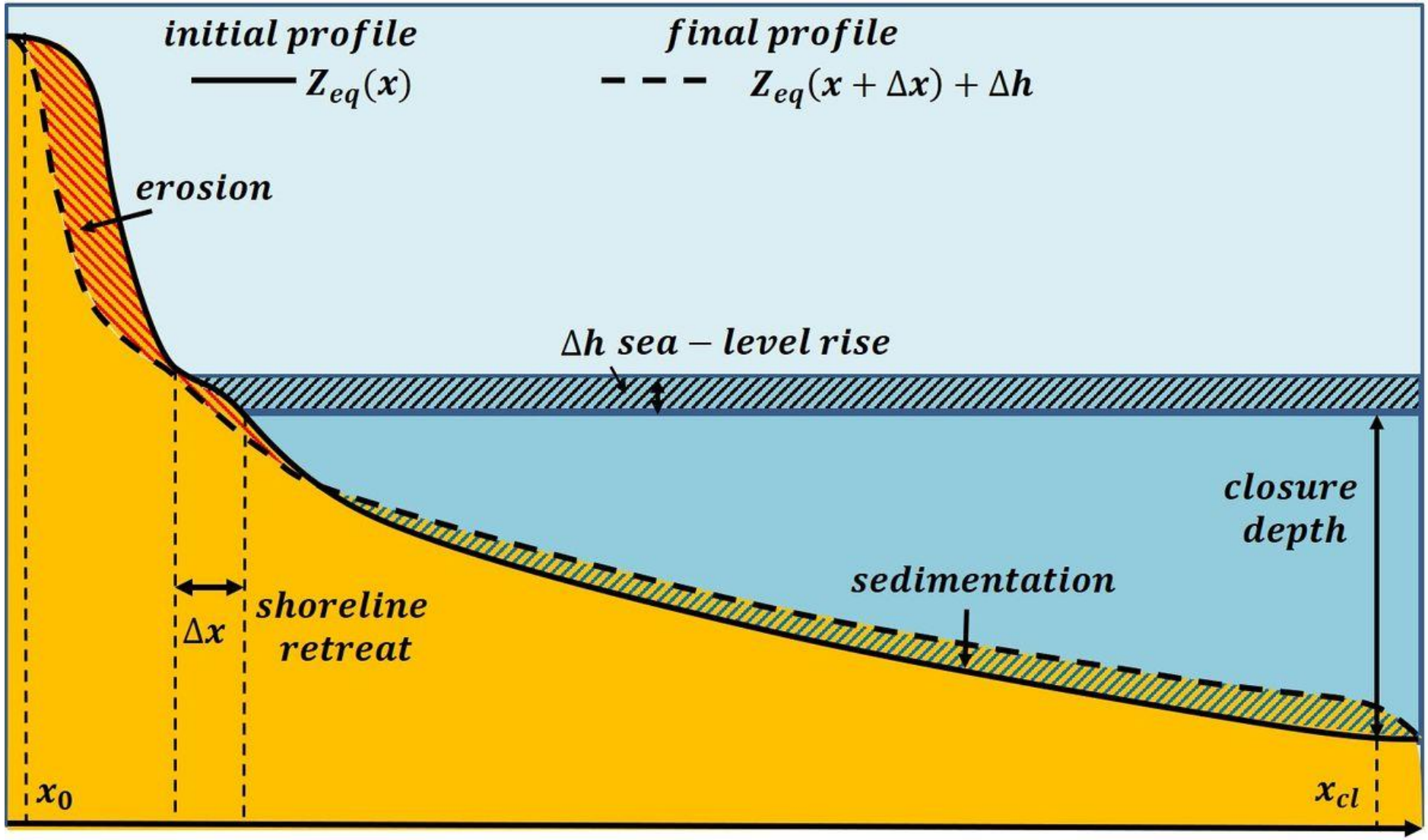
Bruun Rule


initial profile
$Z_{eq}(x)$
final profile
$Z_{eq}(x + \Delta x) + \Delta h$
erosion
Δh sea – level rise
closure depth
sedimentation
shoreline retreat
Δx
x_0
x_{cl}

Speed of waves

$$v \approx \sqrt{\frac{g\lambda}{2\pi}} \quad \text{for deep water, d} > \frac{\lambda}{2}$$

$$v \approx \sqrt{gd} \quad \text{for shallow water, d} < \frac{\lambda}{20}$$

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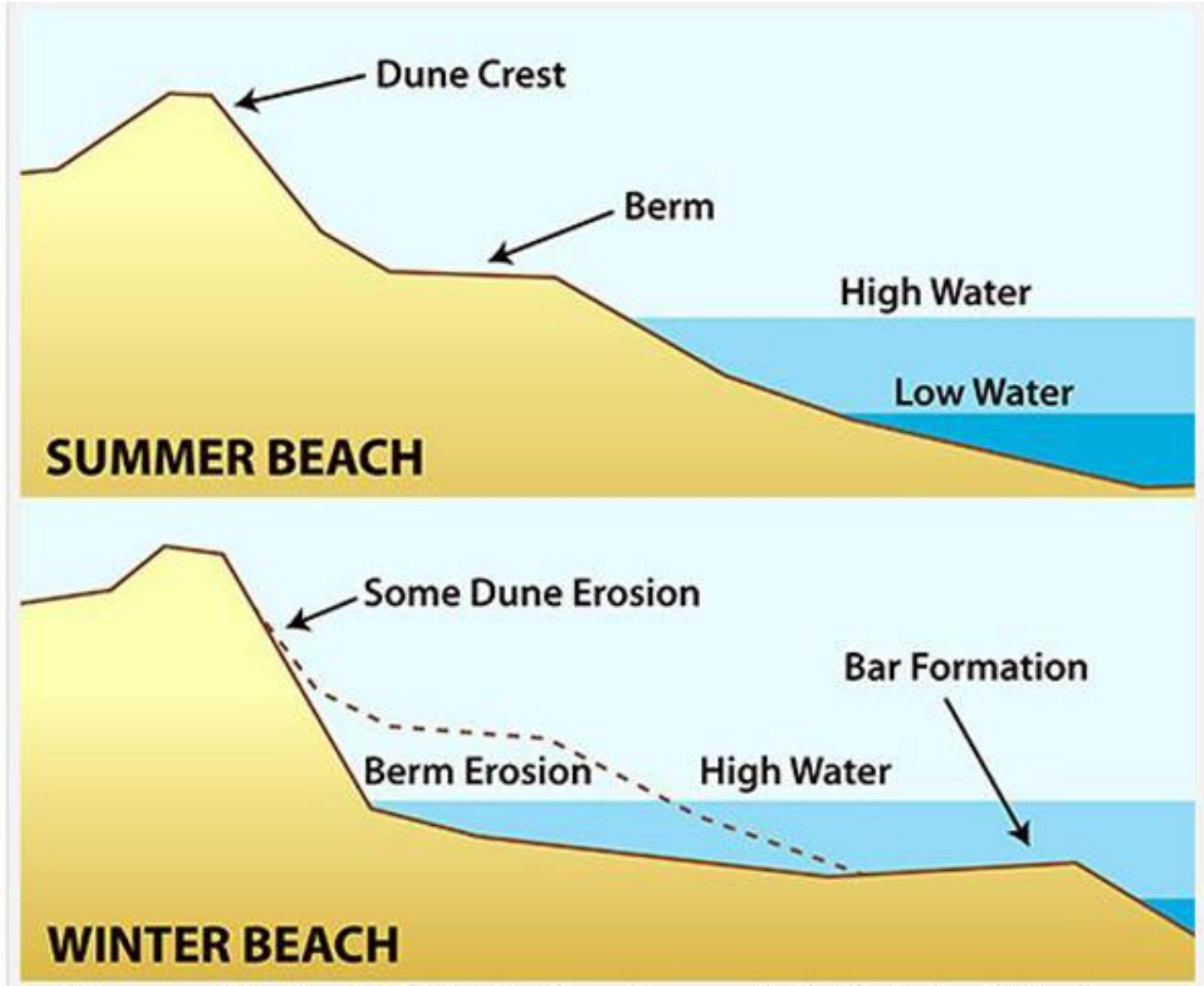
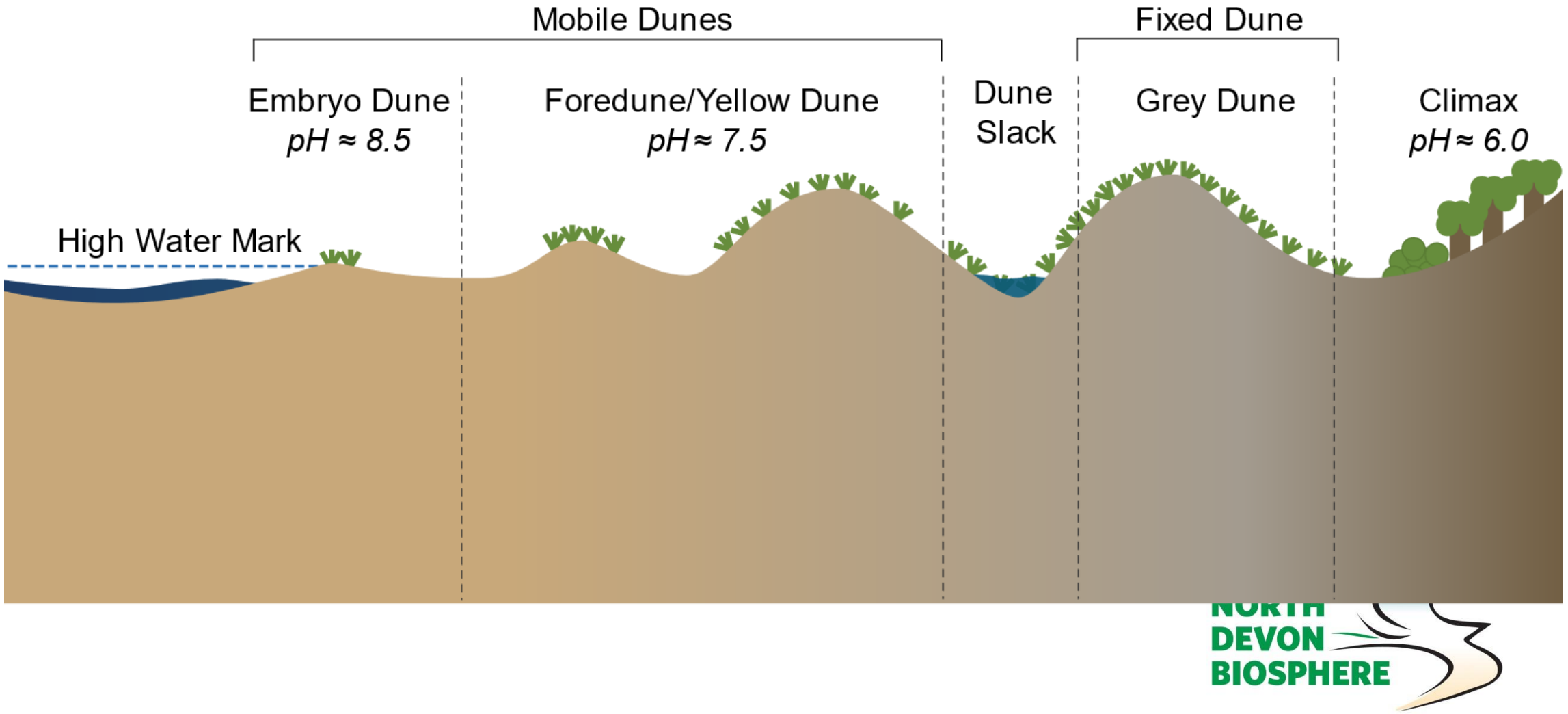

Dune Crest
Berm
High Water
Low Water
SUMMER BEACH
Some Dune Erosion
Bar Formation
Berm Erosion
High Water
WINTER BEACH

Dune Formation



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Historic Change

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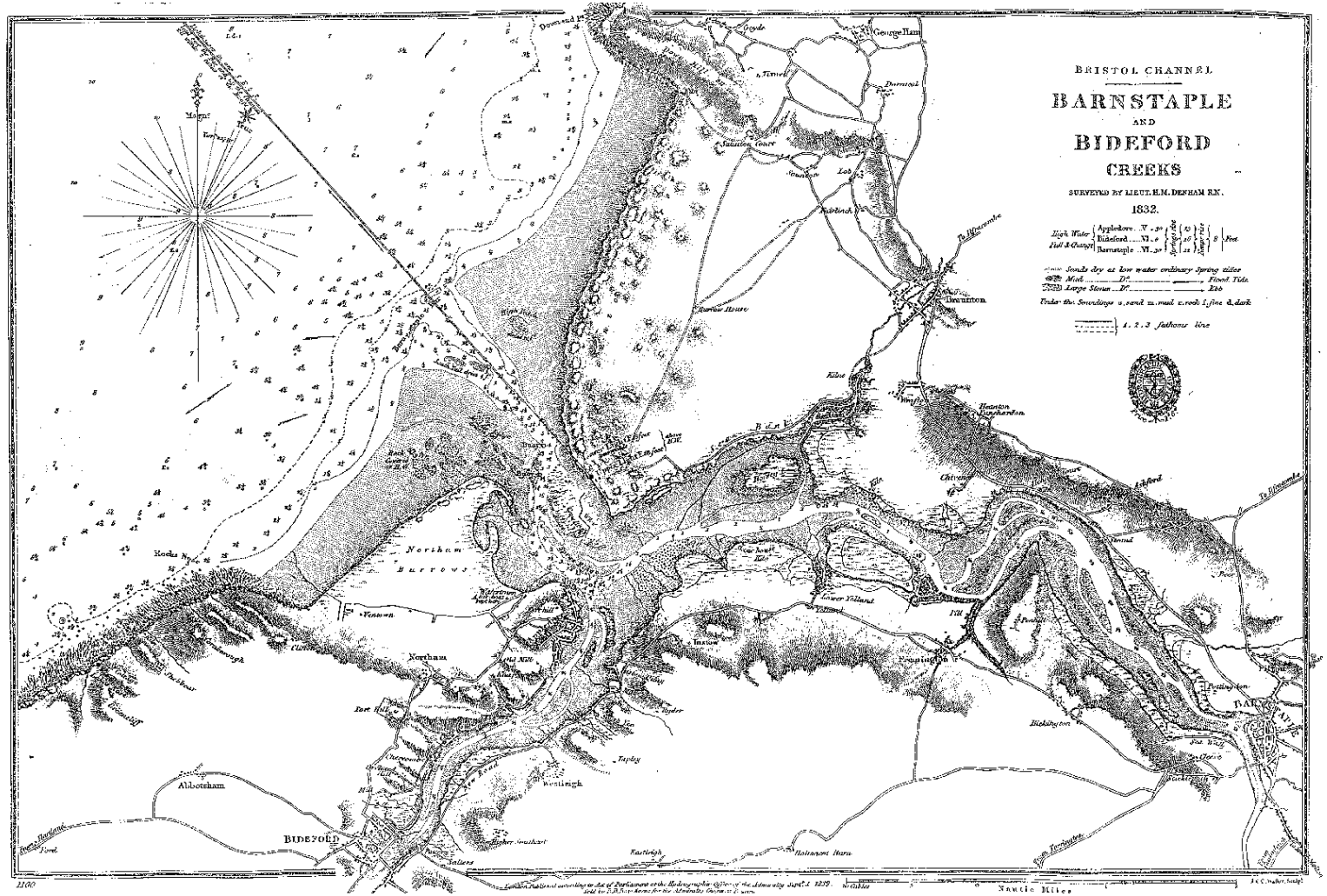
Maps & Charts: 1832



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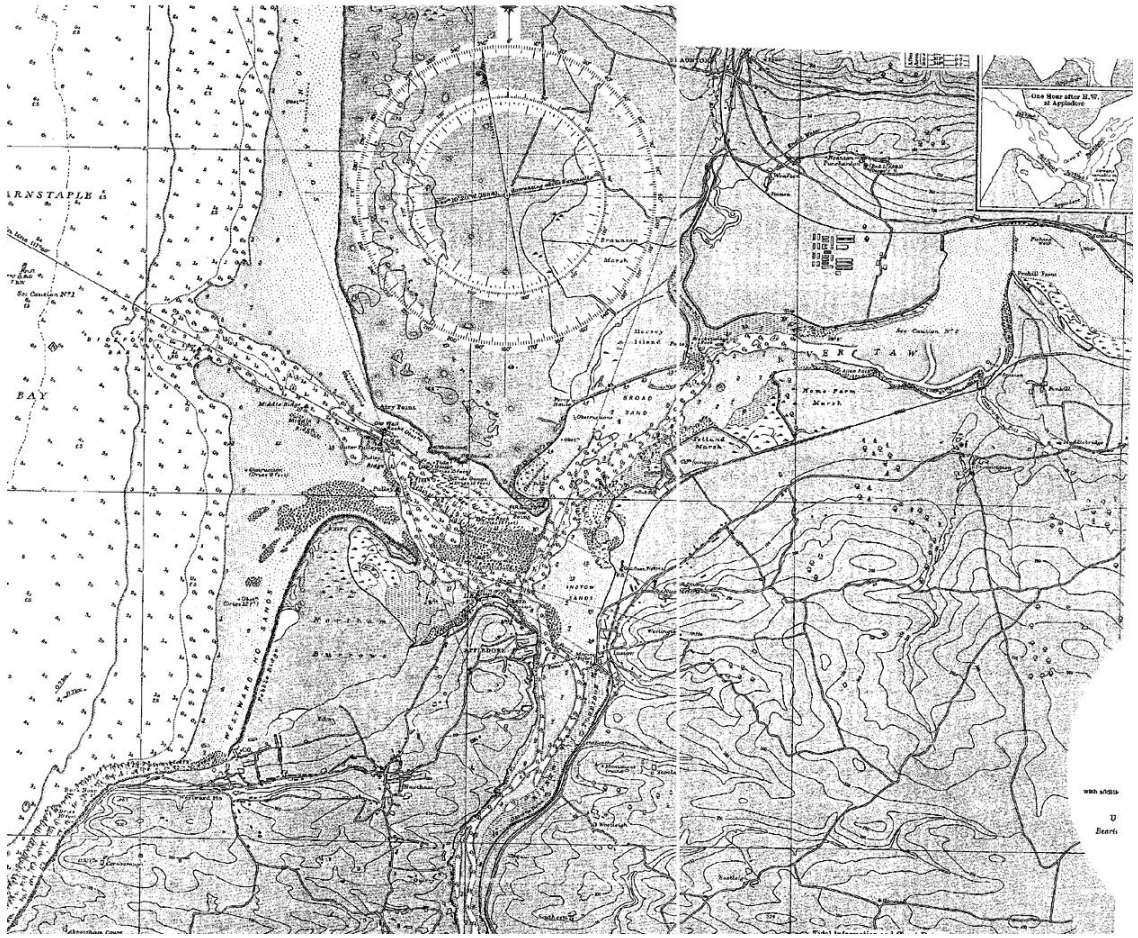

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Future Scenarios

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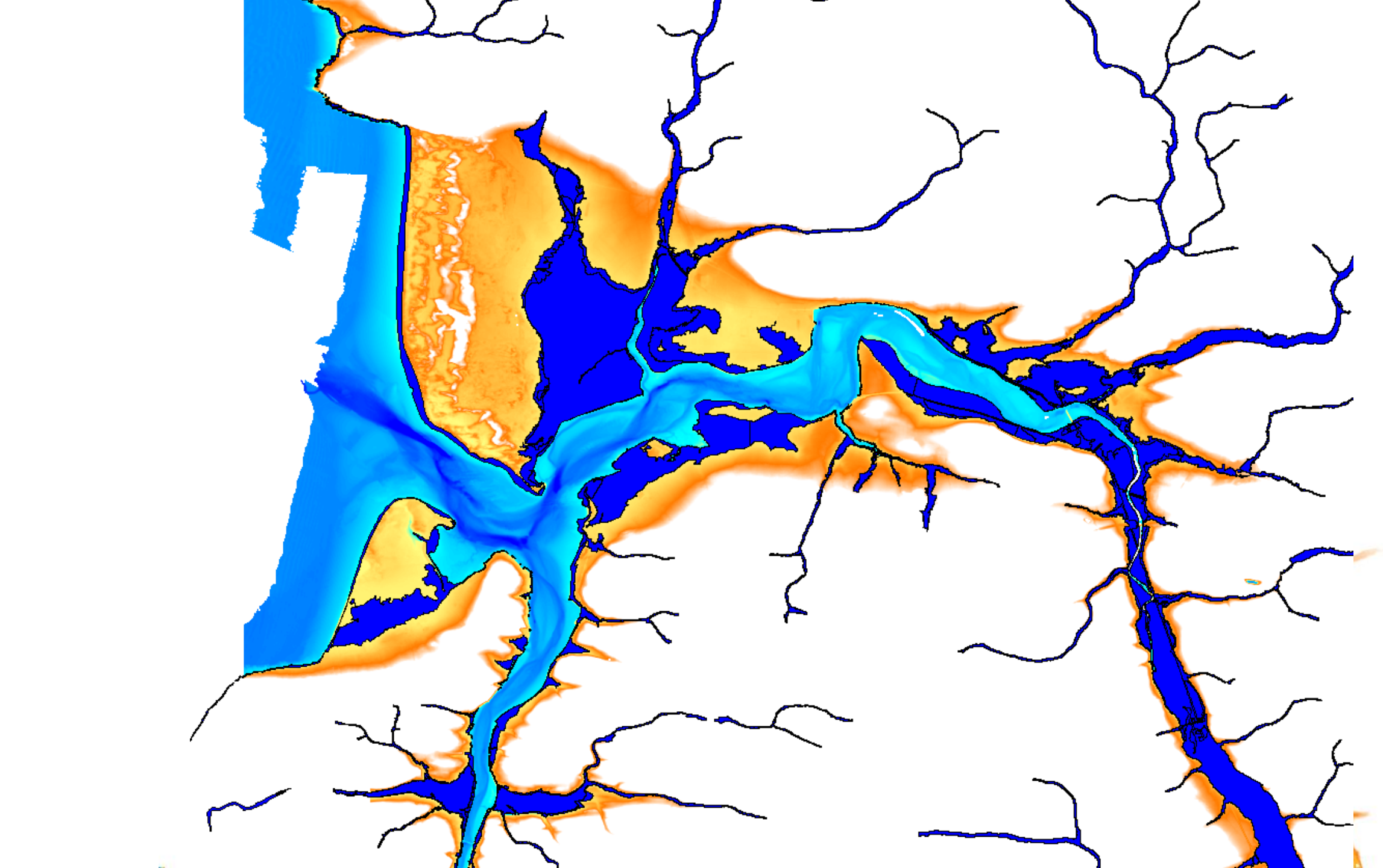

Consider the whole system

Conceptual model

where does the sand come from?

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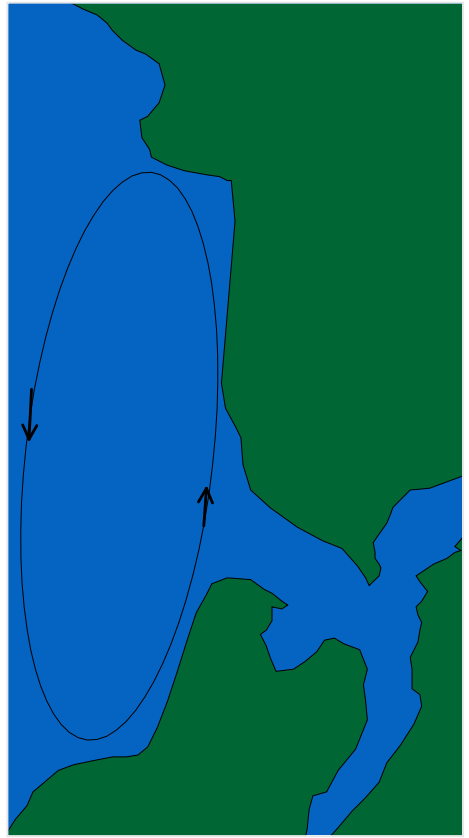
The single gyre model

- Same direction as wave-driven sand drift
- Could explain northerly drift with no source or sink
- But: how does the sand get past the estuary mouth?



The tidal delta

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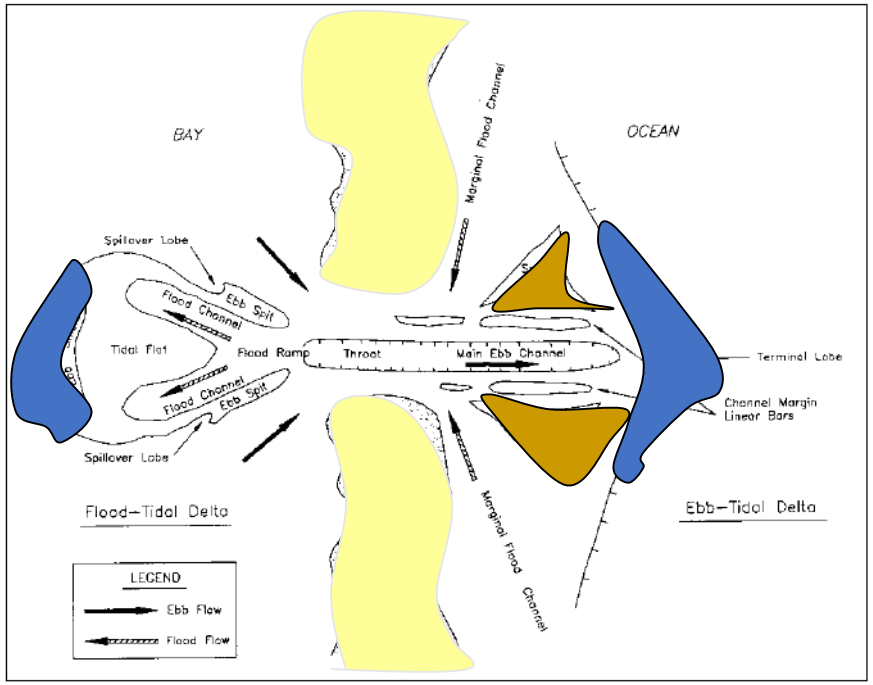
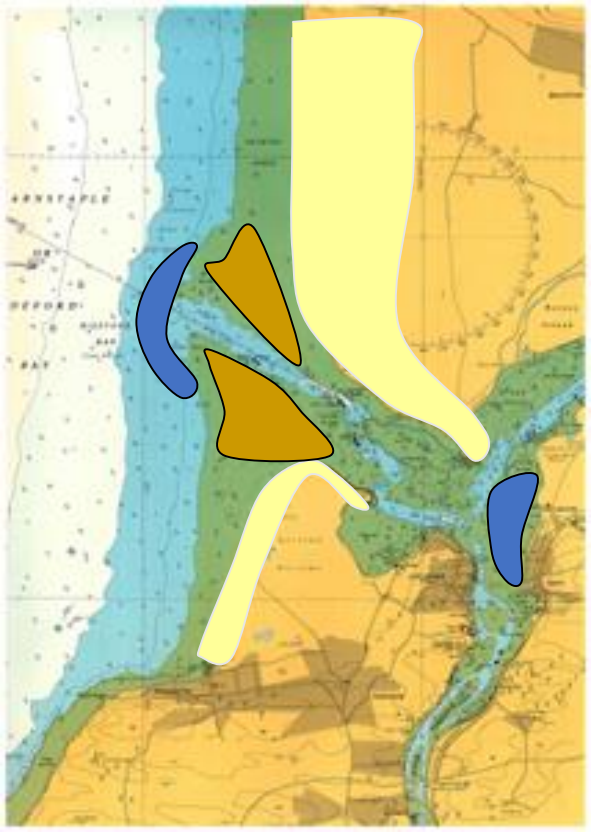
Estuaries and the open coast

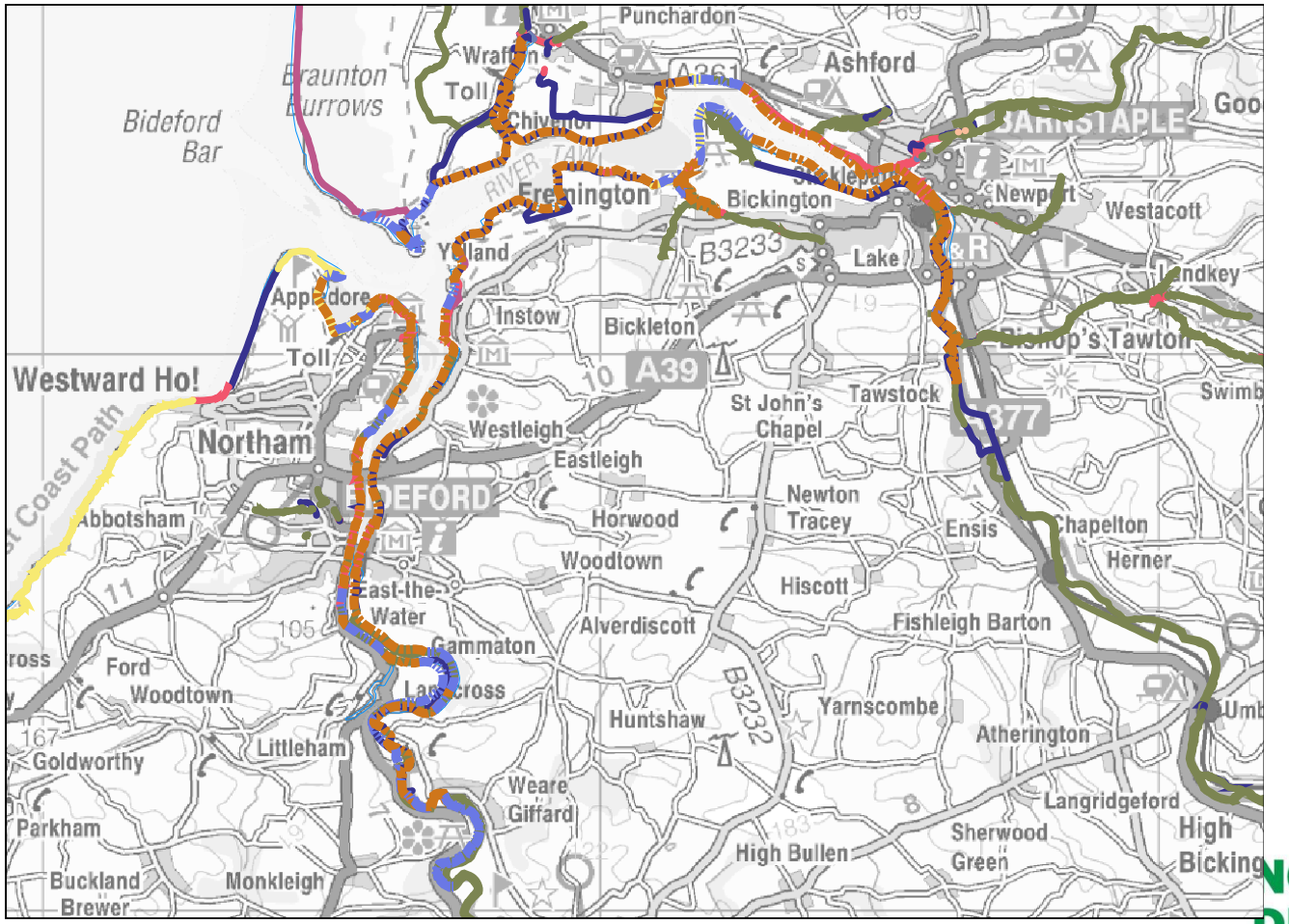
- Tidal deltas are a roundabout : providing by-pass mechanism
- Sediment flows through and around the delta

Tidal deltas and their parts





How do we deal with the change?



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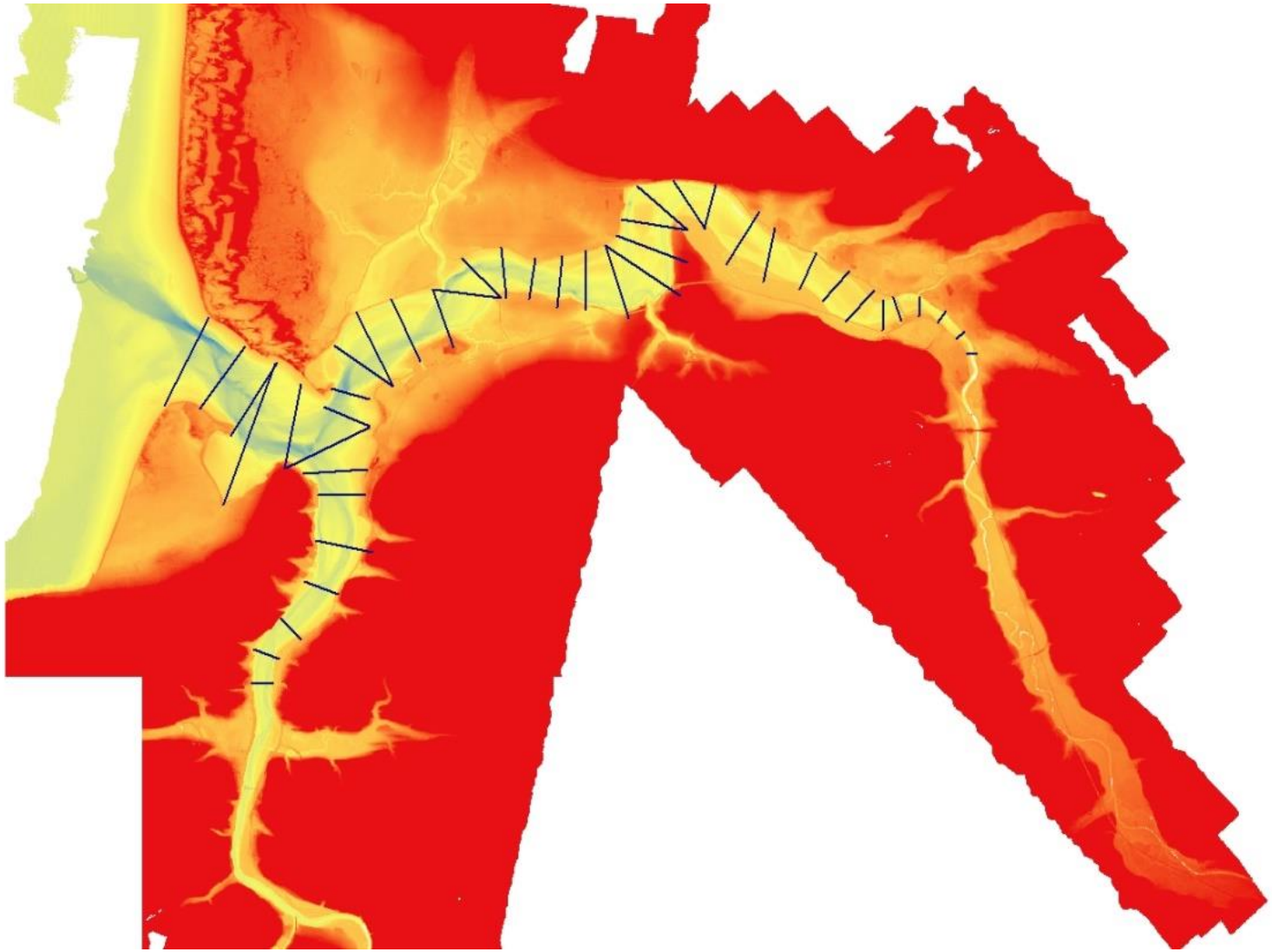
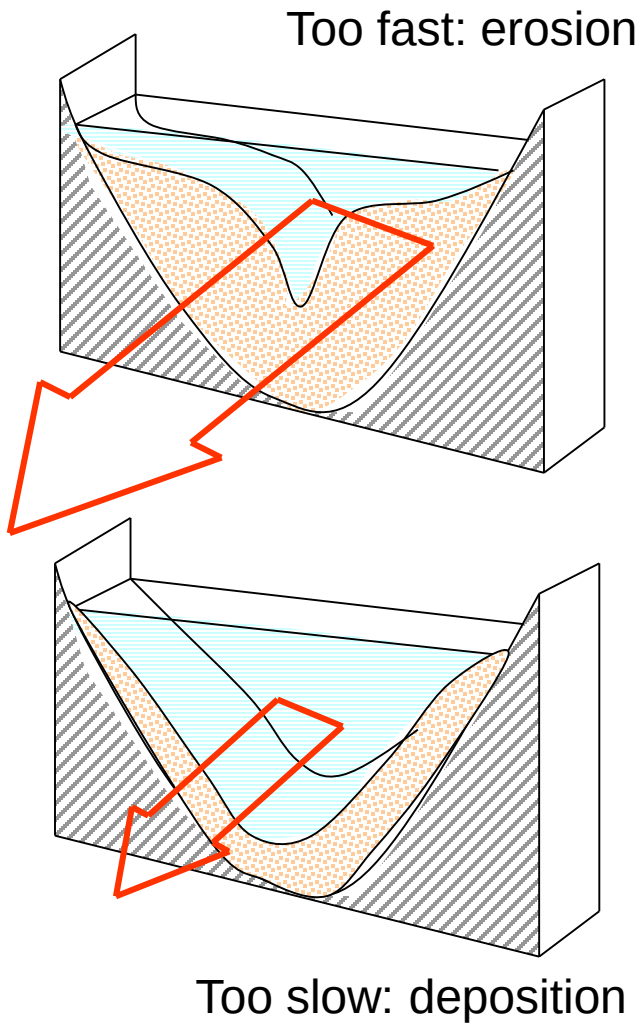
Healthy Estuary



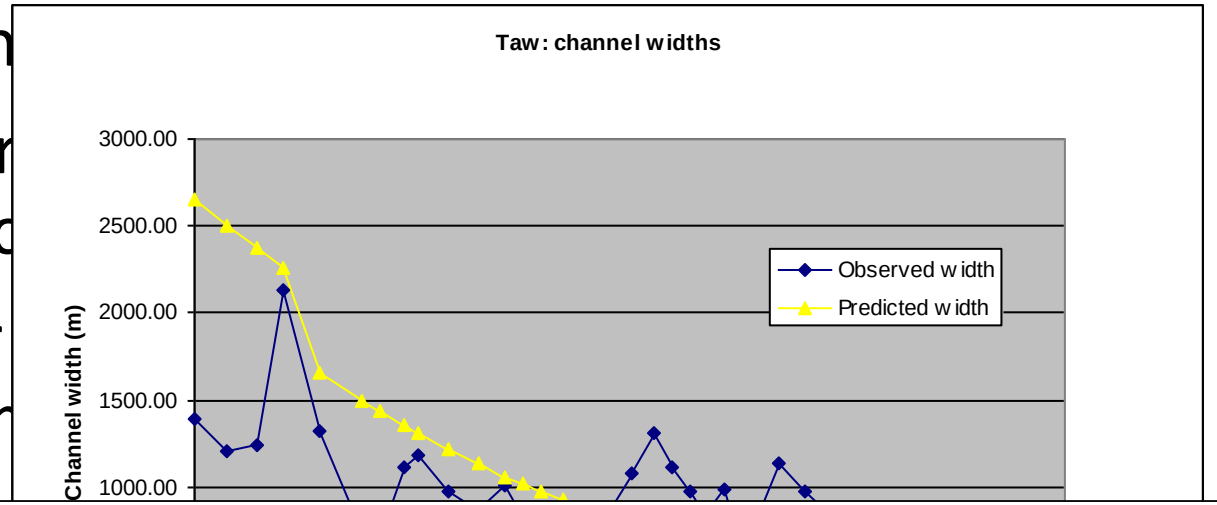
Computer modelling

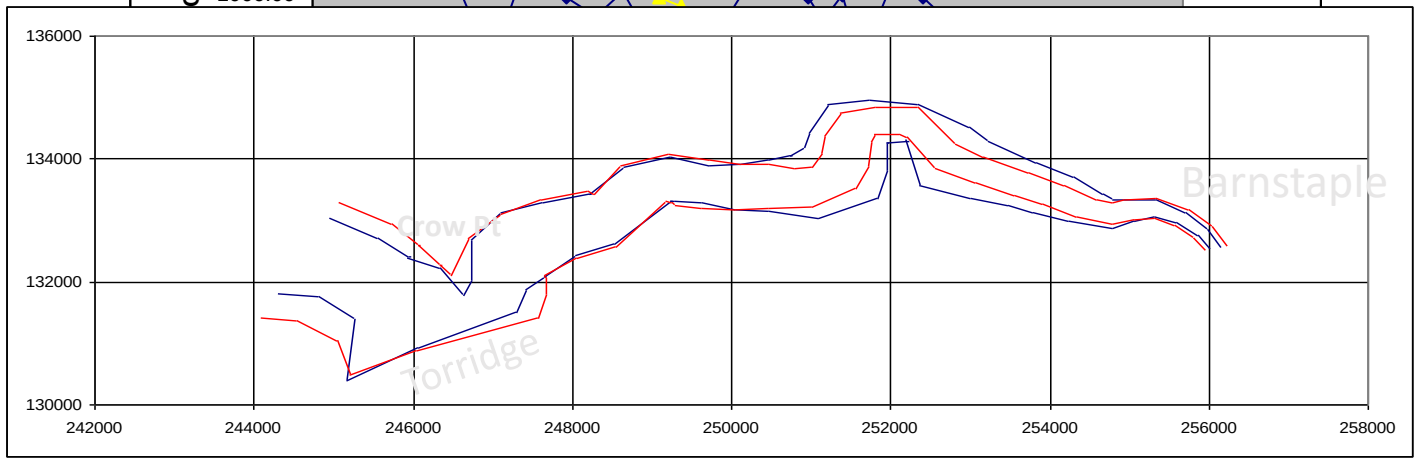
- Want to know future width and depth
- Computer model assesses tidal power available and predicts channel size
- Based on the principle that flow through smaller channel is faster giving erosion and vice versa
- An estuary tends to an equilibrium with no erosion or deposition
- Once it achieves this it is said to be in ‘Regime’



Equilibrium: the Taw

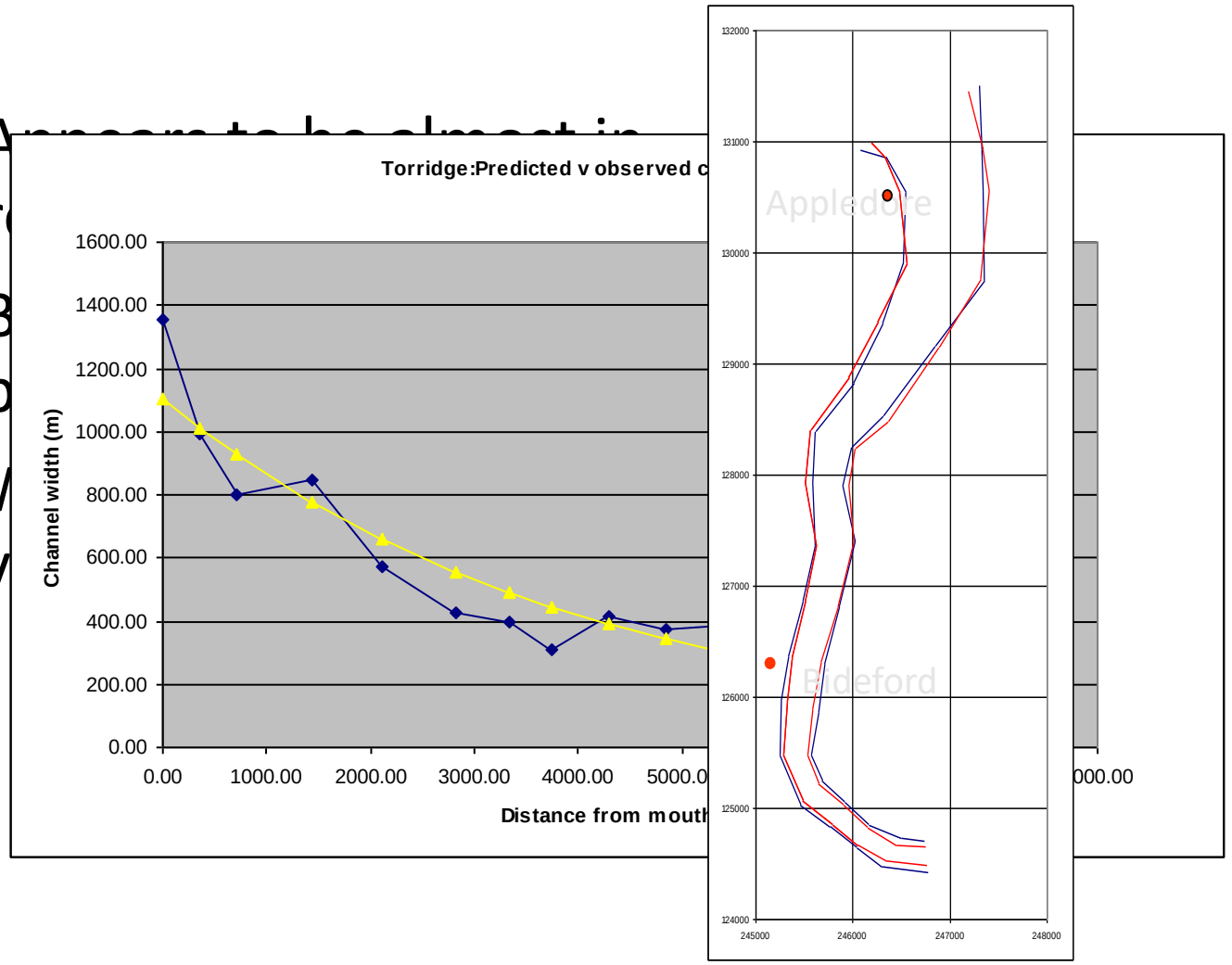
- Taw n
- Outer
  rock c
- Inner
  sedim



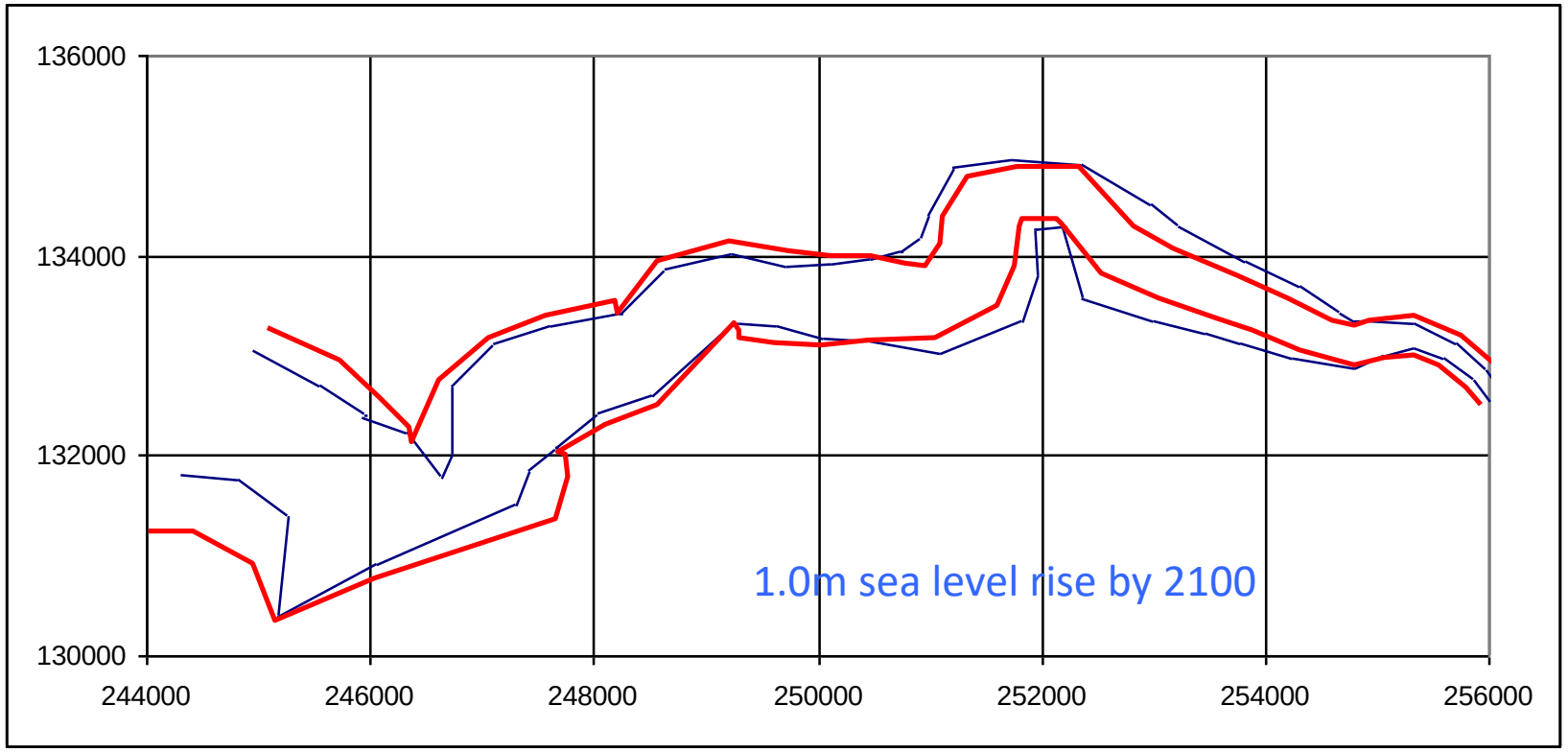


Equilibrium: the Torridge

- A
- B
- V



Sea level rise: Taw



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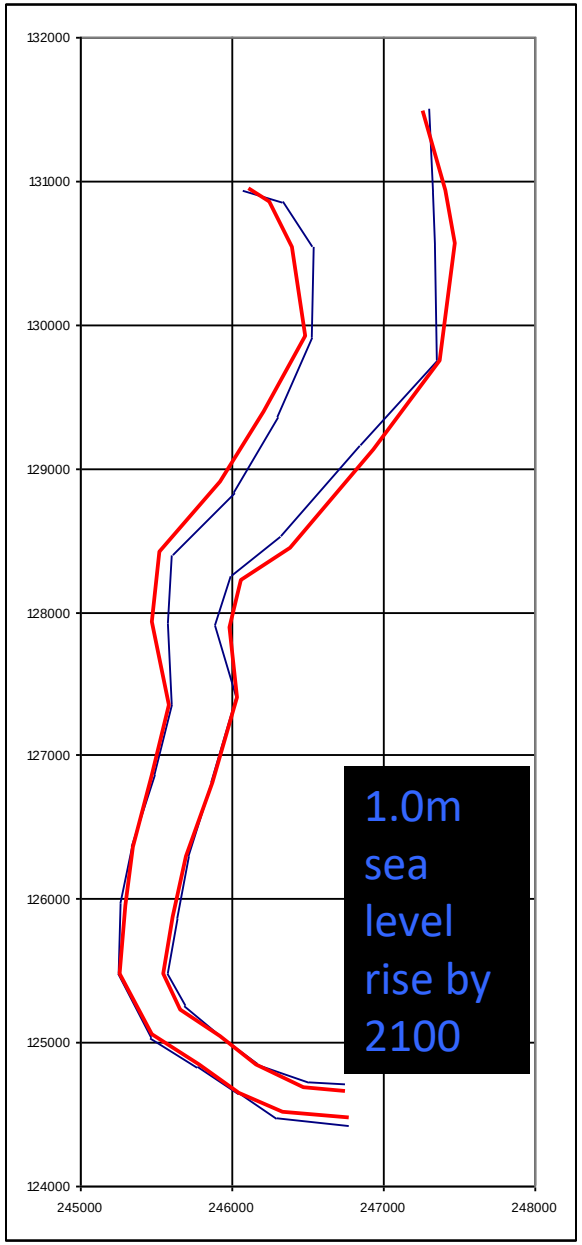
Sea level rise : Torridge



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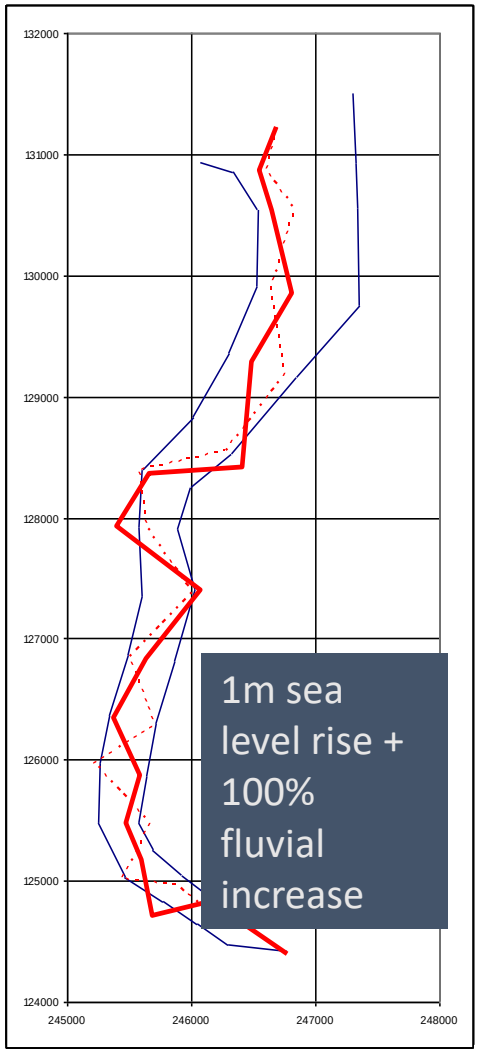
Meanders and sea level rise : Torridge



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Evidence

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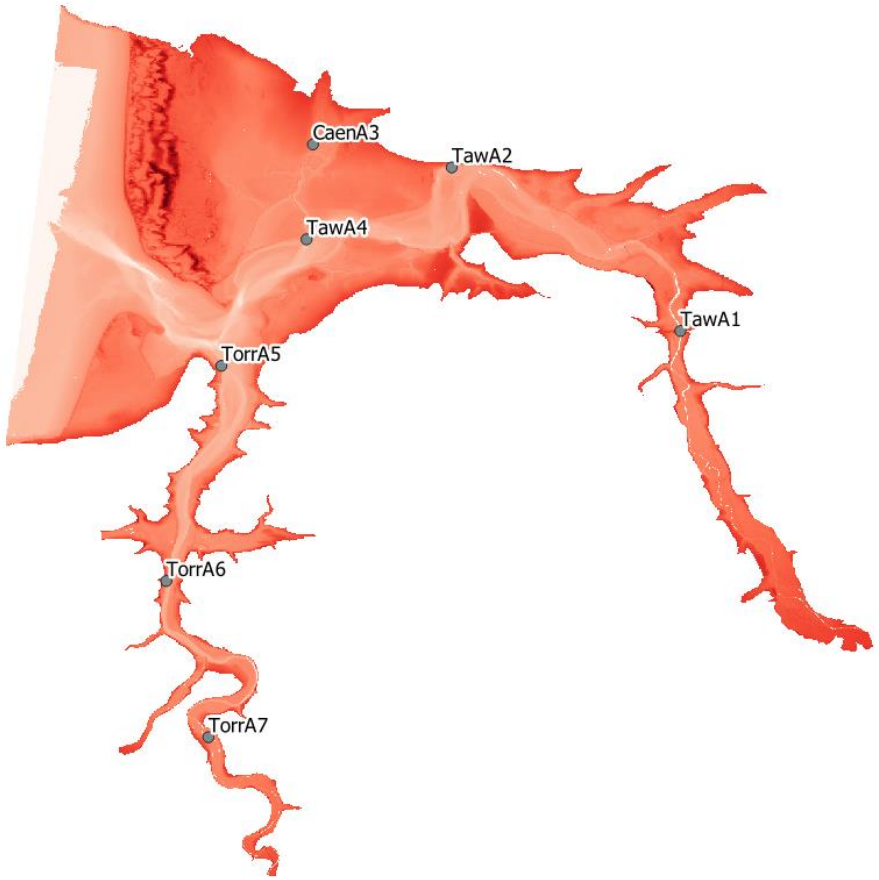
Tide sensors



- Sensors deployed between December 2018 and March 2019
- Analysis carried out in Matlab using U-Tide harmonic analysis

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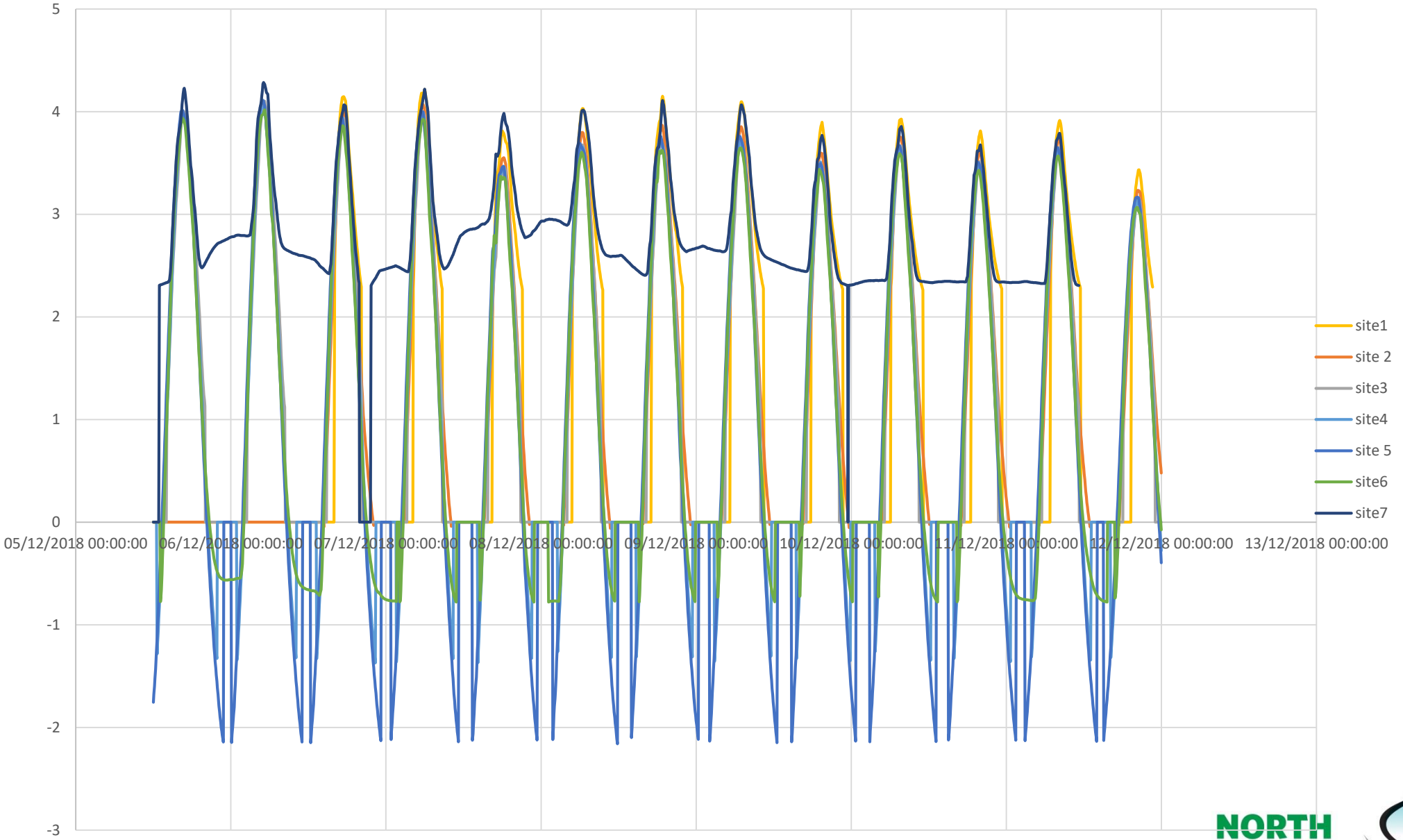

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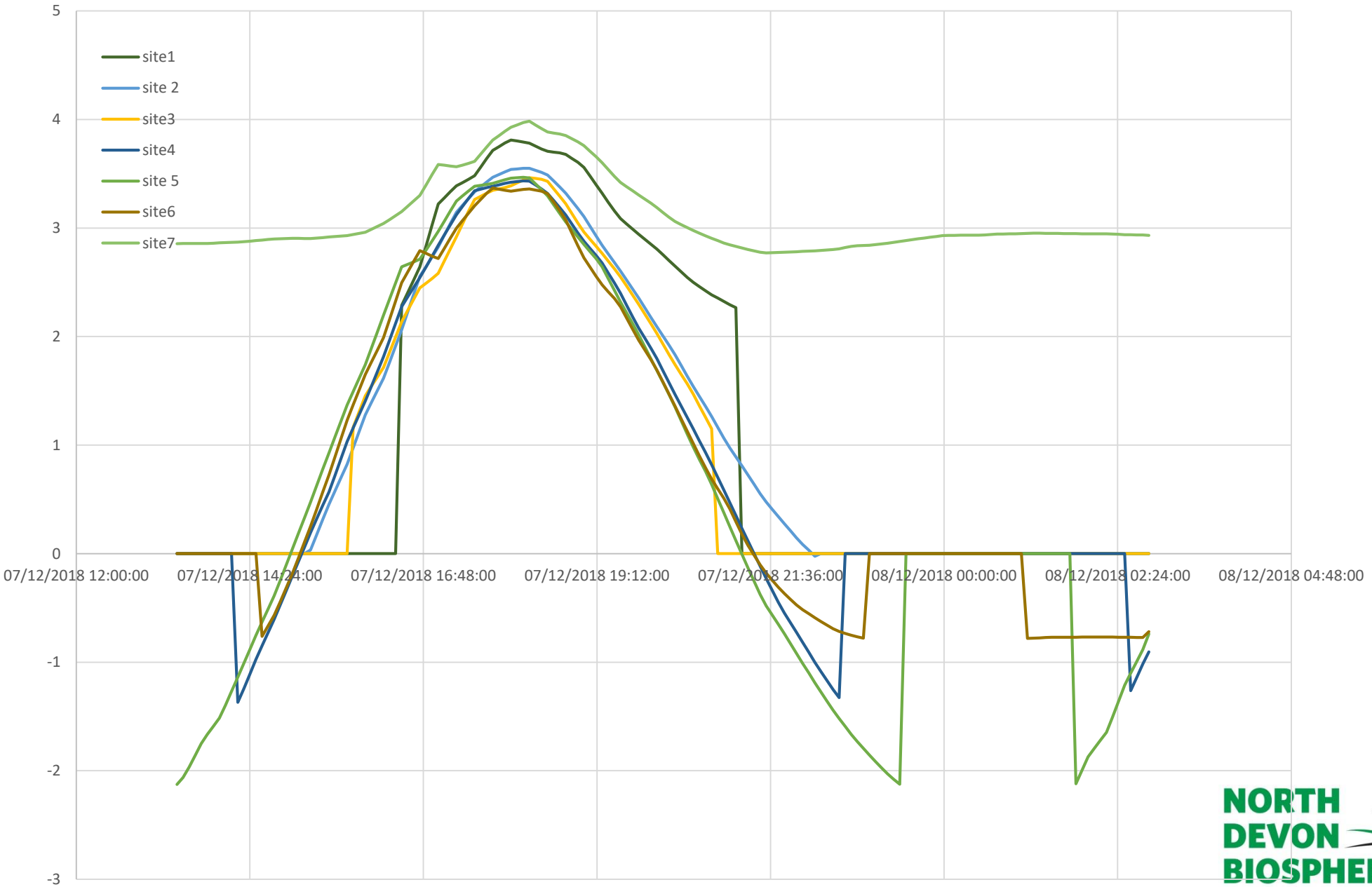

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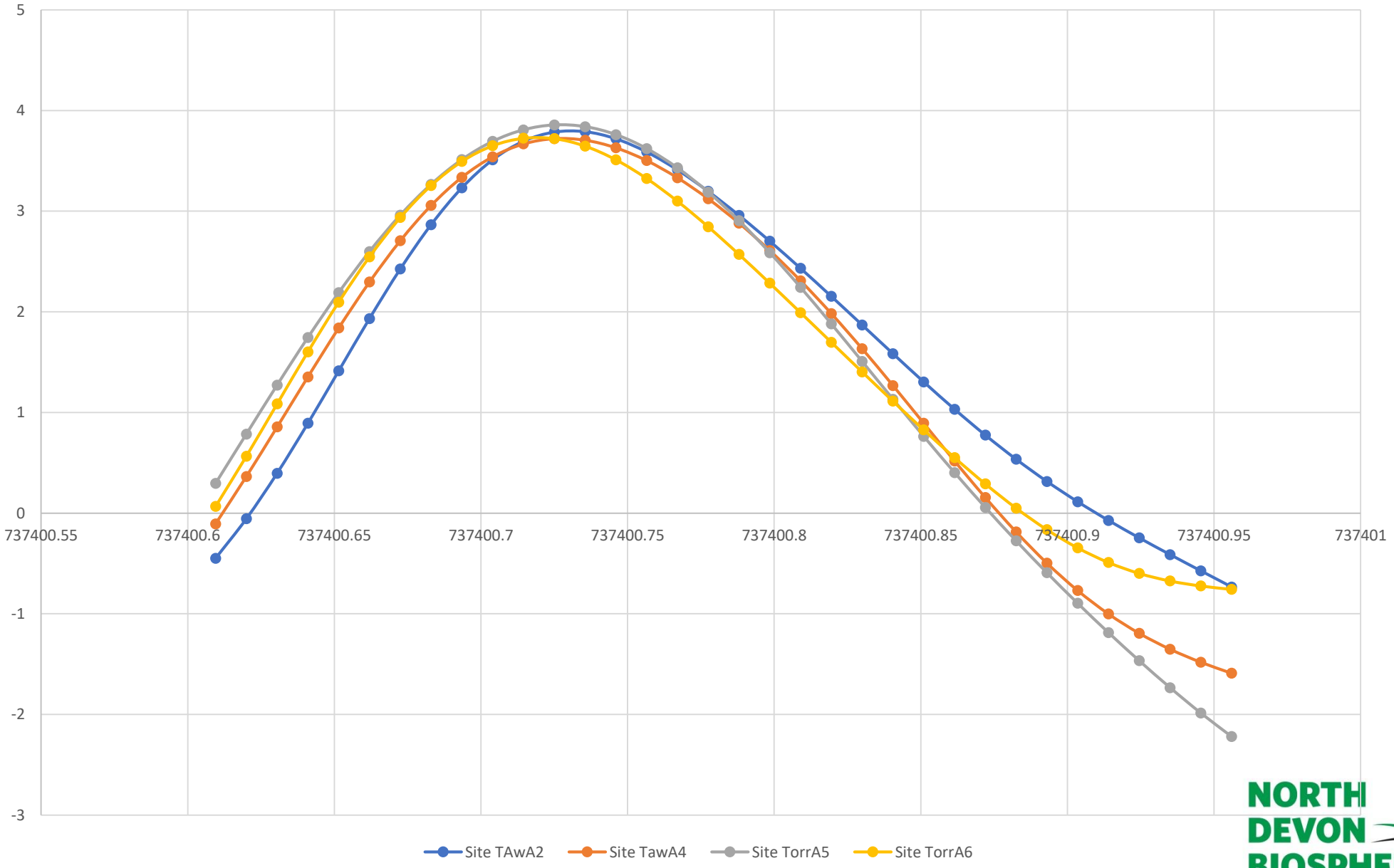
Model output of tides



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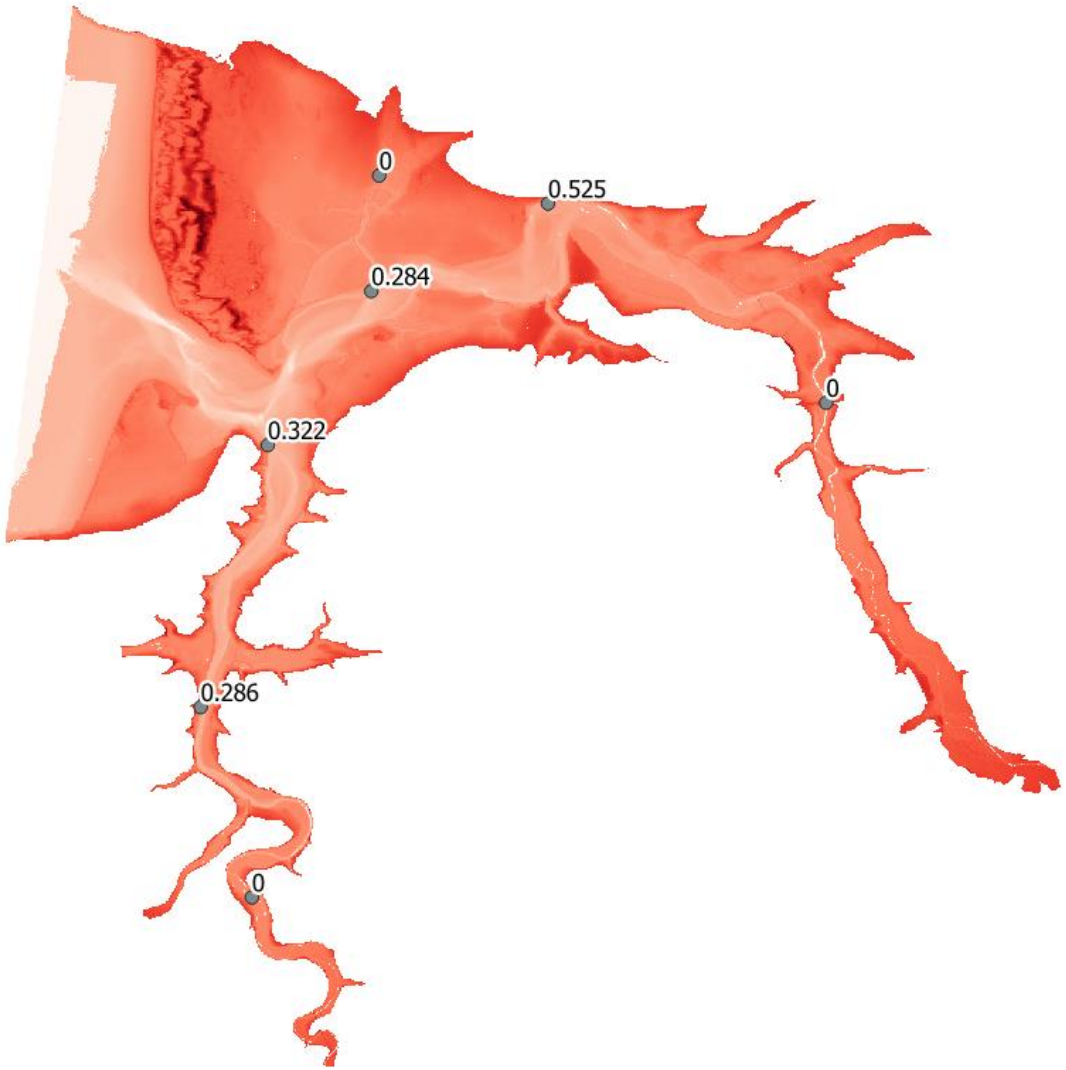
Tidal gauge locations and MSL at location

- 0 indicates that more than 50% of the records did not register a height
- MSL derived by 50% exceedance value.
- NB the progression of MSL of the tide is not a linear progression along the Taw to Penhill



Summary to date

- Sea level is rising and the estuary will change
- The sediment is needed in the estuary to help reduce the impacts of sea level rise on flood defences and natural habitats
- Instow Dunes area a key part of the estuary system as the flood delta.
- Keeping the estuary flood dominant will help keep the sediment in the estuary for the good of all.
- Where the estuary has matured, we can realign and deliver flood defence benefits.

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Instow Dunes

- History of change
- Options
- Discussion

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55148. Appledore, from Instow.

Summary

- Instow Dunes have been growing for a ling time
  - Despite history of dredging
  - Despite the MoD flattening them during training
- Low area of the beach near the steps where the surface water drains.

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Options considered

1. Do nothing
2. Re-locating the sand
3. Beneficial use of sediments
4. Train the dunes
5. Beach wetting
6. Forced circulation
7. Increase the height of the beach wall
8. Remove the sand off site
9. Dredging the estuary

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Re-locating

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Why didn’t it work last time?

- Why didn’t it work last time?
  - Sand was supposed to be placed on top or behind the dunes
  - Fencing was placed on artificial dune face.
  - Big storm.
  - Instructions for beach litter management weren’t followed.

- Lessons:
  - Better contract supervision
  - Fencing with biodegradable matting on stable dune face

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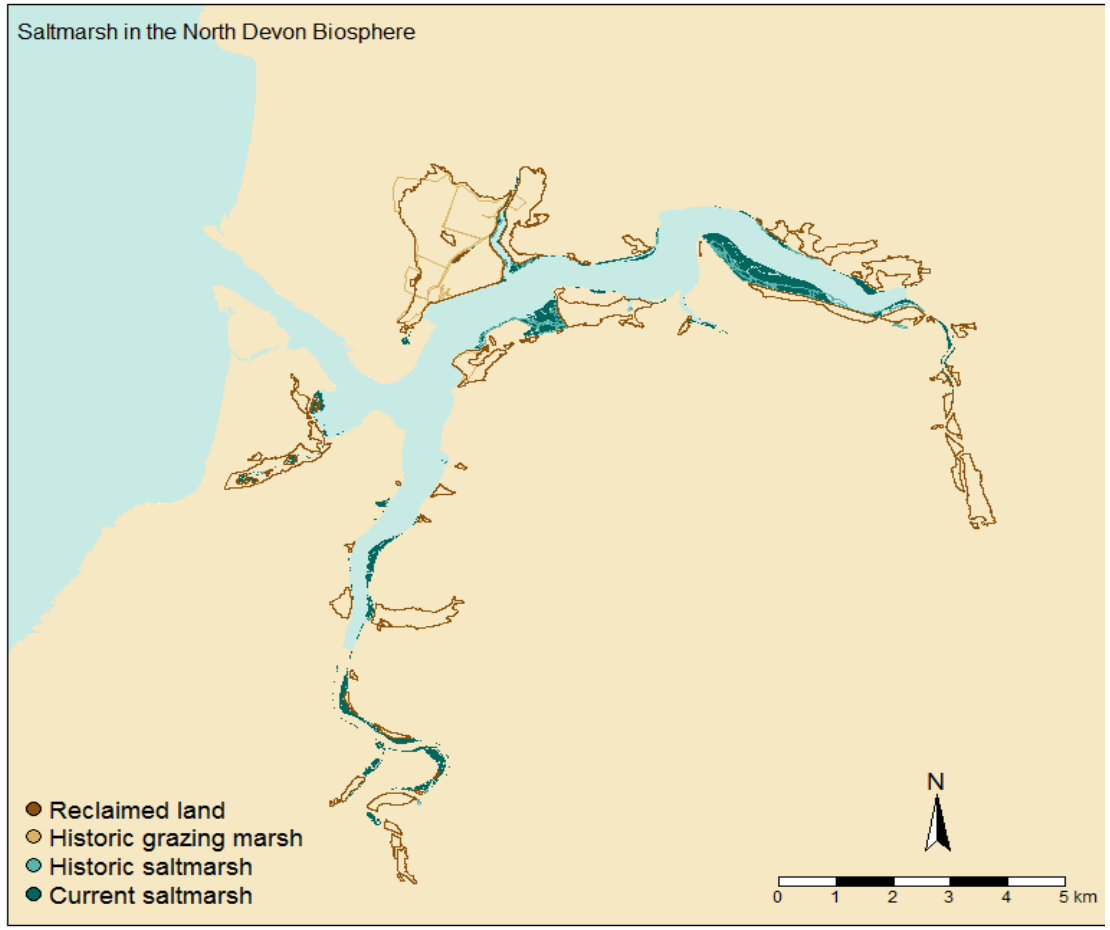
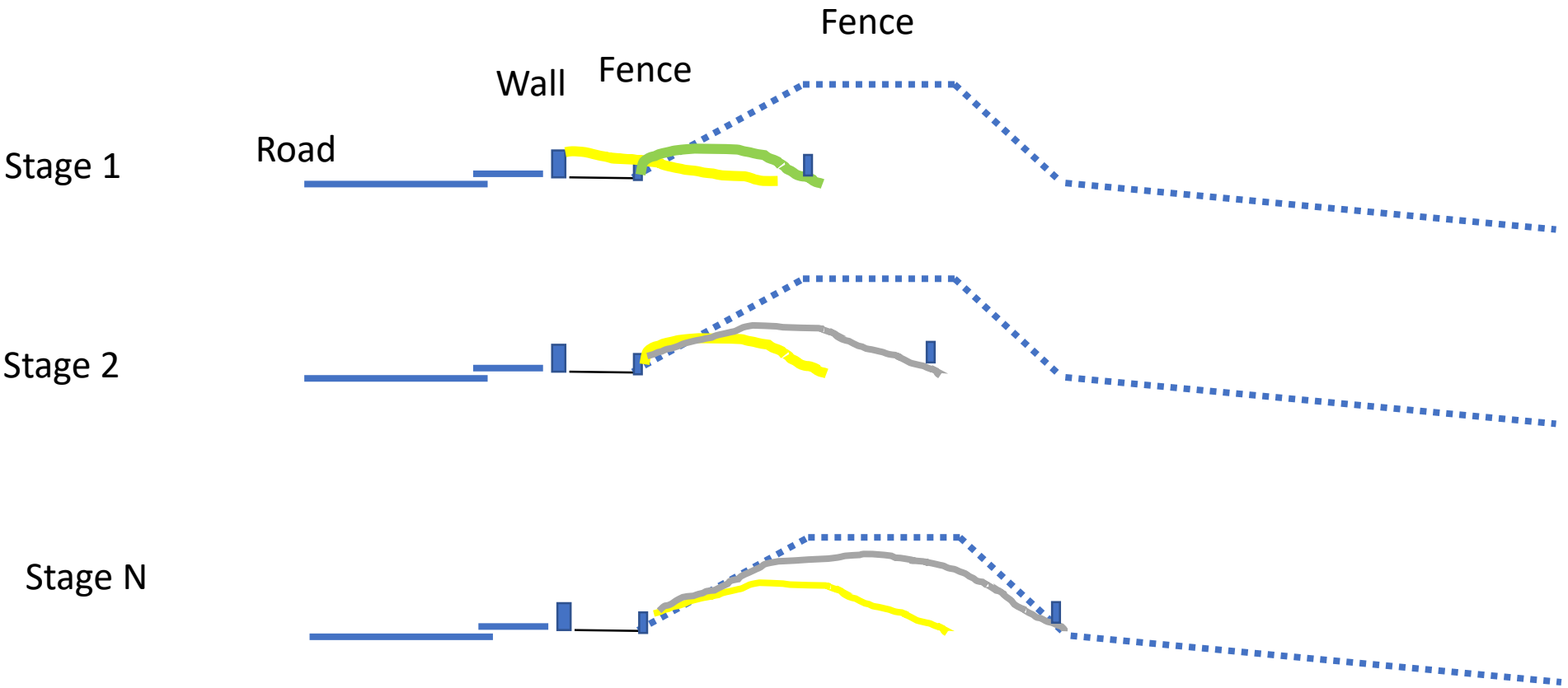
Beneficial use of sediments



Training the dunes.



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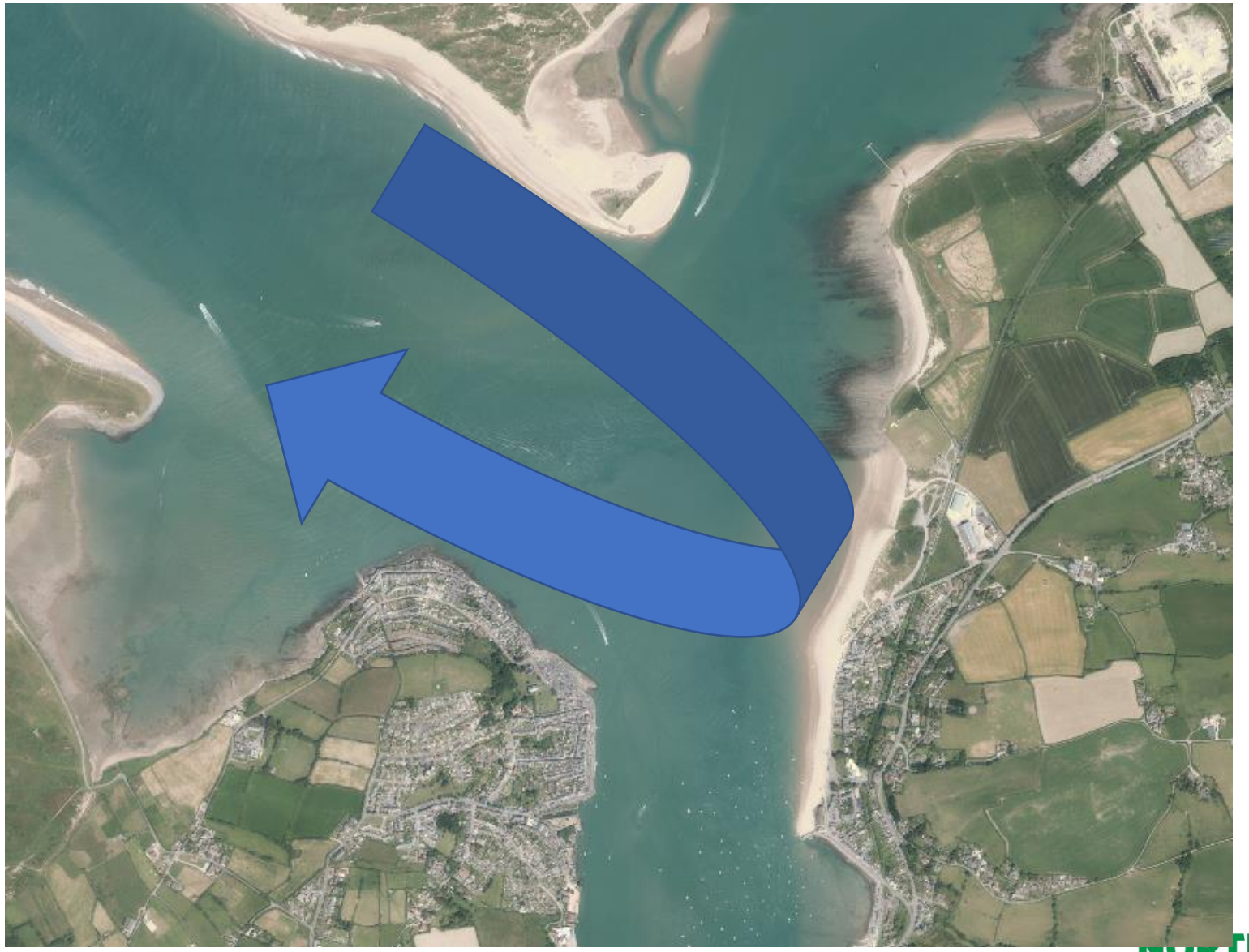

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Beach wetting

- Sand only blows when it is dry
- Wetting the surface will reduce accretion
- Keeping the strandline clear will reduce accretion

Options considered

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7. Increase the height of the beach wall
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9. Dredging the estuary

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Removal of sand

- Extraction of sand was stopped because policy recognised the science that sediment was needed in the estuary.
- Removal of sand will increase the cost of flood and coastal defence and other things. (remember Bruun rule)
- The Sea Sand (Devon and Cornwall) Act 1609 has been superseded.

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Options considered

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Favoured options

- Training the dunes
  - Needs to be tested
  - Not a complete solution
  - Vista from marine parade will be different
  - Won’t impact wave return wall at Marine Court
  - Costs IRO £7K per year
- Sand re-location
  - Has ongoing cost attached to it
  - Running out of space to put the sand
  - Costs IRO £30K per year

Who Pays?

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Thanks for your attention

Andrew BELL

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