Implications of sea level rise on salinity intrusion and flooding

Waihou River Case Study

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Outline

- Background
- TELEMAC model development
- Model calibration
- Salinity intrusion
- Extreme water level
- Potential impacts
- Potential implications
- What's next?

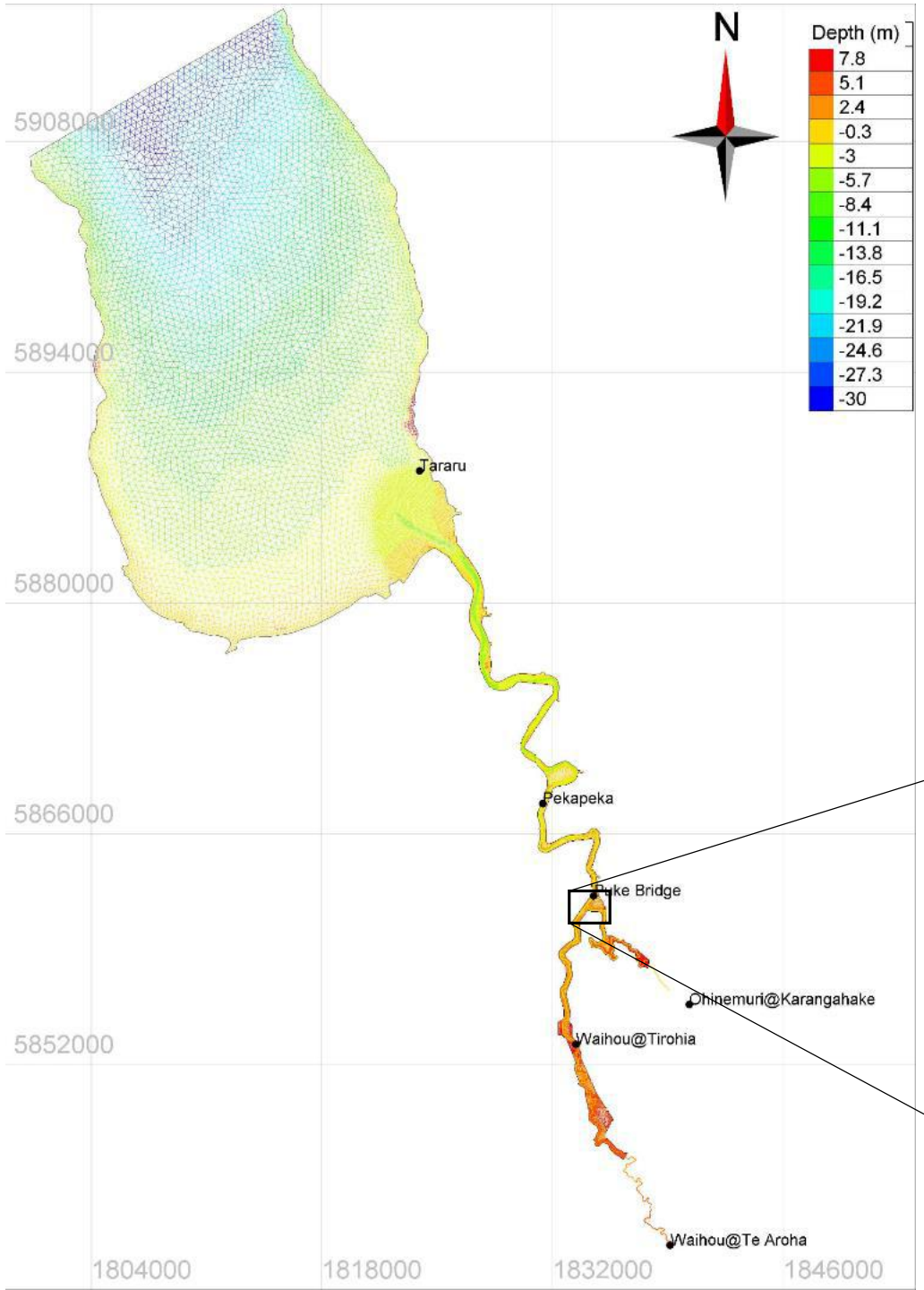
CCII – Waihou River case study

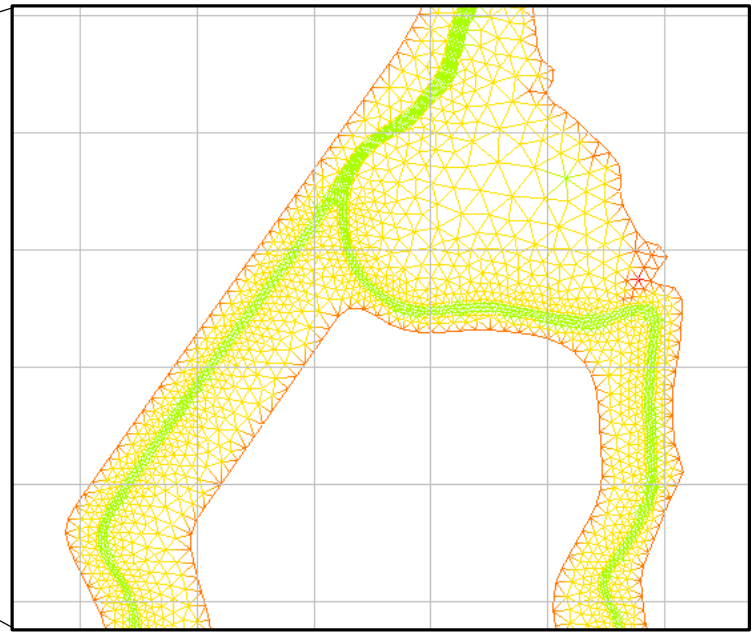
- Determine the impact of sea level rise (SLR) on the inner Firth of Thames and Waihou River

- The Questions:
  - To what extent will SLR cause increased flood inundation?
  - How far will saline water move upstream in the Waihou River?
  - What impact will SLR have on hydrodynamic parameters such as tidal limits, tidal prisms and tidal asymmetries?

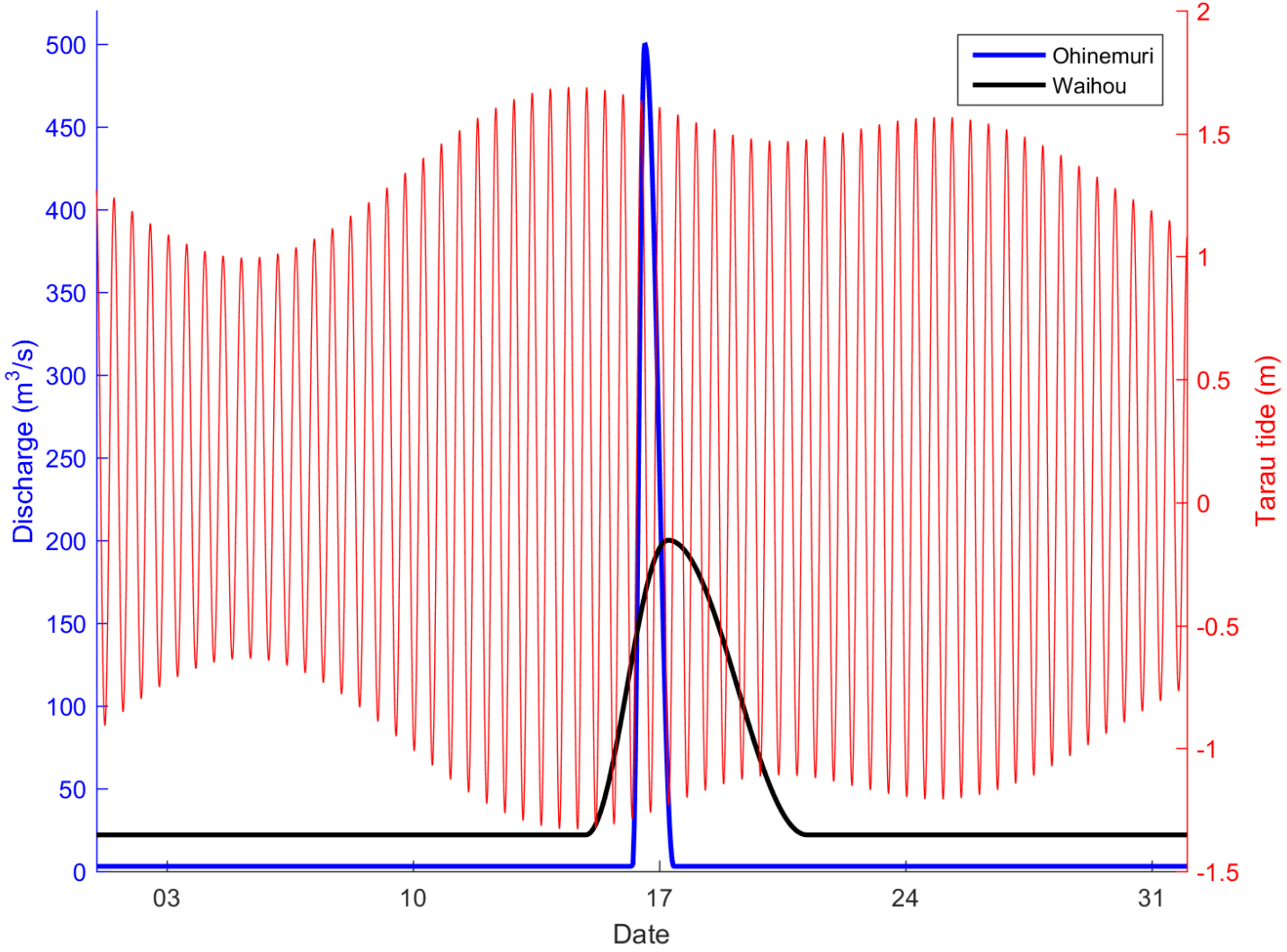
Telemac3D – Unstructured grid

- 8 – layer model, mix of vertically fixed and sigma layers
- 465,040 - Grid elements
- Grid cell area
  - Offshore - 80,000 m^2 (400 m, edge length)
  - Waihou River - 50 m^2 (<10 m, edge length)



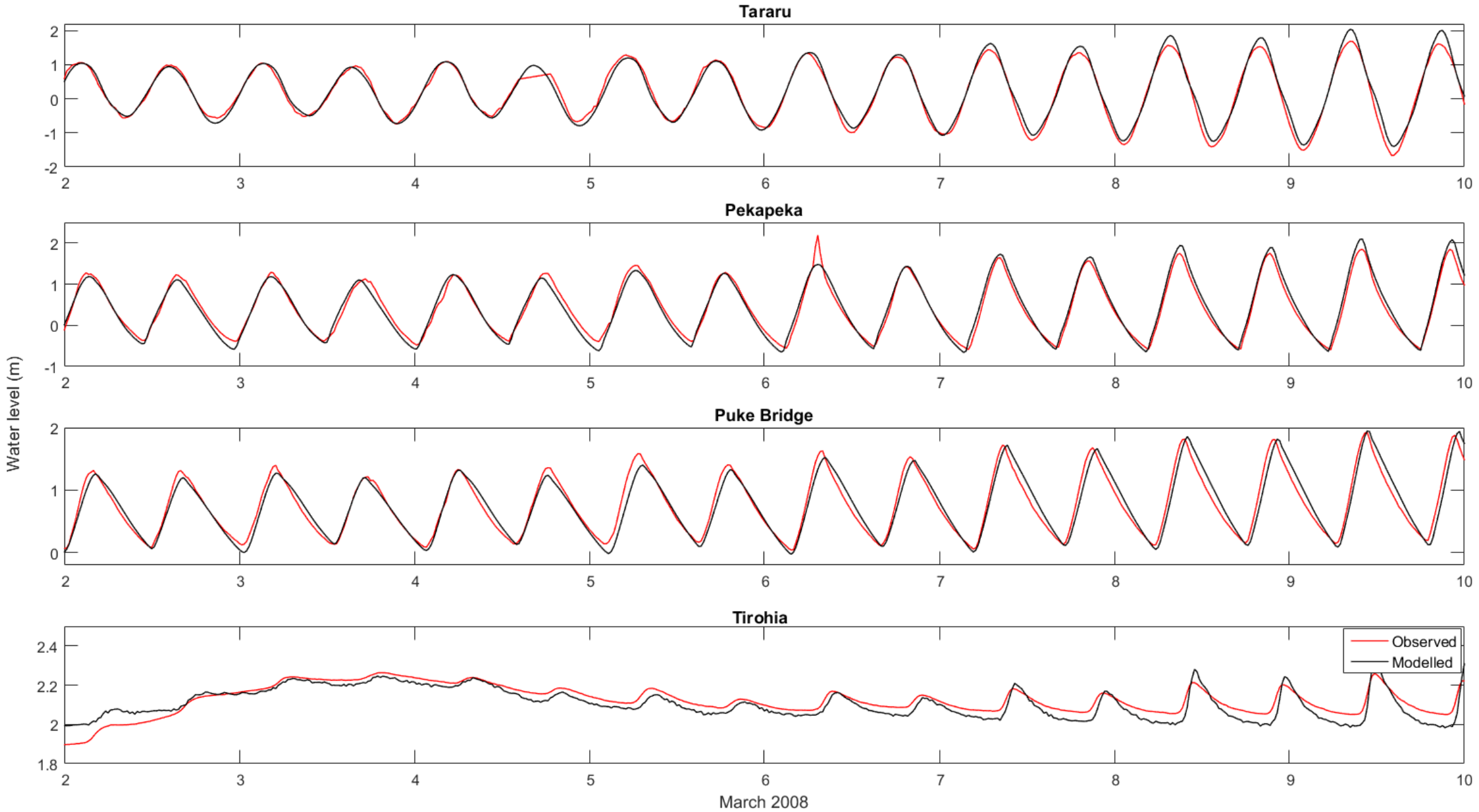


Scenario boundary conditions

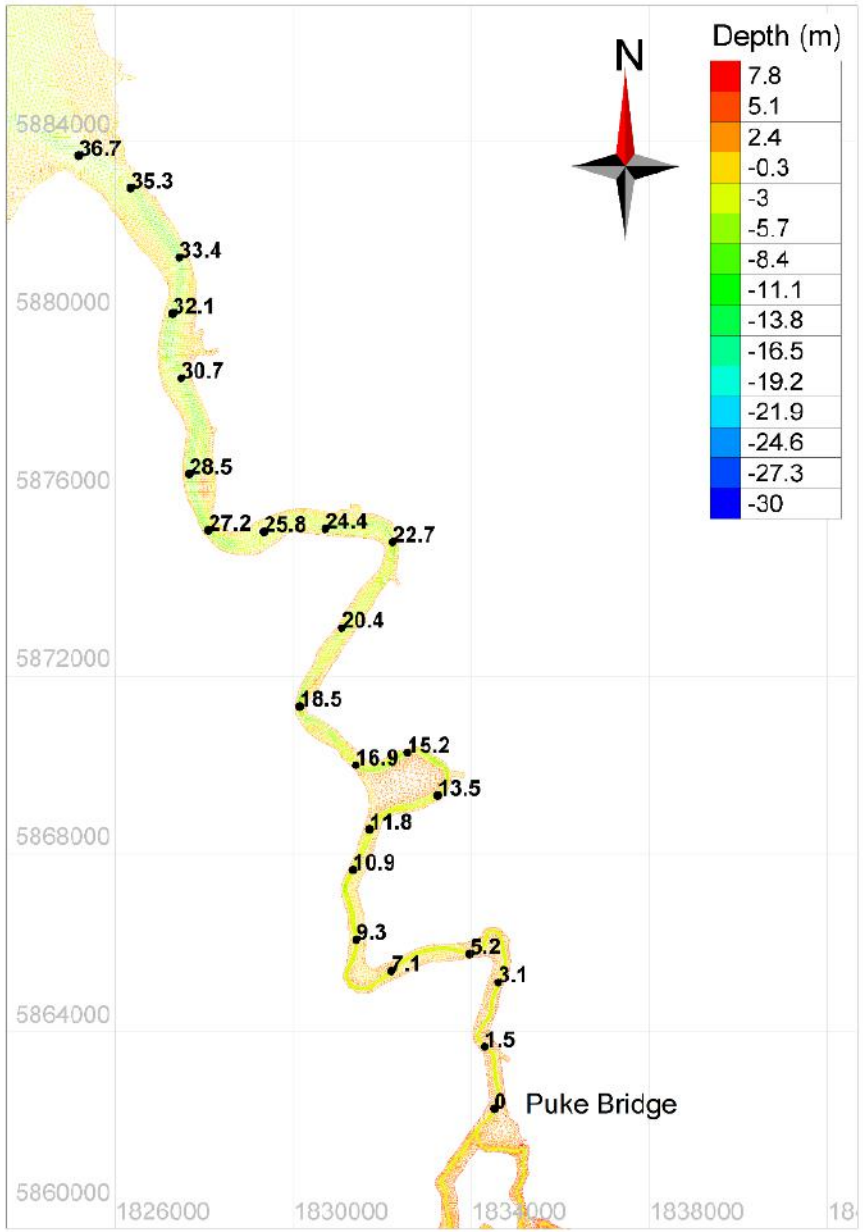


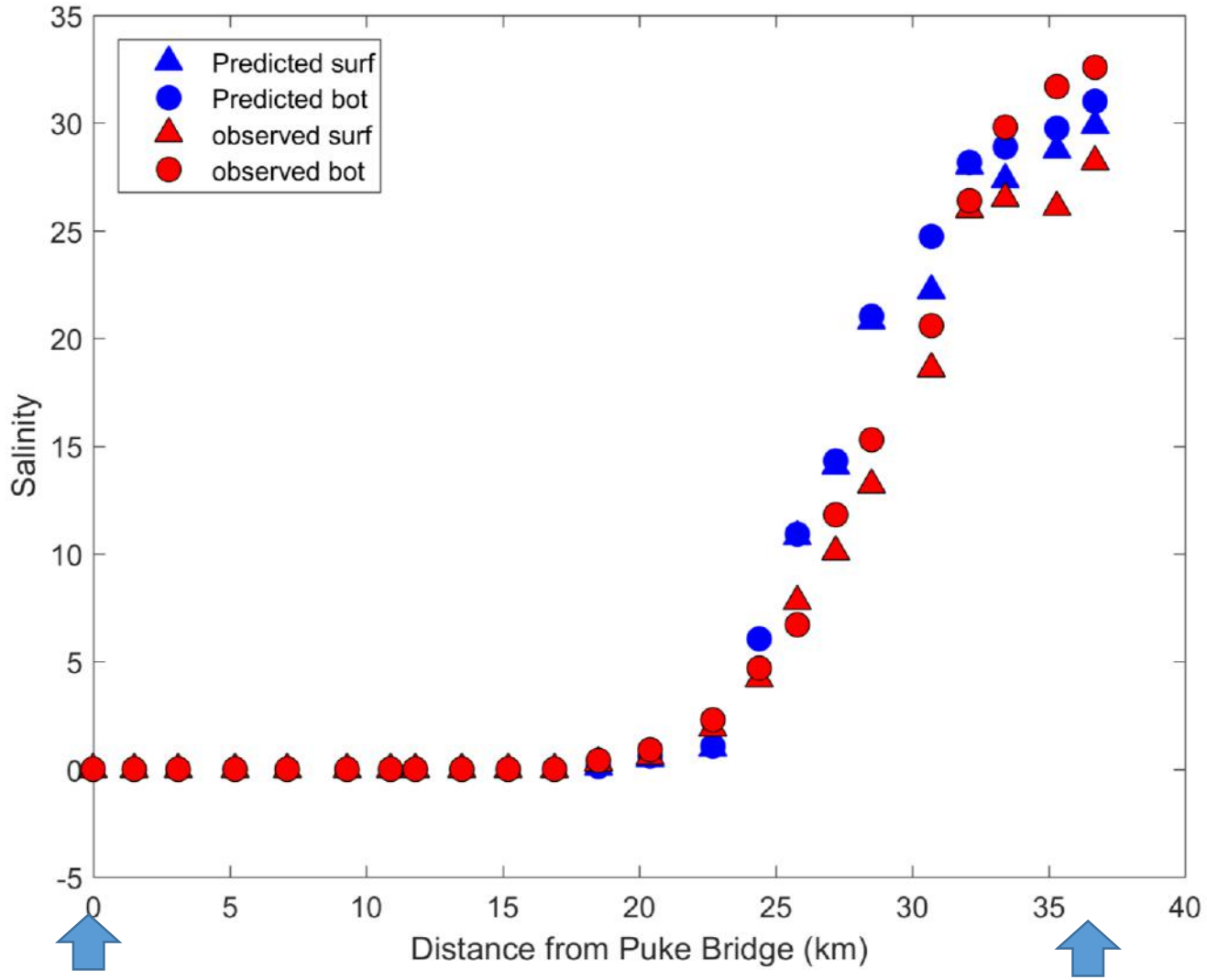
- NIWA EEZ-tide model boundary
- Offshore salinity derived from CTD data
- Salinity simulations - mean annual low river flows
  - Waihou - 22 m^3/s
  - Ohinemuri - 2.3 m^3/s
- Flood simulations - Joint probability idealised flood hydrographs
  - Average peak flood lag 14 hours

Calibration of water levels



Salinity calibration

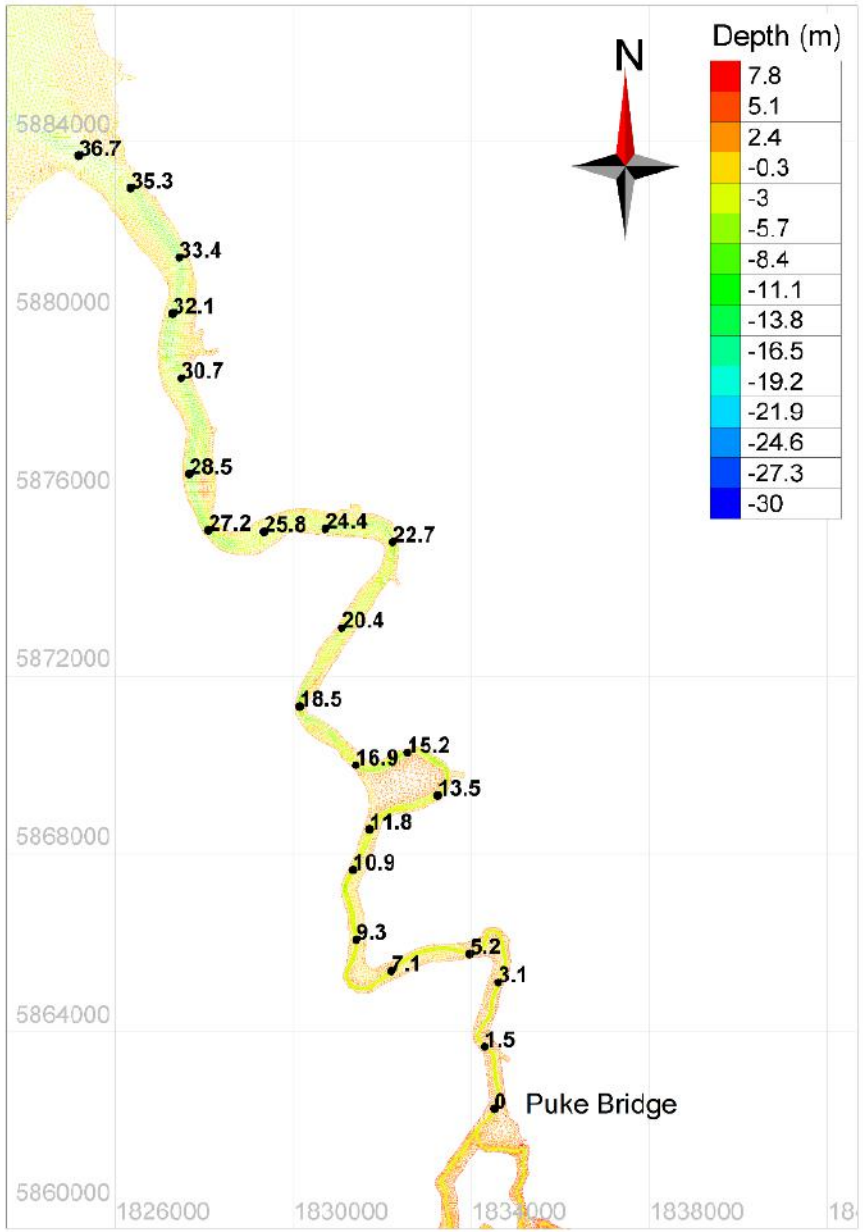


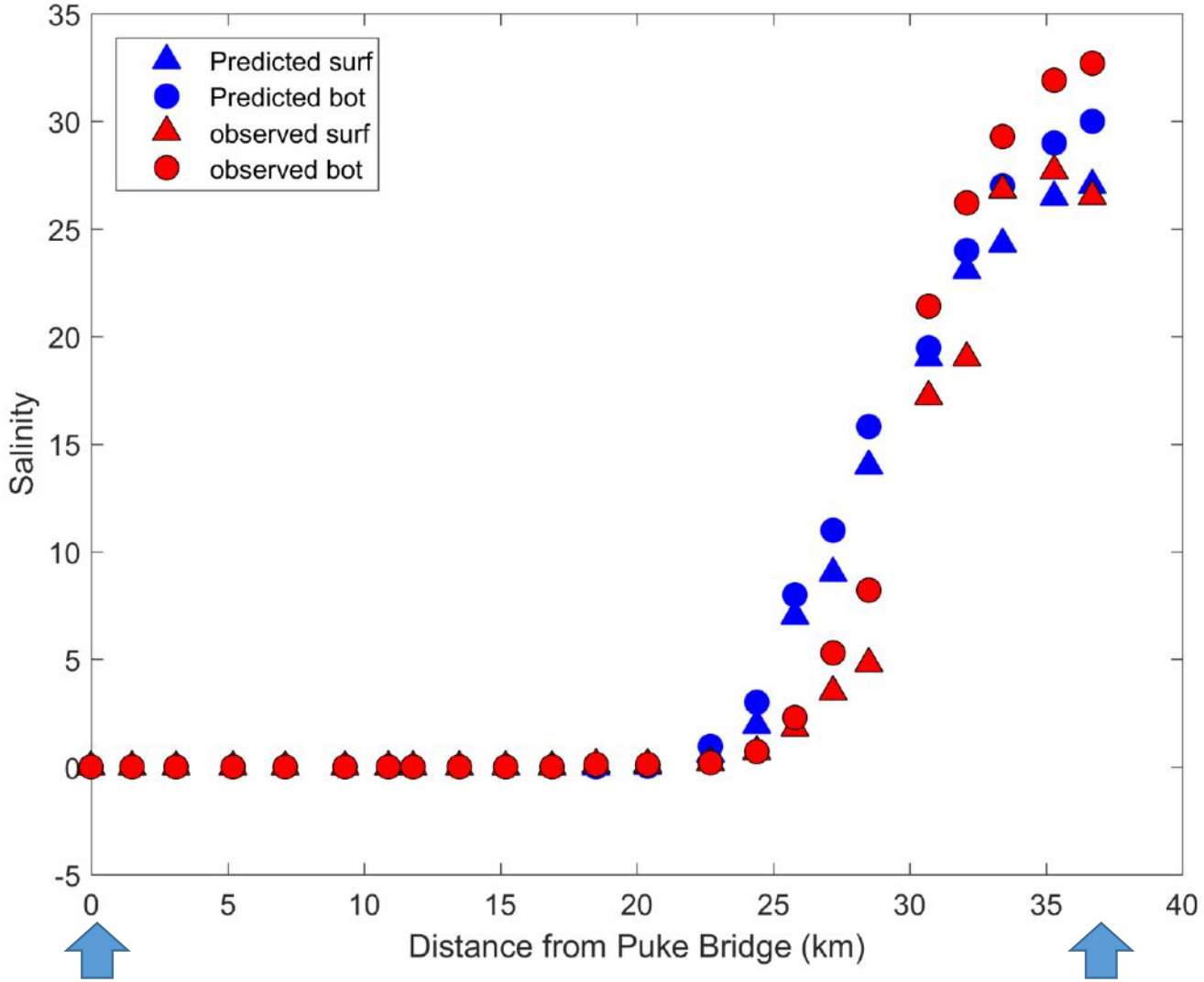


Puke Bridge

River mouth

Salinity validation

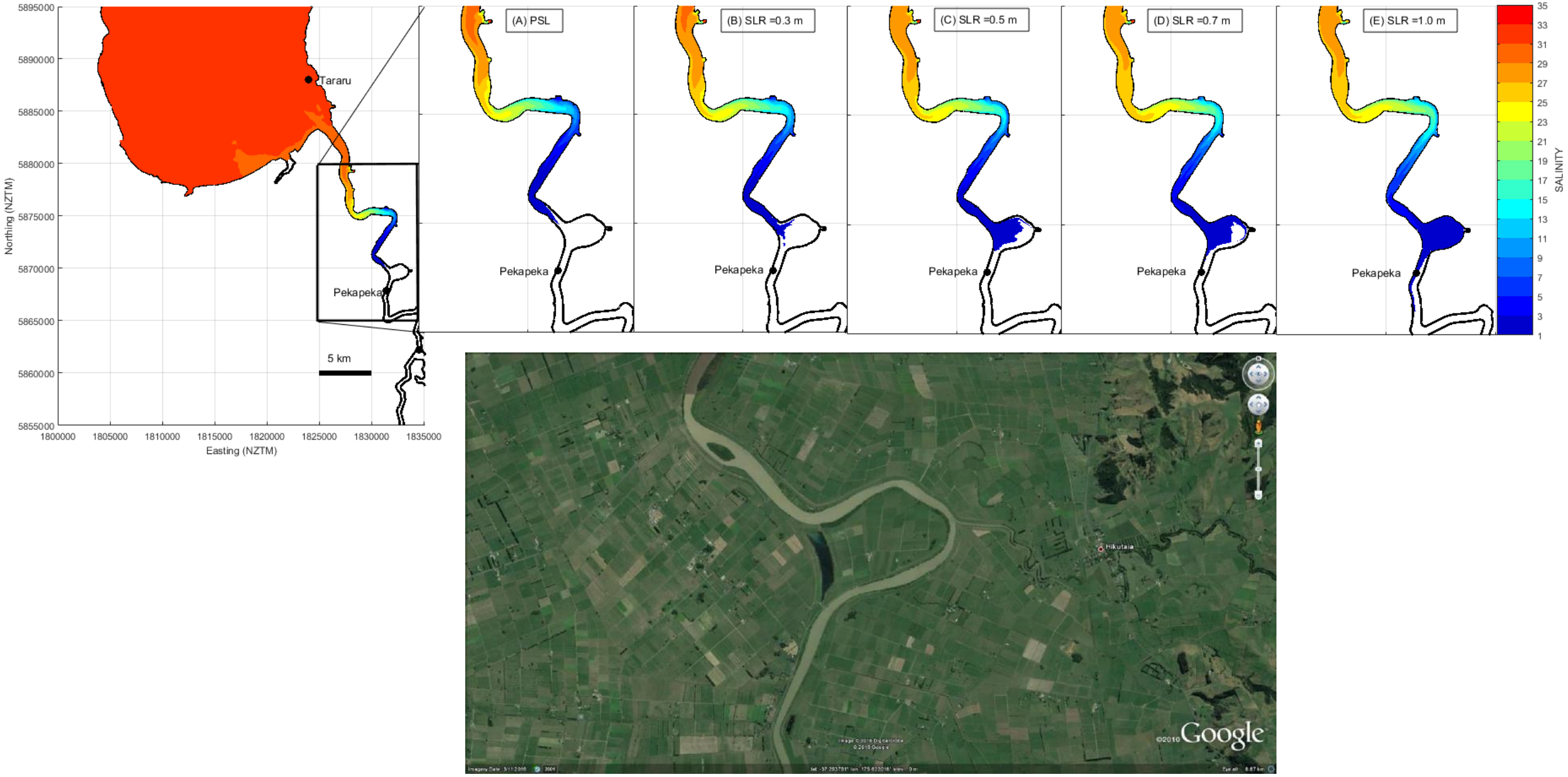




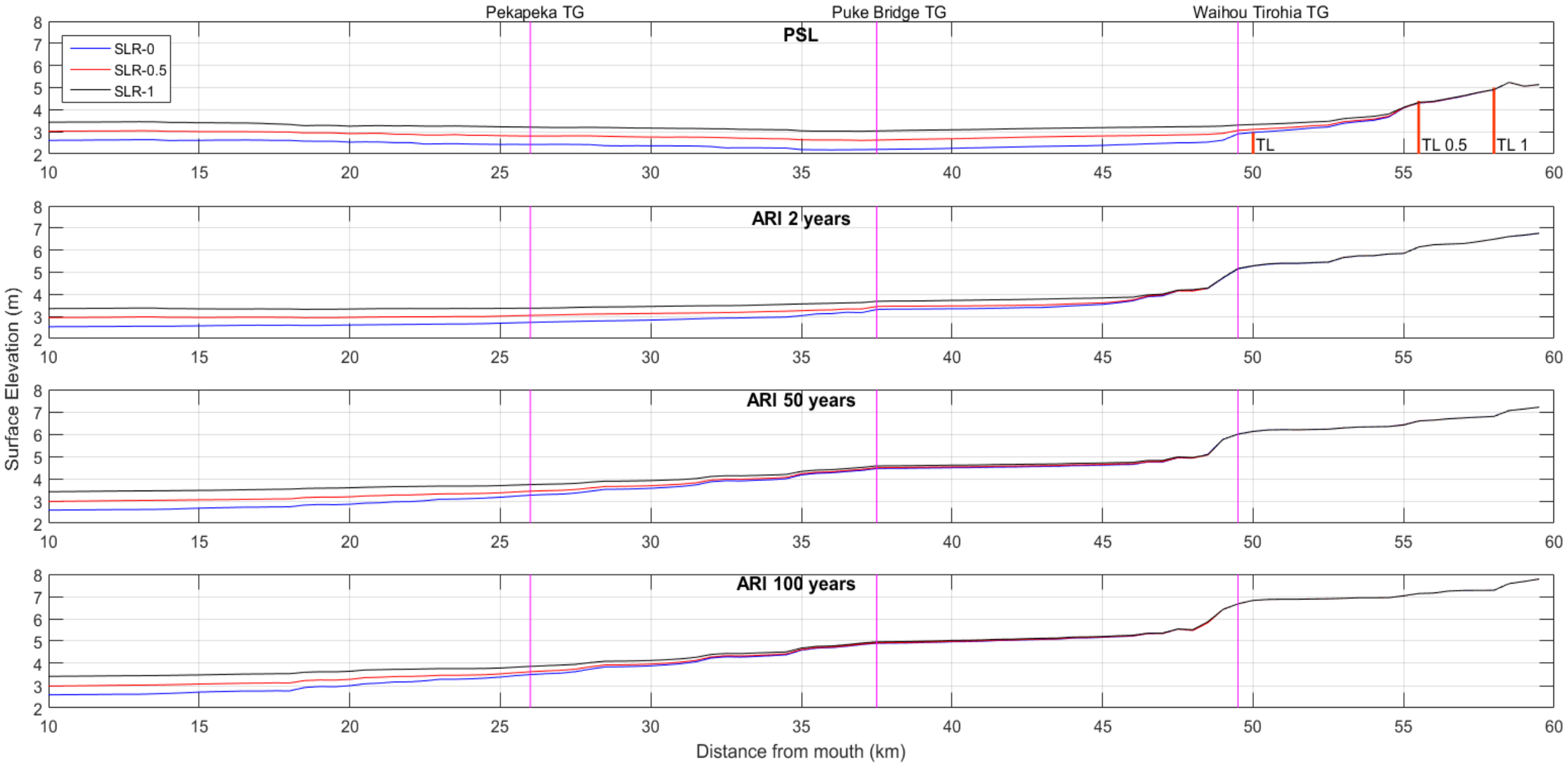
Puke Bridge

River mouth

Salt Intrusion



Floods and sea level rise



Potential impacts?

- SLR will cause the upstream movement of brackish water zone (5 km upstream migration of for 1 m of SLR)
- Upstream movement of the tidal limit (9 km upstream for 1 m of SLR)
- Linear increase in the tidal prism up to 20% for 1 m SLR
- Tide will become less asymmetric (assuming present day riverbed)
- Linear decrease in velocity through mouth (0.9 to 0.8 m/s)
- More nuisance up river flooding (1-10 ARI floods)

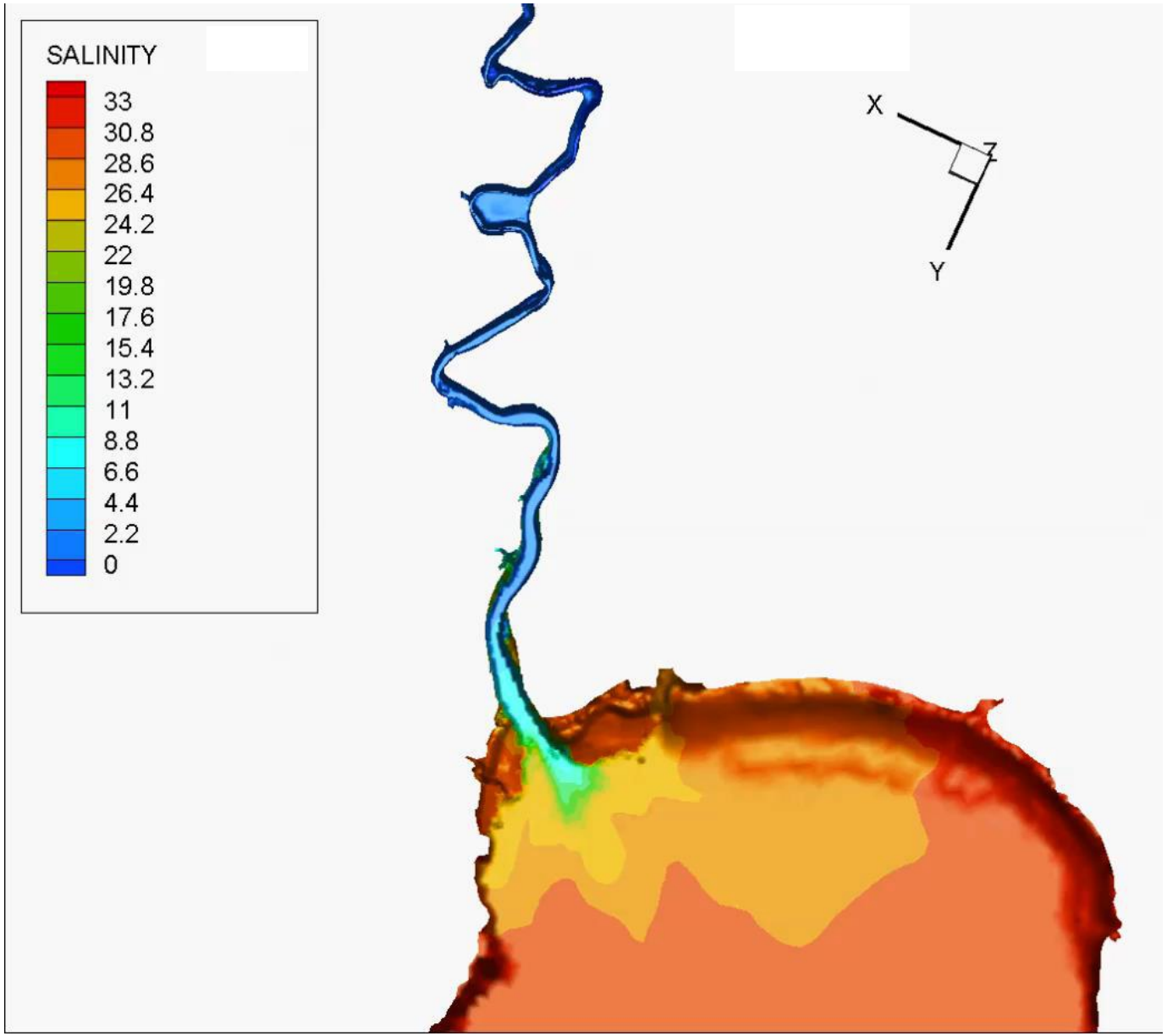
Potential implications

- Marine freshwater zones complicated, so require complex modelling for each local situation e.g. range from large river systems like Waikato River to small streams (Okura Stream)
- Stress on water takes from low land river systems e.g. water extraction down stream of the Pekapeka tide gauge
- Possible changes low land river ecology e.g. Longer brackish water zone in the lower Waihou River (changes spawning habitat?)
- Possible increase in nuisance flooding in low land river sections e.g. higher water levels in the 1-10 ARI river floods below Puke bridge, driven higher by SLR

Where to next?

- Residence times
- Repeat for Ohinemuri and Piako Rivers
- Storm surge/Storm tides
- Adjust weighting of joint probability (floods and storm tides)
- TOPNET (catchment) model results
  - Predicted climatic river flows?
  - Investigate the effect of climate change and land-use on extreme river floods for a given ARI.
- Infer bathymetry levels from the ‘water column model’.

Questions?


SALINITY
33
30.8
28.6
26.4
24.2
22
19.8
17.6
15.4
13.2
11
8.8
6.6
4.4
2.2
0
X
Z
Y