Hydrological Study at Ashfield Flats: A Temperate Coastal Saltmarsh Threatened Ecological Community

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- DBCA
  - Rivers and Estuaries Branch
  - Ecosystem Science
- Town of Bassendean
- Department of Water

Ashfield Flats Reserve

- Bush Forever Site
- Threatened Ecological Community
- Largest remaining river flat in the Swan estuary
- Pressure from urbanization, weeds, known groundwater contamination, climate change

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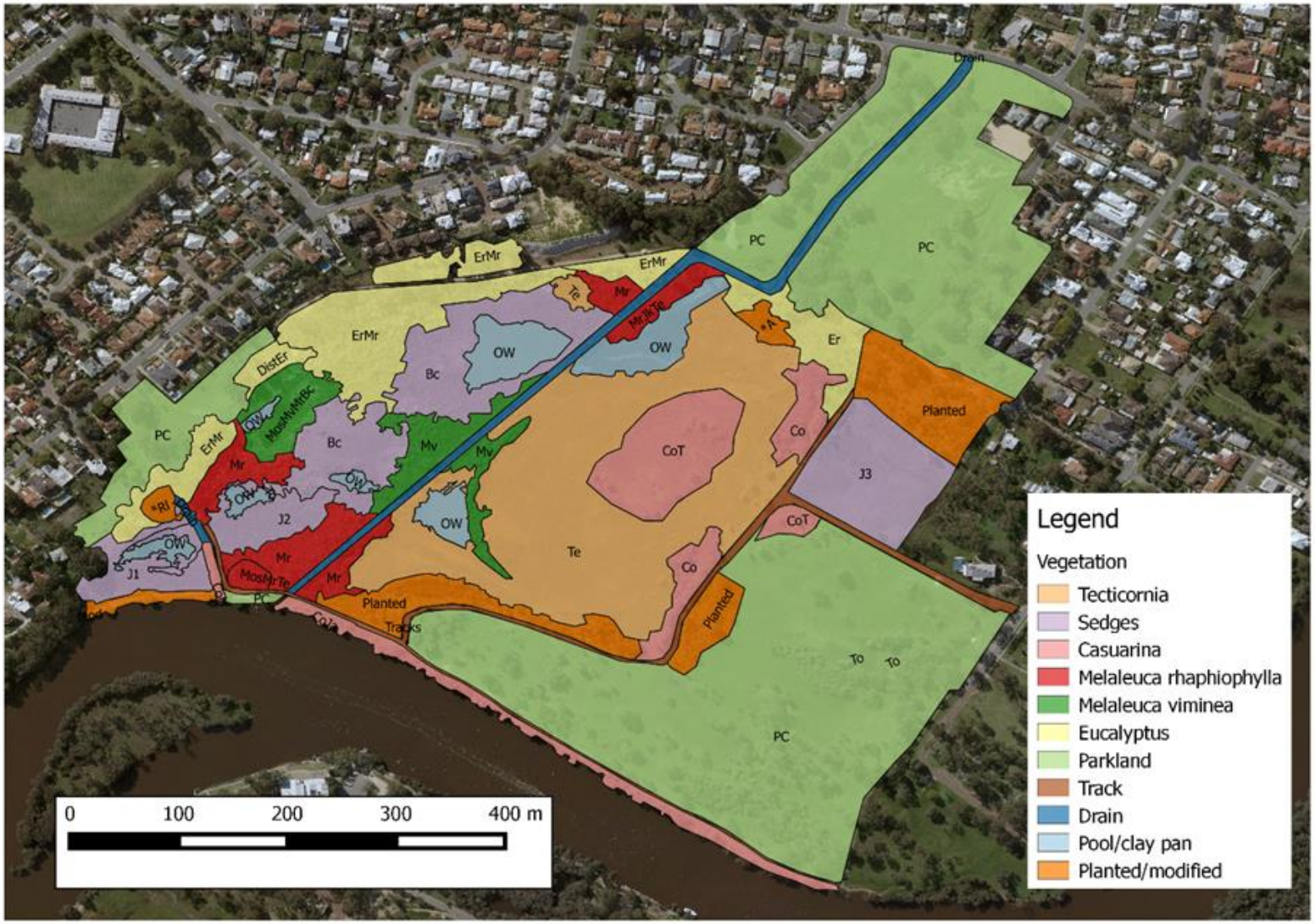
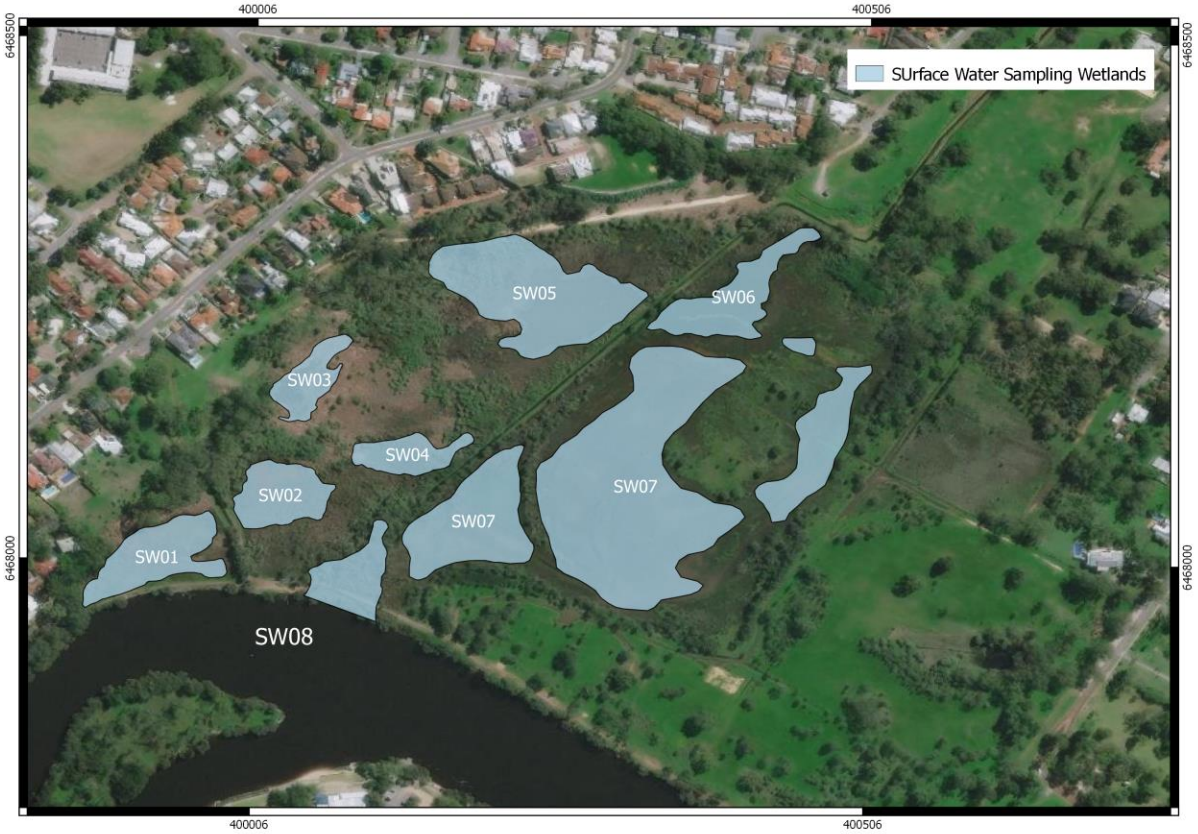

Drain
PC
ErMr
Te
Mr
MrTeTe
OW
Bc
DistEr
MosMrMrBc
Mv
CoT
Co
Er
Planted
J3
J2
J1
MosMrTe
Tracks
To
0
100
200
300
400 m
Legend
Vegetation
Tecticornia
Sedges
Casuarina
Melaleuca rhaphiophylla
Melaleuca viminea
Eucalyptus
Parkland
Track
Drain
Pool/clay pan
Planted/modified

Standing Water Pools



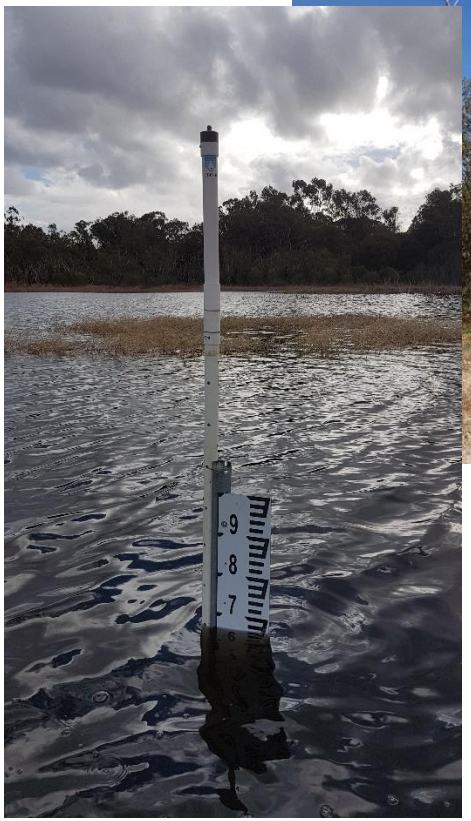
Aims

- Develop an understanding of the dominant hydrological processes sustaining the TEC
- Assess the potential of contamination to the wetland and the Swan River Estuary from urban drainage and known groundwater pollution

Objectives

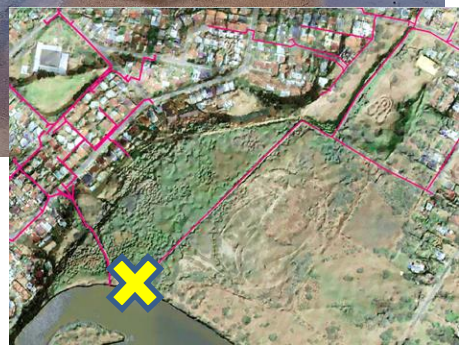
- Conduct a monitoring program to measure components of the wetland water balance
- Quantify water quality and pollutant loads in urban drainage
- Develop hydrological models to inform management

Monitoring Program



- Network of sensors monitoring drain flows, surface water and groundwater levels
- Survey to establish levels to AHD
- Geophysics to image aquifer properties
- Two year field campaign to validate measurements
- Collection of water and sediment samples to assess quality and chemical composition

River Flooding



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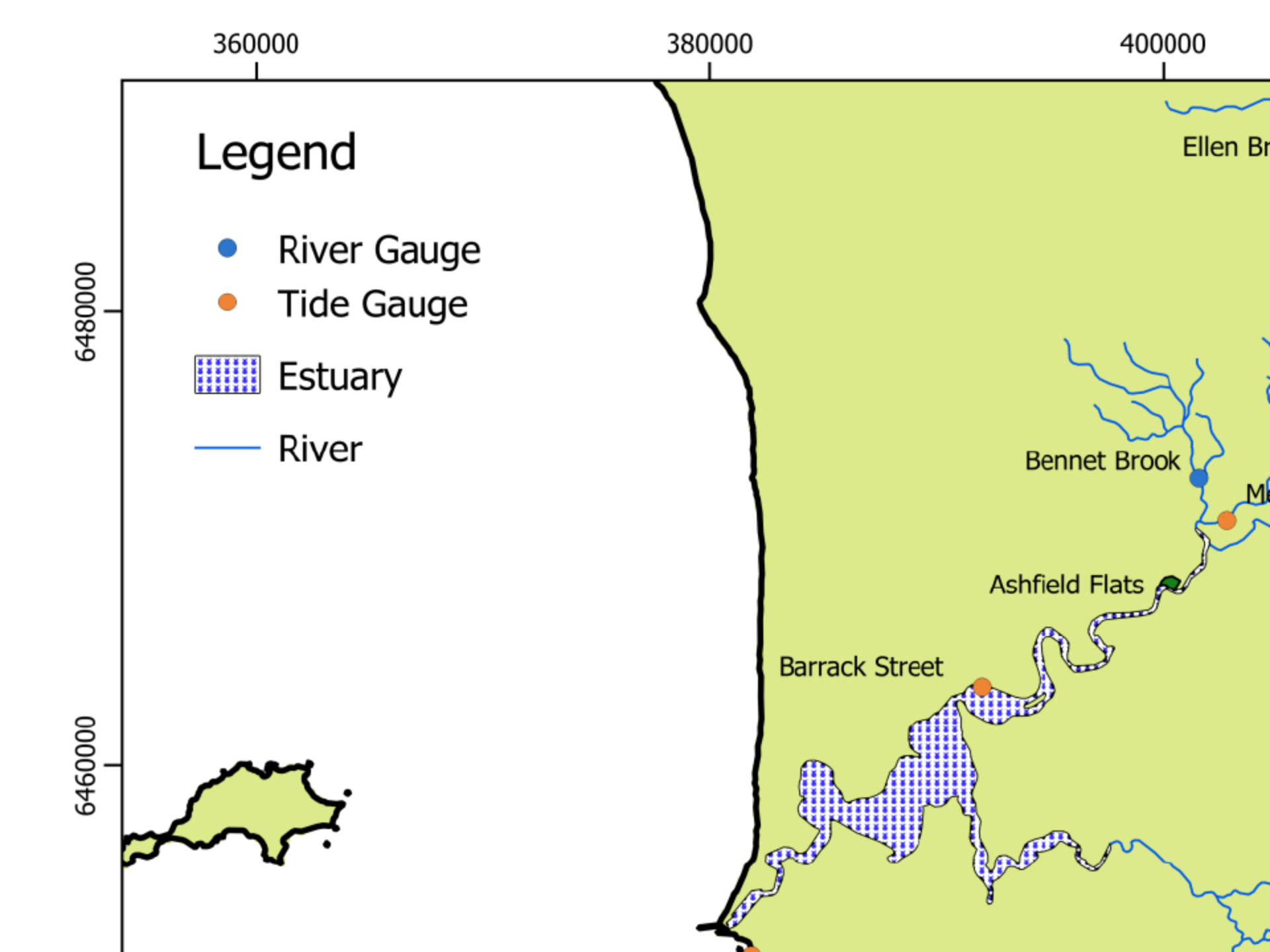

360000
380000
400000
6480000
6460000
Legend
River Gauge
Tide Gauge
Estuary
River
Ellen Br
Bennet Brook
Ashfield Flats
Barrack Street

Micro-tidal South West

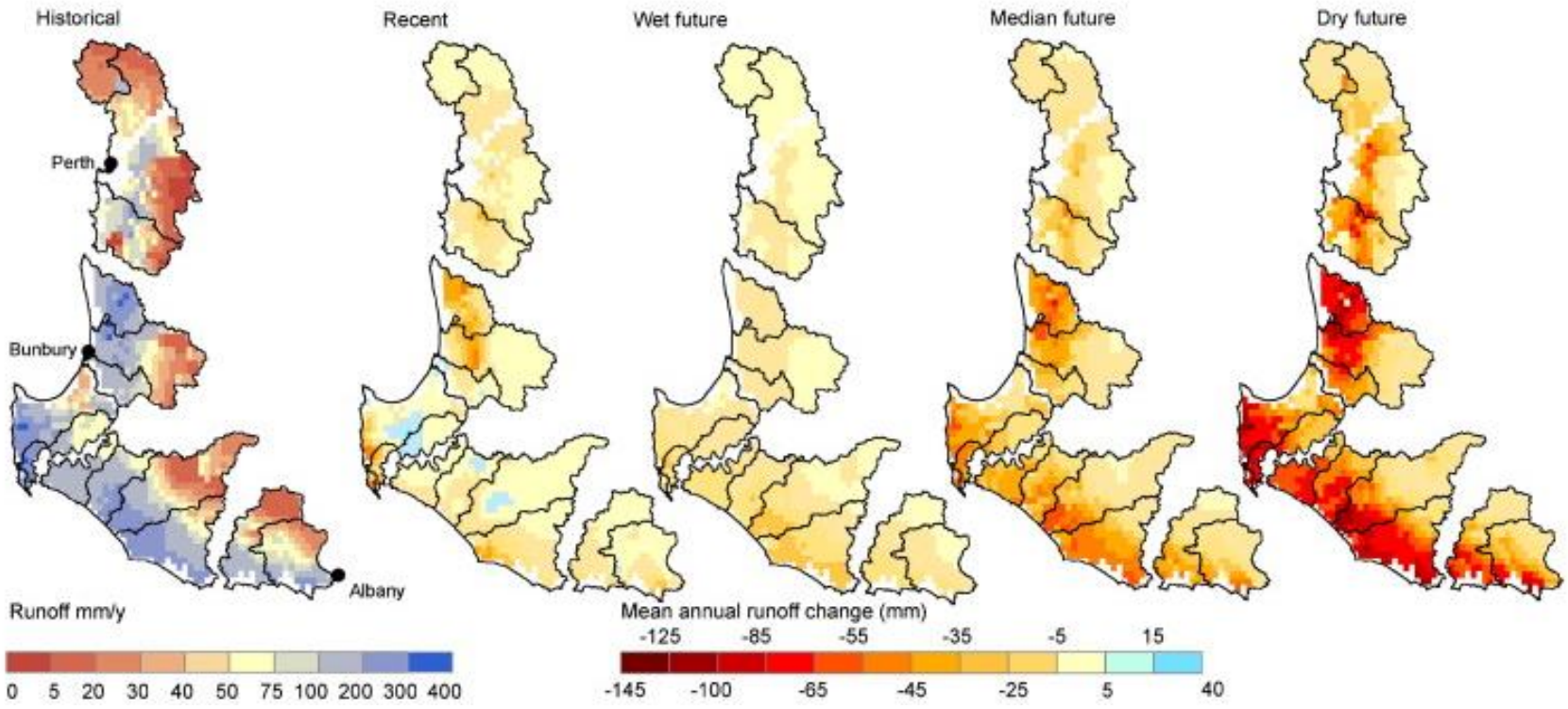
Short time scales

Process	Temporal Scale	Magnitude (m)
Seiche	2 hr	0.2
Wind setup	4 hr	0.2
Tides	12 -24 hr	0.5
Air pressure	1 – 7 days	0.3
Storm surge	2 – 4 days	0.6

Long time scales

Process	Temporal Scale	Magnitude (m)
Leeuwin Current	Seasonal	0.2
ENSO	3 – 5 year	0.25
Nodal tides	8 - 16 year	0.2
Climate change	100+ years	1 – 3 mm/year (accelerating)

Recent and Projected Declines in Regional Runoff



Silberstein et al., (2012) *Journal of Hydrology*

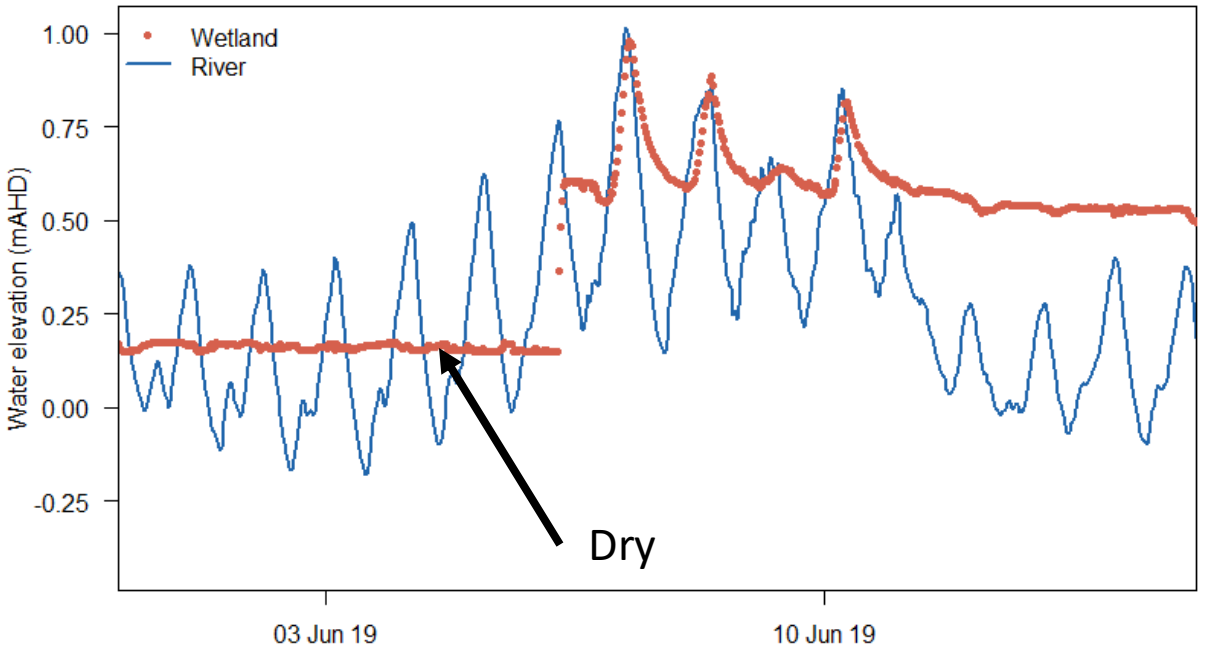
Key Questions

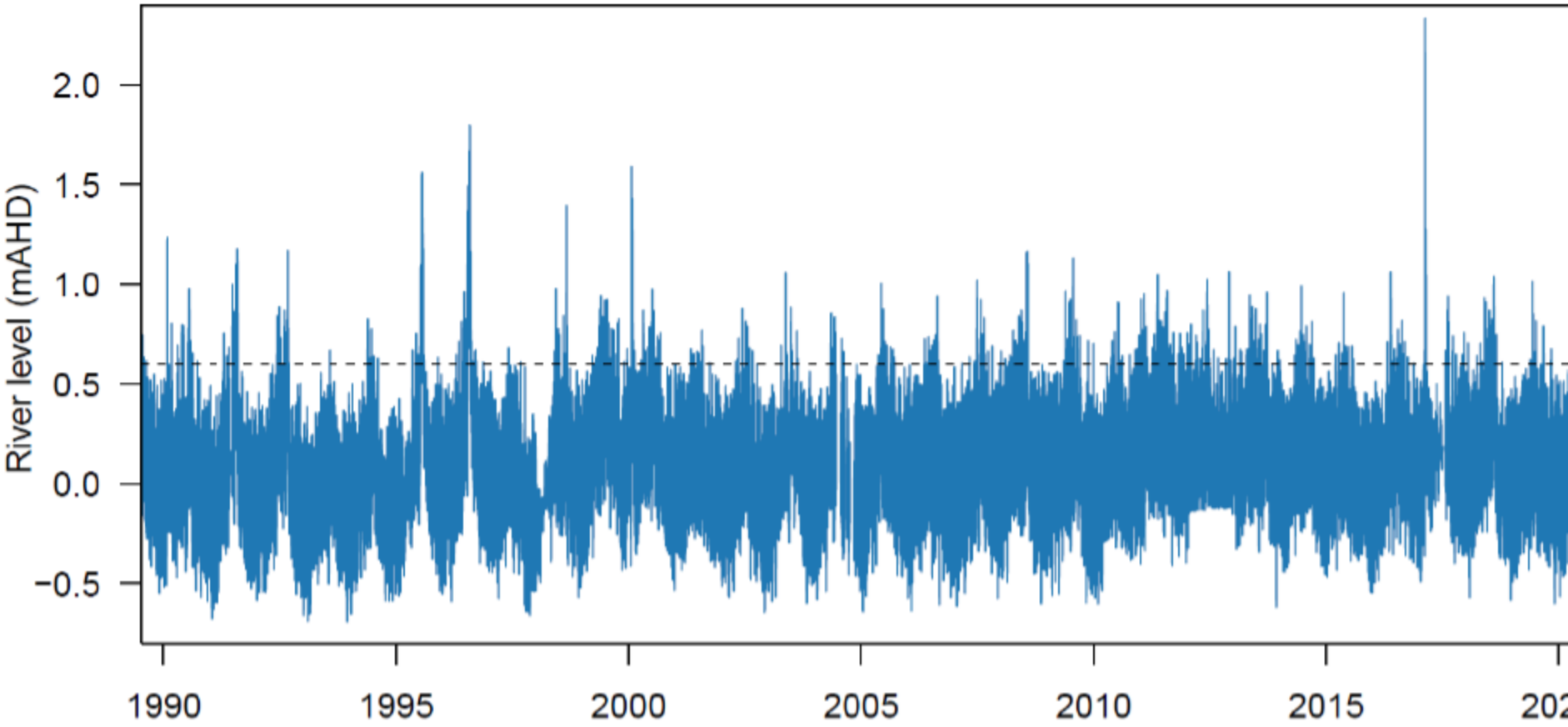
- What processes drive the hydrology of relevance to the TEC?
- How do the river and tides interact?
- What does the future hold?

Surface Water

River the dominant surface water source

River exceeds flooding threshold ~208 hours per year at present




River level (mAHD)
2.0
1.5
1.0
0.5
0.0
−0.5
1990
1995
2000
2005
2010
2015
202

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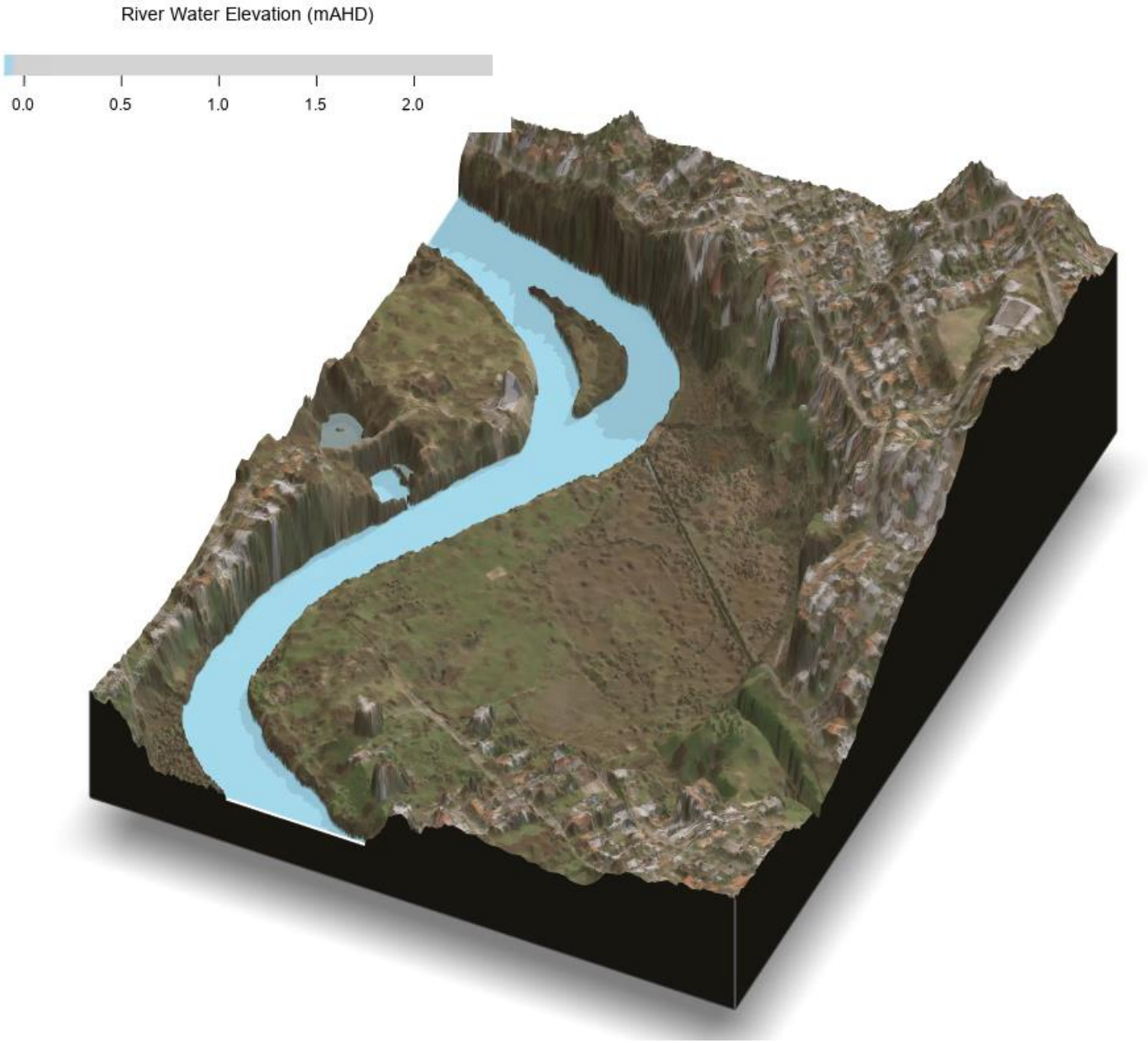
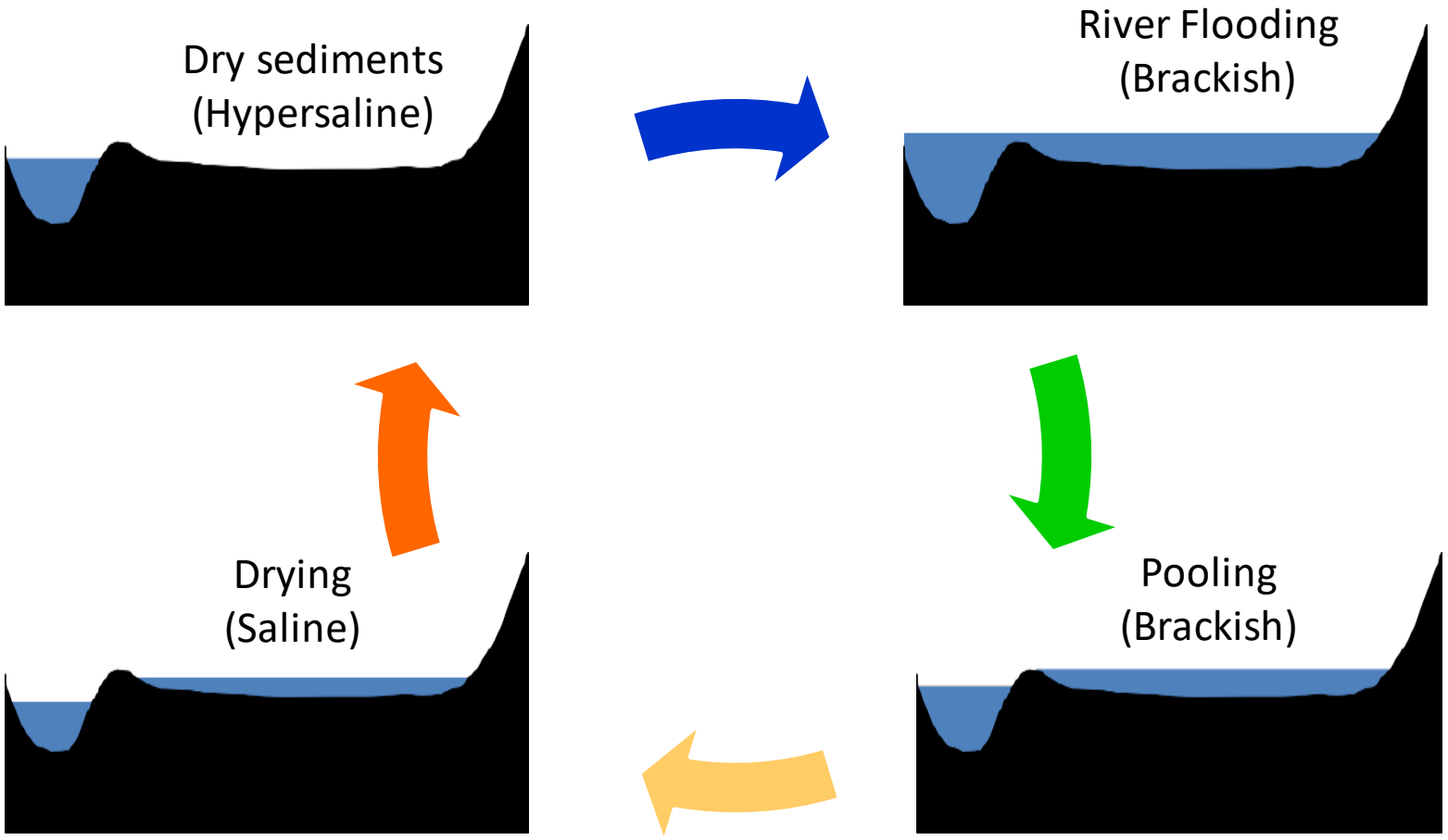
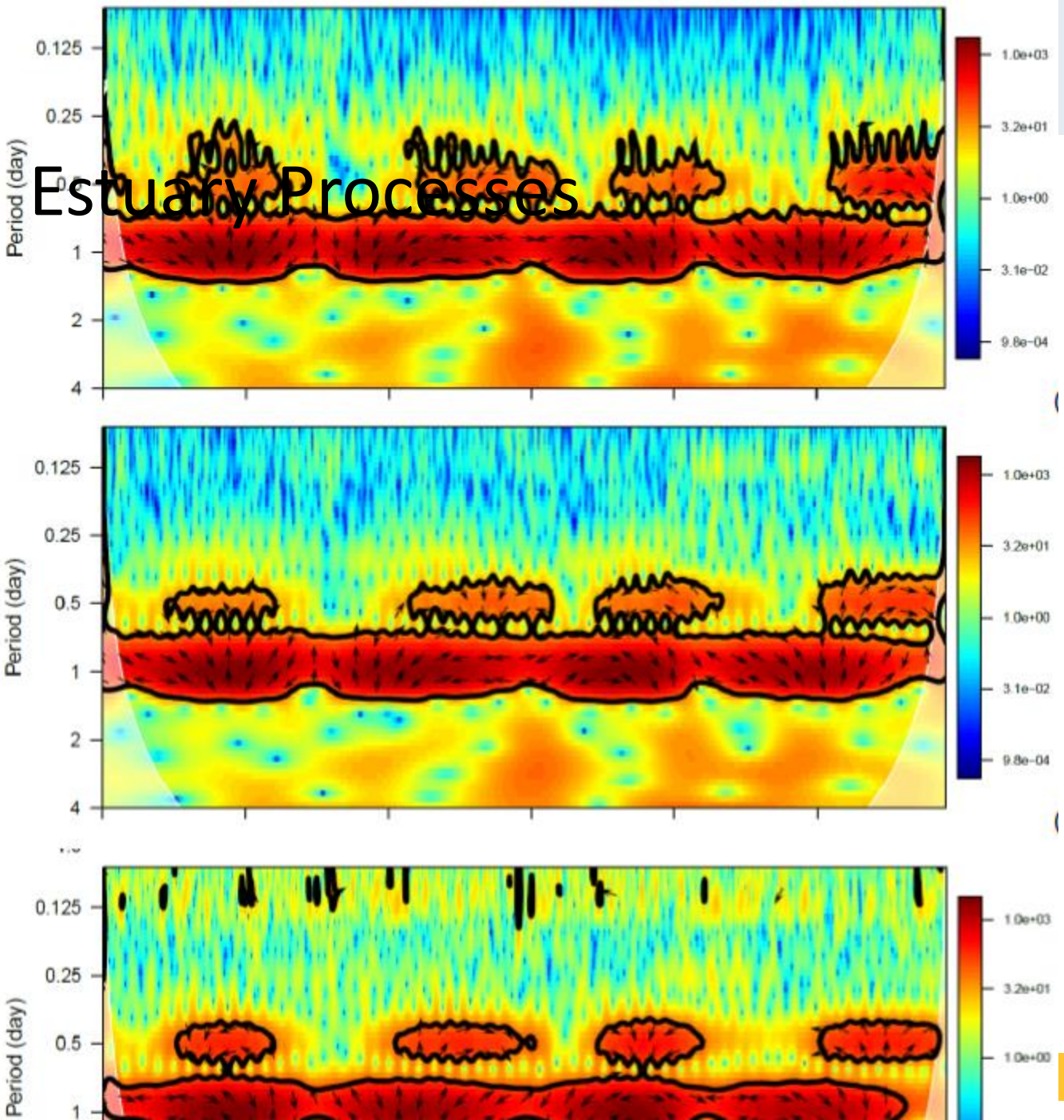


Seasonal Surface Water Cycle



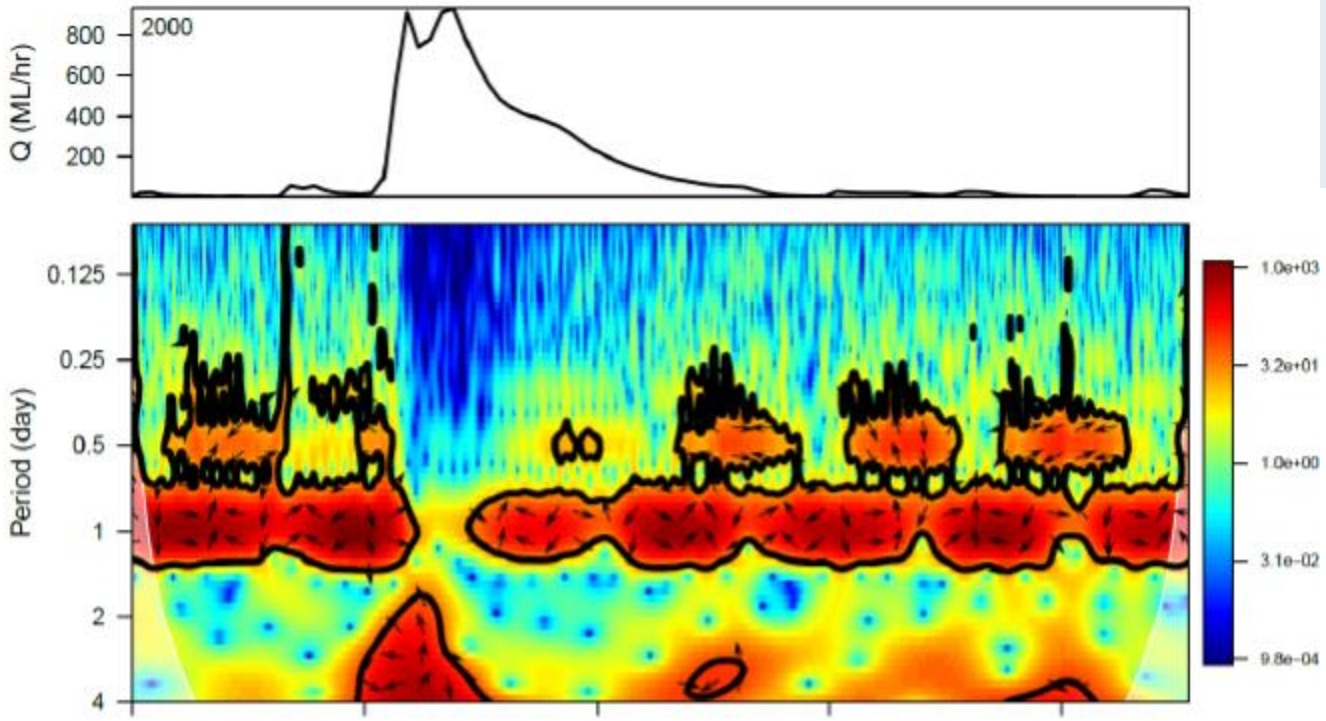
Summer



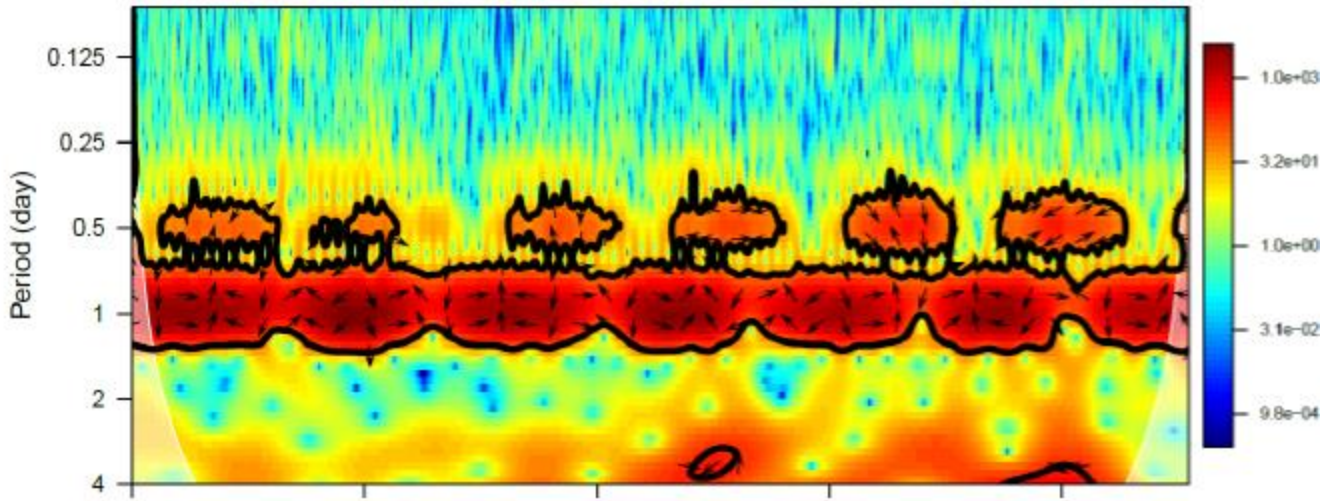
Guildford

Fremantle

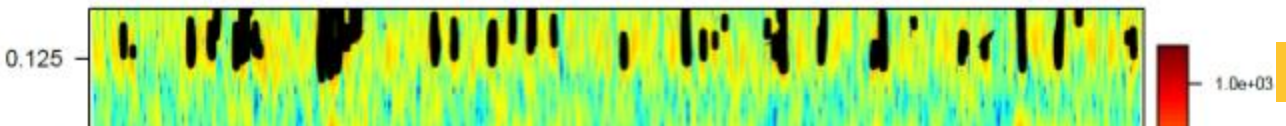
Winter



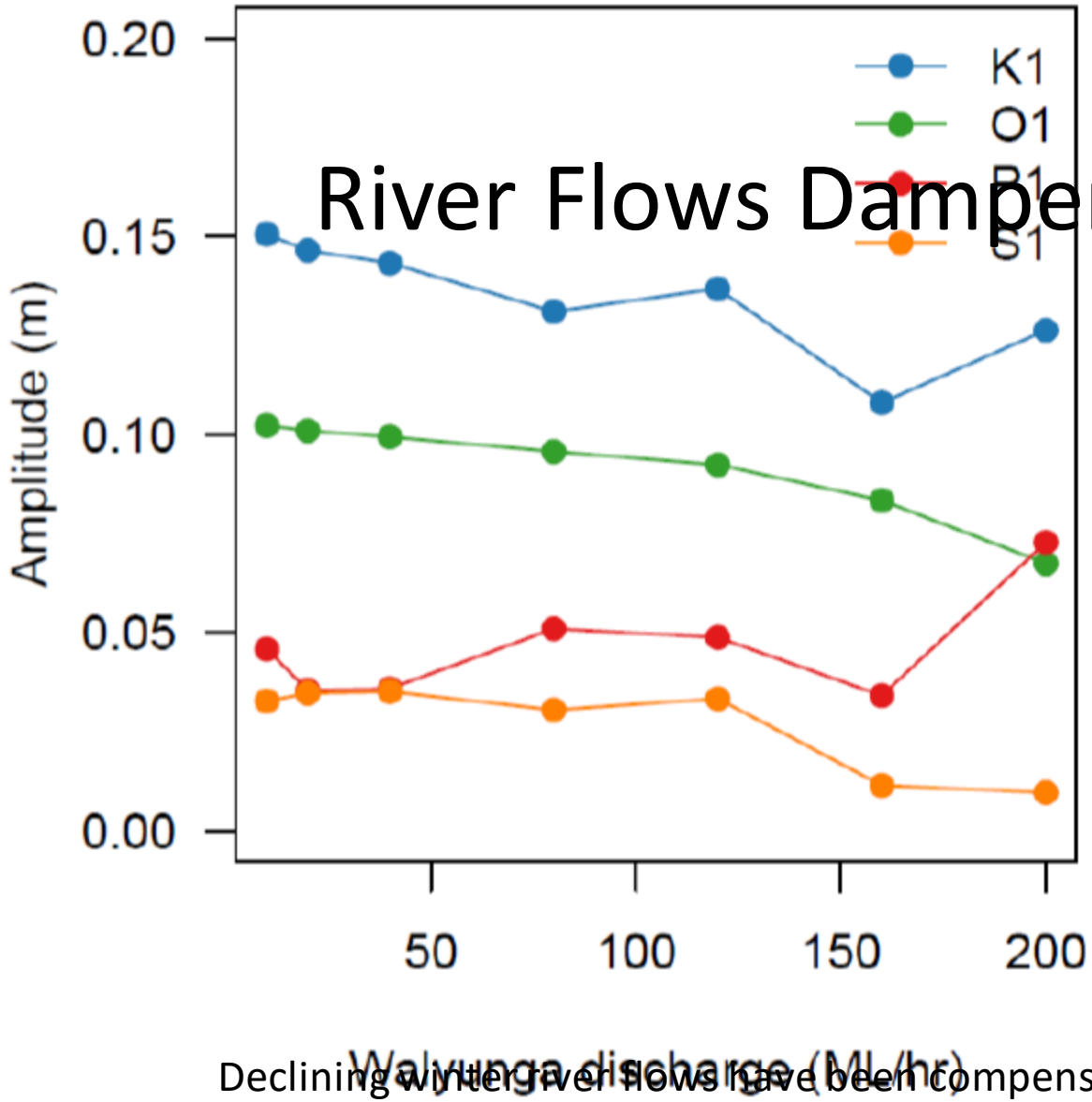
Guildford

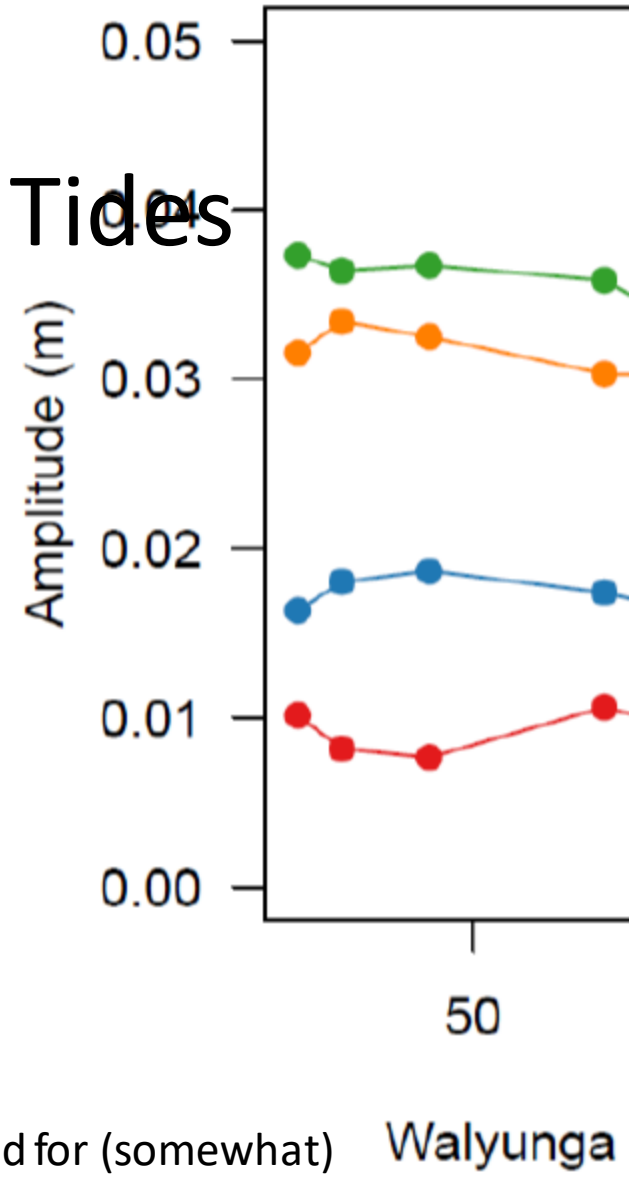


Barrack Street



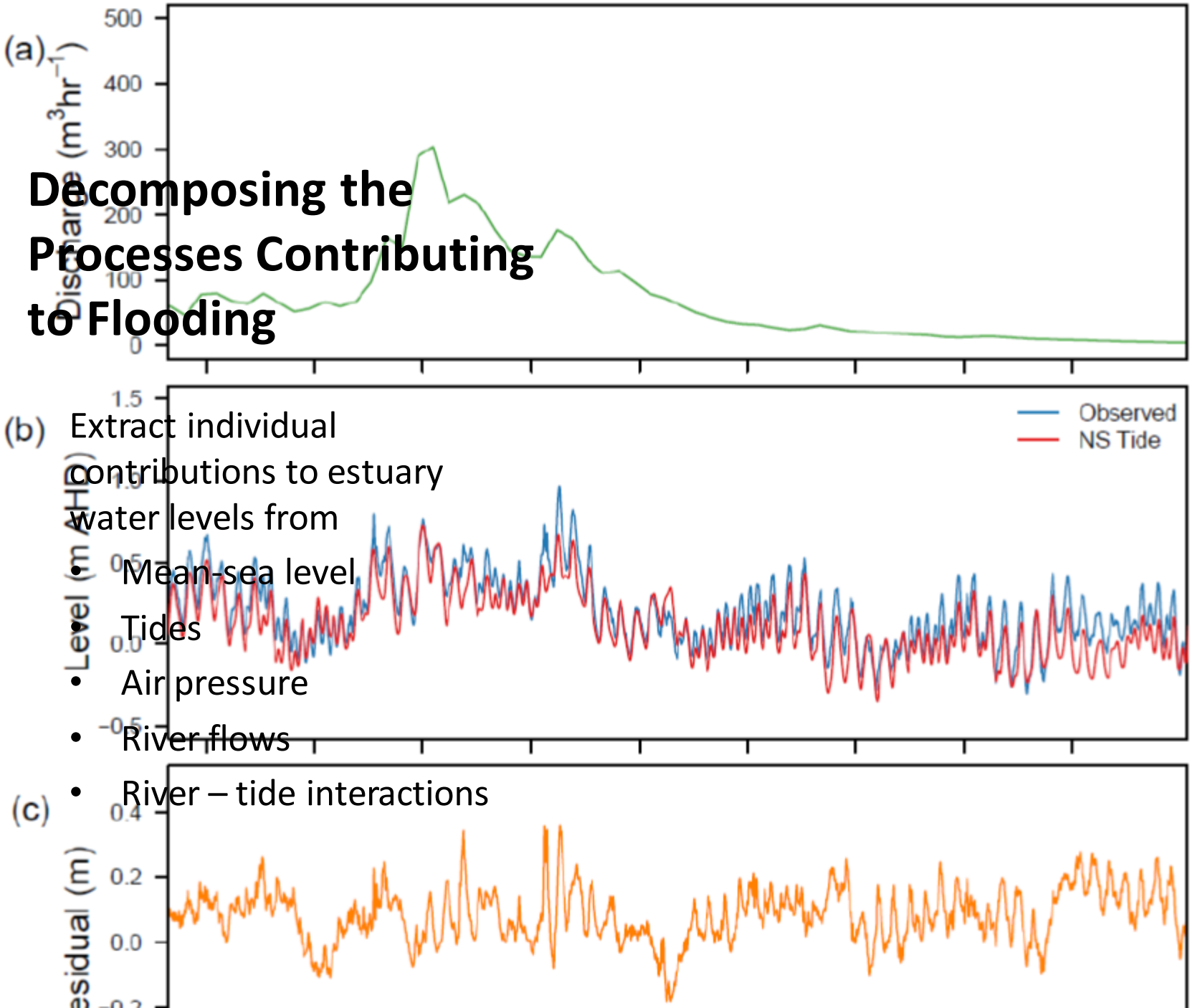
River Flows Dampen Tides





Declining winter river flows have been compensated for (somewhat) by rising tidal amplitudes

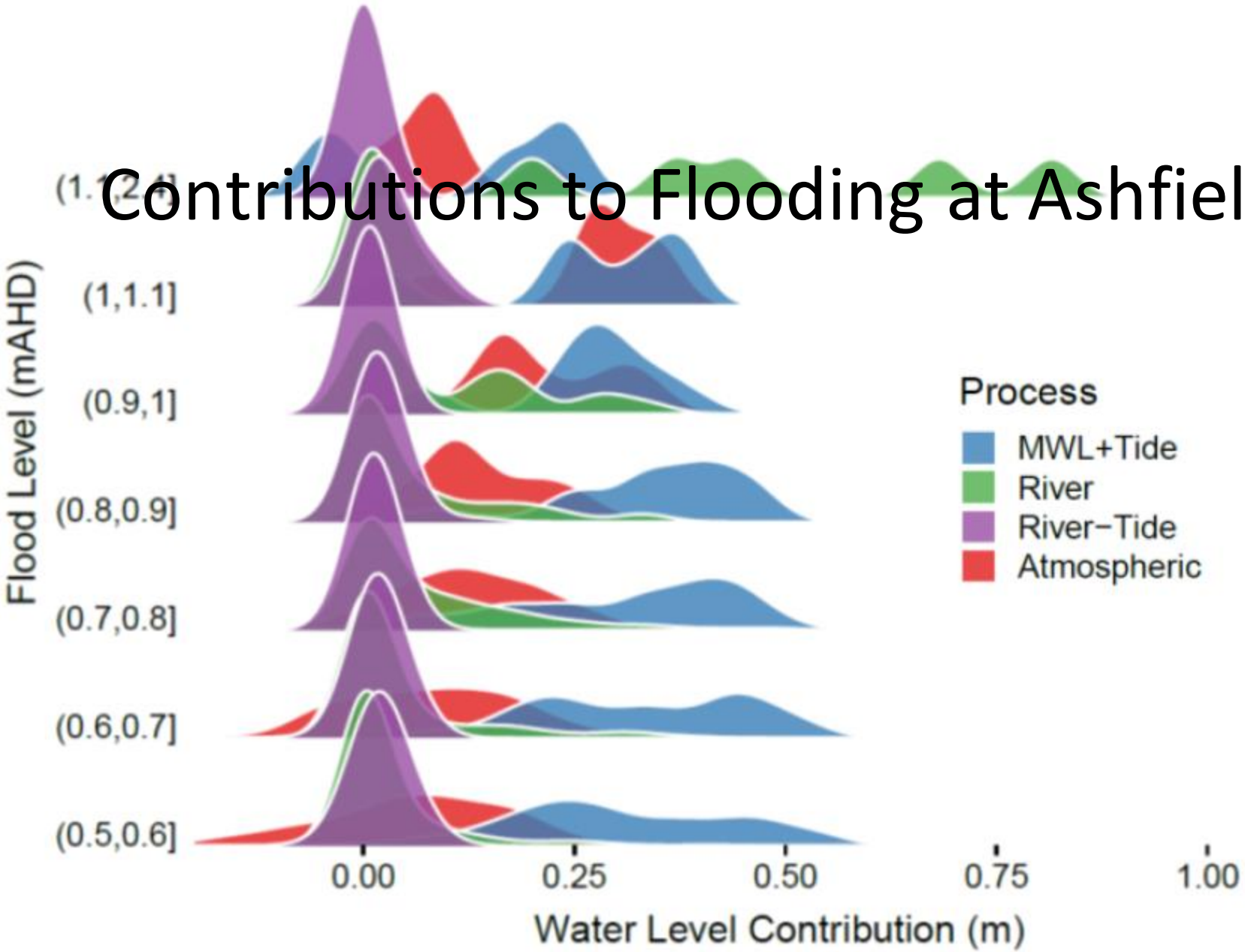
Decomposing the Processes Contributing to Flooding



Extract individual contributions to estuary water levels from

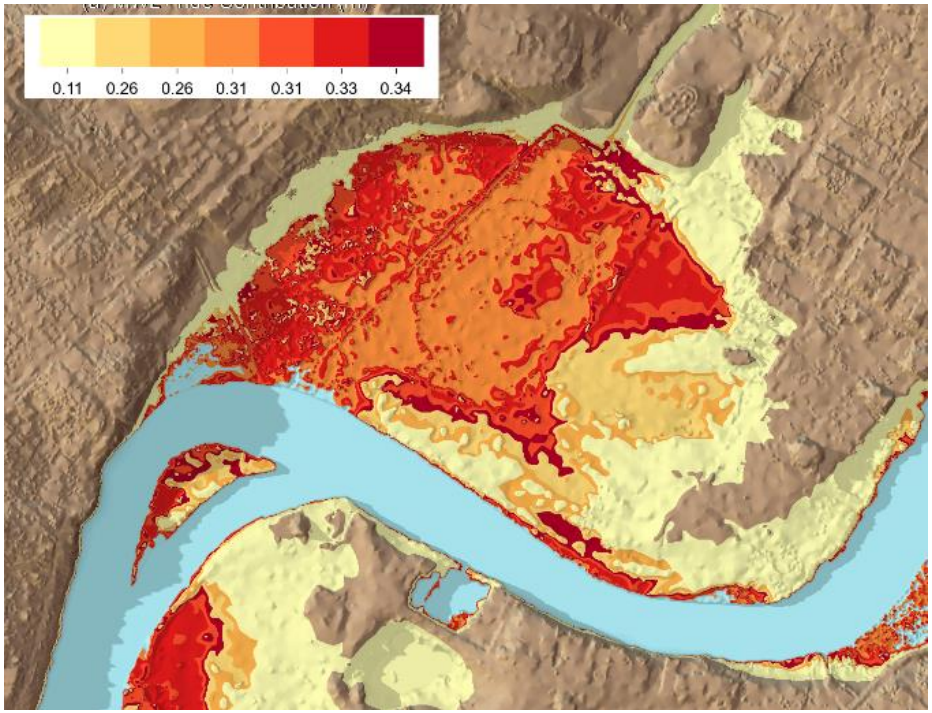
- Mean-sea level
- Tides
- Air pressure
- River flows
- River – tide interactions

Contributions to Flooding at Ashfield

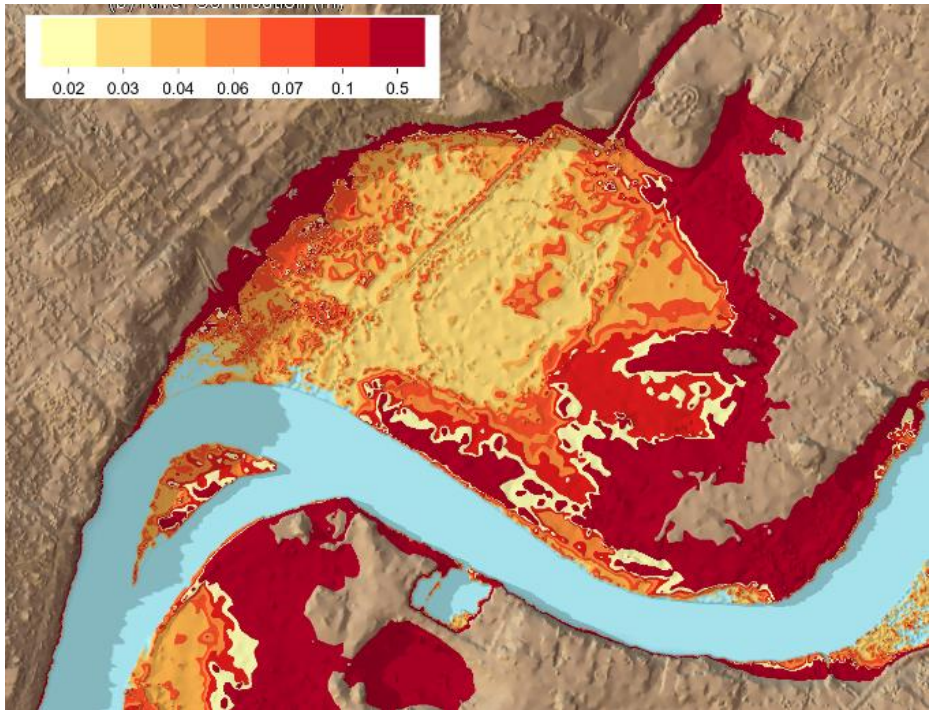


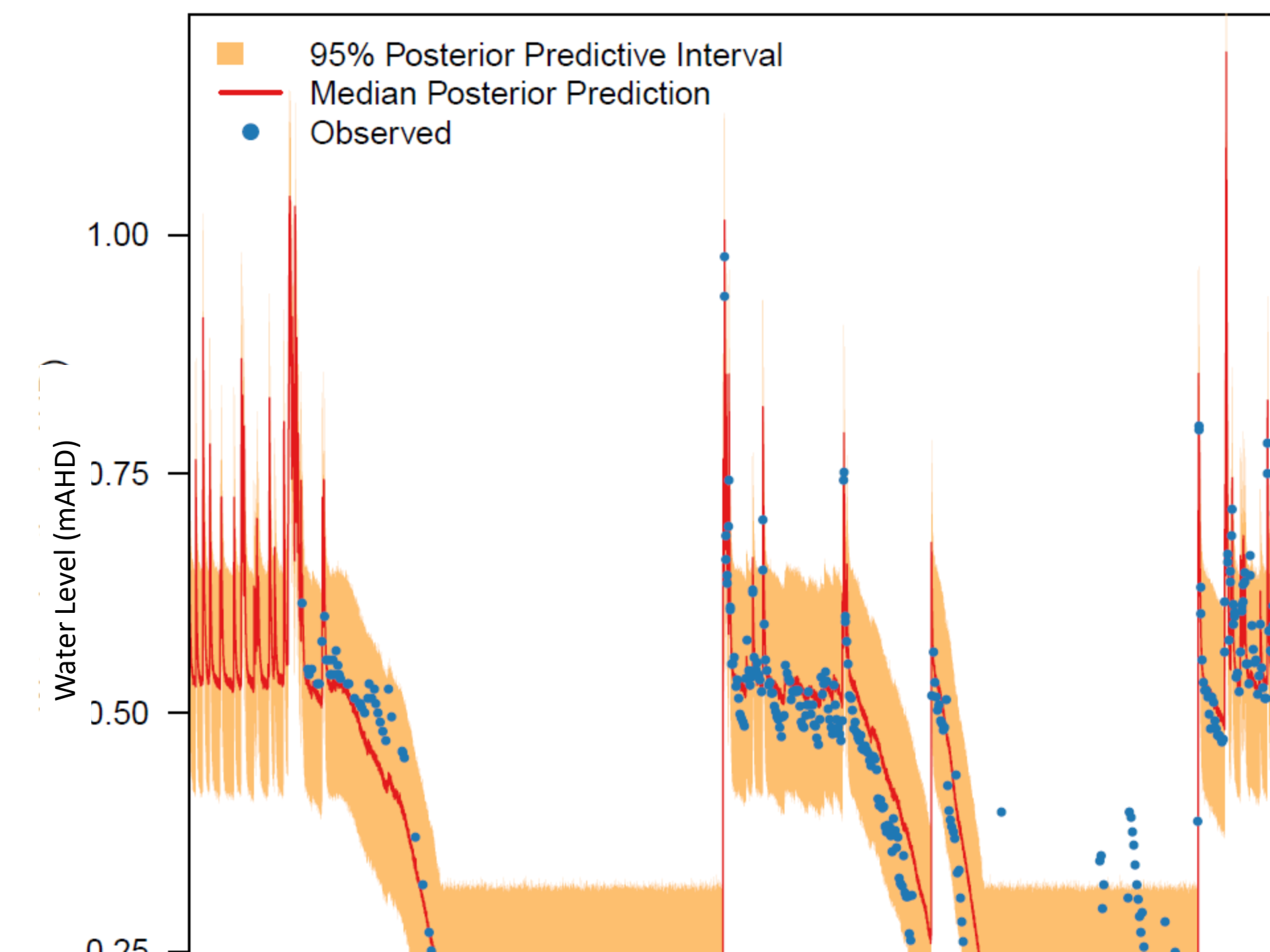
Mean Contributions to Flood Levels

Tidal Flooding



River Flooding

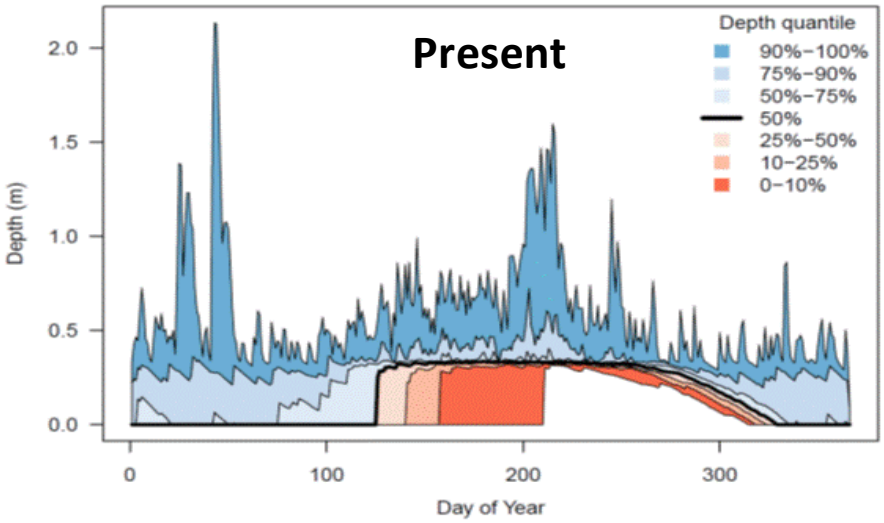


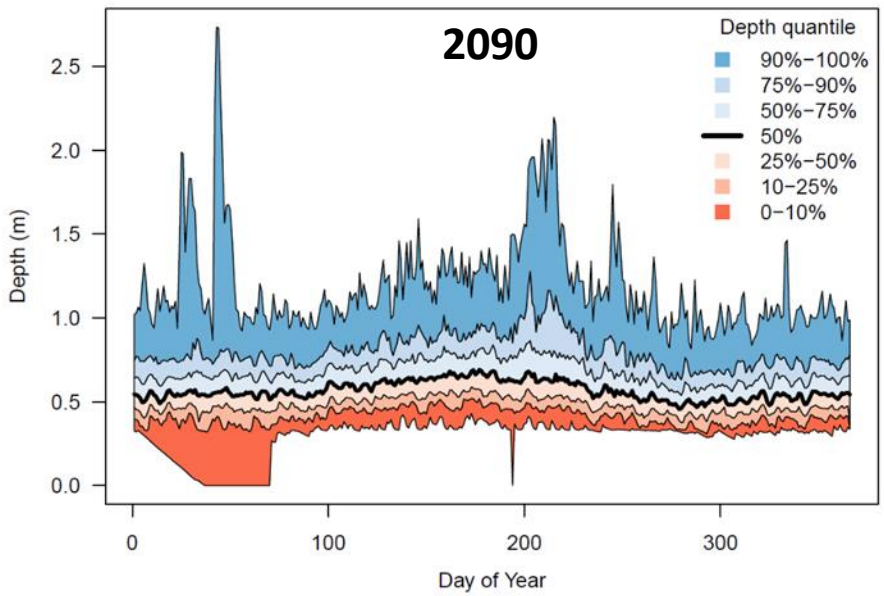

95% Posterior Predictive Interval
Median Posterior Prediction
Observed
Water Level (mAHD)
1.00
0.75
0.50
0.25

Climate Change Scenarios

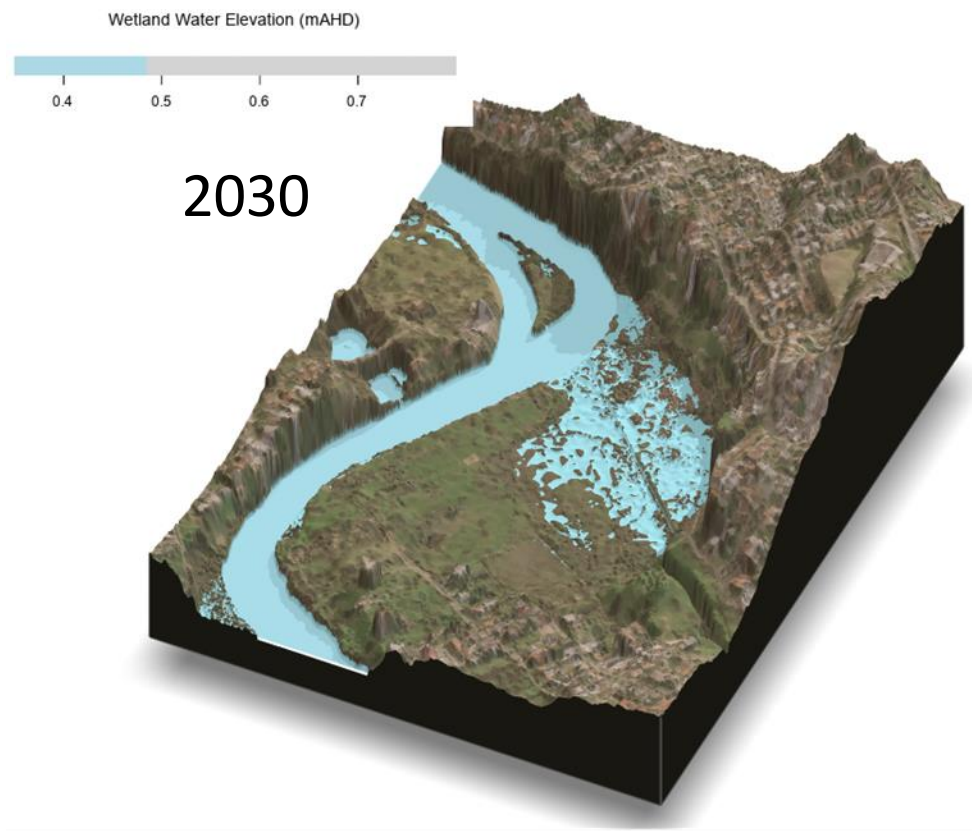
Scenario	Year	Mean Water Depth (m)	Mean Hydroperiod (days/year)
Present	1990-2020	0.20	266
RCP4.5	2030	0.25	325
	2050	0.29	351
	2070	0.33	361
	2090	0.39	362
RCP8.5	2030	0.25	324
	2050	0.30	356
	2070	0.36	362
	2090	0.48	364

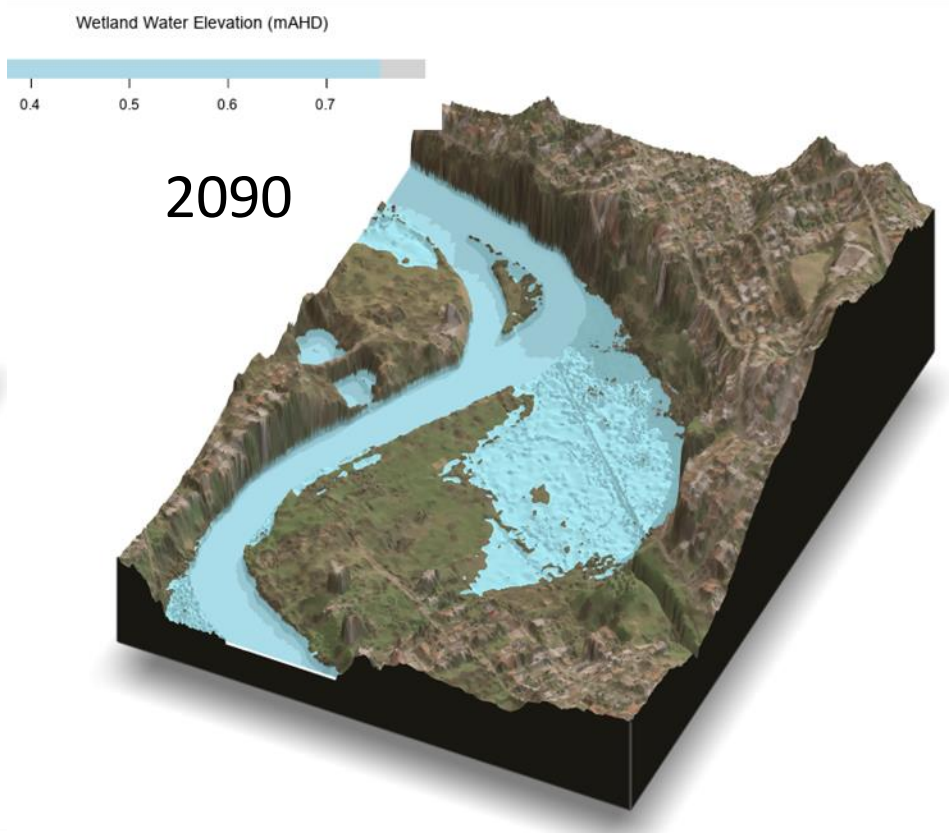
*Hydroperiod defined as having at least 10 cm of water in the north eastern pool



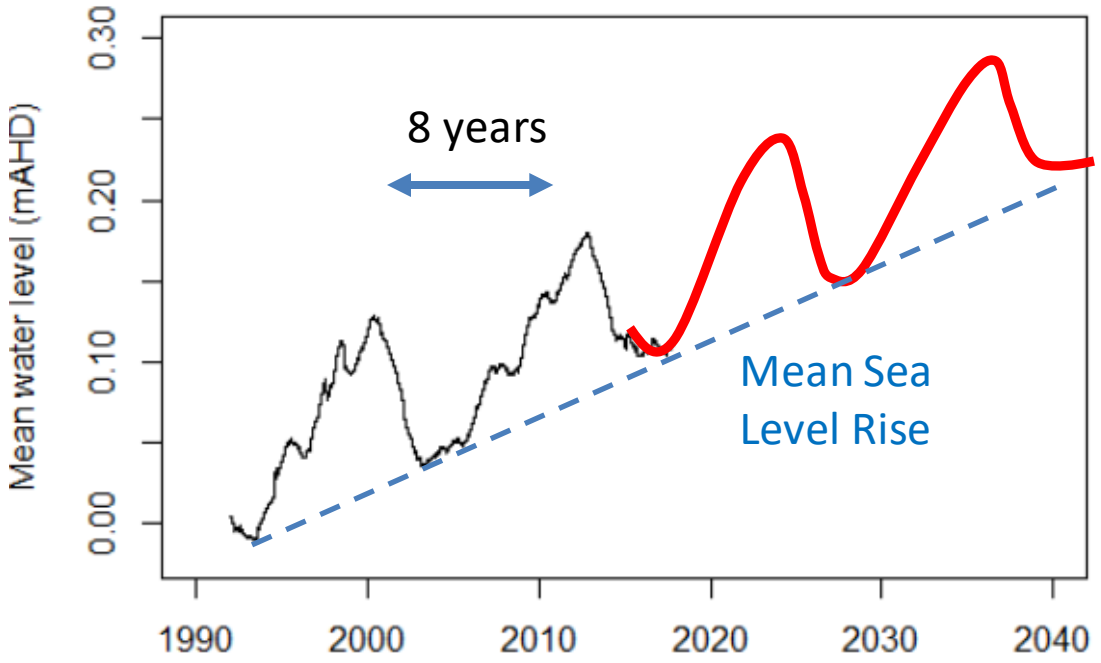


Future Mean Water Levels



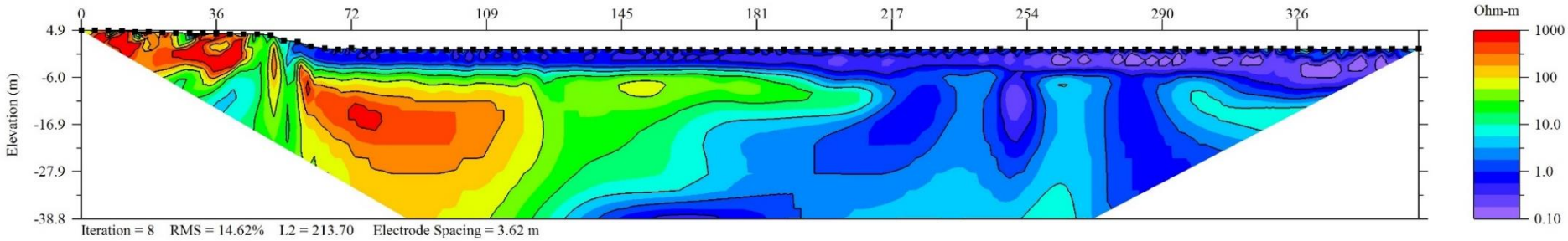


Long-period Tidal Cycles: A Portent

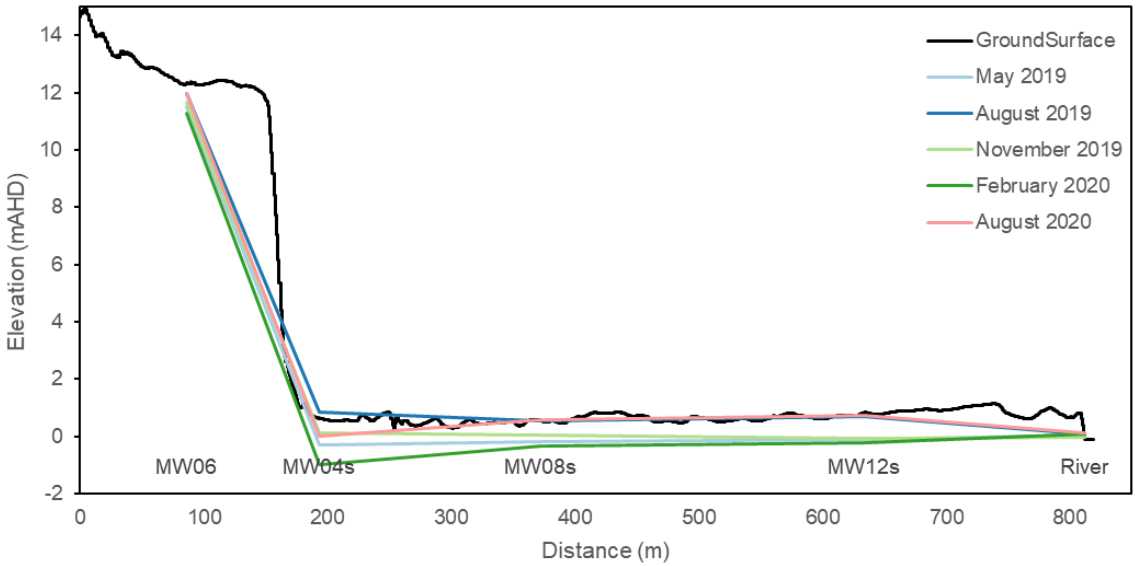


8 and 16 year nodal tidal cycles

Groundwater



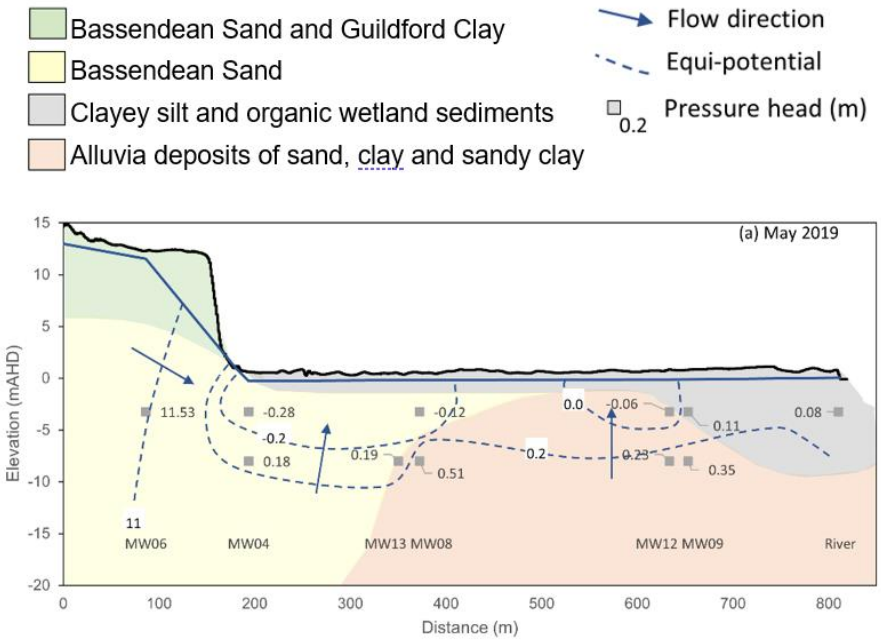
Geophysics



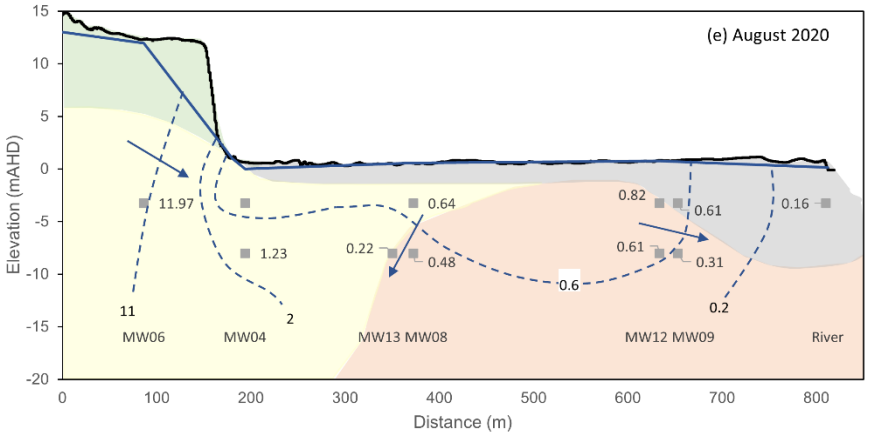
Measured Water Table

Groundwater

- Seasonally evaporating / recharging
- Semi-confined aquifer
- Aquifer properties characterized via barometric and tidal methods

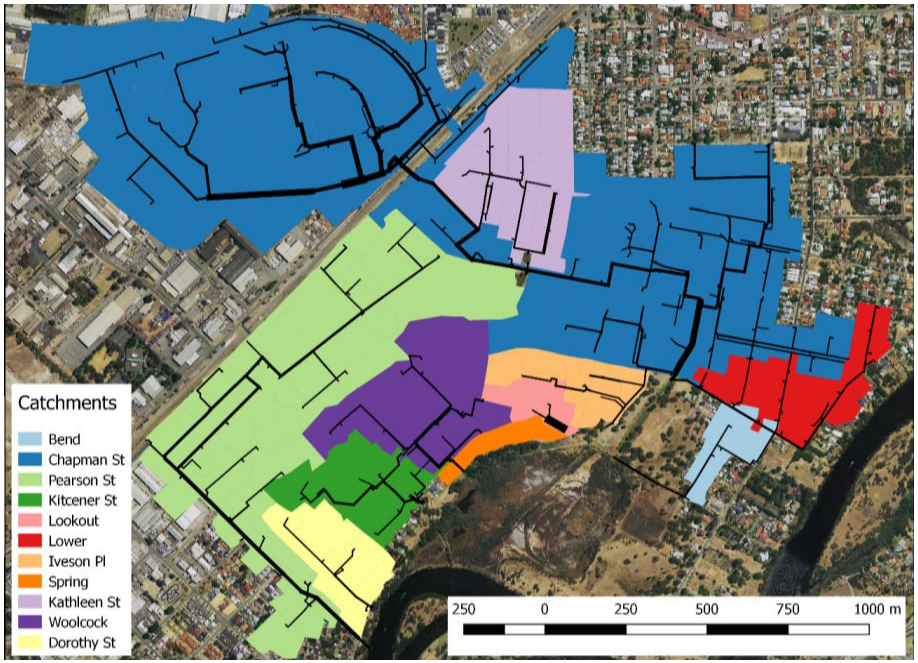


May 2019

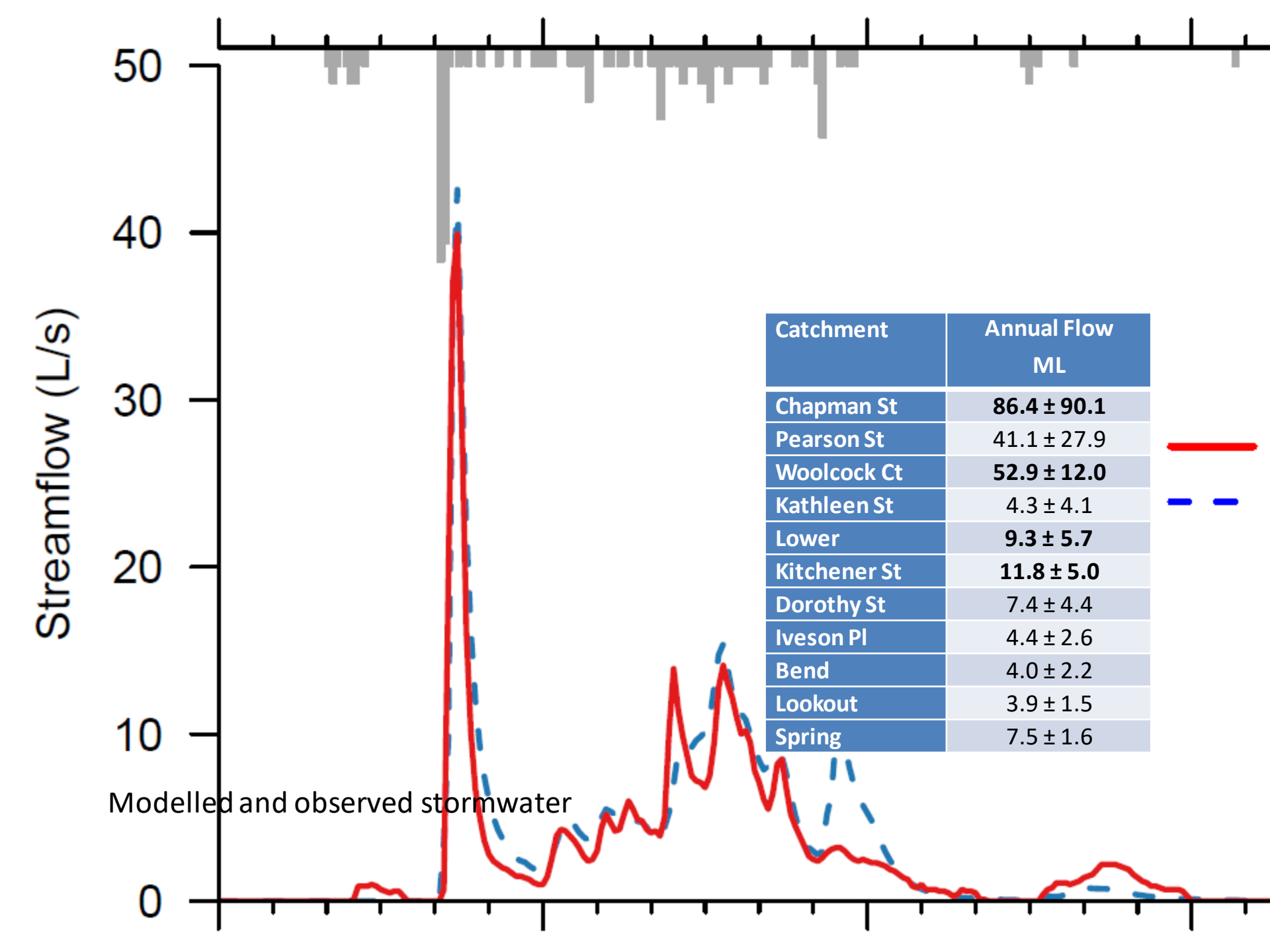


August 2020

Stormwater


Catchments
Bend
Chapman St
Pearson St
Kitcener St
Lookout
Lower
Iveson Pl
Spring
Kathleen St
Woolcock
Dorothy St
250 0 250 500 750 1000 m

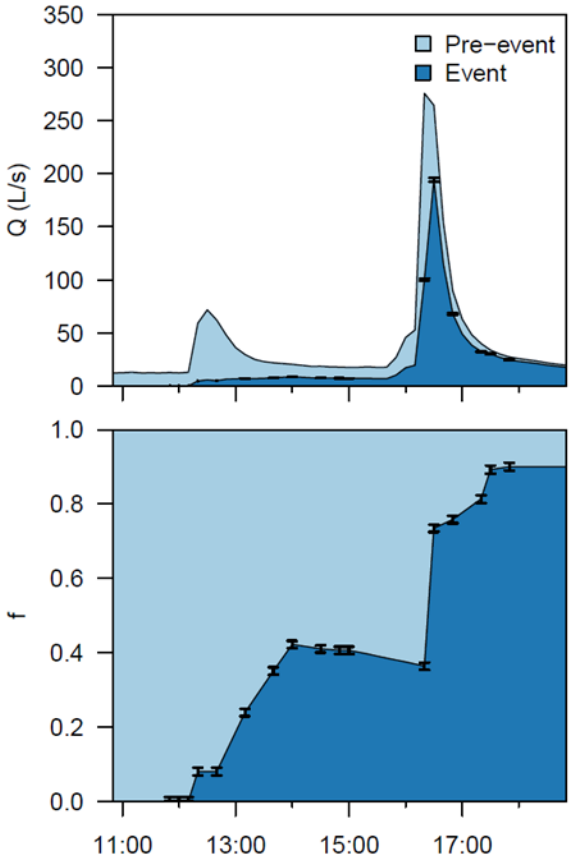

Legend
Woollcock Ct Drain
Chapman St Drain
Kitchener St Drain
0 100 200 300 400 m

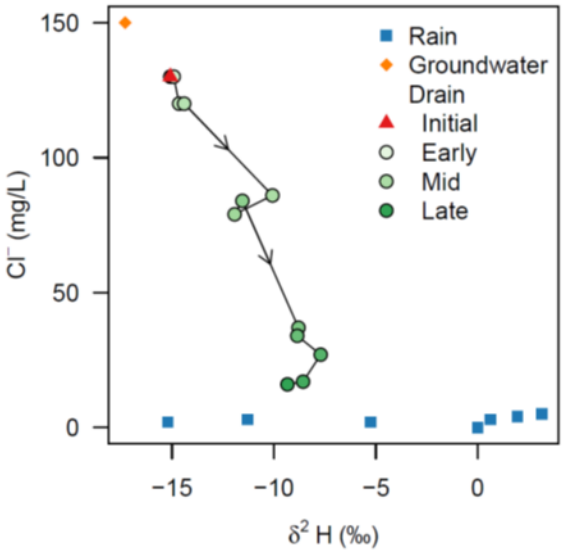


Catchment	Annual Flow ML
Chapman St	**86.4 ± 90.1**
Pearson St	41.1 ± 27.9
Woolcock Ct	**52.9 ± 12.0**
Kathleen St	4.3 ± 4.1
Lower	**9.3 ± 5.7**
Kitchener St	**11.8 ± 5.0**
Dorothy St	7.4 ± 4.4
Iveson Pl	4.4 ± 2.6
Bend	4.0 ± 2.2
Lookout	3.9 ± 1.5
Spring	7.5 ± 1.6

Modelled and observed stormwater

Stormwater Unmixing Sources





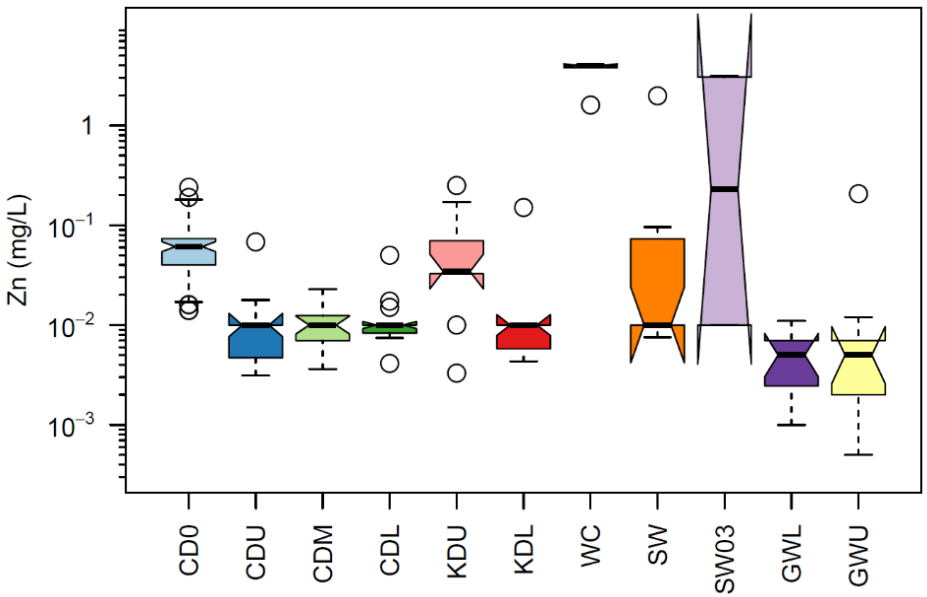
Stormwater is comprised of ~45% groundwater

Sediment and Water Quality

- The site contains actual acid sulphate soils and potential acid sulphate soils (as expected)
- Drains delivering heavy metals and nutrients directly to the wetland (Woolcock Ct Drain) and to the Swan River (Chapman St and Kitchener St drains)

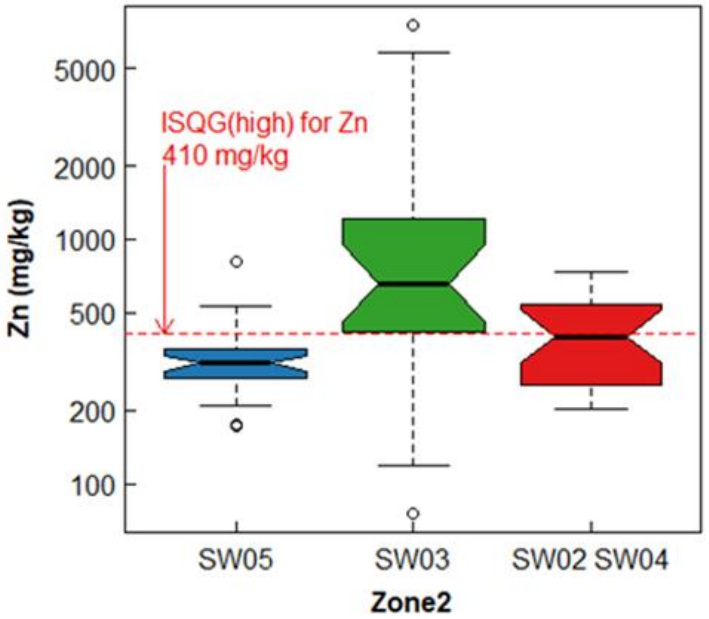
Woolcock Ct Drain Capturing and Delivering Polluted Groundwater

Waters



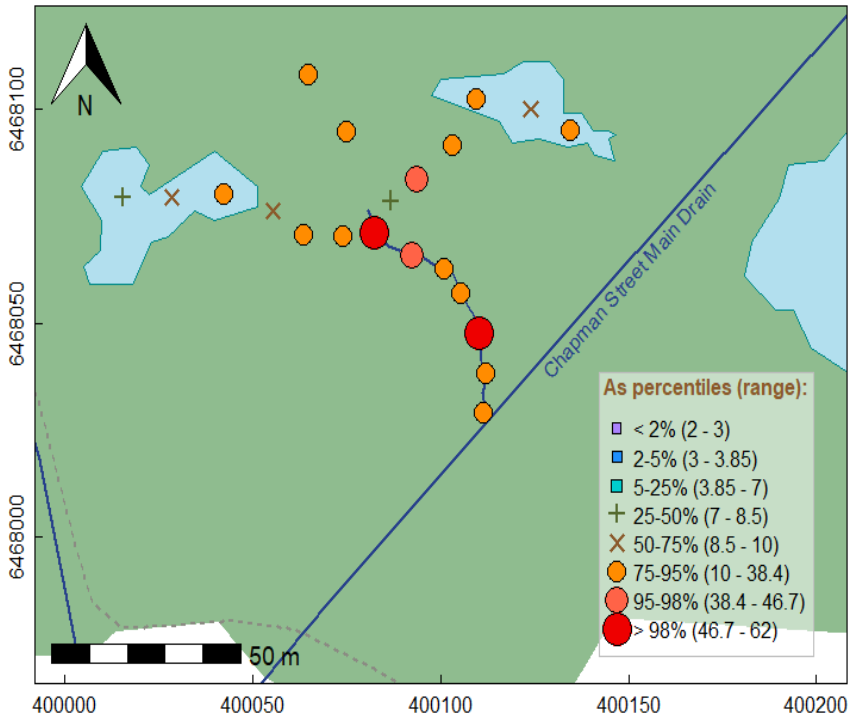
Water samples exceeded ANZECC Marine and Freshwater quality limits of protection (Zn, Ag, Pb, Cd, Cu, Co, Al*)

Sediments

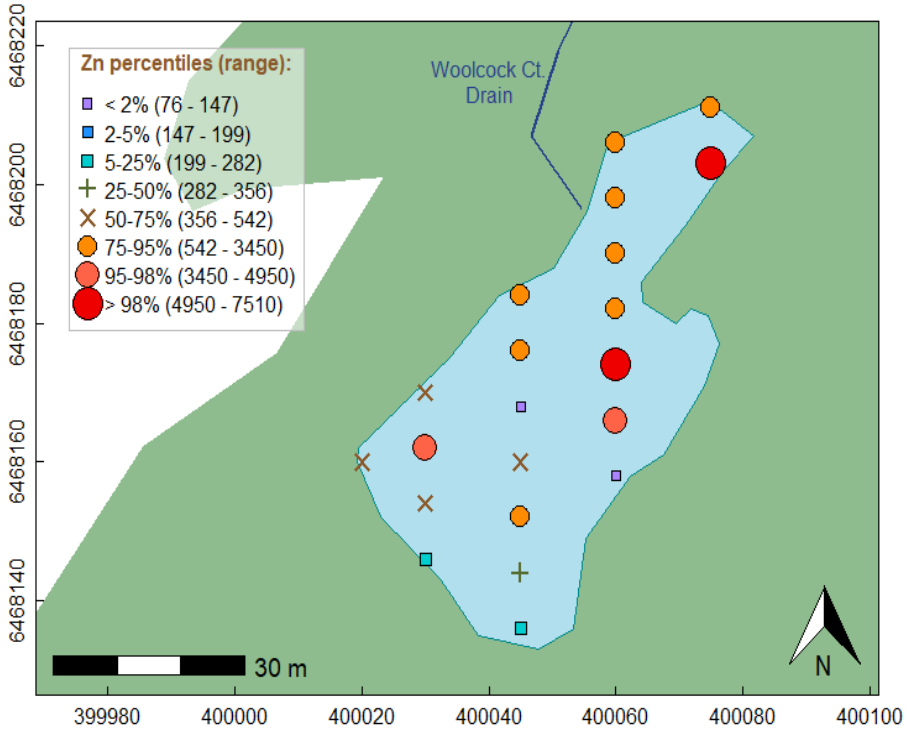


Sediment samples exceed Interim Sediment Quality Guidelines (ISQG) at low levels (Cu, Pb, Ni, Zn) and high levels (Cu, Zn).

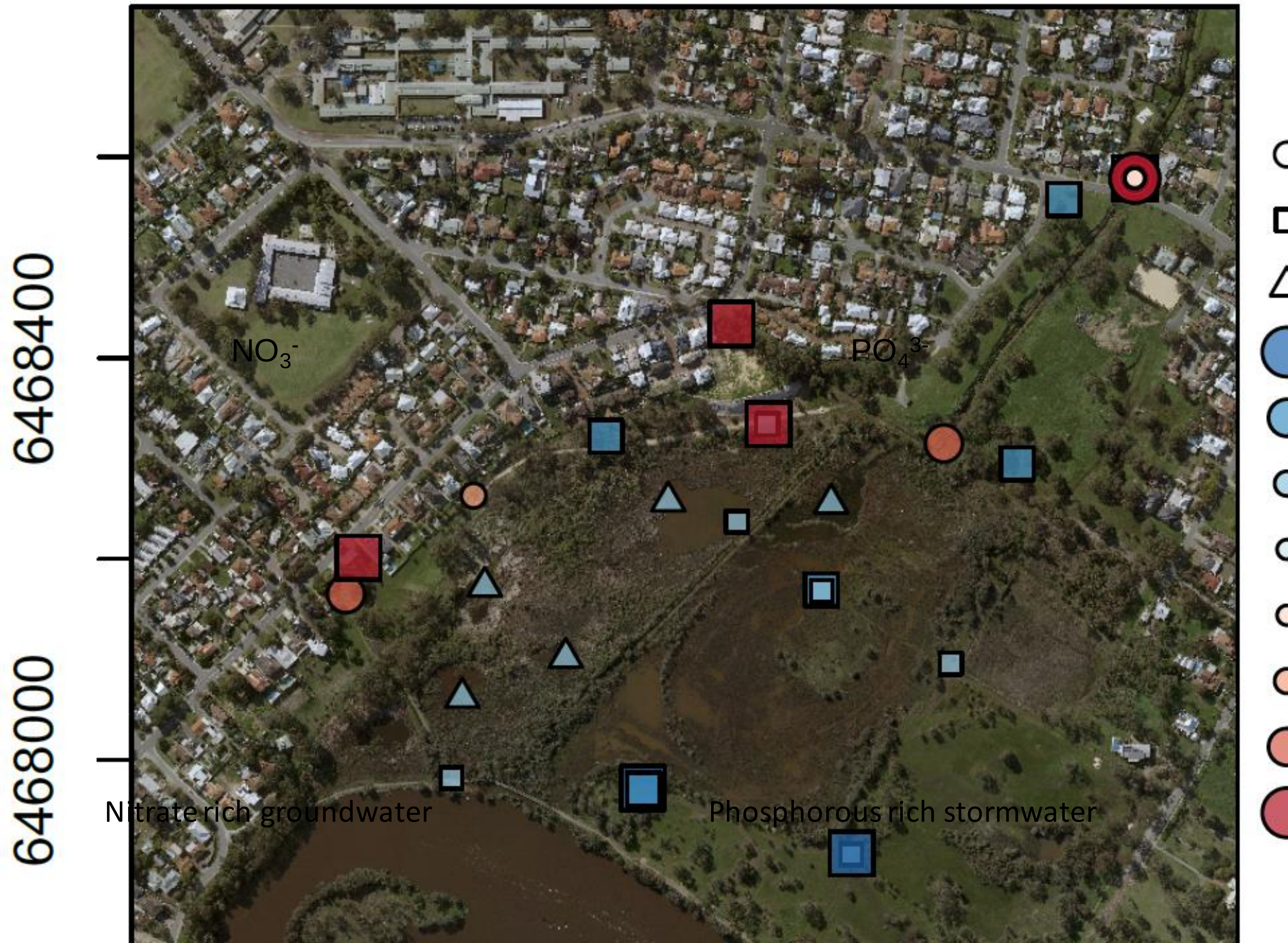
Sediment Quality



Naturally occurring acid sulphate soils

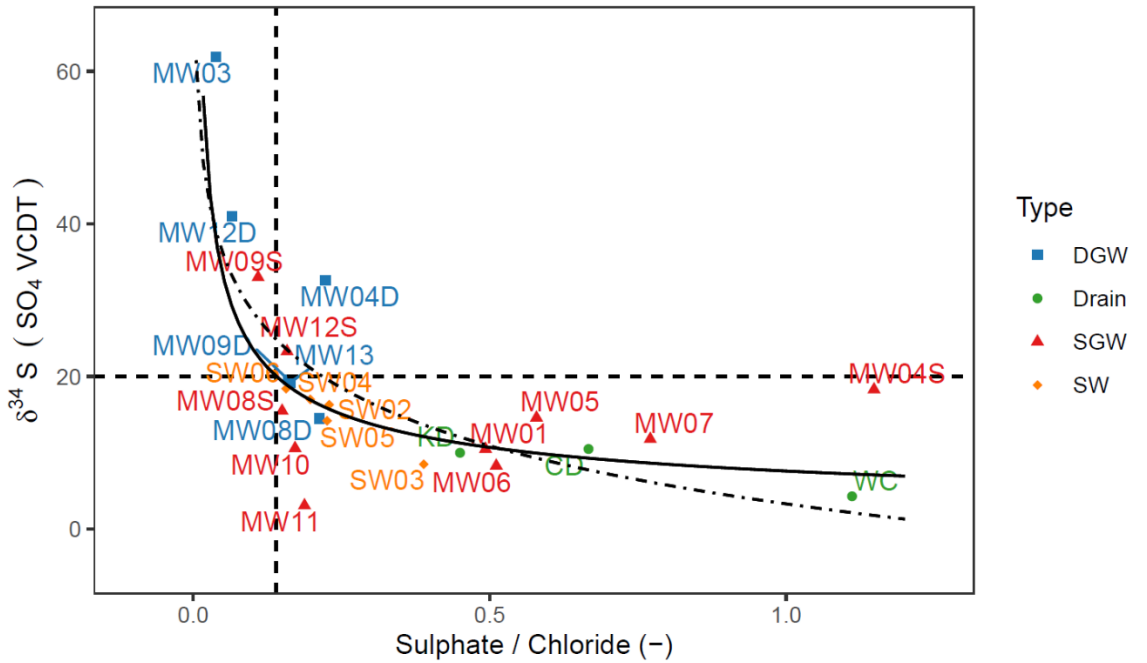


Pollutant capture as an ecosystem service



6468400
6468000
NO_3^-
PO_4^{3-}
Nitrate rich groundwater
Phosphorous rich stormwater

Water Quality Indicators of Mixing and Pollution



Depleted δ^{34}S is indicative of anthropogenic source (i.e. roasting of S for fertilizer production)

Summary

- Tide dominated wetland
- Minor interaction with groundwater
- Wetland impacted by stormwater
- Threats from sea-level rise*
- Woolcock Ct Drain delivering polluted groundwater and freshening pools
- Chapman St and Kitchener delivering nutrients and metals to Swan River

The Future

- Vegetation likely to change as a result of sea-level rise
  - Halophytes to retreat to margins, along the escarpment
  - Increased dominance of sedges or open water
  - Uncertainty whether sediment accretion can keep pace
- Urbanizing drainage may increase impacts to wetland
- Wetland will continue to trap heavy metals, but phytotoxic thresholds may be reached
- Drainage interventions have potential to improve water and sediment quality
- Land use and management will likely change