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Understanding groundwater - surface water dynamics within the catchment of Bell Harbour Bay, Ireland, using Infoworks® ICM

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43rd IAH CONGRESS
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European Union
European Regional Development Fund

Science Foundation Ireland sfi For what's next

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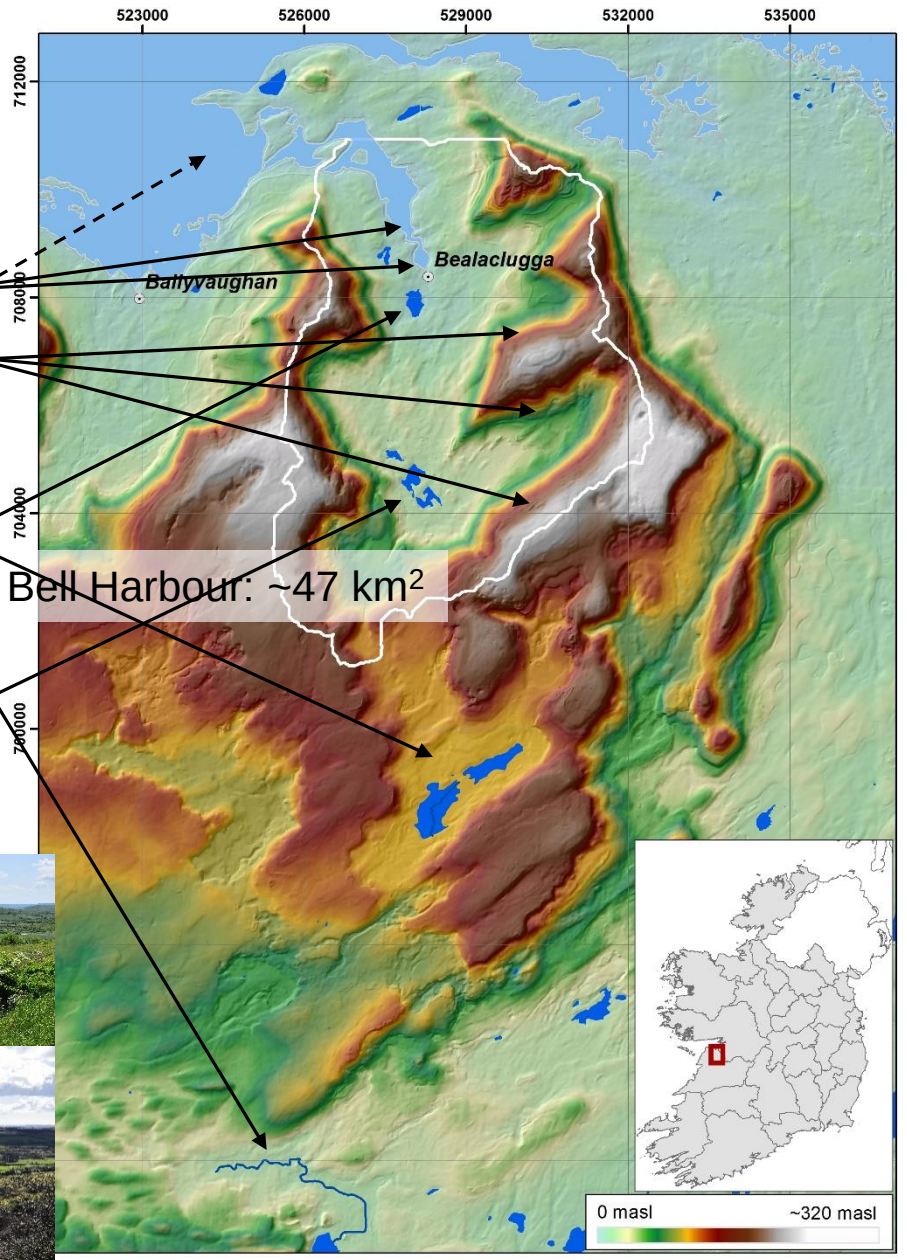
Bell Harbour

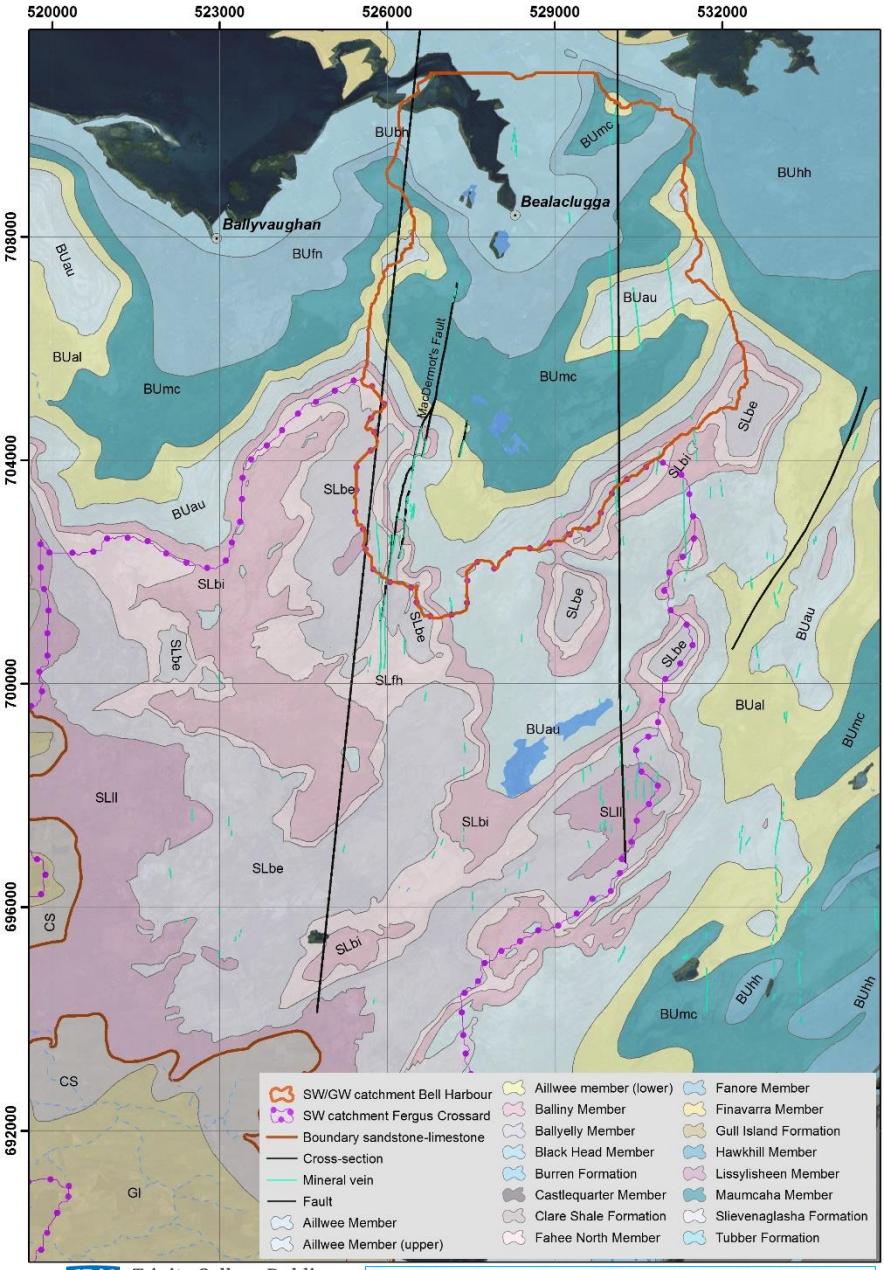
- Groundwater (GW):
  - Submarine/ intertidal springs
  - Minor springs along the hills
- Surface water (SW):
  - Fergus River (~30 masl)
  - Carron depression (110 masl)
- GW/SW
  - Luirk (1.5 masl)
  - Gortboyheen (15.2 masl)



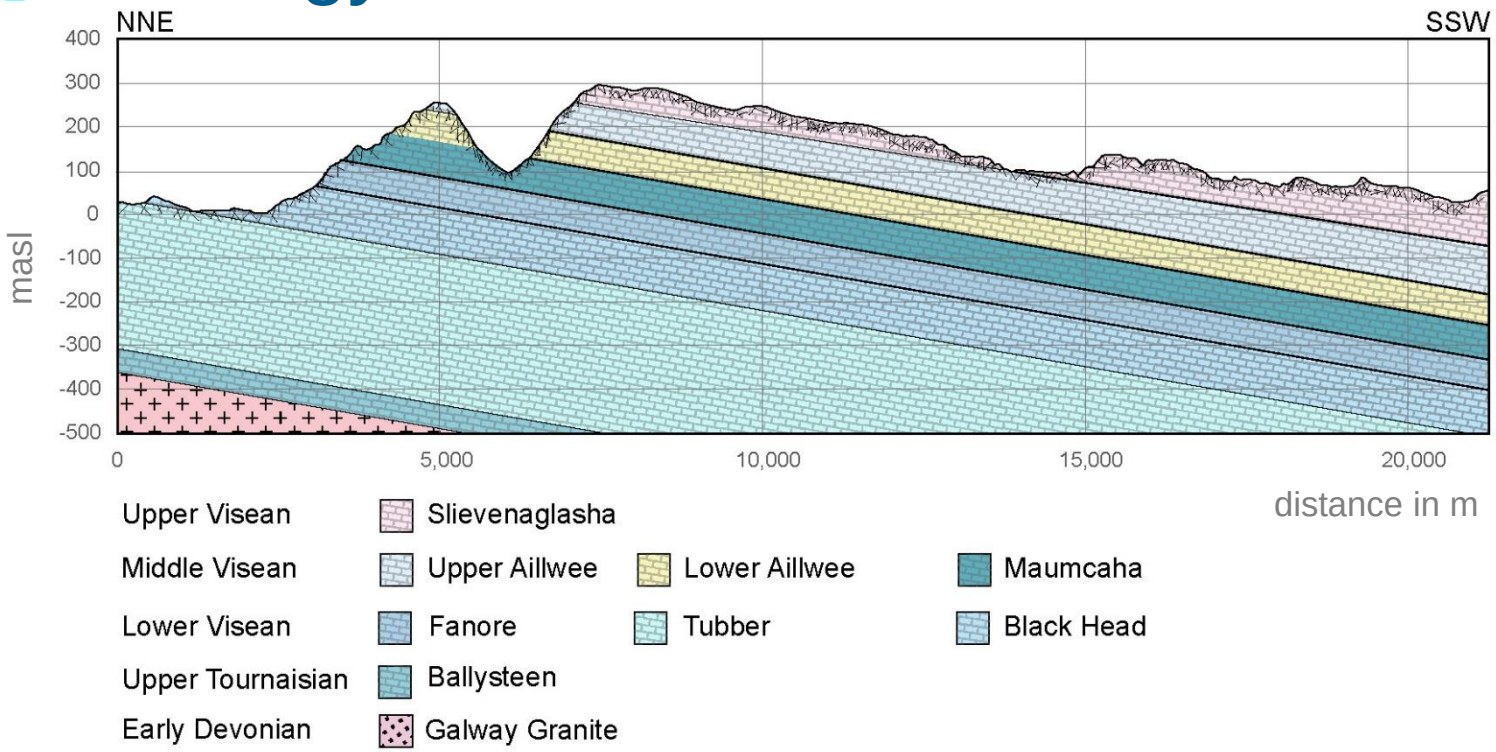
Geology

Period	Age (Ma)		Formation	Member	(m)
Upper Carboniferous	326.5 - 313	Namurian	Gull Island		
			Clare Shale		
Lower Carboniferous: Visean	333 - 326.5	Brigantian	Slievenaglasha 95 m	Lissylisheen	1-2
				Ballyelly	32-33
				Fahee North	25
				Balliny	36
	337.5 - 333	Asbian	Upper Burren 230 m	Upper Aillwee	152
				Lower Aillwee	
				Maumcaha	80
			Lower Burren 159 m	Fanore	71
				Black-Head	88
	346.7 - 337.5	Holkerian	Tubber 300 m	Finavarra	>26
		Ardunian		…	
Tournaisian		Chadian		…	

(GALLAGHER, ET AL. 2006; PRACHT, 2004)



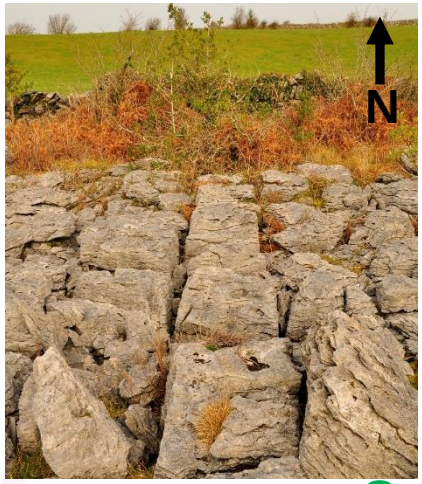
Geology



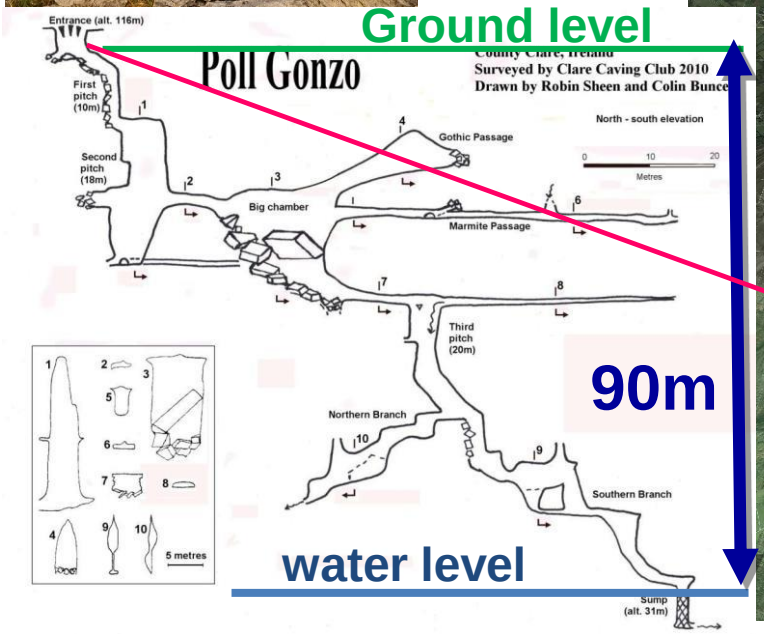
Upper Aillwee outcrop in the Burren

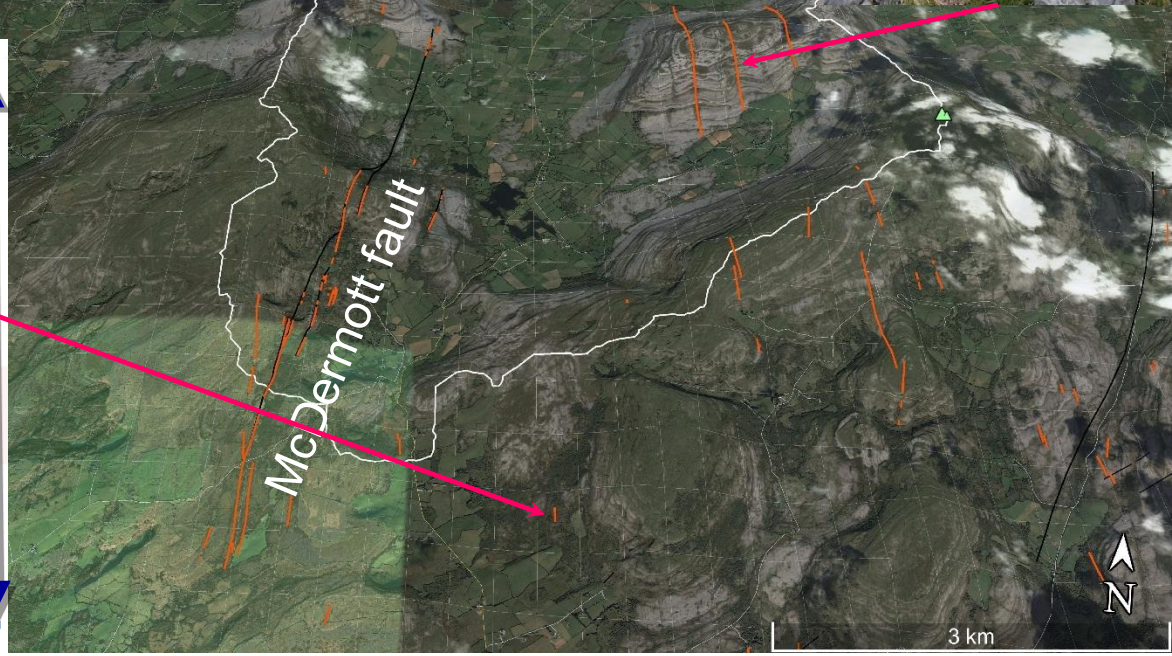
Structure: faults, joints and veins

Mineral veins



Network of grykes and clints

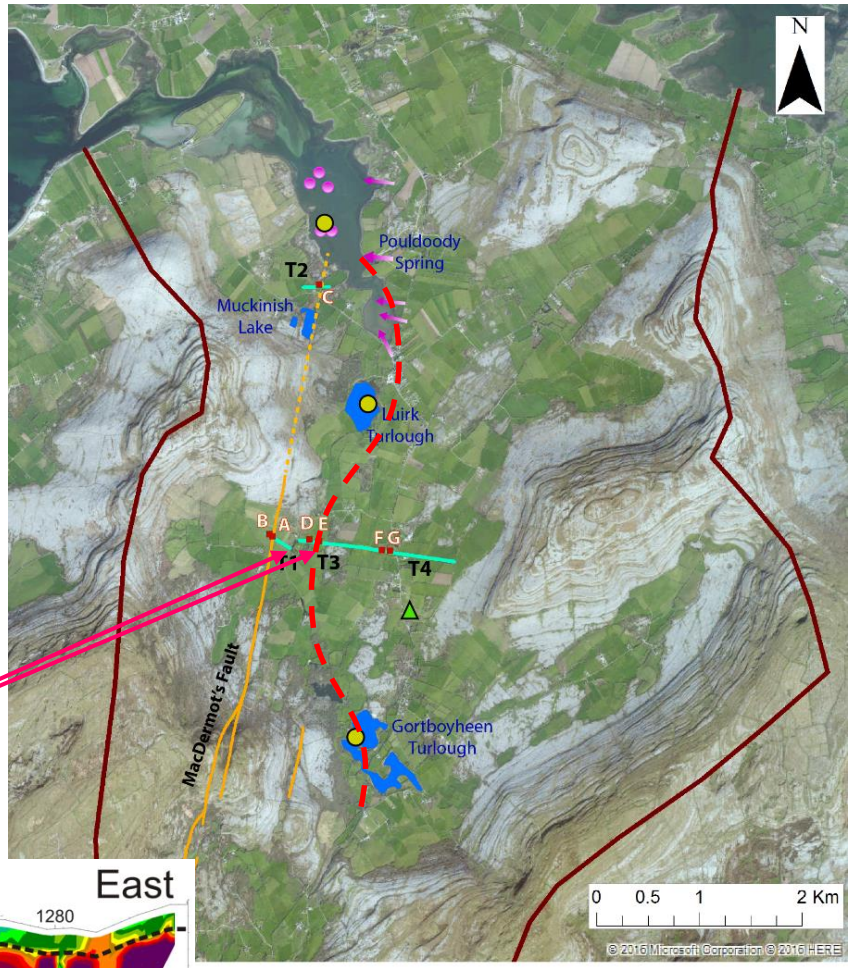


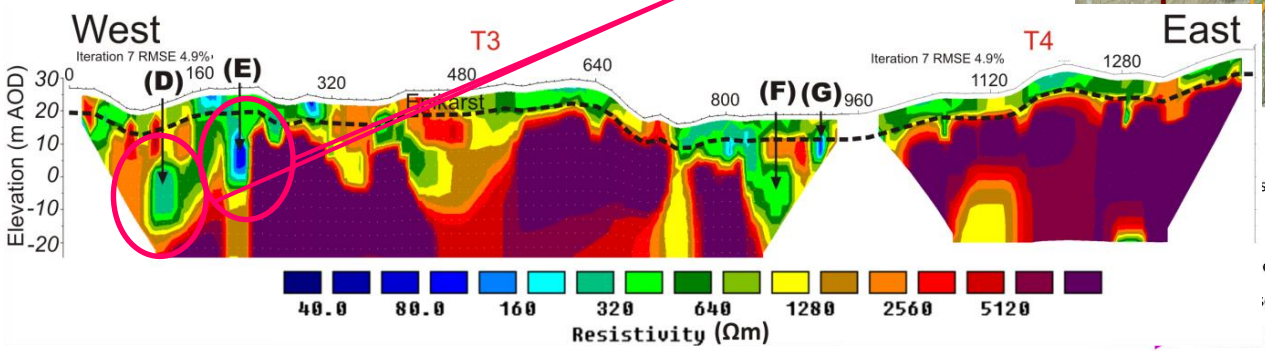


(SHEEN & BUNCE, 2010)

Hydrogeology

- Geophysics (McCormack et al., *in progress*)
- Shallow conduit
- Deeper conduit systems exists (40 - 50 & 70 – 80 mbgl) (Drew, pers. comm.; Goodman, et al. 2004; Kozlowski, 2010)





our Subcatchment Boundary
ects (T1, T2 etc)
Springs

Submarine Springs
Depth Logger Locations
Raingauge
ERT Low Resistivity Zones

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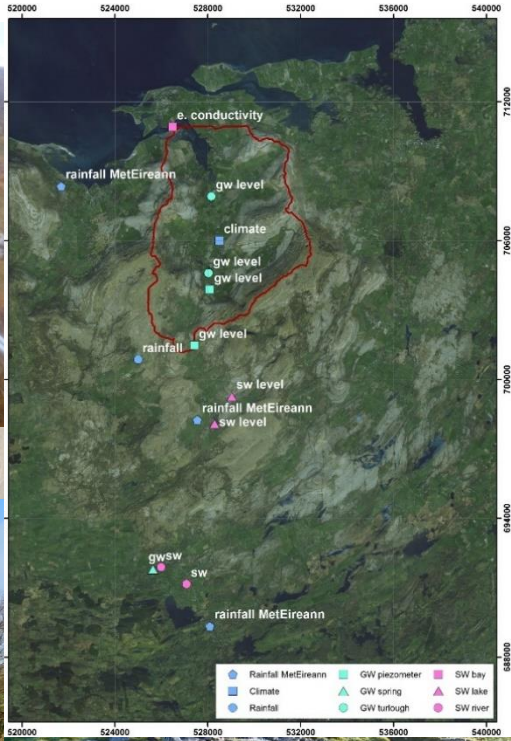
Field Sampling

CTD Buoy Sampler for Bell Harbour Bay: EC & depth

OTT ADCP at Fergus river: Rating curve

DGPS



Weather station in the Burren at ~34 masl: T, RHum, rain, netrad, wind speed, wind dir

Tipping bucket at ~200 masl: rainfall

Turlough water level platform, equipped with diver

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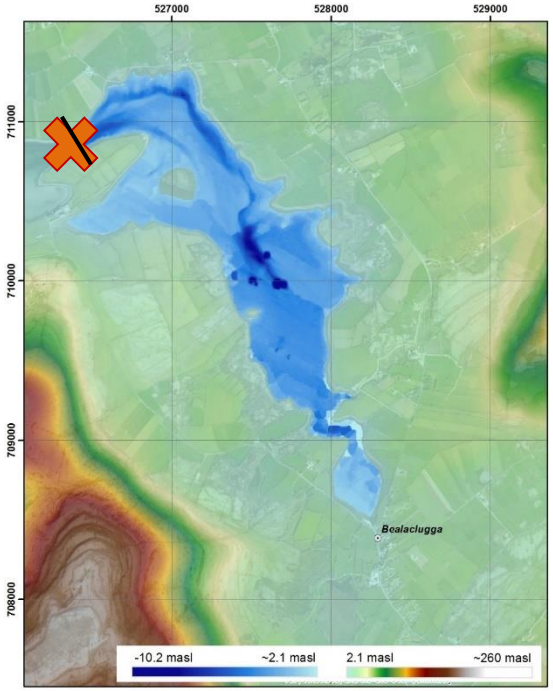
Freshwater discharge Bell Harbour Bay

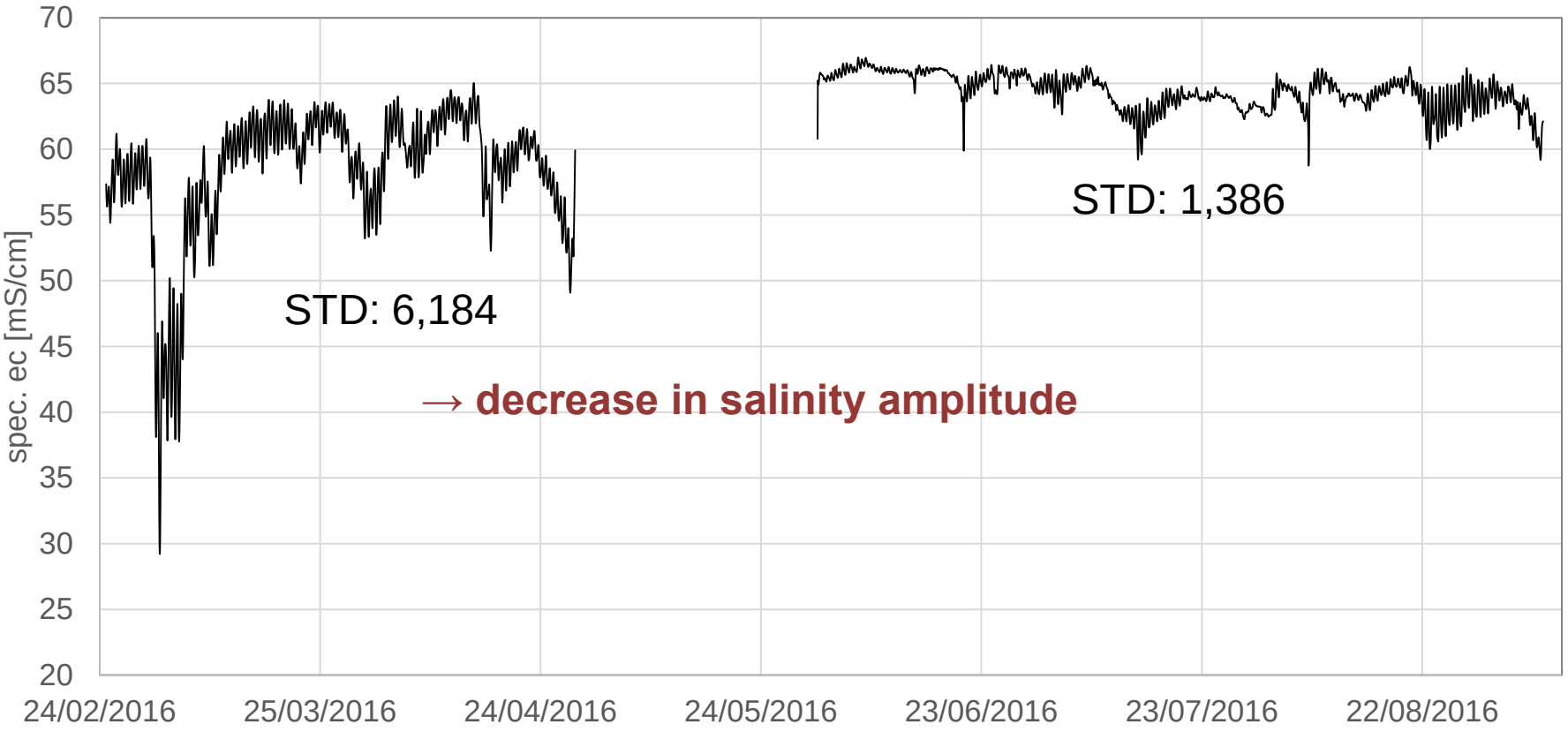
- Tidal Prism model (BARBER, 2003; BARBER AND WEARING, 2004)
- Modelling of **pollution flushing** in well-mixed tidal embayments:
  - Ebb tide:

$$C_{e(n)} = C_0 \left[\frac{V_m - V_t^*}{V_m + V_t^*} \right]^{(n-1)} \exp \left\{ \frac{-\pi Q_f n}{\omega \sqrt{V_m^2 - V_t^{*2}}} \right\}$$

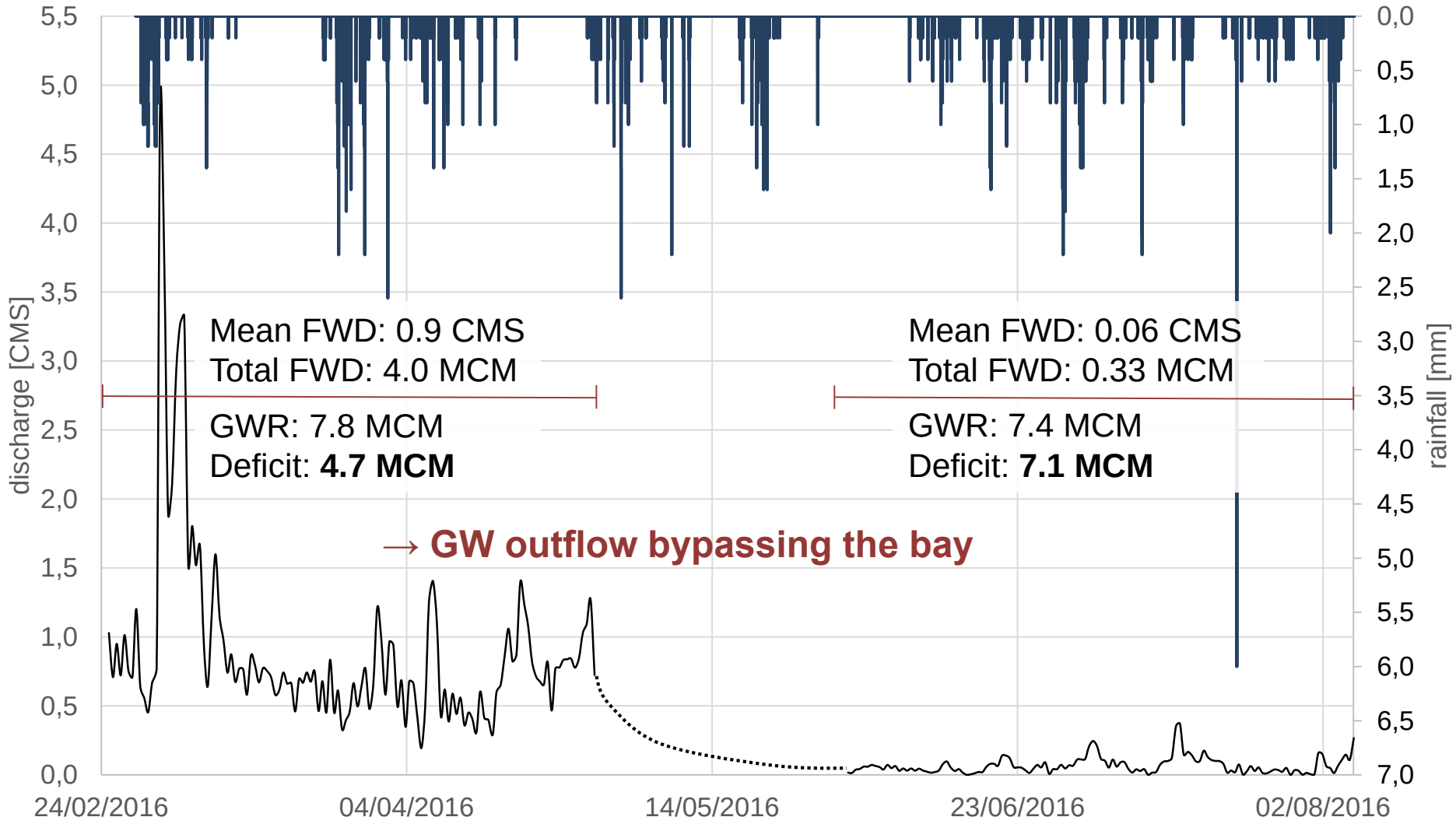
Where $c_{e(n)}$ = is the pollutant concentration after ebb tide *n*,
c_0 = initial concentration at the start of the simulation,
Q_f = steady freshwater inflow from the surrounding land,
ω = tidal angular frequency given by ω = 2π/T where T is the period of the tide,
V_m = mean volume of the basin, and
V_{t*} = amplitude of the oscillatory component of the tidal volume, incl. return flow factor



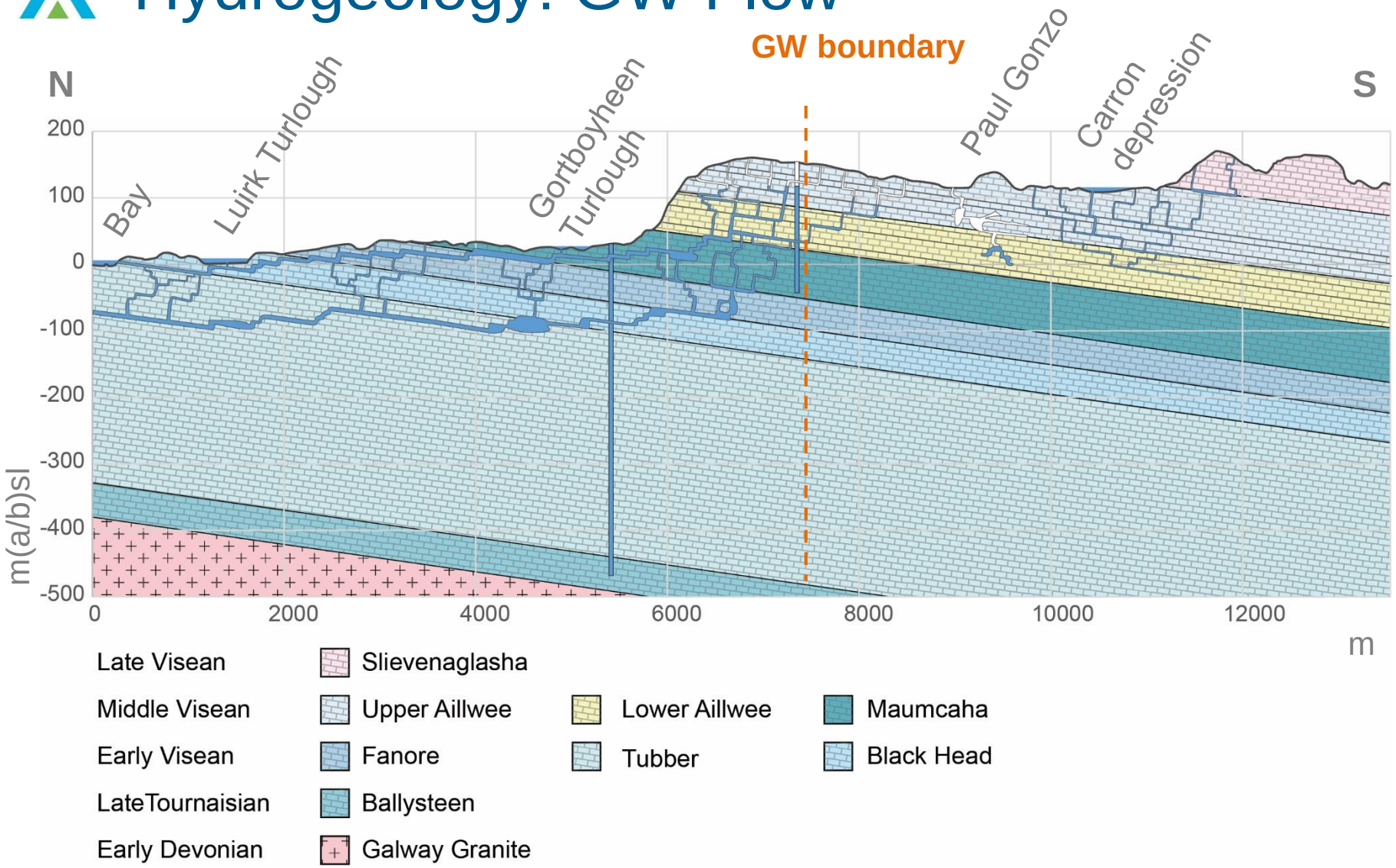
EC records



Freshwater discharge Bell Harbour Bay

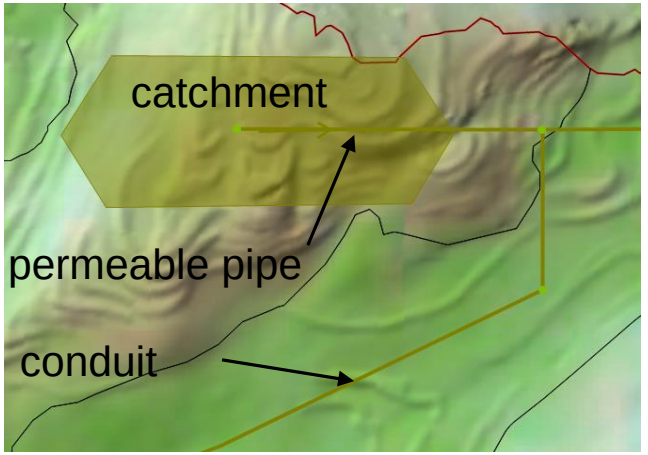


Hydrogeology: GW Flow

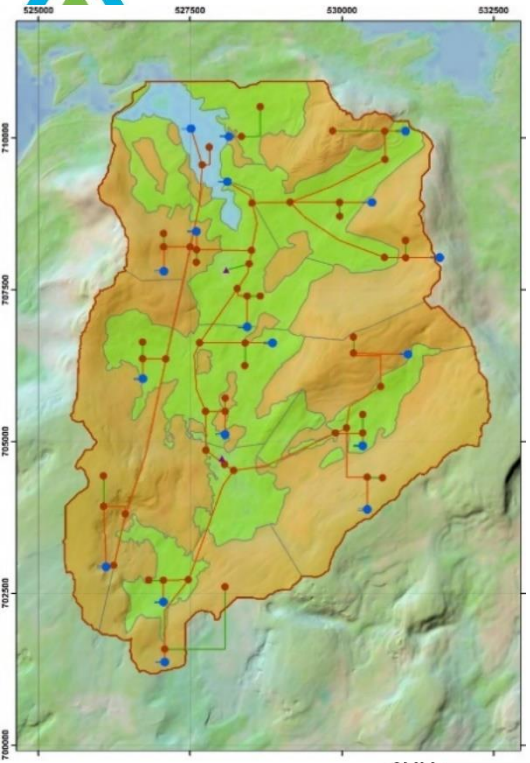


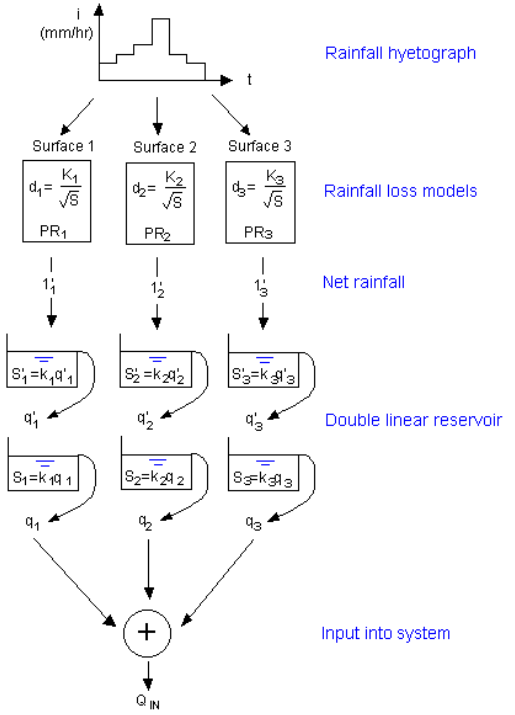
InfoWorks® ICM

- Urban drainage modelling software
- Catchment modelling (Gill, 2010; Gill, et al. 2013; McCormack, 2014; McCormack et al. 2014):
  - Slow flow in permeable pipes: Darcy's Law $Q = -KA\left(\Delta h / L\right)$
  - Fast flow empty conduits: Saint-Venant equations, conveyance by Colebrook-White function



Model Structure

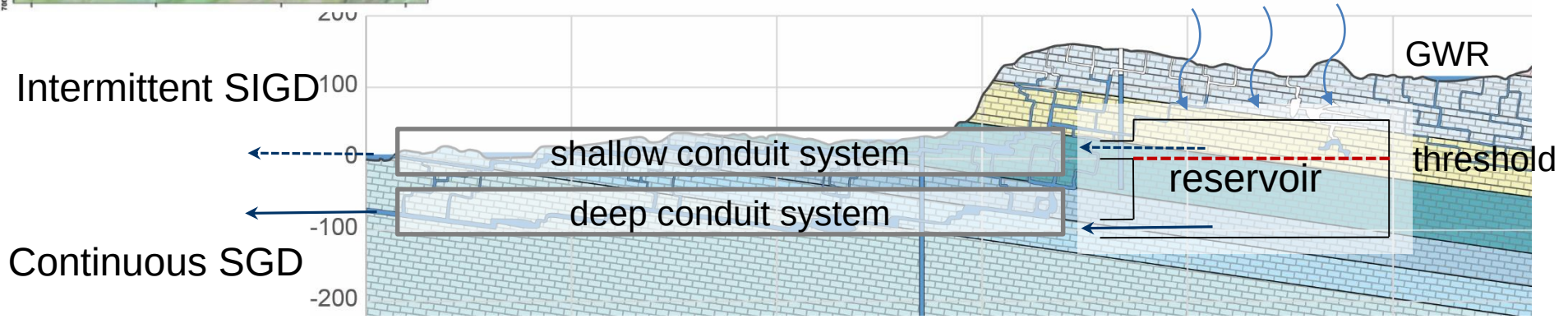




ET

Catchment: Rainfall/Runoff

SR

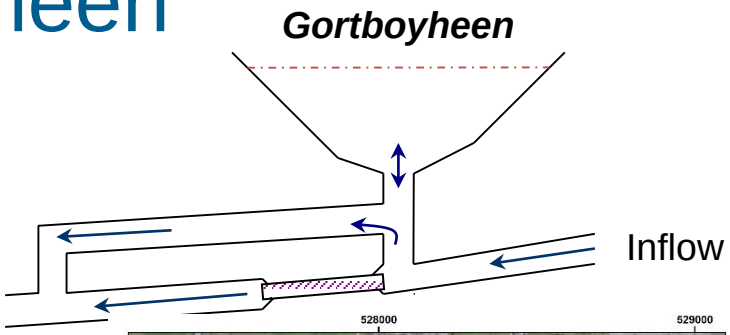


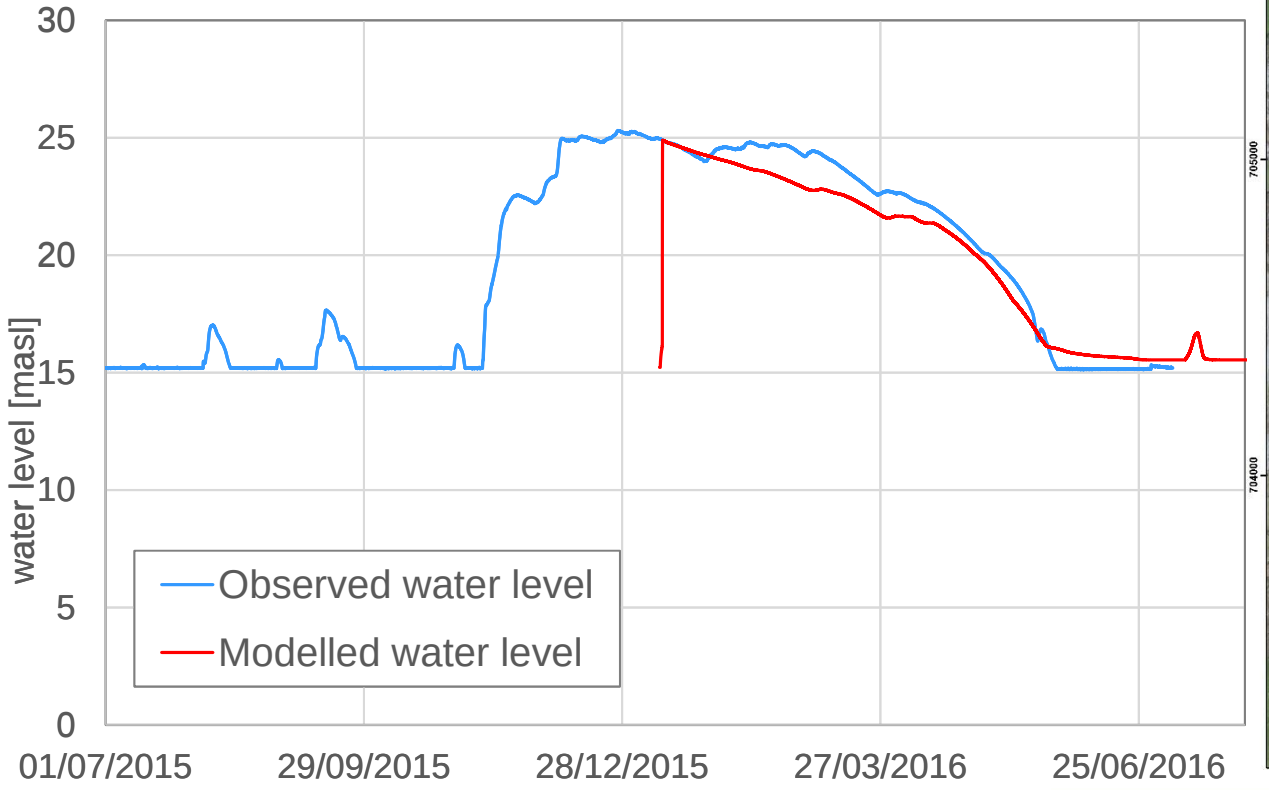
Calibration

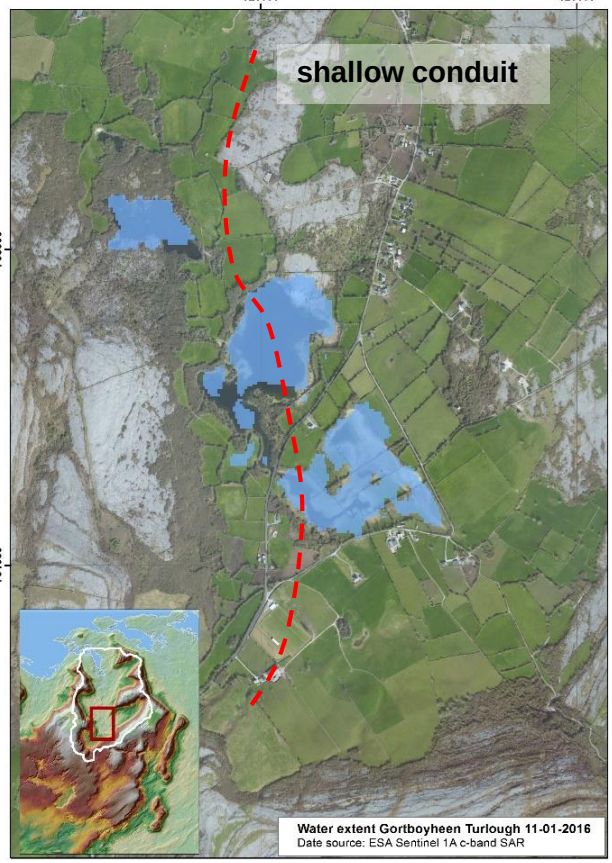
- GW recharge (HUNTER WILLIAMS ET AL., 2013)
- Turlough water level fluctuations of Gortboyheen and Luirk

- Freshwater discharge

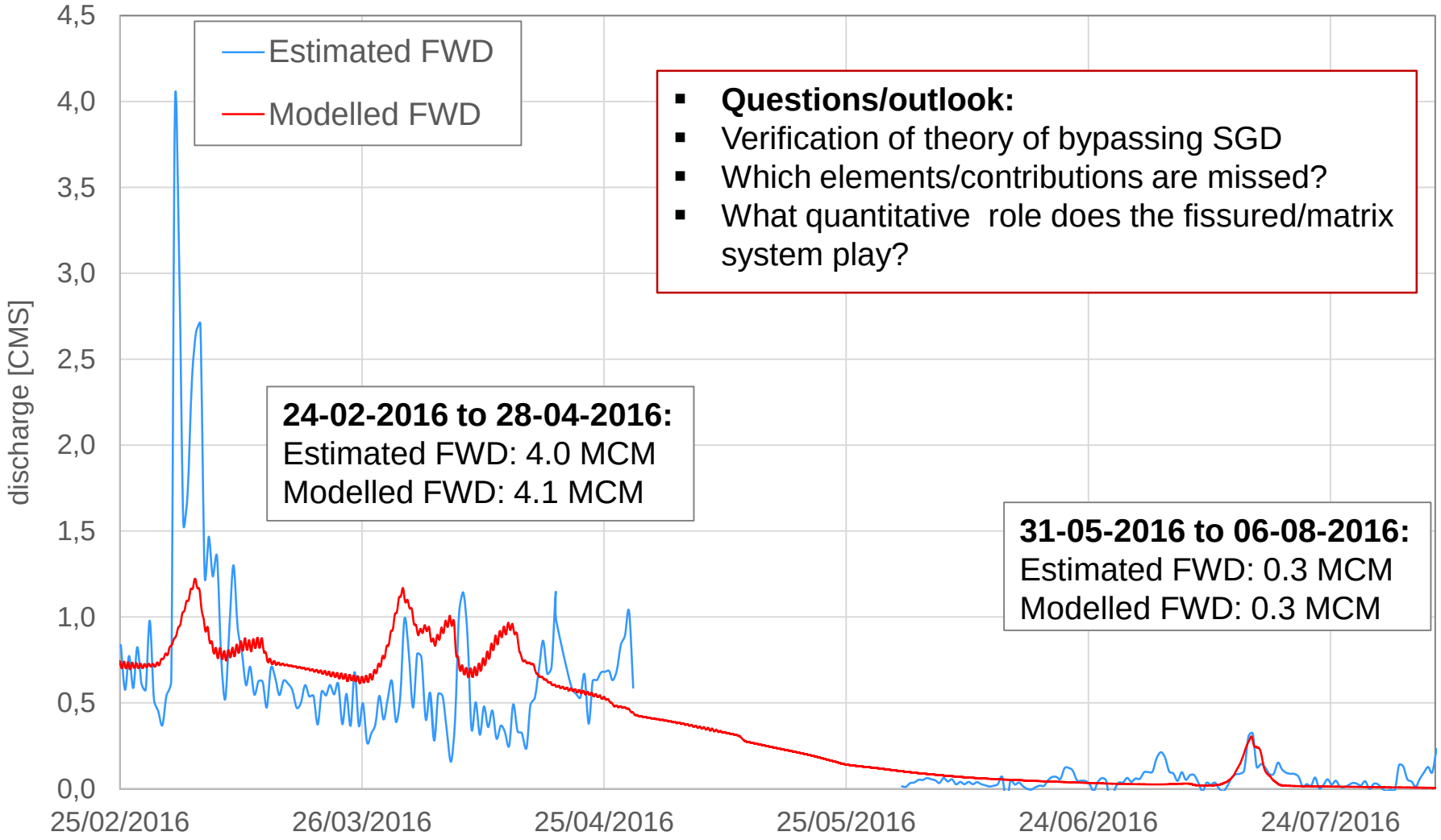
Results: Turlough Gortboyheen







Results: Freshwater discharge



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merci & thank you for your attention!

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