

EGU2020: Sharing Geoscience Online

Session HS8.2.12

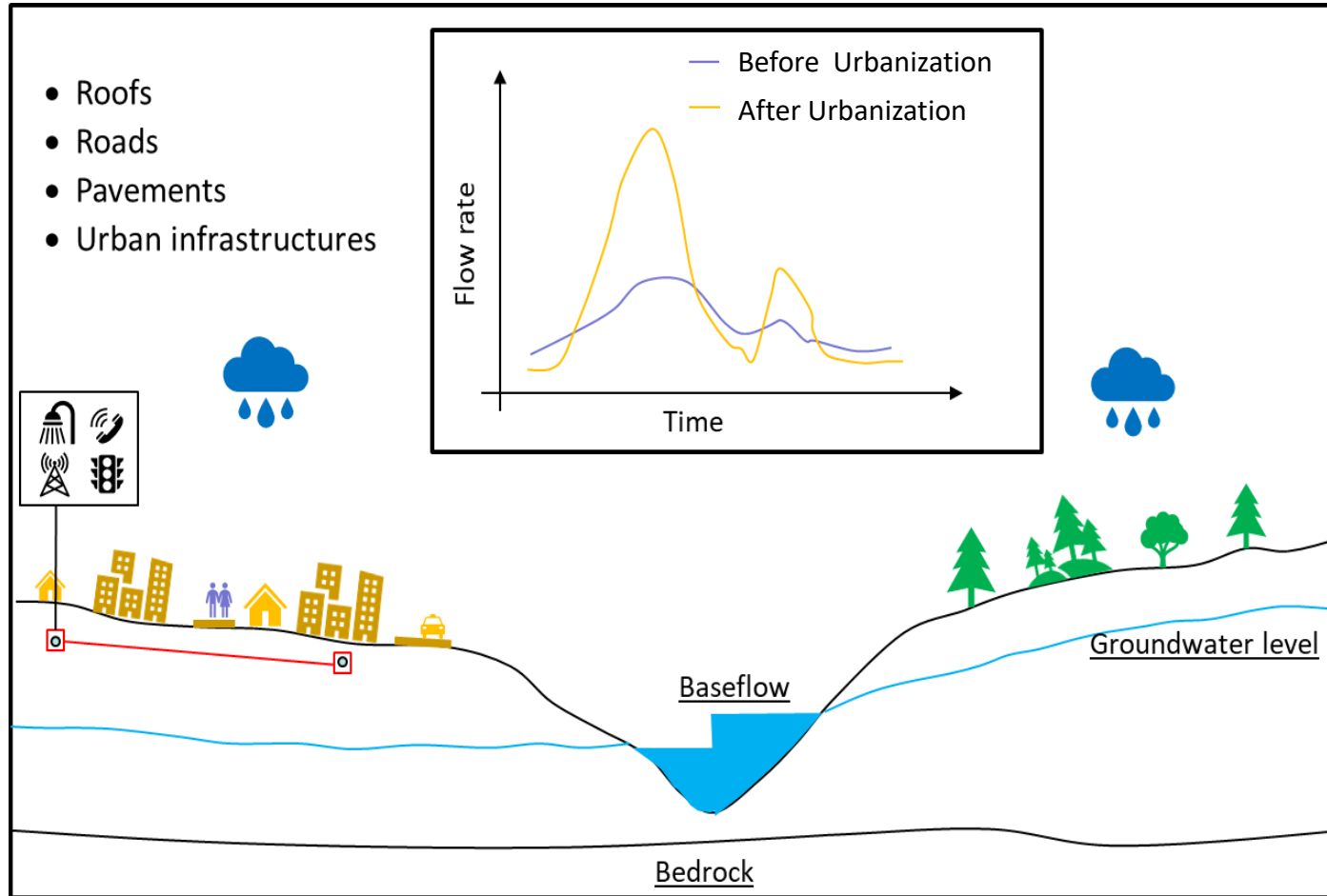
The fate of infiltrated stormwater from infiltration basins to the stream: quantifying the impact of the urban karst

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Urbanization



Impacts on hydrology:

- Increased stormwater runoff volumes
- Magnitude and frequency of peak flows
- Less groundwater recharge
- Soil and water pollution

Water Sensitive Urban Design



Rain Gardens

Infiltration based measures



Infiltration Basins



Detention Ponds



Filter Strips



Porous Pavements



Wetlands

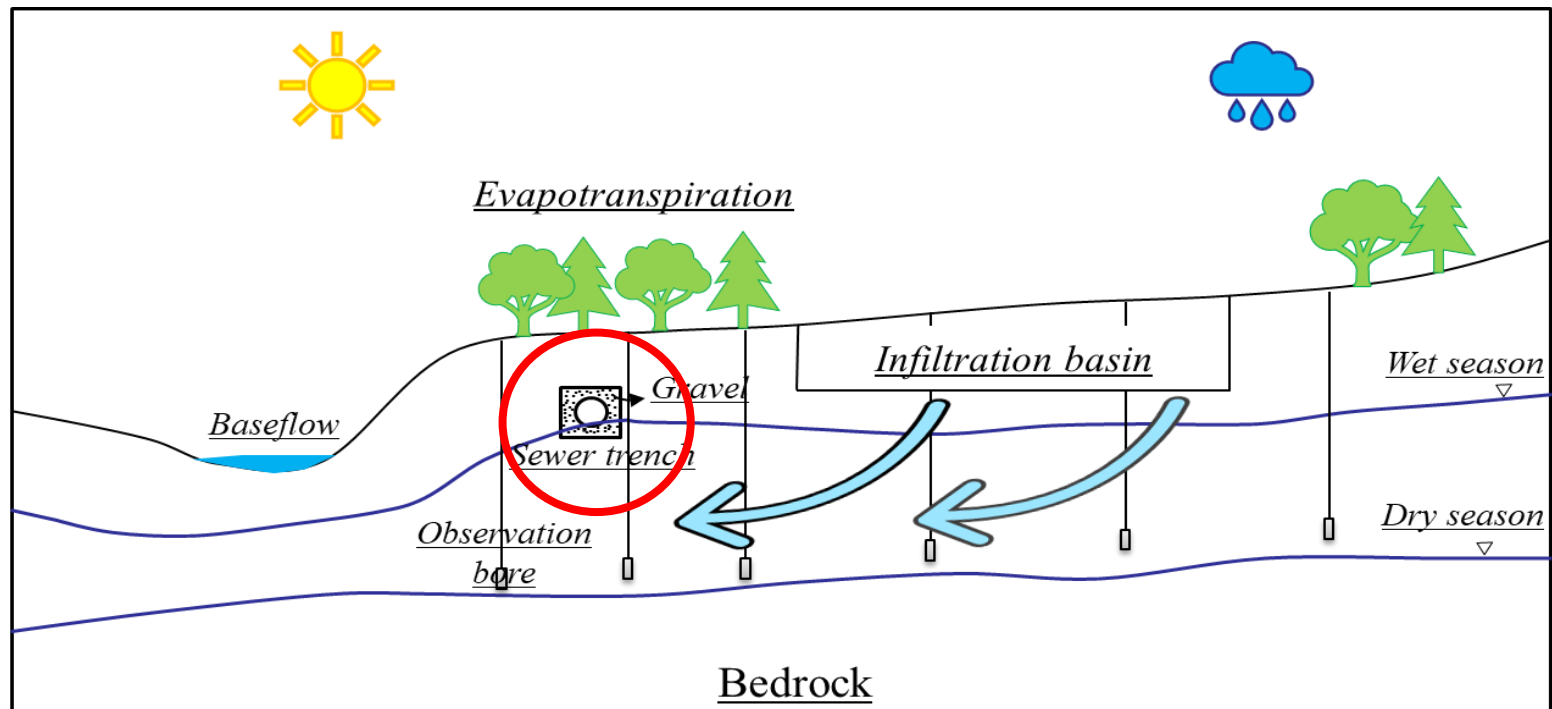
Stormwater Control Measures (SCMs)

Aims:

- Reduce runoff volumes
 - Recharge groundwater by infiltrating water to the sub-surface
 - Reduce pollution discharges to receiving waters
- ✓ Infiltration basins are one of the most commonly used technologies to achieve those aims.
- ✓ Infiltration-based measures play a central role in addressing the low-flow impacts of urbanization to streams.

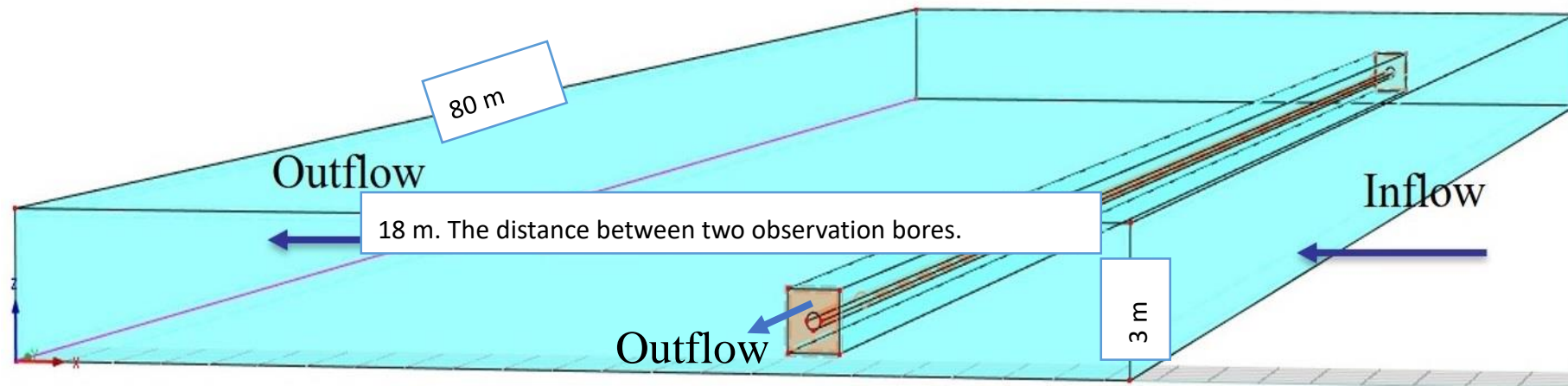
Conceptual model - Questions

- What is the fate of infiltrated stormwater?
- What is the impact of the urban karst on the fate of infiltrated stormwater?
 - Urban infrastructure, such as sewer pipes and telecommunication cables, are usually surrounded by high permeability gravel/sandy trenches collectively known as 'the urban karst'



Methodology

- Develop a model for one site, then try to generalize the results
- Modelling the impact of the urban karst on infiltrated stormwater using HYDRUS-3D



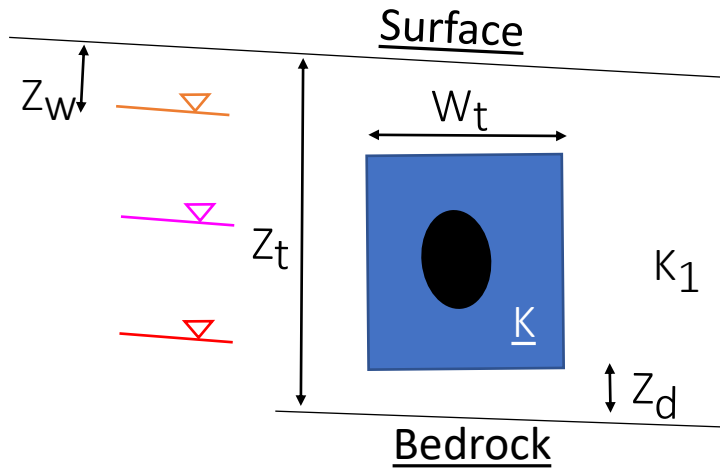
How to generalize the results?

- Propose equations based on groundwater level and the hydraulic conductivities of soil and gravel/sand

- $\frac{K_1}{K}$

- $1 - \left(\frac{Z_d}{Z_t - Z_w} \right)$

- Ratio = $\frac{(((Z_t - Z_w - Z_d) \times W_t) - \pi r^2) \times K \times \tan \alpha}{(Z_t - Z_w) \times W_z \times K_1 \times \tan \beta}$

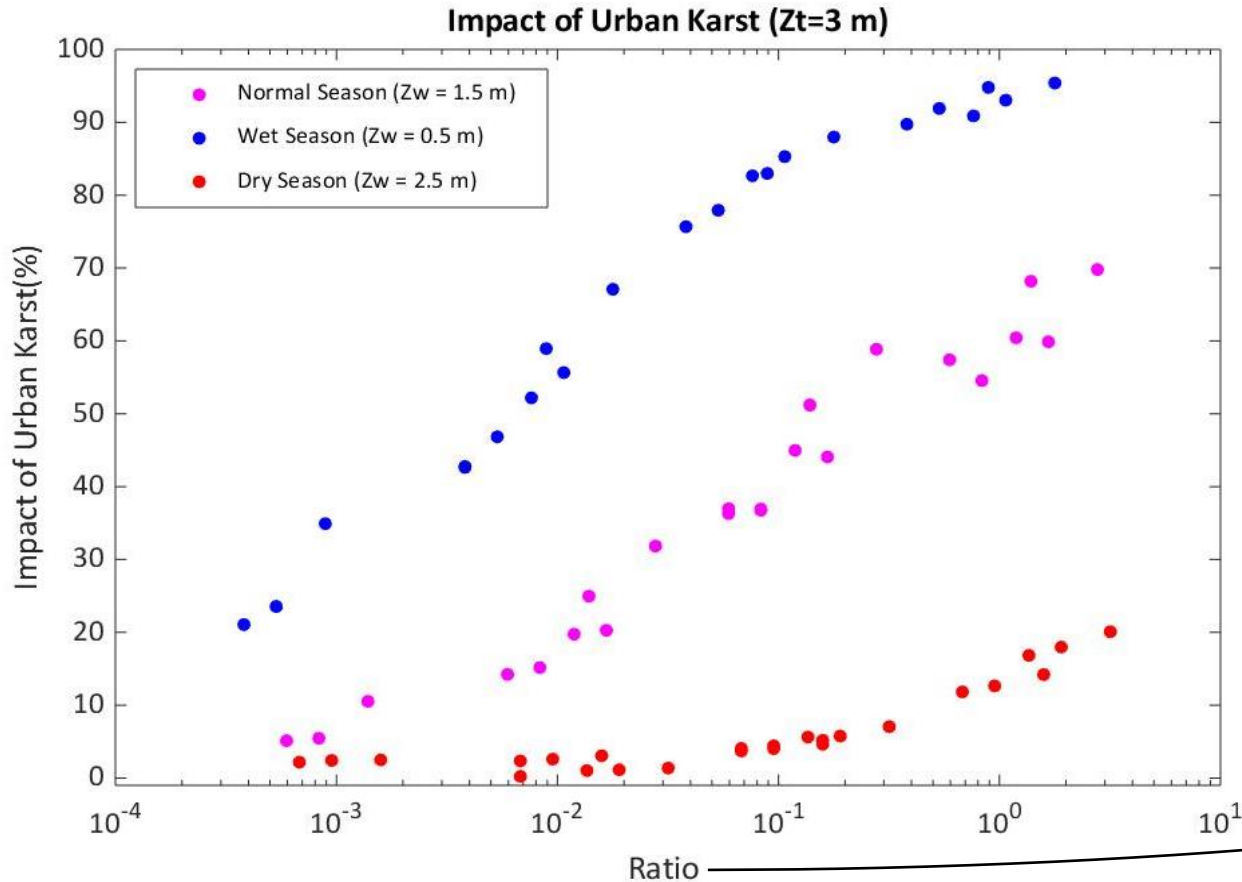


- K : Hydraulic conductivity of gravel/sand
- K_1 : Hydraulic conductivity of soil
- Z_w : Groundwater level

	Variable				Constant			
	Z_w (m)	K_t (m/day)	K_z (m/day)	$\tan \beta$	Z_t (m)	W_t (m)	W_z (m)	$\tan \alpha$
Value 1	1.5	20	0.002	0.05	3	0.0825	80	0.0017
Value 2	0.5	10	0.02	0.03				
Value 3	2.5	1	0.2	0.07				

Results

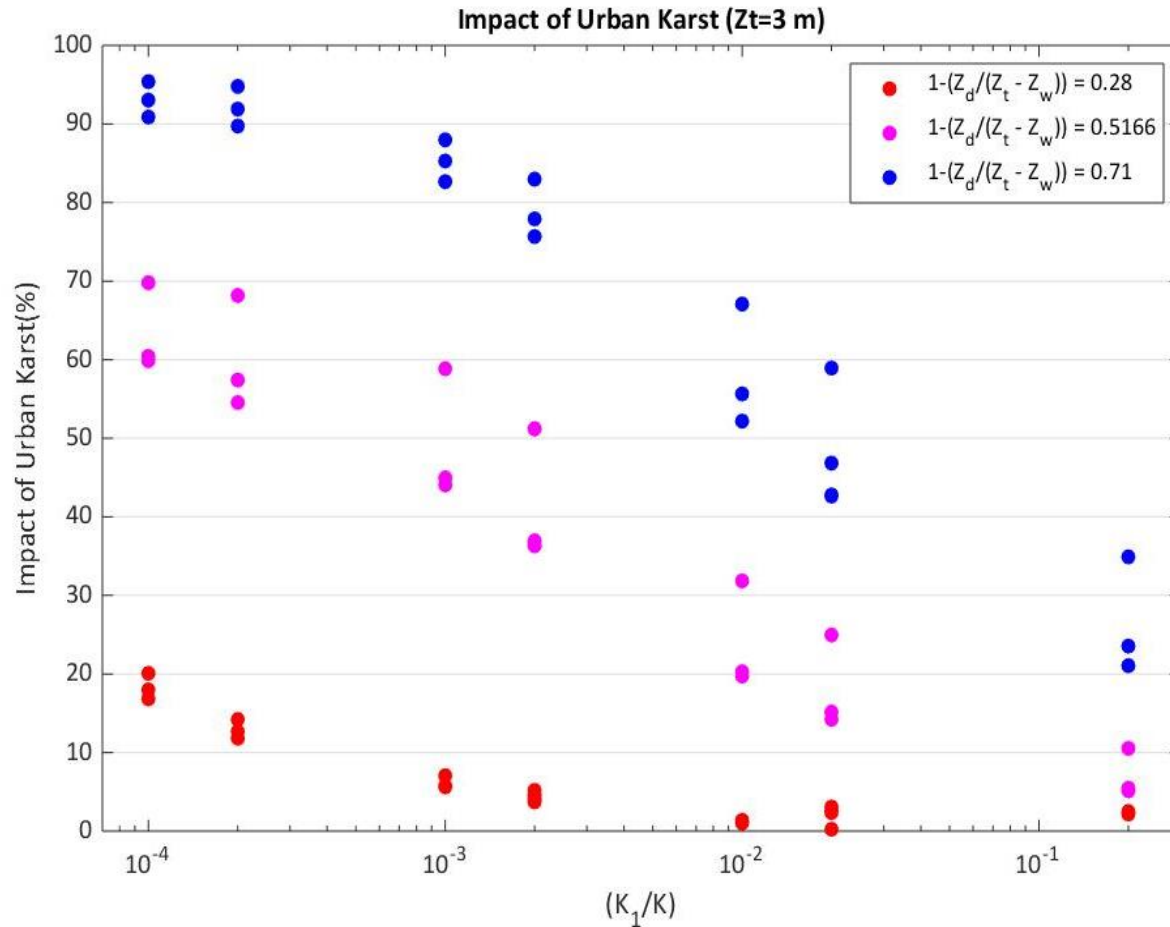
$$\text{Impact of urban karst} = \frac{\text{Inflow to boundary condition (see slide 5)}}{\text{Outflow from urban karst boundary condition (see slide 5)}} \times 100$$



- The higher the groundwater level, the greater the effect of the urban karst on infiltrated stormwater.

$$\text{Ratio} = \frac{(((Z_t - Z_w - Z_d) \times W_t) - \pi r^2) \times K \times \tan \alpha}{(Z_t - Z_w) \times W_z \times K_1 \times \tan \beta}$$

Results



- The greater contrast between hydraulic conductivity of soil and gravel that covers urban infrastructure, the more impact of the urban karst on the infiltrated stormwater.

Conclusion

- Consider impact of the urban karst if goal of infiltration basin is to recharge the baseflow of the stream downslope.
- Basin location is important where urban infrastructure is located between potential infiltration basin sites and downslope stream.
- Impact of the urban karst should be investigated at each specific site before implementing infiltration systems; this study aims to provide simplified representations of impact for design.