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In heavy clay soils, stormwater infiltration trenches with engineered drainage balance the dual objectives of runoff retention and healthy tree growth

Paul Hanley, Tim Fletcher, Steve Livesley, Chris Szota

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L'eau dans la ville | Urban water

Stormwater retention performance of large infiltration trenches designed for suburban streetscapes

Performance de rétention des eaux pluviales des grandes tranchées d'infiltration conçues pour les paysages de banlieue

Paul A. Hanley, Stephen J. Livesley,

Tim F. Fletcher & Christopher Szota

The University of Melbourne



@Paul_A_Hanley

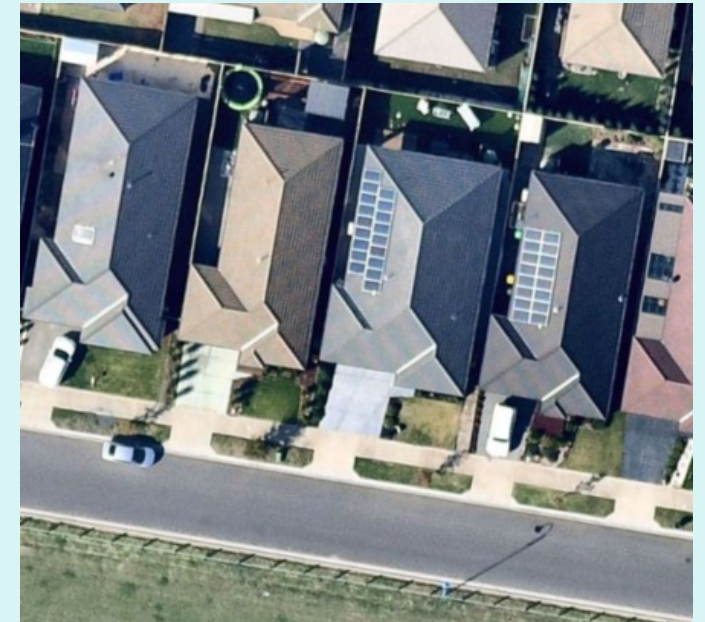
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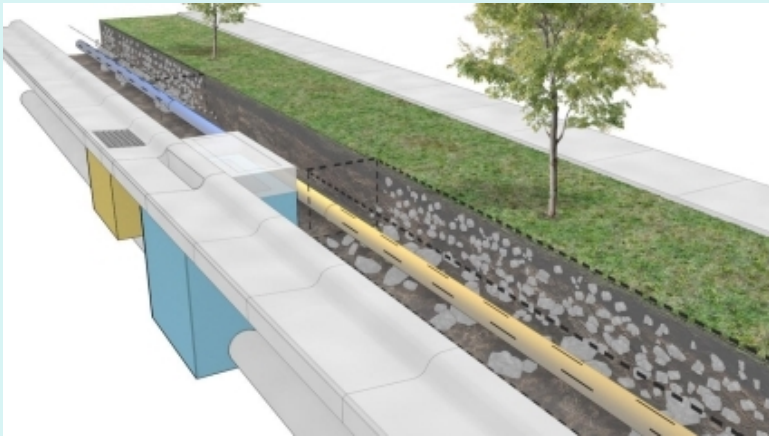
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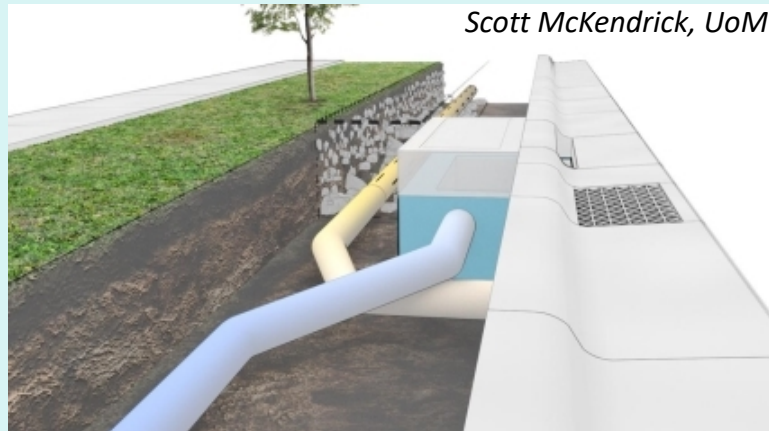
PROBLEM:

- Stormwater degrades streams
- Stream restoration is not possible without volume reduction (Burns et al 2012) – yet targets are hard to achieve
- Interventions at-source are essential to restore pre-development flow regime (Walsh et al 2016) – but space is usually constrained
- Infiltration systems and raingardens often have small system size/catchment area ratios - so runoff reduction % is small

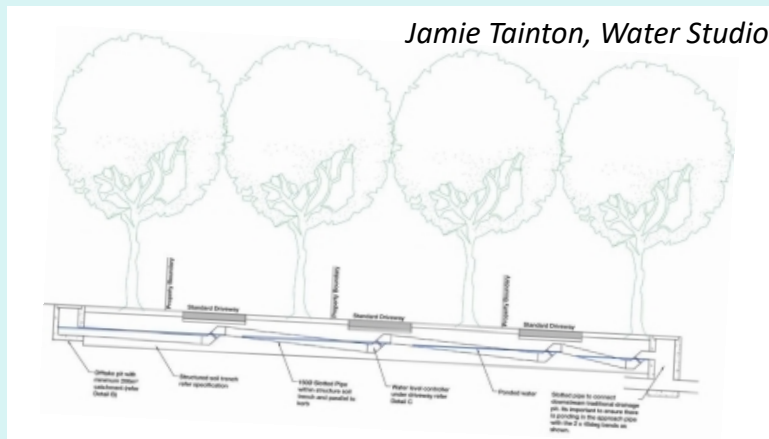




Scott McKendrick, UoM



Jamie Tainton, Water Studio



- Long, continuous structural soil infiltration trenches in suburban streets:
 - big storage volumes & system size/catchment area ratio
 - Can incorporate street trees
 - potentially improve growth


RESEARCH AIMS

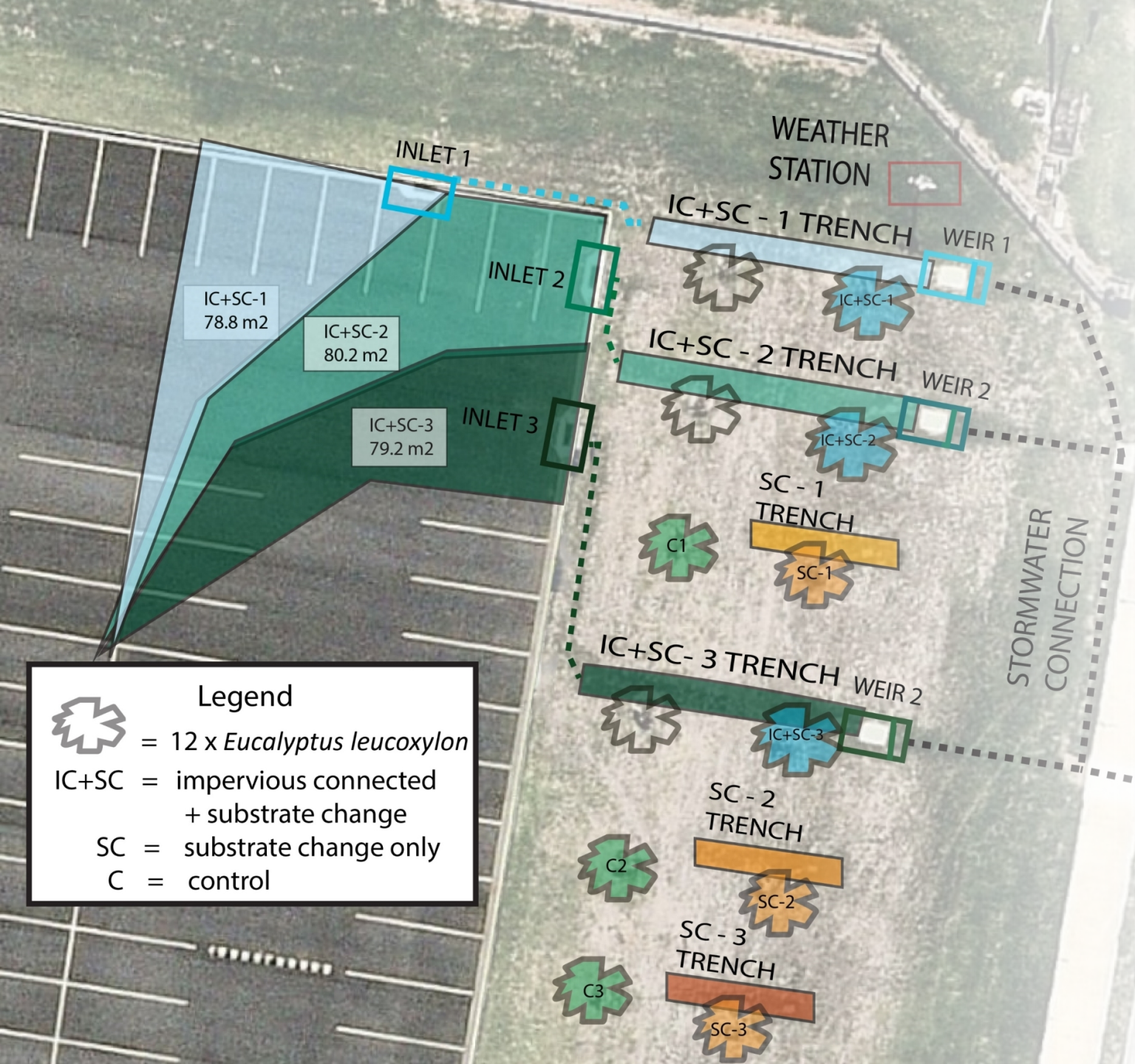
1. How effective is the design at stormwater volume reduction?
2. Does tree growth improve? If so, is it due to additional water or from improved soil conditions?

STUDY APPROACH

- 3 treatments tested:
- Trenches connected to impervious carpark with substrate change (IC+SC)
- Substrate change only (SC) trenches
- Control trees in compacted, heavy clay soil
- Water balance and tree growth monitored for 19 months

Legend

-  = 12 x *Eucalyptus leucoxylon*
- IC+SC = impervious connected + substrate change
- SC = substrate change only
- C = control



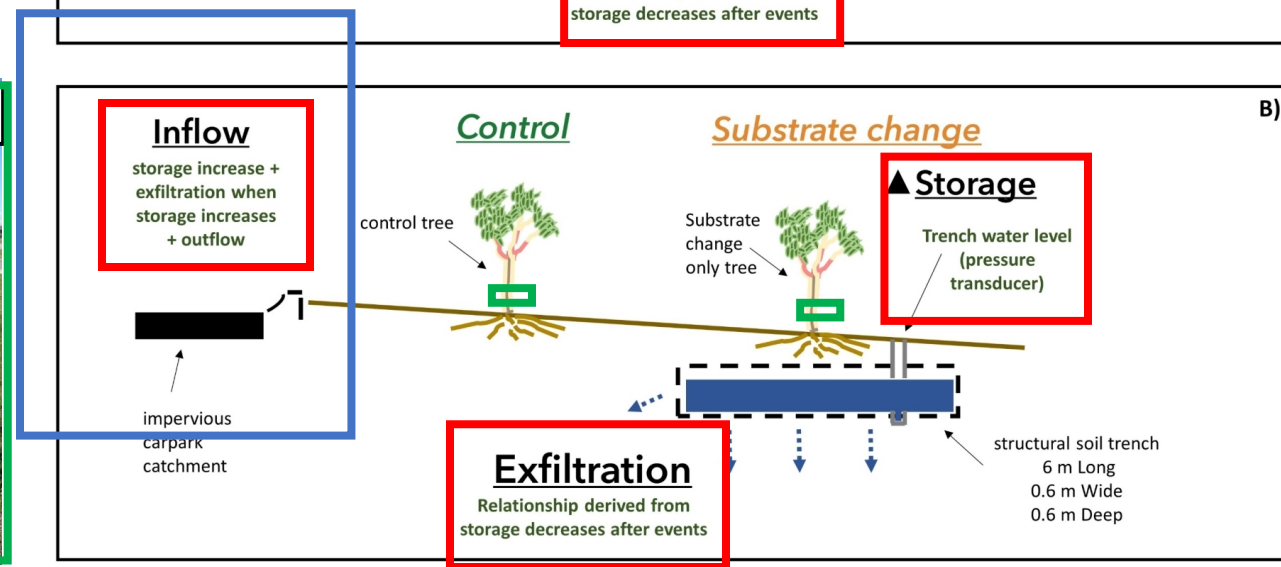
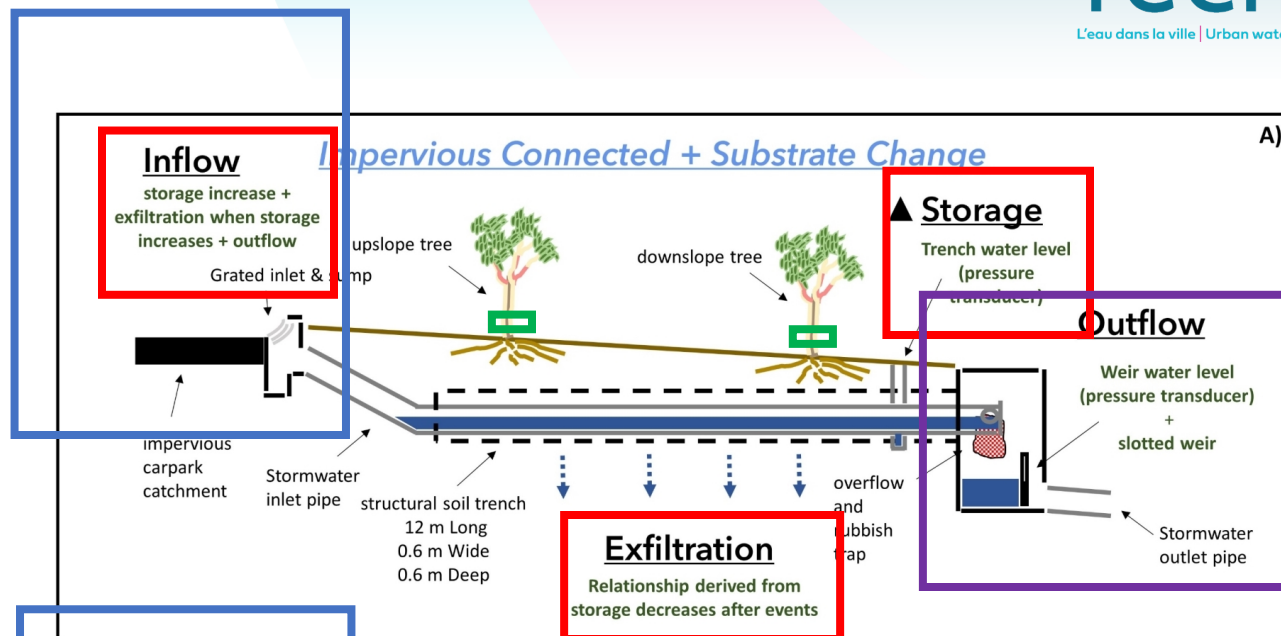
Measurements:

Runoff generation and retention (all 1 min timestep data)

1. Water level in each trench
2. Outflow (via weir water level)
3. Rainfall

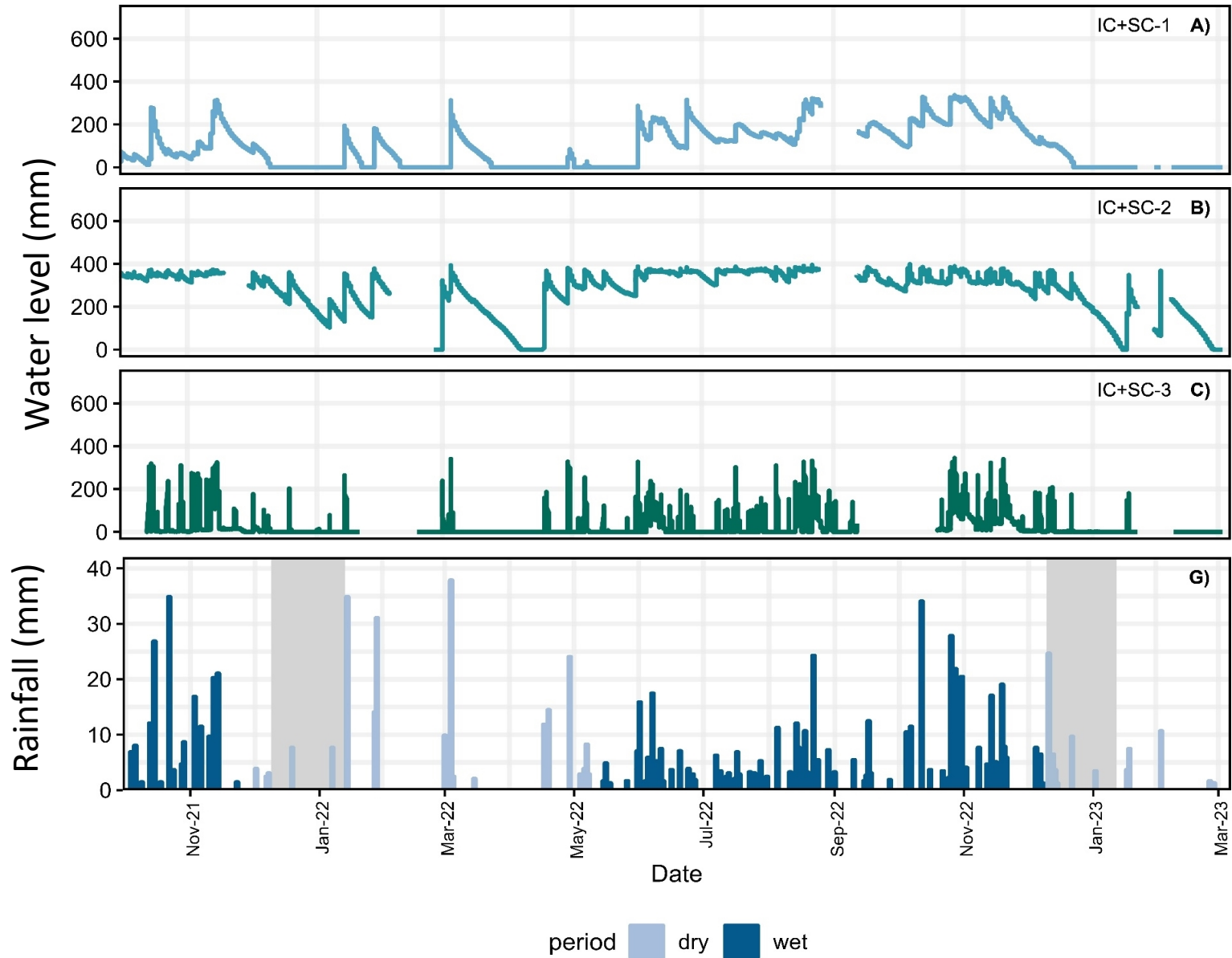
Tree growth

4. **Stem diameter**, tree height, canopy width

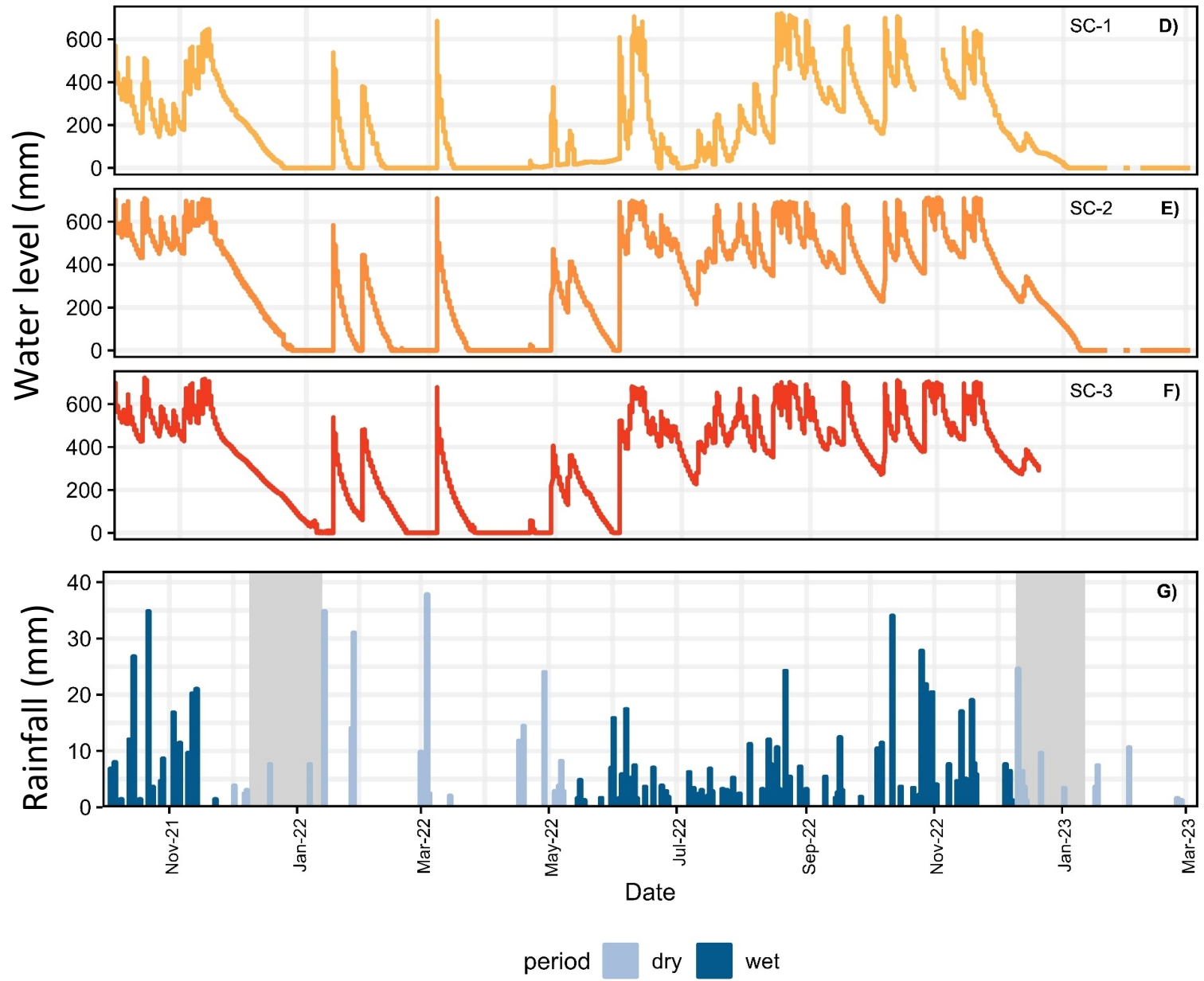


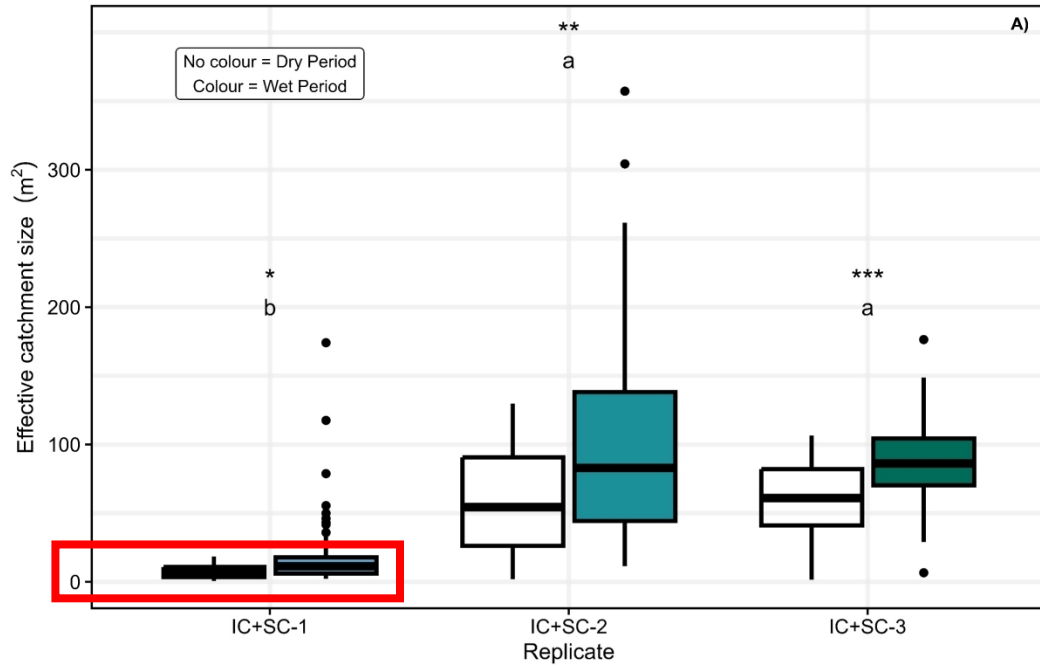
Results and discussion

Impervious connected +
substrate change



Substrate change only





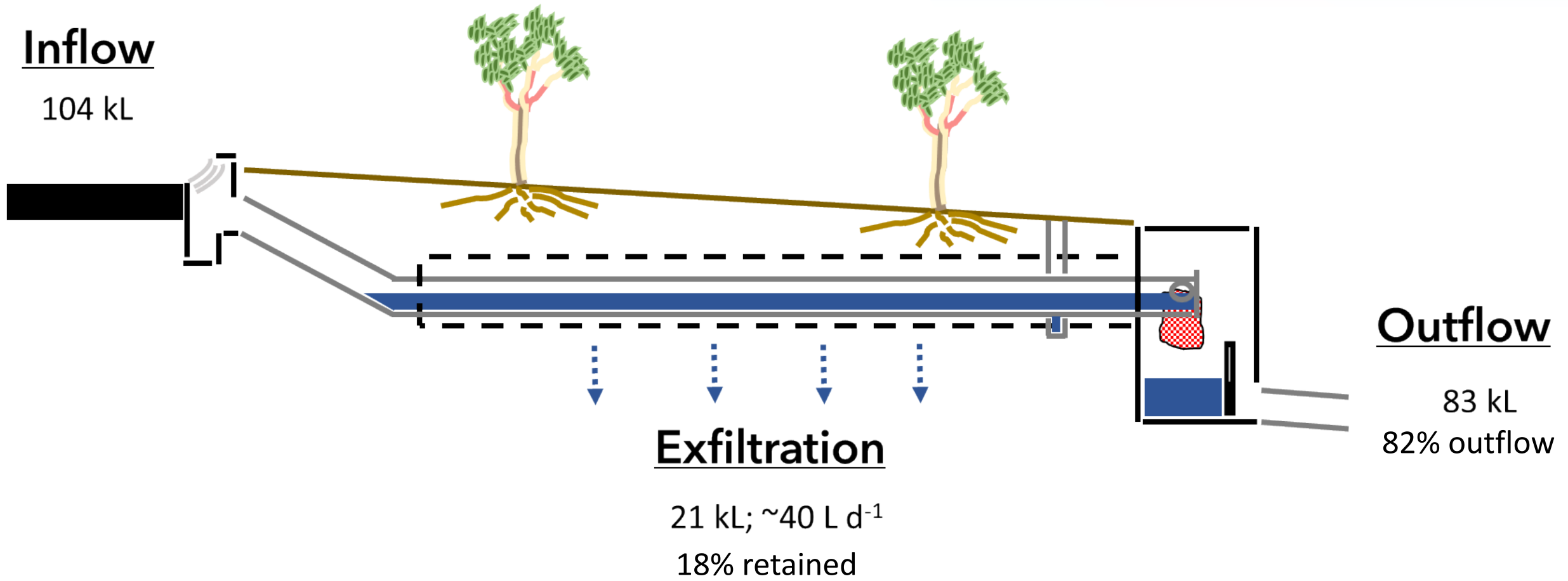
What drives retention and explains differences in IC+SC?

- IC+SC-1 catchment a lot smaller than designed – drained into IC+SC-2
- Exfiltration rates were extremely slow (>0.2 mm/hr)
- IC+SC-3 Exfiltration – mean 1 mm/hr and max of 28 mm/hr



IC+SC-2

Passive Irrigation



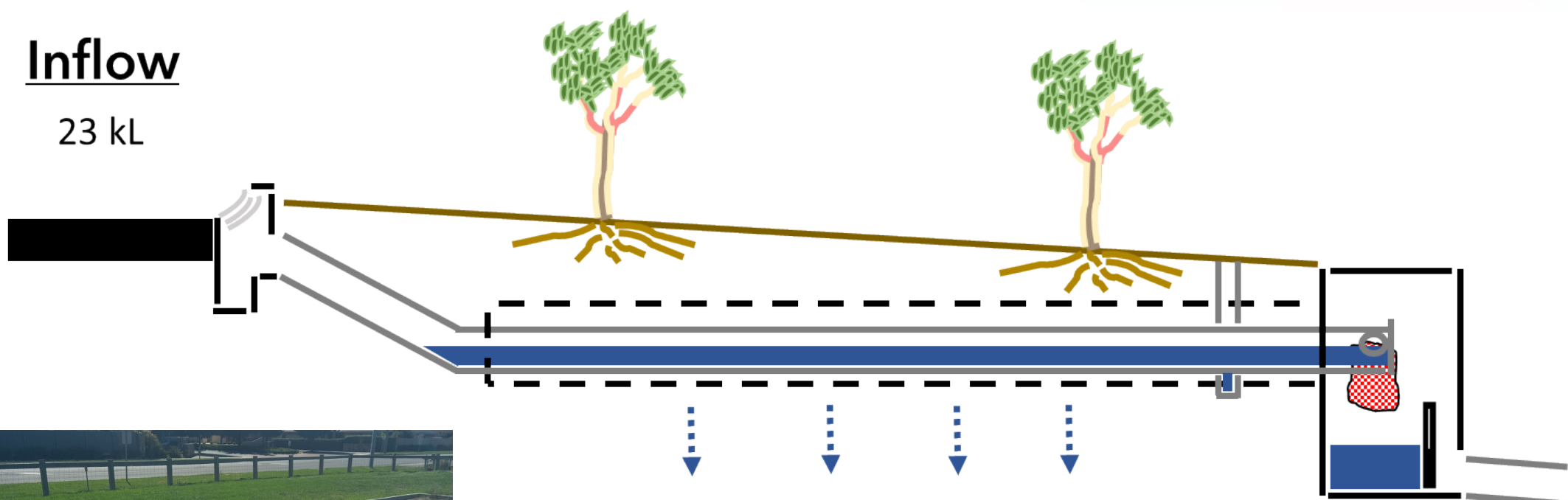
Super-slow exfiltration rate
($<0.5 \text{ mm hr}^{-1}$): heavy clay.

System: Catchment = 6%

IC+SC-1

Passive Irrigation

Inflow
23 kL



Outflow
8 kL
43% outflow

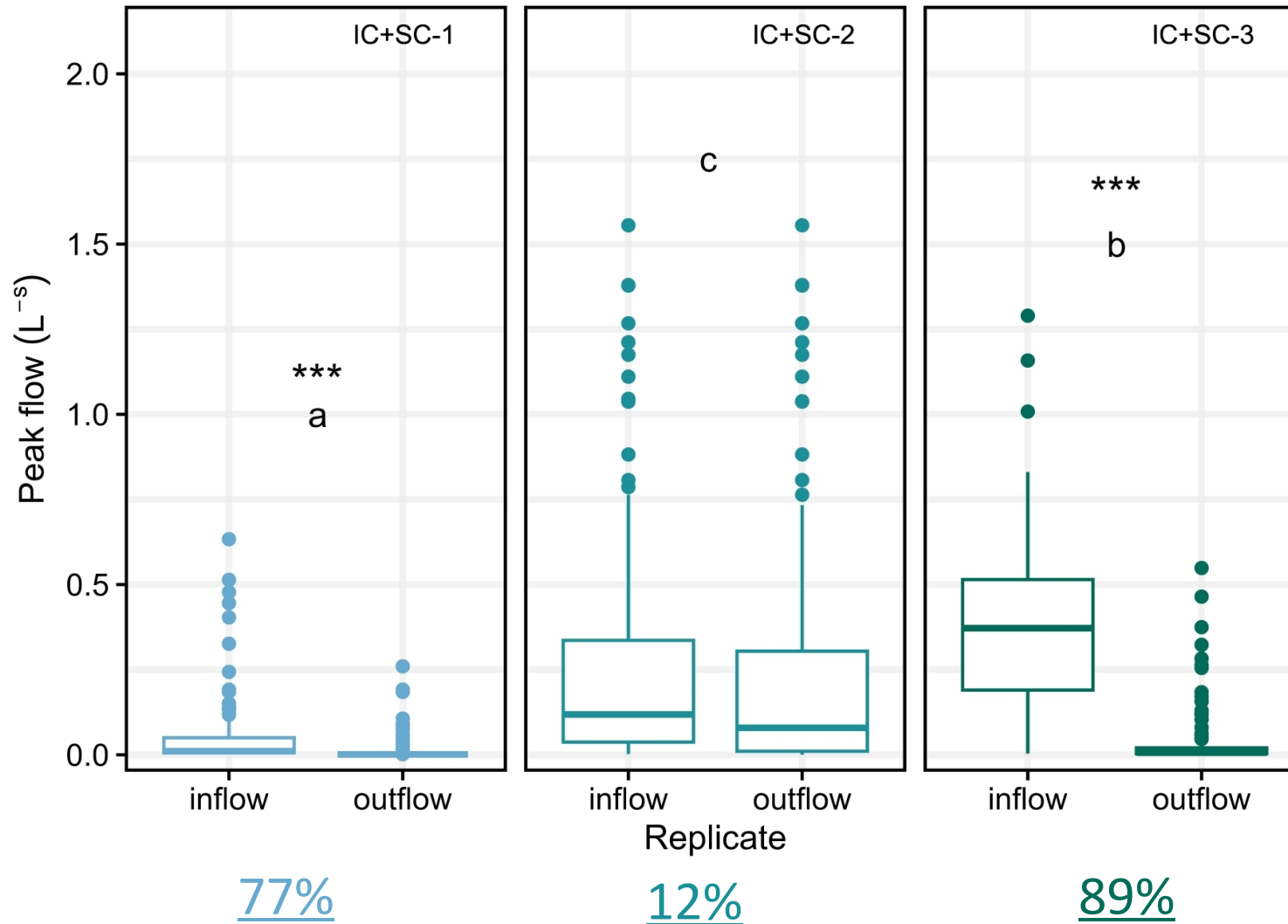
Exfiltration
15 kL; ~27 L d⁻¹
57% retained

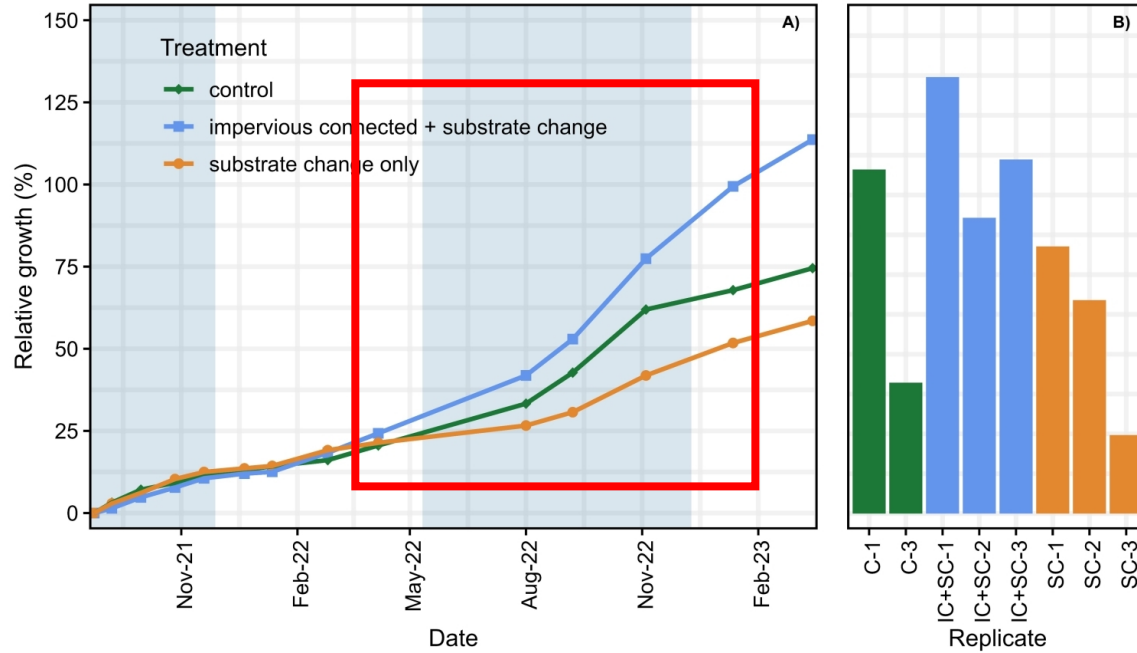


Super-slow exfiltration rate
($<0.5 \text{ mm hr}^{-1}$): heavy clay.

System: Catchment = **39%**

Mean peak flow reduction %





Tree growth

- IC+SC trees had fastest growth
- More variability in C & SC
- IC+SC grew at faster rate in wet period (potentially less waterlogging)



Conclusions

- Exfiltration rate constrained runoff retention
- Larger system size/catchment area ratio will result in higher runoff retention %
- Drainage is needed for better tree growth





Thank you! Any questions?
 @Paul_A_Hanley

