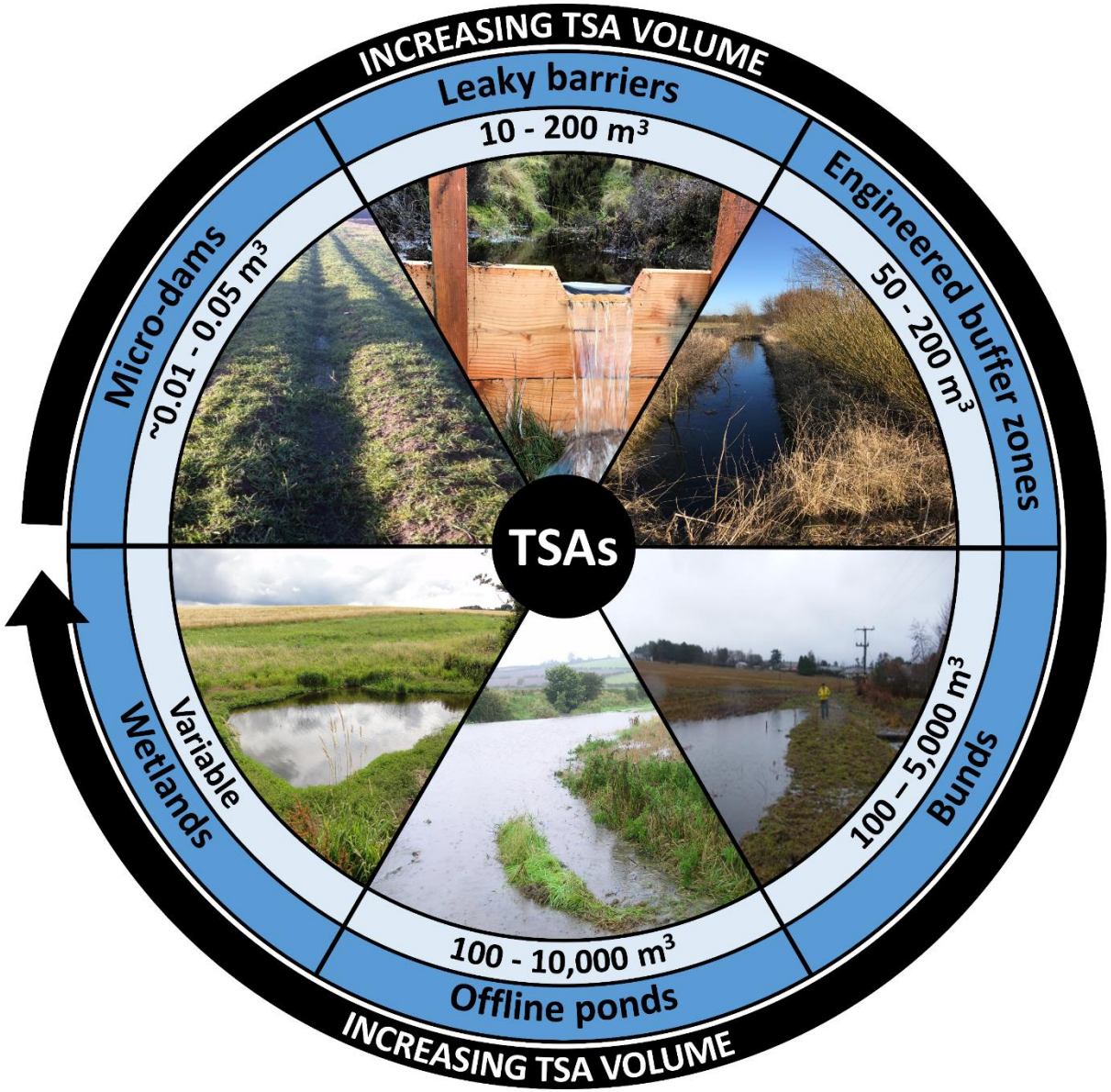
Understanding time-variable drainage rates to improve temporary storage area flood mitigation effectiveness

Martyn Roberts[1,2], Josie Geris[1], Paul Hallett[3] & Mark Wilkinson[2]

1 School of Geosciences, University of Aberdeen, UK
2 James Hutton Institute, Aberdeen, UK
3 School of Biological Sciences, University of Aberdeen, UK

Changing climate

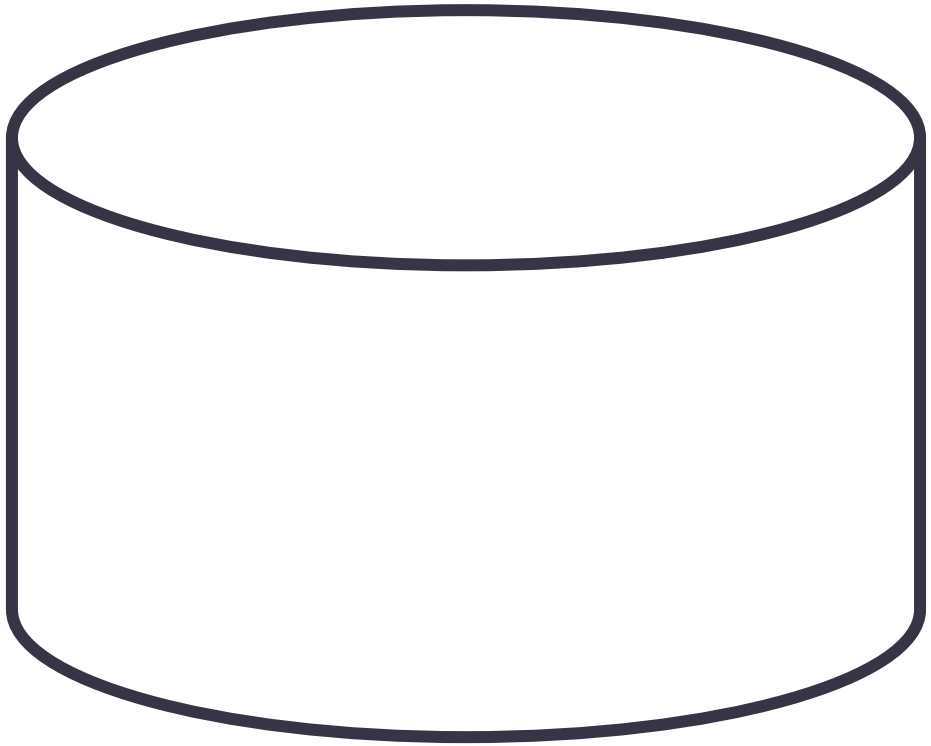
Photo credit: Mark Wilkinson



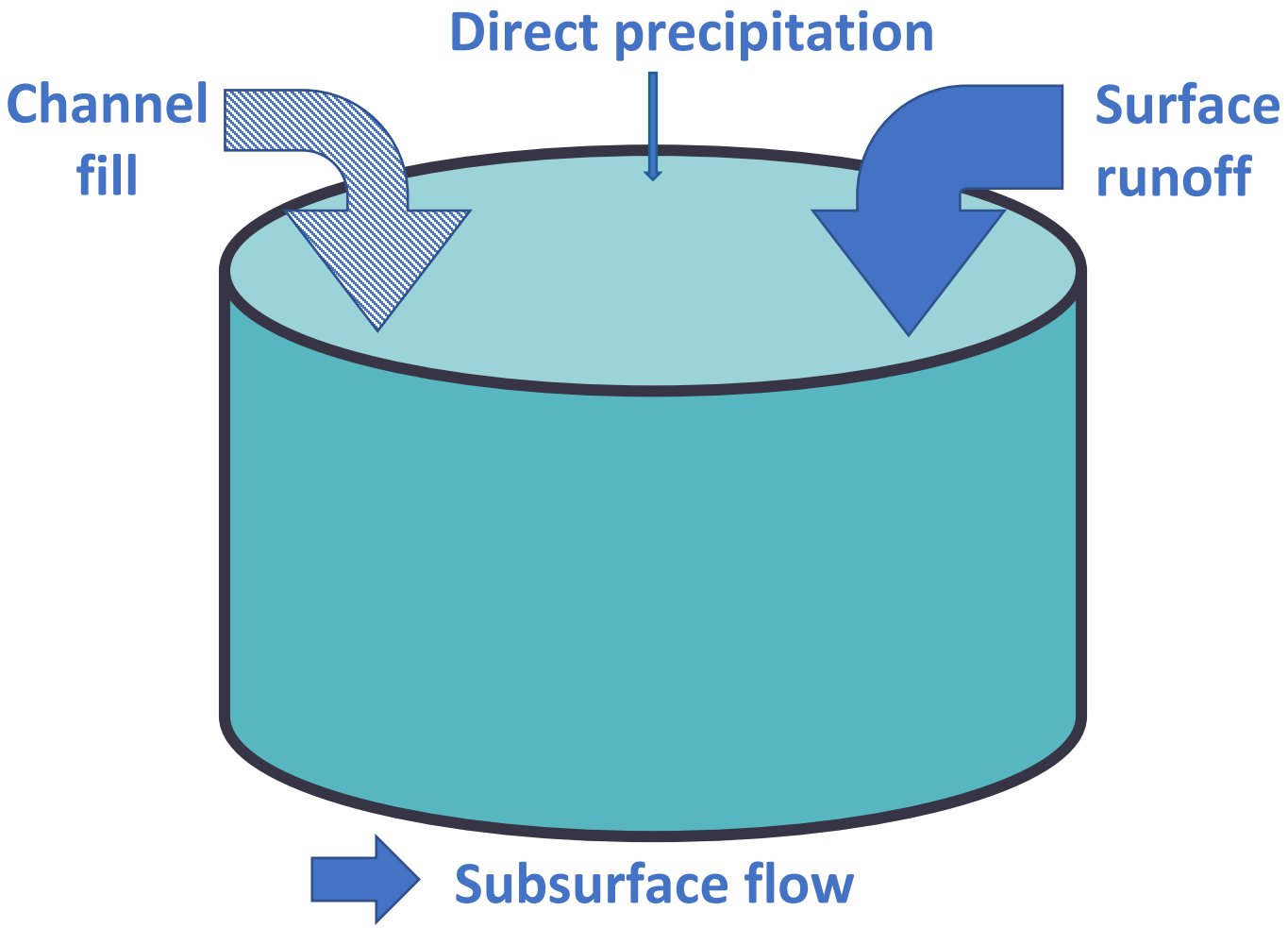
Small-scale headwater temporary storage areas (**TSAs**)

- < 10,000 m³.
- Create new additional water storage.
- Drain within ~1-2 days.
- Reduce water connectivity.

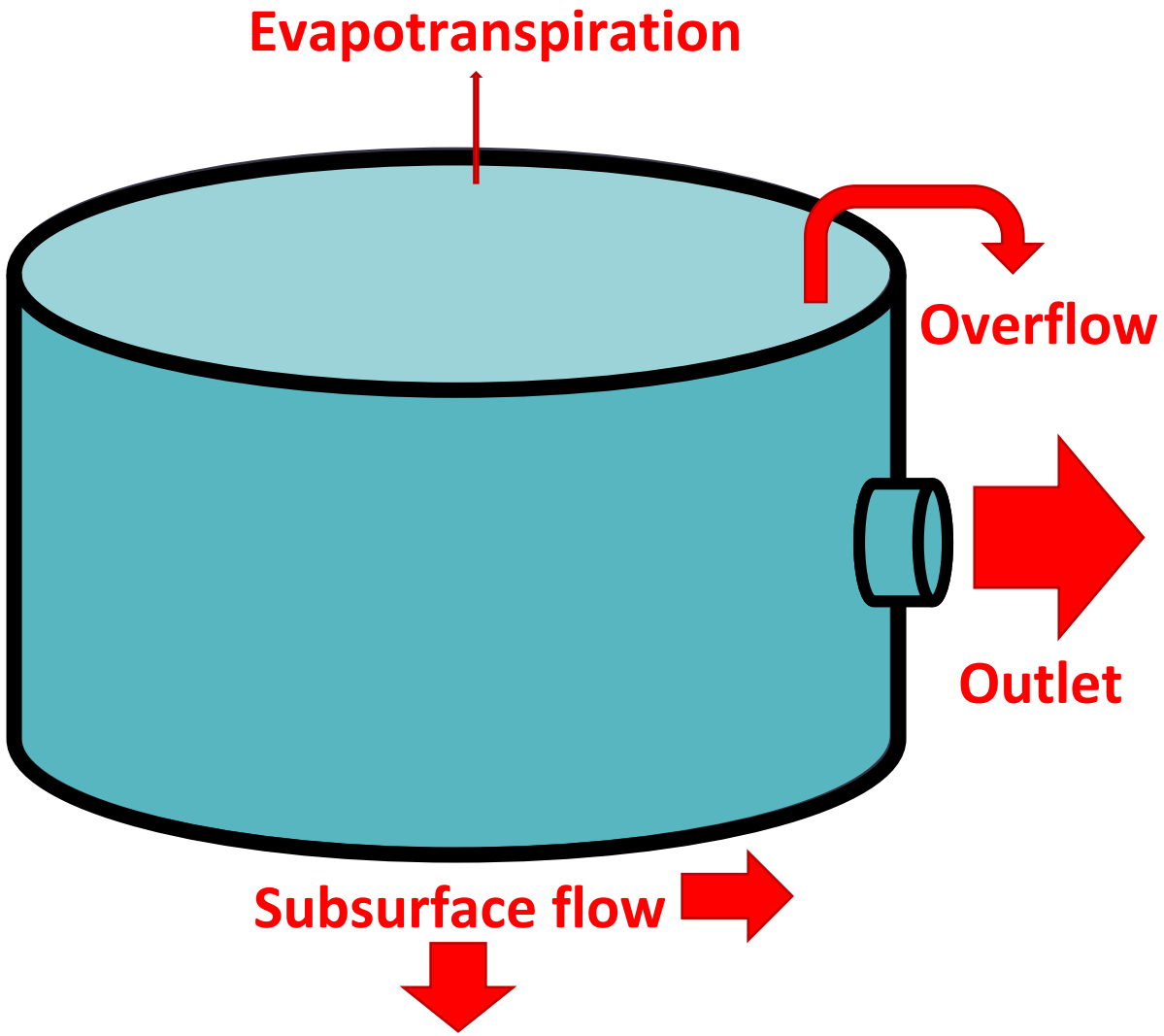
How temporary storage areas work?



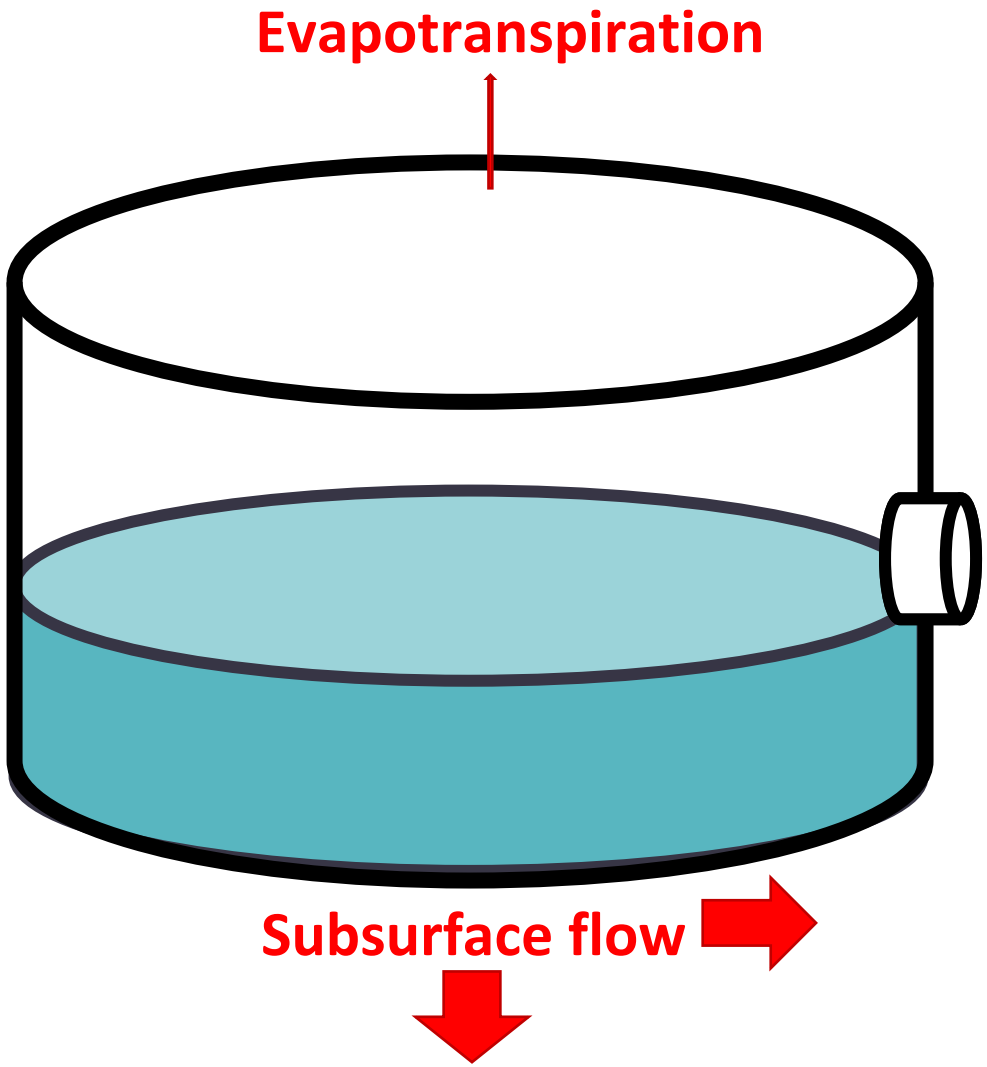
How temporary storage areas work?



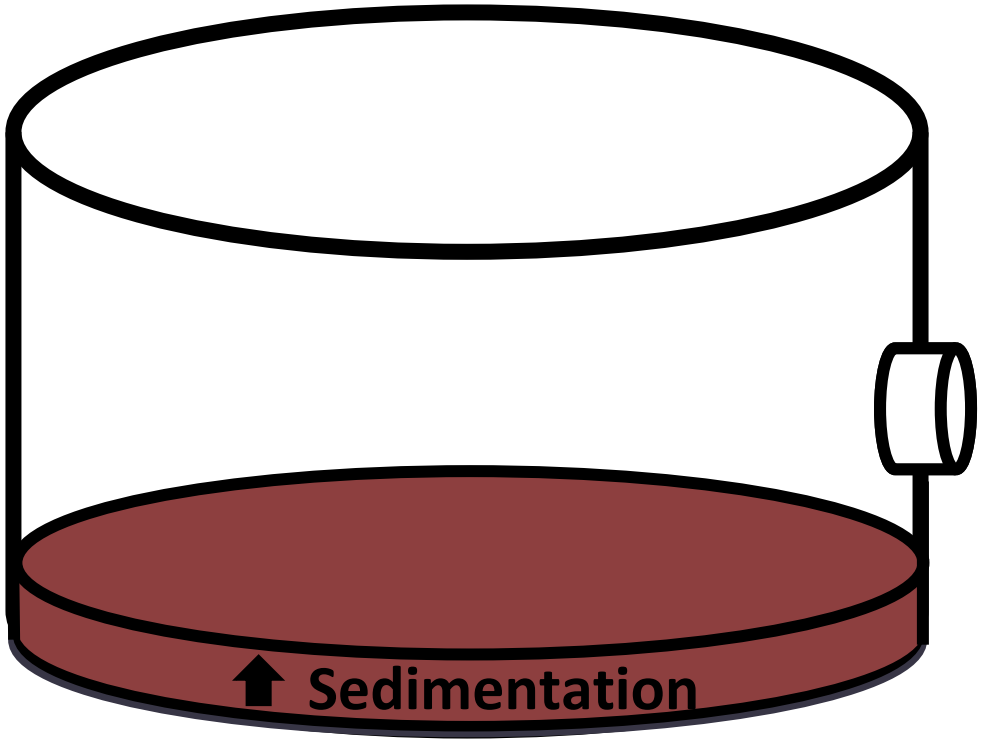
How temporary storage areas work?



How temporary storage areas work?



How temporary storage areas work?



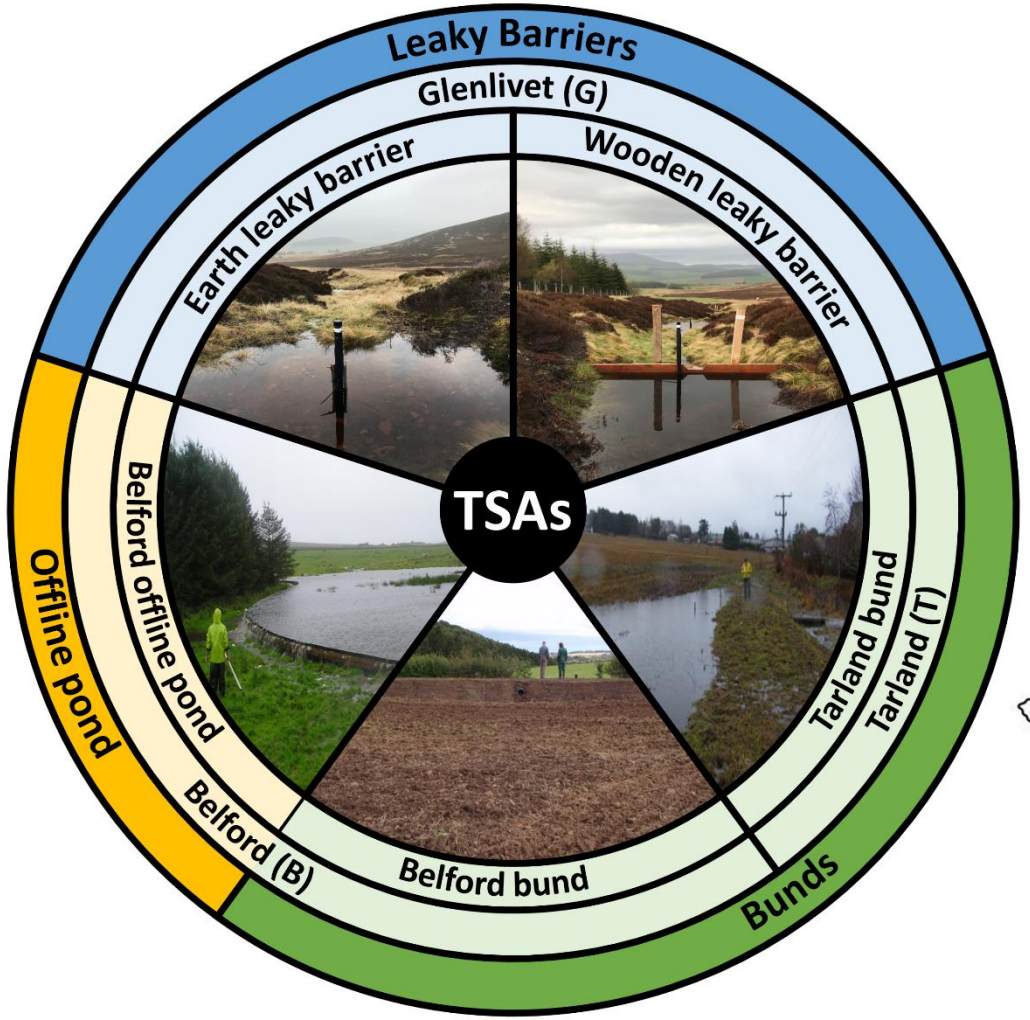
? **Changes in soil structure**

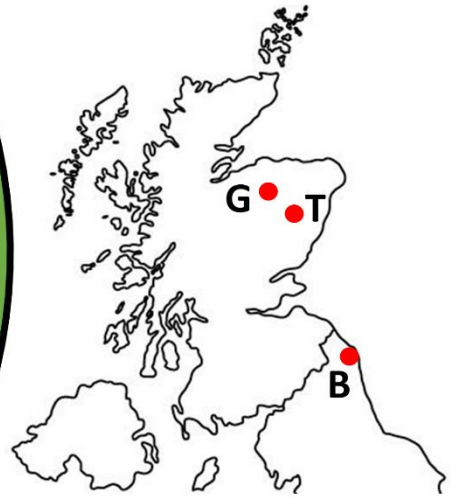
1. New systematic approach for characterising TSA functioning.

2. Do time-variable TSA drainage rates exist?

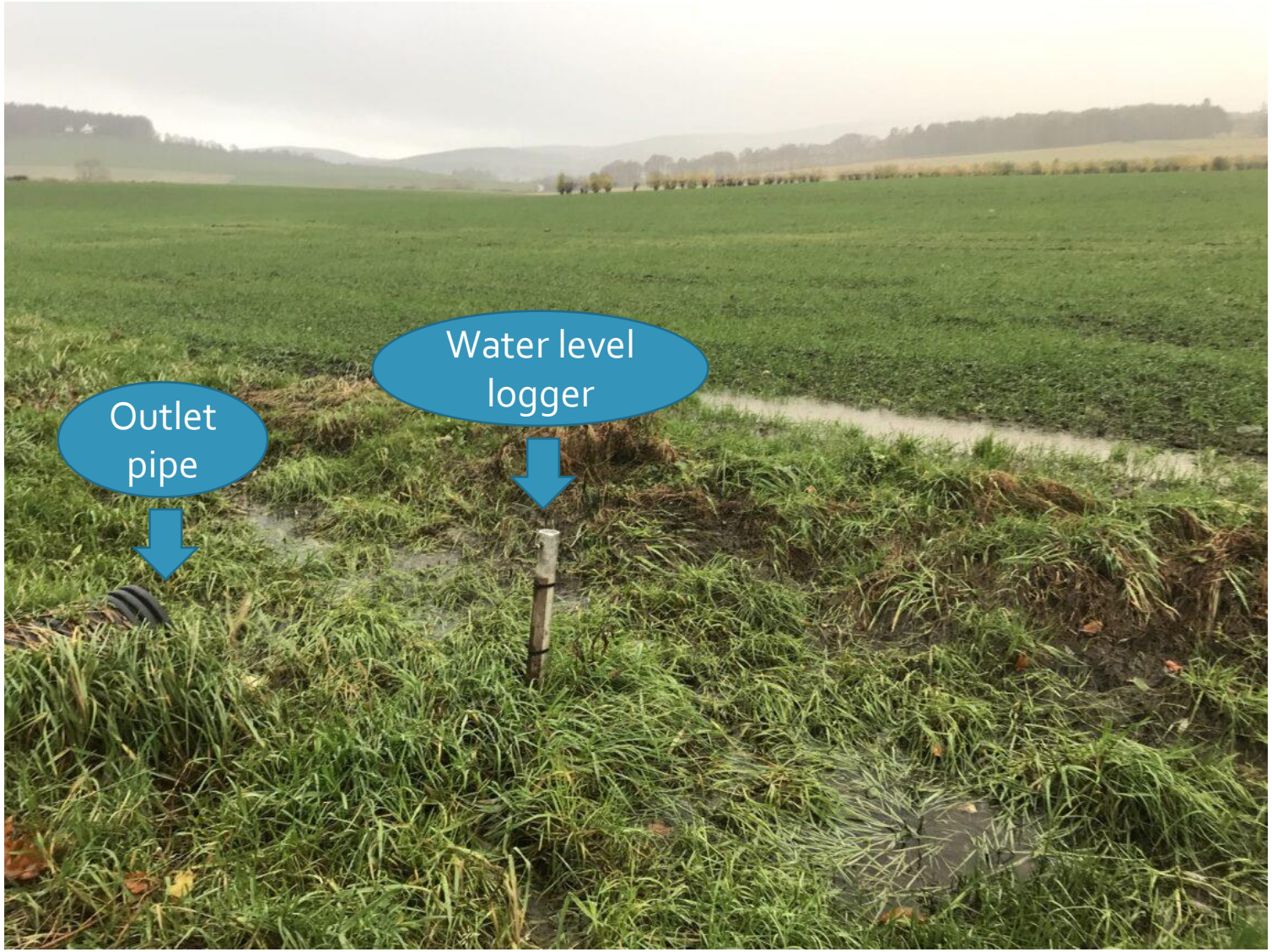
3. Impact of time-variable drainage rates on TSA flood mitigation effectiveness.

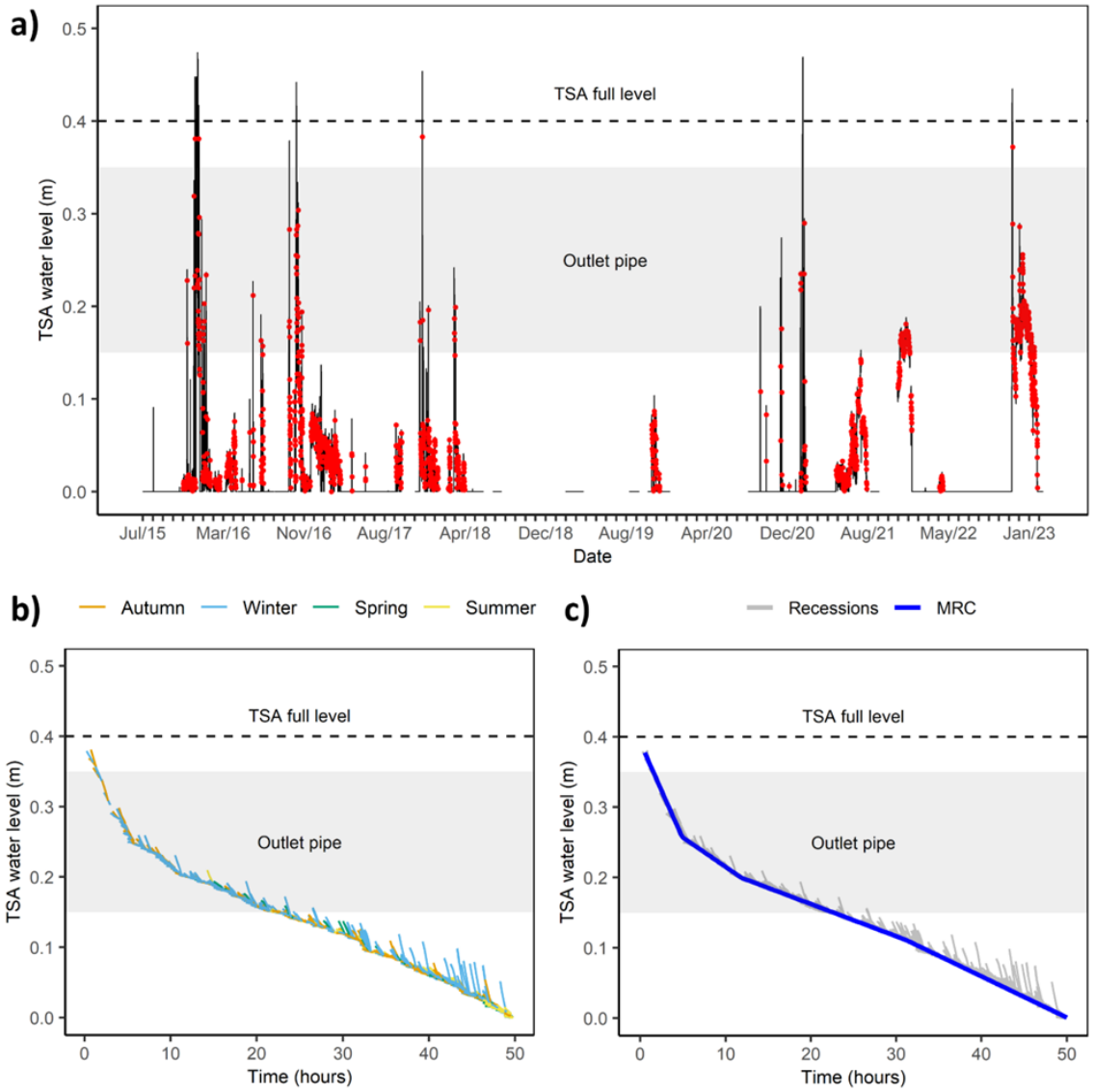
Data and study sites





	Tarland	Belford		Glenlivet	
TSA name / type	Tarland bund	Belford bund	Belford offline pond	Wooden leaky barrier	Earth leaky barrier
TSA storage capacity (m^3)	~200	~500	~800	~0.1	~0.2
TSA height (m)	0.5	1	1	0.35	0.5
Outlet design	Pipe	Pipe	Leaky wall	Leaky wall	None
TSA contributing area (km^2)	0.32	0.18	0.5	0.1	0.1
Land use in contributing area	Arable	Arable / pasture	Pasture	Heather	Heather
Monitoring period	Jul 2015 to Feb 2023	Feb 2010 to Mar 2011	Aug 2008 to Mar 2011	May 2021 to Jul 2023	May 2021 to Jul 2023


Water level logger
Outlet pipe



Methods

TSA drainage rate tool

Data:

Water level logger

Rain gauge

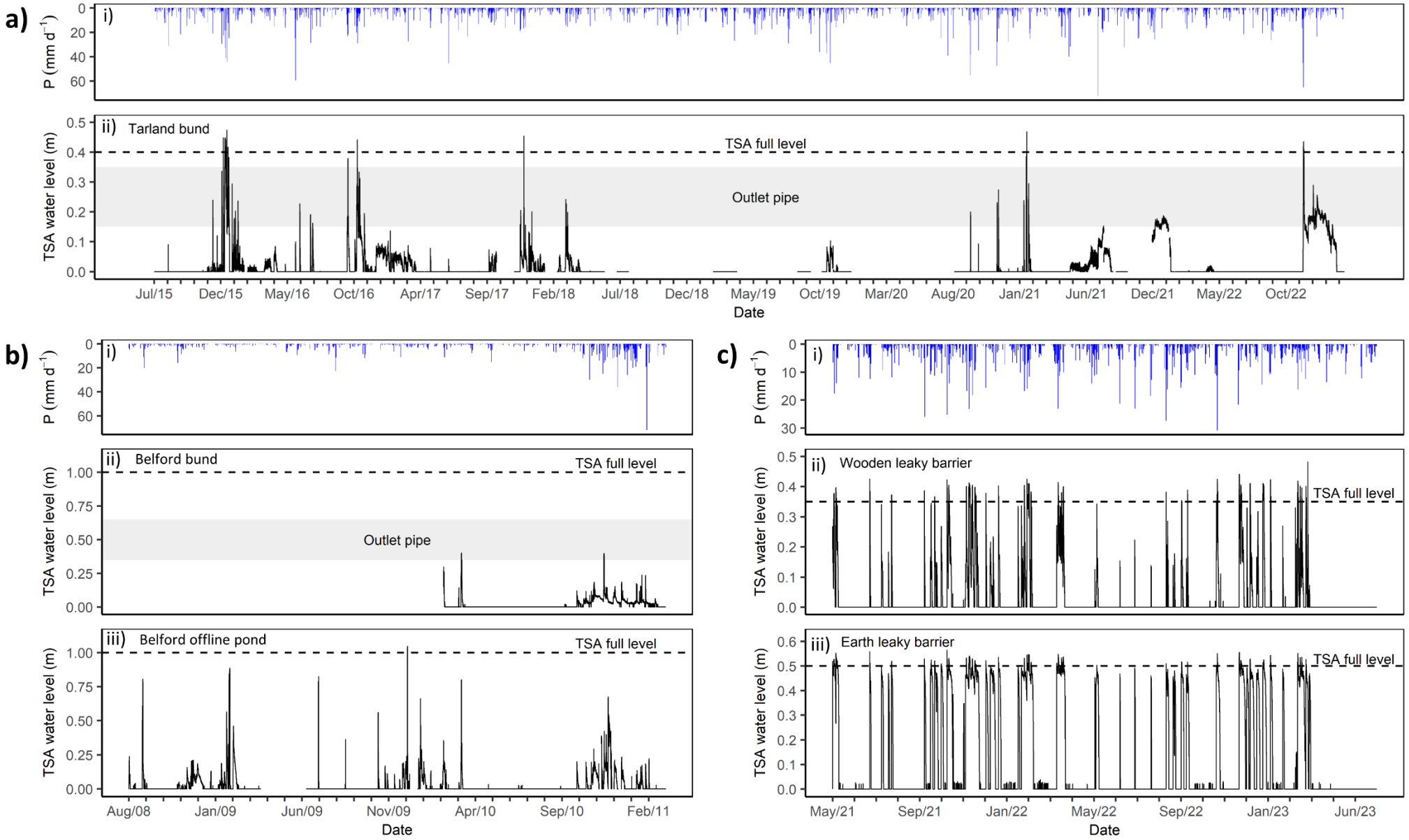
Steps:

1. Extract individual recession curves.
2. Create master recession curve (MRC).
3. Fit segmented linear models to MRC.

Overall

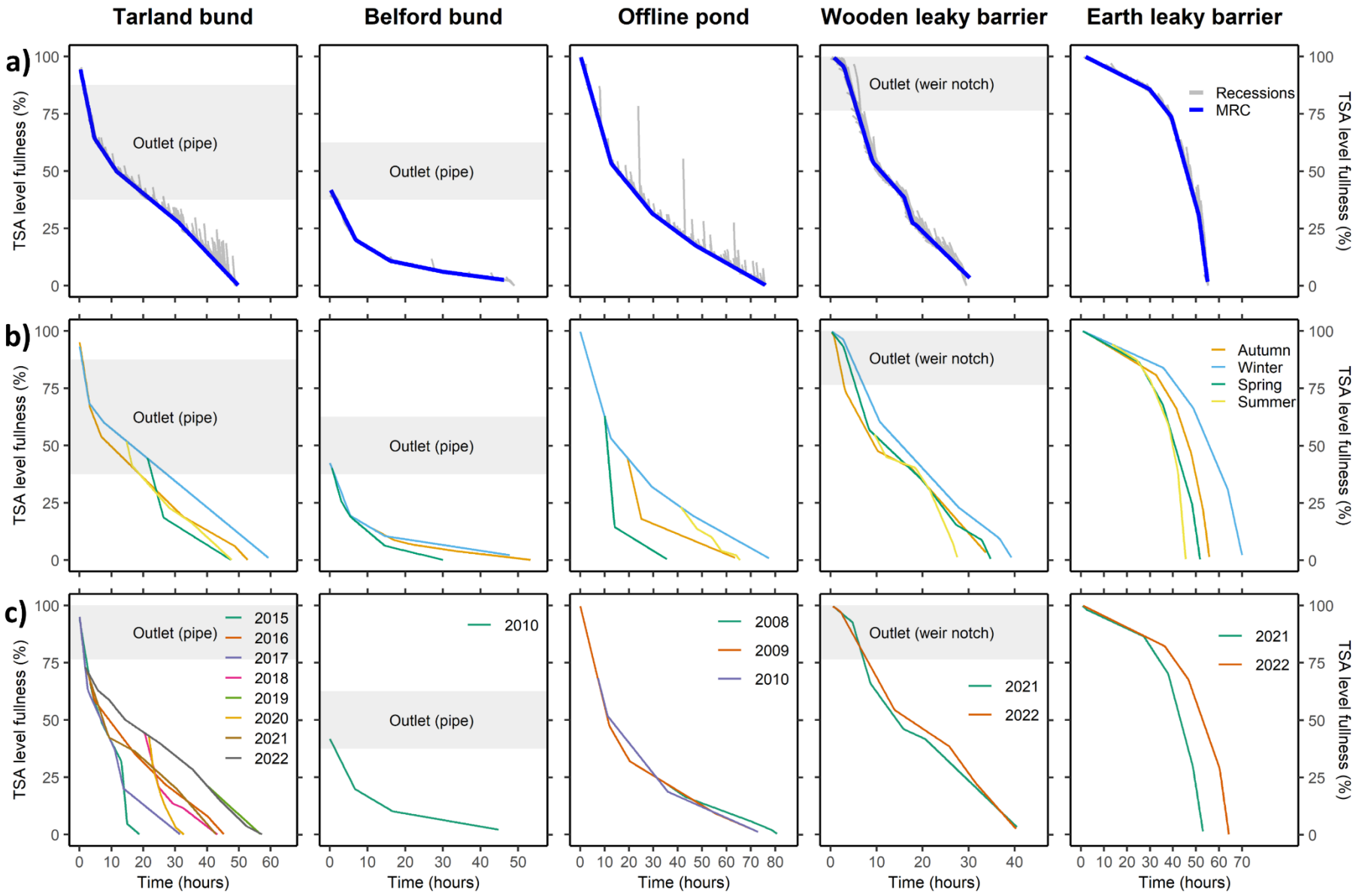
Seasons

Years



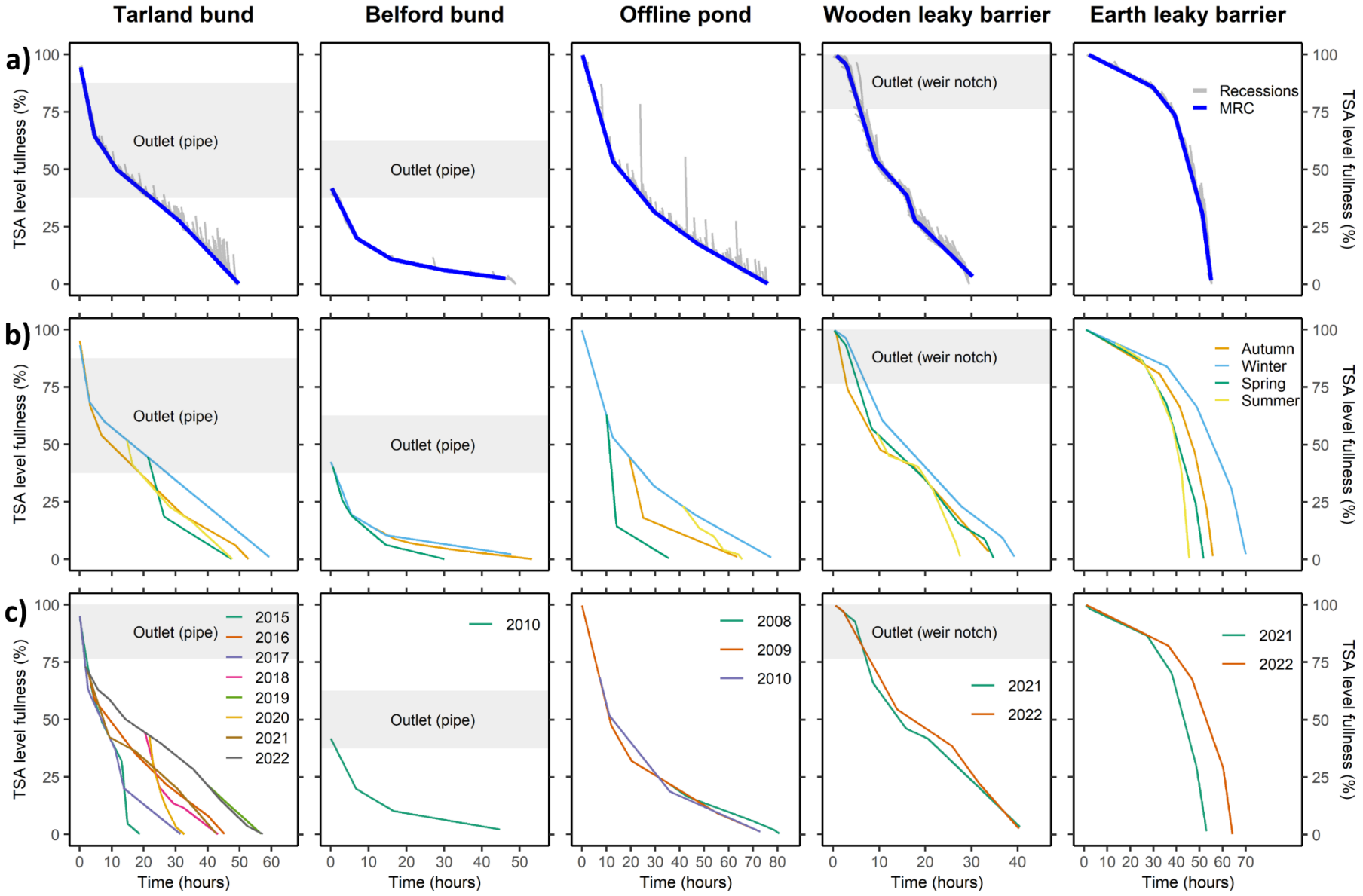
Results

TSA timeseries



Results

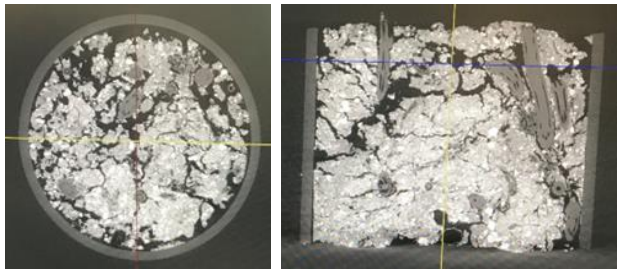
TSA time-variable drainage rates



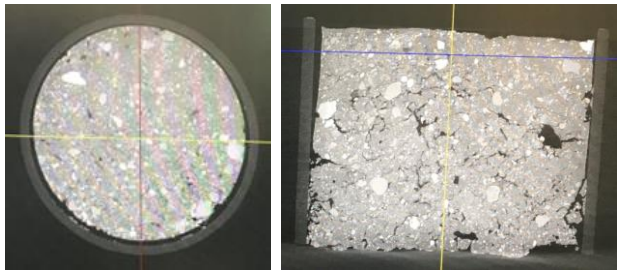
Results

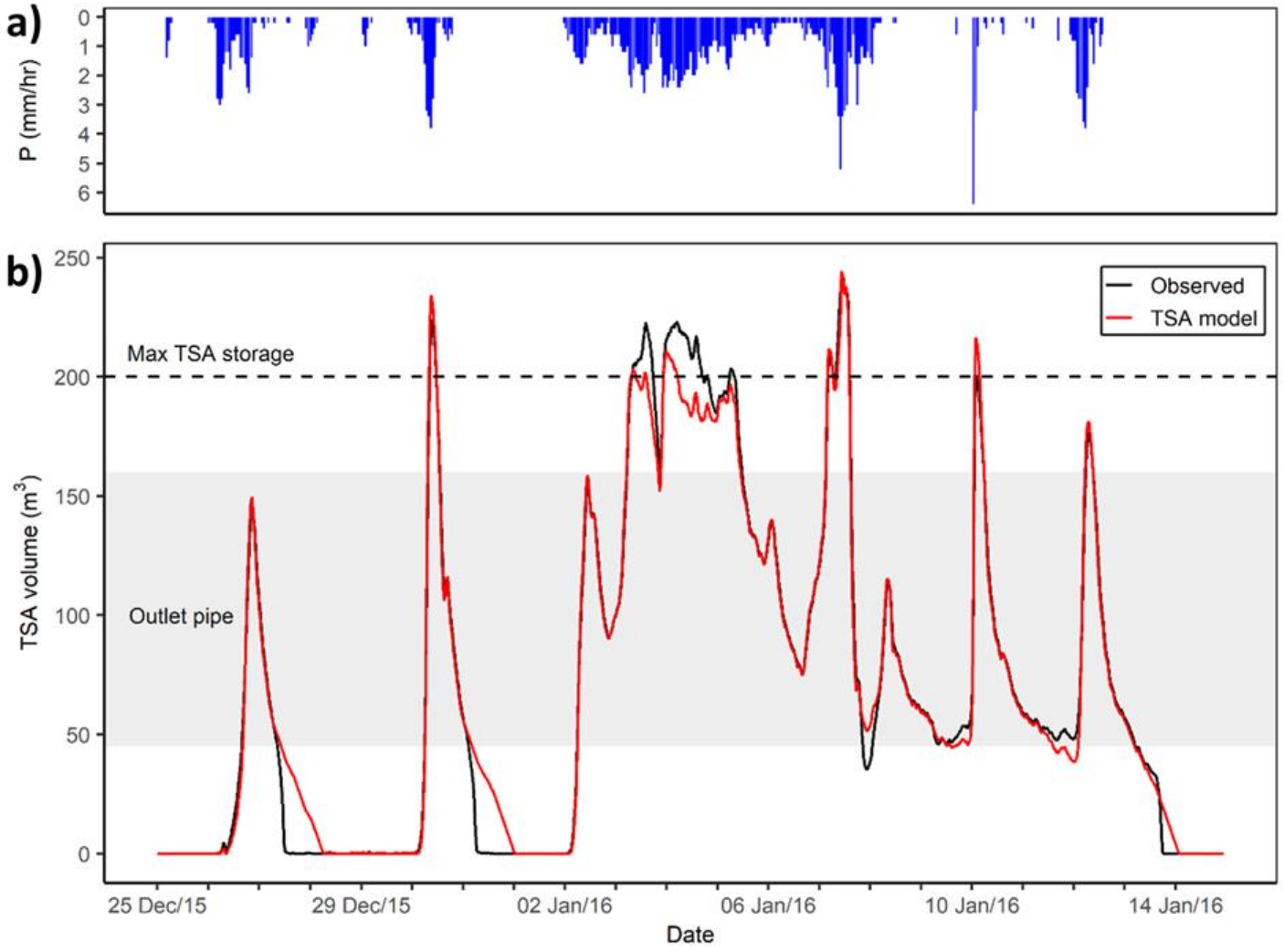
TSA time-variable drainage rates

Spring

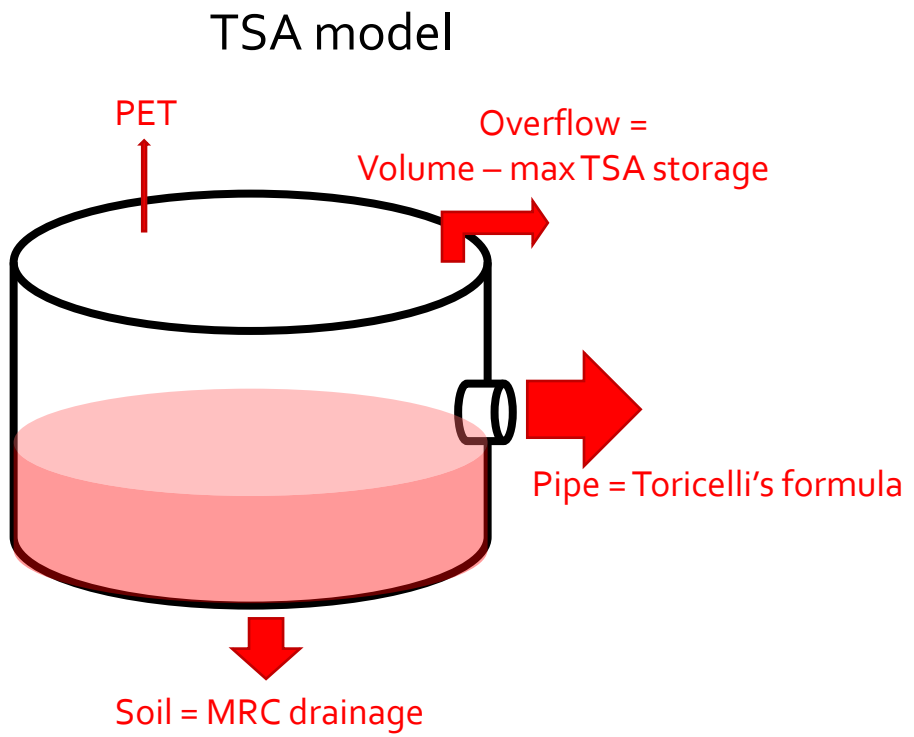


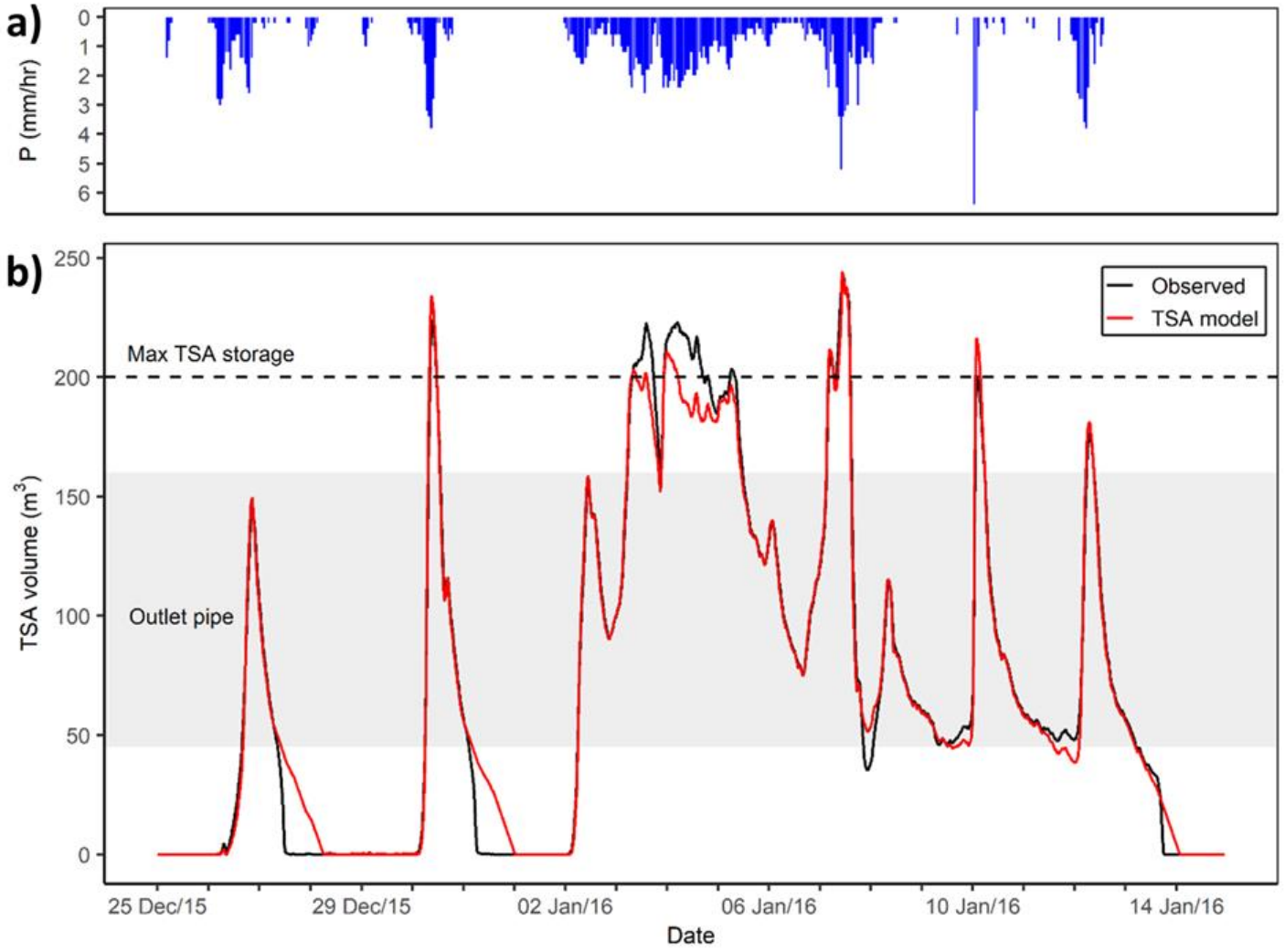
Winter





TSA model and extreme storm event: Tarland bund





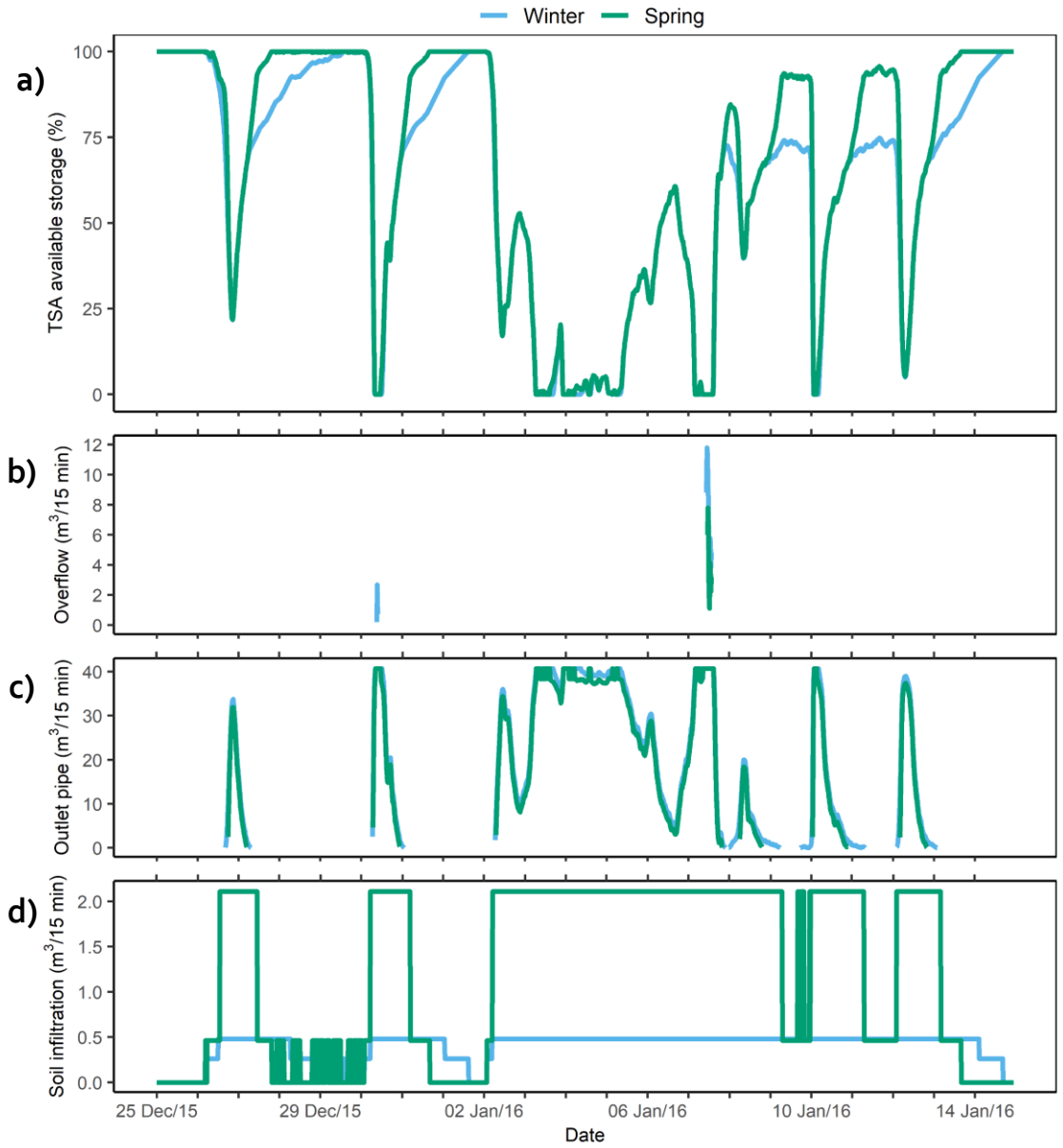
TSA model and extreme storm event: Tarland bund

TSA model

1. **TSA inputs = dVolume – TSA outputs**

2. **dVolume = TSA inputs – TSA outputs**

Time-variable MRC



Time-variable drainage and TSA effectiveness

Highlights:

- Less overflow for spring conditions.
- Well-structured soils can improve TSA effectiveness.

Type and outlet are the main factors controlling TSA drainage rates when full.

Soil properties can impact TSA effectiveness.

A new systematic approach for characterizing TSA functioning

Acknowledgements

Supervised by:

Dr Mark Wilkinson

Dr Josie Geris

Prof Paul Hallett

Funded by Hydro Nations Scholars Programme

Contact: m.roberts.20@abdn.ac.uk

@Martyn20Roberts

mroberts20