The role of soil management and temporal variations on effectiveness of temporary storage areas for surface runoff attenuation

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

[1] James Hutton Institute Aberdeen, United Kingdom [2] University of Aberdeen, Aberdeen, United Kingdom

Email: m.roberts.20@abdn.ac.uk Twitter: @Martyn20Roberts www.hydronationscholars.scot

1495 University of Aberdeen · The James Hutton Institute · Scottish Government gov.scot · Hydro Nation Scholars Programme

1. Introduction

Temporary storage areas (TSA) are a flood risk management concept that aim to attenuate surface runoff, providing additional storage during flood events that then drain shortly after the event.

They vary from the micro-scale (~0.05m³) to large retention ponds (~10,000m³), but all utilise soil hydrological processes to mitigate flood risk.

2. Aim and objectives

Project Aim: Understand the role of scale, place and time on the functioning of TSAs in the context of flood management.

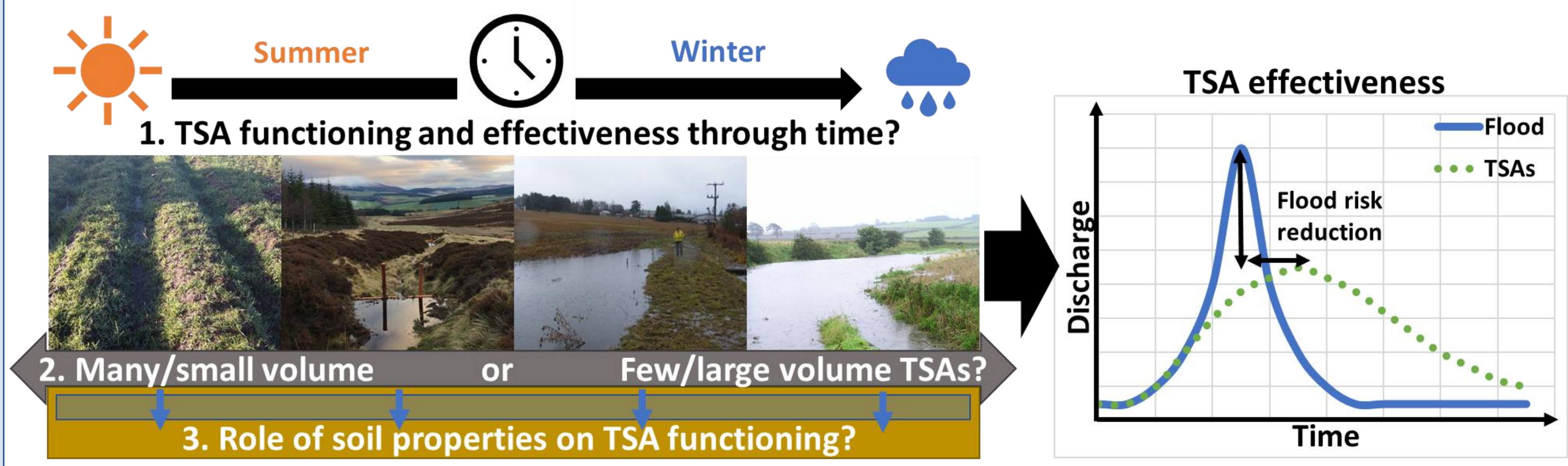


Figure 1: Three research questions the project will focus on to increase TSA understanding.

Objectives:

1. Analyse existing TSA datasets to measure TSA functioning.
2. Explore how soil management and temporal variations impact upslope runoff generation and TSA drainage.
3. Evaluate the relative role of scale, place and soil properties on TSA functioning.
4. Develop a decision support framework tool.

3. Temporal variations of TSAs

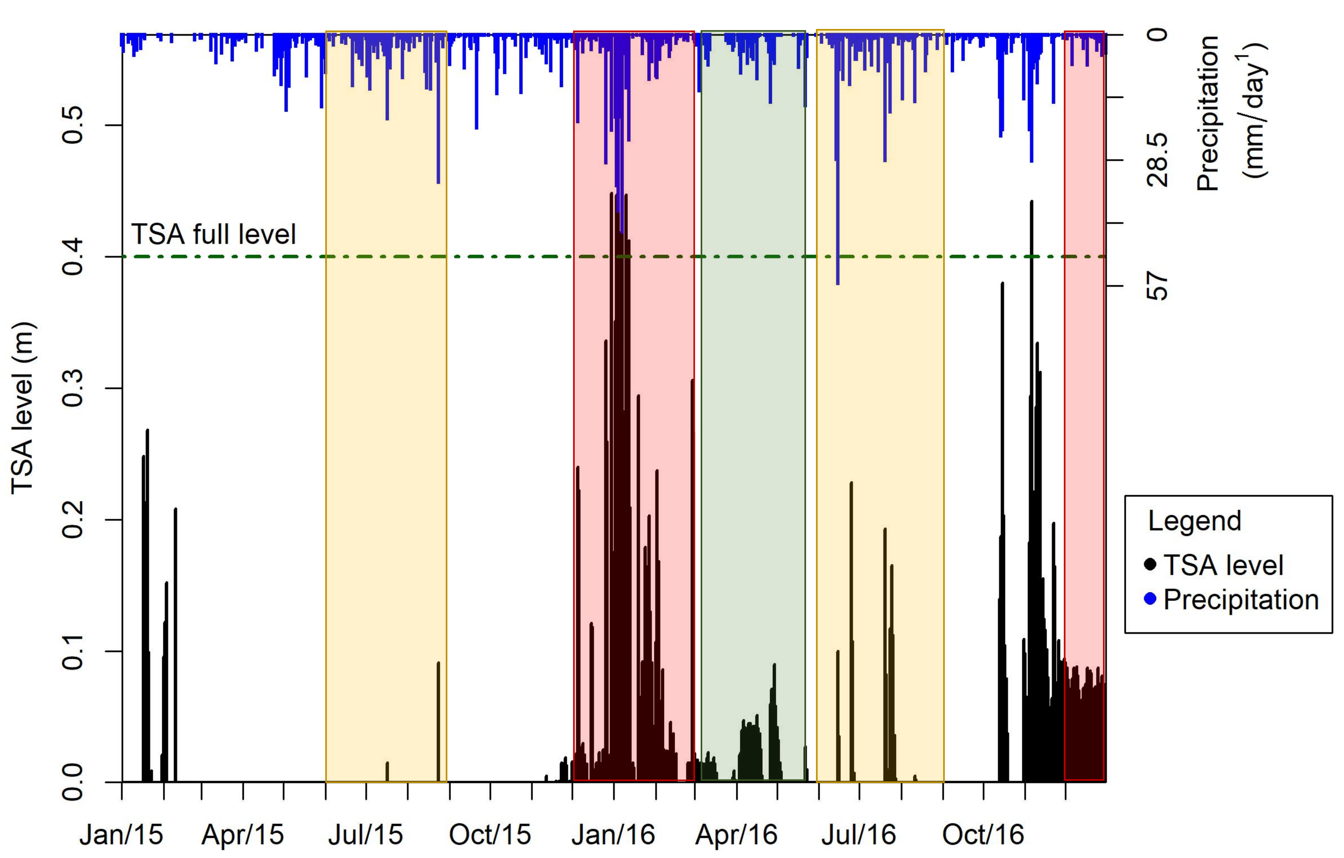


Figure 2: TSA water level and precipitation data from Tarland 2015-16 (NE Scotland).

Temporal variations

Summer
Infiltration-excess overland flow

Winter
Saturation-excess overland flow

Post winter
How do soils degrade and recover following flooding?

4. TSA hydrological monitoring

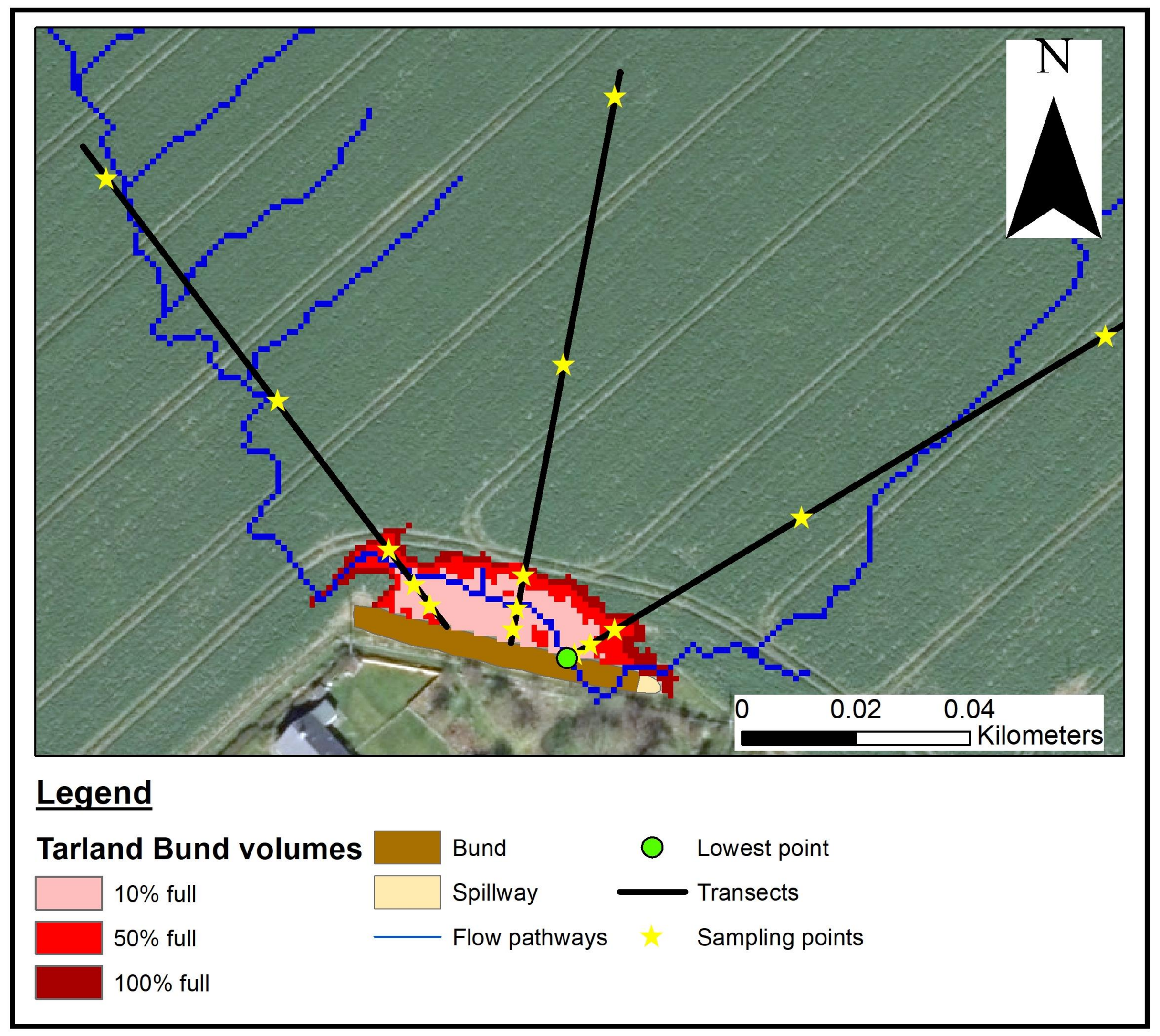


Figure 3: Spatial sampling design to assess soil hydraulic properties within the TSA footprint and contributing area.

10% full = Active zone. Flooded during small to medium events and inundated for the longest time. 6 sampling points.

50-100% full = TSA full. Only active during large storms e.g. Storm Frank. 3 sampling points.

Field. Control points to compare changes in soil properties. 6 sampling points.

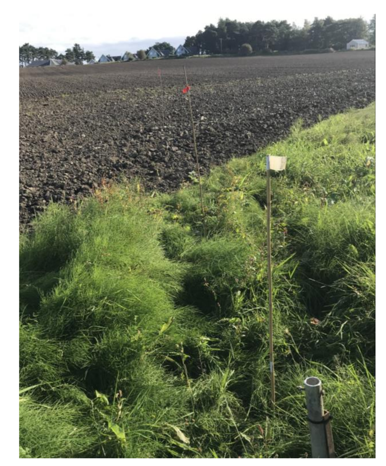
5. Methods

- Temporal variability of soil properties will be studied at 4 bunded sites across Scotland for 2 summers and 2 winters.
- Intact soil cores will be taken at 0-10cm and 20-30cm depths (see Fig.3).

Key soil hydrology measurements

- Saturated hydraulic conductivity (Ksat) – laboratory and field.
- Macroporosity.
- Bulk density.
- Soil water retention curve.

Intact soil cores



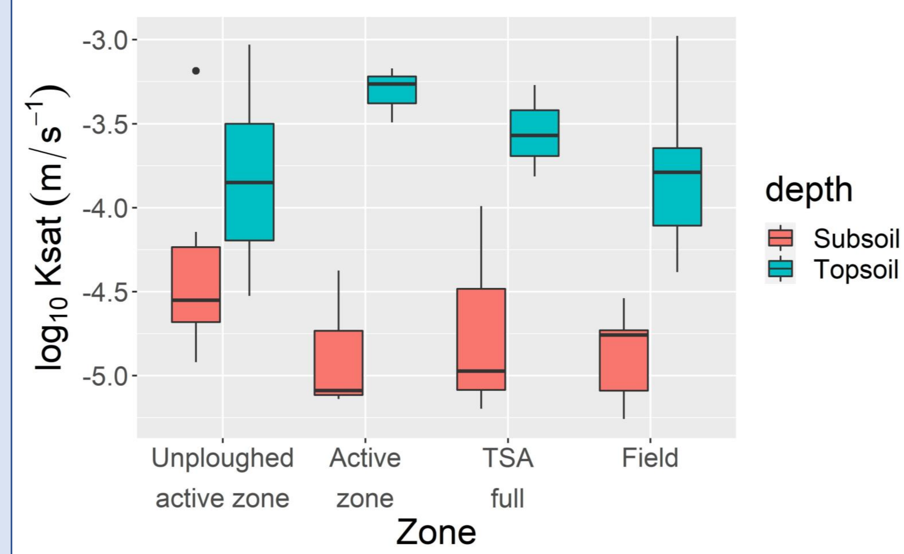
Transect and water level recorder

Bund at Tarland (NE Scotland)

Bund at Invergowrie (NE Scotland)

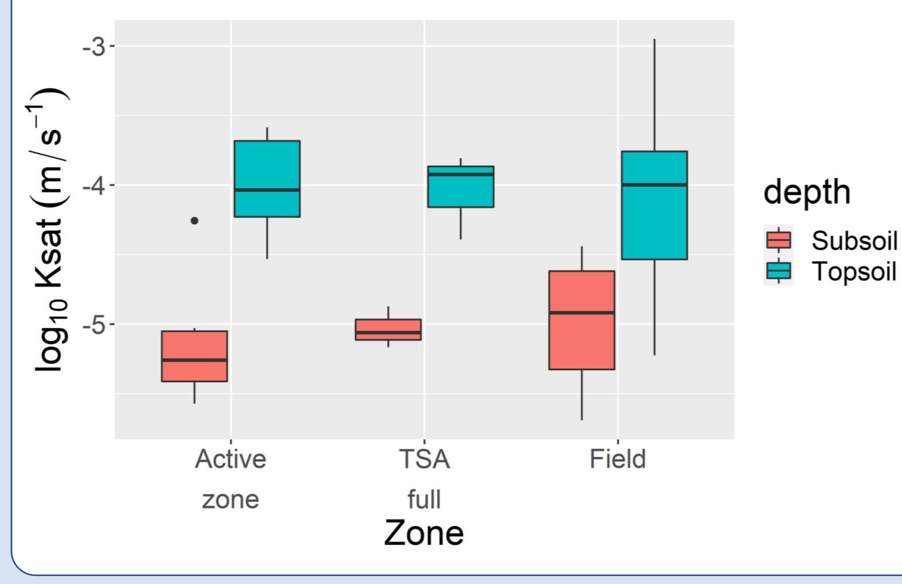
6. Preliminary results

Summer 2021 Results - Saturated hydraulic conductivity (Ksat)



Tarland

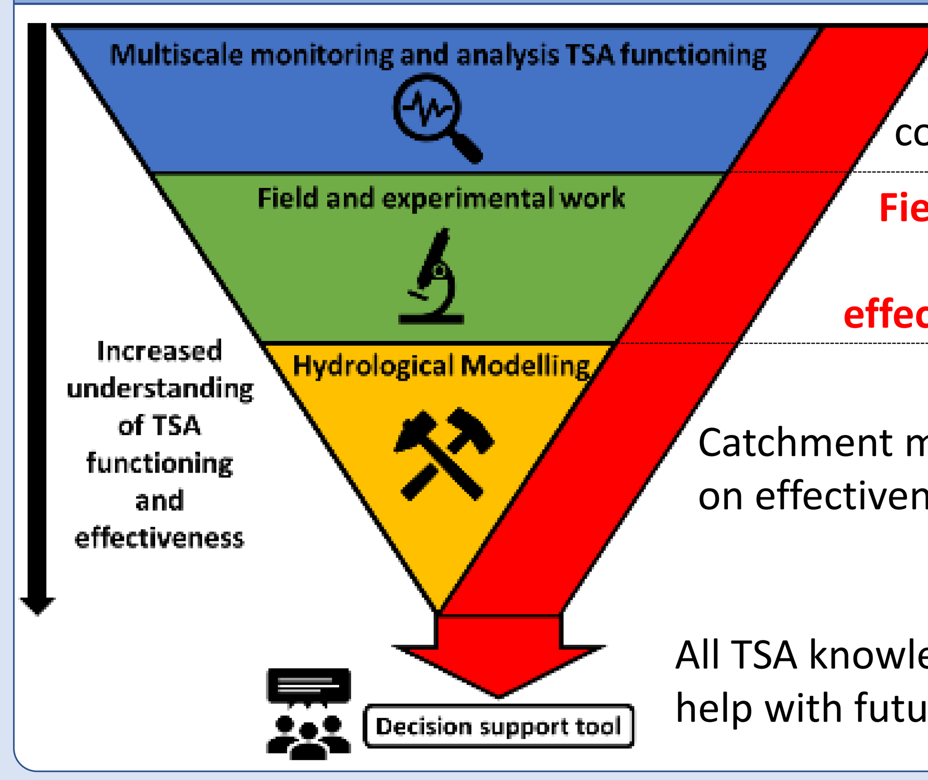
- Post-harvest cultivation for 'Active', 'TSA full' and 'Field' zones.
- Significant difference between depths (P = < 0.001).
- No significant difference between zones for topsoil and subsoil.



Invergowrie

- Spring barley for all zones.
- Significant difference between depths (P = < 0.001).
- No significant difference between zones for topsoil and subsoil.

7. Future work



Evaluate all TSA types across a range of conditions under various states of wetness.

Field assessment of how soil management and temporal variations impact TSA effectiveness for surface runoff attenuation.

Catchment model evaluates the role of place and scale on effectiveness of TSAs for surface runoff attenuation.

All TSA knowledge will inform a decision support tool to help with future management and targeting of TSAs.

8. Summary

Climate change and seasonal extremities will likely have a profound impact on soil hydrology and TSA performance, highlighting the importance of temporal variability for TSA understanding.

Preliminary results suggest that Ksat does not vary between zones and there is no soil degradation following inundation. Therefore, TSAs remain effective at transporting water through the soil profile and future modelling is simplified.

Soil is a key factor determining TSA functioning. The findings will be used to understand the interaction of TSAs with soils and how local soil hydrological changes can be transferred to flood risk reduction downstream.