Understanding spatial and temporal functioning of temporary storage areas to improve their flood mitigation effectiveness

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Hydro Nation Scholars Programme

Introduction

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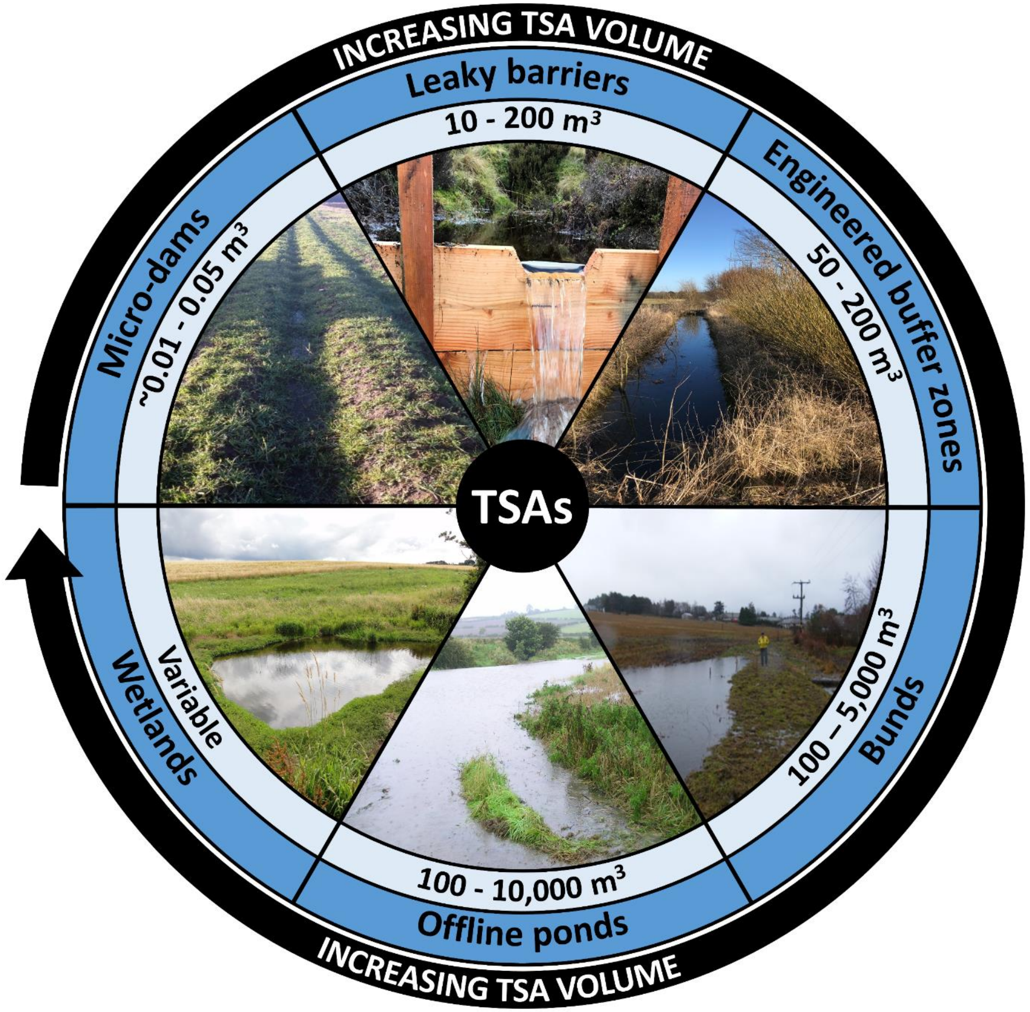


Temporary storage areas (TSAs)

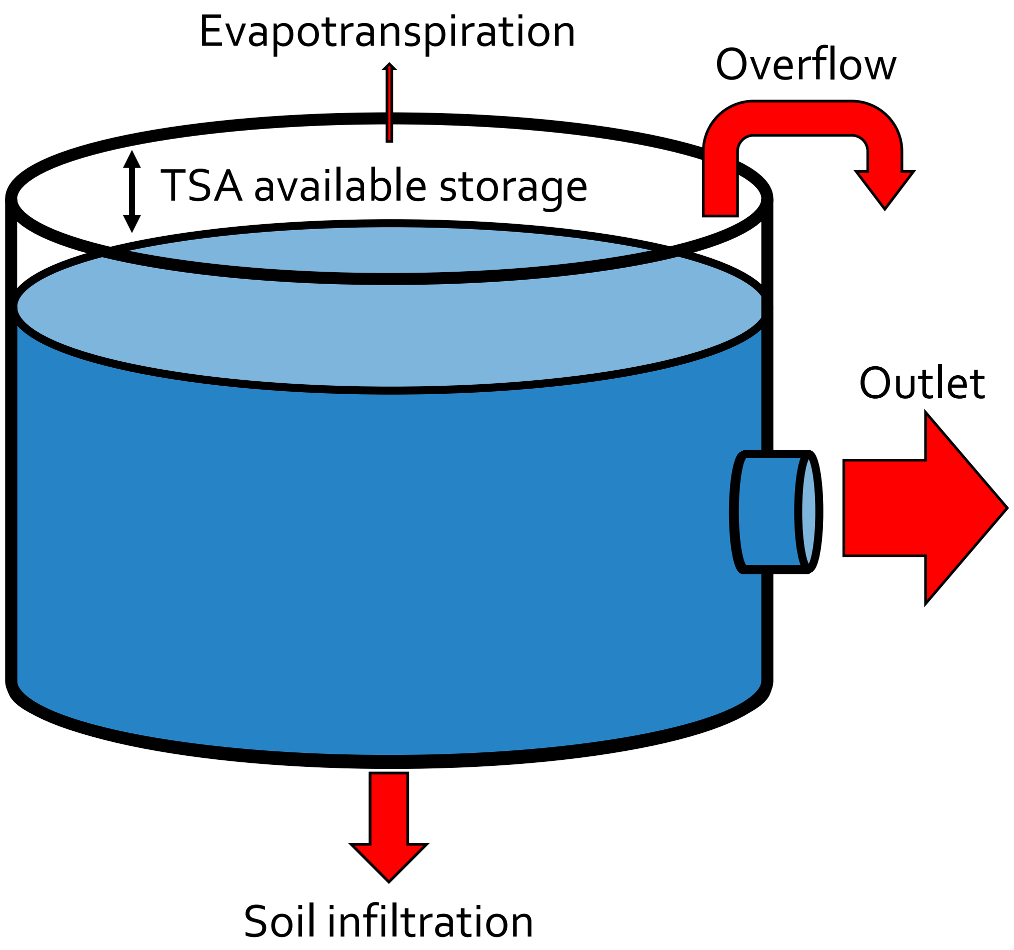
- Capture and attenuate storm runoff in the landscape or drainage network.
- Provide catchment-based storage during storm events.
- Typically occupy <1% of contributing area and their maximum storage is <10,000 m^3.

Research gaps

- How TSAs respond to hydrological extremes?
- What processes are driving TSA time-variability?
- Guidance on management strategies?

TSA functioning and flood mitigation effectiveness

TSA flood mitigation effectiveness =
TSA available storage
+ water retention time



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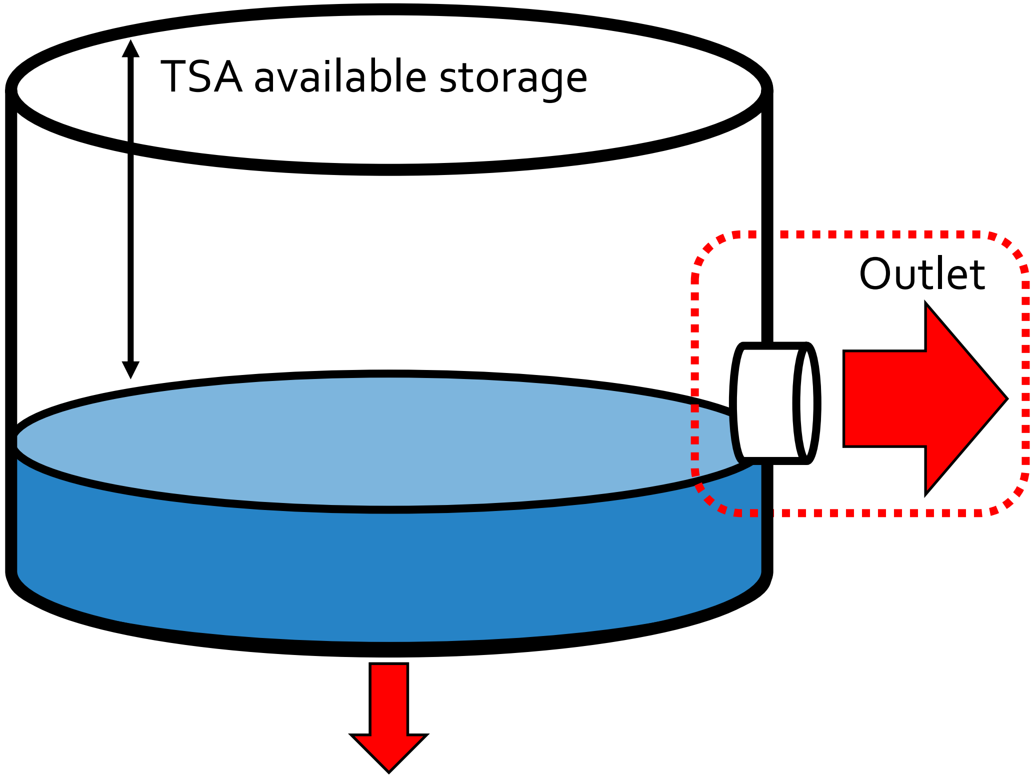

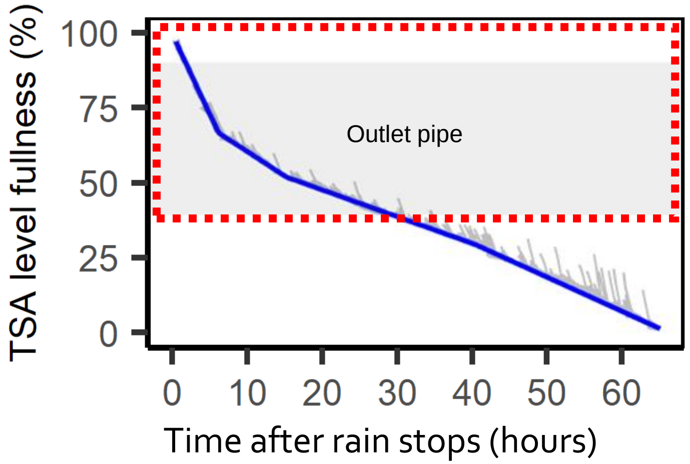

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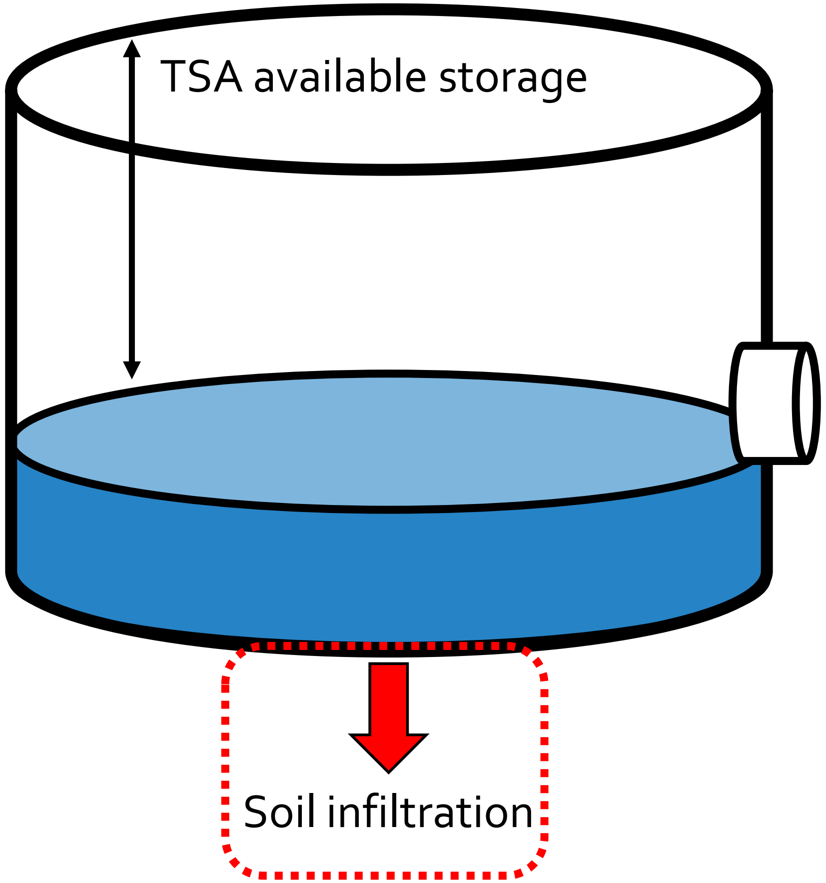

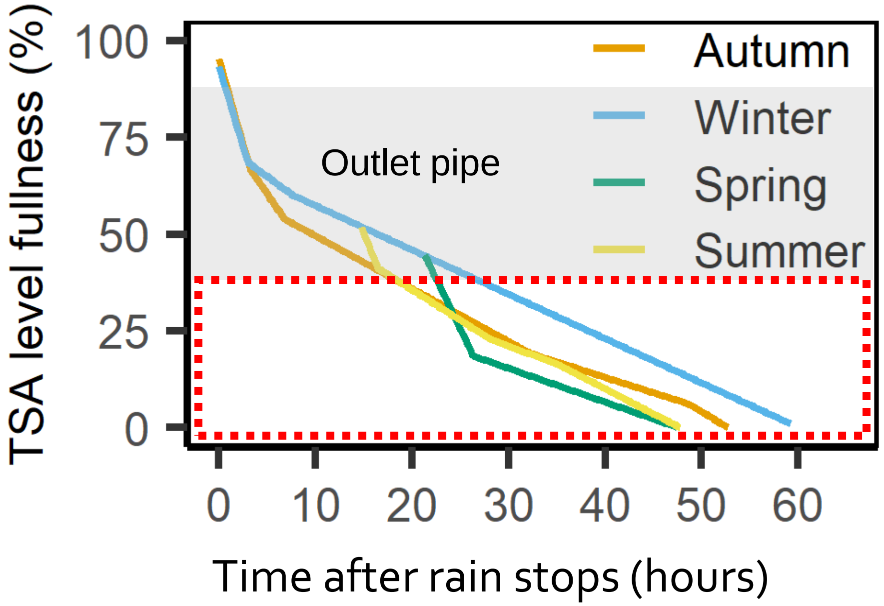

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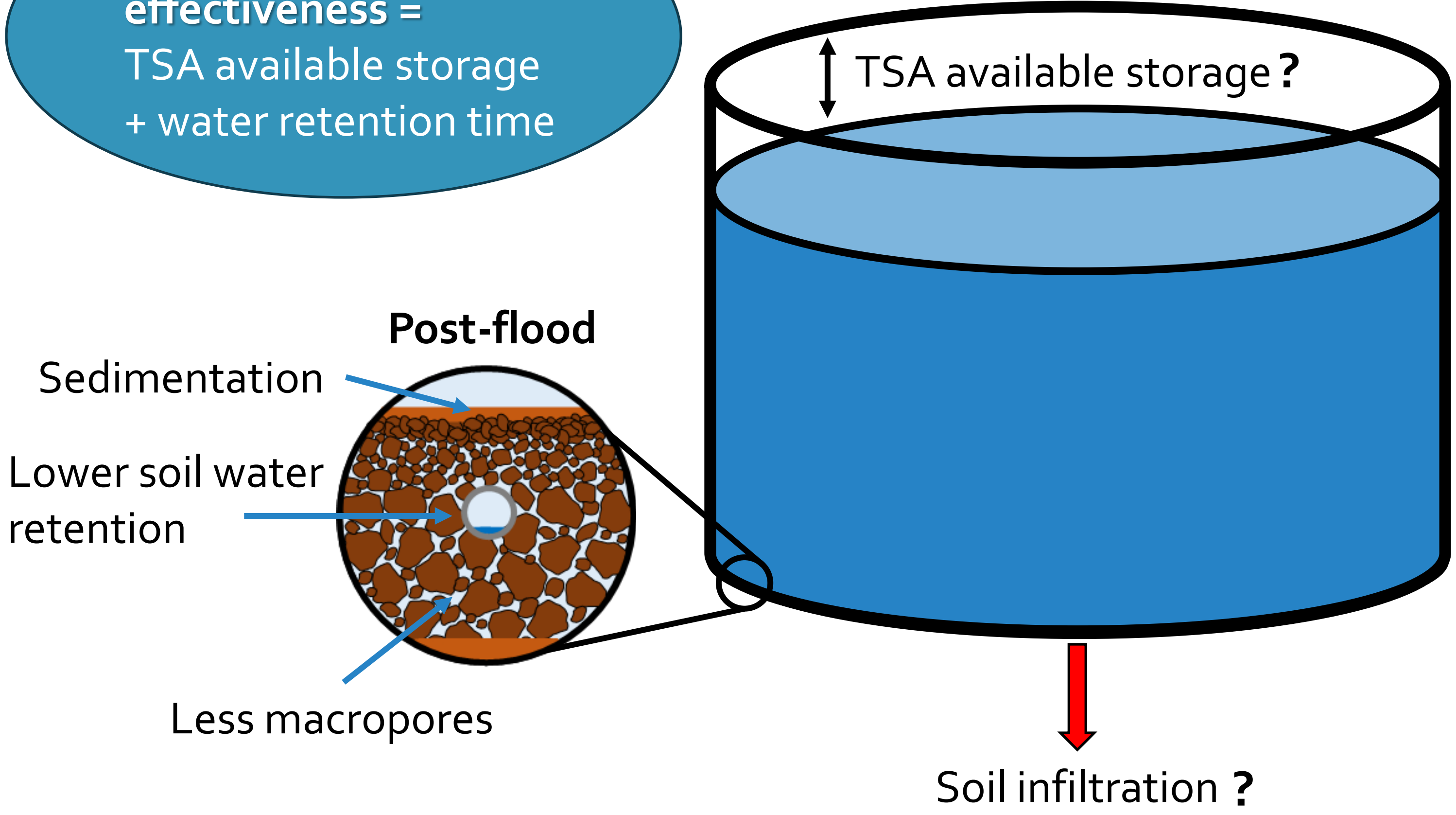

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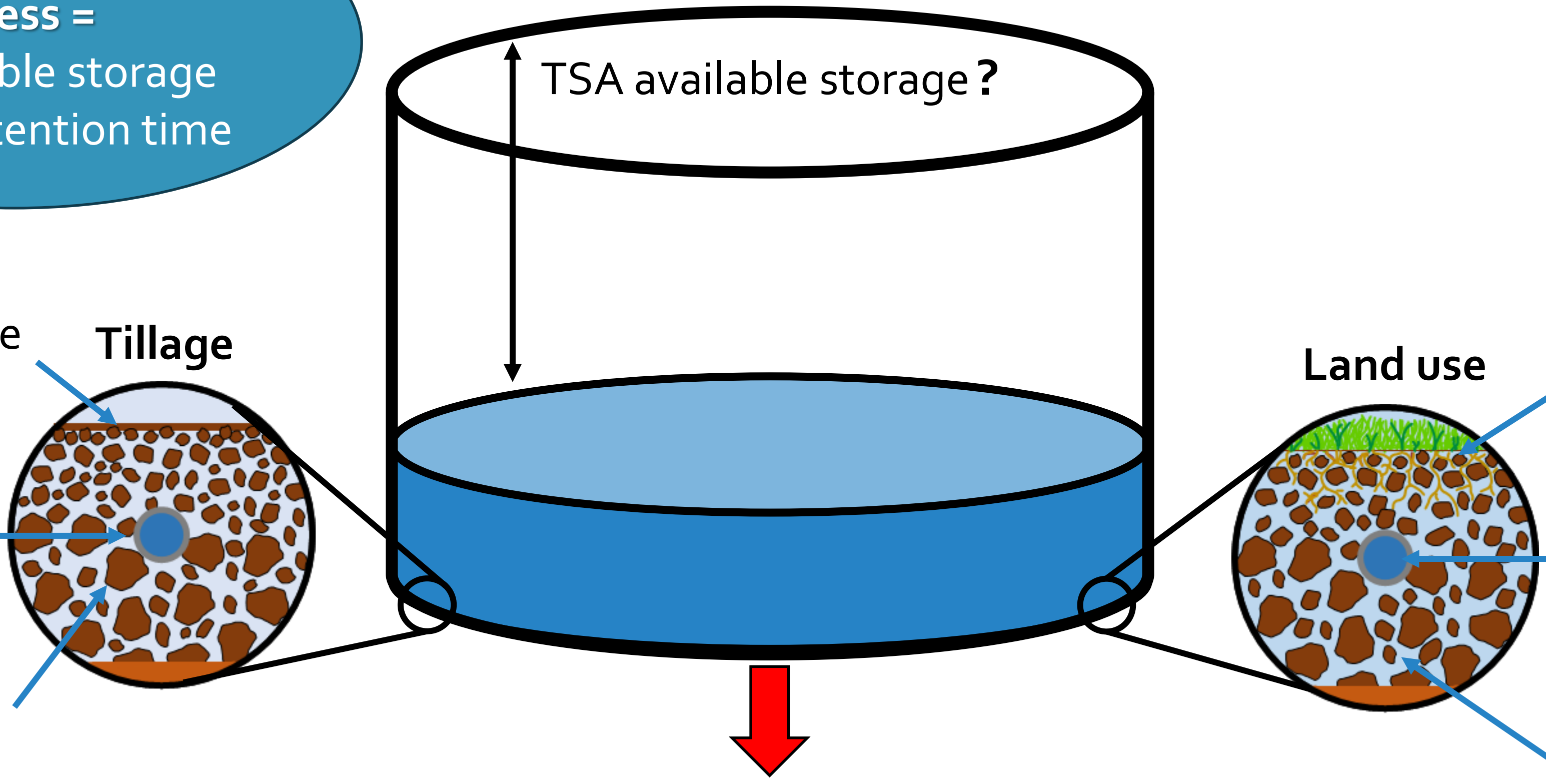
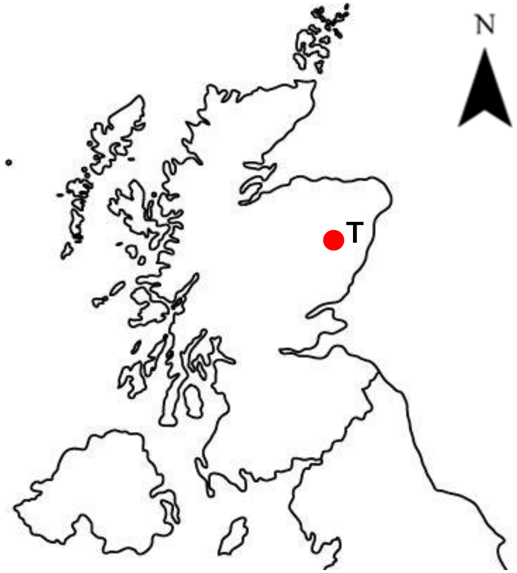


Aim and objectives

Investigate the impact of flooding and land management on TSA soil structure and hydrology.

1. Assess temporal and spatial variations in soil physical properties within the TSA and surrounding field.
2. Explore the main factors influencing changes in soil structure and hydrology.
3. Discuss potential TSA management strategies to enhance TSA performance.

Study site and Methods



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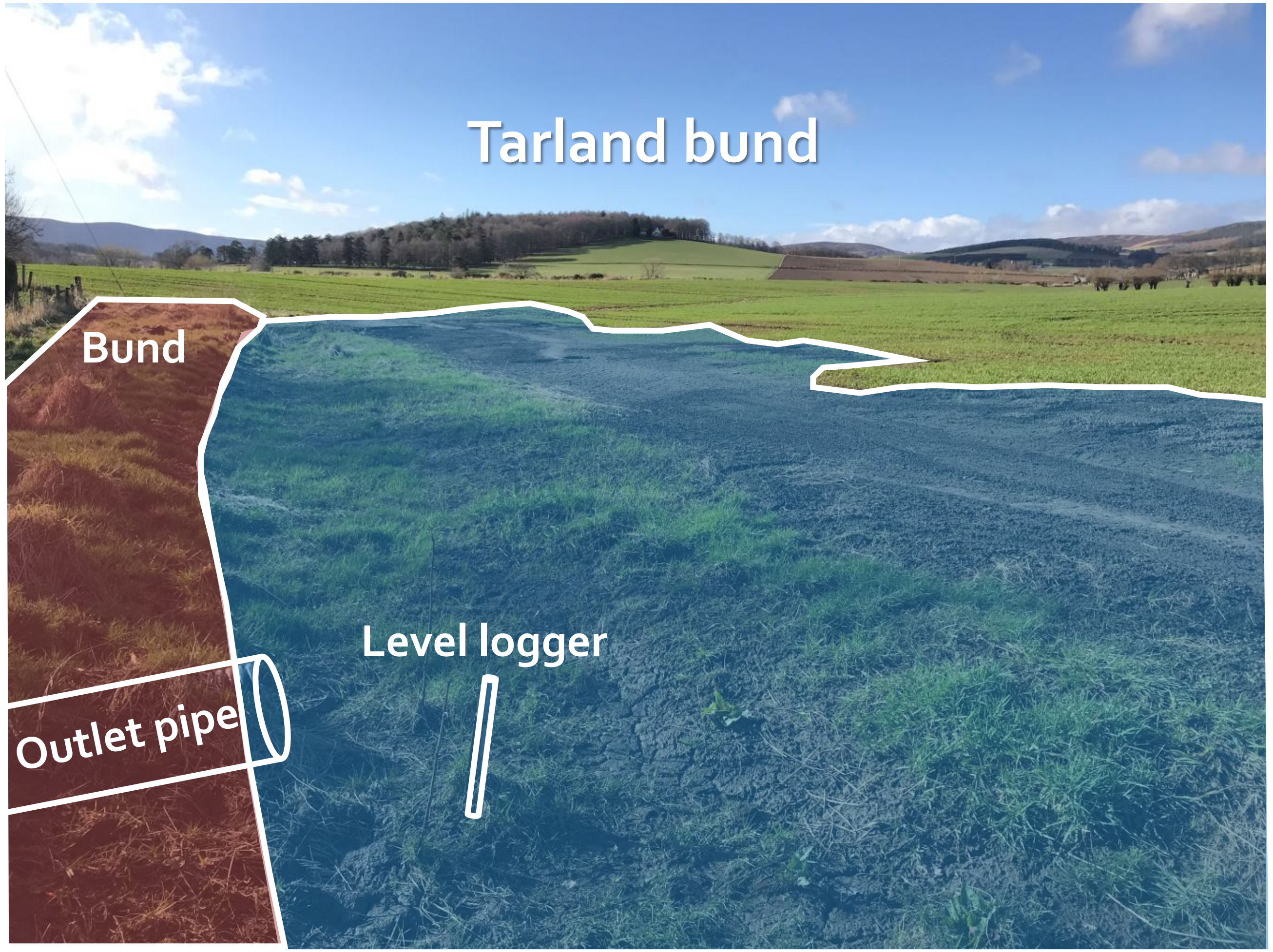

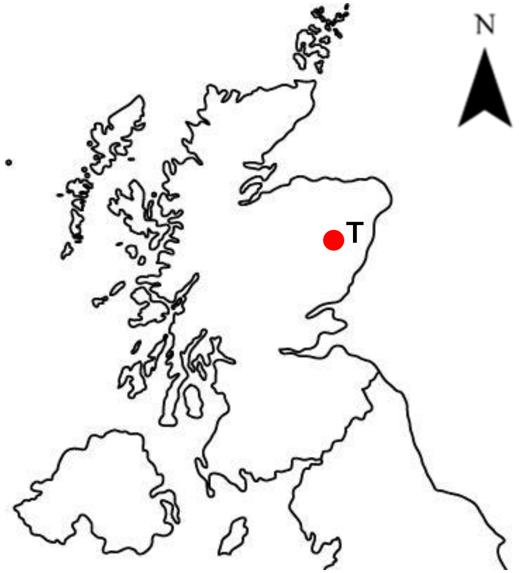

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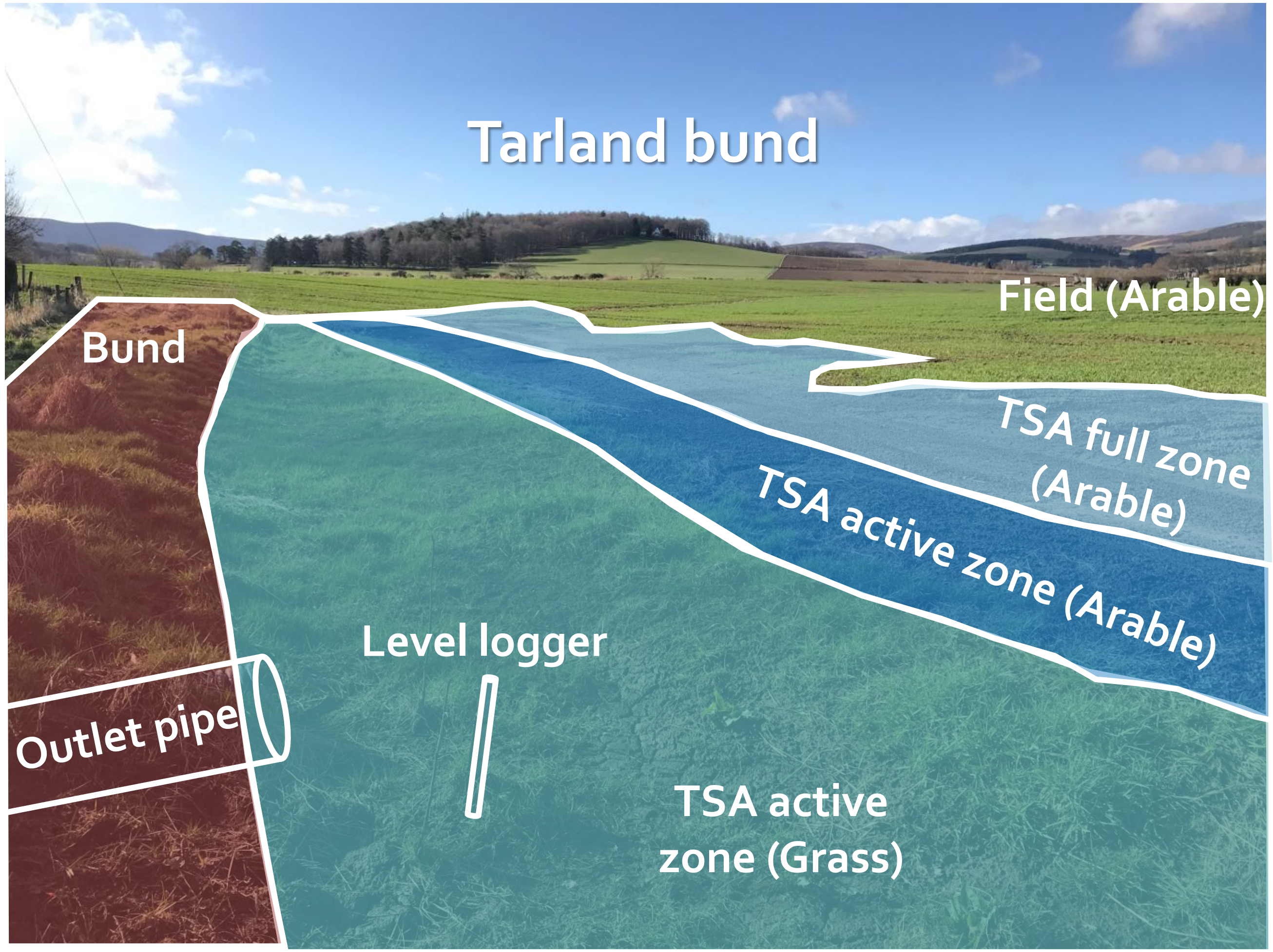
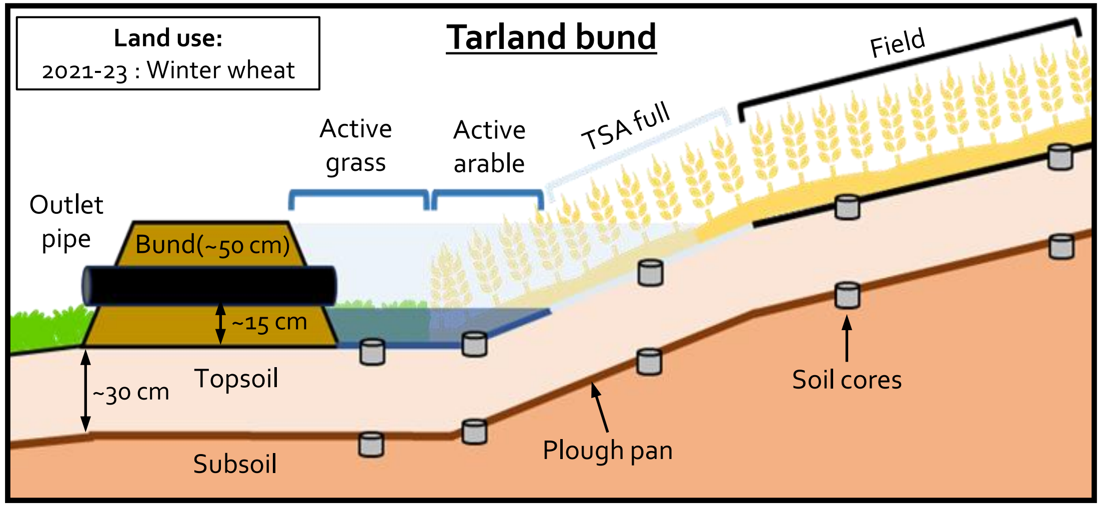


Spatial zones

1. **TSA active** (<10% full) – inundated for the longest time.
2. **TSA full** (>50% full) – active during large storms.
3. **Field** – field control points outside the wetted footprint



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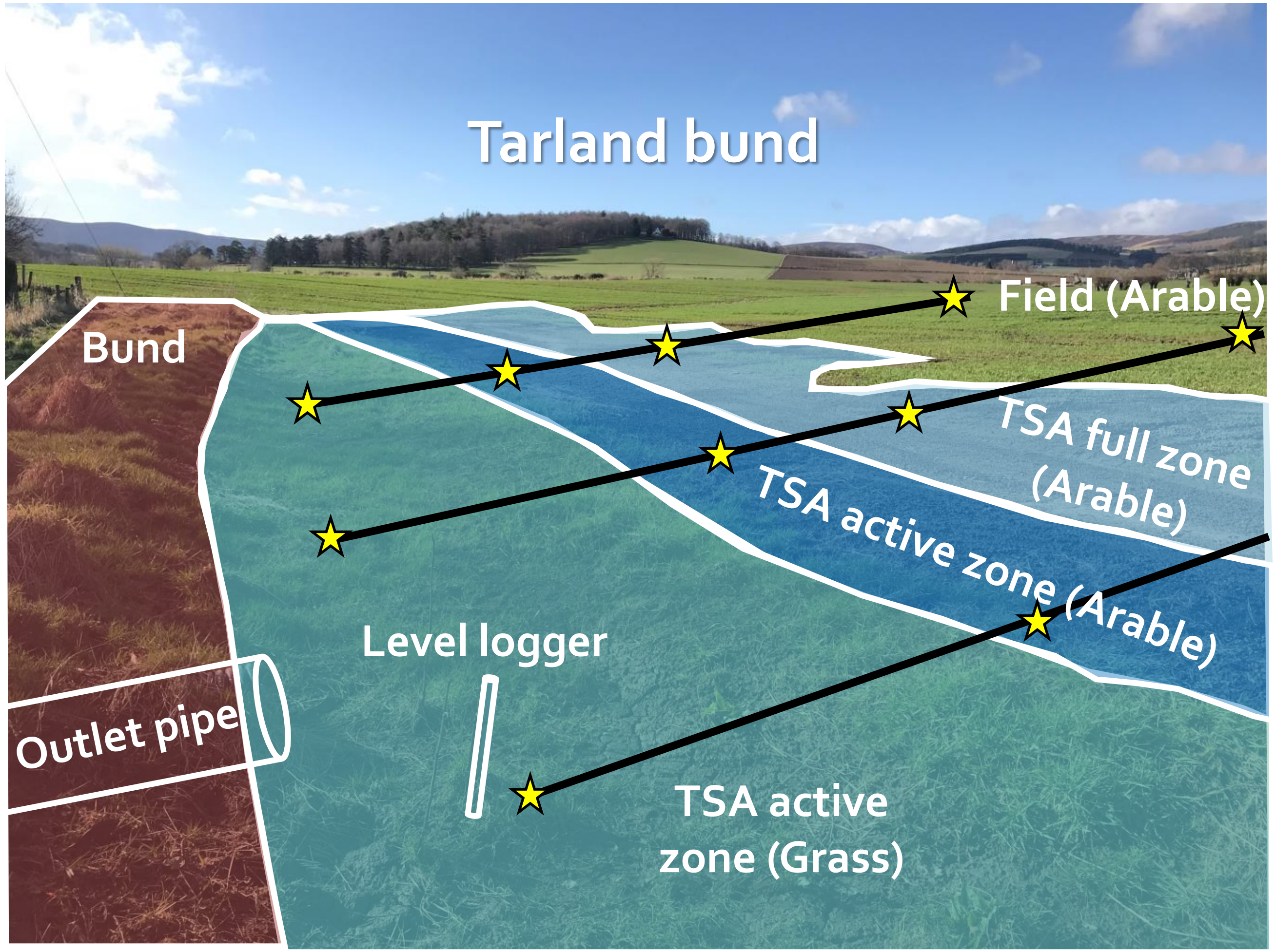

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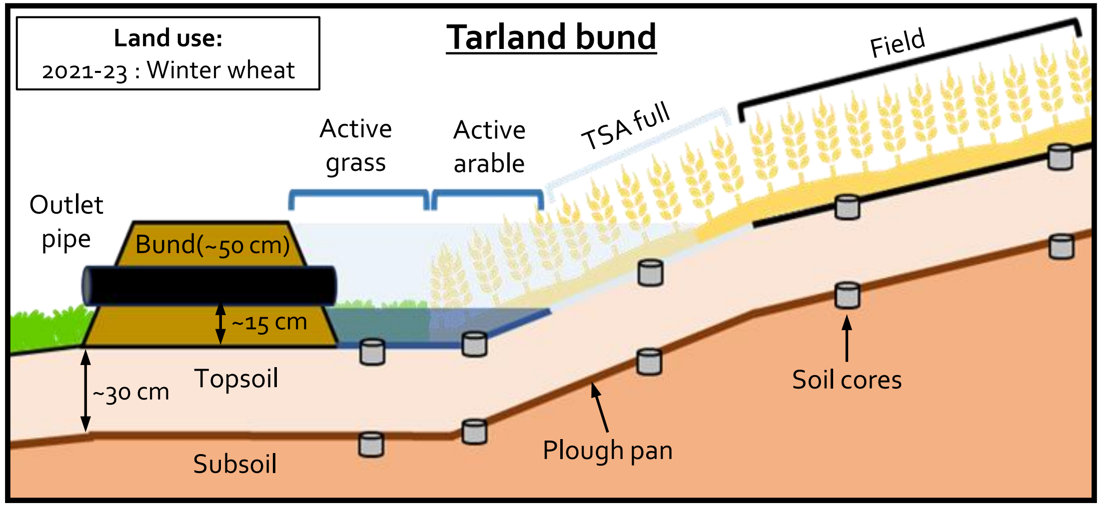

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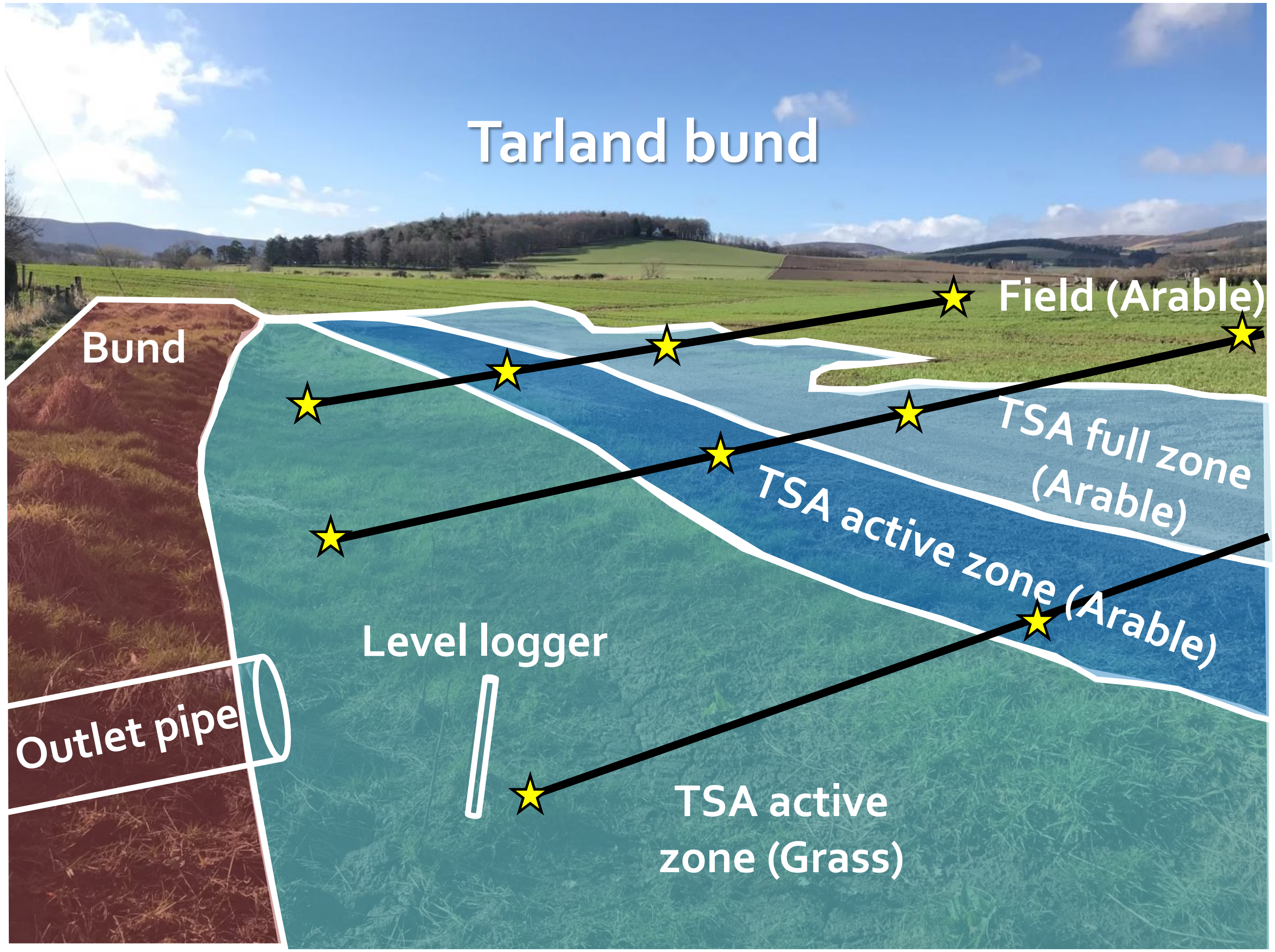
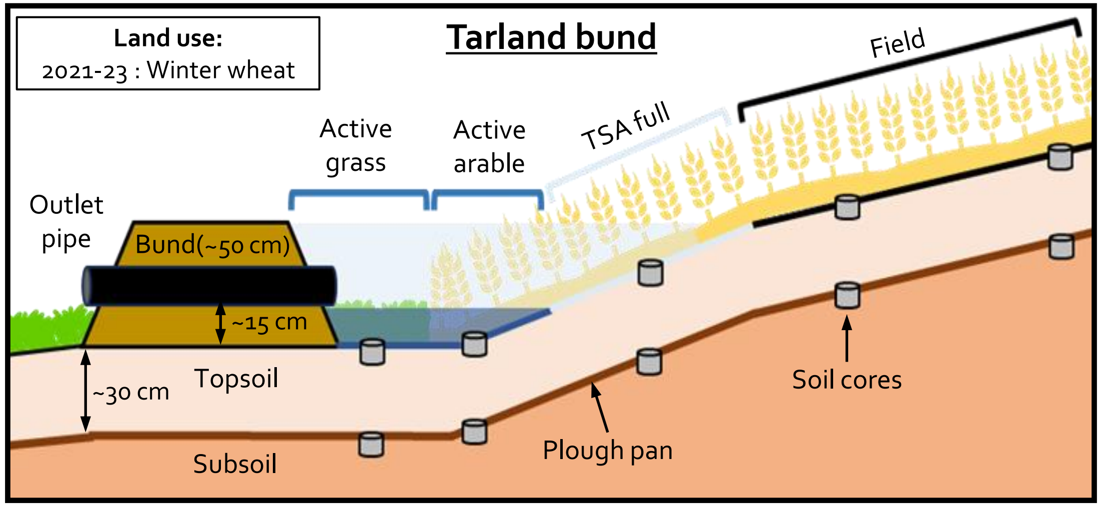


Temporal sampling

- Post-tillage
- Winter
- Growing season
- Post-harvest
- Post flood



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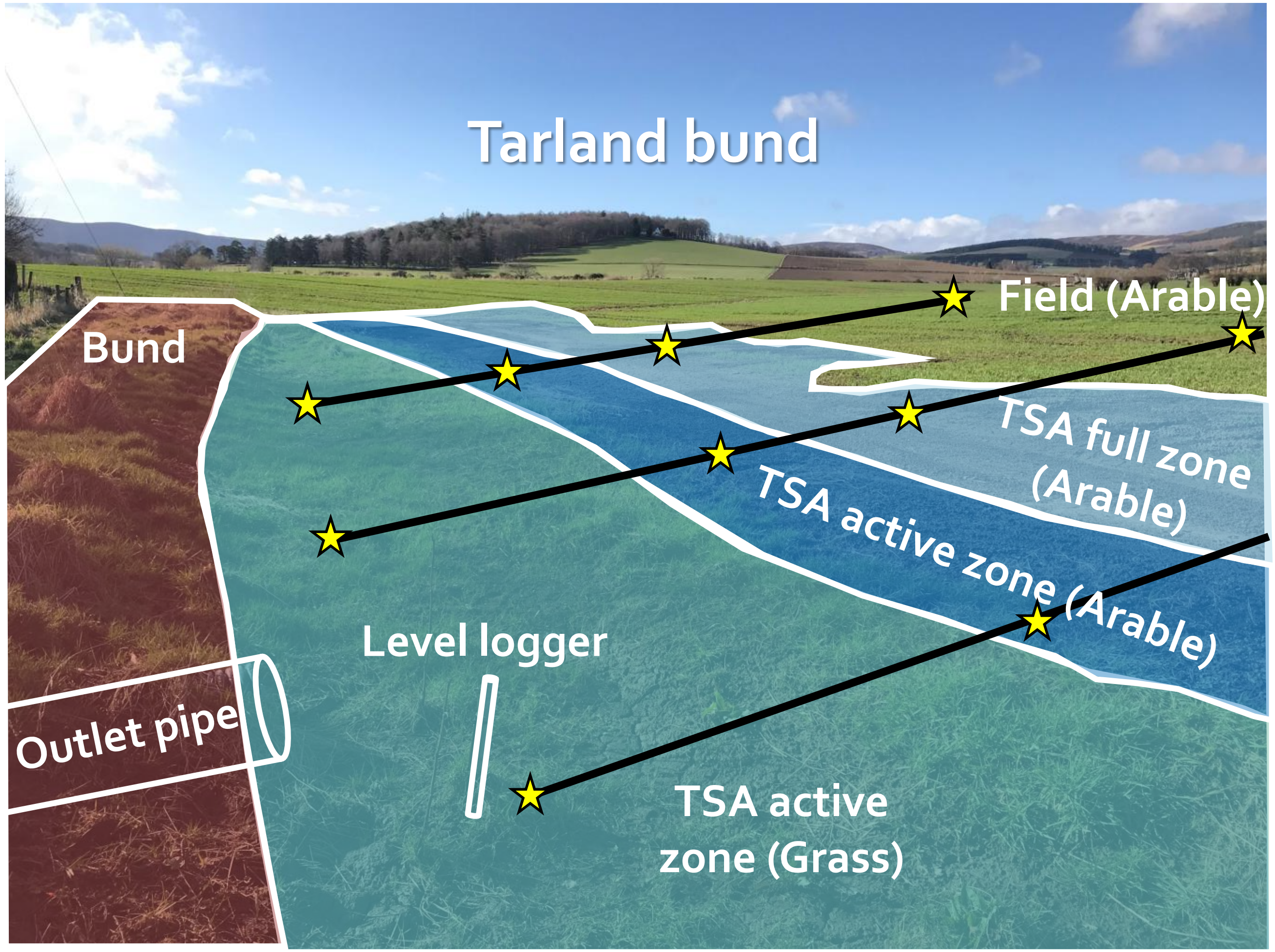
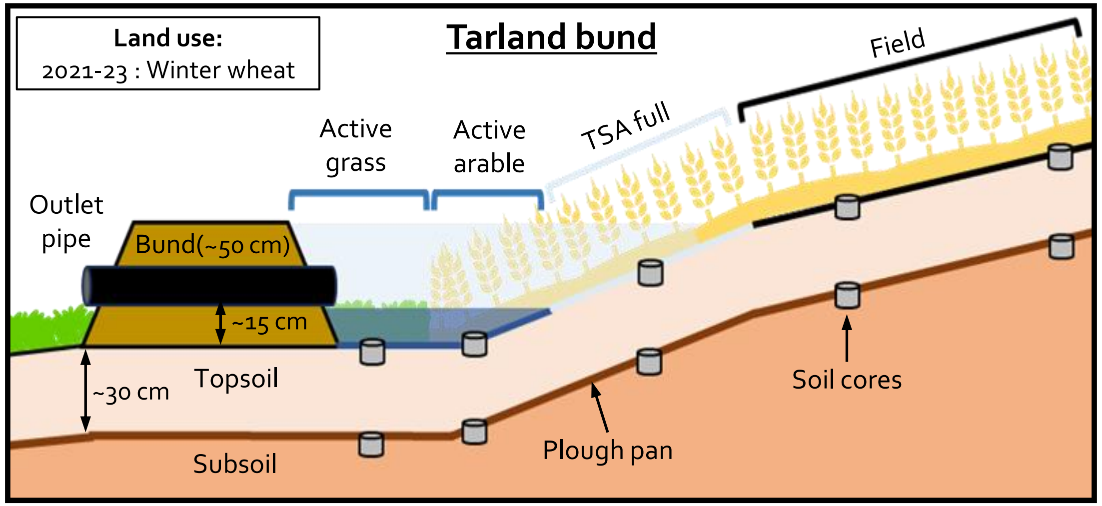


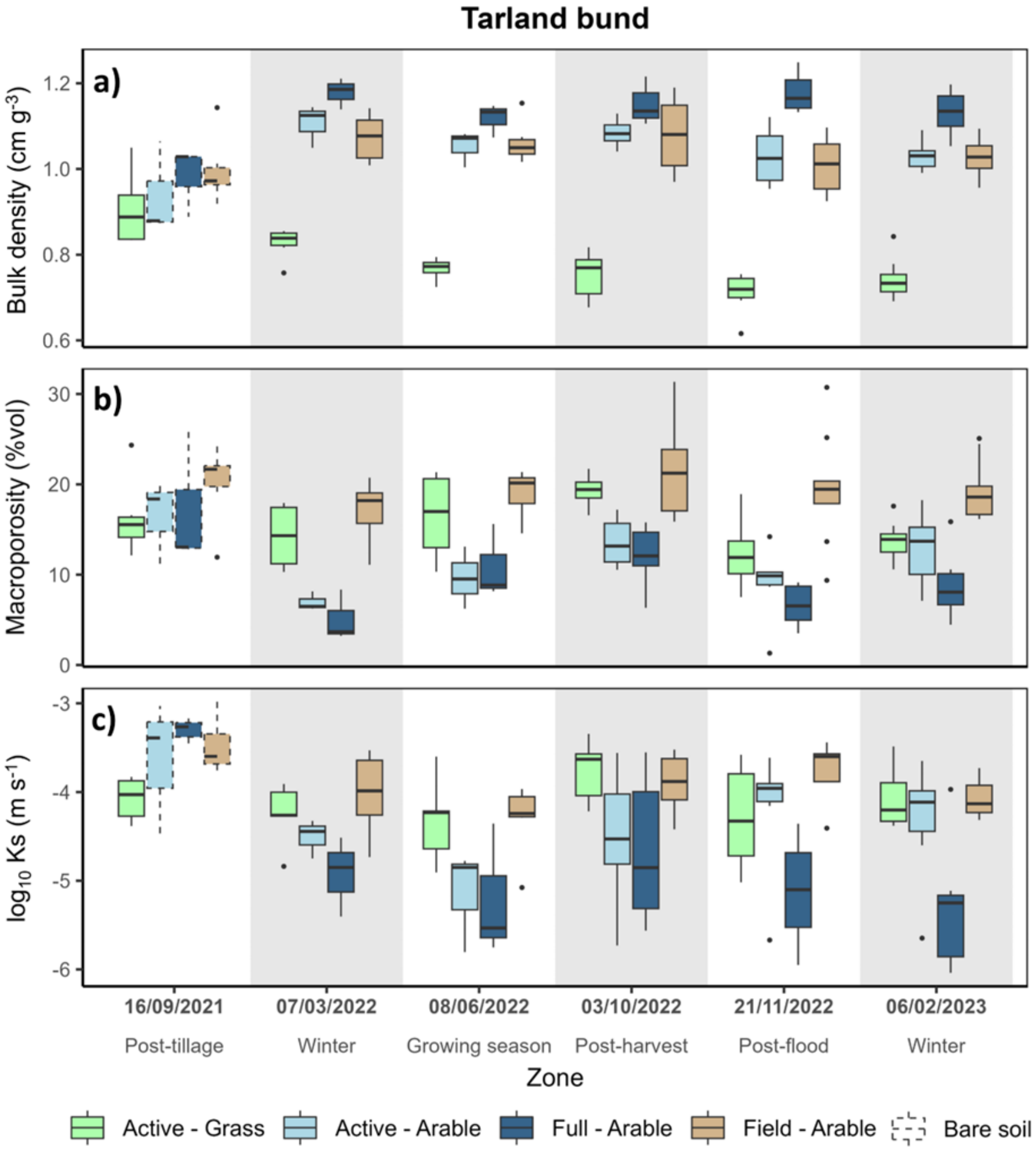
Intact soil core measurements:

- Bulk density
- Macroporosity
- Saturated hydraulic conductivity



Results

Degraded soil = higher bulk density (a), lower macroporosity (b), lower saturated hydraulic conductivity (c)



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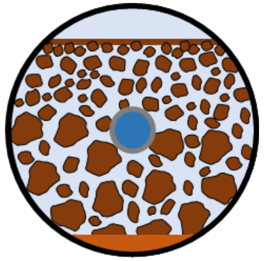
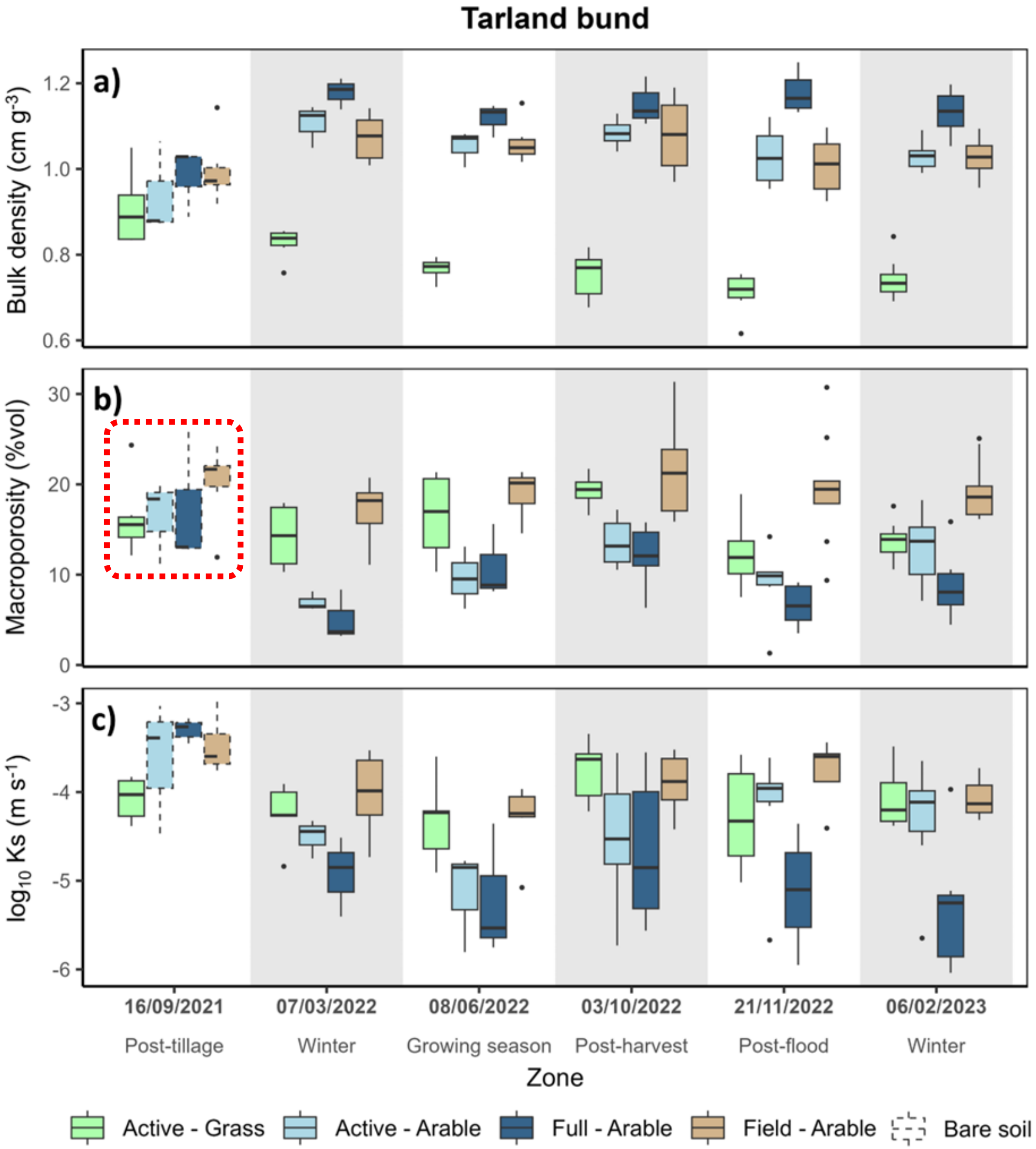


Post-tillage

- Tillage initially improved soil structure
- **No spatial variability**



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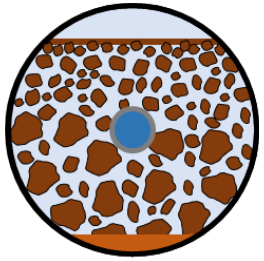

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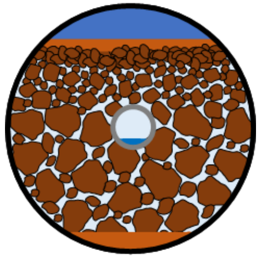
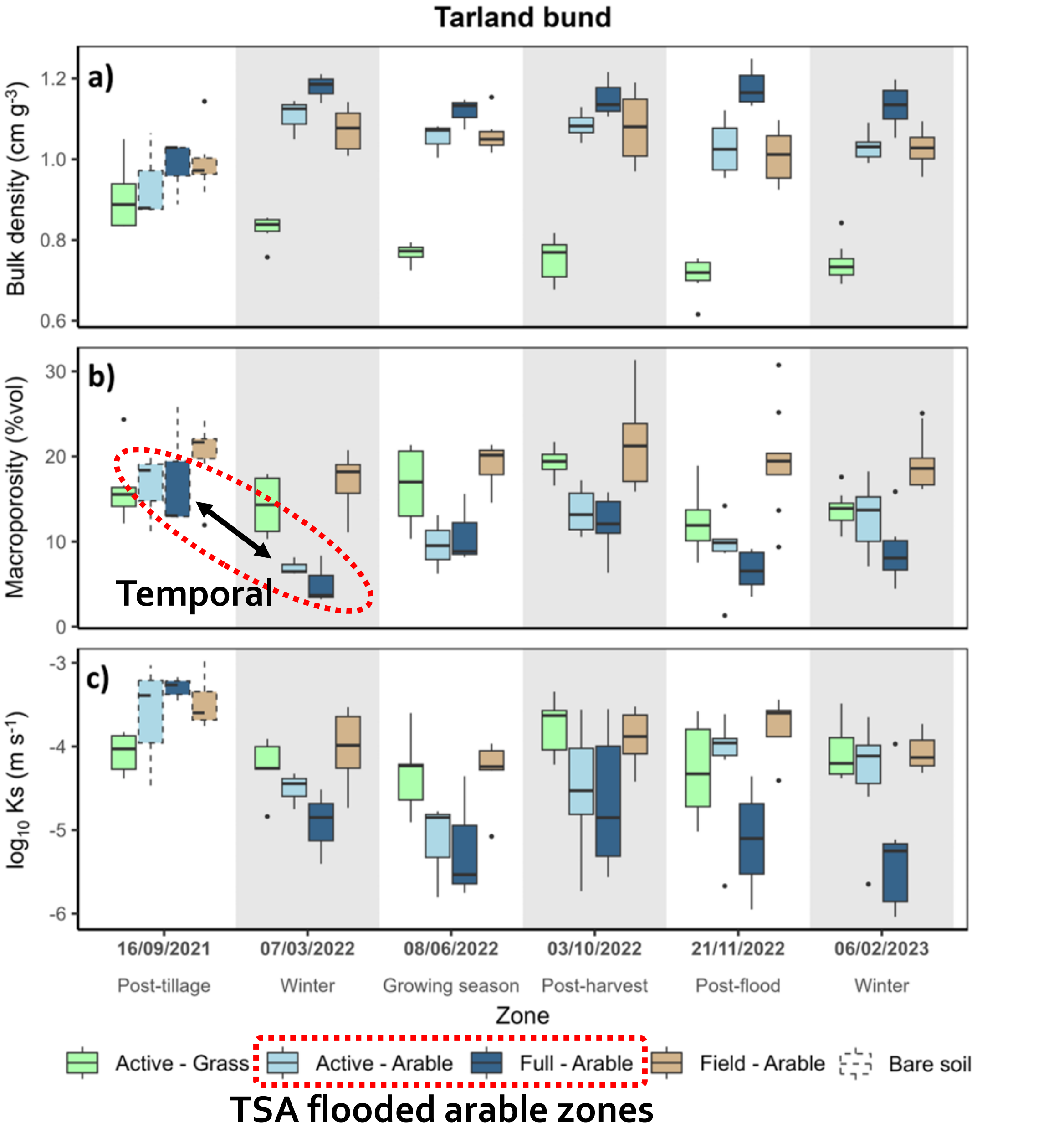


Post-flood

- Inundation and sedimentation degrade soil structure, particularly for bare soils.
- **Temporal and spatial variability**



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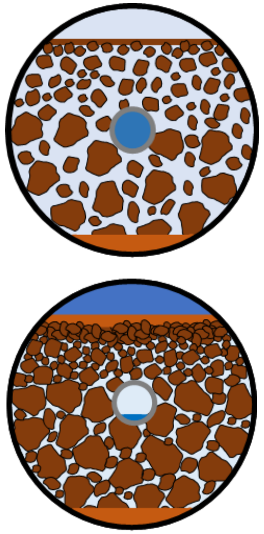

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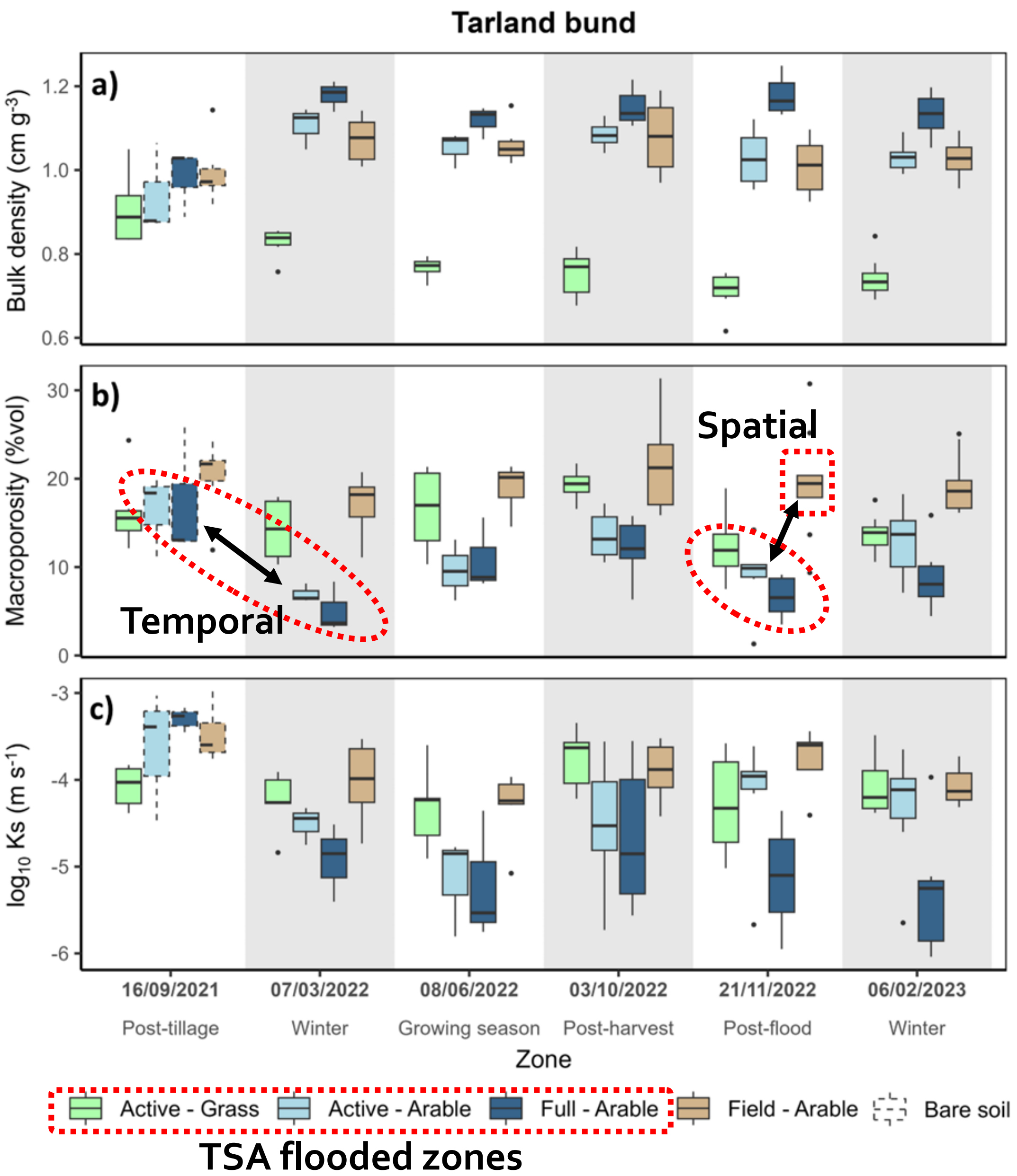

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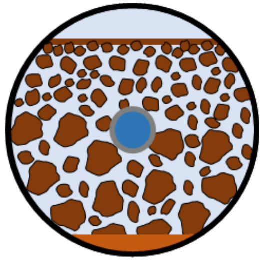

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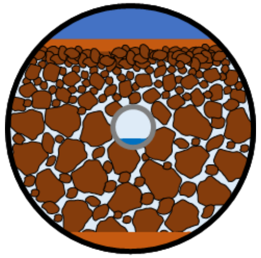

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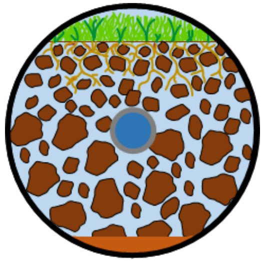
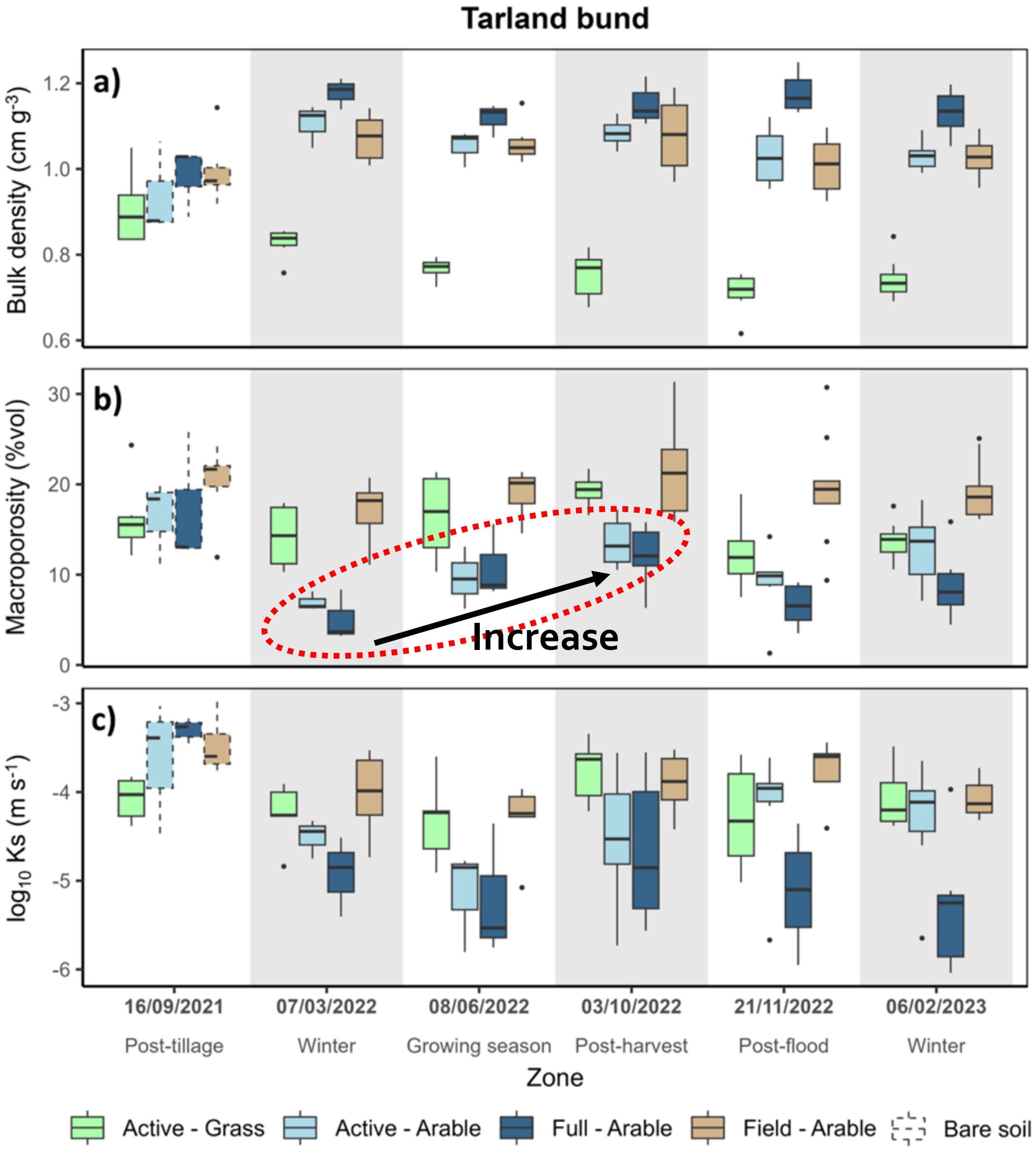


Root growth



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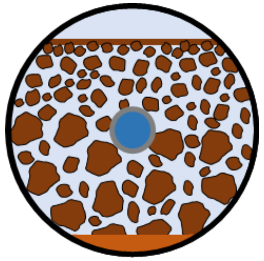

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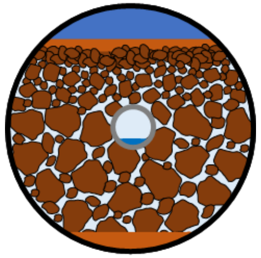

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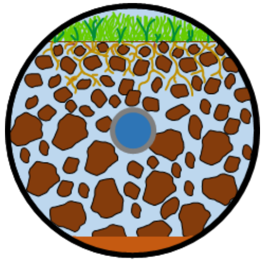
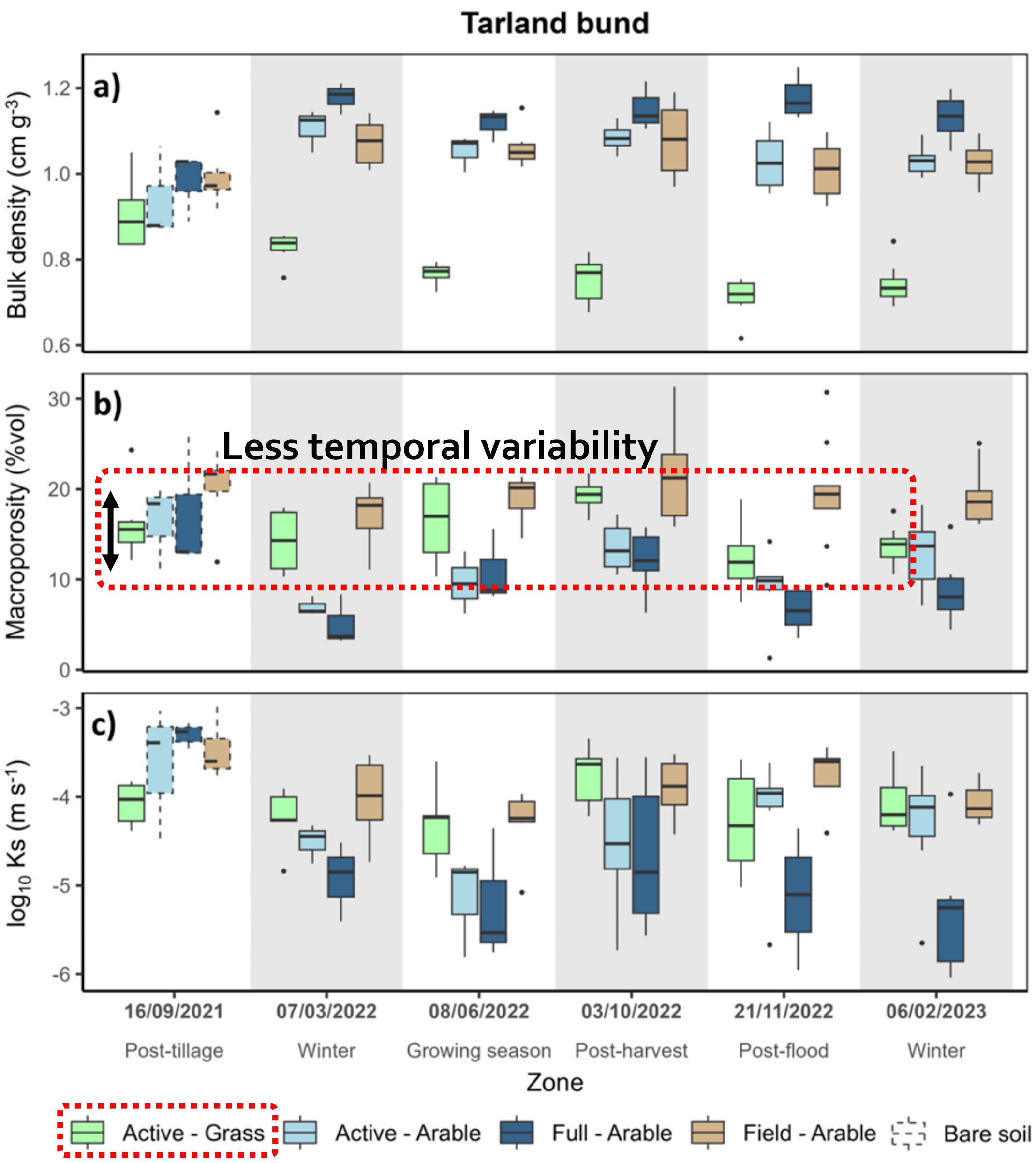


TSA active grass soils

- High vegetation cover enhances soil resilience to flooding.



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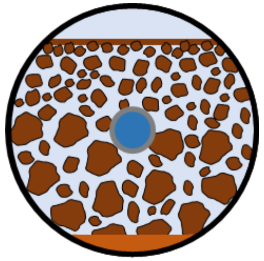

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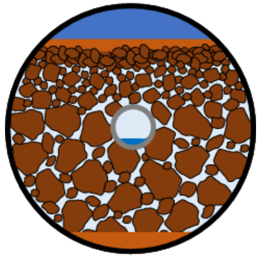

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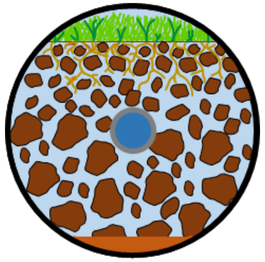
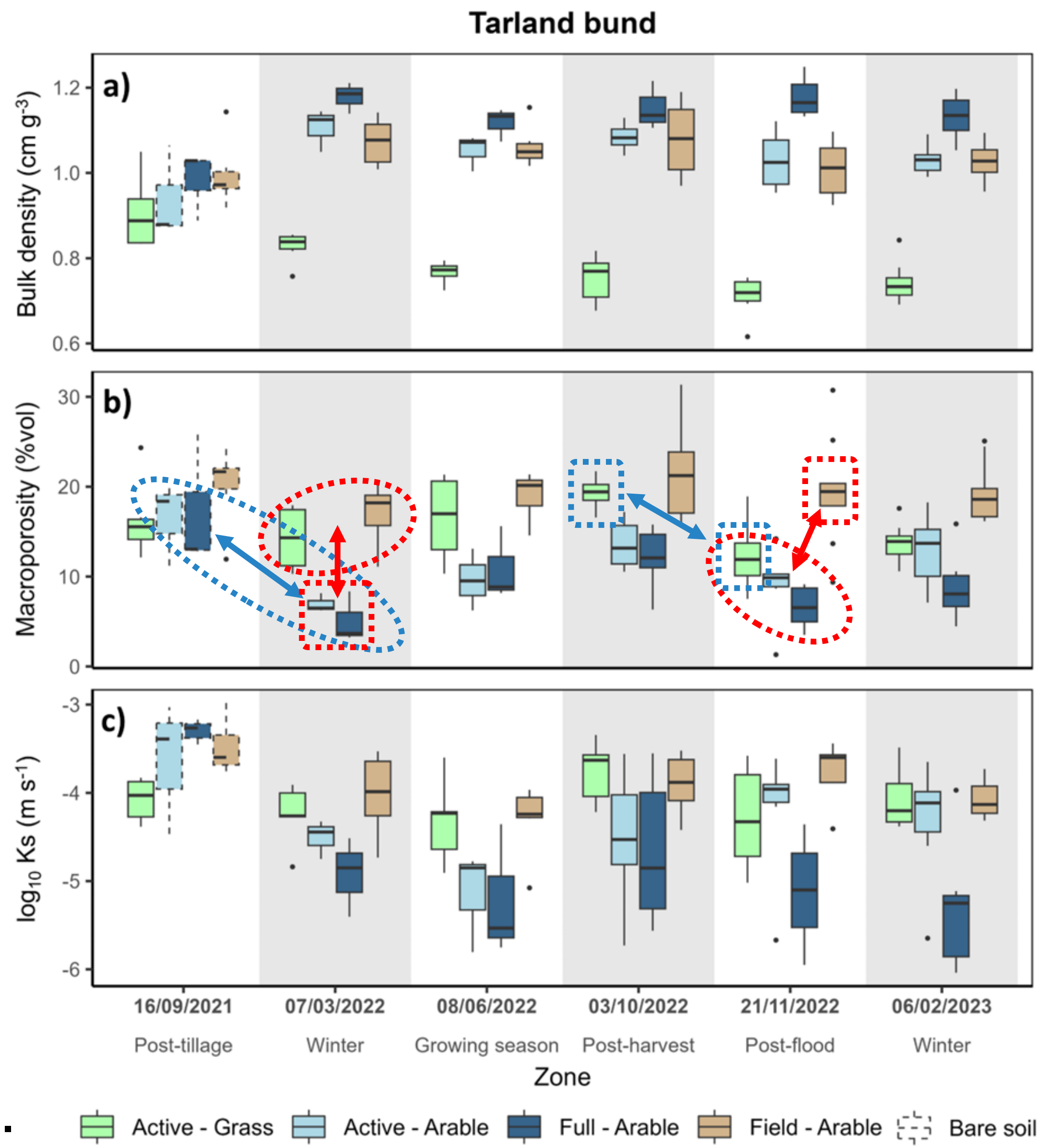


Grass soils

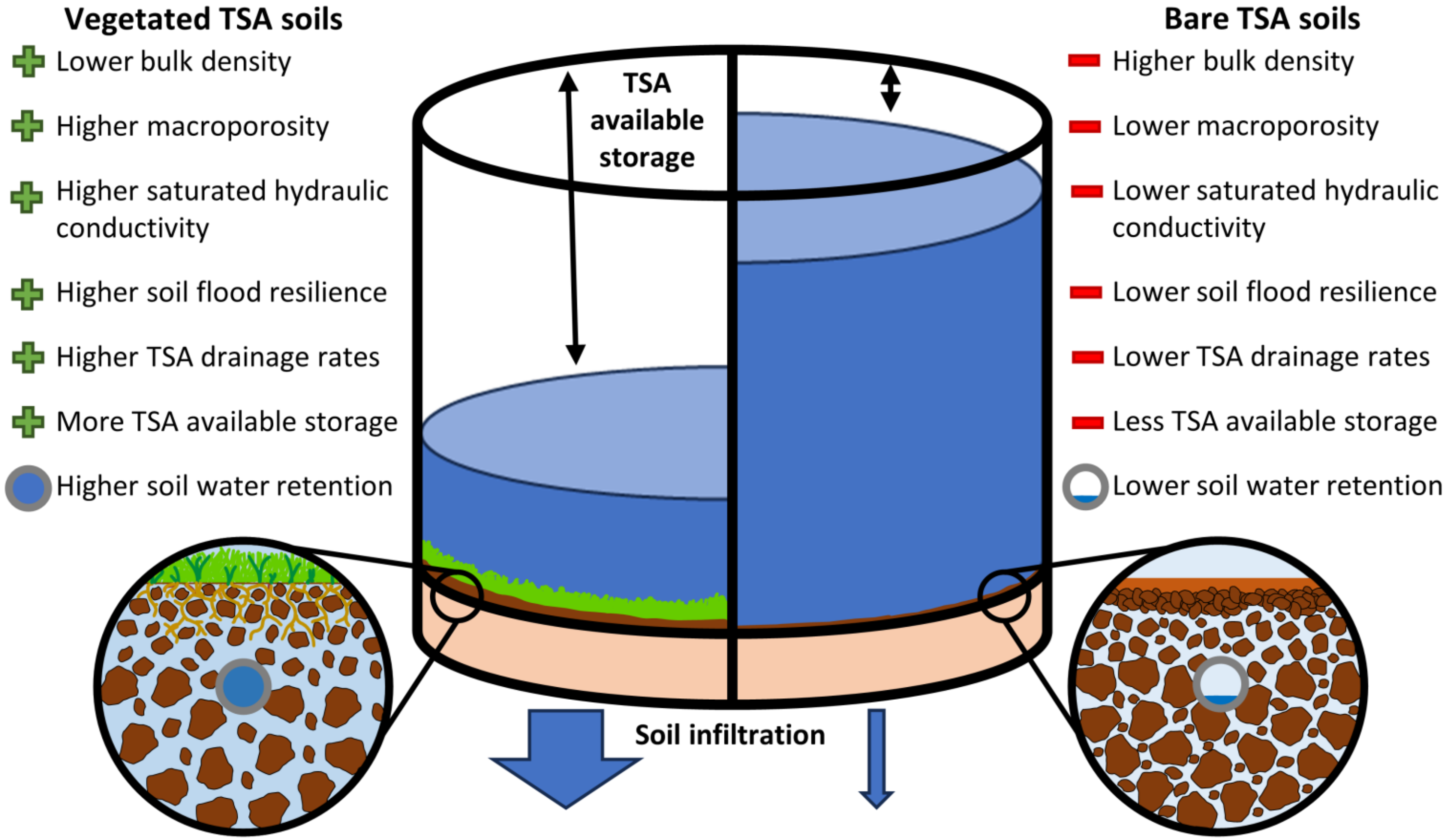
- High vegetation cover enhances soil resilience to flooding.

*** Significant temporal and spatial variations in soil properties.**



Discussion

Temporal dynamics of Temporary Storage Areas (TSAs)



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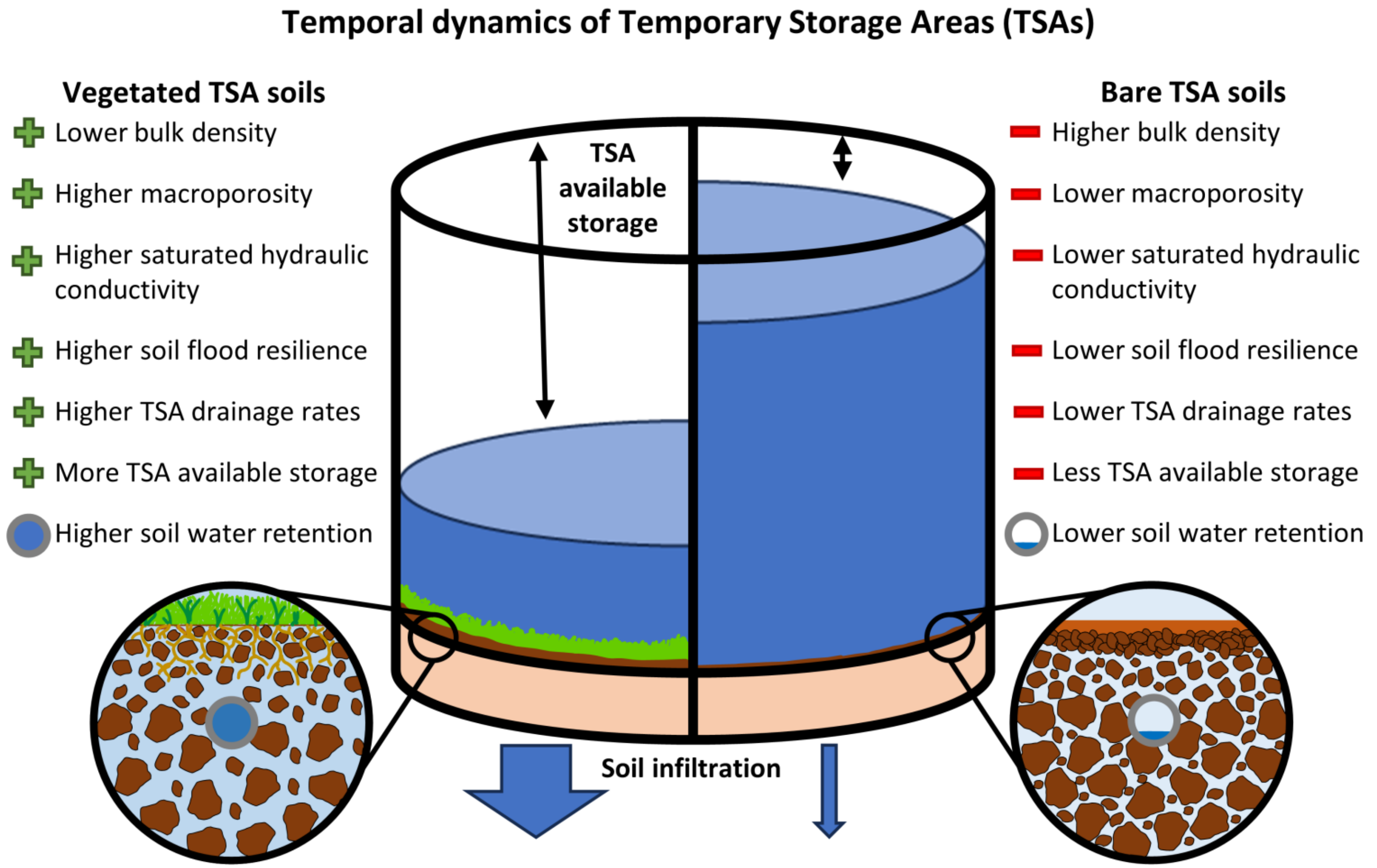

Future TSA management strategies:

1. Increase vegetation cover within TSA footprint.
2. Cover crops to bio-engineer soils.
3. Desilting/tillage every 2-3 years.

Conclusions

Temporal and spatial variations in soil properties exist.

Sedimentation and inundation impact the effectiveness of TSAs.

Active TSA management is needed to ensure longevity of features.

Acknowledgements

Supervised by:
Dr Mark Wilkinson
Dr Josie Geris
Prof Paul Hallett

Funded by Hydro Nations Scholars Programme

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Further reading:

1. Roberts et al. (2023) - Mitigating floods and attenuating surface runoff with temporary storage areas in headwaters.
2. Roberts et al. (2024) - New data-based analysis tool for functioning of Natural Flood Management measures reveals multi-site time-variable effectiveness.