The effects of an offline flood storage area (OSA) on peak flows, water quality and pasture health

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Introduction

- Nature-based Solutions (NbS) utilise natural processes to protect human settlements from pressures such as flooding and may protect water and soil quality[1, 2]
- Offline storage area (OSA) on a farm in Co. Cork to capture portion of peak flows
- Reduction and extension of flood peaks; physical and biochemical attenuation of water quality pressures

Methods

- The OSA designed to capture portion of flood peaks while stream discharge exceeded a threshold (fig. 1-3)
- Hydrological and data water quality data from upstream, downstream and within the OSA (fig. 4)
- Monthly analysis on the sward within the flood-zone and the unflooded zone (Fresh mass, dry mass, chlorophyll a and b)

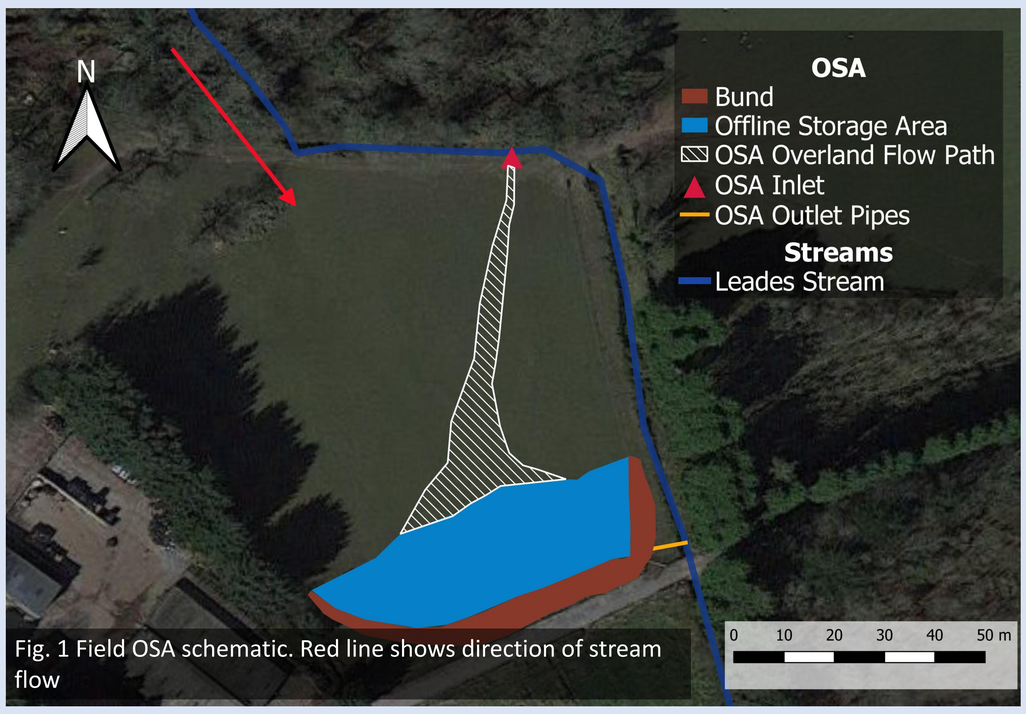

Fig. 1 Field OSA schematic. Red line shows direction of stream flow


Fig. 2 Field OSA retaining water during high-flow event


Fig. 2 OSA outlet pipes releasing water from the field back to stream

Results

- Over 15 high-flow events (March 2021 – January 2023) OSA conferred c.40% flood peak reduction and extended downstream flood peak by mean of 27 hours
- Flood storage lead to attenuation of suspended solids and nitrate; production of SRP and TP (fig. 5)
- Sward productivity in flood zone marginally impaired over winter months but was enhanced during growing months (fig. 6)

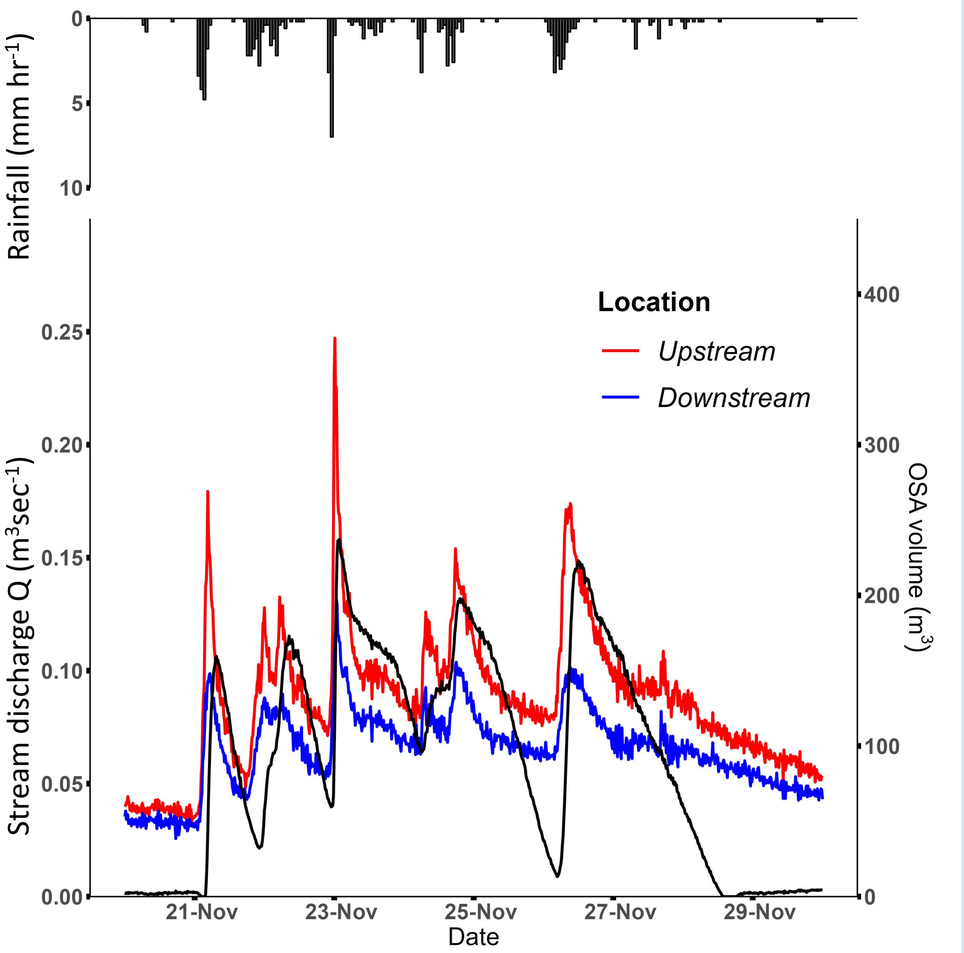

Fig. 4 Filling and emptying of OSA during successive rainfall-driven flood peaks. Stream discharge upstream and downstream of OSA on left axis; volume stored in OSA on right axis. Hourly rainfall shown on top

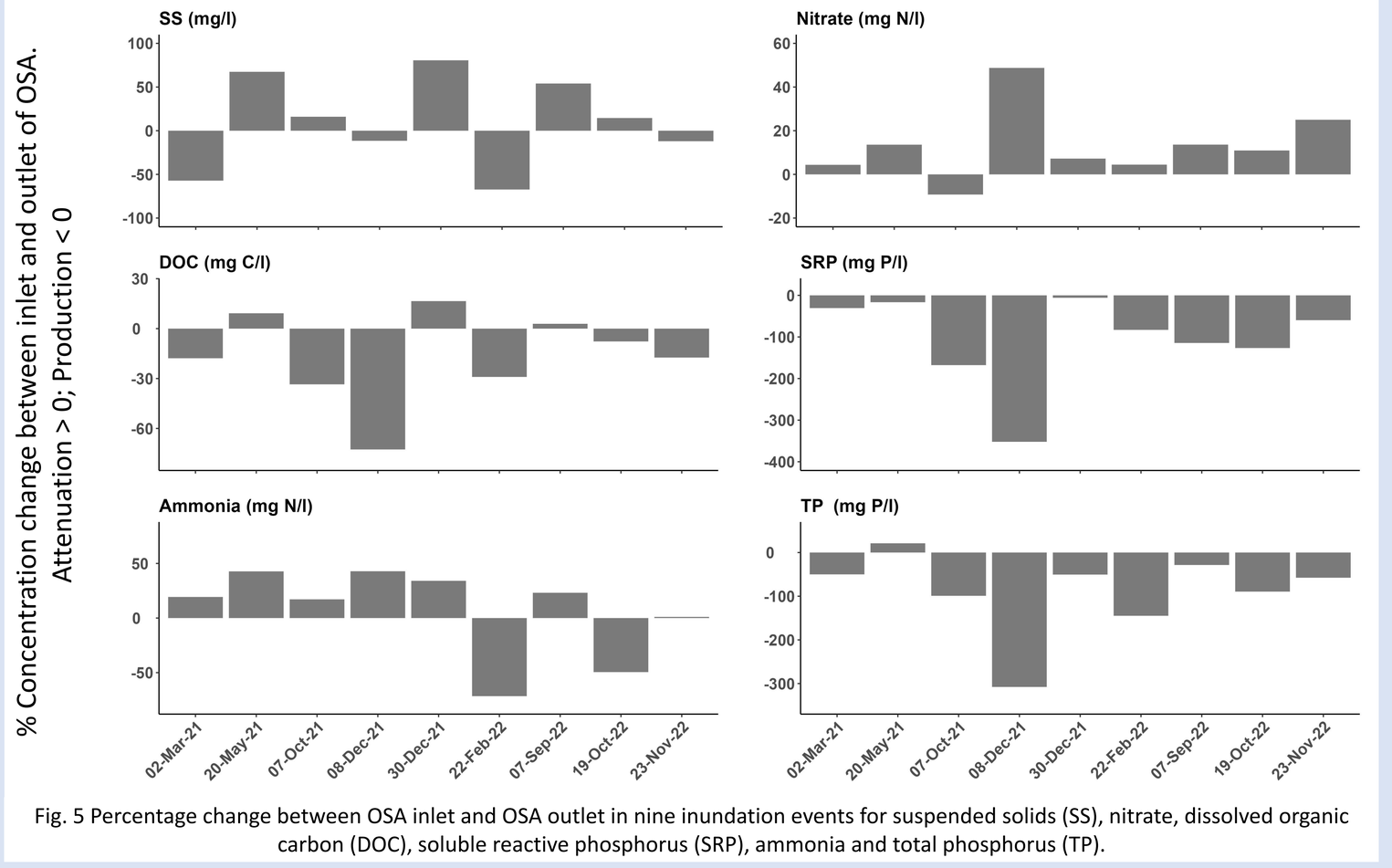

Fig. 5 Percentage change between OSA inlet and OSA outlet in nine inundation events for suspended solids (SS), nitrate, dissolved organic carbon (DOC), soluble reactive phosphorus (SRP), ammonia and total phosphorus (TP).

Conclusions

- OSA can be easily set up but requires diligent observation and maintenance
- Flood peak attenuation may be limited to medium-scale events
- Antecedent soil and hydrological conditions important in OSA performance
- Flood storage has variable effects on water quality
- Inundations of 24-48hrs may promote grass growth during growing season

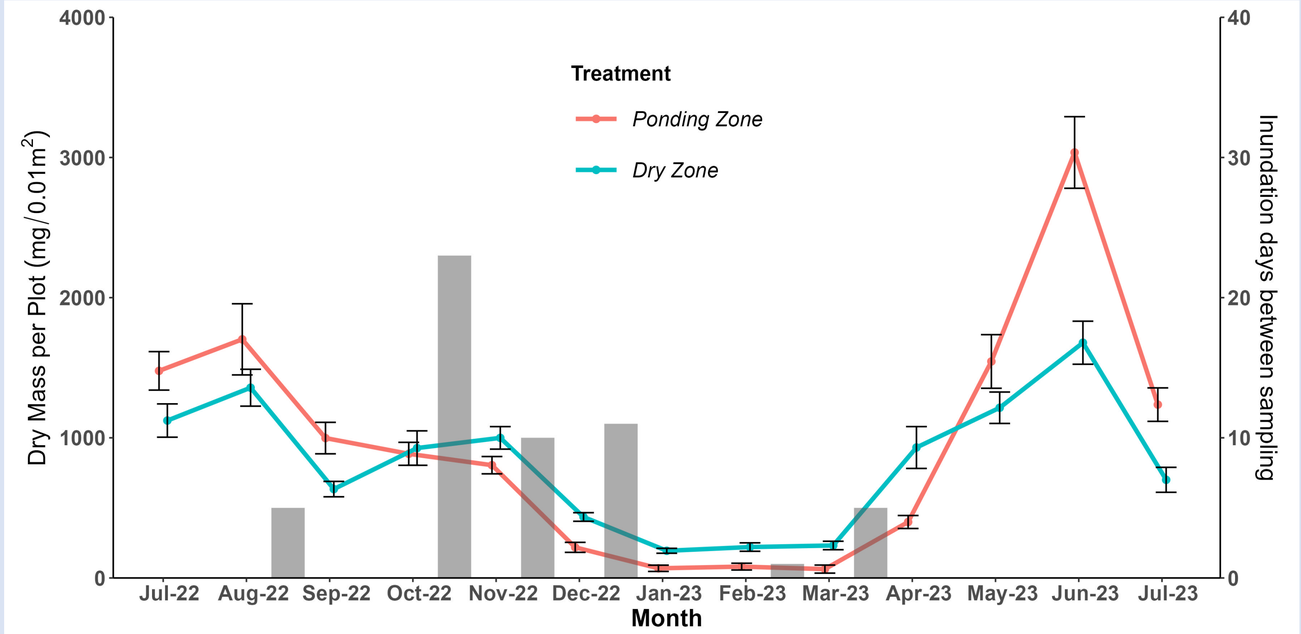

Fig. 6 Dry biomass production from monthly samples at the OSA ponding zone and dry zone (left axis) and the number of days the ponding zone was inundated between vegetation sampling events (right axis).

References

1. Lane, S. N. (2017) 'Natural flood management', *Wiley Interdisciplinary Reviews: Water*, 4(3), pp. 1–14. doi: 10.1002/wat2.1211.
2. Lockwood, T. *et al.* (2022) 'Assessing the efficacy of offline water storage ponds for natural flood management', *Hydrological Processes*, 36(6), pp. 1–17. doi: 10.1002/hyp.14618

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Introduction

- Nature-based Solutions (NbS) strive to utilise natural processes to protect human settlements from pressures such as flooding, while providing additional benefits for wildlife, water quality and more.
- This project utilised an agricultural field for the attenuation of flood peaks and examined changes in water quality and sward health over 18 months on a farm in Co. Cork

Methods

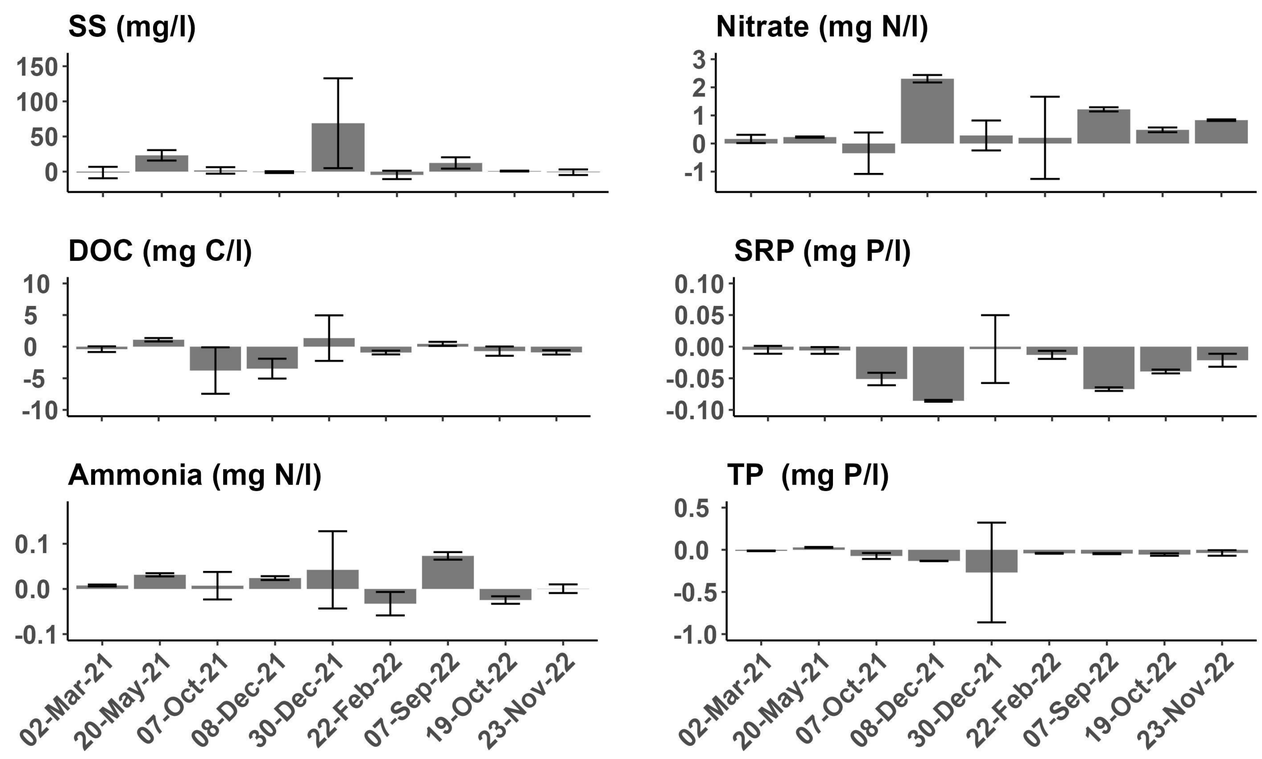
- The OSA allowed a portion of flood peaks to enter and be stored within the field while stream discharge exceeded a threshold
- Water was stored for several hours beyond the flood peak and gradually drained back to the channel
- Water quality was sampled from upstream, downstream and within the OSA over flood events to examine changes in water quality parameters of concern in agricultural catchments
- Monthly analysis performed on the mutli-species sward within the flood-zone and the unflooded zone of the OSA (Fresh mass, dry mass, chlorophyll a and b)

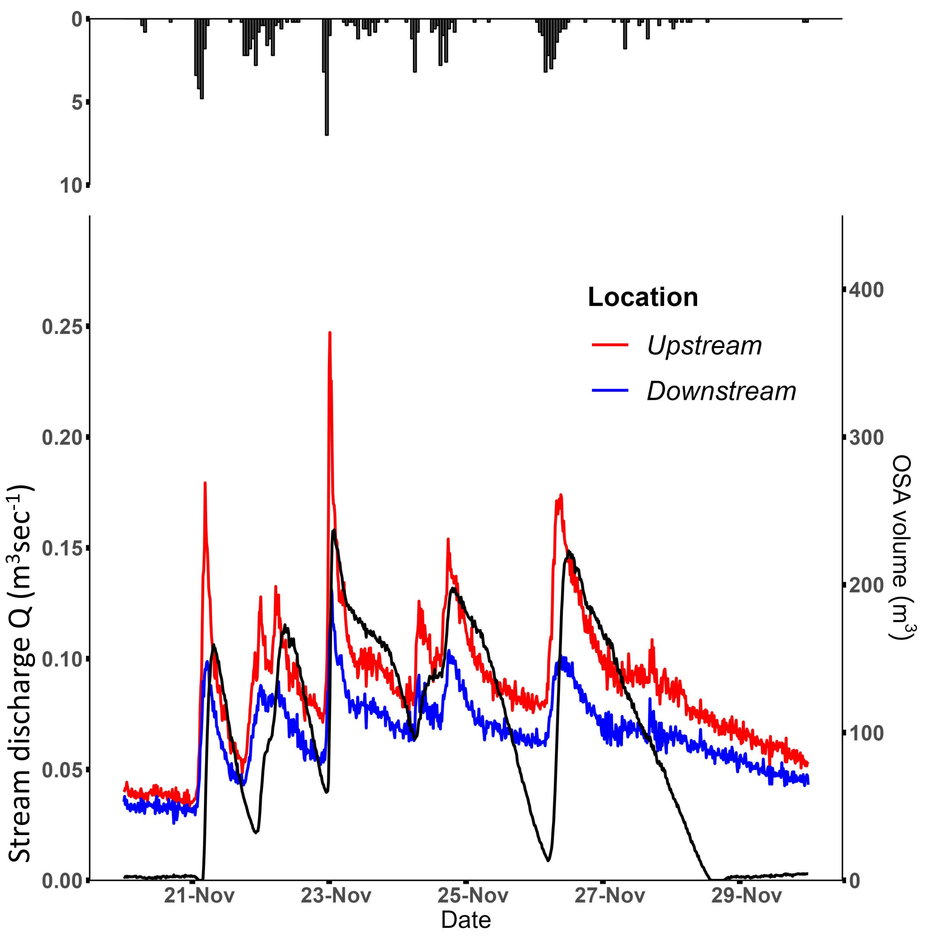
Results

- OSA effectively reduced and extended downstream flood peak durations over 14 high-flow events
- Significant attenuation of suspended solids and nitrate over 11 sampling events; production of SRP and TP.
- High variation among events in both strength and direction of effects on water quality
- Antecedent soil and hydrological conditions important in OSA response to rainfall-induced flood peaks
- Sward productivity in flood zone marginally impaired over winter months but significantly better during growing months
- Evidence the flooding protects sward from drought

Discussion

- Nature-based Solutions can be easily set up but require diligent observation and maintenance to ensure adequate operation.
- OSA can bring about substantial attenuation of medium flood peaks but is limited under large-scale peaks and sustained rainfall conditions
- Water quality changes in OSA are variable
- Year-rounds inundation for periods of 24-48hours may promote grass growth during growing season





% Concentration change between inlet and outlet of OSA. Attenuation > 0; Production < 0