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Evaluation of constructed wetlands for mitigation of diffuse pollution from agriculture: uncertainties

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Outline

- Field Wetlands – conceptual model
- Experimental design – choice of study sites
- Some successes
- Some challenges
- Summary

Field Wetlands as Mitigation Options

Field Wetland Conceptual Model:

An unlined constructed wetland for diffuse pollution mitigation

V. limited data

Potential for reduced air quality = pollution swapping

Atmospheric interactions

CO_2, NO_2, CH_4

Economic viability?

Evidence available from outside UK

Polluted runoff in
Sediment, P, N, C

Trapped sediment & P, N, C

Mitigated runoff out
Sediment, P, N, C

NO_3

Potential for improved streamwater quality = effective mitigation

Groundwater interactions

Potential for reduced groundwater quality = pollution swapping

V. limited data

Flood retention & wildlife habitat

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10 MOPS2 Field Wetlands

	Shallow Single	Shallow Paired	Deep & Shallow Paired
Clay	 		
Silt	 		
Sand	 		

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Sediment trapped

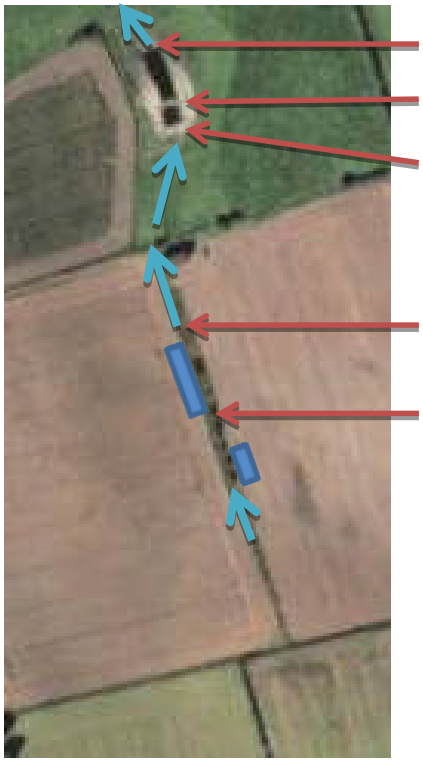
Whinton Hill, Cumbria
2009/10: 26 tonnes
2010/11: 22 tonnes

Crake Trees, Cumbria
2009/10: 4 tonnes
2010/11: Sediment volume using Total Station

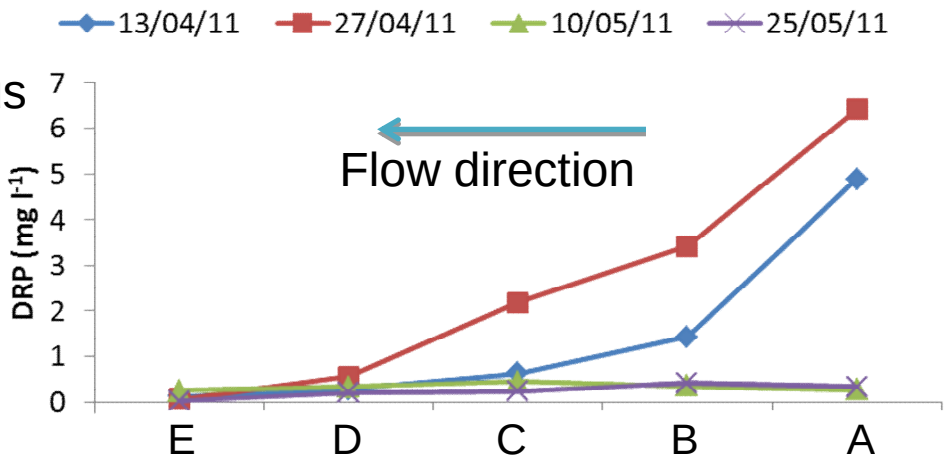
Loddington, Leicestershire
2009/10: 1 tonne
2010/11: Sediment depth from sediment traps

Soluble nutrient reduction

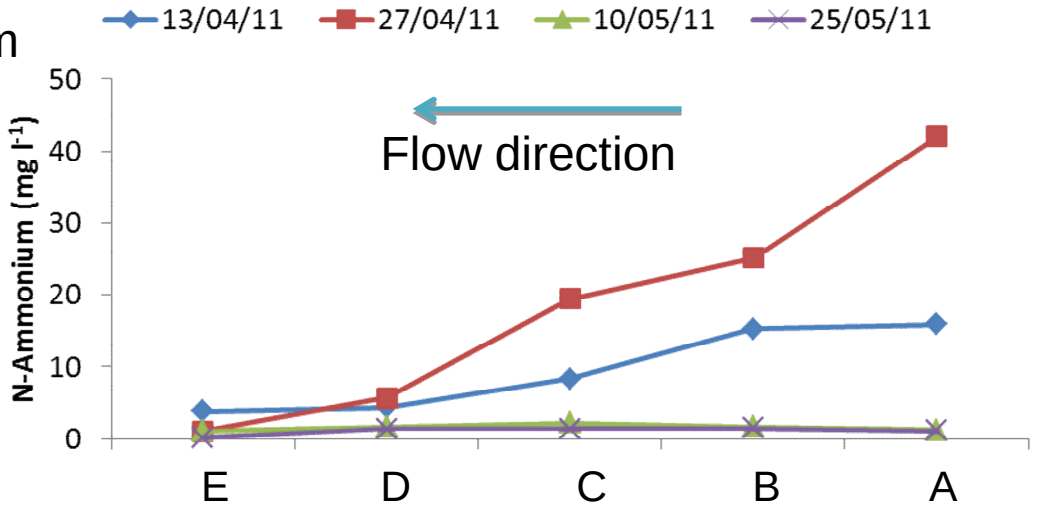
Whinton Hill,
Cumbria



Phosphorus



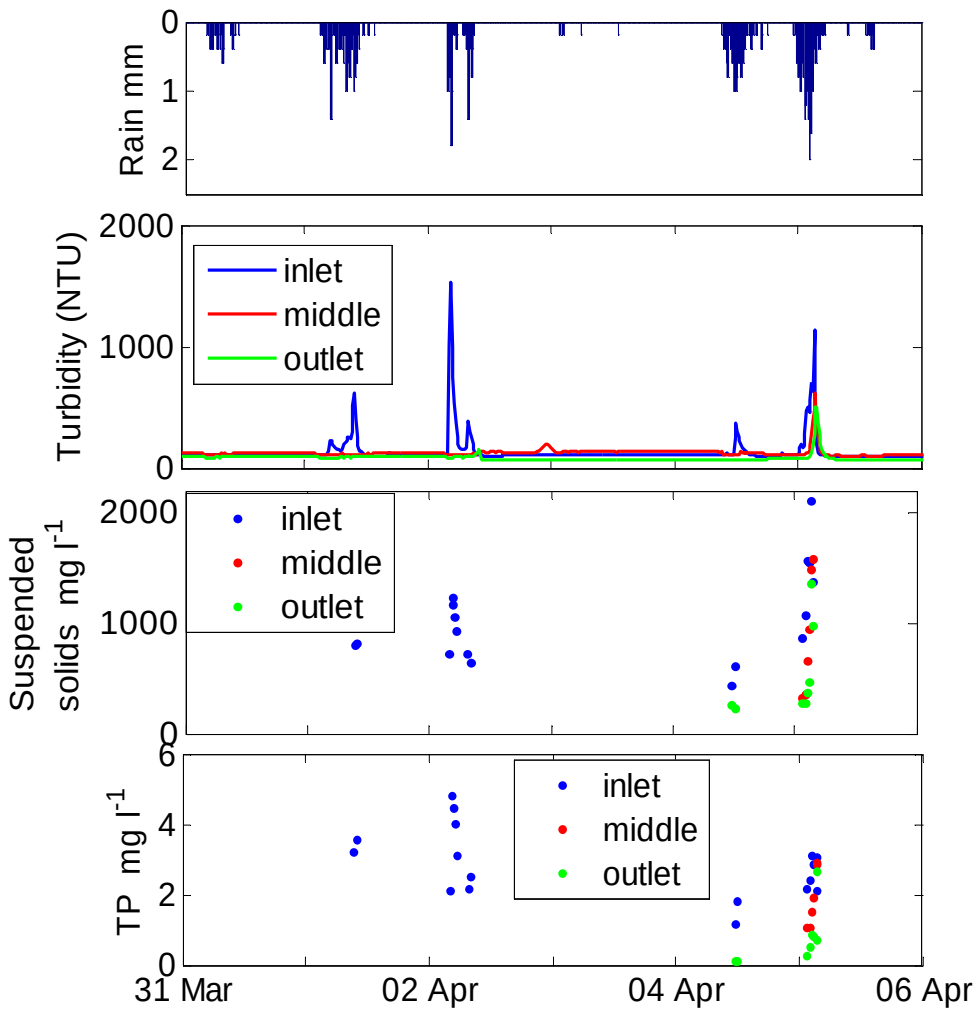
Ammonium



Suspended sediment and total phosphorus reduction

Crake Trees, Cumbria

Surface runoff
1 – 6 April 2011



Suspended sediment and TP concentrations are higher at inlet than outlet

Some challenges

Depth – discharge relationship is more uncertain when:

•Depth too high (flooded) or
too low (below level of detection)

Need: more frequent velocity/flow measurements

Turbidity – suspended sediment relationship breaks down when:

•Turbidity is high due to algae or sensors get blocked at heavily polluted sites

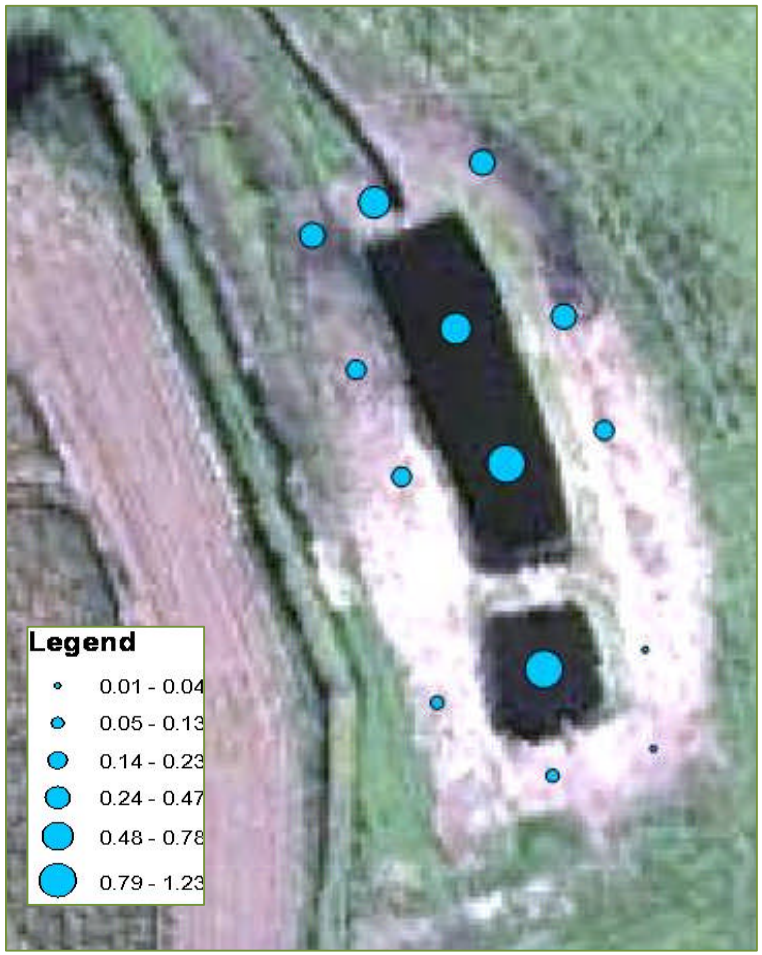
Need: different sampling regime for 'dirty' sites

Pollution swapping?

Whinton Hill, Cumbria:

Multilevel piezometers installed in array around and through wetland

Results suggest leakage of PO_4 (and NH_4) to groundwater



Phosphate concentration 3 m below ground surface, July 2010

PO_4-P (mg l^{-1})

Summary

This data has provided evidence for the success of field wetlands for mitigation of diffuse pollution from agriculture

- Sediment trapped
- Nutrient concentrations reduced between inlet/outlet

The sites in this project are typical of real life agricultural situations. This highlights the difficulty of maintaining continuous field data – and a need to adapt to each different situation. Particularly challenging areas have been:

- Flow data for load estimations
- Turbidity – suspended sediment relationship

If fluxes of nutrients via pollution swapping pathways are significant, need to consider the priorities for catchment management – different for each catchment

- Groundwater monitoring
- Atmospheric interaction

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UK 'Field Wetland' Designs

3 Wetland sizes – generally smaller than used elsewhere but appropriate for UK agriculture:

- *Large* – 0.1% catchment area (100 m^2 for 10 ha)
- *Medium* – 0.05% catchment area (50 m^2 for 10 ha)
- *Small* – 0.025% catchment area (25 m^2 for 10 ha)

3 Wetland types – simplified designs for easy and cheap construction:

- *A: Shallow single pond* - 1 x 50 cm deep vegetated filter
- *B: Shallow paired ponds* - 2 x 50 cm deep vegetated filters
- *C: Deep & shallow paired ponds* - 1.5 m deep sediment trap + 50 cm deep vegetated filter

3 Soils – may affect sediment & nutrient characteristics:

- *Clay*
- *Silt*
- *Sand*

3 Flow sources – may affect sediment & nutrient characteristics

- *Surface runoff*
- *Drainflow*
- *Ditch & Streamflow*