

A multi-disciplinary approach to resolving nitrogen flux in the hyporheic zone

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**Nick Riess, Wairimu Muia, Steve Thornton,
Jonathan Smith, Mark Osborn**

University of Sheffield



Talk Outline

- **Project background**
- **Geochemical survey**
- **Problems with interpreting geochemical data**
- **Strategy for understanding hyporheic solute fluxes and application during this project**
- **Planned hydrogeological study**
- **Problem of heterogeneity/extrapolation**
- **Summary**

Project Background

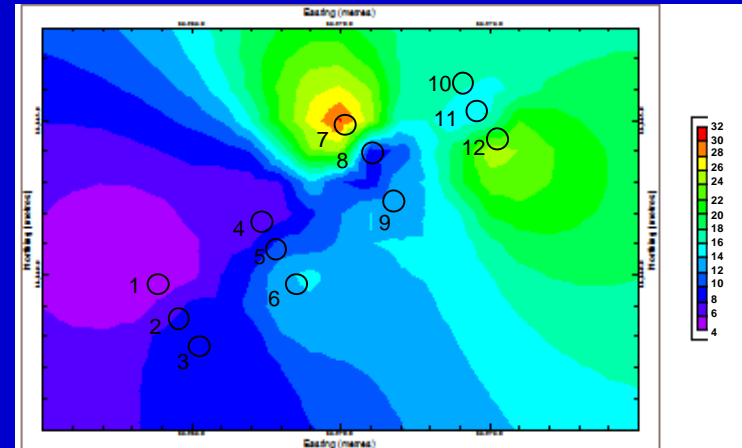
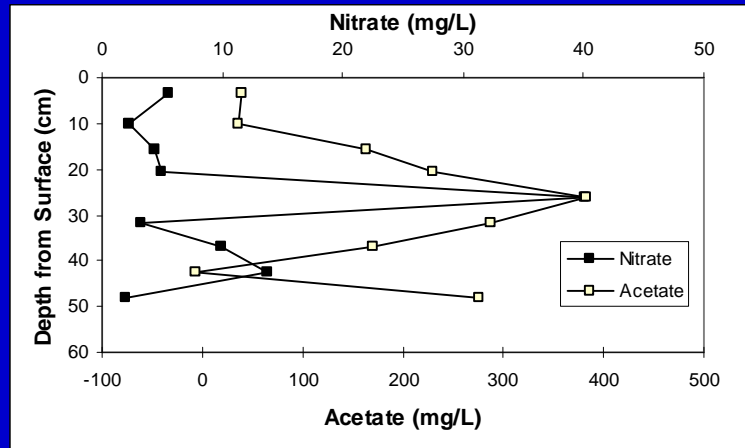
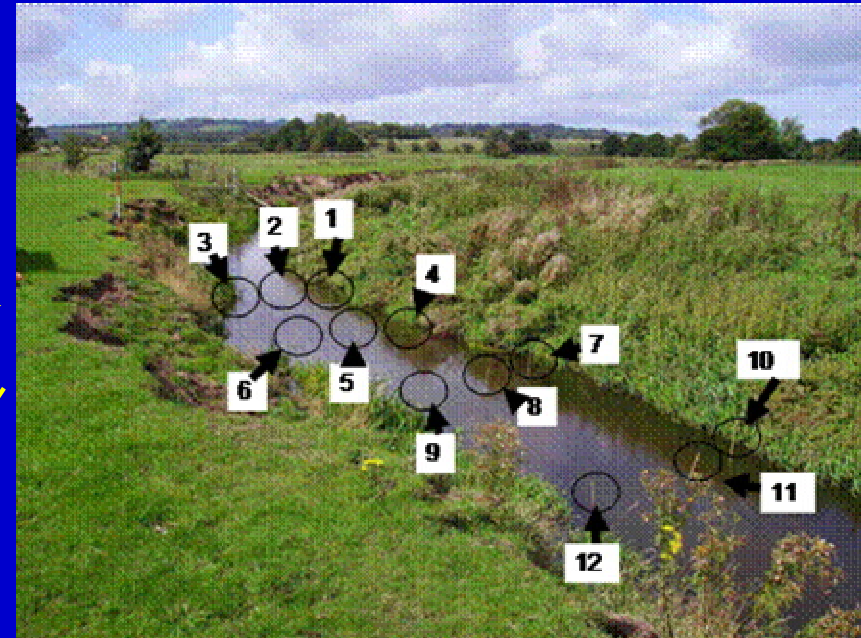
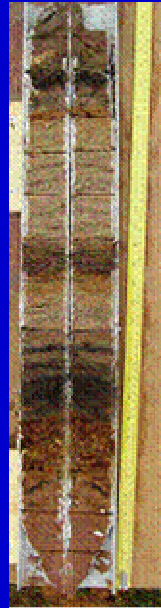
- Understand and quantify nitrogen (N) fluxes across the hyporheic zone/ assess significance of hyporheic processing
- Multi-disciplinary study using R.Tern (Shropshire) as study site



Location of study site in the UK and photos of the 2 study sites used

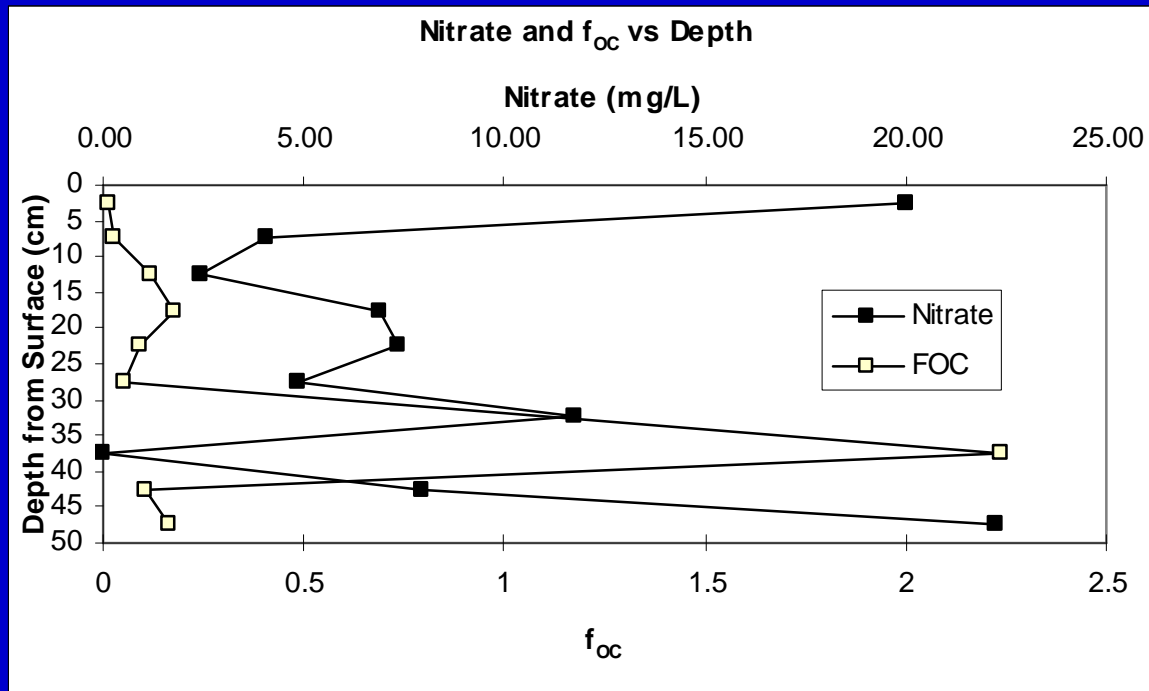


Geochemical Survey



Interpretation Problems 1

Core 2, Site 1

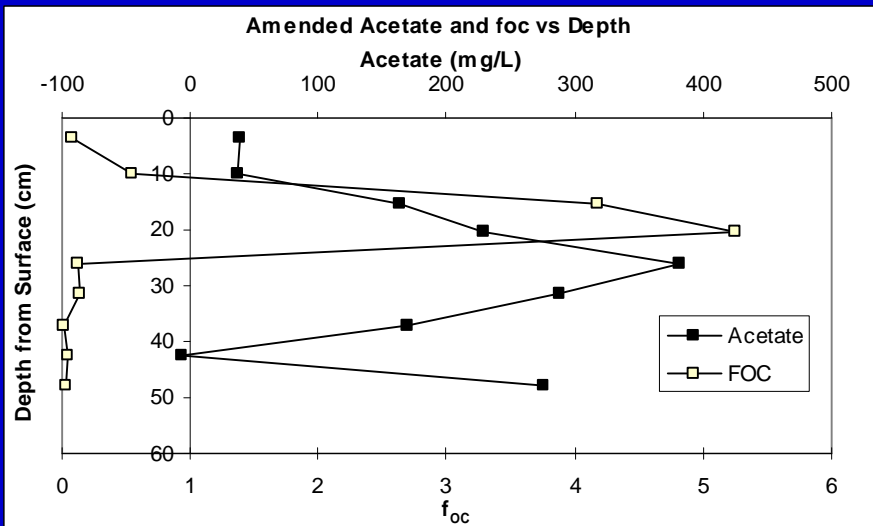
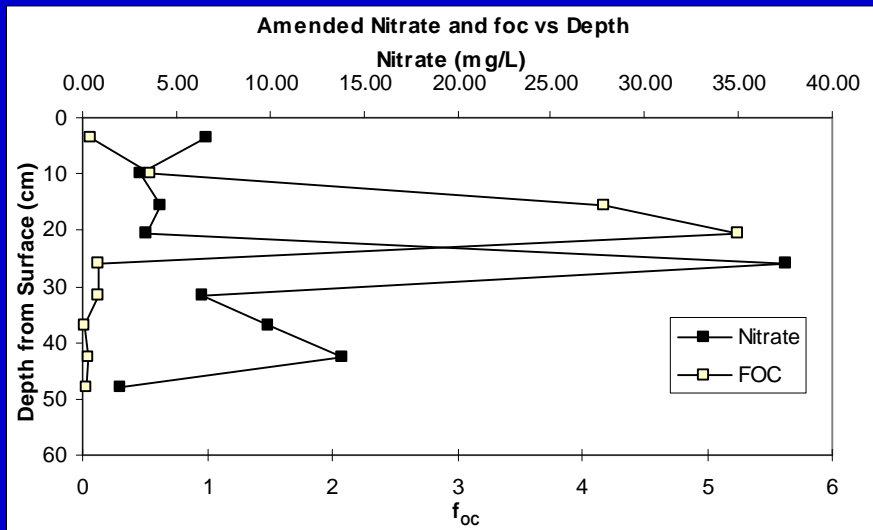


• Flow through high C sediments causing N depletion?

• Flow driven around low permeability/ high C layer?

Interpretation Problems 2

Core 5, Site 1

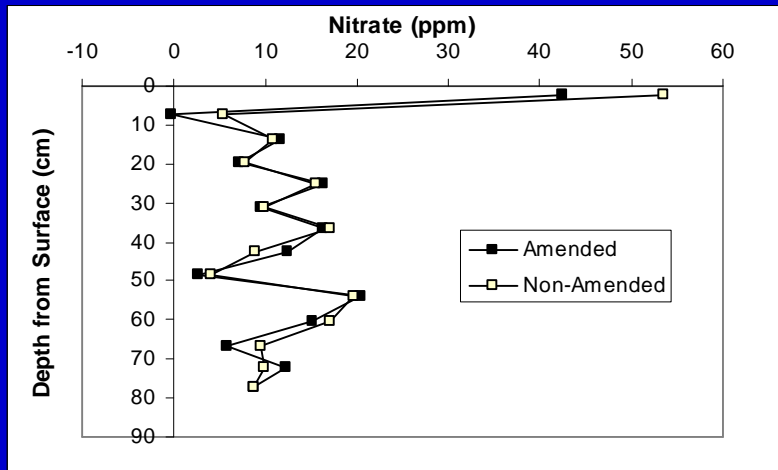


• If flow is *upwards* – high f_{oc} region could be attenuating high NO_3^-

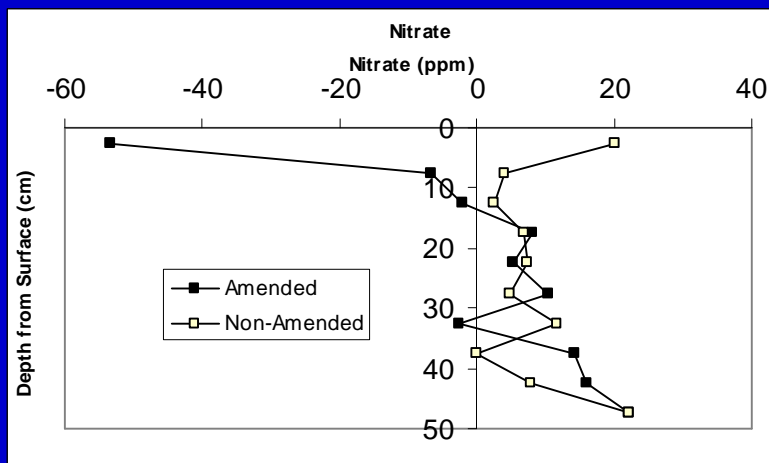
• If flow is *downwards* high f_{oc} region could be releasing NO_3^-

Interpretation Problems 3

Core 9, Site 1



Core 2, Site 1

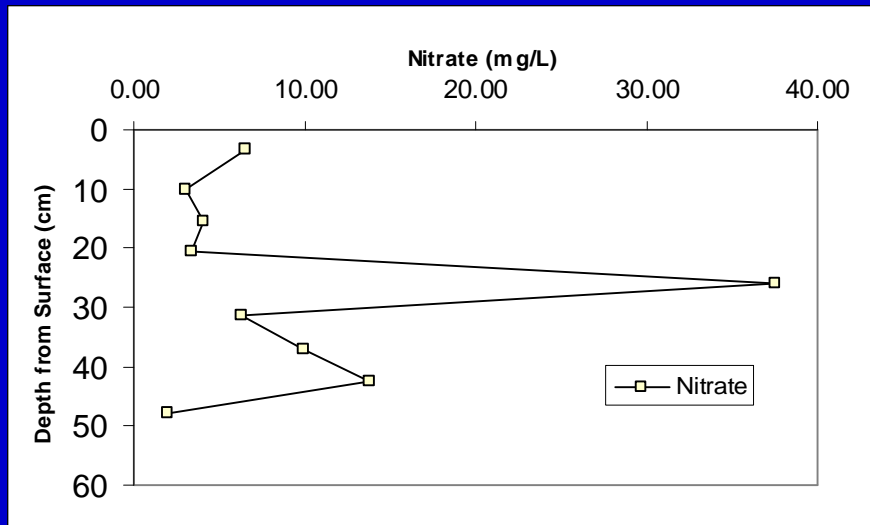


- Appears to be a variable hydrogeological influence on solute levels through the HZ

- Variable biogeochemical processing?

Interpretation Problems 4

Core 5, Site 1



- Little net change in NO_3^- vertically
- HZ “self-regulating”?
- Horizontal flow maintaining discrete vertical gradients?

Understanding Hyporheic Solute Fluxes

Geochemical survey

Provides context for solute transformation

+

Process Understanding

Provides potential transformation rates in terms of key determinants (e.g. flow-rates)

+

Quantify hydrogeological regime

Both flux across GW-SW interface and hyporheic residence time

=

Solute Flux

Understanding Hyporheic Solute Fluxes

Geochemical survey

+

Process Understanding

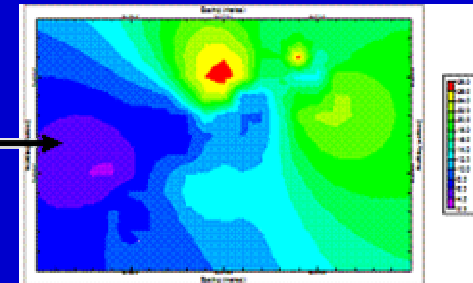
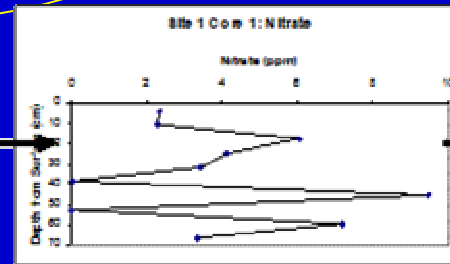
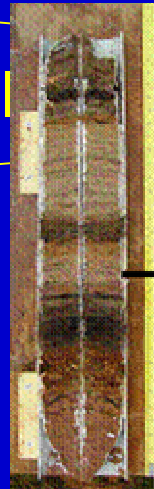
+

Quantify hydrogeological time

=

Solute Flux

- Cores taken from two reaches of the River Tern (Shropshire, UK) and porewater sampled by diffusion
- ¹⁵N stable isotope microcosm/ flow-through experiments
- Piezometers to be sampled to give temporal data
- Molecular biology study



Hydrogeological Study

- Flexible tubing piezometers installed along study site 1 at 1, 0.7, 0.4m depths in same array as cores taken
- Small sampling tubes positioned along piezometers to sample 0.9-0.1m depths at 0.1m intervals
- Detailed hydrogeological characterisation planned including:

From data sheet for portable measuring system TP62, Umwelt Elektronik GmbH

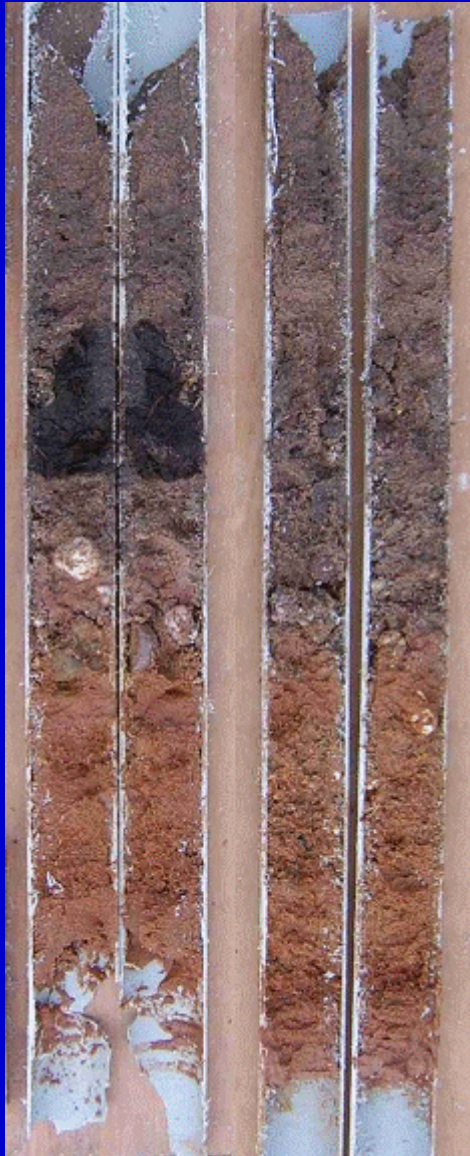


From Rivett et al, QJEGH 2008 (41)

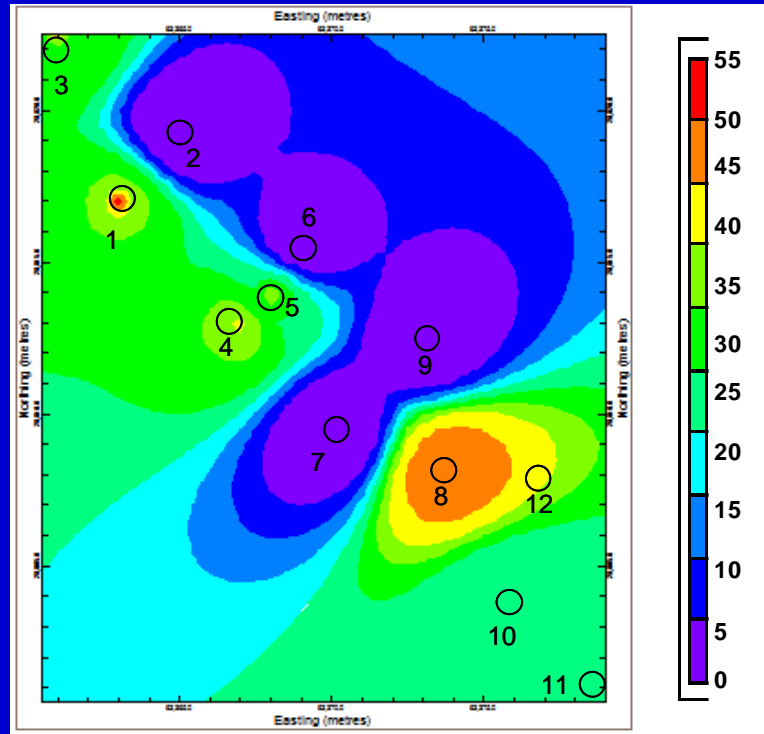


- Falling head tests/ hydraulic conductivity measurements
- Flux measurements
- Reach-scale tracer test
- Borehole dilution tests
- Temperature profiling study

Problem of heterogeneity

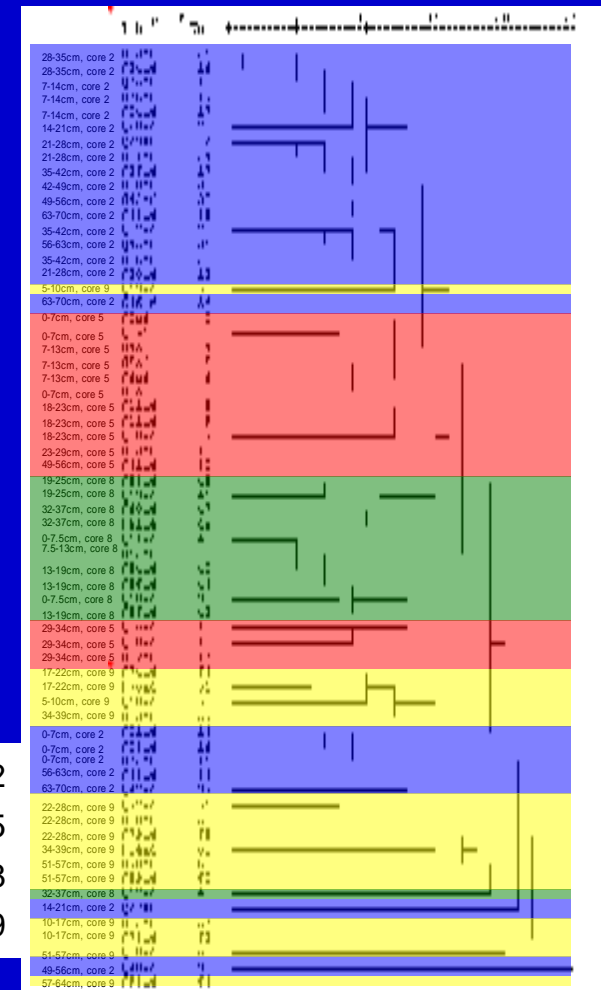


Cores taken approx. 10cm apart from R. Tern



Chemical contour plot for 2nd study site on R. Tern showing NO₃⁻ levels

Dendrogram showing bacterial community similarity between 4 cores from 1st study site on R. Tern via 16S RNA PCR



- Core 2
- Core 5
- Core 8
- Core 9

Problem of heterogeneity (continued)

- **Small areas of HZ potentially responsible for most activity (“hotspots”)**
- **Can “hotspots” of activity be averaged out?**
- **Can heterogeneity be captured?**
- **Does it need to be? Homogenous heterogeneity?**
- **Patterns between heterogeneities and geomorphological setting?**
- **Surveys needed to assess heterogeneity?**
- **Temporal effects?**

Summary

- **N processing can not be resolved using geochemical data alone**
- **Multi-disciplinary approach required to *understand* hyporheic N fluxes. Possible approach described**
- **Heterogeneity exists at small scale (cm) in R.Tern HZ in sedimentology, geochemistry and microbiology**
- **Heterogeneity problem may need addressing to consider catchment scale (km) processes/ fluxes**

Acknowledgments

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- **EPSRC**