Fluvial Sediment Tracing in the Wensum DTC

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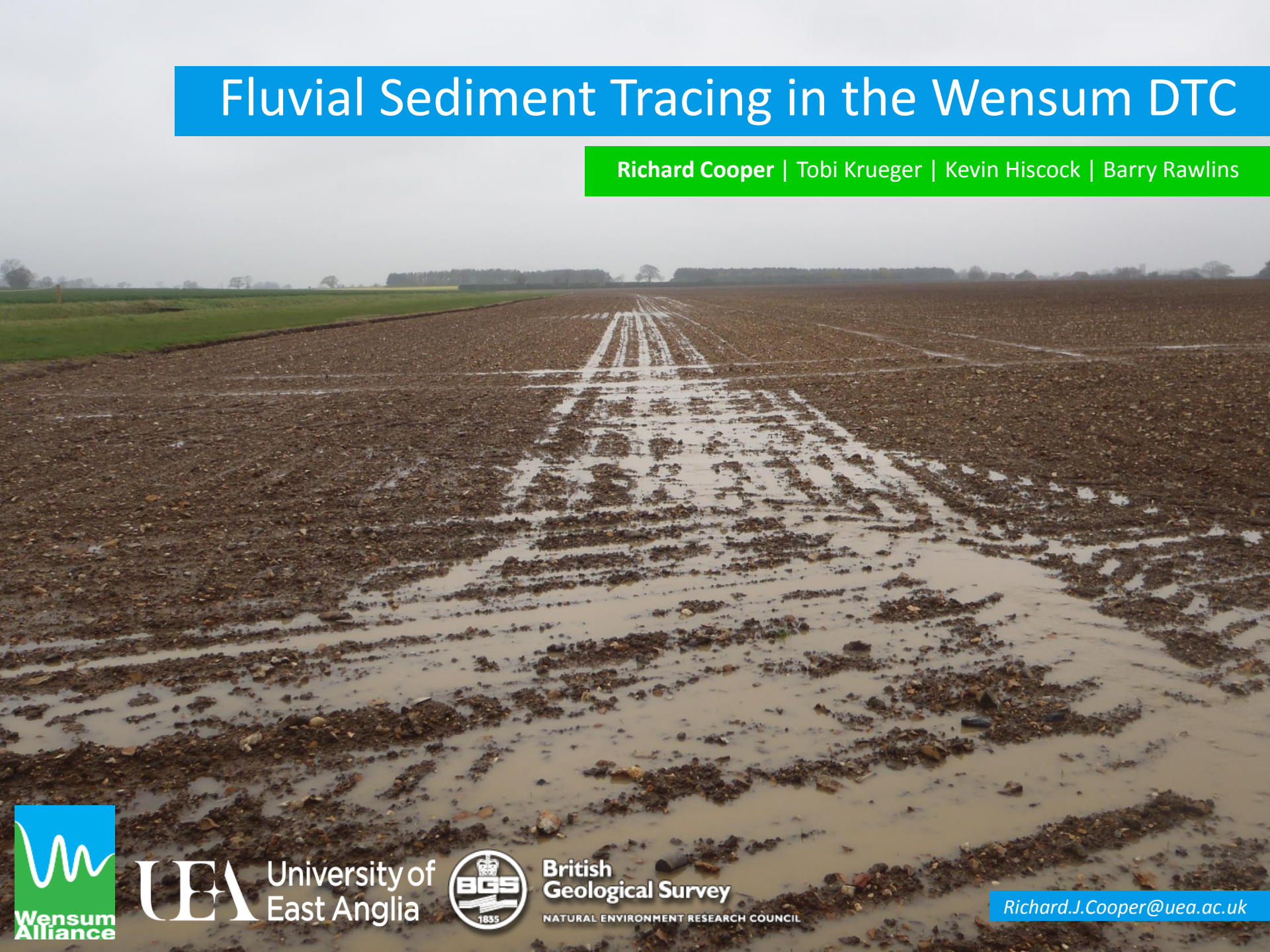

Wensum Alliance

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NATURAL ENVIRONMENT RESEARCH COUNCIL

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Research Aims

- To use spectroscopy as a novel method of assessing the dynamics of suspended sediment geochemistry under a range of in-stream hydrological conditions.

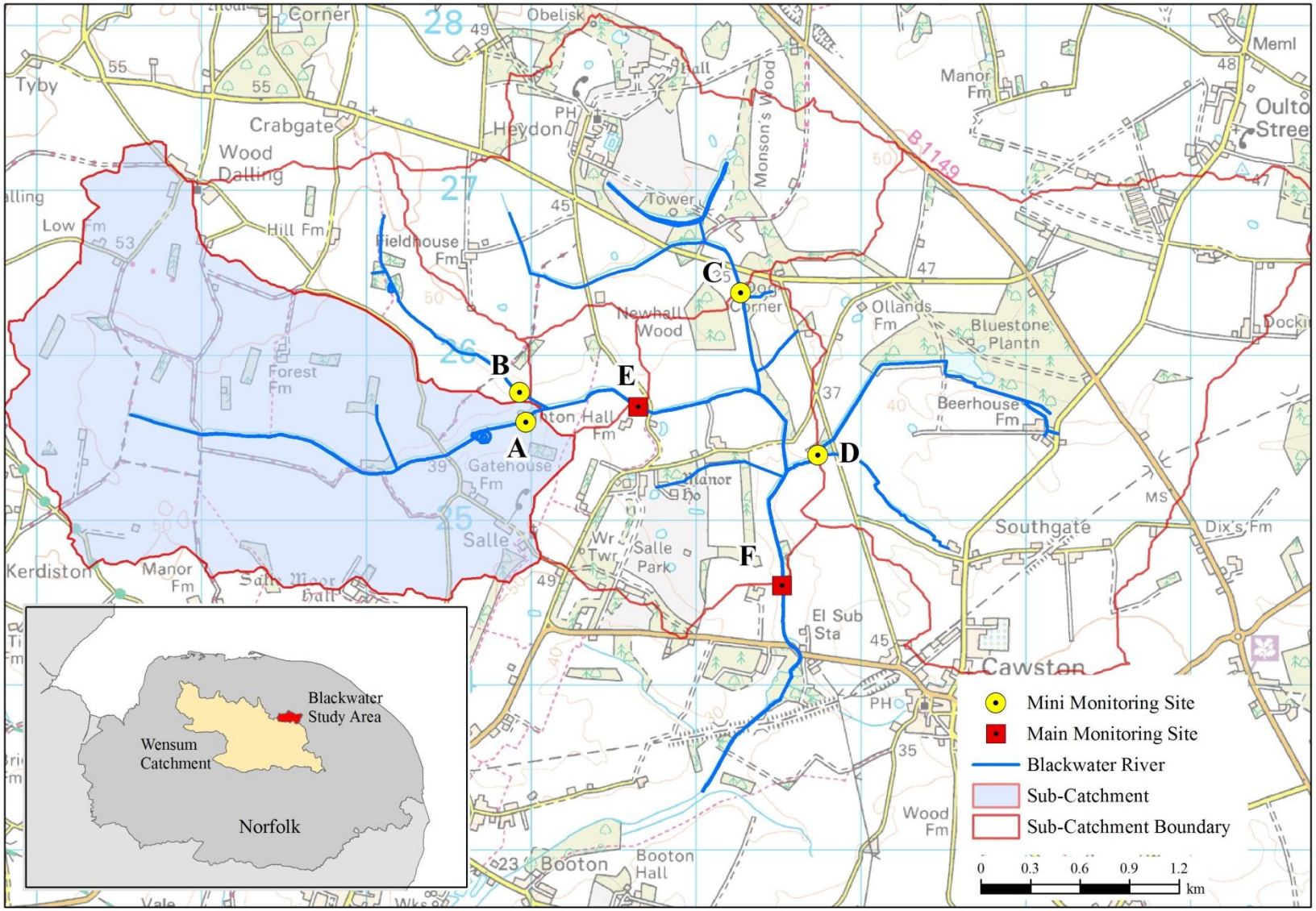
- To develop a high-temporal resolution fluvial sediment source apportionment model for the Blackwater sub-catchment of the River Wensum.

Why is this Important?

- Rivers affected by high sediment volumes suffer from elevated turbidity, smothering of benthic habitats, loss of spawning gravels, damage to fish gills, nutrient enrichment, excessive algal growth, etc.....

- Essential to understand where sediment is coming from to enable mitigation measures to be targeted accordingly.

Mini-Catchment A



Identifying Sources

Channel Banks

Topsoils

Suspended Sediments

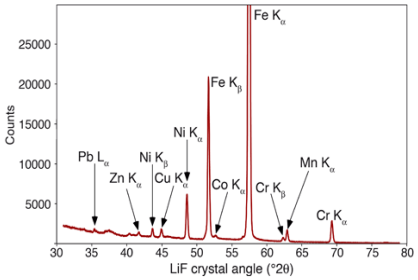
Field Drains

Road Verges

Analysing Sediments

Sediment samples collected from each of the **4 potential source areas** and from the river during heavy rainfall events – ISCO automatic samplers.

All samples vacuum filtered through **quartz fibre filter (QFF) papers** to extract the suspended sediments.

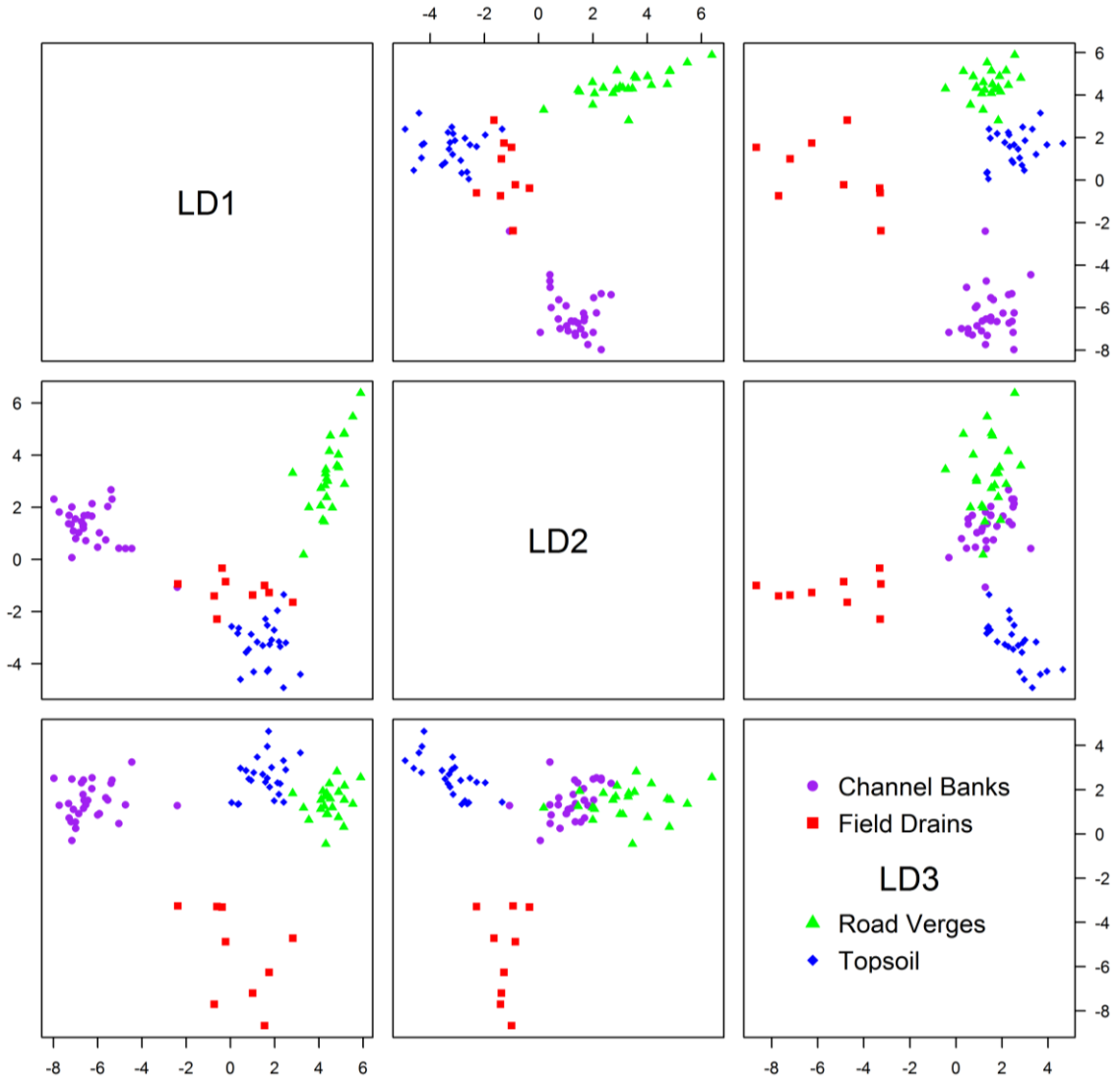


Filter papers analysed by X-ray Fluorescence Spectroscopy (**XRFS)** and Diffuse reflectance infra-red spectroscopy (**DRIFTS)** to determine the concentrations of major elements and compounds – '**Geochemical Fingerprints**'.

Identifying Fingerprints

- **Linear Discriminant Analysis** (LDA) employed to determine the optimum combination of geochemical fingerprints capable of differentiating the source areas.

- In Blackwater mini-catchment A, nine fingerprints proved most effective (**Ca**, **Ti**, **Al**, **Mg**, **Na**, **K, Ce, Fe, P**).



Two Mixing Models

- Mixing models developed which aim to solve the equation:

$$Y_j = \sum_k (S_{kj} \times P_k) \quad \left| \begin{array}{l} 0 < P_k > 1 \\ \sum P_k = 1 \end{array} \right.$$

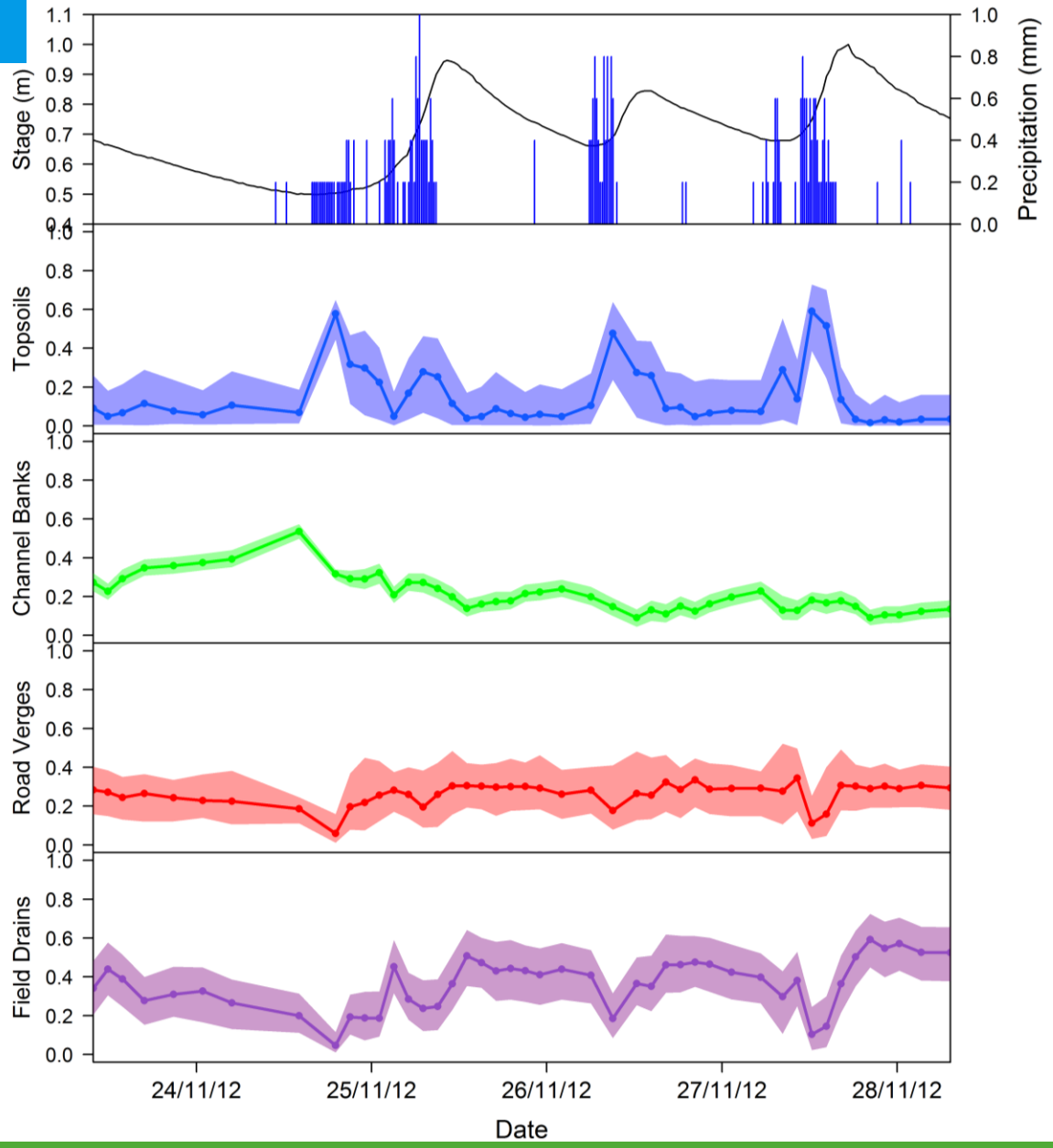
Conc. of fingerprints in suspended sediment | *Conc. of fingerprints in each source area* | *% contribution from each source area*

- **Model 1**: Optimisation based on the minimisation of least squares with Monte-Carlo uncertainty analysis.

- **Model 2**: Bayesian inference using the likelihood function

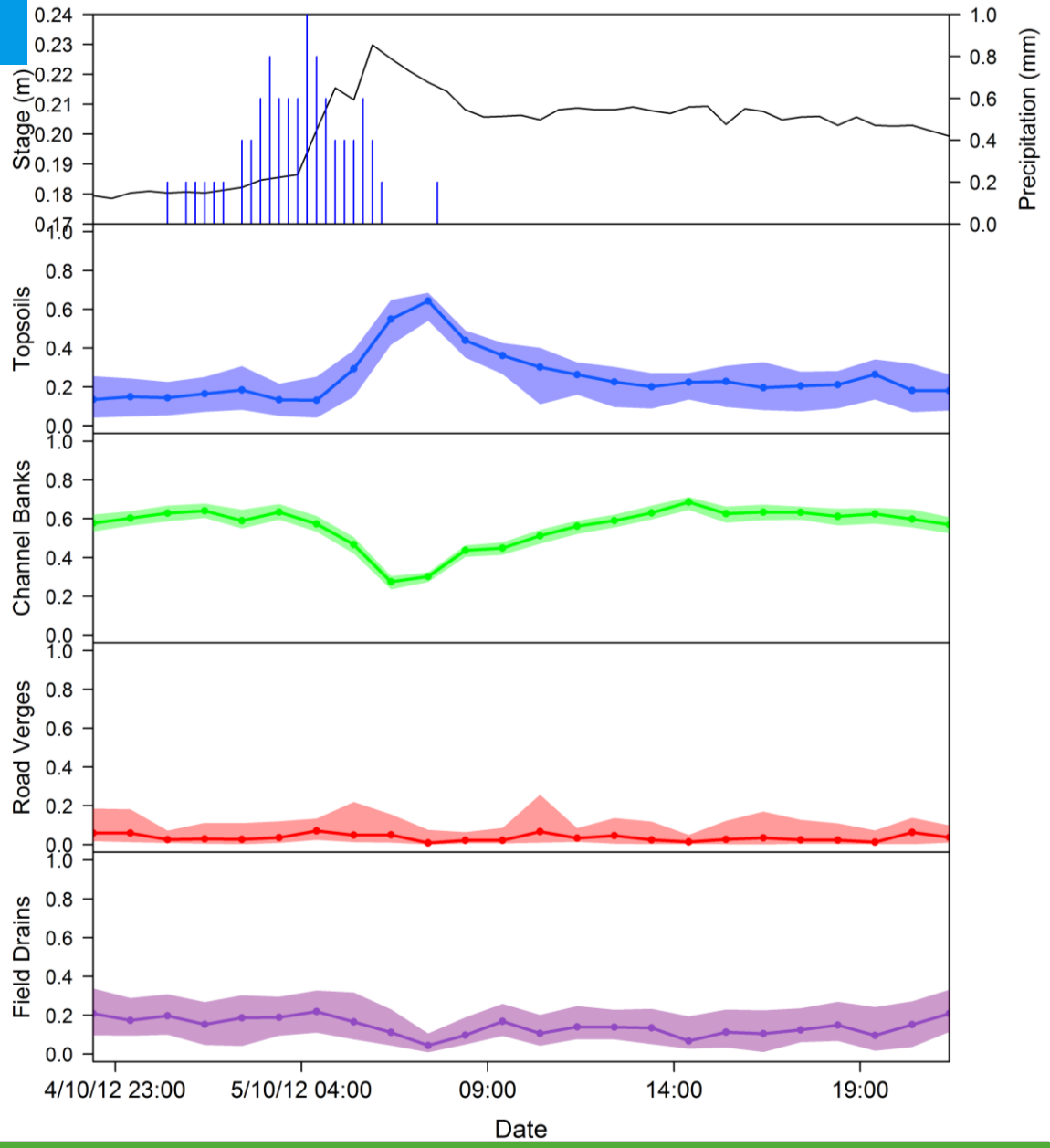
24-28th November 2012

- **36.4 mm** rainfall
- **Increase** in **Topsoil** contribution as rainfall events pass through the catchment generating surface runoff.
- **Declining** contribution from **channel banks** as successive precipitation episodes reduce importance of sub-surface sources.
- Large contributions from **field drains** which increases over time.



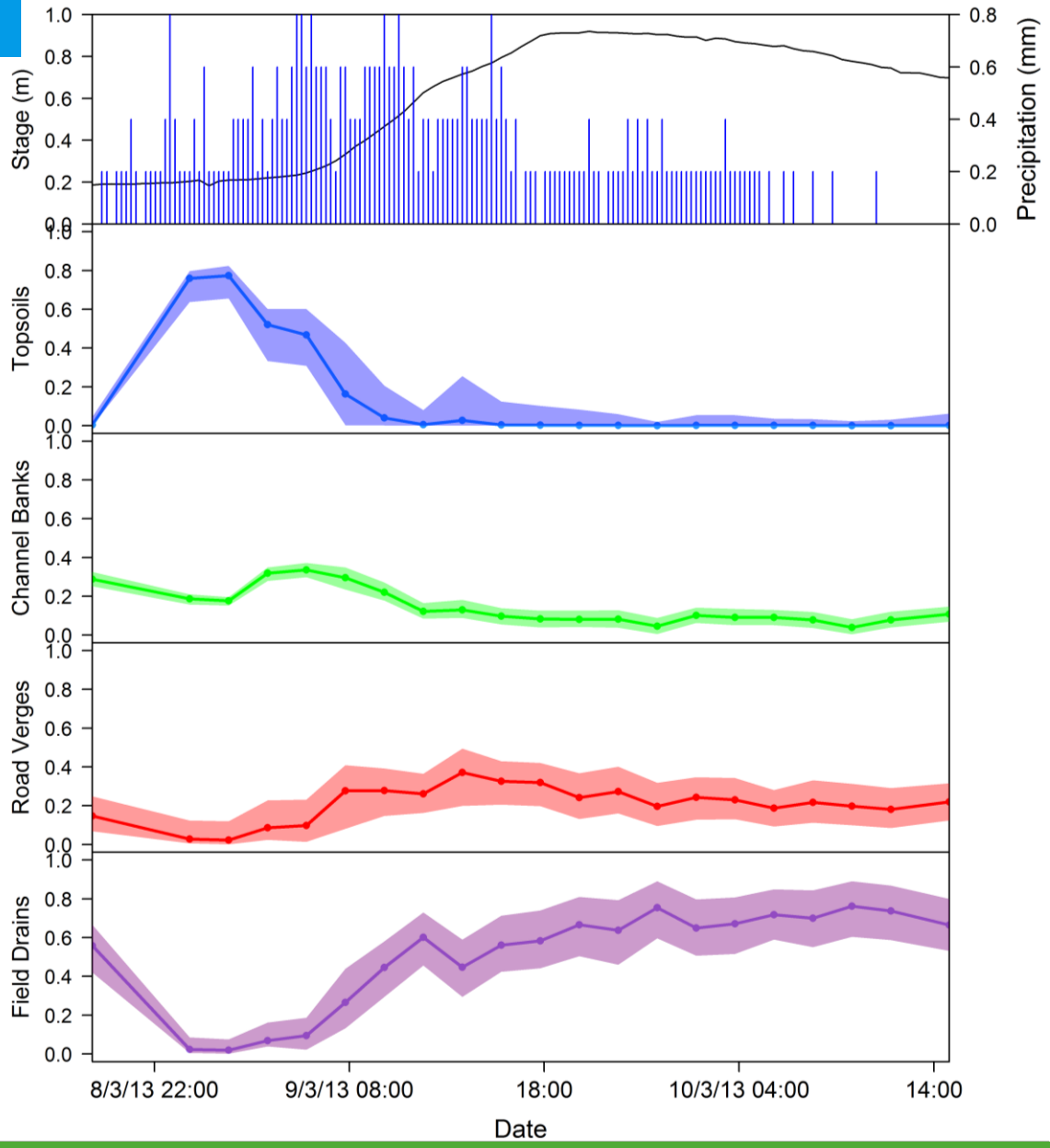
4-5th October 2012

- **10.2 mm** rainfall
- Similar pattern to November.
- **Channel bank** material dominates before the event.
- Rapid increase in **Topsoil** contribution as surface runoff generated.
- Response **1 hour** after onset of heaviest rainfall.



8-10th March 2013

- **47.4 mm** rainfall
- Again similar patterns.
- Large increase in **Topsoil** contribution within first few hours.
- **Road verge** contribution increases 12h into event.
- **Field drains** dominate after ~16h post-event onset.



Summary

- Developed a high-temporal resolution sediment source apportionment model using the geochemical analysis of suspended sediments trapped on filter papers.
- **Channel bank** material dominates under lower flow conditions.
- **Surface source** inputs increase during heavy rainfall – road appears to increase field-to-river connectivity.
- **Field drains** become increasingly important post-rainfall.

Thank You for Listening