

Sources and Fluxes of Dissolved and Particulate Organic Carbon in UK Rivers: A Comparison of DO^{14}C and PO^{14}C in The Ribble Catchment

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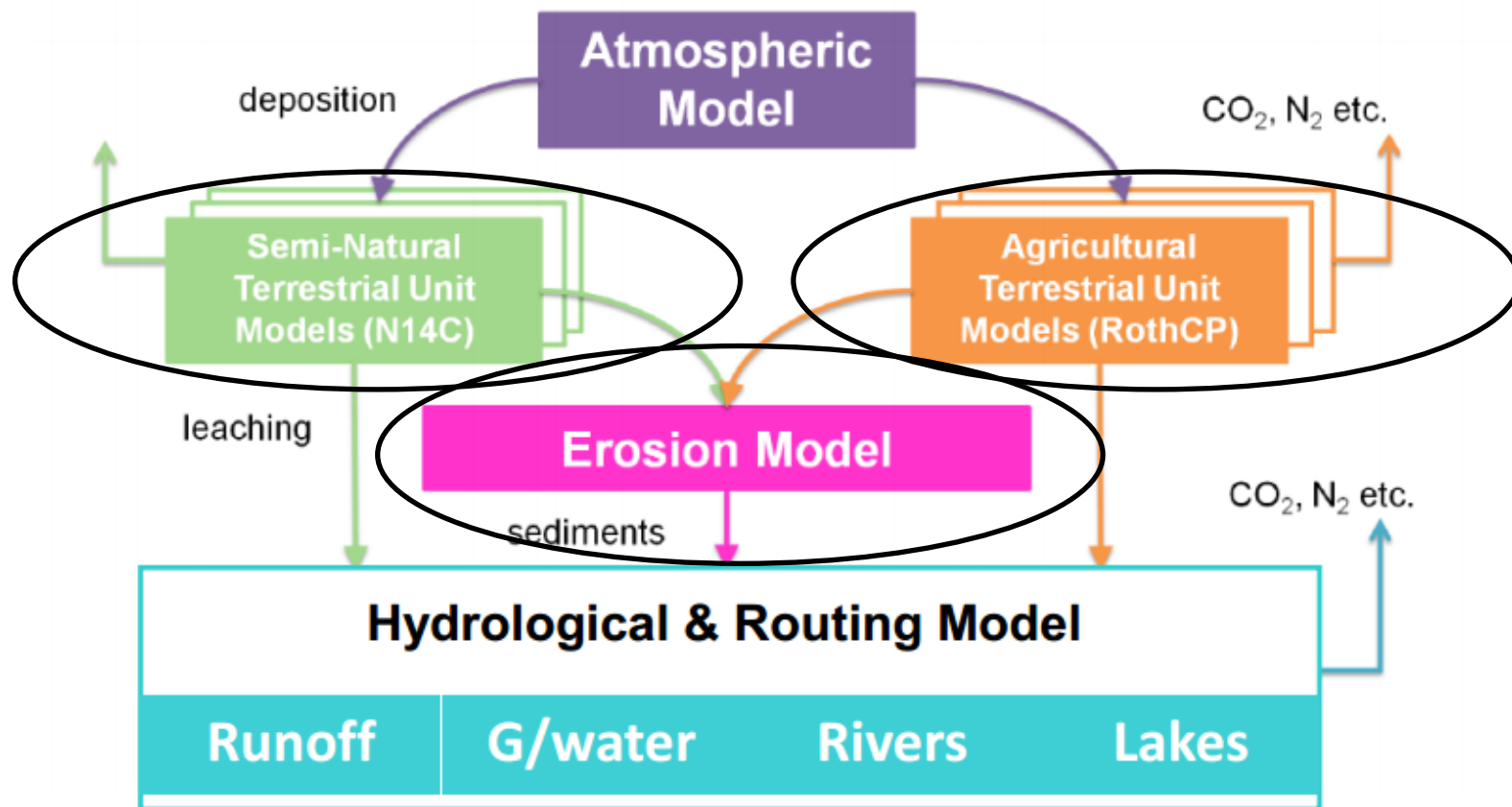
Overview

- Long Term, Large Scale (LTLS) project
- Hypotheses
- Study Catchments
- Methodology
- Results
 - DO¹⁴C
 - PO¹⁴C
- Discussion
- Further work



River Ribble at Samlesbury, tidal limit.

The LTLS Project



Hypotheses

During high flow events, particulate and dissolved organic carbon will mainly originate from topsoil.

Questions:

- Do POC and DOC in the Ribble have different origins?
- How different are the sub catchments?
- Do high flows transport younger ^{14}C ?

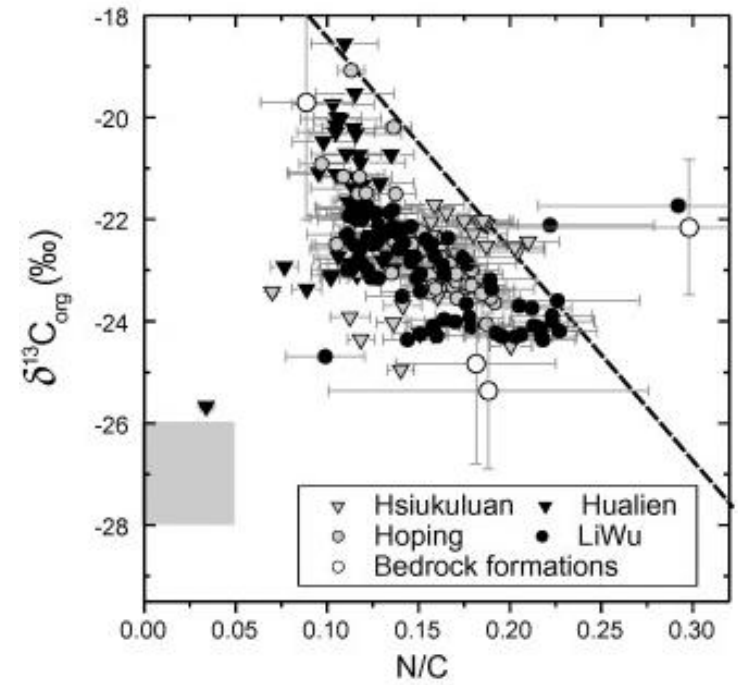
Previous work

DOC

- UK flux (*Worrall et al, 2012*)
- Organic soil DOC export (*Evans et al, 2006*)
- DOC in upland waters (*Evans et al, 2007*)

POC

- Swiss Alps (*Smith et al, 2013*)
- Depth profiling – Amazon (*Bouchez et al, 2014*)
- River Ganges – Nepal (*Rosenheim & Galy, 2012*)



Suspended load N/C vs $\delta^{13}C$ in western Taiwanese Rivers (Hilton et al, 2010)

Conwy

- 590 km²
- Migneint moors, peat
- Mountainous, silt, sand, sedimentary deposits.

Avon

- 1,750 km²
- calcareous river, chalk, clay.
- Arable, improved grassland, woodland.

Dee

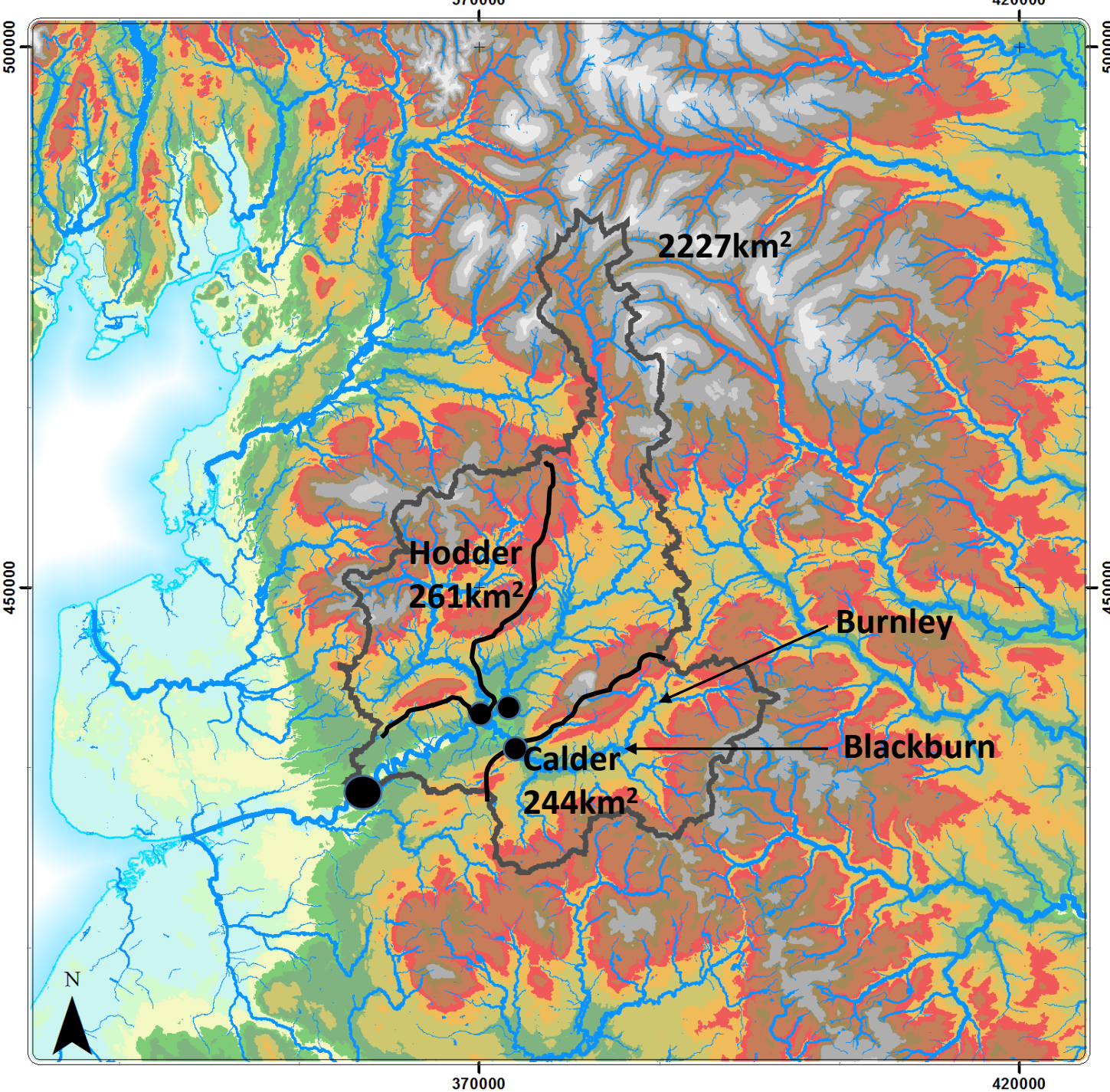
- 2083 km²
- upland moorland and forestry (west)
- Arable & improved pasture (east)
- Mountainous granite, sandstone

Ribble

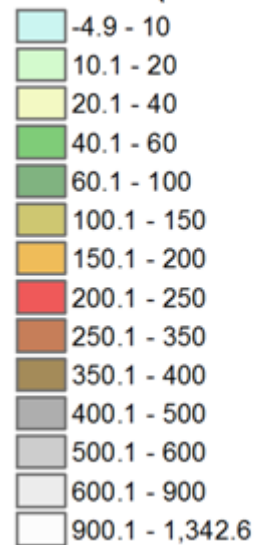


Ribble Catchment

- Population 1.25 million
- 90% urban
- Mudstone, glacial deposits, sandstone

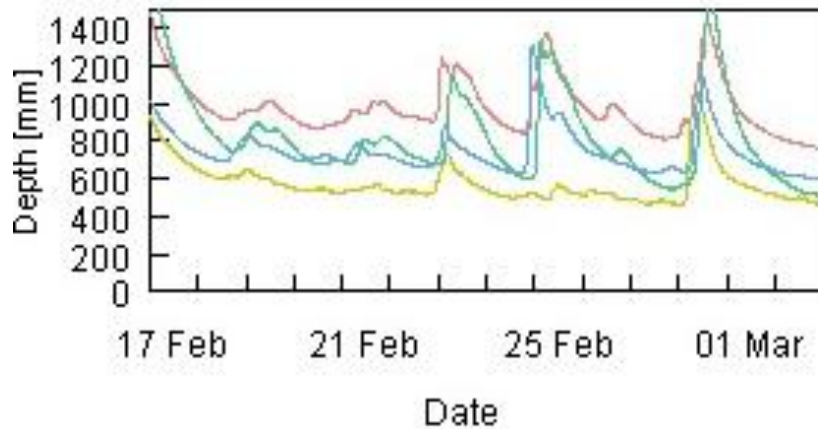


Elevation (IHDTM), mASL



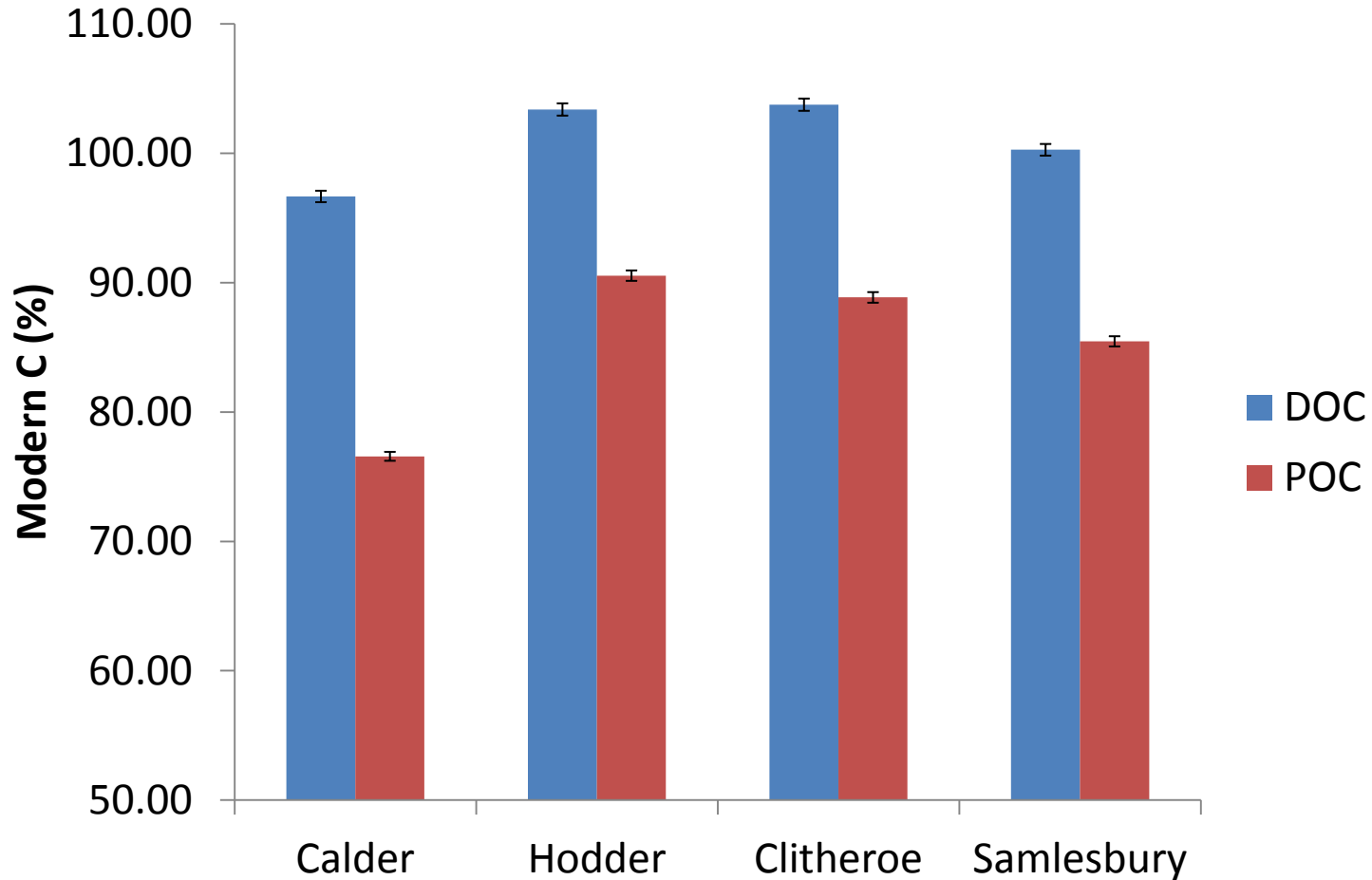
Methodology

- 4 High flow samples
- WISER continuous monitoring
- DO¹⁴C filtration
- PO¹⁴C centrifuge
- HCl treatment
- pH, conductivity, spectral DOC



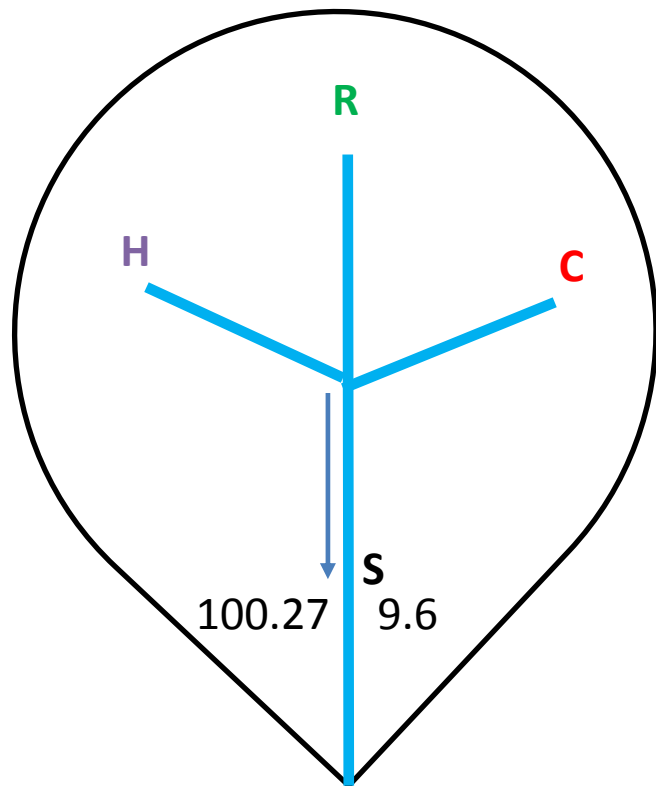
- Whalley Abbey
- Henthorn
- Salmesbury
- Hodder Place

Results: DO and PO¹⁴C



DO¹⁴C and PO¹⁴C For the Ribble, Calder and Hodder catchments. Both Ribble sites are represented by "Clitheroe" and "Samlesbury".

DO¹⁴C Mass Balance

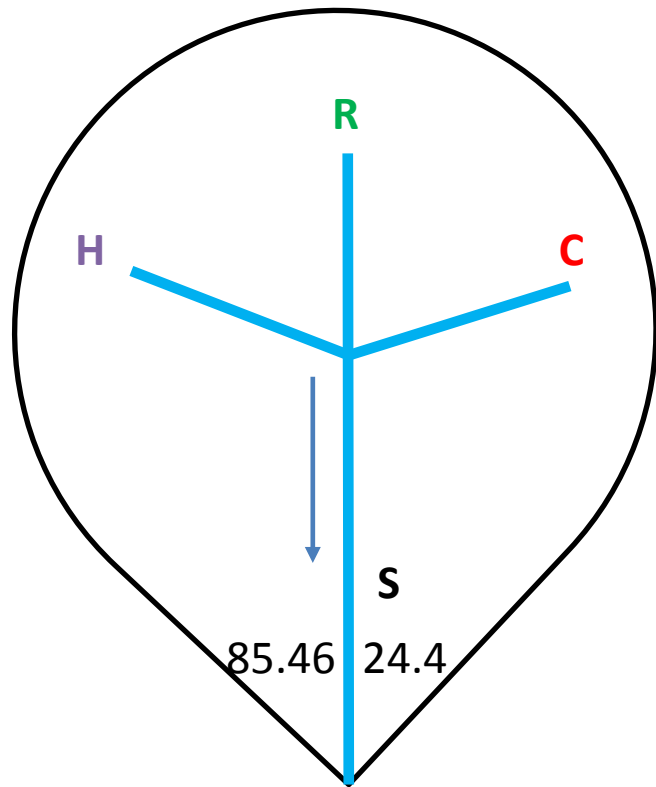


| | Hodder (H) | Ribble (R) (Clitheroe) | Calder (C) |
|-------------------------------------|------------|---------------------------|------------|
| [DOC]mg ^l ⁻¹ | 12.3 | 10.9 | 6.9 |
| ¹⁴ C(%MC) | 103.4 | 103.8 | 96.7 |
| Q (m ³ S ⁻¹) | 8.8 | 13.5 | 8.5 |

$$^{14}\text{C}_s = 102.3$$

$$[\text{DOC}] = 10.0 \text{ mg l}^{-1}$$

PO¹⁴C Mass balance

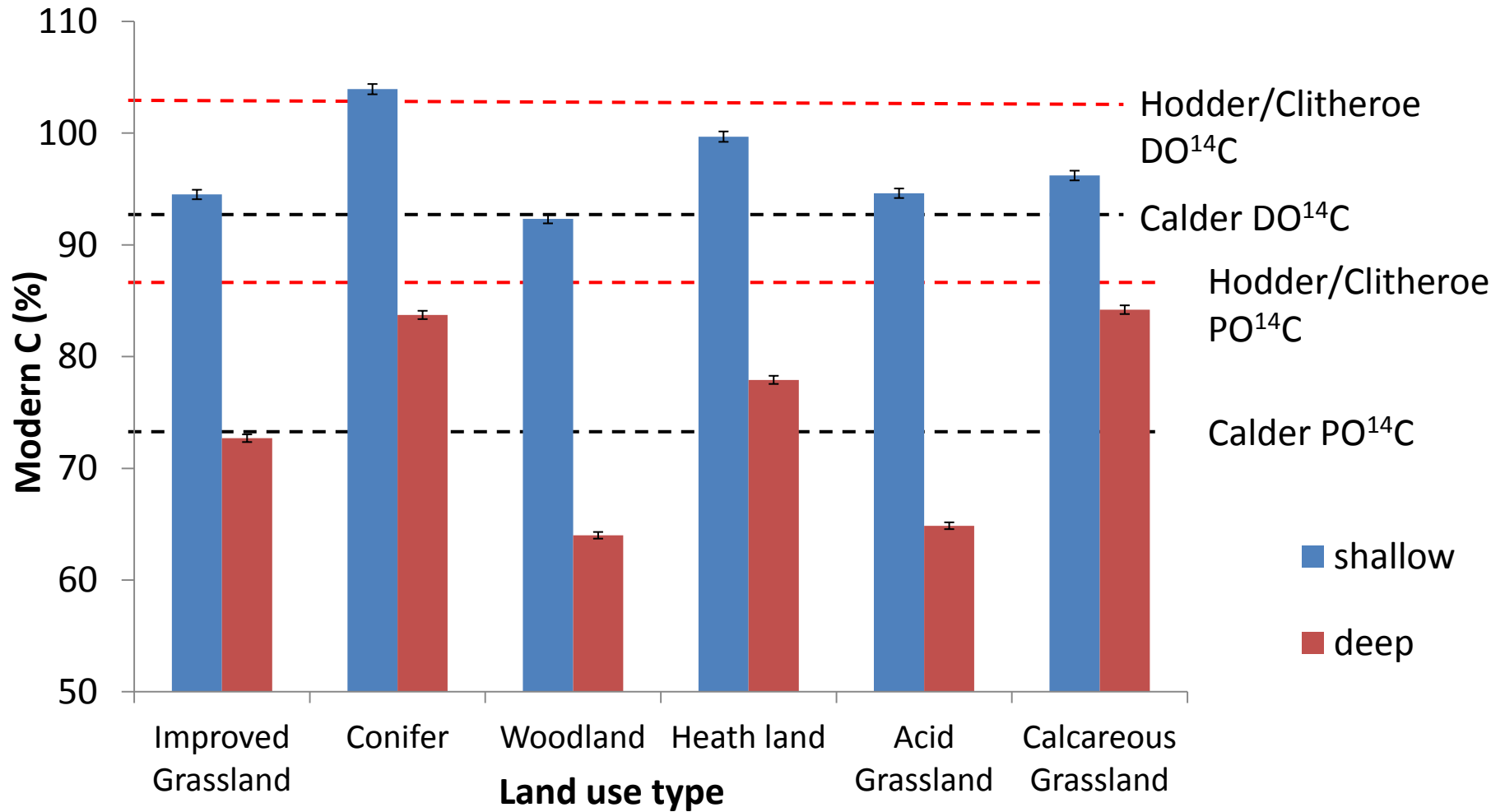


| | Hodder (H) | Ribble (R) (Clitheroe) | Calder (C) |
|-------------------------------------|------------|---------------------------|------------|
| [POC]mg ^l ⁻¹ | 20.6 | 20.6 | 51.1 |
| ¹⁴ C(%MC) | 90.5 | 88.9 | 76.6 |
| Q (m ³ S ⁻¹) | 8.76 | 13.5 | 8.5 |

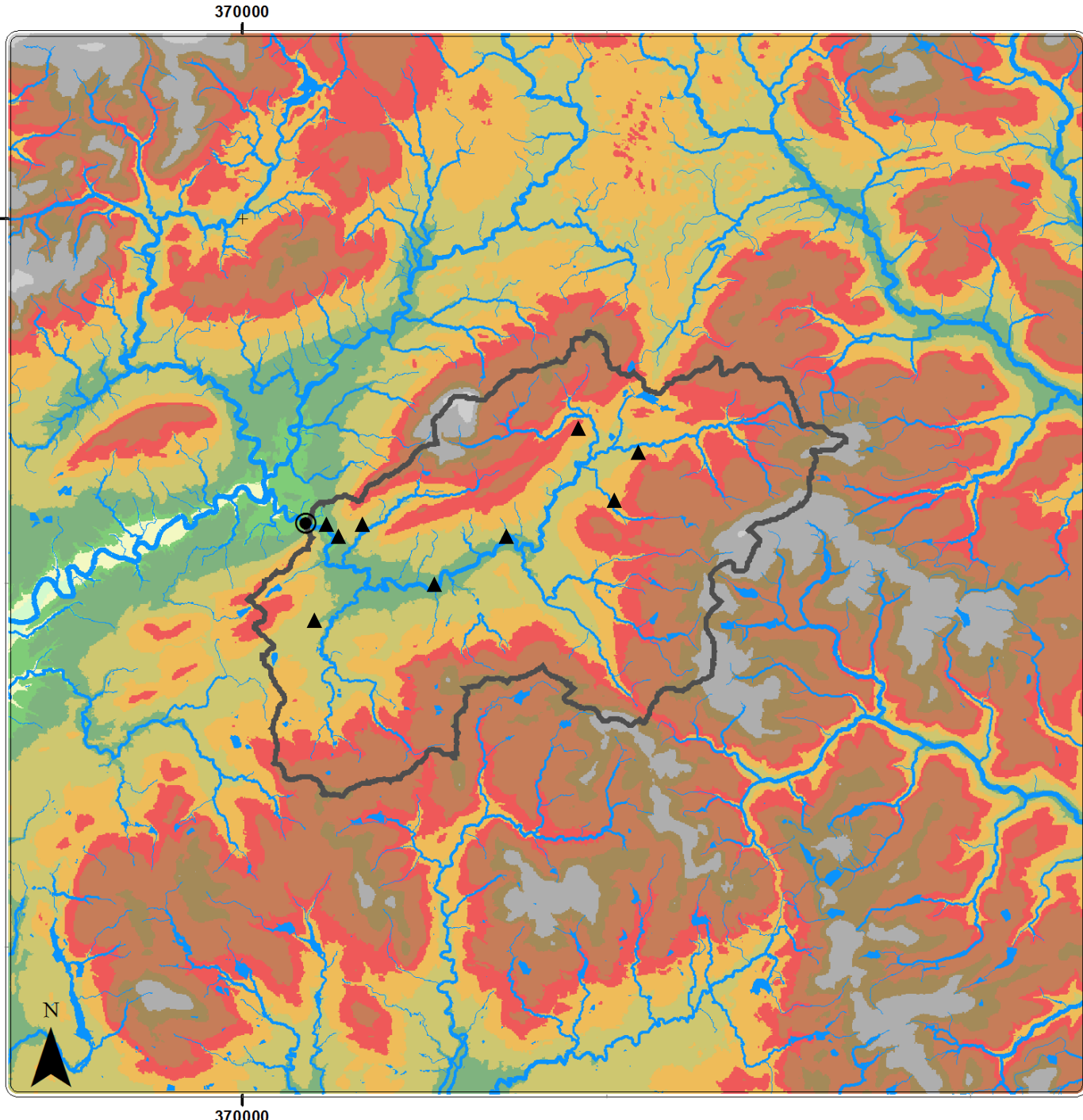
$$^{14}\text{C}_s = 83.22$$

$$[\text{POC}_s] = 30.4\text{mg/l}$$

Soil ^{14}C



Ribble soil ^{14}C for varying land use types



Calder DOC

- Heavily industrial
- High population
- WFD, EA, DEFRA

•25% fossil carbon – US catchment study
(Griffith et al, 2009)

- Petroleum
- Detergent
- pharmaceutical

Calder POC

- River bank exposure
- $PO^{14}C$ between 1000 and 10 000 Years old (*Foster et al, 2009*)

Industrial activity

- Mining
 - mineral
 - coal, past and present



Future Investigation

- Low/summer flow DOC
- Model testing
- Separate terrigenous & biospheric POC (*Hilton et al, 2008, 2011; Galy et al, 2008*).
 - C:N in river sediment



Summary

- 4 storm flows PO and DO¹⁴C
- Model predictions supported
- DOC and POC originate from same area except in Calder
- Calder catchment outlier
 - Sewage treatment works
 - Industry, coal mining.



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