NUTCAT-2050

Estimating Nutrients in Catchments to 2050

Phosphorus transfer under extreme events: analysis of high-frequency data from the River Eden catchment, Cumbria

Mary Ockenden, Lancaster University

with Phil Haygarth, Clare Benskin, Keith Beven, Sean Burke, Adrian Collins, Bob Evans, Pete Falloon, Kevin Hiscock, Michael Hollaway, Jennine Jonczyk, Ron Kahana, Kit Macleod, Gloria Pereira, Kirsty Ross, Catherine Wearing, Paul Withers, Jian Zhou and EdenDTC team

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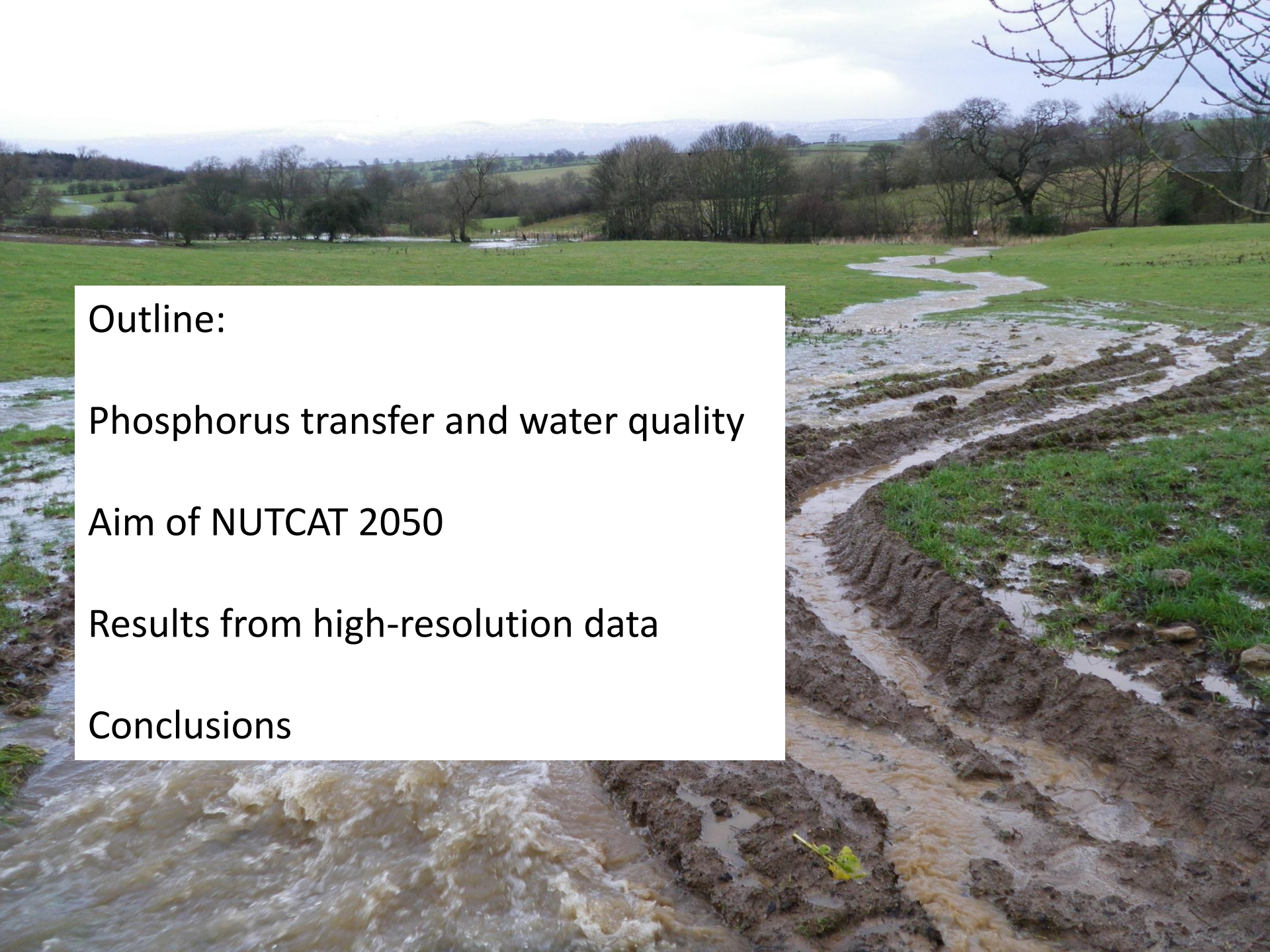
EdenDTC A National Demonstration Test Catchment



Outline:

Phosphorus transfer and water quality

Aim of NUTCAT 2050

Results from high-resolution data

Conclusions

Food security, fertilisers and heavy rainfall…

And this will change in the future:

UK Climate Projections for the River Eden catchment, Cumbria for the 2050s suggest (mean changes for medium emissions):

- **Warmer wetter winters** , +1.9°C, +13% precipitation
- **Hotter drier summers,** +2.6°C, -18% precipitation

More intense events (more intense rainfall, longer droughts…)

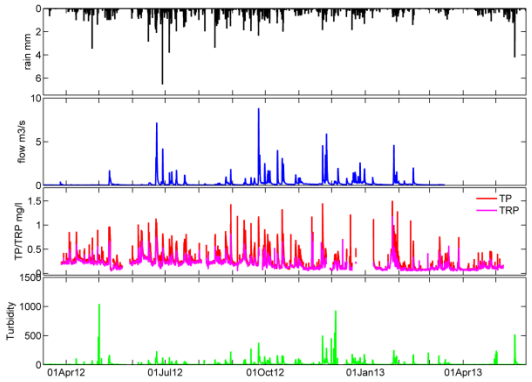
NUTCAT 2050 approach:

Use high resolution data to test and improve current modelling of hydrology and phosphorus transfer, including uncertainty

Use data analysis and experimentation to improve representation of P processes in models

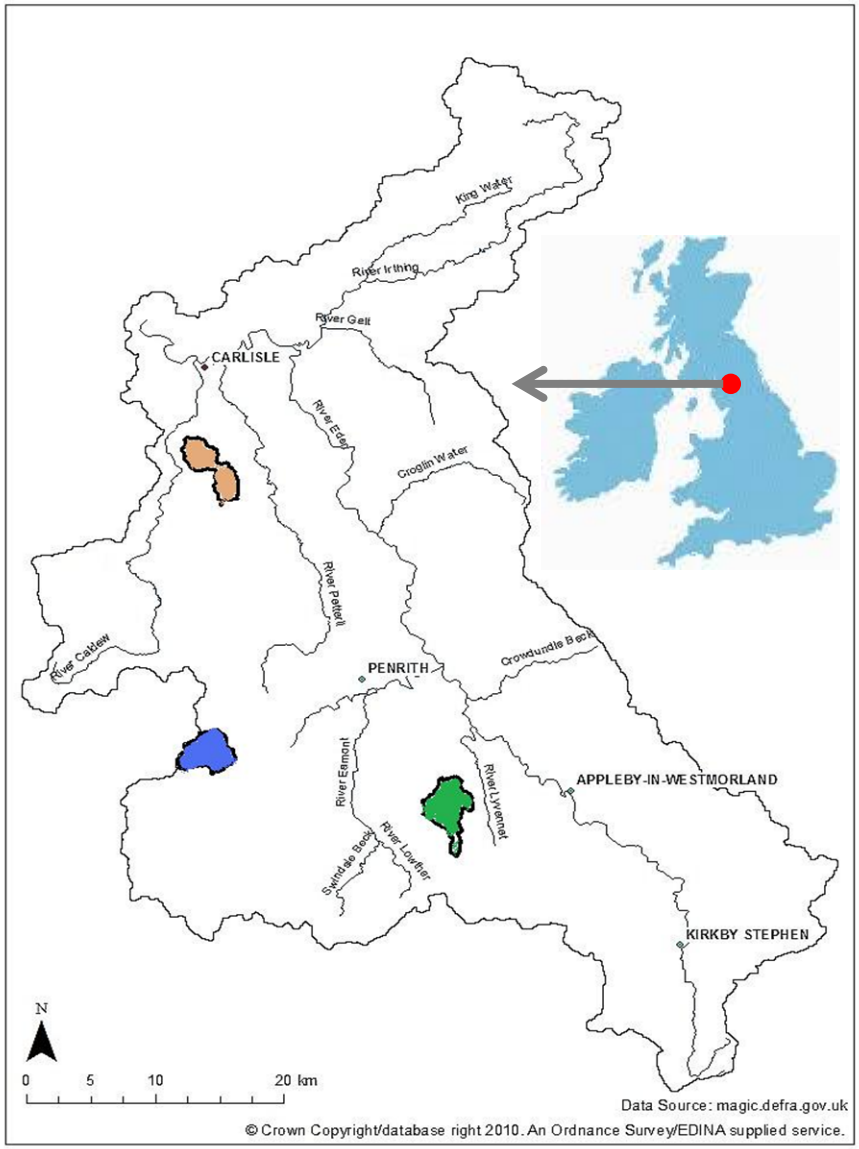
Add future climate and future land use scenarios

Predict future hydrology and phosphorus transfer (including uncertainty) under different climate and land use scenarios



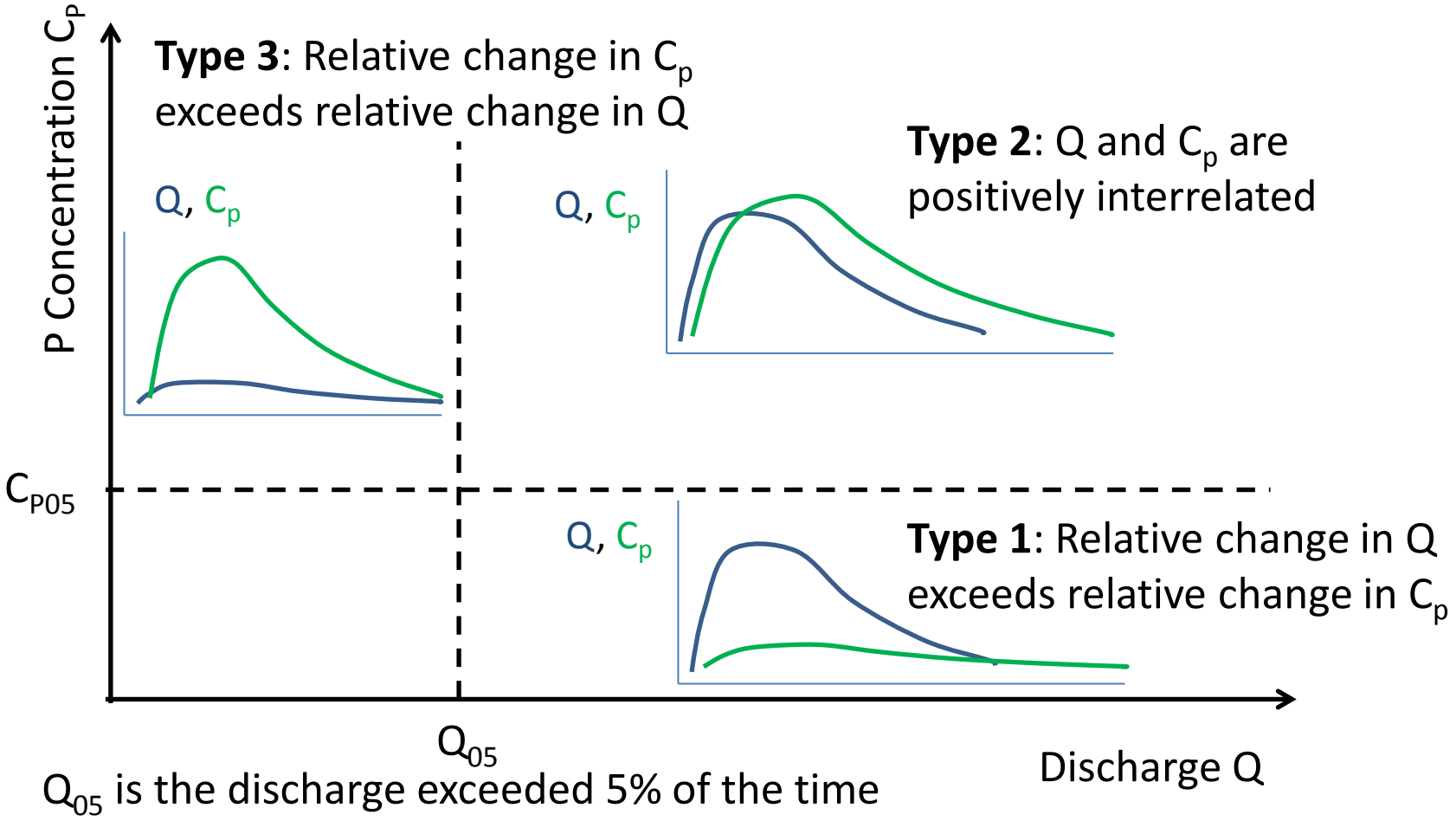
Learning from high-resolution data

- Eden DTC data; 3 small (~10 km^2) catchments, 3 monitoring stations in each
- Rainfall, discharge, turbidity at nine sites (15 min resolution)
- Two sites (Pow outlet, Morland outlet) with bank-side analysis of Total P, Total reactive P (30 min resolution)
- Data collection 2011 – present and continuing, but some data missing



Event classification

- Classification of events according to method of Haygarth et al., 2004 (HESS, 8, 88-97)



Results:

Pow outlet (April 2012 – March 2013)

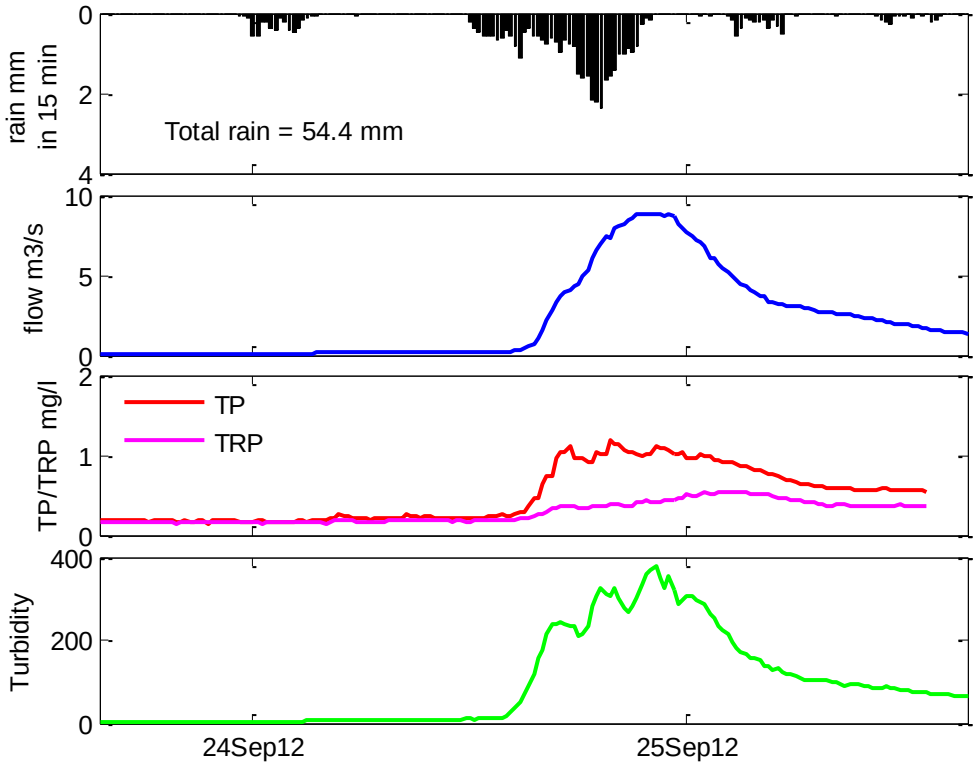
Total	Q_{05} = 0.72, Cp_{05} = 0.55	56 events	75% of TP load
Type 1	Q ≥ 0.72, Cp < 0.55	4	4%
Type 2	Q ≥ 0.72, Cp ≥ 0.55	26	69%
Type 3	Q < 0.72, Cp ≥ 0.55	26	2%

Morland outlet (Sept 2011 – Jan 2013)

Total	Q_{05} = 0.82, Cp_{05} = 0.22	72 events	78% of TP load
Type 1	Q ≥ 0.82, Cp < 0.22	9	1%
Type 2	Q ≥ 0.82, Cp ≥ 0.22	49	76%
Type 3	Q < 0.82, Cp ≥ 0.22	14	1%

The bulk of the load is transported in Type 2 (high discharge, high concentration) events

Pow outlet



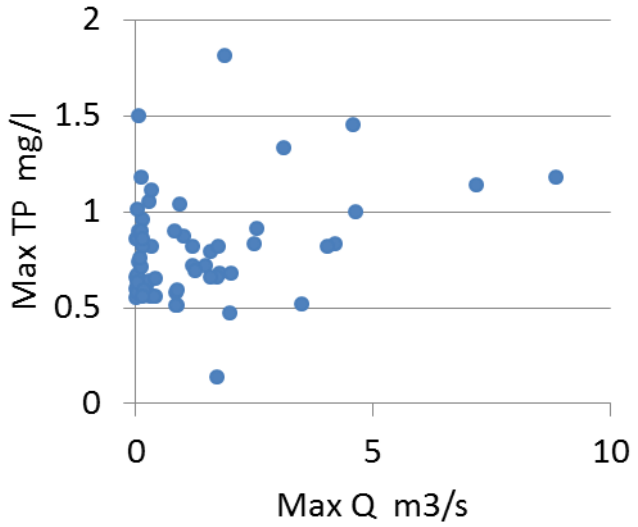
Type 2

- Event with highest peak flow, but not highest peak TP
- This single event accounts for > 10% of total load
- TRP peak later than TP peak

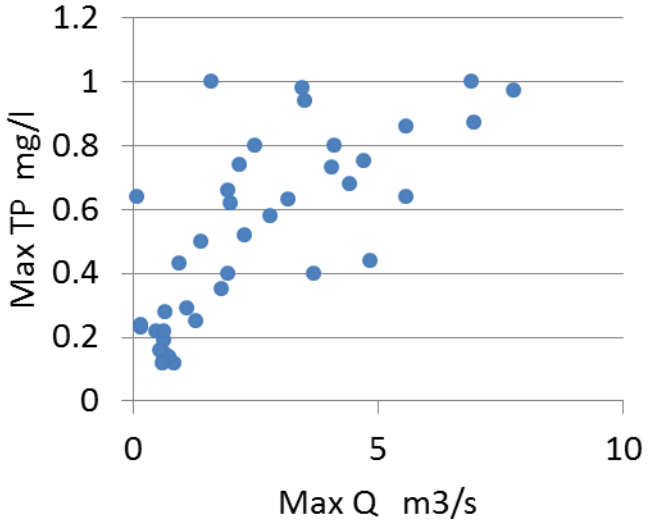
Cross correlation to determine the lag between signals:

Order of peaks: Turbidity, Flow, TP, TRP
Turbidity signal precedes flow by approx. 15 minutes
TP signal precedes TRP by 30 – 60 minutes

Pow outlet

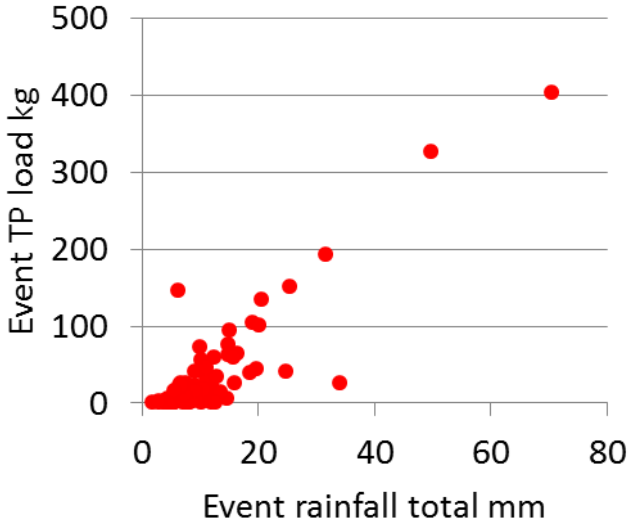


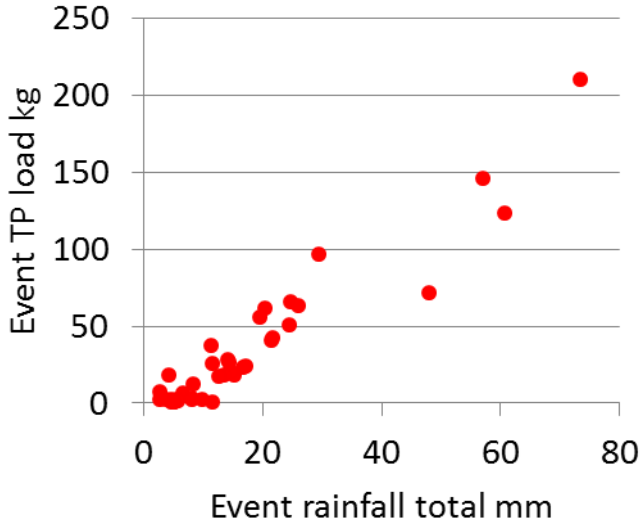
Morland outlet



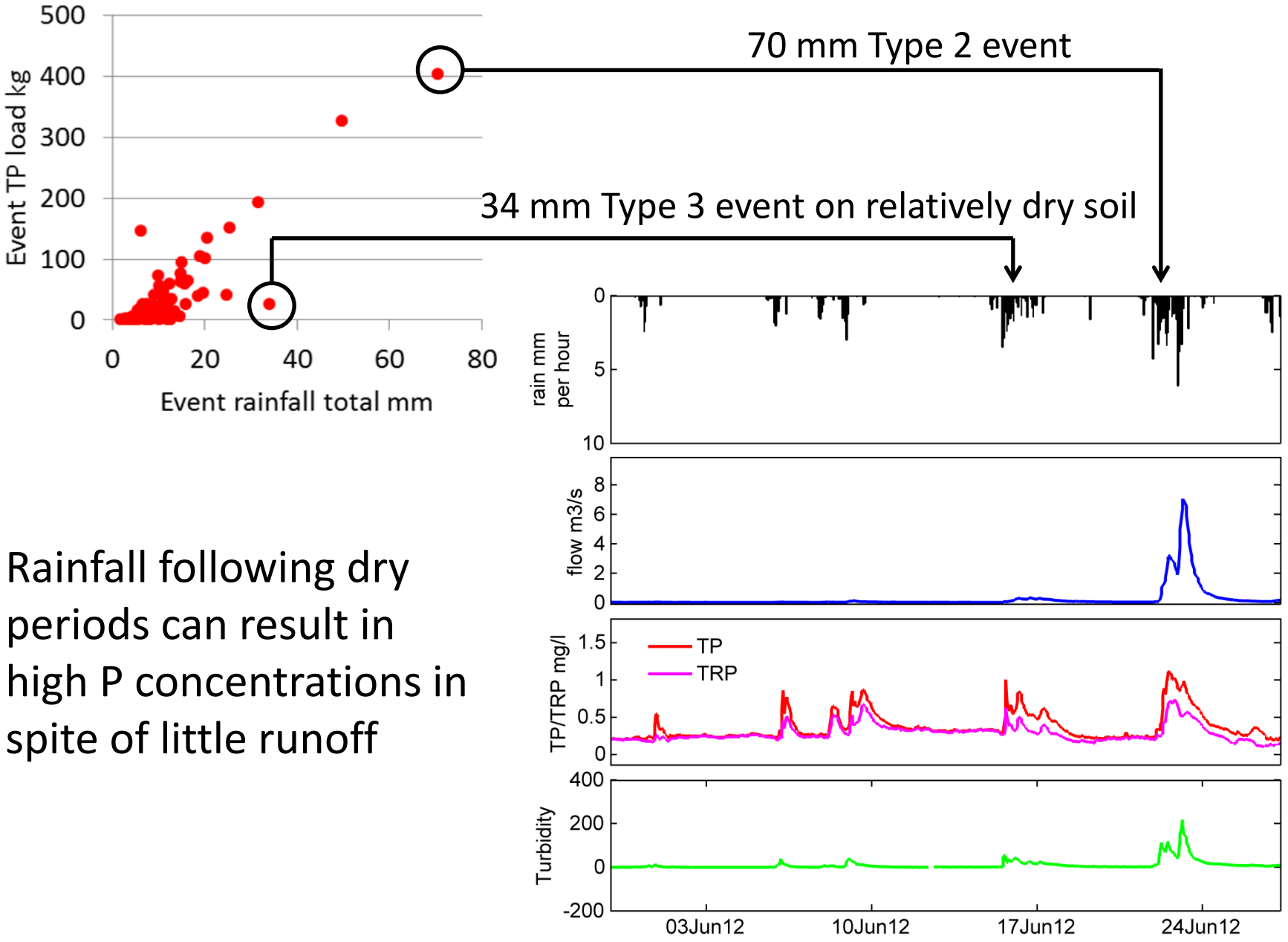
Non-linearity between the peak discharge and peak TP concentration, but better agreement between event rainfall total and event TP load

Pow





Morland



Rainfall following dry periods can result in high P concentrations in spite of little runoff

Conclusions

- Type 2 events ($Q > Q_{05}$, $C_P > C_{P05}$) account for more than 75% of the total phosphorus load at Morland outlet and Pow outlet. These events may become more frequent in future

- The signal response occurs in the order:
  Turbidity < Flow < TP < TRP
  with lag time of approx. 15 mins between turbidity and flow
  30 – 60 mins between TP and TRP

- There is good correlation between event rainfall total (mm) and event total phosphorus load (kg)

Thank you

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For further information, please visit our website:
http://nutcat2050.org.uk/

NERC SCIENCE OF THE ENVIRONMENT

Changing water cycle