# Understanding soil phosphorus systems from emergent behaviour in a headwater catchment

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## 1. Diffuse pollution – the challenge

Phosphorus (P) transfer from agricultural soils, manures and fertilisers contributes to downstream eutrophication in rivers. Better understanding of P processes in catchments is vital in helping to reduce diffuse pollution (Figure 1) and improve water quality.

Figure 1. Polluted runoff from agricultural land

Figure 2. Location of the Pow catchment UK Grid ref. NY386501

## 2. Method

High temporal resolution nutrient data from the Pow headwater catchment (10.5 $km^2$, Fig. 2) in the Eden River basin, UK were collected by the Eden Demonstration Test Catchment (DTC) project. Rainfall and discharge (15 min), total phosphorus (TP) and total reactive phosphorus (TRP) (30 min) were analysed by event classification, according to exceedance of discharge and concentration thresholds (Fig. 3).

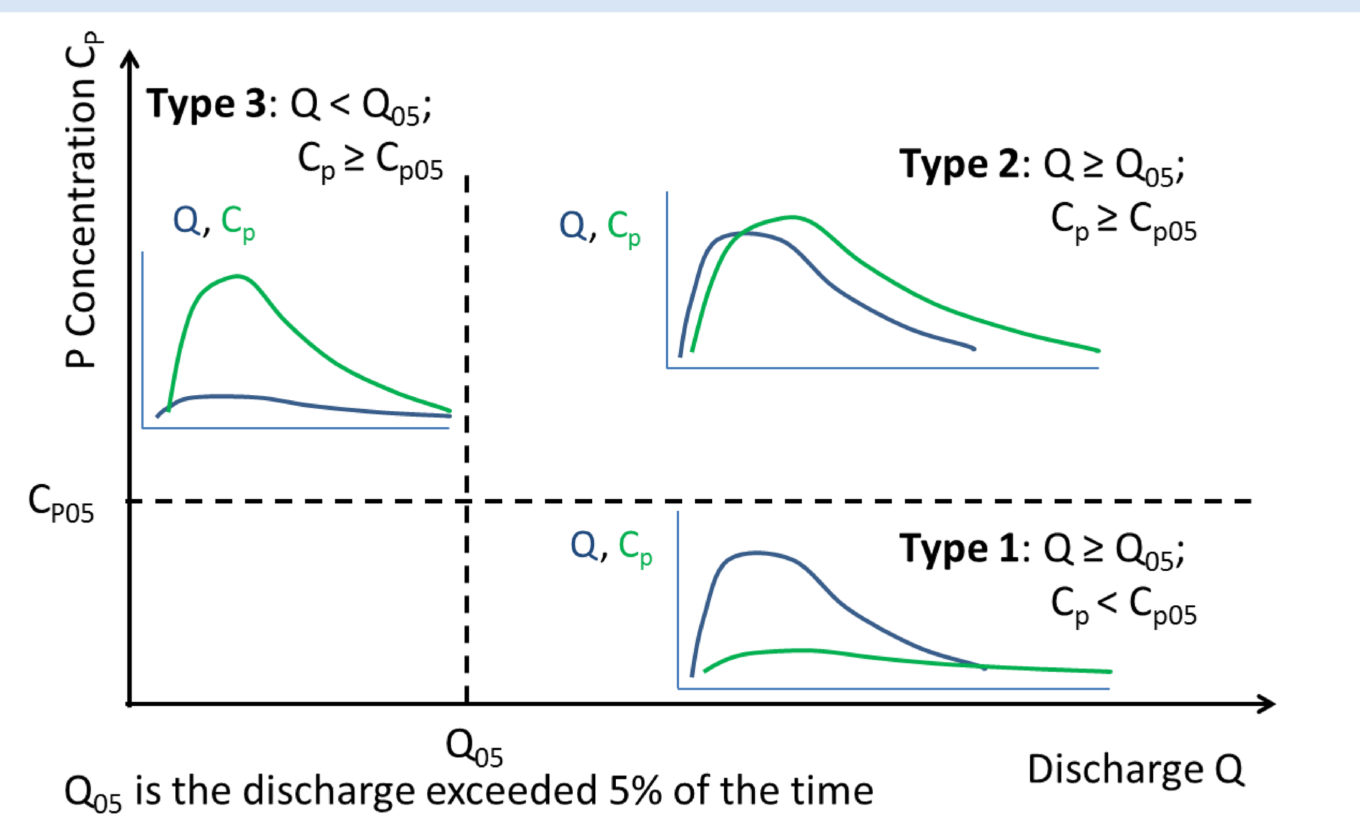


Figure 3. Event classification method, according to Haygarth et al., 2004 (HESS, 8, 88-97)

## 3. Results

The bulk of the load was transported in Type 2 (high discharge, high concentration) events (Table 1).

| 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% |

Table 1. Event analysis for Pow outlet, April 2012 – March 2013, showing the importance of high discharge events. Such events may increase in frequency or intensity in the future.

Total event TP load was correlated with total event rainfall (Figure 4a), but with some outliers. High TP concentrations were recorded during rainfall following dry periods, when there was little response in discharge (Figure 4b).

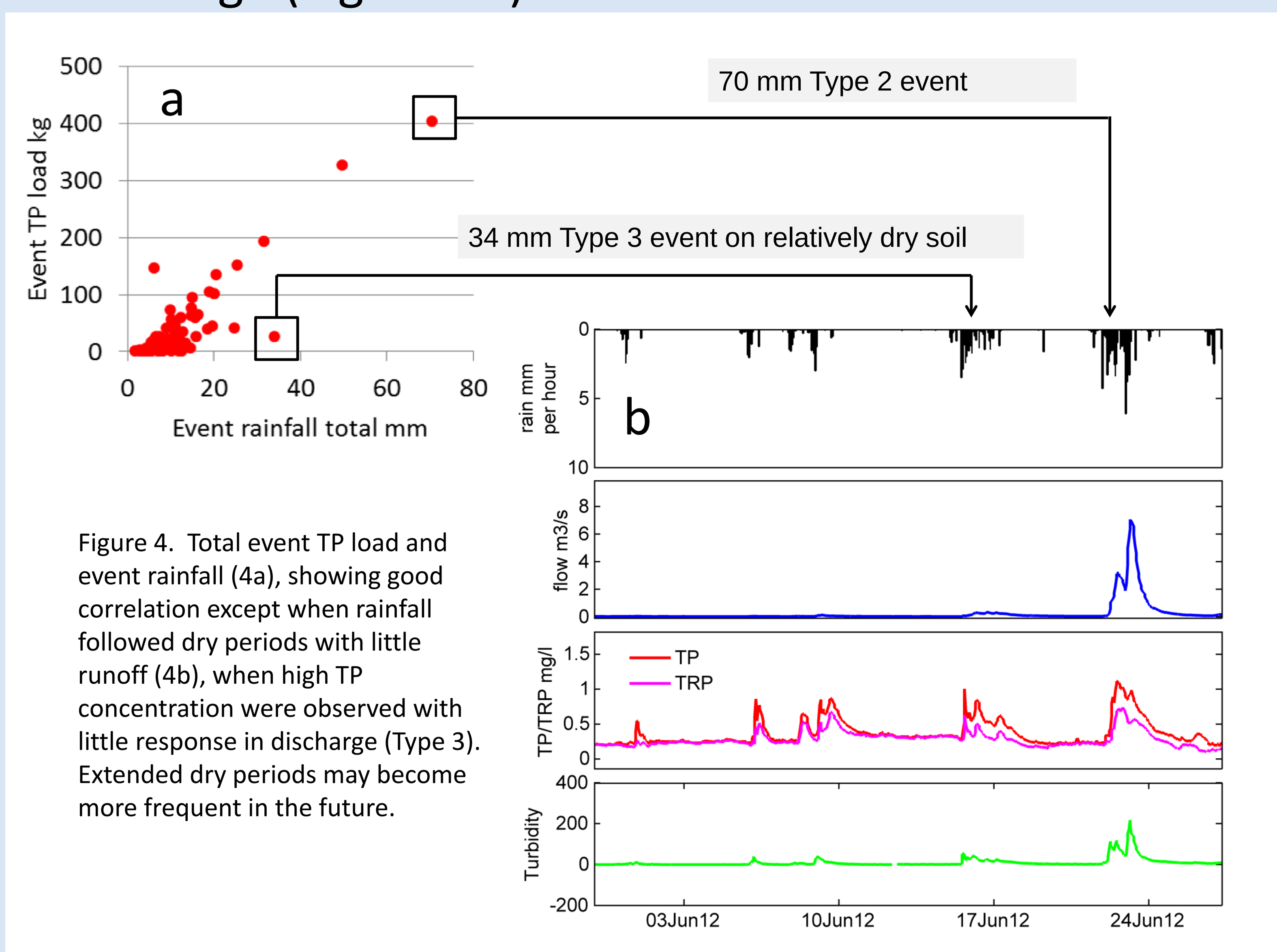


Figure 4. Total event TP load and event rainfall (4a), showing good correlation except when rainfall followed dry periods with little runoff (4b), when high TP concentration were observed with little response in discharge (Type 3). Extended dry periods may become more frequent in the future.

TRP peaked later than TP (Figure 5) indicating different dominant pathways, with TP influenced by quickly mobilised sources and TRP showing the presence of slower sub-surface pathways.

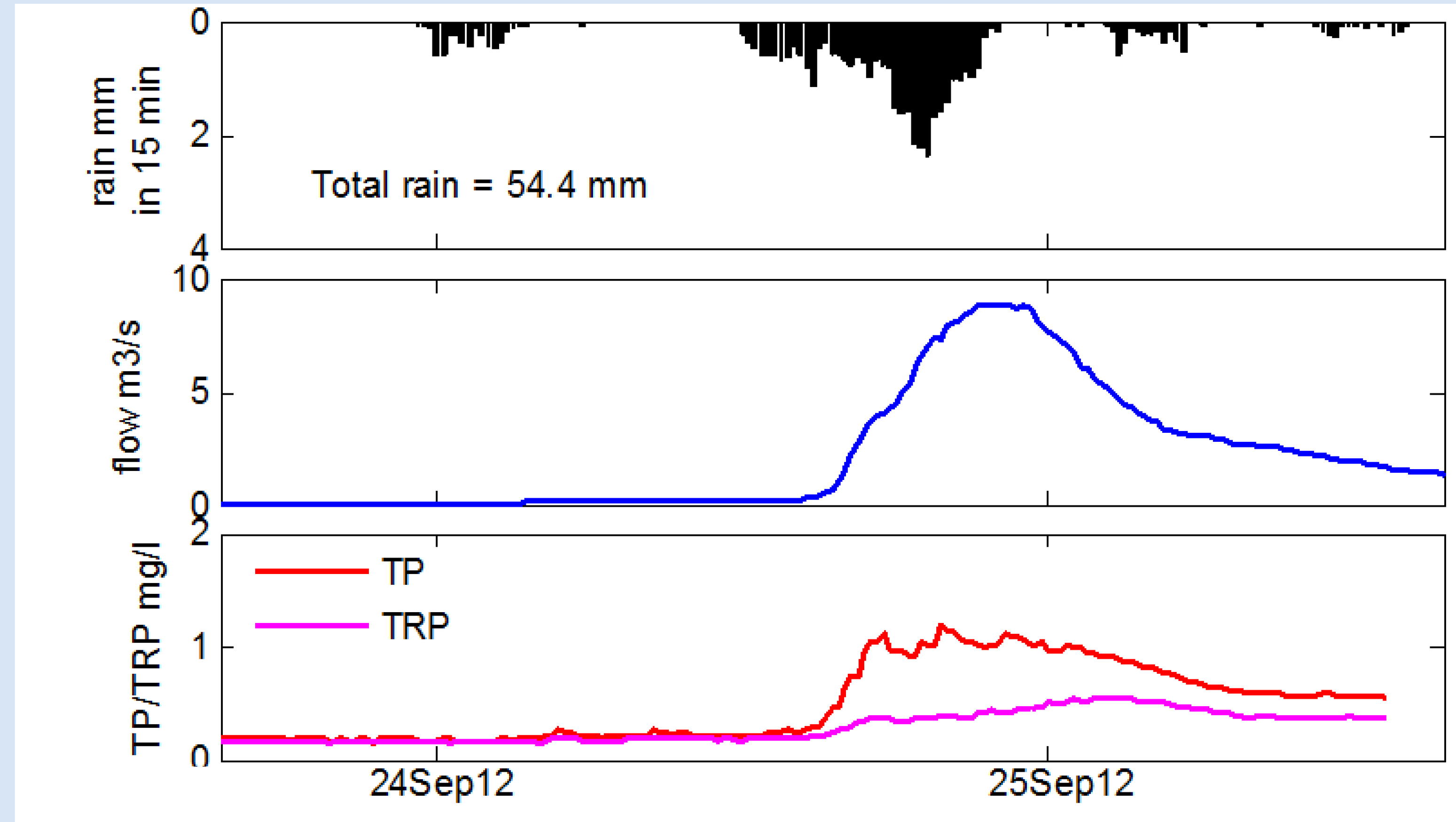


Figure 5. Rainfall, discharge, TP and TRP for a Type 2 event , showing a lag between peak TP and peak TRP

## 4. Conclusions

- More than 70% of the TP load was transferred in less than 5% of the time, during highest discharge
- High concentrations were recorded in the river after extended dry periods with no runoff
- Both heavy rainfall and longer dry periods are expected to be more frequent in the future, suggesting that phosphorus transfers may be increased unless sustainable phosphorus use and land management is planned appropriately

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