EPSRC
Engineering and Physical Sciences Research Council

University of Reading

Hydrochemical processes in lowland river systems: insights from *in situ*, high-resolution monitoring

29 September 2014

Andrew Wade
Department of Geography and Environmental Science

Co-authors

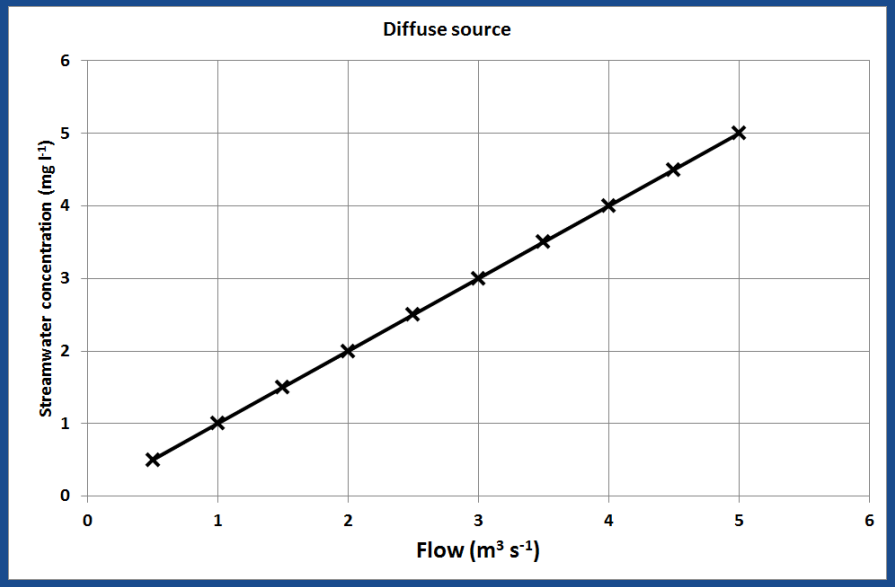
- University of Reading
  - Skeffington RA, Halliday SJ
- Centre for Ecology and Hydrology
  - Bowes MJ, Palmer-Felgate EJ, Jarvie HP, Neal C, Gozzard E, Newman JR
- Environment Agency
  - Loewenthal M
- University of Hull
  - Greenway GM, Bell I, Joly E, Fallatah A, Haswell SJ
- *http://www.hull.ac.uk/limpids*

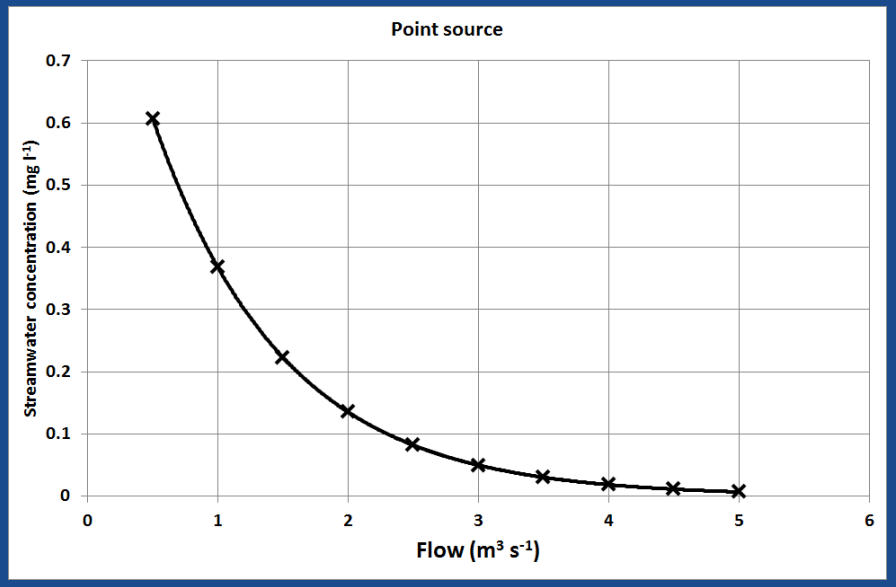
Introduction

- Rationale
- Study sites
  - Two tributaries of the River Thames, UK
- Methods
  - In situ monitoring and load estimation
- Results
  - Load estimation
  - Nutrient sources and processing
- Conclusions
- Next steps

Rationale

- Sub-daily timescale
- Load estimation
- Pollution source identification
- Ecological function
- Water quality standards
- Concentration-flow relationships

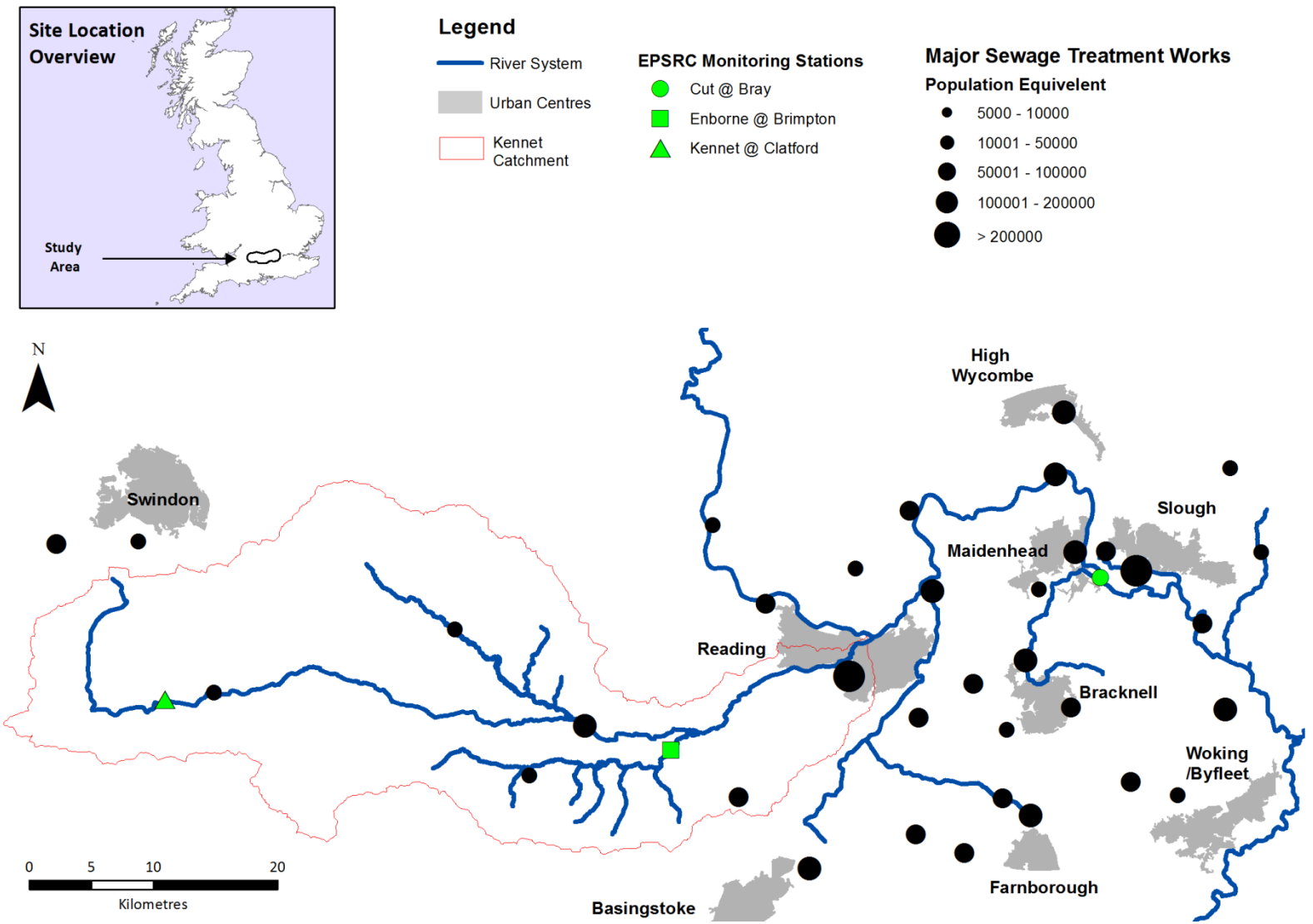




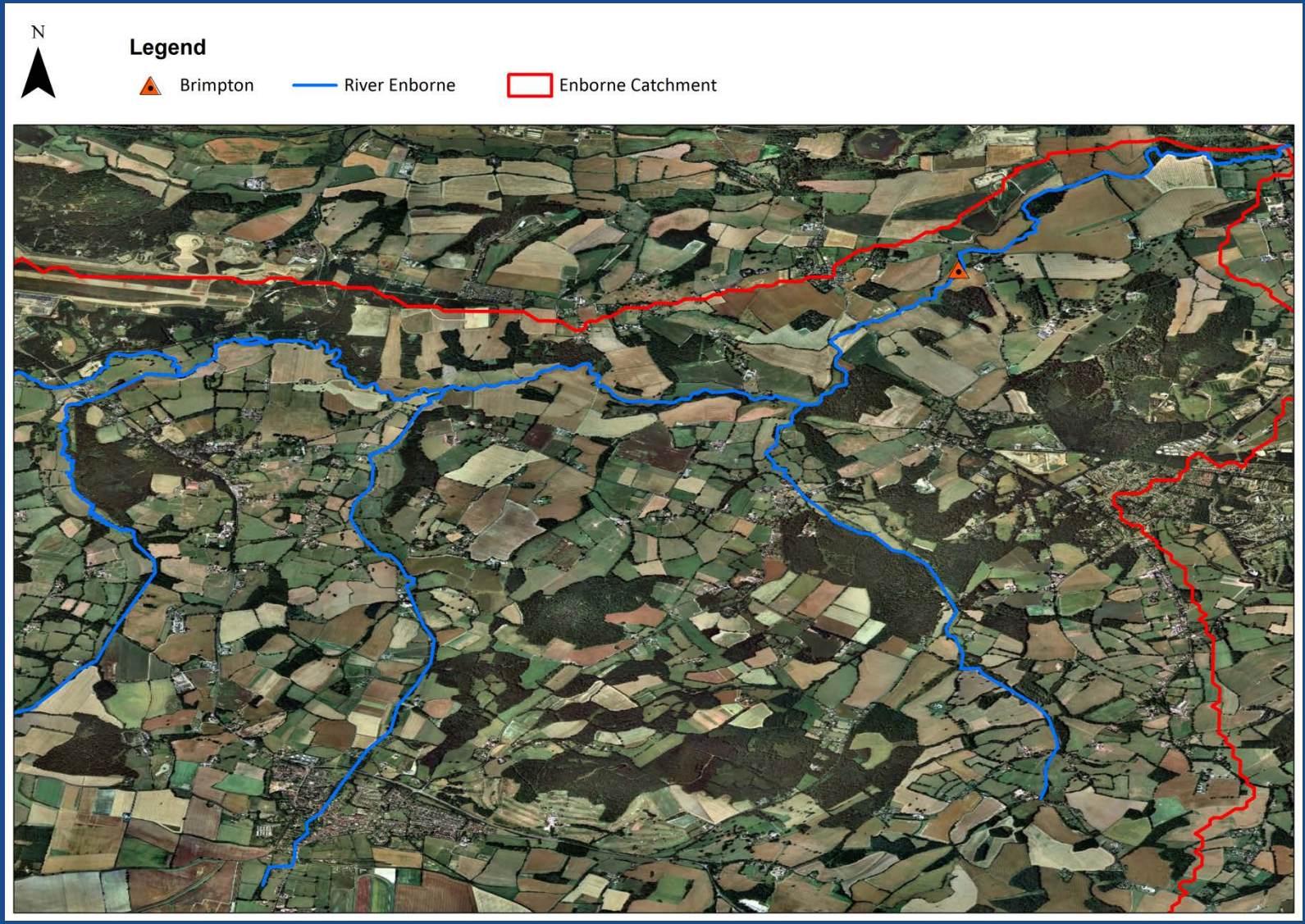
Rationale

- Builds on: Jordan et al. 2005. HESS 9:685-691.
- Complement:
  - Cassidy and Jordan (2011) JoH;
  - Rozemeijer et al. (2010) Environ. Sci. Technol.;
  - Mellander et al. (2012) Environ. Sci. and Policy;
  - Ferrant et al., (2012) Hydrol. Processes.;
  - plus an array of others.
- Urban context and suite of analytes
- Wade et al. 2012. HESS 16:4323-4342.

Thames catchment – *in situ* monitoring



The River Enborne



The River Enborne at Brimpton

The Cut

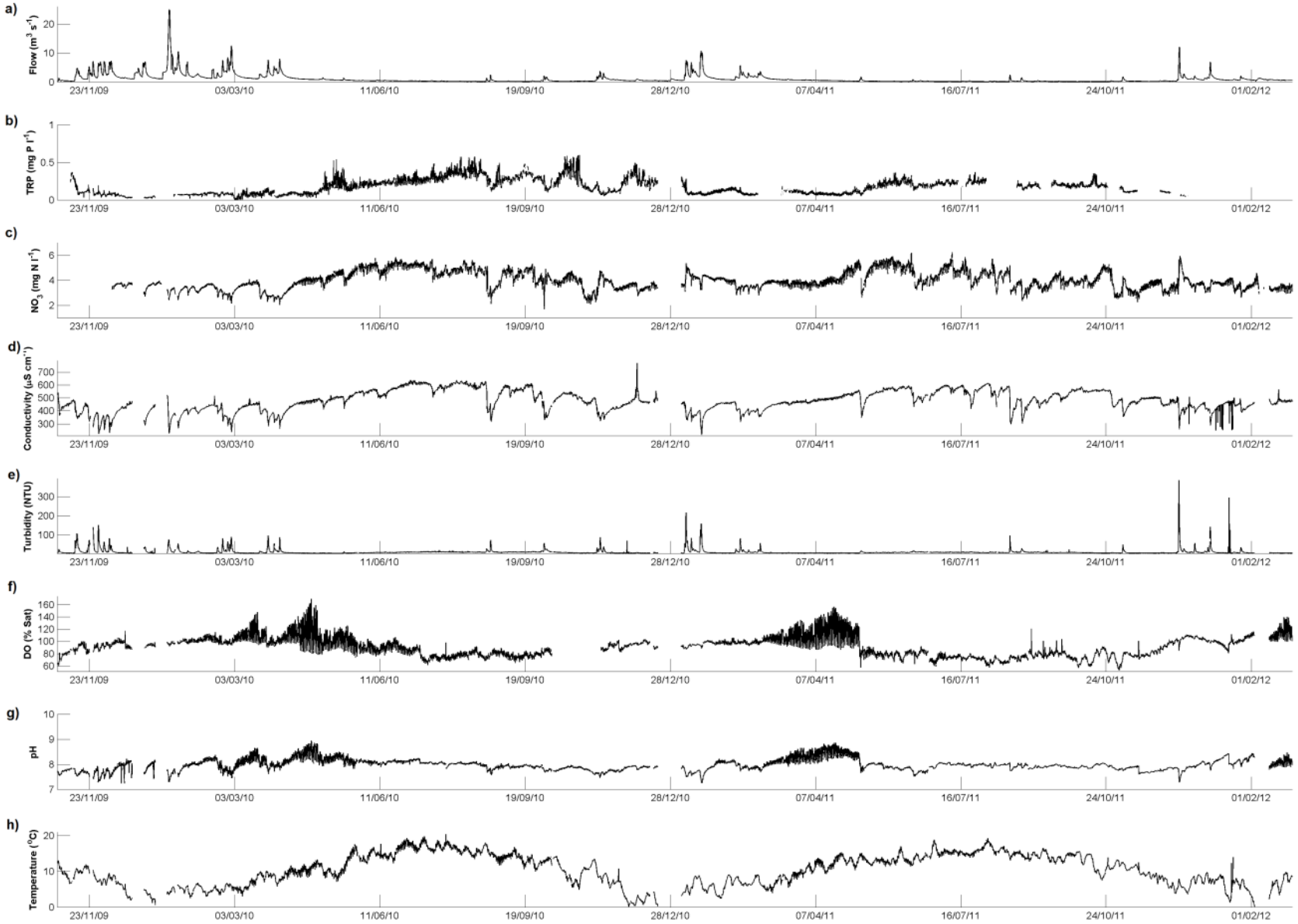
In-situ monitoring

Inside Monitoring Trailer

Hach Lange Phosphax Sigma

YSI Multi-Parameter Sonde (6600)

The River Enborne: full data set



Load estimation

- Walling and Webb, 1995. Mar. Poll. Bull.
- Re-sample

$$L = \frac{K \sum_{i=1}^{n} (C_i Q_i)}{\sum_{i=1}^{n} Q_i} Q_r$$

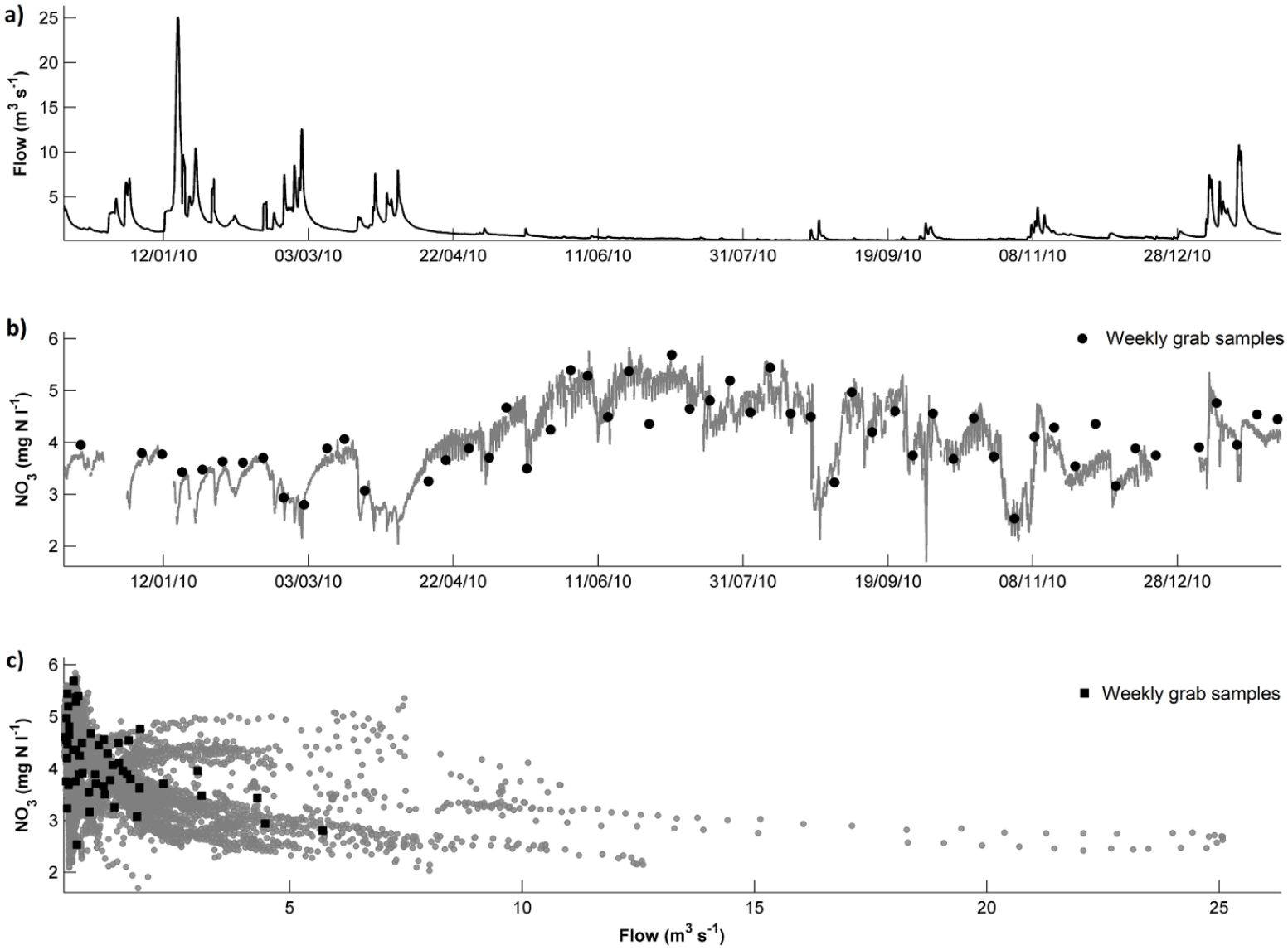
$$Q_r = \frac{\sum_{j=1}^{N} Q_j}{N},$$

Nutrient load estimation

The River Enborne: annual loads

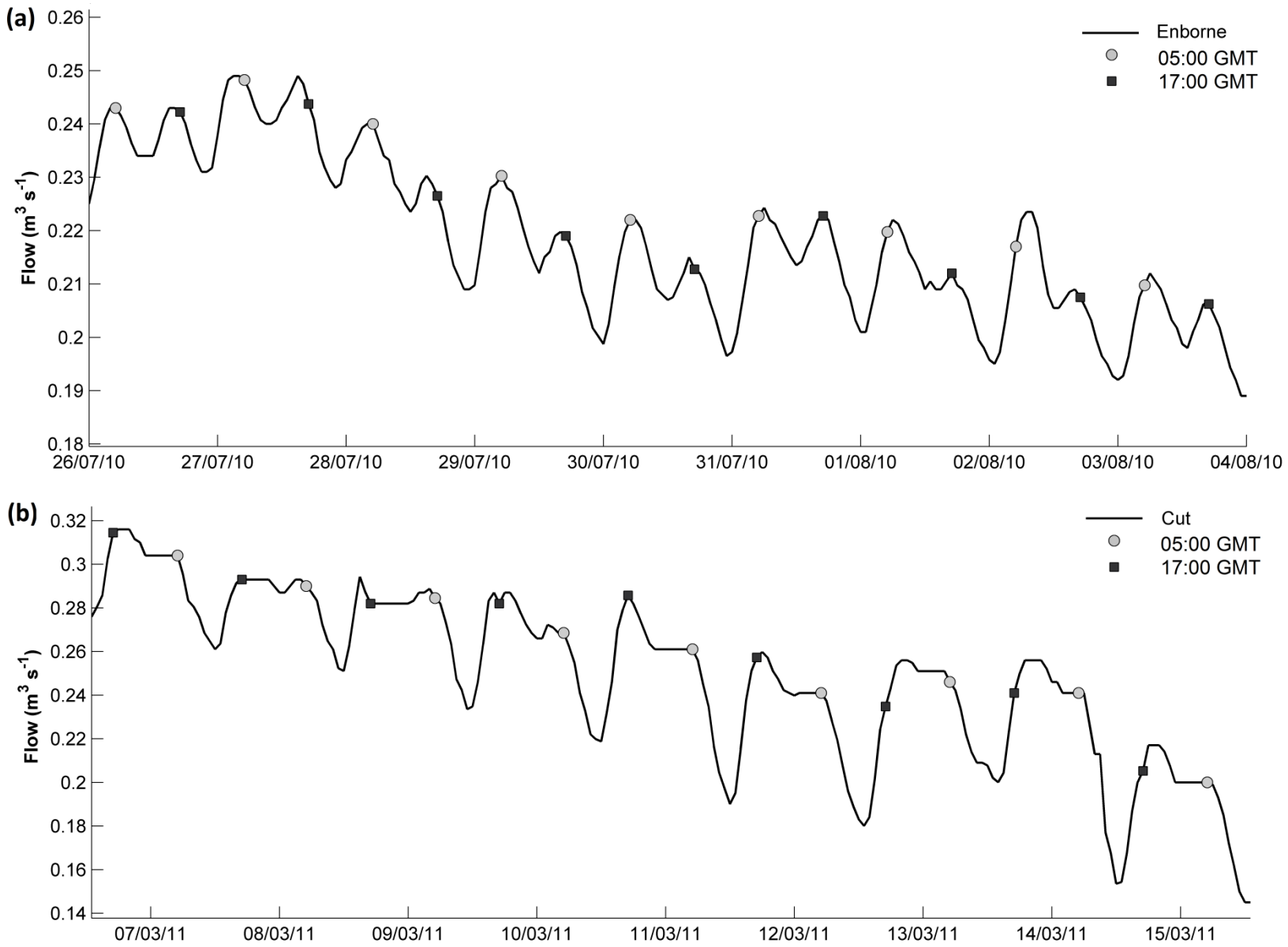
	Load Estimate		Diff. from hourly load estimate	
	TRP (kg P y^{-1})	NO_3 (kg N y^{-1})	TRP (%)	NO_3 (%)
Hourly	3320	120000	--	--
7-hour	3320	121000	0.1%	0.7%
Daily	3300	120000	-0.9%	-0.1%
Weekly	4170	142000	26%	18%
Fortnightly	4300	139000	29%	15%
Monthly (11^{th})	3100	114000	-7%	-5%
Monthly (21^{st})	2000	76800	-39%	-36%

The River Enborne: loads

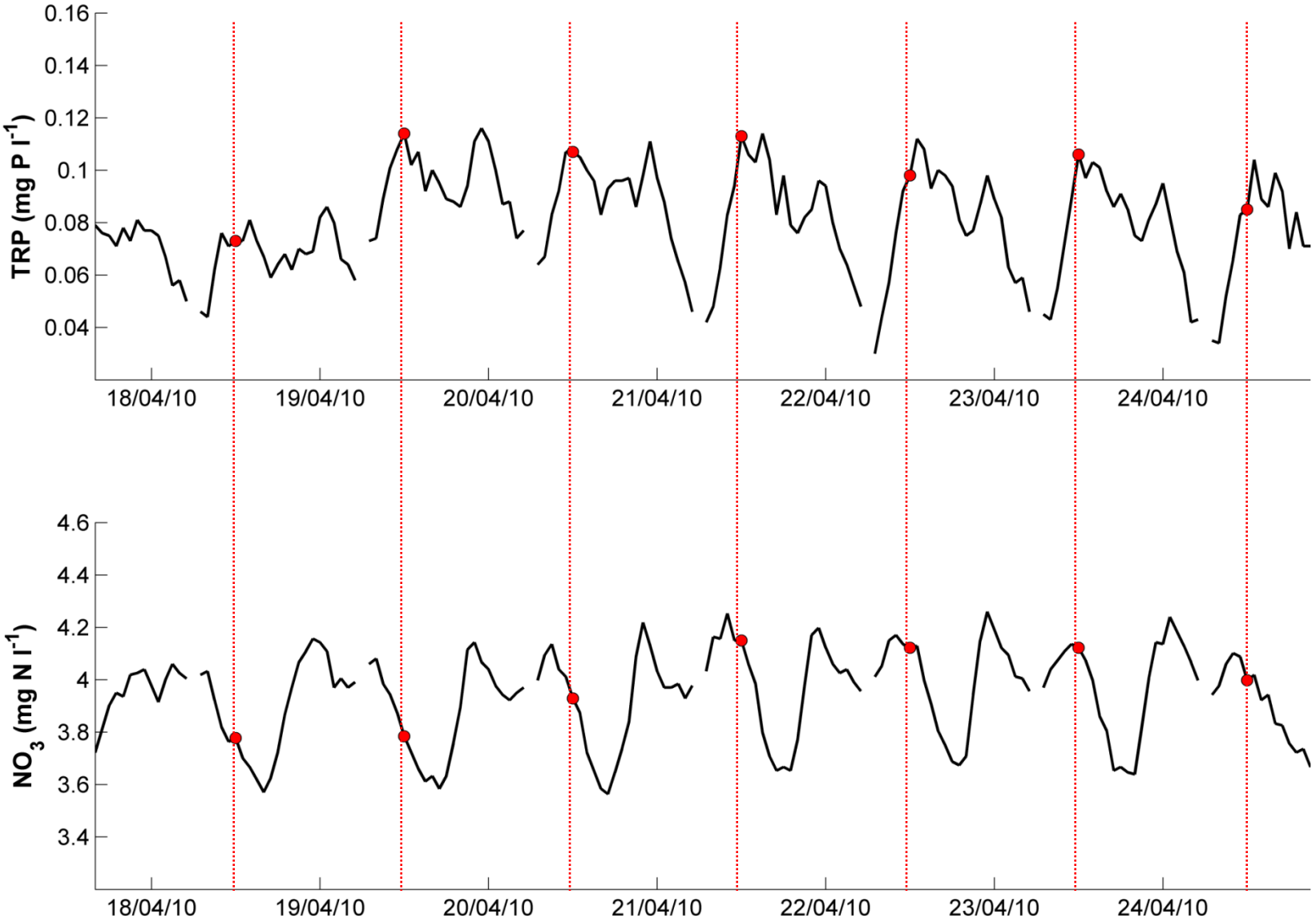


Nutrient sources

Two-peak diurnal pattern in flow

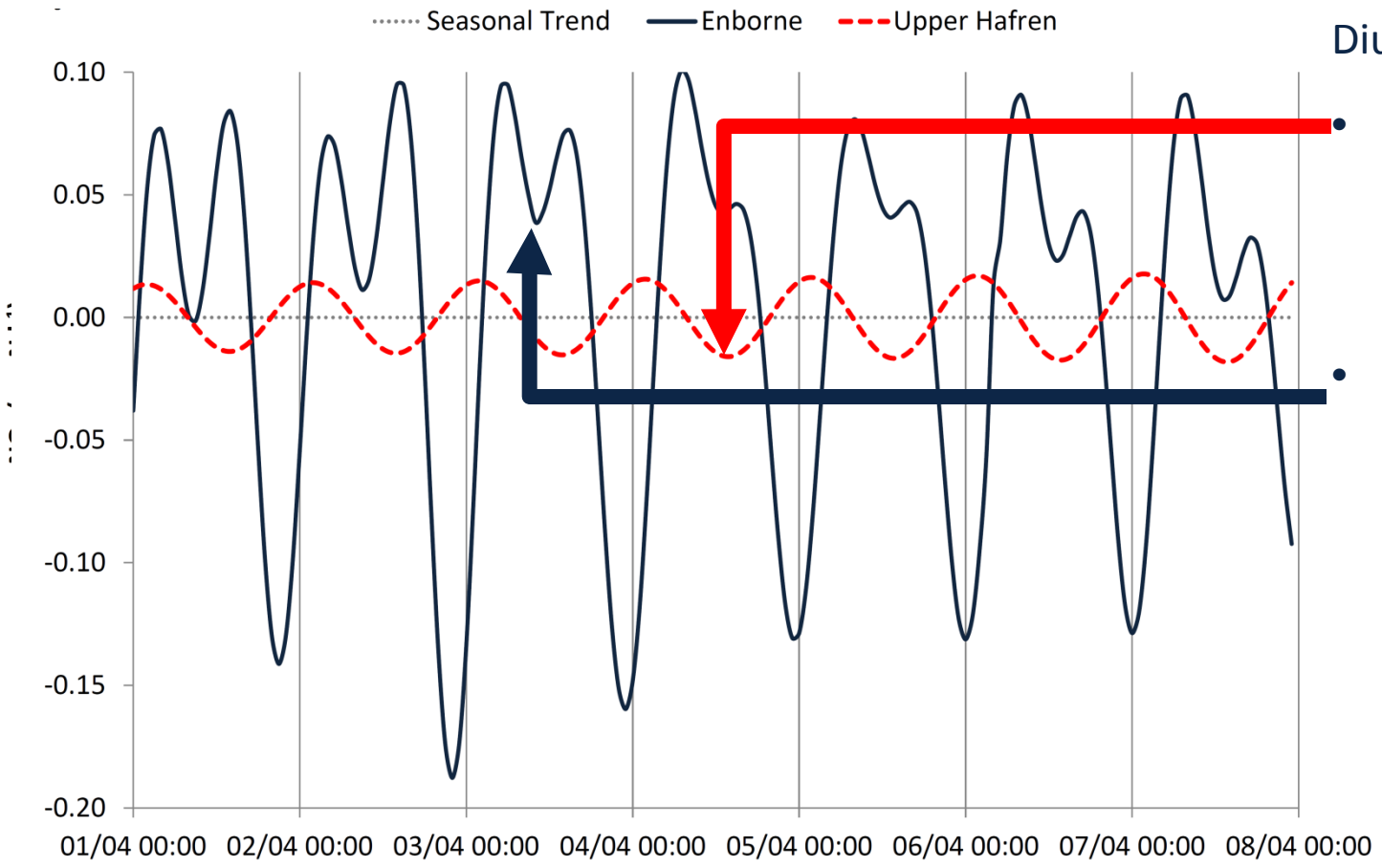


Two peak diurnal pattern in TRP and NO_3 in the River Enborne



Halliday et al 2013 Water

River Continuum

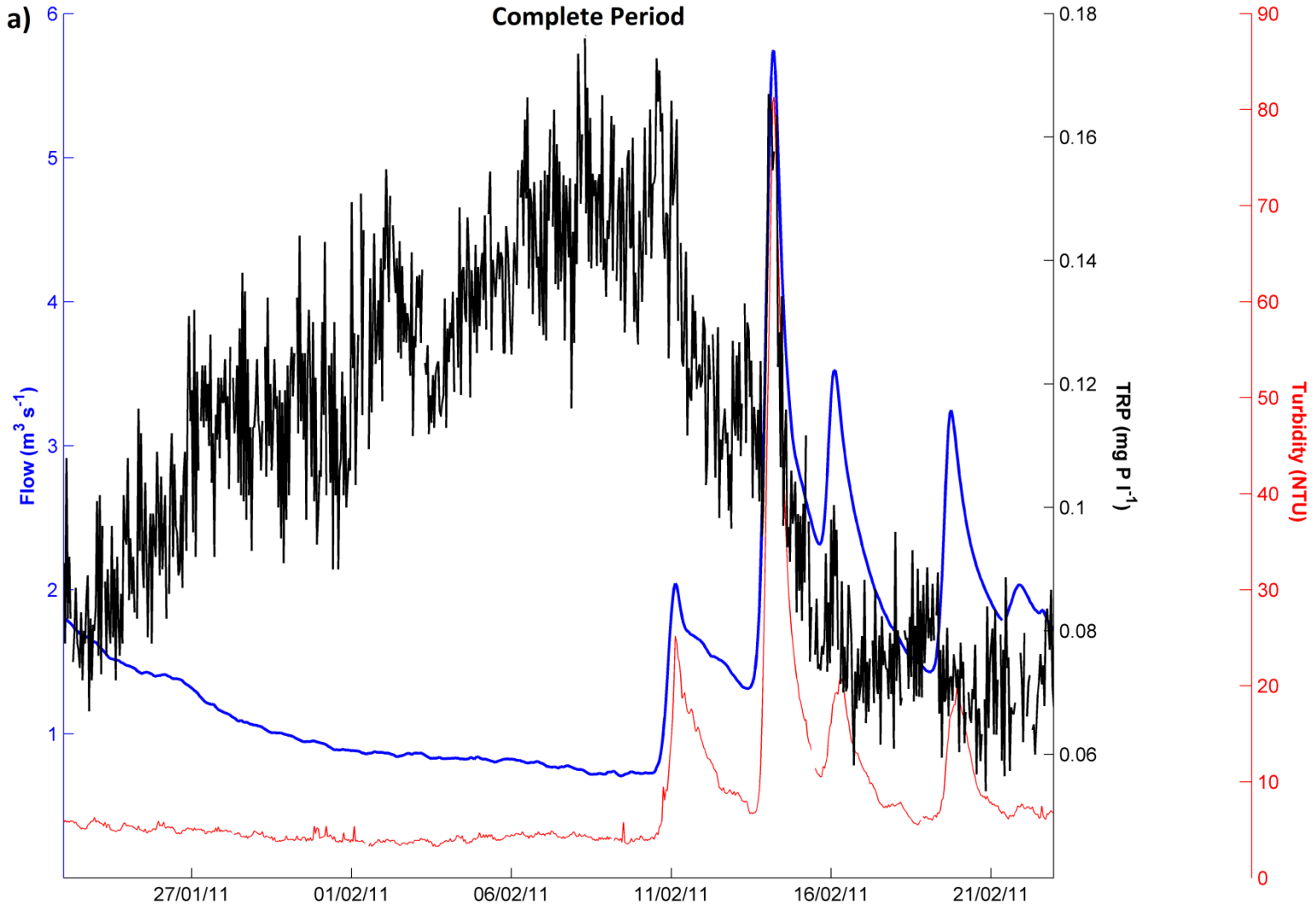


onal dynamics

Diurnal dynamics

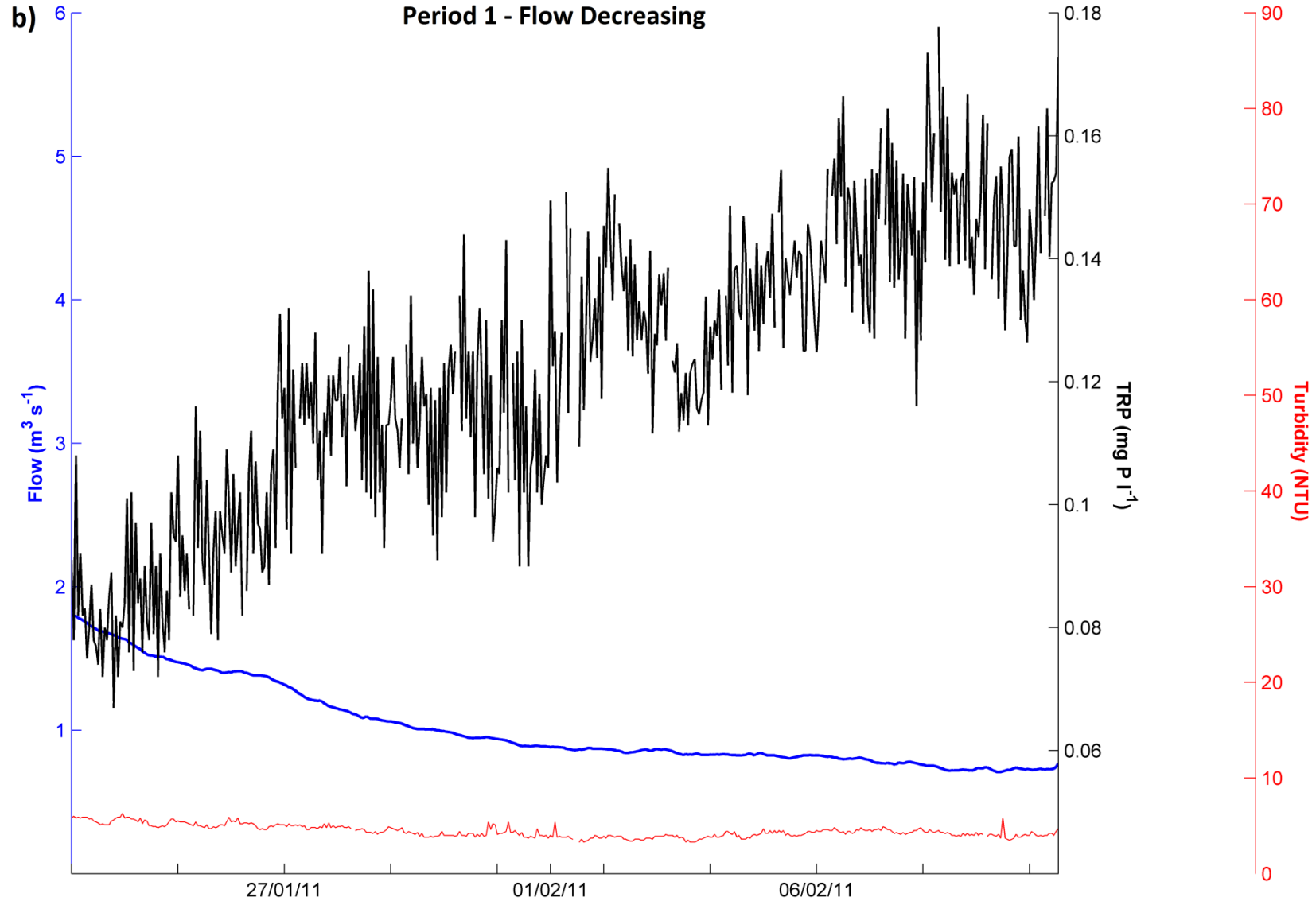
- pland =
  Upland =
  atchment
  nstream
  iological
  utotrophic
  rocessing
  uptake
- owland =
  Lowland =
  Sewage effluent
  discharges

The River Enborne: phosphorus dynamics

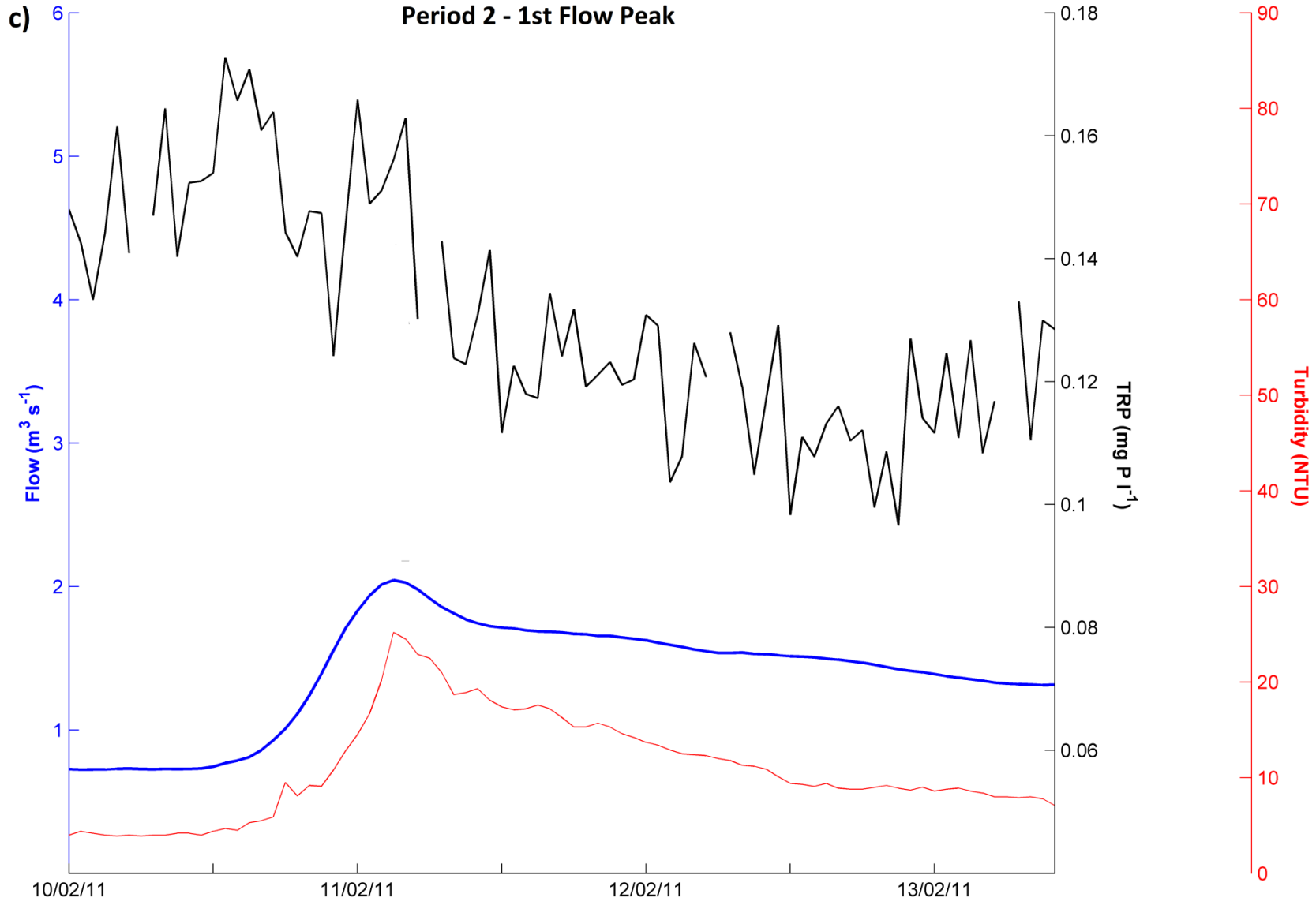


Wade et al 2012 HESS

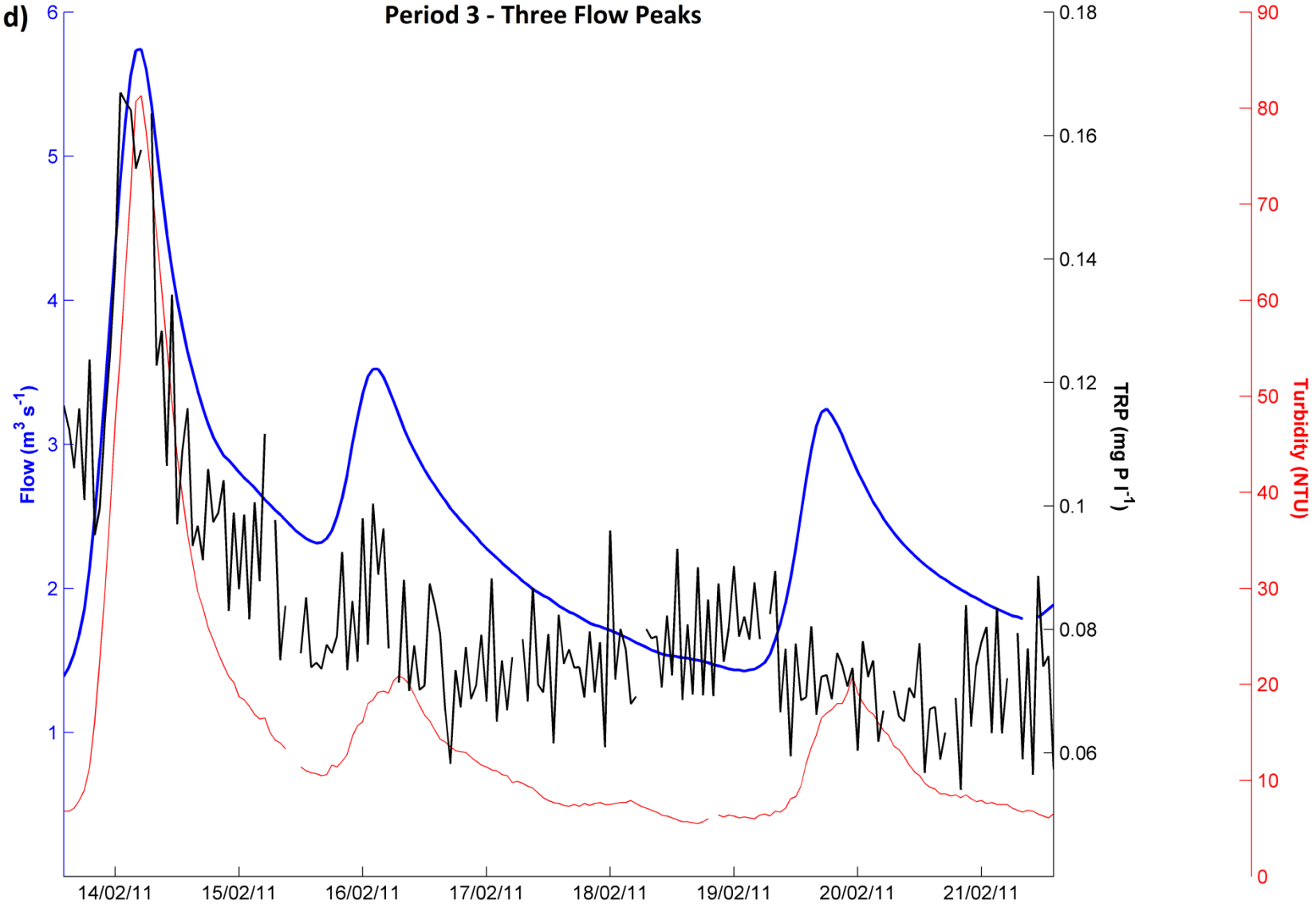
The River Enborne: phosphorus dynamics



The River Enborne: phosphorus dynamics

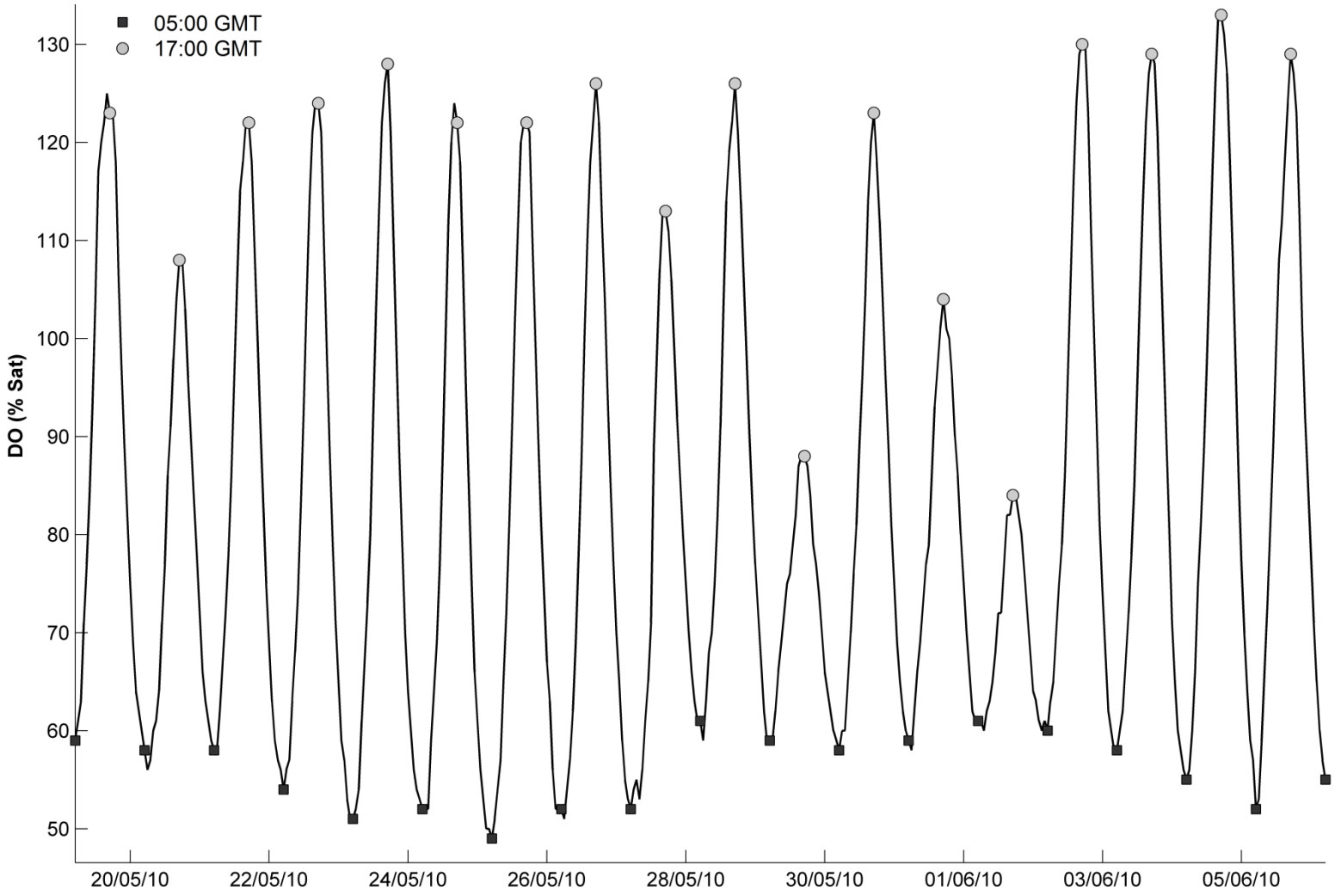


The River Enborne: phosphorus dynamics



Ecological function and water quality standards

The Cut: water quality standards/thresholds



Halliday et al. In review, Hydrological Processes

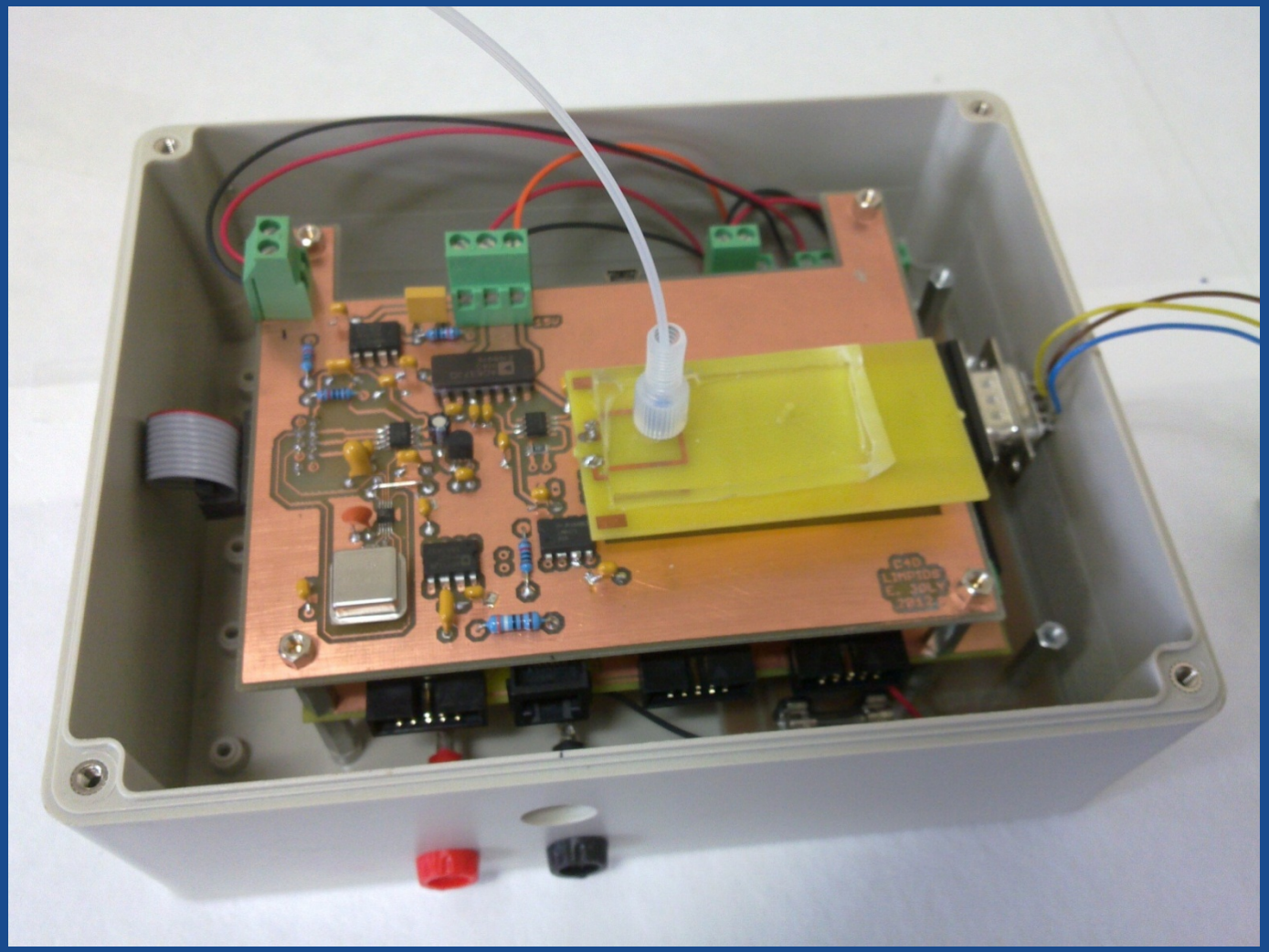
Conclusions

- Nutrient sources
  - Low flows - sewage works in lowlands drive nutrient dynamics
- Complex phosphorus dynamics
  - Start to separate source types?

- Future work
  - Importance of sampling time and frequency
  - Ecological function
  - Combination with algal flow cytometery data
- Miniaturised environmental sensors are the future

http://www.hull.ac.uk/limpids

Next steps: Lab-on-a-chip



University of Hull: Detection chip and baseline suppression board