

# Demonstration Test Catchments



## Newsletter - Summer 2014

Welcome to the Summer 2014 edition of the DTC Newsletter highlighting a few activities and progress over the past 3 months with links for you to follow up on more detailed information about individual items and topics of interest.

*The whole problem with the world is that fools and fanatics are always so certain of themselves and wiser people so full of doubts - Bertrand Russell*

### 'Tis the season to be field visiting

A group of Defra and Natural England scientists, took part in a field trip to Rothamsted Research, North Wyke (<http://www.rothamsted.ac.uk/northwyke>) at the end of June. The first day was dedicated to a catch-up on current research in the centre, with some presentations on phosphorus projects (Martin Blackwell), carbon and soils (Jenni Dungait) and greenhouse gas measurements and inventory (Laura Cardenas), followed by a visit of the field facilities (Robert Orr, Jenni Dungait, Tom Misselbrook and Bruce Griffith). The second day focused on an ADAS lead project (WQ0140) funded by Defra, with contributions from Brian Chambers, Kate Smith and John Williams (ADAS), Rob Dunn, Tom Misselbrook (Rothamsted, N Wyke), John Morgan (Maize growers Assoc), and Stuart Norris (Plymouth University). This project aims at testing whether combining strip tillage techniques with oversown crops (perennial ryegrass or biodiversity mix) can reduce the environmental impact of maize cultivation while maintaining the productivity and profitability of the crop. Results so far show that strip tillage into oversown perennial ryegrass can considerably reduce the environmental impact of maize, mainly in terms of nitrate leaching and sediment losses, while the biodiversity mix has the greatest positive impact on invertebrate biodiversity. However, such practices also considerably reduce maize yields, as a result of competition between the cover crop and the maize in the first six to eight weeks of maize establishment. Further work is needed to develop innovative systems of maize production that deliver viable crop yields and also provide environmental protection.

### Field Visits - a great way to exchange knowledge

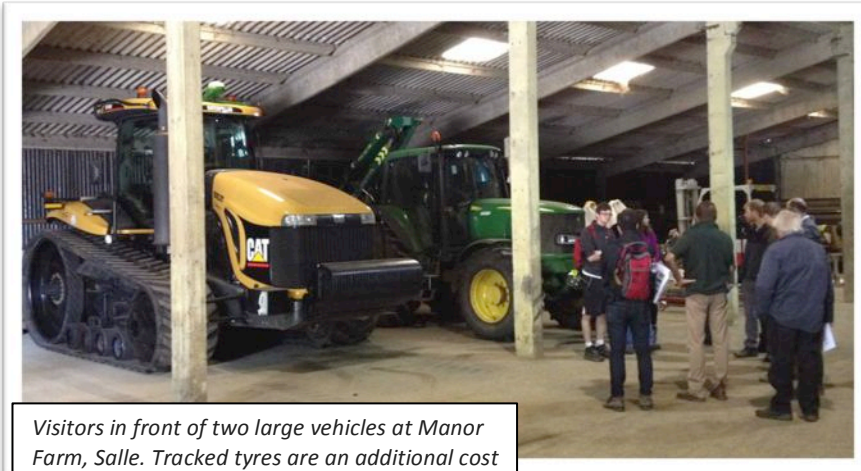
The 'D' in DTC is not just about demonstrating technologies it's as much about exchanging knowledge and understanding differences in points of view. Some recent catchment visits have highlighted the benefits of getting together a variety of actors to informally discuss aspects of farming and environment matters in the field. It is particularly valuable for both policy and operational people to see issues at first hand, partake in discussion with farmers and land owners.

**Eden Catchment** – a small group of Defra staff joined DTC consortia colleagues, Eden Rivers Trust staff and local farmers in a visit to see the measures, which have been implemented in the Morland sub-catchment, and to hear first-hand from one of the farmers about his challenges in managing an upland dairy farm. The party also visited the new state of the art dairy facility at Newton Rigg College, which was



opened at the end of March and will act as a demonstration for farmers across a wide part of the north-west. (picture above – *courtesy of the Westmorland Gazette* - see more at <http://www.newtonrigg.ac.uk/departments/agriculture-land-management>)

**Wensum Catchment** – Defra Water Quality policy staff visited the Salle Estate in the Wensum DTC catchment to learn about the measures being tested and to discuss issues and constraints with



Visitors in front of two large vehicles at Manor Farm, Salle. Tracked tyres are an additional cost but considered to be cost beneficial because of the protection they give to soils.

managers of Manor Farm on the Salle estate, advisors and the research team from UEA. The visitors learnt about the financial aspects and challenges of running a large arable business (over 2000ha in cultivation) ranging from the capital costs of purchasing and maintaining large and expensive items of machinery to making sure large fields of broad beans

reached perfection for the Middle East market during Ramadan. To learn more about the cultivation trials (cover cropping and reduced cultivation) being tested in the Wensum DTC, visit:

[http://www.wensumalliance.org.uk/publications/Spring\\_bean\\_growth\\_summary\\_230514.pdf](http://www.wensumalliance.org.uk/publications/Spring_bean_growth_summary_230514.pdf)

**Pontbren Farmers’ Initiative - woodland shelterbelt creation leads to better drainage**

3 DTC/Defra colleagues visited the Pontbren farmers’ initiative in June to learn more about the use and effectiveness of woodland shelterbelts and the benefits of a localised farmer-led approach over a nationally imposed scheme. The Pontbren stream forms a headwater catchment of the River Severn in mid-Wales where much of the land is improved grassland - ploughed and reseeded with forms of rye grass plus regular fertiliser applications - mainly grazed by sheep with some beef and dairy herds. The Pontbren group of 10 neighbouring farms, manage a large proportion of the land where the

agricultural systems have intensified since the war. Around 15 years ago the farmers decided that this was not how they wanted to farm their land and wished for a more sustainable approach whilst



Visitors to Pontbren by one of the recently planted shelterbelts – note that most of the trees in the distance were also planted during the past 15 years

still getting economic returns. One interesting management practice is the planting of trees as shelterbelts for livestock and presented a chance to study the additional benefits this brought – enhanced drainage/reduced run-off, increased biodiversity, timber supply, more attractive landscape etc. See website link below for the overall research report on the findings.

<http://www.coedcymru.org.uk/images/user/FRMRCreport.pdf>

Just a few **learning points** gleaned from these visits:

- Farming businesses are **very** different. Apart from the common factor of land management, small livestock units in the west bear little relationship to large arable agri-businesses in the east and need to be treated very differently with respect to incentives and advice.
- The DTC research community is increasingly being welcomed by the farmers they work amongst. Poul Hovesen (Farms and Estate Manager at Salle) said that they “have become much better farmers” as a result of working with the researchers and are appreciating the data. Farms like theirs at the top end of the productivity profile “need to know more if they are to overcome the yield plateau in a sustainable manner.”
- Fencing off streams to prevent livestock eroding river banks brings an additional benefit of a reduced incidence of liver fluke in sheep, thus reducing the need for medication. Liver fluke is a highly pathogenic flatworm parasite of both sheep and cattle and the potential losses it causes can be very high. This observation was reported by farmers in both the Eden and Pontbren.
- Looking after the soil brings additional environmental (and financial) benefits. Avoiding compaction and keeping soil aerated avoids pernicious weeds like docks and thistles getting a hold, thus avoiding the need for selective, costly (and potentially damaging) herbicides.
- Doing the “right” thing often brings unexpected additional benefits. The Pont Bren farmers had one focus – shelter for their animals – but the additional benefits have been hugely welcomed.
- Hot tip – if you want to gain a farmer’s attention/confidence, find out their interests. Vintage tractors are a good bet!

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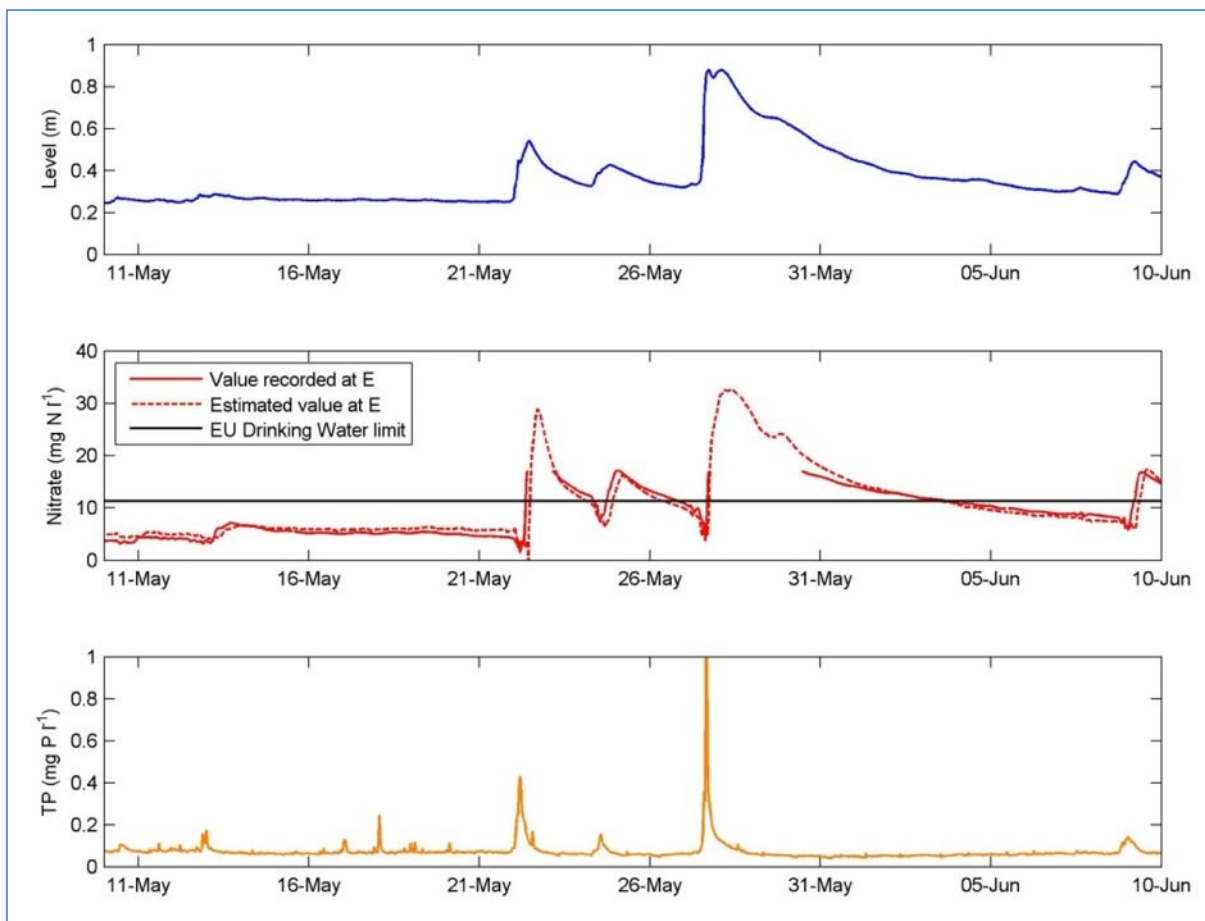


### **Wensum High Spring Rainfall – unseasonal flushes of nitrate**

Between 20 and 28 May this year, 86 mm of rain fell in Norfolk (45 mm in one 24 hour period) much more than the monthly average. In contrast the March and April rainfall totals were 33.2 and 20.4 mm, respectively (long-term average rainfall totals for these months of 49.5 and 46.8 mm, respectively). As a consequence flood water levels and pulses of nitrogen flushing and sediment movement (and therefore phosphorus peaks, mainly from road runoff) were recorded.

This caused a large increase in nitrate concentration, which rose beyond the detection limit of 20 mg N/L of the nitrate probe in the monitoring station at Stinton Hall Farm with each successive heavy rainfall event. Peak nitrate concentrations have been estimated in the figure below by comparing with nitrate concentrations from a second high-spec station downstream. Although these peak concentrations are estimated, it is likely that they were around 30 mg N L<sup>-1</sup> for several days, which is almost three times higher than the EU drinking water standard. An extremely high TP peak of 1mg P L<sup>-1</sup> was also observed.

Nutrient fluxes for this period are around 6500 kg of N and 35 kg P. These losses are equivalent to ~9 kg N per hectare and 0.05 kg P per hectare over the space of a few weeks and are similar to an 'autumn flush'. Conditions are not unlike spring 2012 when there was also a large flush of nutrients following a long period of dry weather in 2011.



These large fluxes are due to a combination of: spring fertiliser applications, a period of sustained dry weather and warm temperatures, resulting in the mineralisation of organic residues and N-fixation from spring beans. All of this leads to a build up of nitrogen in the soil. A significant amount and intensity of rainfall can then result in the flushing of this stored nitrogen from catchment soils when the 'mini-drought' breaks.

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## DTC at the international conference in Poland “Innovative and system solutions for mitigation of diffuse pollution: demonstration catchments in Europe”



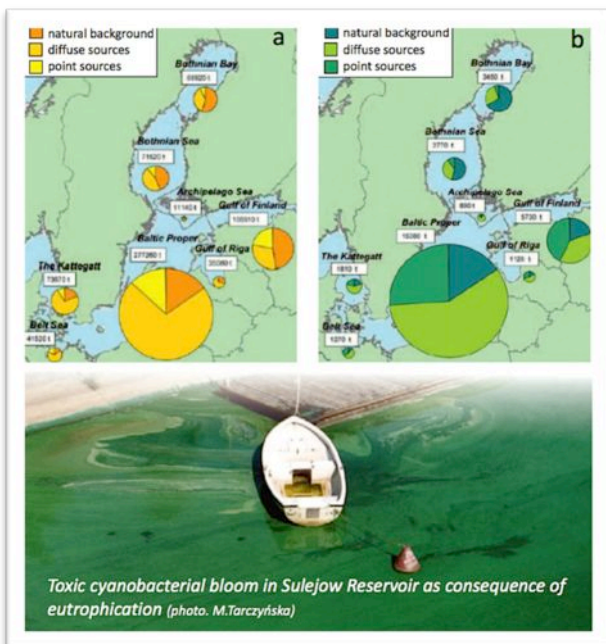
The European Regional Centre of Ecohydrology of Polish Academy of Sciences and the Regional Water Management Board in Warsaw invited two members of the DTC to an international conference on 2nd-4th June 2014 in Bronisławów at the Sulejow Reservoir, Poland. Professor Adrian Collins (Rothamsted Research) and a PhD student, Emilie Vrain (University of East Anglia) attended and presented an

overview of the DTC platform and shared knowledge and experience of the process for implementing the DTC project. They gave details of the methodologies used for gathering hydrochemical, biological and socio-economic evidence for impacts of on-farm mitigation measures.

The conference was organised by the LIFE+ project EKOROB (Ecotones for reduction of diffuse pollution, LIFE08 ENV/PL/000519). The project builds upon extensive data collection, implementation of SWAT modelling, development of buffering sites together with enhancement measures, and consultations with stakeholders. The conference was held for members of the multi-stakeholders platform of EKOROB Project which integrates the representatives of national, regional and local authorities, institutions dealing with water resources management, institutions monitoring the environment, advisory bodies in the field of agriculture, and NGOs.

The conference provided an international floor to exchange knowledge about diffuse pollution and its management. Presentations were given concerning the transfer of knowledge into practice, especially for the synthesis on various mitigation measures applied at catchment scale and their efficiency, and ways to develop efficient cooperation with local society during the implementation phase. Partners of the conference from The European Regional Centre of

Ecohydrology spoke of the biotechnologies and system approach for reducing diffuse pollution, whilst researchers from the LIFE + EKOROB project presented results from mitigation measures implemented at the Sulejow Reservoir. A technical trip was arranged at the end of the conference to visit the Sulejów Reservoir demonstration sites. The key management issue addressed was ecological and health hazards resulting from eutrophication of the river-reservoir system and toxic cyanobacterial blooms. One of the sites visited was the Barkowice demonstration site, which is surrounded by agricultural land (<http://en.ekorob.pl/barkowice-zatoka-demo-site>). The nitrate concentrations ( $\sim 100 \text{ mg NO}_3/\text{l}$ ) in the groundwater exceeded the Nitrates Directive ( $>50 \text{ mg NO}_3/\text{l}$ ). The solution being



tested in the area was a denitrification wall as an additional element in the buffer zone. Although it is an artificial structure, such a wall is invisible in the landscape and intensifies the naturally occurring process of denitrification. A denitrification barrier is constructed by digging a trench perpendicular to groundwater flow and mixing a slowly degrading source of organic carbon (most

commonly used in the form of tree bark, wood chips and leaf compost) with soil. The pilot results show that the denitrification wall is about 86% effective.

N.B. - readers interested in this technique might also like to reference the NITRABAR (LIFE project) which reported in 2009. There is a layman's report at:

[http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=file&fil=LIFE05\\_ENV\\_UK\\_000137\\_LAYMAN.pdf](http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=file&fil=LIFE05_ENV_UK_000137_LAYMAN.pdf)

Novel approaches to help reduce pollution from agriculture are being investigated by other European countries: the use of woodchips or iron coated sand to act as a filter surrounding tile drains for the removal of nutrients in the Netherlands (<http://www.deltares.nl/en/expertise/100807/water-and-soil-quality/1478666>); the use of filter fences for erosion control in the aftermath of potatoes on sloping land in Eastern Scotland; and the use of protection zones and land management to restore nitrate contaminated groundwater on the Island of Tuno, Denmark. A representative from the Western Vansjo project ([www.bioforsk.no/vestrevansjo](http://www.bioforsk.no/vestrevansjo)) in Norway described research on the effectiveness of various mitigation measures to reduce phosphorus losses from agricultural areas, such as reducing P fertilisation to crops, constructed wetlands and cover crops. Farmers were offered financial support and advice to sign a 3-year contract (tailored to each farm) with restrictions on their farming practices. Behavioural change was observed, with the most noticeable shift moving from autumn ploughing to spring tillage.

Excellent relationships were formed between the DTC representatives and the host research institute, as well as with the other international speakers. Attending such conferences provided DTC with the opportunity to proudly demonstrate its achievements and to share knowledge that has been gained through the project. Attendance also allowed a young researcher to present useful findings from her PhD, emphasising the benefits of such a research platform for enabling students to develop themselves and progress within research. **Contact: Emile Vrain – [e.vrain@uea.ac.uk](mailto:e.vrain@uea.ac.uk)**

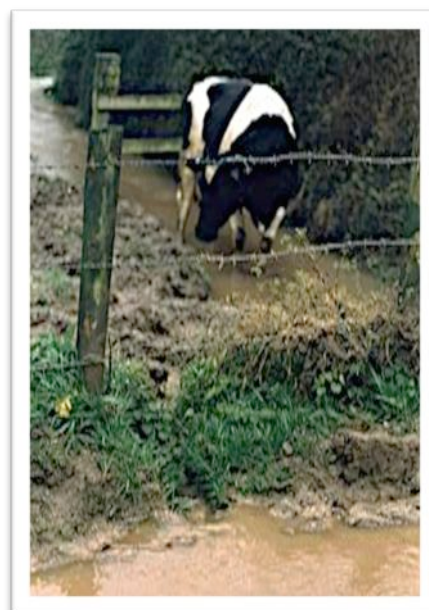
### **New Avon DTC and CSF partnership project**

The Avon DTC will soon begin a partnership project with CSF to identify phosphorus mitigation measures for reducing diffuse water pollution from agriculture (DWPA) to help move towards meeting the phosphorus targets for the River Avon Site of Special Scientific Interest (SSSI) in Pewsey Vale (the Upavon East and West CSF target areas). This work will involve engagement with ~70 farms. A workshop will be used to gain feedback from farmers on the practicality and acceptability of P mitigation measures, followed by some scenario analyses to assess the technically feasible impact of those measures selected by the farmers. A second workshop will be delivered to discuss the scenario analysis with the local farming community.

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## DTC and Greenhouse Gas Data Archive – what will it do?

The archive is more than just a database – rather it is a system designed in accordance with principles developed by libraries and institutions that have expertise in the curation and management of information over the long term. The archive assembles data sets in “self describing” formats that are designed to be robust and persistent even after the original hardware/software systems that hold them have become obsolete.

The archive has been designed to ingest data in relatively aggregated chunks that are consistent with the purpose of the experiments or activities they were originally collected from (this minimises burden on data providers). Data must be provided in CSV format, but ancillary information such as spreadsheets, word documents, PDFs, movies and images can also be uploaded. Chunks of data must be described via metadata to allow 3<sup>rd</sup> parties to understand what the data set contains, how it was collected, and what time period and geographic region the data relates to.

**Data** is retrievable from the archive at the original level of aggregation that it was supplied in (i.e. what goes in will come out). However, the archive has been designed to facilitate retrieval of **information** in more interesting ways via intelligent queries that can combine multiple data sets in novel ways; this includes retrieving data for subsets of the original spatial and temporal extent of the data set. The intelligent restructuring of data is made possible via the use of “linked data” architecture. The data archive will be fully compliant with the requirements of the INSPIRE directive and will be linkable with EU and international data sets via the “Link Data” architecture.

So far the archive developers have produced a data ingestion system that can pull in CSV files and ancillary information. At present the archive is available in demo form on the developer system at the Freshwater Biological Association (FBA) but it will shortly be made available online in response to feedback from data suppliers.

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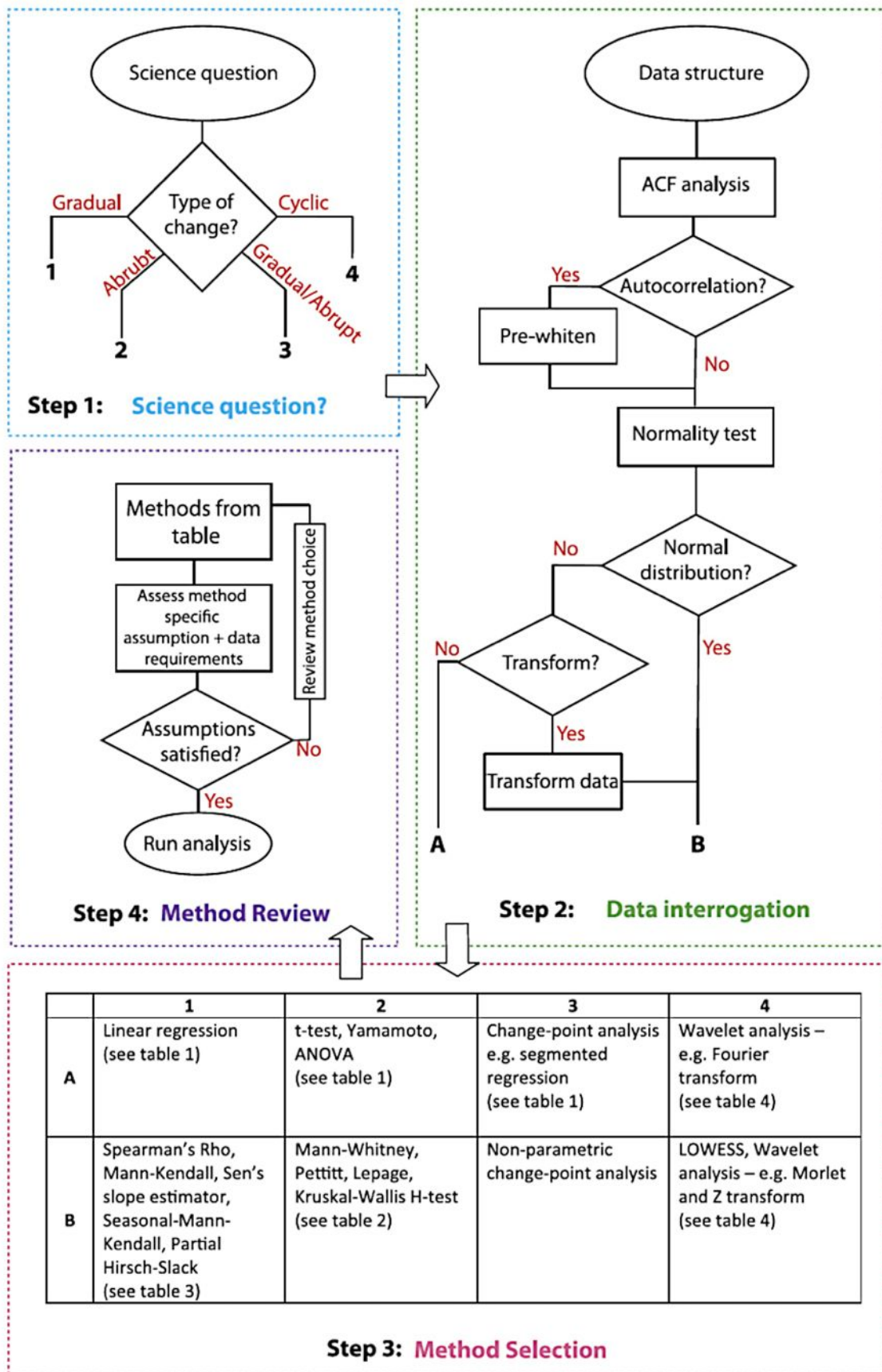
## New Paper from DTC

A paper from Charlotte Lloyd and the Avon DTC team was published online in April in the Journal of Hydrology. Entitled: “*Methods for detecting change in hydrochemical time series in response to targeted pollution mitigation in river catchments*” by C.E.M. Lloyd, J.E. Freer, A.L. Collins, P.J. Johnes and J.I. Jones, the paper discusses the data issues that must be considered when analysing hydrochemical data sets, including non-normality and non-stationarity. A range of statistical techniques is assessed which could be used to detect gradual or abrupt changes in hydrochemistry, including parametric, non-parametric and signal decomposition methods.

The statistical power of these techniques as well as their suitability for identifying change is discussed. Using DTC datasets the efficacy and robustness of change detection methods for hydrochemical data series is analysed. A conceptual framework (see diagram below) for choosing a change detection method is proposed, based on the analysis, in order to raise awareness of the types of questions a researcher should consider in order to perform robust statistical analyses for informing river catchment management and policy support decisions.

The paper is available online at: <http://dx.doi.org/10.1016/j.jhydrol.2014.04.036>

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### How accurately can we quantify nutrient loads using high-resolution data?

The introduction of in-situ quasi-continuous monitoring of water quality as part of the DTC platform provides the means to improve the characterisation of pollutant behaviour and gain new and more robust understanding of hydrological and biogeochemical flux behaviours in catchments. Here we analyse a suite of high temporal resolution data sets generated from in-situ



sensor networks within an uncertainty framework to provide robust estimates of nutrient fluxes from catchments impacted by intensive agricultural production practices.

Previous research into nutrient flux estimation has focused on assessing the uncertainty associated with the use of different load models to interpolate or extrapolate nutrient data where daily or sub-daily discharge data are generally available and used with lower resolution nutrient concentrations. In such studies examples of datasets where paired discharge and nutrient concentrations are available are used as a benchmark of 'truth' against which the other data models or sample resolutions are tested. This work carried out as part of the Avon DTC team illustrates that even given high temporal-resolution paired datasets, where no load model is necessary, there will still be significant uncertainties and therefore demonstrates the importance of analysing such data within an uncertainty framework to obtain robust estimates of catchment nutrient loads.

This study used 15-minute resolution paired velocity and stage height data, in order to calculate river discharge, along with high temporal resolution (15 or 30 minute) nutrient data from four field sites collected as part of the Hampshire Avon Demonstration Test Catchment project between 2011 and 2013. The high-resolution velocity and stage height data illustrate seasonal channel dynamics and highlight why the use of a single stage-discharge curve for discharge estimation is often inappropriate in small headwater research catchments where such mitigation experiments are often conducted. An example of the seasonal variability in the relationship between stage and discharge in Brixton Deverill sub-catchment is shown in Figure 1.

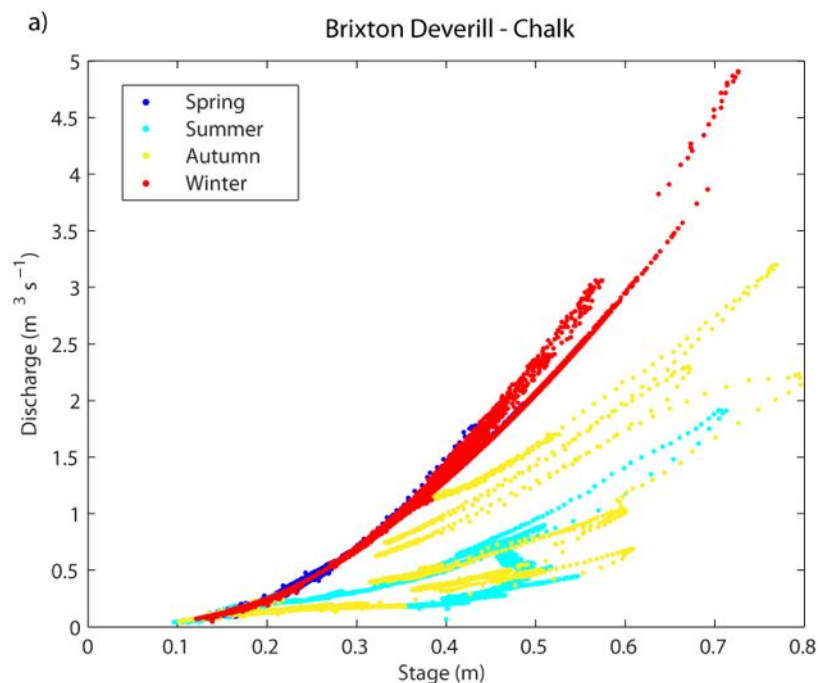
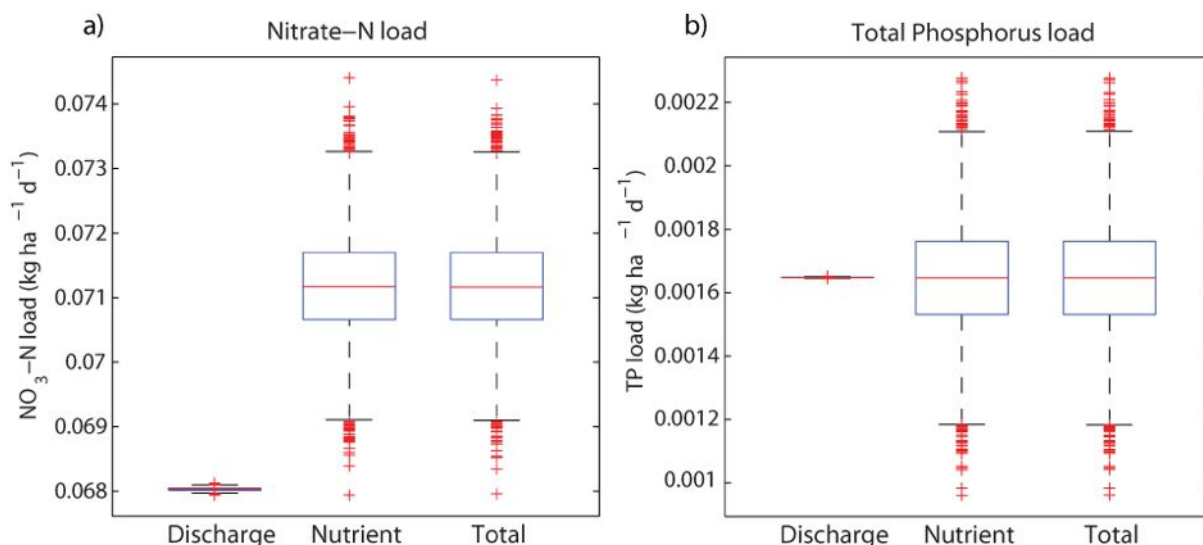


Figure 1: Plot showing paired stage-discharge measurements for the Brixton Deverill sub-catchment, split by season.

This ongoing work quantifies the uncertainty in both the discharge and the nutrient data sets due to measurement error estimated by short time-scale variability. These data are then used to assess the impact of the uncertainty on the estimation of nutrient fluxes. Figure 2 shows the range of load estimates gained from 10,000 iterations of the discharge and nutrient time series including modelled errors. The boxplots show that in the case of Brixton Deverill, the main source of uncertainty is derived from the in-situ sensor data. Uncertainty in the discharge data did also exist

but it was low in comparison with the monitored clay sites in the Avon DTC. This contrast is likely to be because of the lower quantities of suspended sediment in the chalk stream which allows more robust measurements of velocity by the in-situ probes. In some circumstances, however, the very low sediment concentrations in chalk streams can also prove problematic for the discharge gauging.



**Figure 2:** Boxplots showing range of load estimates from sensor data collected at Brixton Deverill, when discharge uncertainty, nutrient uncertainty and both (total) are accounted for.

The above results highlight the importance of acknowledging uncertainty in all data parameters, even when using paired high temporal resolution datasets if a robust estimate of the range of potential nutrient fluxes from catchments is to be gained.

This work was presented at the European Geosciences Union conference in Vienna at the end of April 2014.

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**2nd International  
Interdisciplinary Conference  
on Land Use And Water  
Quality:**



International Interdisciplinary Conference on  
**Land Use and Water Quality**  
Agricultural Production and the Environment  
Vienna, Austria, 21-24 September 2015

**Agricultural Production and the Environment - Vienna, Austria, 21-24 September 2015**

**Abstract Submission:**

Abstract submission will be possible by end September 2014, abstracts are due by 1 February 2015.

More information is on <http://web.natur.cuni.cz/luwq2015/>

**Jointly convened by**

Universität für Bodenkultur Wien (BOKU), University of Natural Resources and Life Sciences, Institute of Hydraulics and Rural Water Management (IHLW), Vienna, Austria (principle organizer); RIVM National Institute for Public Health and the Environment, Centre for Environmental Quality, Bilthoven, the Netherlands; Department of Bioscience - Freshwater Ecology, University of Århus, Silkeborg, Denmark  
Umweltbundesamt, Environment Agency Austria, Vienna, Austria; Umweltbundesamt (UBA), Federal Environment Agency, Dessau, Germany; Faculty of Science, Charles University, Prague

## Objectives

This conference aims to discuss the entire policy cycle for water quality improvement. This cycle includes problem recognition, formulation of technical options, the process of policy development, interaction with policy makers, stakeholders and pressure groups, policy implementation, monitoring and research. This conference also aims to intensify contacts, on the one hand, between scientists with a background in natural sciences and scientists with a background in social and economic sciences and, on the other hand, between scientists, water managers and policy makers. In short, the objectives are:

- to provide a forum for the exchange of scientific knowledge, research on system knowledge, modelling and uncertainty;
- to discuss the entire policy cycle for water quality improvement;
- to intensify contacts (a) between soil/water related scientists, agro related scientists, social scientists, ecological scientists and economists, and (b) between scientists, water managers and policy makers.

## Target groups and keywords

Target groups are scientists, managers and policy makers involved in the policy cycle for water quality improvement. It includes activities characterised by the following keywords: agronomy, agro-economics, agro-sociology, water management, water policy, hydrology, aquatic ecosystems, terrestrial ecosystems, unsaturated zone, groundwater, surface waters, drinking water, monitoring, modelling, water quality, nutrients, pesticides and other organic agrochemicals, heavy metals.

## Scientific Advisory Committee

Marco Acutis (Italy), Marianne Bechmann (Norway), Gitte Blicher-Mathiesen (Denmark), Hans Peter Broers (The Netherlands), Patricia Chambers (Canada), Frank Coale (USA), Ralf Eppinger (Belgium), Chantal Gascuel-Oudou (France), Johannes Grath (Austria), Thomas Harter (USA), Claudia Heidecke (Germany), Henriette Hossy (Denmark), Nicholas Howden (United Kingdom), Gunnar Lischeid (Germany), Daniel McGonigle (United Kingdom), Bob Middleton (United Kingdom), Miquel Quemada (Spain), Pavel Rosendorf (Czech Republic), Jaap Schröder (The Netherlands), István Sisák (Hungary), Roland Stenger (New Zealand), Peter Strauss (Austria), Lærke Thorling (Denmark), Esther Wattel-Koekkoek (The Netherlands), Frank Wendland (Germany), Rüdiger Wolter (Germany)

## Conference Themes

Contributions are solicited according to the following themes, themes A through G.

**A. Increasing system knowledge:** research to increase understanding and improving modelling of the hydro(geo)logical, geochemical and biochemical reality

**B. Impact of climate change and hydrological/weather variability:** assessment of effect on groundwater and surface water quality and distinguishing from manmade effects

**C. Assessment of national policy:** effectiveness of programmes of measures on water quality on a regional and national scale

**D. Field research and data interpretation:** research (monitoring and modelling) at plot and field scale for quantifying effects of farming practices and changes in land use

**E. Managing protected areas:** risk assessment monitoring and modelling of water quality and quantity, for drinking water supply and ecosystem conservation within Habitat and Species Protection Areas

**F and G. Decision-making and implementation:** role of policy, stakeholder and science in decision-making, and social and economic incentives and constraints for implementation (carrots and sticks)

For TOPICS relevant within these themes we refer to <http://web.natur.cuni.cz/luwq2015/index.php?id=2>.

**Further Information:** feel free to contact the Organizing Committee:

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## Update on DTC

DTC Consortia are in the process of submitting a proposal to Defra for Phase 2 of the project that will take it up to 2017. At the same time Consortia are assembling a report on Phase 1 of the project (2010-2014), which will be available in the autumn. Monitoring continues in this interim phase but, apart from the measures work, other field activities have been somewhat reduced until new contracts are let. However, the DTC community has been busy exploring potential collaborations with other partners, in industry and elsewhere, utilising the DTC platforms to accelerate new projects (e.g. the Avon/CSF partnership project mentioned above).