

# Paradigm shifts

Professor Keith Beven and Professor Phil Haygarth discuss the Catchment Change Network, which concentrates on developing a network to aid the exchange of knowledge and change the way scientists look at uncertainties within catchment management – work which may prove to have global relevance



Could you begin by outlining the primary responsibilities and objectives of the Catchment Change Network (CCN)?

**KB:** The Catchment Change Network is a NERC-funded Knowledge Exchange Network developing guidance on how to incorporate risk and uncertainty into catchment change. There are three focus areas within the project: flood risk led by myself, diffuse pollution led by Professor Phil Haygarth and water scarcity led by Professor Enda O'Connell. Uncertainty is particularly important in trying to project the impacts of future land use and climate change onto these focus areas. The visualisation and communication of this uncertainty is an important facet of decision making, so a key aim of the project is to produce Guidelines for Good Practice as a means of formulating and recording the qualitative assumptions that might be necessary in each of the three focus areas.

What are the most common methodologies for predicting the response of a catchment to future change? Are new tools and approaches required due to climate change, increased urbanisation and changing land use?

**KB:** The prediction of future change is generally based on computer models of different types, but these are difficult problems. An important issue in these modelling studies is how to reflect uncertainties that result from

lack of knowledge about current and future conditions in addition to those that result from natural random variability. Random variability can be readily represented in terms of probabilities, but the probabilities associated with different types of knowledge uncertainty are difficult to assess other than in some qualitative way that should be discussed and recorded as part of the communication process.

**PH:** In the area of water quality and diffuse pollution there are some exciting changes taking place in terms of nationally promoting integrated working, through the Defra Demonstration Test Catchments (DTCs) and the NERC pilot Environmental Virtual Observatory. Although both these initiatives are technically 'outside' our project, there are considerable strategic overlaps.

The CCN is comprised of a broad range of scientists and practitioners. How important is the range of disciplines to the development of future proof strategies?

**KB:** The Guidelines for Good Practice in CCN have always been envisaged as a mechanism for involving a wide range of stakeholders in looking at catchment change. The concept is that the decisions to be made in any analysis need to be agreed between the modeller or analyst and other practitioners and stakeholders involved in the process. This serves two purposes: one, to generate engagement from the stakeholders to the process; the other, to aid communication about the assumptions that need to be made to the stakeholders.

**PH:** Innovations are made by the scientists, but impact and change is only made through different and important layers in governance, from scientists, to farmers, catchment managers, and local policy planners (such as the Environment Agency, Natural England) through to Defra. What

is so critical, and of particular relevance to the water quality diffuse pollution focus area, is the joining up and communication across these 'layers'. Some of our guidelines are working towards this.

The CCN Conference 2011: 'Guidelines for Good Practice as a way of encouraging stakeholder involvement across catchment management' took place in July. What were the key outcomes?

**KB:** Foremost, it provided an excellent set of talks and discussions which may be found at our website. Many discussions concerned how best to involve stakeholders in the assessment of change. The issue is common to all the focus areas of CCN. They are even incorporated into practice in the form of the EU Water Framework and Floods Directives. One outcome therefore is to consider whether it might be possible to produce a Guideline for Good Practice document for stakeholder involvement and the participatory process that would be relevant across the CCN focus areas.

Should a greater effort be made to raise public awareness of future catchment issues? Would this aid the implementation of future strategies?

**PH:** Certainly. We believe that the main obstacle to improving catchment management, particularly water quality, is that there is a lack of awareness and ownership in the wider public. We believe that there needs to be a concerted and coordinated campaign to increase the awareness of these issues nationally.

# Known unknowns

While scope for environmental studies and their associated sciences has increased, there is still a great deal of uncertainty left unacknowledged. The **Catchment Change Network** intends to change this

**THE STUDY OF** our natural environment has grown in importance over the years to become one of the leading causes for scientific discourse. As our understanding grows, predicting future natural events remains an uncertain science. Even in today's technology-driven age, experts cannot make fully informed environmental estimates without high degrees of uncertainty. In catchment management, which approaches sustainable resource management from a catchment perspective, these uncertainties are exacerbated by the added potential complexities of future climate change, societal change and technical innovation. The EU Water Framework Directive poses a great many questions to catchment scientists, such as whether climate change or land use change will have a greater effect on sustainability or how we might estimate long-term floods given the little information that is readily available.

The visualisation and communication of uncertainties not only offers significant benefit in terms of how we impact our living environment, but also carries serious economic benefit. Better preparation offers greater environmental security to any nation that might be affected by water scarcity, flood risk or other related disasters.

## LOOKING AT THE LARGER ISSUE

The majority of environmental decision making is based on best estimates of future scenarios. In the UK there are many studies that look at potential changes, but they rarely take every issue

into account. The 2009 UK Climate Projections study (UKCP09), for instance, utilised regional climate models to bring attention to some of the uncertainties we face in future climate change. However, by concentrating only on regional climate models, the study could only go so far in identifying any potential problems in dealing with future climate.

This lack of acknowledgement when it comes to uncertainty is common in natural environment sciences, even when a better appreciation could

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help us deal more effectively with unforeseen disasters. Recognising this requirement, faculty members at the University of Lancaster set up the Catchment Change Network (CCN).

Supported by the Natural Environment Research Council (NERC), the CCN has grown as a network to enable the exchange of knowledge between the NERC research base and the science user community in catchment management. The

network's web of knowledge concentrates on the understanding and mitigation of three main foci: water scarcity, flood risk and diffuse pollution management. For each of these focus areas, the CCN branches out into three teams, each comprising of two lead researchers and core science users. A Focus Area Team for each catchment management area allows for a greater distribution of knowledge and findings to a broad range of users.

## SHOWING THE WAY

One of the main objectives of the CCN is to develop and produce guidelines for good practice that will help stakeholders take uncertainty and risk into account in each of these focus areas. The guidelines are intended to act as a framework to support environmental assumptions and to provide an audit trail for future evaluations and catchment revisions.

These guidelines assist stakeholders at the management and policy levels of public and private sectors to explore the many types of uncertainty that can exist in environmental prediction. One way to reach a more accurate prediction, the CCN shows, is to run a host of different models that appear realistic within the parameters of the catchment. Studies can use varied input scenarios, model structures and parameter sets among other things: "The degree to which this is possible depends on the complexity of the models involved, but as computer power increases, the range of models to which such an approach is feasible is

increasing,” explains Keith Beven, Professor of Hydrology at the University of Lancaster.

## COLLABORATIVE DISCUSSION

The CCN orchestrates many focus area workshops that are open for all network collaborators to attend. In addition, the CCN is working together with the N8 Research Partnership (which represents the eight most research active universities in the North of England) to support a trilogy of debates over 2011. These debates have been designed to highlight current outstanding issues on catchment management and begin to identify ways forward.

The CCN and N8 Research Partnership embrace new technology uses, especially in their workshop development: “Rather than taking a traditional workshop format, these were very much participative and interactive sessions led by a panel with a large online audience,” explains Beven.

The partnership has already hosted two debates, one concentrating on soil carbon sequestration and the other on the value of the environment beyond economics. The debates were streamed live as interactive forums and proved to be a great success. The third debate, which focused on the relationship between water and food security, followed in September 2011. Beven hopes that these debates will help to inspire a change in the way policy is currently created, leading to a positive and coherent approach to strategy.

The CCN also runs an annual conference, developed by each Focus Area Team and attended by delegates from institutions around the UK. In 2010, the conference, held in Lancaster University, concentrated on exploring the different challenges and opportunities for research that could fill current gaps in uncertainty-related catchment research. The 2011 CCN conference, held in July at the Arup Campus in Solihull, looked forward with catchment management acknowledging that, in

order to progress, it would need to rely heavily on multi-stakeholder collaboration. The conference was designed to discuss possible ways in which the CCN's Guidelines for Good Practice could represent a useful tool to encourage more stakeholder participation across catchments. The 2011 conference gave attendants the opportunity to discover what a range of organisations and initiatives had been doing to optimise success under the CCN umbrella.

## WIDENING OUTREACH

In addition to knowledge exchange-based activities, the network runs training for private and public sector organisations and orchestrates many collaborative publications on everything from the uncertainties and good practice in hydrological prediction to risk-based water resource planning.

With its work distributed through a dedicated website, one of the CCN's objectives is to better bridge the gap between scientists and science users with the eventual aim of creating an autonomous platform for education and research based opportunities. The network looks to evolve over time, becoming more self-sufficient as it deals with more user-defined topics, thus continuing long after its NERC support ceases.

As a Knowledge Exchange Network, working alongside practitioners has been vital to the success of the network. It has also given the team great amounts of insight as to what industry users expect. An important objective for the CCN in 2012 is to work in partnership in delivery of the NERC Water Security KE Programme.

While the network's focus has remained on areas throughout the UK, Beven believes that the work he and his team have been completing 'from cloud to coast' could successfully transfer to almost any part of the world. Their next objective will be to determine how findings can act as a pilot for a more international model in the future.

## INTELLIGENCE

### CCN

#### CATCHMENT CHANGE NETWORK

#### OBJECTIVES

To integrate modern uncertainty estimation methods linking risk and uncertainty with a move towards adaptive management at the catchment scale.

#### PARTNERS

Lancaster University, UK (Coordinator)  
• Atkins, UK • Cascade Consulting, UK •  
The Chartered Institution of Water and  
Environmental Management, UK • Durham  
University, UK • Environment Agency, UK  
• JBA Consulting • Natural Environment  
Research Council, UK • Newcastle  
University, UK • Northumbrian Water, UK  
• Ofwat, UK • The Royal Town Planning  
Institute, UK • United Utilities, UK •  
University of Leeds, UK

#### FUNDING

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**PROFESSOR KEITH BEVEN** is a Distinguished Professor of Hydrology at Lancaster University. His research interests include modelling flow and transport processes in catchments, modelling the impacts of climate and land management on flood runoff and flood frequency, and estimation of prediction uncertainties.

**PROFESSOR PHIL HAYGARTH** is a Professor of Soil and Water Science and Director at the Centre for Sustainable Water Management at Lancaster University. His research is centred on understanding the key physical and chemical processes that link soils with water across catchments. This work supports and informs new models that have policy relevance for national and global water management.



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