

Water Security Knowledge Exchange Programme

Specific Priority Subject Workshop

Sub Area 2: Increased Resilience to Extreme Events

2.1: Improving flood prediction, communication and impact assessment

Wednesday 4 April 2012

**Wren Suite, Royal Institute of British Architects,
66 Portland Place, London, W1B 1AD**

The workshop aims to:

- Increase awareness and uptake of research outputs in the water security area
- Identify user needs and potential future research projects
- Strengthen research/user group collaboration and network

Outline Agenda

09:30 **Registration and refreshments**

10:00 **Session 1:**

Setting the scene and making connections

- Introduction: Graham Leeks, Programme Manager, Changing Water Cycle and Storm Risk
- Opportunity to connect with others in the room

Towards a shared understanding of the Priority Subject Area

- Introduction: Lisa Stewart, FEH Team Leader, CEH Wallingford
- Discussion

11:30 **Break**

11:40 **Session 2:**

Making the most of current research activity

- Introduction: Thomas Kjeldsen, Senior Hydrologist, CEH Wallingford
- Open platform for delegates to add information
- Opportunity for researchers/users to learn more/make new connections

See the listing *Current Research Activity*

12:50 **Buffet lunch**

13:30 **Session 3:**

Identify areas for future research activity/collaborations

- Introduction: Neil Runnalls, WSKEP Programme Development Manager, CEH Wallingford
- Identify potential new research areas
- Opportunity to build new research/user collaborations

See the listing *Available Funding for Future Research*

14:40 **Break**

14:50 **Session 4:**

Alliances, networks and next steps

- Introduction: Carolyn Roberts, Director ESKTN, University of Oxford
- How can alliances/networks be improved?
- Key issues and recommendations for Water Security 3-year programme
- Agree next steps and session evaluation

See the listing *Alliances, Networks and Next Steps*

16:00 **Close**

Delegate List

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Session 1:

Setting the scene and making connections

Water Security Knowledge Exchange Programme

Graham Leeks

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The purpose of the NERC Knowledge Exchange Programmes

NERC-funded research produces knowledge, expertise and skills that can provide significant benefits for the environment, for the economy and for the general well-being of society.

Knowledge exchange (KE) plays an important role in delivering these benefits.

The overarching purpose of the KE programmes is to accelerate the uptake of research and help inform the direction of future science. They will do this by conducting and coordinating a range of KE activities which:

Effectively bring together the NERC-funded research community across all Research Centres and Higher Education Institutes that deliver science in the relevant programme area, and build on their strengths and multidisciplinary capabilities.

Proactively engage current and potential users of NERC-funded research, particularly in business, but also among policy-makers, regulators and NGOs.

Systematically identify the key needs and science challenges faced by end-users.

Stimulate the exchange of knowledge, the flow of people and the creation of projects and partnerships that address the needs and capitalise on the opportunities these present.

In particular, the KE programmes will focus on specific areas where NERC's investments have produced considerable scientific strengths that meet key business, policy and societal needs.

The KE Programmes areas of activity

NERC has set up five KE Programmes on the following areas:

- Water Security
- Marine Renewable Energy
- Environmental Management for Food and Agriculture
- Resource Management
- Financial Services risk management and valuation

The Water Security and Marine Renewable Energy Programmes started in April 2011. The other three are in the planning process and due to start in April 2012.

Connectivity with NERC Water Research

Science funded by NERC includes many research teams in universities and research centres. These have undertaken a wide range of research programmes including:

- BESS - Biodiversity and Ecosystem Sustainability Programme
- CWC - Changing Water Cycle Programme
- ESPA - Ecosystem Services and Poverty Alleviation Programme
- FREE - Flood Risk from Extreme Events Programme
- LOCAR - Lowland Catchment Research Programme
- LWEC - Living With Environmental Change Directorate
- Macronutrient Cycles Programme
- RELU - Rural Economy and Land Use Programme
- Storm Risk Mitigation through Improved Prediction & Impact Modelling
- VO - Virtual Observatory

Overall aims of the Water Security Knowledge Exchange Programme

The programme will establish a community of researchers and science users to develop networks for effective knowledge exchange. It will:

- Work with policy-makers, industry and civil society organisations to identify priority areas for accelerating knowledge exchange activities.
- Offer a first point of contact for information about water security related research.
- Facilitate a range of knowledge exchange events, bringing together key researchers and users.
- Help users communicate their needs to shape the development of new NERC research programmes.

The five Sub Areas of the Water Security Knowledge Exchange Programme

The programme has been structured into five sub-area as outlined below. The first three have been selected to form the focus of activity during the first 18 months of the Water Security Knowledge Exchange Programme. The remaining two Sub Areas will be addressed during the second eighteen month cycle of the programme, subject to reassessment of user needs and review of the first cycle.

1. Integrated Water management

The sustainable management of water resources at a catchment scale. This priority area concentrates on integrating an understanding of ecosystems with land and water management techniques to improve the management of water resources within a catchment, encompassing both rural and urban areas.

2. Increased resilience to Extreme Events

The prediction and mitigation of extreme events, with a focus on information management and coordination to increase resilience to events as they occur. This priority area will link with the LWEC Flooding Strategy which is currently being drafted.

3. Ensuring Water Resource Security

Water security is focused on preventing a gap between supply and demand. The threat of climate change may make this problematic and it will be essential for businesses, investors, regulators and government agencies to understand their water-related vulnerability, and the value of water-related ecosystem services. Understanding these factors is vital to protect both the environment and our economy. It is important to develop more accurate data about the services that water provides and the risks that it poses, and to transform this data into practical tools for stakeholders to use.

4. Coordination of Water Data

The focus of this area of impact is to support the coordination of global water data. Because of the complexities associated with managing water quality and supply across the world it is imperative that high-quality data is accessible to businesses, policy-makers and the public.

5. Sources, behaviour and control of persistent and emerging environmental contaminants

Pollution from industry, households and agriculture is widespread in the environment. The multiplicity of sources and of pollutants makes this difficult to control and to legislate against. On the other hand, waste has to be dealt with in a way which protects environmental and human health and potentially provides benefits.

Specific Priority subjects

During the first eighteen months of the programme, WSKEP will undertake smart KE activities directed at nine Specific Priority Subjects from the top three Sub Areas. The subjects were identified at the launch of the Water Security Knowledge Exchange Programme as being particular interest to users and researchers alike.

The Specific Priority Subjects are listed below:

Sub Area 1.

Integrated Water Management

The sustainable management of water resources at different spatial scales. This priority area concentrates on integrating an understanding of ecosystems with land and water management techniques to improve the management of water resources encompassing both rural and urban areas.

Specific Priority Subject 1.1:

Assessing upstream methods of land/water management that improve water quality and quantity

The management of agricultural land influences the quality and quantity of water in rivers and streams. As such, the objective of gaining 'good' status under the WFD can potentially be achieved through changes in land management and land use. This is especially relevant with respect to controlling nutrient pollution. Are there land management schemes that can provide concurrent improvement in both water quantity and quality downstream? Can we identify which land management options have effective impacts on water quantity and quality?

Specific Priority Subject 1.2:

Understanding and managing the impacts of climate change on the ecology of catchments

The ecology of waterbodies is crucial in determining their status within the WFD. Ecological status reflects water quantity and quality, both of which are likely to be impacted by future climate change through, for example, changing flow regime and macro-nutrient cycling. Climate change will be a key consideration in the next phase of River Basin Planning under the WFD. Is there a sufficient knowledge base available on which to base management options with a view to adaptation and mitigation? What is the implication of climate change on the WFD?

Specific Priority Subject 1.3:

Linking natural networks and communities across rural and urban systems

Many major towns/cities lie on, or are at the mouth of, rivers and yet our understanding of the connectivity between the urban centre and the rural catchment is weak. Is there an opportunity to make more use of nature, through understanding ecosystem services, for sustainable water management rather than relying on 'infrastructure'? Are there opportunities in understanding the importance of catchments as networks of interlinked communities?

Sub Area 2.

Increased Resilience to Extreme Events

The prediction and mitigation of extreme events, with a focus on information management and coordination to increase resilience to events as they occur. This Sub Area will link with the LWEC Flooding Strategy which is currently being drafted.

Specific Priority Subject 2.1:

Improving flood prediction, communication and impact assessment

Flooding leads to substantial costs to people and to the economy through impacts on a wide range of commercial sectors. There have been significant advances in flood risk estimation and in flood forecasting but flooding remains a prominent natural hazard. What work is now required to reduce uncertainties in flood prediction and risk assessment? Are the human and environmental impacts adequately understood?

Specific Priority Subject 2.2:

Improving drought prediction, communication and impact assessment

Droughts tend to be regional in extent and so have widespread human health, environmental and commercial consequences. Although droughts build up slowly their prediction is difficult and uncertainties are large. What work is now required to reduce uncertainties in drought prediction and risk assessment? Are the human and environmental impacts adequately understood?

Specific Priority Subject 2.3:

Supporting sustainable and resilient management of droughts

Even with improved prediction of droughts, managing these extreme events to minimise human and financial losses is a major challenge. Are there opportunities to make more use of water transfers?

Specific Priority Subject 2.4:

Supporting sustainable and resilient management of extreme rainfall

Even with improved prediction of floods, managing these extreme events to minimise human and financial losses is a major challenge. Are there opportunities to make more use of 'natural' flood alleviation measures?

Sub Area 3.

Ensuring Water Resource Security

Water security is focused on preventing a gap between supply and demand. The threat of population growth and climate change may make this problematic and it will be essential for businesses, investors, regulators and government agencies to understand their water-related vulnerability, and the value of water-related ecosystem services. Understanding these factors is vital to protect both the environment and our economy. It is important to develop more accurate data about the services that water provides and the risks that it poses, and to transform this data into practical tools for stakeholders to use.

Specific Priority Subject 3.1: Assessing the value of water

Water is essential to the function of the natural environment, to human life and to businesses. What are the options for establishing the 'value' of water to all sectors, especially to ecosystem services, such that appropriate allocation of the available water resource can be made in space and time?

Specific Priority Subject 3.2: Assessing water-related business risks

Business interests and sectors are impacted by current water related risks, notably droughts and floods. Conversely, the water environment is impacted by the business and commercial sector through pollution and water abstraction. These risks are likely to change in the future as a result of climate change. Are the risks adequately known and quantified? Are we making the most of our data and models to explore future risk related scenarios?

Specific Priority Subject 3.3: Informing decision-making for water resources management

The management of the water environment and of water supply is a complex process undertaken and informed by a wide range of stakeholders. Are there opportunities to establish more 'joined-up' management approaches? Are appropriate models, tools and data available to inform the management process?

Aims and outcomes of the workshop

This workshop aims to:

- Inform the second phase of the programme.
- Increase awareness and uptake of research outputs relevant to water security.
- Identify user needs and potential future research.
- Strengthen research/user group collaboration and networks.

Session 1:

Towards a shared understanding of the research area

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Improving flood prediction, communication and impact assessment

In many parts of the world, major costs are incurred in protection and recovery from floods. Even the most advanced countries can suffer large-scale destruction, loss of life, economic costs and disruption. In the UK, at least 6 million properties are at risk from flooding from a number of sources including rivers, sea, surface water, groundwater or reservoir failure. Over the last few years there have been several major flood events that have caused substantial losses to the UK economy. For example, the devastating floods of summer 2007 cost the country a total of £3.2 billion, including £2 billion to homeowners and businesses (Pitt Review, 2008). Putting this into a global context, there were over 200 major floods worldwide during 2007, affecting 180 million people. The human cost was more than 8,000 deaths and over £40 billion worth of damage. Even so, the floods that devastated England ranked as the most expensive in the world in 2007.

Research within this area has a long history in the UK and can be divided into a number of sub-themes including:

- Flood frequency estimation using both statistical and modelling approaches
- Flood forecasting combining real-time information from weather radar with catchment models
- Groundwater modelling
- Flood mapping
- Joint probability studies e.g. fluvial floods and storm surge
- The effects of flooding on individuals and communities

This research leads to the development and refinement of tools to support engineers, planners, regulators and policy-makers. Information on flood risk areas is also widely used by the insurance industry.

Major challenges within this area include:

- The adoption of a risk-based approach to flood estimation
- The quantification of uncertainties in flood prediction and risk assessment
- The likely impacts of climate change
- The effects of increasing urbanisation

Session 2:

Making the most of current research activity

Introduction

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Current research activity – some recent research projects

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Sub Area 2. Increased Resilience to Extreme Events

Specific Priority Subject 2.1:

Improving flood prediction, communication and impact assessment

A data-driven exploratory study of extreme events based on joint probability analysis

Key Funder: NERC
Type of Project: Research Project
Start Date: 01/10/2007 **End Date:** 31/03/2011
Research Project Contacts: Dr Cecilia Svensson, CEH (csve@ceh.ac.uk), Lisa Stewart, CEH (ejs@ceh.ac.uk)
Website: http://gotw.nerc.ac.uk/list_full.asp?pcode=NE%2FF001037%2F1&classtype=

The aim of this project was to examine records of past moderate and extreme flood events, and of associated environmental variables related to the causes of flooding, and to undertake an exploratory data analysis of these. This would avoid relying immediately on the assumptions built into existing methodology and provide an independent check on these. It would also allow the construction of a statistical methodology tailored both to the observed properties of the datasets and to the estimation of the relevant properties of extreme events that need to be extracted from the data. Joint probability analysis would be one of the main statistical approaches being used. As well as providing useful insight into the occurrence of flooding, this has the potential to lead to more statistically efficient estimation of floods. Further insights into flooding problems will be sought by directly considering the seasonality of flood events in all the analyses. The datasets available can realistically be expected to provide good estimates of floods with return periods of 10-20 years, but the statistical models used can be employed to extrapolate to return periods of 50, 100 or even 1000 years. For such extrapolation the uncertainties inherent in this estimation are likely to be large and an important aim of the project will be to provide a useful assessment of this uncertainty. Hourly datasets already held at CEH were used for the project.

Developing enhanced impact models for integration with next generation NWP and climate outputs

Key Funder: NERC
Type of Project: Research Project
Start Date: 11/10/2010 **End Date:** 30/05/2014
Research Project Contacts: Prof. Paul Bates, University of Bristol
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Current best estimates indicate that approximately 5M people living in 2M properties are at risk of flooding resulting from extreme storms in the UK. Of these approximately 200,000 homes are not protected against a 1 in 75 year recurrence interval event, the Government's minimum recommended level of protection. When major floods do occur then total damage costs are high (£3.5Bn for the summer 2007 floods) and the total annual spending on flood defence approaches £800M. Protecting this population and minimizing these costs into the future requires the development of robust hydrologic and hydraulic models to translate the outputs from Numerical Weather Prediction (NWP) and climate models into meaningful estimates of impact (with uncertainty). These predictions of impact can then be used to plan investment decisions, provide real-time warnings, design flood defence schemes and generally help better manage storm risks and mitigate the effects of dangerous climate change. Building on foundations developed by consortium members as part of the NERC Flood Risk from Extreme Events (FREE) and EPSRC/NERC Flood Risk Management Research Consortium (FRMRC) Programmes, we here propose an integrated programme of research that will lead to step change improvements in our ability to quantify storm impacts over both the short and long term. Based on the knowledge gained in the above programmes, we suggest that improvements in storm impact modelling can be achieved through four linked objectives which we are uniquely positioned to deliver. Specifically, these are: 1. Downscaling, uncertainty propagation and evaluation of hydrologic modelling structures. 2. The development of data assimilation and remote sensing approaches to enhance predictions from storm impact models. 3. Fully dynamically coupled extreme storm surge and fluvial modelling. 4. The development of a new class of hydraulic model that can be used to convert predictions of rainfall-runoff or coastal extreme water levels to estimates of flood extent and depth at the resolution of LiDAR data (~1 - 2m horizontal resolution) over whole city regions using a true momentum-conserving approach. The potential of the above four approaches is evaluated to reduce the uncertainty in ensemble predictions of storm impact given typical errors in the NWP and climate model outputs which are used as boundary forcing for impact modelling chains. Our initial characterization of the errors in predicted storm features (spatial rainfall and wind speed fields) in current implementations of NWP and climate models will be based on existing studies conducted by the UK Met Office and the University of Reading. As the project proceeds we will use the advances in storm modelling being developed for Deliverables 1 and 2 of this call to enhance our error characterizations and ensure that the techniques we develop are appropriate for current and future meteorological modelling technologies. We will rigorously evaluate the success of our proposed methods through the use of unique benchmark data sets of storm impact being developed at the Universities of Bristol and Reading.

Impacts of extreme flooding on physical habitats and flood risk management

Key Funder: NERC
Type of Project: Research Project
Start Date: 10/05/2010 **End Date:** 25/07/2011
Research Project Contacts: Prof. David Sear, University of Southampton (D.Sear@soton.ac.uk), Prof. John Dearing, University of Southampton (J.Dearing@soton.ac.uk) and Prof. Paul Bates, University of Bristol (paul.bates@bristol.ac.uk)
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Destructive river floods, like the ones in Cumbria in late 2009, are important to forecast because of their economic and social impacts, but are also important to understand from the viewpoint of how they create new physical habitats and river channels. Whilst recent reports rightly concentrate on the immediate damaging impacts of extreme flooding, less information is available about the long term impacts of changes in river channel. The latter is important for two reasons. First, large economic costs can often result from changes in flood channel maintenance necessitated by post-flood channel adjustments. Second, and in contrast, there may actually be benefits arising from changes to physical habitats and river channels which may lessen subsequent flood risk. This is accepted within a raft of legislation whereby European (and US) river managers are required to restore and enhance river channels to meet stringent ecological standards. In this sense, our current knowledge of the benefits resulting from extreme flooding is poor. One strand of this research analysed the changes in habitat and channels that were caused by the extreme floods in Cumbria in late 2009. Current river restoration methods are both spatially limited and expensive, but we aim to demonstrate that extreme floods can provide substantial changes in physical habitats and have the potential to deliver channel-scale restoration as demanded by regulators. Extreme floods are forecast to become more frequent under a range of climate and land use scenarios in the UK and elsewhere. But there is a lack of knowledge about the frequency, or return time, of extreme floods because monitored records of river flooding are often relatively short. A second strand of our research therefore takes the opportunity to find the signal of the recent extreme Cumbrian floods in the recent lake sediments accumulating at the bed of lake Bassenthwaite. If the recent flood signal can be clearly established, earlier 20th/21st century floods can be identified in lower sediments and confirmed by flood records. Deeper sediments can then be analysed to provide a regional record of flood frequencies and their sizes over several centuries. From these data, we can then say more about how common extreme floods are when viewed over centuries and whether the floods are becoming more or less common during the major periods of climate change and human activities since the early 20th century. The project collected field data from sites in and downstream of lake Bassenthwaite that were seriously affected by recent flooding in Cumbria. The research will impact directly on assessing appropriate post-flood management of floodplains and channel, and on the strategic assessment of the likelihood of future extreme flooding - both to the benefit of many stakeholders including local residents and farmers, the Environment Agency, DEFRA and a large international academic community.

Is flood risk increasing? Exploring the relationships between atmospheric circulation, extreme rainfall and flooding

Key Funder: NERC
Type of Project: Postdoctoral Fellowship
Start Date: 01/10/2006 **End Date:** 31/03/2011
Research Project Contacts: Dr Hayley Fowler, Newcastle University (h.j.fowler@ncl.ac.uk)
Website: http://gotw.nerc.ac.uk/list_full.asp?pcode=NE%2FD009588%2F1&classtype=

There is now a broad scientific consensus that the global climate is changing in ways that are likely to have a large impact on our society and the natural environment over the coming decades. Global warming, and its impact on extreme weather events, may have a profound influence on the way we live in the future. Recent extreme weather events, such as the unusual number of hurricanes in the US 2005 hurricane season, the unprecedented flooding in central Europe in summer 2002, the tragic loss of life in the European heatwave the following summer, or the severity of flooding in the UK during autumn 2000, have been said to be a possible impact of global warming by the media. This has made us focus our attention on the possible impacts of future climate change on our society. However, how can we predict how future global warming may change the frequency and intensity of extreme weather events and their impacts if we do not understand how current local scale climatic variability is governed by the larger-scale atmosphere and how these processes may change in the future? This fellowship will examine these and other fundamental research questions through collaboration with international experts in the US at the National Center for Atmospheric Research, Europe and through links with the Centre for Ecology and Hydrology and the Environment Agency in the UK. This fellowship will examine the links between large-scale atmospheric circulation patterns, local scale extreme rainfall and their impact on flooding using the UK as a test-bed. The recent government-funded Foresight project suggests that flooding costs the UK £2.2 billion annually; £800 million on flood defence and £1.4 billion average damage. This may rise to somewhere from £2 to £27 billion by the 2080s, depending on how we manage greenhouse gas emissions in the future. Whilst changes through time in UK flooding are reasonably well characterised, changes in the spatial extent and severity of flooding are not. Additionally, we do not understand the atmospheric mechanisms that cause severe rainfall events and thus flooding, how these may be currently changing and how these may further change under global warming. The UK is an ideal location for this study as it has a wealth of hydrological, climatological and meteorological data, and the study will concentrate firstly on an understanding of the climatic processes that contribute to flood risk UK-wide. It used two case studies, the river Ouse in Yorkshire and the river Eden in Cumbria, to look at the more detailed response to climate variability within a river catchment using a hydrological modelling framework. Although the study has a UK focus, the results will be applicable to other parts of the world, through an understanding of the processes that combine to cause flooding. Finally, using this new understanding of the complex atmospheric processes that cause extreme rainfall events and flooding, I will develop a method to investigate the impacts of future climate change on the risk of flooding in the UK. The methodology was developed using the latest regional and global climate model outputs and contributed to the development of a new probabilistic framework for climate change impacts in Europe and new tools that can be used by managers to design flood defence systems that are robust to the impacts of climate change. These will be necessary for the future management of flood risk in UK catchments under climate change; as indicated by the UK government's Department for Environment, Food and Rural Affairs (DEFRA) recent report 'Making Space for Water'.

Land Use Management Effects in Extreme Floods

Key Funder: NERC
Type of Project: Research Project
Start Date: 01/10/2007 **End Date:** 30/11/2010
Research Project Contacts: Prof. Chris Kilsby, (chris.kilsby@ncl.ac.uk) and Prof. Enda O'Connell (p.e.o'connell@ncl.ac.uk) Newcastle University
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It is increasingly recognised in the UK (e.g. Making Space for Water, Defra, 2005), and internationally, that the management of land and water is strongly interdependent, and that integrated management approaches are needed. There are particular issues for floods, where there is evidence that agricultural land management can increase local flood risk, but no evidence-based quantification of downstream impacts at larger scales. If such effects exist, as the local evidence suggests, clearly there is potential for use of land management to mitigate flood risk. The basic scientific question to be addressed in this research is therefore: how do the effects of land use management propagate from the local scale (~ 1 ha, and below) to that of mesoscale catchments (~ 100 km²) and affect extreme floods? If an answer can be found, it will be possible to make useful predictions for the effects of future land use management changes on extreme floods. Such predictions would have wide use, including in preparing catchment flood management plans. Research like this demands high-quality long-term data sets, but there are relatively few data sets available. Modelling is essential to make the best use of the available data and to encapsulate and explore the understanding of the processes involved in the link between changes in land use management and flooding. Unfortunately, our current rainfall/runoff models are simply inadequate for this task, because they cannot adequately represent the underlying complexity associated with the effects of land use management on runoff generation, or the propagation of these effects downstream. The level of activity and interest in understanding and manipulating the link between land use management and flooding is very high, and recent mitigation works and investments in field research have resulted in new unique and important data sets being available to the Investigators: the FRMRC field sites at Pontbren in the upper Severn catchment; the CHASM multi-scale monitoring for the Eden catchment; and the SCAMP large-scale land use management changes currently underway in the Ribble catchment. There are also new relevant developments in modelling, including local-scale runoff generation modelling developed at Imperial College and network routing modelling and information tracking methods developed at Newcastle University. The data and modelling were brought together to tackle the basic scientific question above, within the practical context of predicting the likely effects that given land use management mitigation and adaptation strategies would have in reducing flood risk in the Severn, Eden, and Ribble catchments, for a range of specified extreme flood return periods. The project provided improved scientific understanding of the effects of land use management in extreme floods, and also provided results of the type required by those involved in decision-making, such as consultants and policy makers looking for answers to some of the general questions raised in Defra's Making Space for Water consultation. The results included maps showing the application areas for any management interventions achieving effective downstream hydrograph attenuation, for the present and possible future climates. The project also represents a major contribution to the next generation of whole-catchment continuous simulation modelling, which will help improve its capability and reliability for predicting the effect of land use management change on extreme flooding. The EA/Defra have agreed to fund a parallel programme of experimental research in the upper Ribble (funding £200K), to provide the necessary data for the effects of afforestation and blocking of moorland grips.

Near real-time flood detection in rural and urban areas using high resolution Synthetic Aperture Radar images

Key Funder: NERC
Type of Project: Research Project
Start Date: 01/10/2010 **End Date:** 31/03/2011
Research Project Contacts: Dr David Mason, University of Reading
(d.c.mason@reading.ac.uk)

Website: http://gotw.nerc.ac.uk/list_full.asp?pcode=NE%2FI000658%2F1&classtype=

Flooding is a major hazard in both rural and urban areas worldwide, and has occurred regularly in the UK in recent times. A near real-time flood detection algorithm giving a synoptic overview of the extent of flooding in both urban and rural areas, and capable of working during night-time and day-time even if cloud was present, could be a useful tool for operational flood relief management. The latest generation of very high resolution Synthetic Aperture Radar (SAR) satellites now make such technology a real possibility. The vast majority of a flooded area may be rural rather than urban, but it is important to detect the urban flooding because of the increased risks and costs associated with it. Flood extent can be detected in rural floods using SARs such as ERS and ASAR, but these have too low a resolution (25m) to detect flooded streets in urban areas. However, a number of SARs with spatial resolutions as high as 1m have recently been launched that are capable of detecting urban flooding. They include TerraSAR-X, RADARSAT-2, ALOS PALSAR, and the first three of the COSMO-SkyMed satellites. An important factor making near real-time operation possible is that accurate geo-registration can now be performed rapidly. For example, the images from TerraSAR-X can be made available in geo-registered form to better than one pixel locational accuracy using precise knowledge of the orbit parameters. In the absence of significant wind or rain, river flood-water generally appears dark in a SAR image because the water acts as a specular reflector. A near real-time flood detection algorithm using a split-based automatic thresholding procedure applied to multi-look single-polarisation TerraSAR-X data has been implemented at DLR Oberpfaffenhofen's Centre for Satellite-Based Crisis Information. This searches for water as regions of low SAR backscatter using a region-growing iterated segmentation/classification approach, and requires minimal user intervention. However, the algorithm would require modification to work in urban areas containing radar shadow and layover. In contrast, a semi-automatic algorithm for the detection of floodwater in urban areas using TerraSAR-X has also been developed previously. It uses the DLR SAR End-To-End simulator (SETES) in conjunction with LiDAR data to estimate regions of the image in which water would not be visible due to radar shadow or layover caused by buildings and taller vegetation. The algorithm is aimed at detecting flood extents for calibrating and validating an urban flood inundation model in an offline situation, and requires user interaction at a number of stages. This invariably introduces an element of delay into the production of the final product. The research project revised and combine the existing algorithms to automate the steps requiring manual interaction and to take advantage of the availability of LiDAR data in the urban area, to lead to a near real-time algorithm. This was tested on the TerraSAR-X image of the Tewkesbury 2007 flood.

September 2008 Morpeth Flood addition - Performance of ensemble rainfall forecasts in relation to pluvial flooding impacts

Key Funder: NERC
Type of Project: Case Study
Start Date: 01/04/2010 **End Date:** 30/09/2010
Research Project Contacts: Dr Geoffrey Parkin, Newcastle University,
(geoff.parkin@ncl.ac.uk) and Prof. Chris Kilsby, Newcastle
University (c.g.kilsby@ncl.ac.uk)
Website: http://gotw.nerc.ac.uk/list_full.asp?pcode=NE%2FI002189%2F1&classtype

Following the major floods in 2007, the UK Government commissioned a report (the Pitt Review) which formulated the actions needed to respond to this issue. A key recommendation of the report was the need for 'improved modelling of all forms of flooding'. Most attention so far has been paid to developing computer models of flooding from rivers (fluvial flooding), but a significant percentage of flooding is from rainfall events which lead to localised runoff (pluvial flooding). These flood events are difficult to predict as they are often have local high intensity rainfall (typically associated with convective storms) and runoff in urban areas through subsurface drains as well as overland. A new version of the Met. Office's operational weather forecast model has recently been developed with a high (1.5km) resolution that is capable of representing these local rainfall events more accurately, with the potential to be used to support better predictions of pluvial flooding. This case study aimed to use the outputs from the new model for the case study event of the 6th Sept. 2008 Morpeth flood that affected around 1,000 properties. This case study is particularly valuable, as it is one of the very few events for which the dynamics of the flooding have been measured in detail in a previous project from publicly-sourced information, which has allowed detailed reconstruction of the different sources of flooding for comparison against flood models. The quality of the detailed rainfall data from the 1.5km weather forecast model for the Sept. 2008 Morpeth flood event will be assessed through comparison with raingauge observations and other standard approaches currently used in the UK, including assessment of the uncertainty in the rainfall data. These data will then be fed into hydrological models of runoff from the localised catchment areas, and used to simulate the volumes of water flowing into the town, and how the floodwater reaches the different areas of the floodplain, allowing comparison against the observed flood levels for this event. This case study is the first to use the new weather forecast model rainfall predictions including uncertainty for flood modelling, and will help to support development of flood prediction modelling from pluvial sources across the UK.

Project Foster: Flood Organisation Science and Technology Exchange Research (FREE)

Key Funder: NERC
Type of Project: Knowledge Exchange Project
Start Date: 01/02/2012 **End Date:** 31/03/2012
Research Project Contacts: Prof. Carolyn Roberts, University of Oxford (carolyn.roberts@earth.ox.ac.uk), Dr Matt Reed, University of West of England (mreed@glos.ac.uk) and Prof. Lindsey McEwen, University of West of England (lmcewen@glos.ac.uk)
Website: http://gotw.nerc.ac.uk/list_full.asp?pcode=NE%2FH001786%2F1&classtype=

Science and engineering is crucial to understanding flood risk and will become even more significant as we adapt to the increased risk that climate change will bring.' (Pitt Review 2008, ES.17) The Pitt Review and the subsequent UK Government's Response have identified major areas of challenge in the scientific understanding of floods, for key people in organisations such as local government that are responsible for flood risk policy and management. Most of these professionals are not specialists, and flood management forms only a minor part of their duties; some are elected Councillors at County or District level, volunteers but with key roles. There are also significant questions around effective transference of concepts and information from scientific 'experts' to these organisations, and the potentially productive reverse flow of local knowledge and experience. To fill this critical gap, FOSTER will develop and trial an exciting suite of innovative inquiry-based 'events' involving use of new communication technologies to exchange cutting-edge research findings with the extended community of flood science 'users'. The Project's overarching objective is to improve the flood science understanding of users in key organisations with responsibilities for all aspects of policy and management: planning and building development; emergency planning at Silver and Bronze command level; steering flood adaptation planning; and promoting organisational and community resilience. Gloucestershire, Warwickshire and Worcestershire, with their recent catastrophic flood experiences, will provide the setting for developing and testing. Highly motivated Project Partners, including the Environment Agency, who have flood science capacity-building high on their organisational agendas are involved. The Project also capitalises on team experiences of two recent projects focused on the Severn-Avon catchment, GLIF (a NERC-FREE programme Gloucestershire Scrutiny Inquiry appraisal) and a Royal Society COPUS project, as well as existing scientific knowledge about different types of flooding in the region, and more generally. FOSTER will extend the existing appraisal of scientific knowledge needs amongst 'users' in organisations at local and regional level. In parallel, it will translate cutting-edge scientific knowledge about flooding drawn from recent research projects, and research international good practice in developing public sector institutional understanding of flood science. It will then design and pilot a variety of novel, stimulating, and inquiry-based learning experiences that draw on active learning strategies and capitalise on new technologies. Three distinctive education models will be compared: (a) conventional workshops but with new twists including video resources hosted on 'Facebook' or similar publically-accessible sites; (b) role-play simulation events involving users adopting 'development planning', 'emergency' or 'resilience' roles, supported by ICT information and materials, some techniques training e.g. on interpretation of GIS, followed by discussion and critical reflection; and (c) interaction and learning through immersion in 3D virtual world simulations using 'Second Life' and related technologies such as blogs, podcasts and a Moodle site. Research will evaluate the effectiveness of these different learning strategies and participant experiences in nurturing practical understanding of new flood

science. As outcome, FOSTER will cascade best educational practices and experiences, customisable to different UK and international contexts, and updateable in the light of future scientific research findings on flooding. The dissemination strategy will promote the overall findings and Project legacy - a sustainable on-line, interactive repository of educational materials that can freely be drawn on in future by those organisations with responsibilities for educating non-specialist 'users', and other scientists.

Local flood forecasting capability for fluvial and estuarine floods: Use of GridStix for constraining uncertainty in predictive models

Key Funder: NERC
Type of Project: Research Project
Start Date: 01/10/2007 **End Date:** 31/03/2009
Research Project Contacts: Prof. Keith Beven, Lancaster University
(k.beven@lancaster.ac.uk), Prof. Gordon Blair, Lancaster University (g.blair@lancaster.ac.uk) Dr Woldek Tych, Lancaster University (w.tych@lancaster.ac.uk)
Website: http://gotw.nerc.ac.uk/list_full.asp?pcode=NE%2FE002439%2F1&classtype=

The project aims were to make use of lots of networked GridStix depth sensors to improve predictions of flood inundation and water level elevation at important locations with a view to improving flood warning capabilities. The project involved improving the software that links the sensors and distributed computing resources. This allowed distributed hydraulic routing models to be run, with the possibility of reducing the uncertainty in their predictions by using the sensor information in real-time. Since the GridStix also have on-board computing capabilities there is also a possibility of building a cheap local forecasting system for specific points at risk of flooding. The science questions involved include how best to make the networking robust, how best to constrain the uncertainty in flood routing models and improve their predictions, and how best to implement the local flood forecasting models. The research will be implemented on the River Ribble, subject to regular fluvial flooding, and the tidal system of the River Dee Estuary. The research represents a collaboration between Lancaster and Bristol Universities, the Proudman Oceanographic Laboratory and the Environment Agency.

Session 3:

Available Funding for Future Research

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The following are a list of currently available sources of funding for research, innovation, knowledge exchange and demonstration activities in the general area of freshwater, particularly in regard to NERC's fields of interest of natural sciences. This list includes the entire spectrum of grants – from those supporting very basic fundamental research where there is limited scope for user involvement, to schemes designed to facilitate the transfer of knowledge from the science base into application by end users.

Funding schemes which are continuously open are listed first, while specific on-off Calls focusing on high priority issues are listed from page 6 onwards. Information about all NERC research programmes can be found at: <http://www.nerc.ac.uk/research/programmes/>

Examples of programmes to fund immediate transfer of expertise from the research base to a user (government, industry or NGO) include:

NERC Connect A and B scheme;

NERC KE Fellows;

NERC Policy Placements

Similar schemes to the above are available through the other Research Councils

Technology Strategy Board – Knowledge Transfer Partnership (KTP's)

European Commission DG Environment Life+ Programme

European Commission DG Research – Support to SME's

Very small grants, (generally for field work costs) are available from some charities.

The Water Security KE Programme Secretariat may be able to provide you advice in where to look for research and knowledge transfer funding.

NERC Standard Grants

This is an open competition for curiosity-motivated basic, strategic or applied research.

Grants are for a minimum of £25,000 for directly incurred costs (total of costs under this heading). The primary criterion for assessment is scientific excellence, with all applications subjected to an Initial Review stage that makes decisions on which proposals should proceed to external review. Moderating Panels meet annually in June and December to grade the applications and make recommendations for funding.

Closing Dates: 1st July and 1st December

Eligibility : Research Organisation – Universities, public research organisations

Website: <http://www.nerc.ac.uk/funding/available/researchgrants/typesofaward/standards.asp>

NERC Large Grants

Large Grants are supported through responsive mode funding, but the size and nature of these awards mean that they will often incidentally have a strong strategic element.

The minimum funding level for large grant proposals is £1.2m, 100% (Full Economic Cost). The maximum funding level for large grant proposals is £3.7m, 100% (Full Economic Cost) with a duration of up to five years.

Applicants must first submit an outline proposal that will be assessed by members of the Peer Review College, plus independent experts as required. Selected proposals will then be invited to proceed to the full proposal stage.

Full proposals will be peer reviewed by international experts and the assessment process includes presentations by applicants at the moderating panel.

Closing Dates: The Consortium Grants scheme will in 2012 to operate via one grant round per year rather than two, and an outline stage assessed by members of the Peer Review College will be introduced.

Website: <http://www.nerc.ac.uk/funding/available/researchgrants/typesofaward/large.asp>

NERC Connect A Scheme

The Connect A scheme facilitates and promotes new partnerships between universities and research institutes and public/private sector science users (industry, business, commerce or public sector agencies). The funds are for planning and initiating collaborative research not eligible for funding through other schemes (LINK, KTP, CASE or contract research).

Funds will support two basic types of pump priming activities.

- Proof of concept proposals for a specific research activity relating to ideas emerging from the science base that have potential application but have a high degree of technical risk and perhaps lack a clearly defined end user. Project costs sought should be those eligible under standard NERC research grants.
- Costs for workshops or seminars on a theme both partners are interested in. Participants should be from both communities. Funding can be sought for accommodation, hire of audio-visual equipment, travel costs for speakers/rapporteurs and ancillary costs.

Applications are assessed according to the criteria below; NERC may seek the advice from the peer review college.

- Degree of user involvement in the proposed activity.
- How the UK economy will benefit.
- Novelty of the proposal.
- Cost effectiveness of approach.
- Need: urgency, and inability of other schemes to respond.
- Likelihood of this leading to a proposal for a co-funded project (e.g. Partnership Research Grant).

Awards

Awards are made up to £4 000 for the total directly incurred costs per application. NERC pays the standard proportion of full economic costs (see the NERC Research Grants Handbook for full details).

Closing Dates: There are **no closing dates** applications are accepted and processed at any time.

Website: <http://www.nerc.ac.uk/using/schemes/connecta.asp>

NERC Follow-on Fund

This is a 'proof of concept' fund to support the commercialisation of ideas arising from research funded by:

- Natural Environment Research Council
- Biotechnology & Biological Sciences Research Council
- Engineering & Physical Sciences Research Council
- Science & Technology Facilities Council

The Follow-on Fund is designed to help researchers maximise the societal and economic benefit of their research by extending its impact through commercial means.

The NERC fund is open to researchers with current or past NERC funding. Applications for follow-on support must build on the outputs of previous NERC-funded research activity.

There are two schemes to apply for:

Follow-on Fund Pathfinder

Pathfinder awards are available to carry out work that will help you develop a greater understanding of the commercial aspects and possibilities of your research, and hence a more robust, better informed application for a full Follow-on Fund grant.

Follow-on Fund

This is the main scheme. Applications must demonstrate a sound understanding of the market opportunity, as described above, and a clear and robust linkage between the proposed technology development plan and the strategy proposed for commercialising the project's outputs.

Closing Dates:

Follow-on Fund: Closing dates for 2012 are 1st February, 6th June and 3rd October.

Follow-on Fund Pathfinder: There is no closing date for this scheme; applications can be submitted at any time.

Website: <http://www.nerc.ac.uk/using/schemes/followonfund.asp>

NERC Knowledge Exchange Fellows

Proposals to host a KE Fellow are invited from schools or departments in approved UK Higher Education Institutes currently in receipt of NERC research funding.

KE Fellows can be employed for one to three years, for a minimum of 20% and a maximum of 80% of their time. It is anticipated that the fellows will already be employed by the host institution.

Proposals are welcomed for the Knowledge Exchange Fellowships in any area of policy, business or third sector with the aim of boosting the impact of any type of NERC funded science. It is a responsive, rather than a directed, scheme. Successful applicants whose proposal covers one or more of NERC's priority areas for knowledge exchange may be given the option of linking to wider NERC KE initiatives.

Four to six fellowships will be available for those who come forward with a work plan of their own choosing to generate impact from NERC funded research in their host institution. For these applicants, the fellowships will cover the KE Fellow's salary, including superannuation, NI and specific allowances, plus up to £40k for travel and other associated work plan costs.

Closing Dates: There are two calls a year with a closing date in April and November of each year.

Website: <http://www.nerc.ac.uk/using/schemes/kefellows.asp>

NERC Knowledge Exchange Call

NERC will run the KE Call Projects and the KE Fellowships opportunities concurrently; applicants may submit a proposal to both of these schemes at the same time. Proposals may be linked, if appropriate, although they will be assessed separately as stand alone applications. We welcome proposals for KE projects in any area of policy, business or third sector with the aim of boosting the impact of any type of NERC funded science. KE Call Projects is a responsive rather than a directed scheme.

Successful applicants whose proposal is in the area of one or more of NERC's Knowledge Exchange priorities may be given the option of linking to wider NERC KE initiatives.

Closing Dates: There are two calls a year with a closing date in April and November of each year

Website: <http://www.nerc.ac.uk/using/schemes/kecall.asp>

NERC Partnership Research Grants

In line with its strategy to embed end-user engagement into the research process, NERC has taken the decision to fully integrate its Partnership Research Grant scheme into the Standard Grant Scheme.

At present, Partnership Research Grants are assessed by the same panel as Standard Grants and using the same criteria. These aspects will not change. However, instead of having to apply via a separate mechanism, researchers will simply submit their proposals to the Standard Grant scheme, following the usual Standard Grant procedures, which already allow for the inclusion of end-user Project Partners.

Going forward, it is likely that certain Research Programmes will use Partnership Research-style grants to encourage end-user engagement in line with their own strategic objectives; such opportunities will be announced in the usual manner, as and when they arise.

Website: <http://www.nerc.ac.uk/using/schemes/partnershipgrants.asp>

EPSRC Follow-on Fund

The Follow-on Fund helps researchers to bridge the funding gap between traditional research grants and commercial funding by supporting the very early stage of turning research outputs into a commercial proposition. After completing the follow-on work, the prospective business idea should be in a much stronger position to secure further support from venture capital or seed funds.

The fund provides up to 12 months support for technical and business development activities that will establish the commercial potential of a concept by demonstrating both commercial feasibility and scientific/technical merit. Projects predominantly concerned with overcoming technical obstacles or extending the original research will not be accepted.

Closing Dates: The Follow-on Fund operates through calls for proposals; information on future calls will be published when available.

Website: <http://www.epsrc.ac.uk/funding/grants/business/schemes/Pages/followonfund.aspx>

EPSRC Network Grants

The main objective of Networks is to create new interdisciplinary research communities and topics, by developing interaction between the research community and appropriate science, technology and industrial groups. The aims are to:

- Transfer experimental techniques, models and scientific insights
- Promote mobility between academe, universities and industry.

Networks are expected to lead to new collaborative multidisciplinary research proposals and some may develop into virtual centres of excellence, providing critical mass of analytical expertise.

Under full economic costing there is no limit on the amount of funding that can be applied for, although the network should last for no longer than three years. Funding is intended to cover the operating and support costs of the Network and full justification for the sum requested should be included in the proposal. Funding will not be renewed beyond the original length of the grant.

Closing Dates: Network proposals may be submitted at any time in the Responsive Mode. However, EPSRC may also occasionally issue specific calls for proposals which have different objectives from those listed above. EPSRC has established various initiatives to set up Networks in specific programme areas.

Website: <http://www.epsrc.ac.uk/funding/grants/network/networks/Pages/default.aspx>

EPSRC Platform Grants

Platform Grants are a flexible mechanism of providing underpinning funding to well established, world leading research groups.

Platform Grant funding provides a baseline of flexible support (a platform) that can be used for the retention of key staff, feasibility studies, longer-term research and International Networking. This flexibility should enable the group to take a strategic view of their research which will be enhanced by the submission of responsive mode applications during the lifetime of the Platform Grant.

Applicants are required to have an internationally leading reputation and a high international profile. They must be able to demonstrate that their group has a strong track record in obtaining support from EPSRC and other funding sources. They should hold a substantial portfolio (a range of grants relating to the research area of the Platform Grant) of current EPSRC research grant funding, typically over £2 million in value which Platform Grant funding would underpin. In some cases funding from other sources (e.g. other Research Councils, EU, TSB, and Industry) may be taken into account depending on the nature of the funding, and type of grant. As a guide this portfolio should be at least double the level of resources that Platform Grant funding would provide. The portfolio that would be underpinned should be sustained to a significant degree during the period of the proposed Platform Grant.

Closing Dates: 27th January, 30th March, 25th May, 27th July, 28th September, 30th November 2012

Website: <http://www.epsrc.ac.uk/funding/grants/capacity/platform/Pages/default.aspx>

EPSRC Programme Grant Scheme

Programme Grants, which can be awarded for up to six years duration, are a flexible mechanism for providing funding to address significant major research challenges. Following a number of reviews, it is evident that giving leading researchers the stability of long-term funding allows them the flexibility to be creative, innovative and able to address some key challenges.

Specifically a Programme Grant is to support a suite of related research activities focusing on one strategic theme. Although it is expected that most proposals will be interdisciplinary and collaborative in nature, they can address key challenges in a single discipline. Programme Grants are not just large grants but must be strategic in nature.

The proposal must demonstrate that research of the highest quality will be undertaken by a world-leading team. The research programme should be ambitious, creative and innovative addressing key research challenges. It should be clearly stated why the challenges are ambitious; applicants should set the proposed research in context in terms of the current state of knowledge and other work under way in the field. The research programme should also be sustainable beyond the lifetime of the grant and have significant impact beyond its immediate group.

The principal investigator should have brought together a world-class team with complimentary expertise so as to enhance the potential to achieve the vision.

Closing Dates: 1st April and 1st October

Website: <http://www.epsrc.ac.uk/funding/grants/capacity/programme/Pages/default.aspx>

EPSRC Standard Research

EPSRC research base funding is very flexible. EPSRC fund projects ranging from small travel grants to multi-million pound research programmes. You can apply for whatever length of funding you require, whether it is a month or six years.

You can apply for funding for a wide range of activities, including research projects, feasibility studies, instrument development, equipment, travel and collaboration, and long-term funding to develop or maintain critical mass. EPSRC particularly want to encourage high-risk/high-return research proposals relating to new concepts or techniques. There are no closing dates so you can apply at any time.

Closing Dates: There is no closing date for this scheme; applications can be submitted at any time.

Website: <http://www.epsrc.ac.uk/funding/grants/rb/Pages/default.aspx>

Future Calls

Technology Strategy Board

Water Competition

The scope of the competition will be to help UK companies gain access to global markets by demonstrating the commercial and technical viability of step-change innovations that address the water security challenge.

There has not been a call for this yet, but will be due in the second quarter of 2012.

Website: <http://www.innovateuk.org/competitions.ashx>

NERC

NERC Macronutrients Programme

The Macronutrients Programme address key issues related to N, P and C cycling in catchments under a changing climate. This programme held its first main Call for proposals in late 2011 and successful projects were announced in late January 2011. A second Call is likely in early 2013 which will address gaps in science that are not covered by projects funded under the first Call. Total budget of approx £9.55 million.

Next Call Date: Probably early 2013.

Website : <http://www.nerc.ac.uk/research/programmes/macronutrients>

NERC Biodiversity and Ecosystem Service Sustainability (BESS) 2011-15

The Biodiversity and Ecosystem Service Sustainability Programme announced the results of its first Call for proposals in mid January 2012. A second Call targeting gaps in the science not covered by projects funding under the first round, will probably be made in early 2013.

Next Call: probably early 2013

Website : <http://www.nerc.ac.uk/research/programmes/bess/>

NERC Flooding from intense rainfall

(£5.2m, contributes to natural hazards theme)

Intense rainfall events commonly last for a few hours, or even a few minutes, but present flood forecasters and flood risk managers with major problems. Our knowledge of processes associated with such extremes is poor and we cannot predict associated flood risks with confidence.

This NERC-led, LWEC, UK-focused programme will reduce the risks of damage and loss of life caused by surface water and flash floods through improved identification, characterisation and prediction of interacting meteorological, hydrological and hydro-morphological processes that contribute to flooding associated with high-intensity rainfall events.

The programme will:

- Improve the length and accuracy of forecasts of the occurrence and intensity of rainfall associated with convective storms.
- Identify the susceptibility to high-intensity rainfall of different catchment types, based on characterisation of the properties that govern the dynamic, non-linear, hydrological and hydro-morphological processes which initiate, extend and intensify associated flood risks.
- Enhance flood risk-management through the development of both flood risk estimation and real-time forecasts of floods associated with high-intensity rainfall, integrating multiple meteorological and hydro-morphological processes occurring before, during and after intense precipitation events.

There has not been a call for this yet, but will be due in the second half of 2012.

Website: <http://www.nerc.ac.uk/research/themes/tap/tap-phase3.asp#flooding>

UK Droughts

(£6.5m, contributes to natural hazards and climate system themes)

Droughts can cause enormous socio-economic damage through their impact on water supply, health, food security, and infrastructure. They pose a significant hazard to the UK, and are likely to increase in frequency and severity as a result of climate change.

Decision-makers find it challenging to make informed adaptation and management choices in relation to droughts as it is difficult to predict their occurrence, duration, intensity and extent of their impact. Currently the many drivers of drought, both meteorological (e.g. anticyclonic blocking) and societal (e.g. supply & demand balance, water storage, transfer and utility trends), are often considered in isolation.

This programme will identify and predict the interrelationships between multiple drivers and impacts of UK droughts - over daily to multi-annual timescales and on spatial scales from metres to 500km - to inform adaptation and management decisions before, during and after drought events. The scientific goals are to:

- Characterise the historical occurrence, intensity, geographical pattern and impacts of drought in the UK through identification of the contribution of multiple drivers of drought, including antecedent conditions (e.g. cumulative dry winters¹³) and water utility patterns.
- Identify, model and predict the climate drivers of key drought types at lead times from months to years. A particular focus should be on the potential for exceeding the historical envelope, for example through the interaction of climate change with natural climate variability.
- Identify the nature, extent of impact, interaction and functioning of key ecological and hydrological systems during periods of water scarcity - addressing in particular non-linear responses, system thresholds and potential for recovery.
- Develop integrated tools to assess the risks associated with drought, by coupling new and existing models that describe the drivers, feedbacks and impacts, to support decision-making before, during and after drought events, and determine optimal adaptation and management strategies.

There has not been a call for this yet, but will be due in the third quarter of 2012.

Website: <http://www.nerc.ac.uk/research/themes/tap/tap-phase3.asp#drought>

Session 4:

Alliances, networks and next steps

Networks in relation to informing decision-making for flood management

Carolyn Roberts

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Introduction

Research involves breaking new ground in terms of understanding hydrological and geomorphological patterns and processes, and for many researchers necessarily forms part of the process of developing some practical or commercial application. For many organisations focussing on application, and including government and water companies, 'innovation' is the key. Much of the current debate around effective networking for innovation concerns 'open innovation'. Whereas conventionally, innovation in any sector was seen as a rather linear process involving a set of stages from 'conceptual development' and 'experiment stage' through to 'commercialisation' with 'research and development typically appearing in the early stages, our conceptions now recognise the chaotic nature of many research and development processes. A typical representation of the linear process is seen in Fig 1, also described as the innovation funnel, as the number of research projects being developed usually falls from start to finish, as different barriers are successively overcome, or not. Typically, both research and innovation are expected to take place within the institution – research centre or company, for reasons associated with competition, career development of key stakeholders, intellectual property protection and similar. End users of research engage, as the term implies, at the end of the process when 'results' are forthcoming. In the context of flooding, the stakeholders include a notably wide set of groupings and individuals.

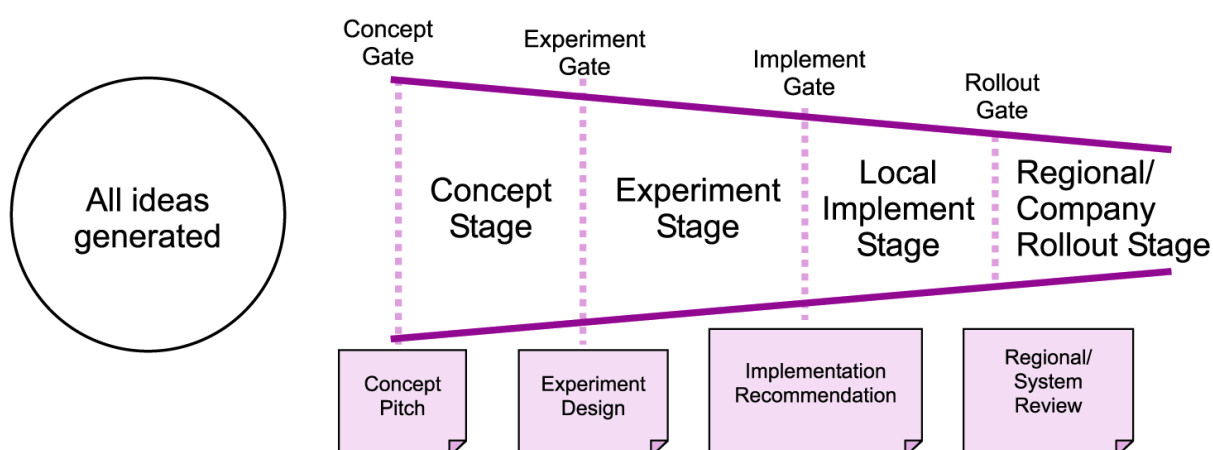


Figure 1. The Research Pipeline

Abstracted from Moosa N. and Panurach P. (2008) *Encouraging front-line employees to rise to the innovation challenge Journal of Strategy and Leadership* 36 (4).

However, the chaotic development of much research in practice is frequently now described in terms of 'open innovation' models, where the process is viewed as much less constrained. Open innovation takes advantage of multiple stakeholders and complex interactions. Representing this diagrammatically, the boundaries are permeable, and the progress of projects is more akin to a process of diffusion, with researchers, knowledge and ideas moving into and out of different host organisations quickly, and with resources such as funding and equipment being drawn into projects from diverse sources. New ideas are generated or spun off along the way, which may be passed on for development or further research or action elsewhere (through licensing or sale in commercial cases, or more typically through 'stakeholder engagement' or 'public involvement' in the case of flood management) if the host organisation is not immediately able to benefit or is not able to do so for legislative reasons. The winners will be those who exchange most ideas, most quickly, wherever they come from. Such models are potentially attractive in the current challenging economic regime, and to a certain extent represent public policy in the UK. They emphasise rapidity, and dialogue with wide sets of stakeholders, including potential users of findings, from the point of initiation of a research idea or project onwards. For university researchers, this might well include organisations in the commercial, governmental and voluntary sectors, such as local authorities or community groups. The Flooding and Water Management Act 2010 requires some of this interaction, and the new responsibilities of Local Authorities under the Act also necessitate such conversations. Issues of language become very important.

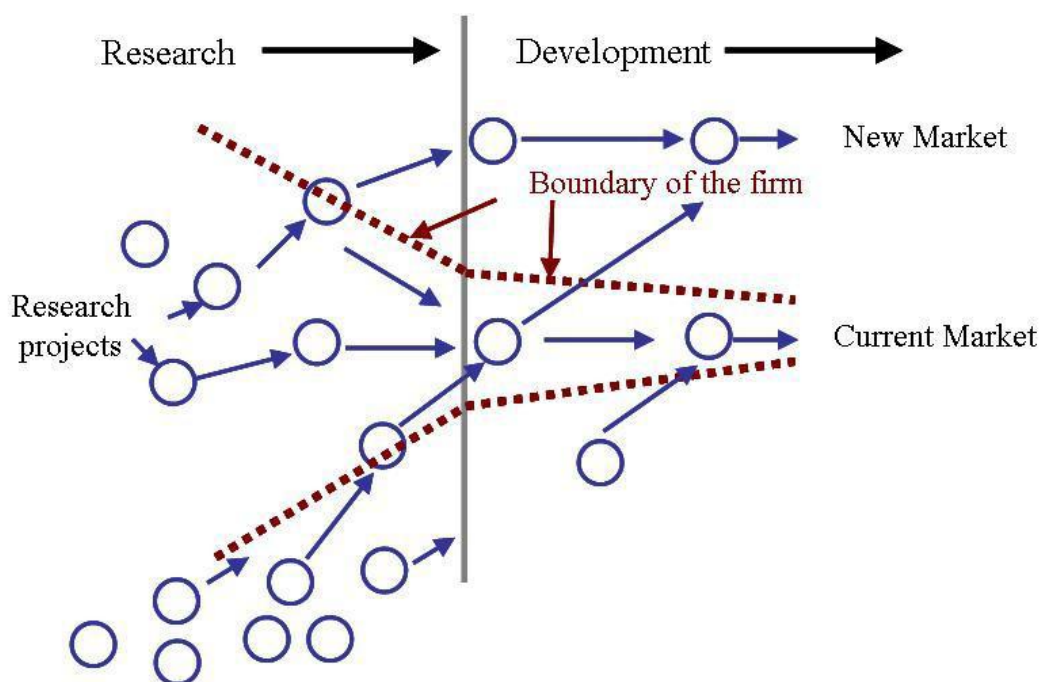


Figure. 2. Open Innovation

Abstracted from: Chesbrough, H. (2003), *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Harvard Business School Press.

Relevant organisations

Given this situation, and perhaps despite concerns about the potential harshness of this vision of entrepreneurial activity, our research and development networks at least need to recognise the need for effective and open networking, in order to flourish.

Previous seminars in this series have identified some of the plethora of research and professional networks that could be drawn upon by the NERC Water Security Knowledge Exchange Programme to foster open innovation in water sciences.

There are two broad drivers for the formation of these networks:

1. Member driven through professional or organisational networks
2. Research driven through funded research programmes

Some examples are:

- The Local Government Flood Forum (<http://www.lgff.info/>)
- The National Flood Forum (<http://www.floodforum.org.uk/>)
- British Water SUDS (Sustainable Urban Drainage Systems) Focus Group
(http://www.britishwater.co.uk/how_we_do_it/SUDSFG.aspx)
- The Landscape Institute (<http://www.landscapeinstitute.org>)
- National Farmers' Union (<http://www.nfuonline.com>)
- The Environment Agency
(<http://www.environment-agency.gov.uk/homeandleisure/floods/98503.aspx>)
- International disaster recovery organisations such as Oxfam, CAFOD and similar.

Further information on these and other relevant organisations are given in the next section.

Alliances, networks and next steps

ACE - Association for Consultancy and Engineering (<http://www.acenet.co.uk/home/57>)

ACE represents the business interests of its members and the consultancy and engineering industry in the UK. It is the leading business association in this sector, counting around 650 firms - large and small, operating across many different disciplines, as its members. ACE members are some of the world's leading consultancy and engineering businesses. Renowned for the quality and excellence of their work, they regularly win awards for engineering innovation and achievement.

BOND - UK NGO Network – Water Group (<http://www.bond.org.uk/pages/uk-water-network.html>)

The purpose of the UK Water Network is to increase the impact of its members by providing a forum where agencies can exchange information, enhance their analysis and coordinate their advocacy towards the UK Government and other relevant institutions on freshwater issues. This includes issues on water and sanitation, the preservation of the ecology and biodiversity of freshwater systems, food, energy production and leisure.

BARSC - British Association of Remote Sensing Companies (<http://www.barsc.org.uk/>)

The British Association of Remote Sensing Companies actively promotes the interests of all organisations and individuals who work with remote sensing technology and data. Remote Sensing (or Earth Observation) includes companies and organisations involved in satellite building and launching, processing, distributing and selling the collected data as well as offering expert services to make best use of this incredible resource. It is not surprising to know that Remote Sensing is an industry that contributes a huge amount of revenue to the UK economy and supports thousands of jobs.

BHS – British Hydrological Society (<http://www.hydrology.org.uk/>)

The British Hydrological Society (BHS) was formed in 1983 in response to a clear need for a new, broad-based national society for the advancement of hydrology.

The Society caters for all those with an interest in the inter-disciplinary subject of hydrology, and aims to promote interest and scholarship in scientific and applied aspects of hydrology and to foster the involvement of its members in national and international activities.

BHA – British Hydropower Association (<http://www.british-hydro.org/index.html>)

The BHA promotes the hydropower industry in the UK and abroad and aims to increase the awareness of its quality and scope in the wider world. Hydropower is one of the most reliable, predictable and least environmentally intrusive of all renewable energies. The BHA strives to ensure that its potential is realised.

The hydropower sector in the United Kingdom is going through an exciting phase. Government policy to limit carbon emissions has given us the opportunity to develop hydropower projects which previously would have been unviable. Businesses, communities

and individuals are now involved and are playing their part in the fight against climate change. In turn this has stimulated interest in the manufacturing and service sectors. There is also a massive overseas market to be addressed. This will only get bigger as the importance of hydropower as a tried and tested renewable energy technology is realised.

The BHA is the only UK trade association which solely addresses the demands of the growing hydropower sector. The expertise we can call upon is the best and most experienced that is available.

British Water SUDS (Sustainable Urban Drainage Systems) Focus Group
(http://www.britishwater.co.uk/how_we_do_it/SUDSFG.aspx)

This group was formed to provide commercial manufacturers and suppliers of proprietary goods and services to the water industry such as pipework, valves, porous paving, underground water storage systems, structural grids and similar with a route through which to monitor and lobby in relation to the development of SUDS Regulations. They also promote engineered SUDS components within the overall design and application of SUDS, but are increasingly working on 'softer' engineering solutions. The Focus Group works with the environmental regulators to develop and publish guidance information and to disseminate the information to planners, developers and regulators. Changes in the guidance provided in public planning policy documents is a current focus of discussion.

CCN – Catchment Change Network (<http://www.catchmentchange.net/about>)

The Catchment Change Network (CCN) is a NERC-funded Knowledge Transfer Network that brings together university scientists with a broad interest in catchment management along with a wide range of practitioners to consider the assessment of future change in catchment systems.

The science of the natural environment is an uncertain science. Practitioners cannot make predictions for real problems without significant uncertainty in representing the processes involved. In catchment management, this inherent uncertainty is exacerbated by the additional complexities of future climate change, societal change and technical innovation. These are difficult to anticipate or quantify and suggest a need for an adaptive approach to management with a science need driven by existing and emerging legislation.

CCN will explore the ways in which the latest scientific methodologies can inform this process in the three Focus Areas of flood risk, water scarcity and diffuse pollution. Network activities will include mapping of future research needs in collaboration with a wide variety of potential users, the development of Guides of Best Practice in each focus area and the development of a range of professional training opportunities across our science user groups.

CIWEM – The Chartered Institution of Water and Environmental Management
(www.ciwem.org)

A professional membership organisation providing professional qualifications for engineers, environmentalists and scientists working in the field of water and environmental management, with over 10,000 members.

CIRIA – Construction Industry Research and Information Association

(http://www.ciria.org/service/Home/AM/ContentManagerNet/HomePages/CIRIA_1502_20080929T115140HomePage.aspx?Section=Home)

CIRIA is the construction industry research and information association.

Operating across market sectors and disciplines CIRIA deliver a programme of business improvement services and research activities for our members and those engaged with the delivery and operation of the built environment. CIRIA is an independent member based, not-for-profit association.

CREW – Centre of Expertise for Water (<http://www.crew.ac.uk/>)

CREW is a partnership between the James Hutton Institute and all Scottish Higher Education Institutes which ensures that water research and expertise is available and accessible to the Scottish Government and its agencies, in a timely and effective manner.

EIC – Environmental Industries Commission (<http://www.eic-uk.co.uk/main.cfm>)

The EIC was launched in 1995 to provide environmental technology equipment and services suppliers with a strong and effective voice to influence the debate on the future of the industry among policymakers in Westminster, Whitehall and Brussels. It aims to promote constructive co-operation between the regulated, the regulators and the UK's environmental technology suppliers who serve them. Over 240 companies are members of the EIC and the number is growing rapidly.

Through its innovative Sector Working Groups, the EIC actively promotes a supportive legislative and fiscal framework that emphasises cost effective policies, coherent standards and practical solutions. The EIC facilitates the exchange of information and experience on R&D, market opportunities, funding and training.

ESKTN Environmental Sustainability Knowledge Transfer Network

(<https://connect.innovateuk.org/web/sustainabilityktn>)

KTNs have been set up by the Technology Strategy Board as 'open innovation' networks to drive the flow of knowledge within, in and out of specific communities. KTNs are funded to bring together diverse organisations and provide activities and initiatives that promote the exchange of knowledge and the stimulation of innovation in these communities. The ESKTN's mission is to accelerate the UK's transition to a low carbon, resource and energy efficient economy by connecting businesses, universities, other research organisations and government agencies, and catalysing innovation across a wide range of environmental technologies. Approximately 9000 people are currently members, across businesses, universities, government departments and other agencies, with approximately 25% of these falling into the water sector. Membership is free, and the KTN draws on a wide range of communication methods, including a large web presence (with interactive tools for partner searches, funding searches, research topic identification for Master's level research), meetings of different formats, technical workshops, publications, narrowcasting, social networking in many formats and so on.

FWR – Foundation for Water Research (<http://www.fwr.org/>)

The Foundation for Water Research (FWR) is an independent, membership based charity dedicated to education and information exchange. It is based in Marlow, Buckinghamshire, UK.

It was founded in 1989 and its mission is to advance the education of the public in science, engineering and management of water through specialist forums, reviews of current knowledge, publishing and information support.

FBA – Freshwater Biological Association (<http://www.fba.org.uk/>)

The FBA, founded in 1929 and a charity since 1966, aims to promote the study and application of freshwater biology through membership services, research and information dissemination. As a membership organisation FBA work throughout the UK, with activities centred on two sites in Cumbria (Windermere) and Dorset (the River Laboratory). Historically closely associated with academics and professional water resource managers, FBA products and services are nowadays being designed also to appeal to those with a general interest in freshwater biology, including young people and amateur enthusiasts. FBA are regarded as one of the country's foremost providers of information about fresh waters, including identification guides, training courses, scientific meetings and both physical and electronic information holdings. FBA training courses attract as tutors the most highly respected experts in the UK.

FRMRC – Flood Risk Management Research Consortium (<http://www.floodrisk.org.uk/>)

This interdisciplinary research Consortium focuses on some of the more recently identified strategic research investigating the prediction and management of flood risk and is the primary UK academic response to this challenge. The Flood Risk Management Research Consortium (FRMRC) was formed with the express wish at its inception of linking academic and industrial research partners. The principal sponsor is the Engineering and Physical Sciences Research Council (EPSRC) in collaboration with the Environment Agency (EA), the Northern Ireland Rivers Agency (DARDNI), the United Kingdom Water Industry Research (UKWIR) Organisation, the Scottish Government (via SNIFFER), the Welsh Assembly Government (WAG) through the auspices of the Defra/EA and, uniquely, the Office of Public Works (OPW) in the Republic of Ireland.

The academic members of the Consortium currently comprise 16 Universities and in addition, a number of key collaborators (Proudman Oceanographic Laboratory (POL), Meteorological Office, Halcrow, CIRIA, HR Wallingford and UKWIR) are either heavily committed or form part of the Consortium.

HYDRA – Hydrosociences Research Association (<http://www.hydra.uk.net/>)

HYDRA is the **HYDrosociences Research Association** for strategic multi-disciplinary research in water science, policy and management. HYDRA's aim is to help policy makers and managers find solutions to some of the most significant environmental challenges facing society in the next few decades.

Membership comprises the leading UK water science research groups in SE England and is also open to stakeholders and policymakers with interests in water science and management.

ICE – Institute of Civil Engineers (<http://www.ice.org.uk/>)

ICE is a global membership organisation that promotes and advances civil engineering around the world. The purpose of ICE is to qualify professionals engaged in civil engineering, exchange knowledge and best practice, and promote their contribution to society. ICE members help to create the structures and systems that sustain society. They are responsible for designing, building, maintaining and improving bridges, roads, canals, docks, office buildings, hospitals, schools, airports, power stations, railways, flood defences, water-treatment facilities.

IES – The Institution of Environmental Sciences (<http://www.ies-uk.org.uk>) a charitable professional body which promotes and raises public awareness of environmental science by supporting professional scientists and academics. A high proportion of the 2000 members are professionals in the water sector, and are either, or both, Chartered Environmentalists or Chartered Scientists.

IGD – Institute for Grocery Distribution (<http://www.igd.com/index.asp?id=0>)

IGD was formed in 1909 to provide education through information and training in handling products for people who worked in grocery stores. IGD charitable aims have not changed and today the need for education is still there, but it is different.

They now deliver public benefit as a charity by:

- Providing information and practical training that enables people working in the industry to deliver for consumers and to develop personally
- Helping people and the industry make informed choices on diet, health and nutrition
- Driving sustainable improvements in the industry through collaboration and sharing best practice along the supply chain

IWO – Institute for Water (<http://www.instituteofwater.org.uk/>)

As a membership organisation, the ultimate ownership and direction of the Institute of Water resides in the hands of members.

Regional activities are run by Area Committees made up of volunteers drawn from local membership. There are eight areas covering the UK.

The Institute of Water has a small Board of Directors and an Area Forum. The Board are responsible for managing the business, policy implementation and legal compliance. The Area Forum concentrates on sharing best practice whilst retaining the ability to influence overall strategy and policy-making.

ICID – International Commission on Irrigation and Drainage (<http://www.icid.org/>)

The Mission of ICID is to stimulate and promote the development and application of the arts, sciences and techniques of engineering, agriculture, economics, ecological and social sciences in managing water and land resources for irrigation, drainage, flood management and river training applications, including research and development and capacity building for achieving sustainable irrigated agriculture.

ICID has more than half-a-century of experience in the transfer of water management technology and in the handling of related issues. Building on its past experience, accomplishments, and the comprehensive water management framework, ICID strives to promote programs to enhance sustainable development of irrigated agriculture. ICID has been involved in the global discussions leading to Agenda 21, World Water Vision, World Water Forums etc., which have become the focal point of several of its technical activities.

IAHS – International Association of Hydrological Sciences (<http://www.iahs.info/>)

IAHS aims to promote the study of Hydrology as an aspect of the earth sciences and of water resources;

- to study the hydrological cycle on the Earth and the waters of the continents; the surface and groundwaters, snow and ice, including their physical, chemical and biological processes, their relation to climate and to other physical and geographical factors as well as the interrelations between them;
- to study erosion and sedimentation and their relation to the hydrological cycle;
- to examine the hydrological aspects of the use and management of water resources and their change under the influence of man's activities;
- to provide a firm scientific basis for the optimal utilization of water resources systems, including the transfer of knowledge on planning, engineering, management and economic aspects of applied hydrology.

IAHS also aims to provide for discussion, comparison, and publication of research results and to initiate, facilitate, and coordinate research into, and investigation of, those hydrological problems which require international cooperation.

IWA – International Water Association (<http://www.iwahq.org/1nb/home.html>)

The International Water Association is a global reference point for water professionals, spanning the continuum between research and practice and covering all facets of the water cycle. Through its network of members and experts in research, practice, regulation, industry, consulting and manufacturing, IWA is in a better position than any other organisation to help water professionals create innovative, pragmatic and sustainable solutions to challenging global needs.

The Landscape Institute (<http://www.landscapeinstitute.org>)

The Institute is the Chartered body for professional landscape architects, and their members are increasingly involved in masterplanning of settlements and other areas of development to minimise flood risk and promote infiltration of floodwaters. As landscape designers, members usually work collaboratively with civil engineers to ensure that biodiversity and amenity or aesthetic considerations are represented alongside the hard engineering solutions relating to reducing flood risk. In particular it promotes a coherent approach to green infrastructure, emphasising multifunctional and connected green spaces and ecosystem services. Ecosystem services is an important and growing area of analysis in the UK.

The Local Government Flood Forum (<http://www.lgff.info/>)

The LGFF is the independent voice of local government on flooding matters and attempts to give local councils a strong voice and a fair deal. Established by Gloucestershire County Council and the Local Government Information Unit in response to the summer 2007 floods, and during the period of consultation for the Flooding and Water Management Act 2010, the Forum maintains a website providing subscribing local authorities with information. It has the following aims:

- To provide a coordinated voice on flooding issues for local government
- To discuss the key flooding issues for local government
- To generate new ideas and policy solutions that help local government

LGFF runs meetings and seminars for Officers and Elected members in Local Authorities, but also draws in consultants, central government representatives and academics.

N8 Group Water Group – Water Business Development

(<http://www.lec.lancs.ac.uk/cswm/N8/home.php>)

The N8 Water group aims to create more effective business and academic partnerships to explore and exploit new models of science, engineering and technological commercialization. Creating such effective partnerships will help the N8 Group stakeholders address their long-term business and technology needs.

Through strategic engagement with industry, government bodies, regulators and others we are currently focusing on four key themes

- Catchment knowledge and technology integration
- Water cities
- Water for Life
- Water Footprints

The National Flood Forum (<http://www.floodforum.org.uk/>)

The National Flood Forum is a charity providing support and advice to UK communities and individuals that have been flooded or are at risk of flooding. It aims to influence central and local government and all agencies that manage flood risk. The Forum has a wide range of strategic aims, including

- To advise and support communities and individuals that flood or are at flood risk
- To raise awareness of the plight of flood victims that experience flooding
- To encourage the establishment of community led groups for mutual support and action to mitigate their future risk of flooding
- To instigate multi agency collaboration and mediation between those that flood and those that manage flood risk
- To organise "flood fairs" to provide public information and advice from the NFF, government agencies and self help protection firms
- To work to secure effective and appropriate action by working with Government, Insurance Companies, Environment Agency, Local Authorities and Water Companies.

It also provides short term advice to victims of flooding.

National Farmers' Union (<http://www.nfuonline.com>)

The National Farmers' Union champions British farming and provides professional representation and services to its Farmer and Grower members. It is the largest farming organisation in the UK, providing a strong, independent voice for the industry. The NFU was founded in 1908 and is financed by members' subscriptions, and maintains professional staff in the UK and Brussels. It produces policy briefings and informs national debate on flooding through representation in national and regional debates, through running conferences and workshops, and through advice to individual and groups of members through an extensive network of local offices and regional advisors. It is increasingly involved in debates around natural capital, and the ability of agricultural land to offer multiple services, including for flood reduction.

The Rivers Trust (<http://www.riverstrust.org/>)

The "Association of River Trusts" for England and Wales was launched in 2001 following extensive consultation with existing charitable rivers trusts and other related interests. The organisation changed its name to "The Rivers Trust" on 2nd August 2011. Rivers trusts now represent catchments across a large part of England and Wales and new ones are continually forming. In addition, a similar movement exists in Scotland, and there is excellent co-operation with the Rivers and Fisheries Trusts of Scotland (RAFTS).

The principles of RT are based on:

- Consent
- Subsidiarity - where RT will serve its members
- Partnership
- Education and technology transfer

The main aims of RT are, to co-ordinate, represent and develop the aims and interests of the member Trusts in the promotion of sustainable, holistic and integrated catchment management and sound environmental practices, recognising the wider economic benefits for local communities and the value of education.

RMS – Royal Meteorological Society (<http://www.rmets.org/>)

The Royal Meteorological Society is the Professional and Learned Society for Weather and Climate.

The Society serves not only those in academia and professional meteorologists, but also those whose work is affected in some way or other by the weather or climate, or simply have a general interest in the weather. The membership includes scientists, practitioners and a broad range of weather enthusiasts.

RMS administer the national qualifications of the profession and under the Royal Charter pursue the purpose of the advancement of meteorological science. As meteorological science has developed it has come to include not just the science of weather and climate itself, but the application of this to disciplines such as agriculture, aviation, hydrology, marine transport and oceanography, as well as the impacts of climate change and the interaction between the atmosphere and the oceans.

SNIFFER – Scotland and Northern Ireland Forum For Environmental Research

SNIFFER provides a service to its members and partners to manage and deliver knowledge relating to the environment and quality of life. Many of the research areas are of relevance to water security.

SWAN – Smart Water Networks Forum (<http://www.swan-forum.com/>)

SWAN - The Smart Water Networks Forum - is a worldwide industry forum promoting the use of data technologies in water networks, making them smarter, more efficient and more sustainable.

SWAN brings industry leaders together to create and accelerate awareness and effective use of smart data systems for water networks.

The SWAN forum encourages targeted discussion to:

- Raise awareness for smart water networks
- Create and report upon the methodologies, standard performance indicators, and industry best practices
- Develop new approaches and solutions to improve network operations
- Share members' experience, case studies and research
- Promote interoperability, synergy and common measurements

SWIG – Sensors in Water Interest Group (<http://www.swig.org.uk/>)

SWIG is a not for profit information, ideas-exchange, and networking group with a diverse UK-wide membership drawn from the water and process industries, sensor manufacturers and their distributors, academic institutions involved in sensor research, regulatory bodies and consultants working in the field of water management.

SWIG promotes the dissemination of information on sensor developments and fosters collaboration through targeted workshops. SWIG offers a cost effective way of maintaining an up to date knowledge of, and dissemination of, information on individual new technologies and/or sensor applications.

SWITCH – (www.switchurbanwater.eu)

SWITCH is a recently concluded major research partnership funded by the European Commission with a budget exceeding €20 million which ran over the period 2006 to 2011. It involved an implementing consortium of 33 partners from 15 countries.

SWITCH involved innovation in the area of sustainable urban water management often also referred to as integrated urban water management (IUWM).

SBWWI – Society of British Water and Wastewater Industries (<http://www.sbwwi.co.uk/>)

The Society of British Water and Wastewater Industries (SBWWI) is an active, not-for-profit, trade association representing the interests of UK manufacturers, contractors, consultants, distributors and others supplying the Water and Wastewater Industry.

Its aims are to develop an effective, consultative and innovative supply chain to the UK water industry and to help members serve the industry better by providing a forum for discussion and the dissemination of information.

UK ADAPT Agricultural Diffuse Aquatic Pollution Toolkit (<http://www.uk-adapt.org.uk/>)

UK ADAPT is an initiative of ADAS, UKWIR and Water UK, with the full support of Defra, the EA and Scottish Government.

There is currently considerable activity as the UK starts to implement the Water Framework Directive, including research projects, consultations and numerous other stakeholder initiatives. UK ADAPT believe that now is the time to take stock of the lessons learnt so far about management of catchments to reduce rural aquatic pollution.

UK ADAPT is a resource for researchers and funders to make everyone aware of projects that contribute to our understanding of managing catchments to decrease diffuse pollution from agriculture.

UK GF – UK Ground Water Forum (<http://www.groundwater.org/>)

The Groundwater Foundation provides motivational and inspirational education and community-based action programs that creatively involve individuals, communities, public and private entities in groundwater conservation and protection.

UK GF educate people and inspire action to ensure sustainable, clean groundwater for future generations.

UKCEED – UK Centre for Economic and Environmental Development (<http://ukceed.org/>)

UK CEED is an independent not for profit charity that promotes and supports eco-innovation and the economic benefits of sound environmental practice. UKCEED support the growth and development of businesses in the cleantech and low carbon and environmental goods & services sectors whose innovative solutions are needed to create an economically and environmentally sustainable future in the UK. UKCEED have an excellent reputation and work with a large number of public and private sector partners from the UK, Europe and around the world.

UKIA – UK Irrigation Association (<http://79.170.40.182/iukdirectory.com/iuk/>)

UK Irrigation Association (UKIA) is the only independent organisation representing irrigation in the UK. UKIA are a voice for irrigation in the debate over the future of UK's water resources; they advocate the wise use of water in agriculture, in amenity and in sports and leisure; and they promote good irrigation design and management practices.

Irrigated agriculture is important in the UK's rural economy. More than 1,000 agri-businesses, large and small, depend on irrigation to supply high quality fresh fruit and vegetables to the nation's supermarkets - arguably one of the most sophisticated markets in the world. Irrigated agriculture employs over 50,000 people and annually contributes over £3bn to the rural economy.

Irrigation is also important in the urban environment - keeping sports turf in peak condition for play and providing high quality amenity and leisure facilities.

But today, irrigation faces new challenges - new regulations, increasing risks of droughts and floods, climate change, public pressures for greater accountability and environmental sustainability. UKIA helps members to meet these challenges.

UKWIR – Chemical Investigation Programme (www.ukwir.org) - Control over a wide range of potential contaminants is an important requirement of the Water Framework Directive. To meet this requirement, the CIP has been designed to investigate the management and control of concentrations of Priority Substances. All of the UK Water and Sewerage Companies are involved in this programme which concludes in 2012. The end result will be a comprehensive understanding of how the priority hazardous substances listed under the WFD daughter directive enter the water environment and how they can be effectively and economically eliminated.

UKWRIF – UK Water Research and Innovation Framework
(<http://www.lwec.org.uk/publications/author/29>)

The Framework is based on recognition that government, research organisations, academia, NGOs and industry working with other users of water need to provide the evidence to support effective decision-making, joined-up policies, and a co-ordinated coherent approach to the development and dissemination of new knowledge, technologies and skills.

Making changes to the way we manage and use water in the future will need a strong and robust evidence base supported by appropriate research and innovation. Collaboration within the UK, with the EU and its member states, and other international stakeholders will help the UK contribute to future global water security.

Urban Futures (www.urban-futures.org)

Urban Futures is a four year research project which started in May 2008, funded by the Engineering and Physical Sciences Research Council (EPSRC). The project consortium is led by the University of Birmingham and includes the University of Exeter, Lancaster University, Birmingham City University and Coventry University.

VNN – Valuing Nature Network (<http://www.valuing-nature.net/>)

The Valuing Nature Network was set up to support interdisciplinary partnerships to scope, develop and promote research capacity in the valuation of biodiversity, ecosystem services and natural resources and facilitate the integration of such approaches in policy and practice in the public and private sectors.

Specific aims

- Articulating the challenge of valuing the contribution that the stock of natural capital and the flow of ecosystem services makes to human well-being, and developing meaningful methods of valuation.
- Identifying and developing the underpinning socio-ecological system knowledge that will enable robust monetary and non-monetary valuation to be achieved.

WaPUG – CIWEM’s Urban Drainage Group (<http://www.ciwem.org/knowledge-networks/groups/wapug.aspx>)

WaPUG, now CIWEM's Urban Drainage Group, has a long history of promoting best practice in the field of urban drainage. Formed in 1984, it organises technical conferences and

specialist workshops that attract delegates from all parts of the urban drainage community and at all levels, from trainees to senior managers.

WaPUG:

- Promotes best practice in sustainable planning, design and management of urban drainage systems
- Influences Government policy on urban flooding and pollution risk
- Provides a forum for discussion and debate on leading issues
- Enables members to socialise, develop their professional skills and share expertise
- Promotes technical excellence through Codes of Practice and technical guides
- Supports CIWEM by lobbying for policy development, responding to consultations, providing policy statements and providing spokespeople

Water UK - (<http://www.water.org.uk/home/about>)

Water UK represents all UK water and wastewater service suppliers at national and European level. The organisation provides a framework for the water industry to engage with government, regulators, stakeholder organisations and the public

WERH – Welsh Environmental Research Hub (<http://www.werh.org/>)

The overall objective for WERH is to improve collaboration and effectiveness within the environmental science sector in Wales, and promote links to policy-makers so as to support delivery of the objectives of the Wales Environment Strategy. WERH will assist in the co-ordination of environmental science research in Wales by identifying areas of synergy, helping to strengthen research links and increasing the leverage of research funding into Wales. WERH will provide a focal point for disseminating information on environmental expertise, infrastructure and funding opportunities. It will seek to enhance the performance of the environmental research sector by exploiting the unique coverage of terrestrial, freshwater and marine systems in Wales, and assisting in the development of the nation's pool of environmental scientists and researchers.

WMS –The Water Management Society (<http://www.wmsoc.org.uk/>)

The Water Management Society (WMSoc) has been in existence since 1970

By gathering together expertise from every sector of the industry the WMSoc can offer informed and experienced assistance in all matters relating to the responsible management of water in industry and commerce through publications, conferences and journals.

Members are represented on relevant government and industry Consultation panels and are regularly consulted on matters of immediate concern.

WMSoc members come from a wide of disciplines including water suppliers, scientists, engineers, manufacturers, consultants and facilities managers.

WEF Water – World Economic Forum-Water (<http://www.weforum.org/issues/water>)

The World Economic Forum is an independent international organization committed to improving the state of the world by engaging business, political, academic and other leaders of society to shape global, regional industry agendas.

