An introduction to the project
Professor Sarah Whatmore

Devastating environmental events like flooding can move those affected by them to interrogate and, sometimes, to dispute the expert knowledge claims associated with the science and management of environmental risk. "Why do they keep saying it's a one in a hundred year event when we've been flooded three times in five years?" "Wouldn't proper maintenance of the river channels be more effective than building flood walls?" "We're the ones with experience of flooding, why aren't the professional 'experts' interested in what we know?" Legitimate questions that are not easy to answer and which expose the scientific and policy practices meshed together in the 'expertise' of flood risk management to the demands of public scrutiny. Questions and demands that are framed in specific local contexts, within which conditions themselves vary, and which can only be adequately addressed at the same scale. Such ***knowledge controversies*** have typically been seen in environmental science and policy communities as troublesome problems to be avoided. This project follows work in science studies and the philosophy of science, particularly that of Isabelle Stengers, in investigating whether knowledge controversies might not play a more constructive or ***generative role*** in developing the capacity of democratic societies to handle environmental uncertainty and, if so, how?

There are four, interrelated, dimensions to how we have set about this investigation:-

(1) An analysis of how scientific knowledge claims about flood risk are produced and how they come to inform the evidence-base of flood risk management in the UK. This focuses on the working practices of ***mathematical and computer modelling*** that are the mainstay of flood science, and on its products - ***predictive models*** that are the primary device by which this knowledge circulates and informs flood risk management practice (Work Package 1).

(2) An analysis of how and why flood risk expertise becomes a matter of public controversy in two flood affected localities - Ryedale (North Yorkshire) and Uckfield (East Sussex). This centres on the trial and evaluation of ***an experimental research methodology that we call Competency Groups*** and involves social and natural scientists in the project team working collaboratively with local volunteers to interrogate 'expert' framings of local flood risk and try out alternative propositions of our own (Work Package 3).

(3) The development of ***new ways of modelling flood risk*** that better forecast the in-river and floodplain effects of rural land management in specific local contexts. This ***'knowledge-theoretic'*** approach to modelling is informed by, and responsive to, the knowledge of local members of our Competency Groups in two flood affected localities. (Work Package 2).

(4) The identification and ***transfer of key lessons*** from our analysis of the flood science/policy case to other fields of environmental risk management reliant upon modelling science (ecology and climate change), and the ***production of an interactive web resource*** for scientists, policy-makers and concerned citizens to identify and interrogate environmental knowledge controversies for themselves (Work Package 4).

What work do flood models do? The production and circulation of flood risk knowledge (WP1)

Professor Sarah Whatmore and Dr Catharina Landström (University of Oxford)

The aim of this Work Package has been to understand three related aspects of the relationship between flood science and policy as it impacts the experiences and concerns of people directly affected by flood events :-

(i) how the ***knowledge claims*** of flood science (predictive estimations of flood risk) are produced, analysing the working practices of flood modelling/modellers;
(ii) how these modelling practices become standardised through particular ***technologies*** (like software packages) data sets and contractual arrangements with key policy agencies and hard-wired into the procedures of flood risk management; and
(iii) how and why this complex mesh of flood science/policy 'expertise' sometimes becomes the subject of ***public controversy***, and with what consequences.

In addition to the audio/video records and transcripts of the two Competency Groups at work, our activities have generated three main kinds of empirical material: - (a) recorded/transcribed interviews with key flood risk scientists, consultants and policy-makers in the UK; (b) participant observation with two sets of modelling practitioners - the modelling team in a leading engineering consultancy and the project team's own modellers at work (WP2); and (c) archival research on key moments in the development of flood science through the 19th and 20th centuries, notably the mathematical formulation of 'roughness' as a dimension of hydraulic process and its changing technical standardisation in handbooks and software.

The technical arrangements and institutional procedures of flood risk management today rely most on the scientific practice of ***mathematical/computer modelling*** (rather than laboratory experiment or field observation). As modellers would be the first to acknowledge, the knowledge claims advanced through modelling are both uncertain and provisional. ***Uncertain*** in that modelling is an exercise in predicting future (unknown) events from projections of observed (known) events and, in the case of flooding, in estimating the return period of a flood event of a specified magnitude. ***Provisional*** because the predictive capability of models is only as good as the data sets available to make them run, which are always imperfect and subject to the cost and reliability of data generation. Such careful provisos tend to become dulled as software packages facilitate the standardisation of modelling practices amongst the engineering consultancies on which the responsible government agencies rely for their estimations of flood risk. The public face of this complex mesh of expertise is the Environment Agency (EA) and those moved by the event of flooding to interrogate it are likely to encounter scientific and technical knowledge presented in its final form, in which divested of all the uncertainties associated with its production it achieves a misleading kind of certitude.

Here we highlight two themes:- (i) what 'modelling' involves varies significantly in different institutional contexts, notably between commercial and academic modelling cultures; and (ii) the contractual terms set by the prevailing regime of flood risk management are a major influence on the standardisation of modelling practice.

Competency Groups: An experimental method of working with people affected by flooding (WP3)

Professor Neil Ward and Ms Sue Bradley (University of East Anglia and University of Newcastle)

The Competency Group (CG) experiment is a conscious attempt to translate the 'generative capacity' of environmental knowledge controversies into a research methodology. CGs involve the natural and social scientists in the project team collaborating with volunteer residents in localities in which flood risk management is already a matter of public controversy. At its most basic, the working practice of CGs is ***to 'slow down' reasoning*** in order to understand how local flood risk problems and solutions are framed both by the 'experts' (EA) and by university and local Group members. This methodology has three goals: - (i) to trace existing flood management policies back through to the scientific knowledge claims and practices that inform them; (ii) to enable those affected by flooding to try out alternative ways of framing and ameliorating the local flooding problem; and (iii) to produce a collective model of local flooding and associated proposals for action that enable the Group's work to travel and, potentially to make a difference, in local civic and policy networks.

Our first Group was convened in ***Ryedale*** (running September 2007 to June 2008) and the second, in ***Uckfield*** (running September 2008 to May 2009). It was evident from local press coverage in Ryedale that flood risk management was a hot issue, intensified by the July 2007 flood event that occurred shortly after we advertised for local members to join the Group. In Uckfield the controversy was less intense, with the experiences of the 2003 winter floods receding as we began work there, but reignited by the news that the town had been declared ineligible for funds to provide adequate management schemes. Both controversies centred on the knowledge-base underpinning alternative flood risk management options.

In each case, the CG comprised some 5-6 project team members and 5-8 local members, plus a dedicated camcorder operator. Group activities centred on bi-monthly meetings in which ***hands-on modelling*** became the key practice through which 'expert' and Group members' knowledge-claims about the local flood problem could be tried out. These meetings were supplemented by a variety of other activities which emerged in the course of the Group's work such as field visits, video recording, interviews with local figures and personal testimony work. Each Group was supported by a password restricted website hosting a resource depository for materials collected by group members (eg maps, transcripts, photos/videos, newspaper cuttings, policy documents etc) and a group blog. Audio and video recordings were made of every CG meeting and transcribed for reference/use by all Group members.

The collective ethos of this way of working requires a sustained commitment from all participants to learning to negotiate each others' different ways of 'framing a problem' and to appreciate the different kinds of 'expertise' each others' attachments bring to the co-production of environmental knowledge. This ethos extends to the development of a ***collective ethics protocol*** permitting all participants to share access to the materials produced by the Group, subject to individual requests to remove components from this permissive arrangement. This ethos informs four dimensions of CG conduct:-

(i) Group members participate as individuals in a personal capacity rather than as representatives of any constituency;
(ii) Group members endeavour to speak from their own experience rather than relying on received wisdom;
(iii) Group members are open to, and respectful of, different points of view. There will be disagreements but these are generative to this way of working.
(iv) Group members learn together both about flooding and collaborative working, so that other researchers might be able to pursue this approach in future.

From Data-theoretic to knowledge-theoretic modelling of flood risk (WP2)
Professor Stuart Lane and Dr Nick Odoni (Durham University)

The rate of progress in quantitative modelling since the 1950s has been such that application of sophisticated computer models to a wide range of geoscientific problems is now routine. It is generally held that by making such models more physically (physics) based, their explanatory power and predictive reliability are enhanced. This formulation, a ***model-theoretic approach***, assumes accurate knowledge of the properties, states and relationships between all of the objects that are known to matter within the system of interest but, simultaneously, an incomplete understanding of the totality that this knowledge creates. In hydrological modelling, this translates into a severe dependence upon the kinds of data that are needed to make a hydrological model work. The opposite extreme is a ***model-data approach*** in which measurements become the basis of generic relationships. Even in the most heavily data derived cases (e.g. neural network forecasting of river flows) these data models can be shown implicitly to have a theoretical content. Thus, both model-theoretic and model-data approaches sit within a general class of modelling, best labelled as ***'data-theoretic'***.

In our work, we have been developing an alternative approach that we label ***'knowledge-theoretic'*** rather than data-theoretic, to capture the much richer sources of knowledge available to the modeller. The models that we developed in both Ryedale and Uckfield were co-produced through the collective ways of working of our Environmental Competency Groups. These groups forced together, negotiated and reformulated the expertise of natural and social scientists and local members of our groups to produce models specific to flood risk management in the two locations. These models were spatially-explicit, time-dependent flood risk models that allowed active exploration of possible interventions to reduce flood risk by all group members. Although the models were coded by Nick Odoni (one of the university members of the CGs), the content of the models and their use in practice (e.g. trying them out, evaluating them etc) was grounded in the wider, collective practices of the Groups (see WP3).

The models produced through our Competency Group work, which Conference participants will be able to try for themselves, combine the general (e.g. Newtonian physics) with the particular (e.g. simplifications and assumptions made to fit particular locations), such that they are 'bespoke' models that are not transferable. However, we conclude that, as the work in WP1 shows, ***all models have to be made to perform for particular places and times***, ie to lose their supposed generality. What is distinctive about our approach is the point in the practice of flood risk science that the performance was made to happen. In the case of Ryedale, our 'performance' was sufficient to define a new flood risk reduction strategy that has since been taken up by the regional Environment Agency and won funding as a ***DEFRA demonstration project*** and is now in the process of being trialled and delivered.

Transferable resources and project impacts (WP4)
Professor Stuart Lane and Dr Geoff Whitman (University of Durham)

The aim of this Work Package is to provide a long-term ***web-based 'civic resource'*** that draws upon the project's wider findings and ***to broaden the empirical focus from flooding to areas of environmental science***. The web-based resource has the following objectives:

(1) To introduce and to explore the nature of Environmental Knowledge Controversies in general, and with reference to the specific case of flooding.
(2) To demonstrate the possibility of a radical repositioning of science in environmental and other forms of research, where the purpose of science is to redistribute expertise in ways that allow new forms of political intervention.
(3) To document and to differentiate the Environmental Competency Group methodology so as to provide a framework with which others can experiment.
(4) To use innovative forms of communication for the purpose of (1), (2) and (3), whilst also providing a long-term archive of the project's findings.

Our approach to (4) aims to move away from 'linear' presentations of material, ordered by the creator, to enabling the user to define their own ordering in response to the material that they encounter. In this presentation we will illustrate the three main elements we are using as part of (4). First, we are using **a visualisation system called *prezi*,** an interactive digital resource that can contain text, imagery, sound recordings, video-recordings and even models. The *prezi* system allows us to map component parts into a coherent whole, and to undertake this mapping in different ways to produce different 'wholes'. Second, we are **developing a tool**, ***Living with Flooding*** that combines the rich set of Competency Group recordings with interviews and personal testimony materials in an original and accessible form. This is based on a resource developed from video testimonies from New Orleans, in the wake of hurricane Katrina. It links together excerpts from different records, concerned with the same issue, whilst retaining the link to the context (e.g. Group video, testimony) in which the record was generated. Hence, it allows us to transcend the personal accounts of 'the self' with the systematic accounts that emerge from across the many. This part of the web-site resource will provide the primary means by which the wider project's materials will be archived. Third, WP4 is **staging an experiment in on-line debate**, to demonstrate another resource that can be used to animate controversies: ***debategraph***. Debategraph is akin to a blog, but more sophisticated in that postings are interactively and dynamically linked to one another, rather than remaining linear and unconnected. We are convening this debating experiment around the draft Flood and Water Management Bill.

Once created, we plan to try these resources out on two other areas of environmental science which share some of the characteristics of our focus on flooding. – (i) The position and role of ecological knowledge in public policy, spurred by a tension between the ***'science' of ecology*** with its peer-reviewed, formal knowledge and data collection and the 'art' of conservation which is experience-based, creative and non-systematic. Here, we observe a mapping of formal knowledge and data collection onto 'experts' which in turn privileges certain ecological accounts over others. (ii) The possibilities of using our experimental approach as a means of engaging diverse communities of people in ***climate model science***. Central to our approach here is bridging the current separation of anthropological understandings of climate with those encoded in and predicted by climate models.

Cross-cutting theme 1

Environmental knowledge controversies: generative events for science and politics?

Professor Sarah Whatmore (University of Oxford)

Where uncertainty is a normal, indeed necessary, feature of scientific knowledge production, the entry of these same uncertainties into the public arena finds politicians, media commentators (and sometimes scientists) handling them like hot coals. Is there something about the demands placed on environmental science in the service of 'evidence-based' public policy that is inclined to harden scientific knowledge claims, with all their provisional candour as conditional propositions, into technical statements, with all the reassuring certitude of known facts? Can this be understood in terms of a tension between the ways in which knowledge claims become reliable through the ***experimental ethos of scientific claims-making*** and the ***managerial ethos of public policy claims-making***?

The central role that the idea of knowledge controversies has played in the work of the project team, including the design of our Competency Group experiment, is prompted by the question of whether they have a more constructive or ***generative role*** to play in developing the capacity of democratic societies to handle environmental uncertainty than has conventionally been acknowledged and, if so, how?

This, it turns out, is not a simple question concerned with managing the consequences of a **pre-existing** ***public*** disagreeing with established ***experts*** about how to ameliorate an **already defined** ***problem***. Our project interrogates the taken-for-granted status of each of these three terms by tracing the disruptive power of events like flooding to arouse in those affected by them a heightened concern with the nature of the problem and the reliability of expert knowledge claims about it; concerns which can swell into new forms of association and demand that force expert reasoning to 'slow down' under the weight of scrutiny.

In this, our work suggests that knowledge controversies can be generative for science and politics in the sense that they act as force-fields in which expertise (the claim to relevant knowledge) is redistributed through the emergence of:-
(i) ***new knowledge claims***, resulting from different kinds and communities of knowledge being brought to bear on the production and distribution of flood risk expertise; and
(ii) ***new knowledge polities***, in which events like flooding gather publics around them with political attachments and capabilities that did not exist previously.

If this all sounds rather challenging for flood risk management practitioners – this is undoubtedly the case, but these challenges also represent opportunities to develop new kinds of working practice that handle both environmental uncertainty and public engagement differently. Our Competency Group methodology is an experimental attempt to do just this, the transferability of which to other kinds of issue and practitioner areas we will be working with other to evaluate.

Cross-cutting theme 2

Repositioning Science in Flood Risk Management: from knowledge transfer to co-production

Professor Stuart Lane (University of Durham)

In this paper, we reflect upon how our project has forced the repositioning of science in flood risk management, asking the simple question: ***What happens to both science and scientists when co-producing knowledge*?** We will make the following points:

(1) our experiment reveals a deep and distributed understanding of flood hydrology across all experts, certified and uncertified, involved in the experiment;

(2) this understanding not map onto the conventional dichotomy between 'universal' scientific expertise and 'local' lay expertise;

(3) working with this understanding required us to put our knowledge at risk, and to negotiate and renegotiate it, but not our elimination from the research process;

(4) ironically, though, our experience of doing science was in many senses truer to the ways in which normal science is done in practice, as opposed to accounts of how that normal science should be done found in general accounts of scientific method;

(5) working with events (not just the 'flood' but also the very experiments and interventions) forced our way of working; and

(6) the manner in which our experiment repositioned us in the practice of their science was radical because the purpose of our experiment, the science we practised, became as much about creating a new public capable of making a political intervention in a situation of impasse, as it was producing the solution itself.

As scientists, we worked with the hybridisation of science and politics rather than trying to extract science from politics.