

## Models, decision-making and flood risk: doing simulation modelling differently

Local people, such as householders or farmers, often mistrust the computer simulation models that 'experts' use to address their environmental problems. But, if local knowledge can be used in building and using these models, they may have greater credibility.



### Policy and Practice Notes

**Models, nowadays based on computer simulations, allow predictions to be made of events that are distant in time and space. Governments, technical agencies, companies and professionals use them all the time, to design, to plan and to regulate. The apparent predictive power of models often seems to give distant officials and experts, knowledge and insights that are superior to those of ‘non experts’.**

**But Relu research suggests that, in situations of environmental controversy, local knowledge could play an important role in making better models, and in making more effective use of them. Researchers have investigated new approaches to interdisciplinary science, in which non-scientists, together with natural and social scientists, are engaged throughout the process of model building and application. The particular focus of this work was a major environmental management issue linked to rural land management – namely flooding – but the work has relevance to any kind of problem that uses models to make decisions about policy or management.**

## What is modelling all about?

**A model is a representation of the real world that is designed to help make decisions.**

**Our day-to-day lives are replete with models and their predictions:**

- Developing a model involves turning a set of concepts and rules, based on science or expert judgement, into some kind of computer programme, and making sure that the model works as a generic tool, by examining the fit between its predictions and real situations.
- For instance, the speed with which a traffic light changes from green to amber to red is based upon a model of how drivers respond to the change in signal.
- Model application involves taking this kind of developed model and using it to inform decision-making.
- Models are used, with varying degrees of reliability, to forecast the performance of systems, from the weather to the economy.

## Why do we use models?

**Simulation models underpin decision-making in rural environments for many reasons and these can be grouped into four broad headings:**

**In order to understand the complex geography of the rural environment:**

**Relating a particular problem of, say, flooding or pollution, to land management, is not straightforward, because the causes and effects are spread over large areas with complex connections:**

- The effect of runoff from a single field or part of a field on a river is unlikely to have anything other than a local impact. But when there are many fields contributing, spread across large areas, this runoff may accumulate in rivers and lakes and so become serious.
- Not all land contributes equally to these problems: it depends on how it is being used, and where it is located within the catchment.
- Spatial models are thus needed to identify critical geographical locations where interventions may be more or less effective.

### **To assist emergency planning:**

**Events like the outbreak of an animal disease, or a flooding episode, have to be managed by interventions that are proportionate, cost effective and timely.**

#### **Models can help to:**

- Estimate how the problem might spread across the landscape.
- Test possible interventions.
- Decide when and where warnings need to be issued.

### **To look ahead at different possible futures:**

**Achieving change in rural environments, such as in land use, can be both expensive and slow. Models can help because they provide a way of:**

- Looking ahead and examining several different possible outcomes.
- Testing how alternative futures could be achieved through decisions taken now, and evaluating them.

### **To prioritise the allocation of scarce resources:**

**The investment of scarce public resources, whether payments to farmers to adopt more environmentally-sustainable activities, or investments in infrastructure to reduce flood risk, has to be prioritised.**

- Models can be used to test different strategies, such as options for flood risk reduction, or where to prioritise preventative measures to reduce pollution of water courses – generally called ‘catchment sensitive farming’.
- They can provide an analysis of both the costs and the benefits of different allocations.

## **Why is modelling controversial?**

**These four reasons for using simulation models in rural environments all share one common rationale: they all provide a means of knowing and understanding those environments, especially in situations where such knowledge cannot be provided by other means.**

### **But the models may themselves feed controversy:**

- Some of the problems that the models are addressing are controversial, for example, sources of pollution. They are also linked to allocation of resources, such as agri-environment payments and so have political and economic implications.
- The models have a ‘surveillant’ character. They are generated and used by policy-makers and practitioners who take decisions based on the model’s predictions, but may have never visited the locations to which the predictions relate. Those who have to live with outcomes of these decisions may not even know that their activities

are being ‘watched’ until they come across the predictions. Thus, models give policy-makers and practitioners the evidence that they need to make difficult decisions about the environment that affect people’s lives. But the people affected may take the view that the policymakers and practitioners have no ‘real’ knowledge about the place or their situation.

- Authorities pride themselves on making ‘evidence-based’ policy and most people think of ‘evidence’ as something they can observe. But models provide a different sort of ‘evidence’. For example, a model could provide information about pollution levels: it is impossible to measure the run off from every single field, so the model extrapolates from a sample. Or a model could be used to work out the possible future damage from flooding, so that measures can be put in place to prevent this. In both of these situations the people producing and using the information are not able to see any concrete ‘evidence’ – only the results that the model produces, which makes it vulnerable to controversy.

## **How can models become problematic?**

### **Models are useful but they do have limitations:**

- Models are only *generally* right. This is because they are simplifications of the real world. They may not have all the data that they need to make them run properly for every situation. This means that whilst the models may do reasonably well, their detail may be wrong. For example, although weather forecasting has become much more accurate over recent years, most people accept that the forecast will not be entirely correct every day, or for every part of the country.
- But when models are being used to generate environmental information, people who live in a particular area and are familiar with the environment, may be very aware that the model is ‘wrong’ for them. So there is a tension between the ‘generally-correct’ models that policy makers and practitioners use routinely to inform policy and decision-making, and the local knowledge of the residents which to them makes a model ‘personally wrong’.
- This tension is becoming more acute because of the commitment to freedom of information, which means that model predictions can be accessed more readily. Model predictions may actually be actively disseminated to help effect changes in people’s behaviour – the online dissemination of flood risk maps, by postcode by the Environment Agency in England and Wales, is an example – but may provoke controversy rather than behaviour-change.

## Can modelling and local perspectives be reconciled?

People who live in the places where models are being used to predict processes and events – such as flooding and pollution – are also experiencing these first hand, which gives them considerable knowledge. But there are conflicts between this and the modellers' perspective.

- While those who develop and use models believe that their models are fit for purpose, those who have to live with the predictions from those models often do not.
- The local knowledge of people who live in and experience a particular environment, does not always fit with what the models are saying, leading to mistrust.
- Model developers and users believe what the models say – not because they predict the 'real world' (it may not be possible to know whether this is the case or not) but because their professional practices reinforce their belief in the model.
- For this reason, when problems are controversial, local people who have to live with or respond to model predictions, should also inform and contribute to their development and use. It is only by this kind of involvement that they may come to understand the nature of model predictions, and perhaps even to trust them.
- The practice of modelling, therefore, needs to move 'upstream' into fields and farms, community halls, pubs, so that those who live with model predictions, and who have local knowledge to contribute, might become involved in generating them, and so trusting them.

## How can policymakers move modelling 'upstream'?

Policymakers could ensure that models are 'fit for purpose' if they applied four principles:

- **Accept** that people for whom model predictions matter, must be involved in developing and using them if they are to trust them.
- **Recognise** that more useful models might be developed if the public can be involved in framing how the models work and what goes into them, and also experience using the models and all the practices that modelling entails.
- **Believe** that moving the practice of modelling upstream is a means of developing more effective democratic accountability.
- **Note** that research suggests that people for whom predictions are a real 'matter of concern', for example, those at risk of flooding, are often able and willing to make an active contribution to the modelling process

## Further information

This research was carried out at the universities of Durham, Oxford, East Anglia and Newcastle.

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**Project website:**

<http://knowledge-controversies.ouce.ox.ac.uk>

**Useful resources:**

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