VII - Uncertainty and decision-making

Parallel session D – Tuesday 11th March 14:00-15:30

ID Nº: [64]

Title: **HOW IS UNCERTAINTY ADDRESSED IN THE KNOWLEDGE BASE FOR NATIONAL ADAPTATION PLANNING?**

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Adaptation actors are generally encouraged to develop adaptation strategies that are robust in the presence of unavoidable uncertainties. However, where can they obtain information on key uncertainties relevant to their decisions? In response to this question, we review the consideration of key uncertainties in the knowledge base for adaptation planning in 14 European countries. In this context, the adaptation knowledge base is understood as information that is directly relevant for adaptation planning and which is provided by or on behalf of public authorities (e.g. through reports and web portals). It includes in particular national climate projections, relevant non-climatic scenarios and climate change impact, vulnerability and risk assessments.

We find substantial differences across countries and jurisdictions. Some key findings are as follows. Almost all national-level climate change projections consider uncertainties related to emission scenarios, global climate models and downscaling methods. Many countries have established web portals that provide access to climate projections; their functionality and the presentation of uncertainty vary widely across them. Only a few countries have developed non-climatic (e.g. socio-economic, demographic and environmental) scenarios for use in climate change impact, vulnerability and risk assessments. All countries have conducted climate impact, vulnerability or risk assessments. The consideration of uncertainty within these varies widely, from a generic qualitative discussion to a probabilistic assessment based on a comprehensive modelling exercise. Most countries have developed guidance material for decision-makers concerned with adaptation. Such guidelines generally explain key sources of uncertainty in climate and climate impact projections but only few guidelines provide practical guidance on adaptation decision-making under uncertainty.

We conclude that substantial efforts are needed to improve the appreciation of uncertainties in climate and climate impact projections by decision-makers and the public at large. Dynamic interactive tools in web portals can be an important part of the tool box for those who are confronted with adapting to climate change. In addition, targeted guidance is needed that explains the relevance of key uncertainties and how they can be addressed by appropriate adaptation strategies in a specific adaptation context.

Presenter

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ID Nº: [146]

Title: **QUANTIFYING THE UNCERTAINTIES WITHIN A CROSS-SECTORAL, INTEGRATED ASSESSMENT OF CLIMATE CHANGE IMPACTS, ADAPTATION AND VULNERABILITY IN EUROPE**

Authors: Mark Rounsevell[1]; Calum Brown[1]; Evan Brown[1]; George Cojocaru[2]; Paula Harrison[3]; Cristina Savin[2]
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A number of models have been used to explore the likely course and magnitude of the consequences of climate change. However, individual models tend to focus on single socio-economic sectors that are implicitly assumed to operate in isolation, neglecting the many feedbacks that occur between sectors in reality. Increasingly, this problem is tackled by combining models in large ensembles or in integrated assessment platforms (IAPs). The CLIMSAVE IAP is an example of this, combining 10 different sectoral, meta-models to simulate cross-sectoral impacts, adaptation and vulnerability to climate change in Europe. Where disparate models are combined, however, attention must be paid to the reliability of the results because of the potential errors that integration can introduce. A major source of errors and uncertainties stems from the design of the models themselves, including the underlying data used, the parameters that are included, and the treatment, simplifications or assumptions concerning the interactions of these parameters. It is crucial, therefore, to understand model-based uncertainties, especially where such uncertainties could combine with one another in previously unconsidered and potentially unpredictable ways.

The CLIMSAVE IAP has many potential sources of uncertainty that affect confidence in the results and hence the use of the IAP in support of decision making. We present the results of a quantitative uncertainty analysis of the IAP, which investigated aggregate uncertainties in the IAP outputs caused by uncertainties in input parameters (and therefore in the underlying model and scenario uncertainties). Probability density functions (PDFs) were created for each of the IAP's input variables and for four scenarios with Monte Carlo sampling across these PDFs used to explore the ranges of uncertainties in IAP outputs. A limited set of IAP output metrics were used to capture the range of impacts of climate change on human and natural systems, including agricultural food production, flooding, water availability, landscape diversity, land use intensity and biodiversity. The aggregate outputs of the IAP at the European scale were found to have limited uncertainties, which allows specific impacts to be predicted with definable levels of confidence. There was substantial overlap between different socio-economic scenarios, suggesting that changes in socio-economic conditions cannot reliably overcome climate-related uncertainty. The range of climate change impacts on biodiversity, for example, was found to be more negative than positive. Nevertheless, there is evidence to suggest that particular adaptation actions may significantly alter the impacts of climate change, especially at local or national scales. This was evident in the case of flooding, where flood protection measures were crucial in not only reducing impacts, but also in reducing impact uncertainties and hence flooding risks.

Presenter

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ID Nº: [45]

Title: **OF CLOUDS AND CLOCKS: AN APPROACH TO THE PROBLEM OF UNCERTAINTY IN CLIMATE CHANGE ADAPTATION**

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Speaking on the problem of rationality and the freedom of man, Karl Popper introduced the analogy of a spectrum of determinism in the behaviour of complex systems, ranging from unpredictable, highly uncertain clouds at one end to rigidly structured and consistent clocks at another. Modern society has come to view all complex problems as clockwork, requiring only a sufficient level of analytical deconstruction to enable certainty in the prediction of the problem system's behaviour. Viewed from this perspective, uncertainty represents failure, as resulting from perceived shortcomings in analysis. However, Popper's contention that many complex systems are instead analogous to clouds places uncertainty at their very heart, the evolution and behaviour of such systems emerging as a result of stochasticism rather than simple linear mechanics.

In the context of managerial decision-making at local authority level in Ireland, where the majority of adaptation decisions must be taken, esoteric scientific discussions of cloudlike or clockwork system behaviour have proven at best unhelpful. Attempts by the research community to integrate climate change within local planning processes have foundered on the uncertainties surrounding the modelling and downscaling of climate system behaviour. Due to land use decisions often being hotly contested and politicised, plan making at local level thus typically reverts to a matter of rigid clockwork rather than flexible cloudiness.

This poses a critical challenge to the adaptation research community: how can rigidly deterministic approaches to future planning at the local scale be made compatible with the complexity and uncertainty inherent to climate change adaptation? In seeking a solution to this issue, we have developed and employed a clockwork interface to the analysis of what are undeniably cloudlike social-ecological systems. The analytical interface, a web-based tool called Ireland's Adaptive Social-Ecological Systems Simulator (iAsess), is based on structured, semi-quantitative fuzzy-logic concept modelling. Using this approach allows local level planners to construct their own model of the system they must adapt, which is effectively based on simple, linear rules of causality – in line with existing planning practices and understandings. However, the subsequent behaviour of the modelled system when forced under simple scenarios of climate and socioeconomic change is dynamic, variable and often surprising. This provides crucial insight for local scale planners regarding the potential for uncertain outcomes to emerge even from well-known and parameterised system relationships that are familiar to them. This serves to broaden local perspectives about the role and nature of certainty in the management of complex adaptive systems, and provides invaluable entry points for the introduction of climate change as an adaptive challenge to be addressed in concert with many other, equally uncertain, cloudlike system issues.

Presenter

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ID Nº: [265]

Title: **QUANTIFYING CLIMATE SCIENCE UNCERTAINTY: FROM MODEL ENSEMBLES TO EXPERT ELICITATION**

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Understanding the character of climate science uncertainty is a key element in its appropriate use for adaptation planning. Where reliable probabilities exists, either for now or for future predictions, a range of economic and decision optimising tools can be applied. Where they do not, another range of tools can be brought in to service. Consequently it is of great significance whether the probabilities produced in studies of models, or more generally from physical climate science, are robust and suitable to be used as probabilities in decision making.

Here I will contrast the assessment of two types of "probabilistic" information which is often available from physical climate science; namely climate model ensembles and expert elicitation.

In the case of climate model ensembles one would expect, from a nonlinear systems perspective, that the chaotic nature of the system would produce intrinsic uncertainty at all timescales. As a consequence, and even if our model was a perfect representation of the real world, there would be uncertainty resulting from our imperfect knowledge of the present state of the climate system. This intrinsic uncertainty can be studied and quantified with initial condition ensembles, providing an upper bound on the reliability of model based probabilities. A method will be presented whereby the probabilistic reliability of a model ensemble predictions is related to the size of the initial condition ensemble available [Daron and Stainforth, 2013]. They suggest that today's GCM ensembles are likely to be too small to be interpreted probabilistically, even on the assumption that the model were perfect.

An alternative approach is to gather probabilistic information through elicitation of expert views on the behaviour of climate. The conventional approach is to assume that the experts questioned have a probabilistic understanding of the uncertainty in the variable of interest. This, however, need not be the case; their understanding may not be probabilistic in nature but rather indicative of ambiguity. Methods exist in the economic literature to identify ambiguity. I shall present results of an elicitation exercise designed to identify ambiguity amongst climate scientists [Millner et al., 2013]. They suggest that the assumption of probabilistic knowledge is itself inappropriate for climate predictions.

The lack of reliable probabilities does not imply the lack of useful scientific knowledge for adaptation decision makers. It does, however, imply that tools suitable to the source of information must be applied and that climate services must be careful to communicate climate science in ways which avoid over-interpretation.

Refs:

Daron, J., and D. A. Stainforth, *On Predicting Climate Under Climate Change,* **Env. Res. Let.**, 2013 (8)

Millner, A., R. Calel, D. Stainforth, and G. MacKerron, *Do probabilistic expert elicitations capture scientists' uncertainty about climate change?* **Climatic Change**, 2013. 116(2): p. 427-436.

Presenter

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