CIRCLE 2
CLIMATE IMPACT RESEARCH & RESPONSE COORDINATION FOR A LARGER EUROPE
EU FP7 ERA-NET

Uncertainties Workshop Proceedings

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The authors thank Roger Street and Nafees Meah for their valuable comments on an earlier version of these proceedings

Security*: Public

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1. Workshop overview

Data and venue: 11-12 November: Stockholm Sweden

Objectives: Identification of research needs and opportunities for joint research, and sharing of knowledge on: dealing with and communicating climate change uncertainties in support of climate change adaptation policy development.

Organizing committee: Carin Nilsson (SHMI/CIRCLE-2), Nina Ceric (SHMI), Jessica Mårtensson (SHMI), Rob Swart (KvK/CIRCLE-2), Saskia van Pelt (KvK), Annette Münzenberg (DLR/CIRCLE-2), Marianne Lillieskold (SEPA/CIRCLE-2), David Avelar (FFCUL/CIRCLE-2).

Advisory Committee: Tiago Capela Lourenco (FFCUL/CIRCLE-2), Markus Leitner (UBA-A/CIRCLE-2), Sergio Castellari (CMCC/CIRCLE-2), Kathryn Humphries (DEFRA/CIRCLE-2), Suraje Dessai (Exeter University), Arthur Petersen (PBL).

Participants: 47 CCIVA uncertainty experts; EU, national and regional policy makers; and research managers. Participation was by invitation only.

Output: The current proceedings of the meeting - including a set of recommendations for EU and national programmes, a policy brief, and a network of people to follow up on the recommendations.

2. Key insights:

- A disconnect exists between the scientific and 'colloquial' interpretation of the concept of uncertainty, which complicates communication. Our understanding as to how uncertainty can be used to inform assessments of impacts, vulnerability and adaptation in support of decision and policy making is still limited. There is also a disconnect between how the scientific community and the decision and policy communities use uncertainty. An open dialogue between policymakers and scientific researchers is a good starting point. Cooperation and communications are key.

- No one-size-fits-all approach exists. The definition of target groups is very important. Scientific communication should be tailored to match the policymaker's knowledge level and problem framing. Scientists should be aware of the abilities of the end-user to understand and use complex scientific information.

- To enhance communication, uncertainties could be framed and defined in ways that are most useful from a policy perspective. For example, scientists could frame uncertainties through climate risks.

- Most of the workshop participants acknowledged that complete neutrality in the analysis and presentation of climate research is not attainable. In order to keep and build credibility and trust, scientists should try to be transparent about this bias.

- A new set of guidelines for uncertainty management and communication should be developed in cooperation with end users. A platform to reach end users and other communities with such guidance should be identified, e.g. through national CIRCLE-2 partners, EU FP7 research, or the EU Adaptation Clearinghouse. This is particularly important because currently the user (and provider) communities are rapidly evolving and growing.

- Early indications suggest that probabilistic climate projections have advantages over other types of climate information, particularly in the context of risk and adaptation assessments. However, they are complex and difficult to interpret, and require sufficient support to the end-users. Just like with deterministic and multi-model climate projections, improper use of probabilistic projections could potentially lead to poor or costly decision making.

- Selection and analysis of scenarios should be rationalized for reasons of limited time, resources and accessibility. For climate change impacts and adaptation analysis, easily accessible guidance of combination of climate and socio-economic scenarios and sets of nested scenarios at different spatial and temporal scales would be required.

- There is a need to train the scientists on how to communicate climate change. These can be selected, would include interested researchers, or specific intermediate “knowledge brokers”. Professional networks and organizations in climate-relevant sectors can also play a role.

- Dealing with uncertainties is a normal element of policymakers’ daily decisions and it might in some cases encourage a precautionary approach or act as a barrier to taking action. However, ‘uncertainty’ also gives policy makers flexibility to respond in ways that align with their values. Climate researchers can provide support through the identification of methodologies to achieve robust, adaptable and flexible solutions.

- Overly complex methods of communicating uncertainties can confuse practitioners and policymakers. Visualization of impacts and adaptation measures can work as a trigger to kick-start uncertainties dialogue. However, care should be taken to guard scientific integrity by not hiding uncertainties through visualization techniques.

3. Expanded Workshop Summary

Session 1: Plenary opening session

This session set the stage for the workshop by introducing the different types of uncertainties and their relevance from a science and policy perspective.

The differences between researchers and policy makers in dealing with uncertainties was highlighted as a gap that needs to be filled. Different perspectives, framing and knowledge of the climate problem lie at the core of the communication difficulties. Different approaches to address the gap exist, including better personal communication or through information systems. Uncertainty is an issue for both communities; the workshop formed the beginning of a dialogue by agreeing that uncertainty is an issue. With some notable exceptions (including IPCC, Netherlands Environmental Assessment Agency), structured exchanges of views on uncertainties between climate scientists and policy makers are rare in Europe. Scientists have produced several guidelines for dealing with uncertainty but it is not clear which should be used for which purpose, and do they solve the communication problems and enhance the utility of the uncertainty information so that it is informative to the user communities?

There are many types of uncertainties to be dealt with in climate change impacts, vulnerability and adaptation research and assessment (CCIVA). There are different ways to frame uncertainties. It may be that the traditional "top-down" scientific framing is not the most appropriate and approaches such as those developed within 'post normal science' should be followed more. It would seem that how uncertainties are communicated is a vital step, but it is unclear how this should be done in the most effective manner.

Uncertainty is not something new for policy makers; they deal with it all the time. For the uncertainties evident in climate change, it is necessary to foster a dialogue between scientists and policy makers. Building relationships of trust will be crucial. Researchers will need to be able to present their findings in an open, targeted, true and accessible way; this represents a huge cultural change for science. Policy makers do not seek certainty nor spurious quantification, but confidence in the big picture inferences drawn from the science. and presented in a manner that can inform decision and policy making. The confidence is not be equated with prescription, as action is necessarily a social process.

Resources need to be made available to advance the communication of uncertainties and redress the problem that in many research projects uncertainties are acknowledged but often only as an afterthought. According to one participant, the use of 'roulette' as a metaphor of uncertainty has demonstrated in developing county situations that, when efforts are made to communicate scientific knowledge, responses change; the creative use of similar metaphors in participatory processes rather than using scientific jargon might be useful in developed countries also.

Key insights session 1

Uncertainties in climate change science are as acknowledged to be an issue for both scientific and decision and policy making communities. A dialogue between the two communities is indispensable as a starting point. Just the communication of uncertainties is already a vital step, but what is communicated and how this is done is just as important.

Session 2A/B: Guidance on uncertainty management for EU research and Scenarios in EU Impacts, Vulnerability and Adaptation (IVA) research

This session combined both the use of scenarios in climate change research and the added value of developing a guidance on uncertainty management. The discussion was stimulated by two key questions:

1. *Is it desirable to develop a set of guidelines for EU and national IVA research programs on how to deal with and communicate uncertainties, and if so, what would it look like and how would it be organized?*

The newly revised IPCC guidance were presented and considered to be useful for communicating about climate scenarios in a generic, global assessment context. However, in the context of CCIVA research and assessment, an approach that engages a broad community including regional and local stakeholders, such as the NUSAP "framework"(Funtowicz and Ravetz, 1990; Van der Sluijs et al.,2005), may be more useful. Furthermore, global or generic guidance documents may not be useful at the local scale or for specific sectoral questions. The CCIVA community is very heterogeneous and so are the stakeholders involved. So, there is no one-size-fits-all approach. To avoid that uncertainties are only considered in the final stages of research, assessment or policy support, scientists should identify the relevant disciplinary and stakeholder communities and the way they will deal with uncertainties already in the research proposals. Any guidance notes need to be developed in cooperation with end users and the guidance should include methods & tools. Existing guidance (US, IPCC, PBL) can be used as a basis. US research agencies require research projects to explain how uncertainties will be reduced. Acknowledging that clarifying uncertainties is more important and feasible than reducing them, research managers in Europe, such as the CIRCLE partner programmes and DG RTD, could either encourage the usage of such guidance or even make it mandatory. Several participants expressed interest in becoming involved in the development of such guidance, which may be realized in the context of ongoing European projects. It is important to institutionalize attention for uncertainty, but this will involve more than producing a guidance document alone.

2. *Is it desirable to harmonize or coordinate usage of scenarios in existing and future FP7 projects – e.g. RCP and IPCC AR5?*

Although harmonization and coordination of the selection and use of scenarios would be useful from the perspective of comparative analysis across countries and across sectoral impacts research, the feasibility of this was considered to be low. It would be difficult to coordinate the usage of scenarios between many poorly connected communities that can have different questions and priorities. The availability of a 'clearinghouse' to advise on the use of existing scenarios would be more feasible than streamlining scenarios. This could be picked up by various initiatives, such as the EU Adaptation Clearinghouse and efforts of European climate research and meteorological institutions to build a system of European climate services. There is a need for diversity in scenarios for specific applications. Nesting of scenarios at different scales is important to take the multi-level character of CCIVA issues into account.

Key insights session 2A/B

A clear demand for guidelines for uncertainty management was identified, to be developed in cooperation with end users. Mechanisms to reach end users and other communities should be identified. Scenario development and use could benefit from more cooperation and coordination within the scientific community, but its diversity makes coordination difficult. Rather, (nested sets of) scenarios should be selected in a rational way, and communicated transparently.

Session 2C: (Mis-)use of uncertainty

Session 2C examined the use, or possibly misuse, of uncertainty by scientists as well as policymakers. The debate was triggered by the following question:

Is it ethically justifiable to use uncertainties strategically to push your own climate agenda?

First, questions were raised about the strategic use of uncertainties by scientists and whether scientists have their own biases or whether they can ever be completely neutral. Although initially individual participants differed in opinion, eventually there was broad agreement that researchers are human and make value judgments, and complete neutrality is not attainable. Scientists should therefore not claim to be totally objective or value free. The degree of trust is important when communicating with policy makers, the media or the public. Therefore, scientists need to recognize their choices and possible biases and be transparent about them, to maintain and improve their credibility. Policymakers, who have there own biases, may like to have completely objective information, but it is important they acknowledge any biases where these exist.

The communication of uncertainty in this context is a big challenge. It was felt that intermediates, ”knowledge brokers” within or outside the climate scientists’ community, could play an important role, since many researchers do not have the skills or interest to communicate with policy makers, media or public. Scientists and (local) policymakers or other stakeholders should enter into a dialogue when research information is used to support policy decisions. The role of the knowledge broker should include two-way communications that engage both users and providers.

Also the “optimal” amount of knowledge on uncertainties that is communicated was discussed. Sometimes, especially in the case of adaptation, the danger of too detailed and complex information is that it is not understood by policy makers, putting off decisions or basing them on other considerations. For many adaptation options, overly complex information is not always required.

The second aspect of the question related to the appropriate response of scientists when they see that information about uncertainties is being used in ways that they consider wrong or inappropriate, e.g. to push a particular agenda by emphasizing worst case scenarios, or to postpone measures. Less time was spent on this aspect of the main guiding question above, but there was some agreement that communication in these cases should be left to researchers or intermediaries with the appropriate skills to communicate about the results in a scientifically credible fashion.

Key insights session 2C

Intentionally or unintended, scientists can be biased in setting up and communicating about their research. To keep or build credibility, they should recognize this and be transparent about it. There is a need for intermediaries or knowledge brokers to facilitate and sustain communication among providers and users of climate information. How this should be done should be evaluated on a case-to-case basis.

Session 3A: Uncertainties in practice: policy application

This session started with the presentation of some practical examples of dealing with uncertainty. An invited response of a policymaker and a scientists stimulated the debate.

According to participating researchers, policymakers usually initially demand precise numbers. The question is what level of detail and precision is both scientifically defensible and useful for policymakers. Dependent on the particular policy question, just an indication of trends is often sufficient for policymakers because the sign of projected change is quite relevant and relatively easy to understand. It was also noted that few decisions have adaptation to climate change as the only objective, usually climate concerns are just one of many concerns. It is important that there is a synergy between the climate change adaptation- and other objectives. And evidently, policymakers base their decision also on political preferences and intuition, not only on scientific information.

Providing uncertain climate information with associated uncertainties to inform political decisions is more of an art rather than science. This is an area where there is need for more research to inform the provision of climate information. Care should be taken not only to focus on the communication of uncertainty. Also adequate communication of complexity should be addressed. Reducing complexity can make information more digestible, but may be misleading.

Scientists should be careful about information overload. They should carefully consider not only what they have, but also what is really needed (fit-for-purpose) and also what may not be required. Policymakers should not be overloaded with information or maps much of which they may not need to allow them to make informed decisions.

Key insights session 3A

Policymakers base their decision not only on scientific information, but also on political preferences, intuition, and information about all kinds of other considerations. Scientific information should be fit-for-purpose, provided at such a level of detail and in such a format that a policymaker can use it. Reducing complexity can make information more digestible, but may be misleading.

Session 3B: Uncertainties in practice: the supply side

Session 3B continued on the subject matter of session 3A, with again presentations of practical examples, but now focused more on the supply side.

Participants wondered if the emphasis on communicating uncertainties triggered by political demands for full certainty would not be exaggerated. Science cannot provide full certainty about the future, and this should not lead to postponement of appropriate response on the basis of what is known. “uncertainties should not be blown up too much”.

The speakers and participants noted that policymakers are used to dealing with uncertainty in decision making, but also that climate change uncertainties and long time perspectives do not match their short term goals. They also claimed that many policymakers are not used to scenario planning as a way to deal with future uncertainties. They noted the important complication that scientists and policy makers use a different language and can interpret the terms differently, for example for terms used in the context of statistics and modelling. Framing climate change by way of changing weather events brings the issue closer to terminology with which policy makers are familiar. Another example is the usage of futures storylines rather than abstract “scenarios”, and the development of regional “translations” of global scenarios. A shift in focus from uncertainties as barrier to other approaches and how to use uncertainty to inform policy and decision making such as precautionary actions and adaptive management and could help the policy process.

Key insights session 3B

Scientific communication should be on a level and using terminology matching the policymaker’s knowledge level and problem framing. Scientists should be aware of the abilities of the end-user to understand complex scientific information. Conversely, the end-user should not hesitate to challenge the scientist to be clear and transparent.

Session 4A: Is provision of probabilistic information worth the trouble?

In this session the provision of probabilistic information was debated with presentations of pros and cons of the use of probabilistic information. The core question stimulating the debate:

> *What are arguments pro and contra the use of probabilistic information for supporting policy makers and can we provide recommendations on good practice guidance?*

Arguments contra: Probabilistic projections strongly suggest to the uninformed that the probability distribution of future changes in the climate system is known, but in reality they strongly depend on data and methodology, e.g. the selected models and emissions scenarios. Especially for the local scale, many extra steps are required, as for any climate information. The future probability distribution of the climate variable of interest (e.g. temperature or precipitation) is not known and this will not change in the future. Overconfidence in probabilistic projections as for any climate scenario or projection can lead to misuse, including mal adaptations. It takes a major investment of time and resources to produce probabilistic projections and make them available and useable.

Arguments pro: Even if probabilistic projections do not represent the full uncertainty range, they are an advance over non-probabilistic projections that are less useful from the risk perspective that many policy makers have. They do not provide the actual probability of occurrence or particular outcomes, but the frequency distribution of model output and can provide information on the strength of evidence that supports a projected outcome (as is the case for UKCP09). Knowing and understanding the strength of evidence that supports the projections can be informative when undertaking a VIA assessment. To make sure that these subtleties are understood, it is very important to spend sufficient time with users. Sustained engagement of providers and users has shown to be beneficial in understanding how the information provided can be presented, interpreted and used and in advancing their appreciation of the value of the information provided.

Participants agreed that probabilistic projections can be worth the trouble, but only if “the whole package” is provided. Putting projections on a website is a start, but not nearly enough for users to use them in a robust way. New data are not necessarily better than existing data and should only be published if they improve adaptation planning and decision-making processes. What users initially want is not necessarily what they need or what science can provide - sustained two-way engagement is required. Many policymakers do not stay in one position very long, and repeated dialogues are needed. Recognition and appreciation of skills and capacity of policymakers by researchers, and the other way around, is important.

Key insights session 4A

Probabilistic projections could be worth the trouble, but only if sufficient support is provided to the end users that goes beyond providing data through a website, otherwise it could lead to mis-use including mal adaptation. New data are not necessarily better than existing data and should only be published if they improve adaptation planning.

Session 4B: Visualization of uncertainty information

Session 4B offered some new ideas on visualizing uncertainty information. The discussion was triggered by the presentation of a number of case studies using 2D and 3D techniques.

Presenting 3D visualization of CCIVA images can be an “ice breaking tool” and trigger to start a discussion about uncertainties with the practitioners and policymakers.

The definition of target groups is very important! Depending on that the communication can be presented with charts, numbers or images and with or without uncertainties. Downscaling to a local level is an “art”, make use of co-production of information, participatory methods should be employed. It is also important to be aware of ethical problems. For example, visualization of people’s property can be a sensitive action: presenting scenarios or projections at the individual property scale can be problematic and misleading.

Some short messages:

- The “opportunities lost” can be shown with images too, to shift attention to positive impacts.
- Communicate uncertainty instead of communicating numbers.
- Use uncertainties to find the solution, don’t use it to implement the solution.
- Do not include too much information in maps.
- Communicate one thing at the time
- Test the effect of information and do not use in isolation.
- Do not assume the provision of information is sufficient to stimulate action

Key insights session 4B

The definition of target groups is very important; the presentation and visualization of uncertainties should be adapted to the end-user.

Session 5: Synthesis and future collaboration

In the final session feedback from the previous parallel sessions was presented and discussed, followed by a dialogue on future collaboration and follow-up on this workshop. A key point from earlier discussions was reiterated in the final session: both participating policy makers and scientists alike worried that too much emphasis on what is not known can be counterproductive: be aware of what we don't know, but do not focus too much on it. Recommendations were discussed in four categories:

1. **Develop guidance.** There was broad support for the development of a more systematic methodology on dealing with and communicating uncertainties, and participants volunteering to contribute. This should be tested in different EU countries and sectors, to see if it works outside one case. It could be made available through various mechanisms, such as CIRCLE partner programmes and the EU Adaptation Clearinghouse. New national, CIRCLE and European climate research calls could make attention to uncertainty communication mandatory, requesting information about the methods and tools to be applied.

2. **Consolidate networking.** It was suggested that in general science has become too competitive, and more cooperation is needed, also in this area of uncertainty management and communication. Participants of the workshop expressed their interest to remain involved in activities on this subject. The CIRCLE management agreed to consider practical ways of achieving this without overloading people with information. The hope was expressed that not only in a few years a follow-up workshop could revisit the issues, but also that real progress could be reported at that time.

3. **Stimulate communication research and training.** Little is as yet know about how to best communicate about complex issues such as climate change uncertainties and focused research would be valuable. At the same time, it was established that most European researchers lack skills to communicate scientific information in general and uncertainties in particular. Training programmes for selected scientists and knowledge brokers with communication experts were recommended as well as new collaborative efforts with professional networks working on adaptation. Questions about uncertainty could be reframed as questions about risk, with which concept policymakers are more comfortable. Probabilistic information should be provided with care and much time for interaction.

4. **Connect to policy.** On the longer term, the above three recommendations would improve the ability of the European climate researchers to communicate complex climate science information to policy makers. To communicate requires engagement and trust which suggest sustained engagement of providers and users with the accepted goal of informing each other. As an immediate action, a short policy brief will be produced and circulated to CIRCLE-2 and other national research managers, EU research managers (DG RTD / FP7, INTERREGs, ESF, LIFE+), national policy makers on adaptation (e.g., through EEA/EIONET and the Climate Adaptation Interest Group of the European Environmental Protection Agencies), and International adaptation policy makers on adaptation EU (DG Climate Action, UNFCCC, US contacts).

Key insights session 5

There is still much too be learned and discussed on dealing with and using climate change uncertainties. More cooperation and shared knowledge is important in four areas: development of guidance, consolidating the expert network, develop communication training programmes, and continue to better connect science to policy.

4. Annexes

4.1. Annex A – Agenda

DAY 1 - Thursday, November 11th

Location: Stockholm University, Geovetenskapens Hus, Room Nordensköld (3 stairs up) + 2 extra rooms

09.00-11.00 Session 1: Plenary opening session. Chair: Annette Münzenberg (DLR, Germany)

- Opening and welcome by Carin Nilsson (SMHI, Sweden)
- Different types of uncertainties and their relevance for CCIVA policy questions by Rob Swart (WUR, Netherlands)
- Why do policy makers need to know about uncertainties by Nafees Meah (DECC, United Kingdom)
- Uncertainties in different elements of cause-impacts-adaptation chain by Ole Bøssing Christensen (DMI, Denmark)

11.00-11.30 TEA AND COFFEE BREAK

11.30-13.00 Session 2: Parallel groups

A. Scenarios in EU IVA research. and B. Guidance on uncertainty management for EU research.
Chair: Hans Martin Füssel (EEA)

- Use of global, European and regional/local scenarios in European CCIVA research *by Tim Carter (SYKE, Finland)*
- Revised uncertainty guidance for the IPCC AR5 *by Kristi Ebi (IPCC WG2 TSU)*
- Uncertainty guidance of the IPCC and the Netherlands Environmental Assessment Agency: lessons for EU research *by Arthur Petersen (PBL, Netherlands)*

Dialogue addressing questions:

- Is it desirable to develop a set of guidelines for EU and national IVA research programmes on how to deal with and communicate uncertainties, and if so, what would it look like and how would it be organized
- Is it desirable to harmonize or coordinate usage of scenarios in existing and future FP7 projects – e.g. RCP and IPCC AR5

C. (Mis-)use of uncertainty in decision making. Chair: Anna Bratt (County Administrative Office Östergötland, Sweden)

- (Mis-)use of uncertainty in decision making *by Anna Bratt (CAOÖ, Sweden)*
- 3 practical examples *by Rob Swart (KvK, Netherlands)*

Dialogue addressing question:

- Is it ethically justifiable to use uncertainties strategically to push your own climate agenda?
- The dialogue on this question will be stimulated by the 3 practical cases.

13.00-14.00 LUNCH

14.00-14.45 and 14.45-15.30 Session 2 continued

- Participants change group twice, rapporteurs report earlier discussion to start debate.

15.30-16.00 TEA AND COFFEE BREAK

16.00-17.00 Session 3a: Plenary: uncertainties in practice: policy application. *Chair: Annette Münzenberg (DLR, Germany)*

- Uncertainties in regional climate change impact assessment with focus on hydrology - Results of the project: Adaption strategies on climate change for the Austrian water management *by Klaus Haslinger (ZAMG, Austria)*
- How do decision makers manage uncertainties when climate-proofing urban planning *by Niels Bent Johansen (Copenhagen Energy, Denmark)*

Invited response of policymakers and scientists

Dialogue with audience about lessons leaned (do's and don'ts)

17.00-18.00 Experiencing climate change of the Baltic Sea with the Dome (SMHI and Norrköping Visualiseringscenter give two demonstrations on the future of the Baltic Sea inside a huge tent!)

20.00 WORKSHOP DINNER AT JÄRNET, STOCKHOLM

DAY 2 - Friday, November 12

Location: Stockholm University, Södra Huset, Room E306 and E319

08.30-10.00 Session 3b: Plenary: uncertainties in practice: the supply side. *Chair: Marianne Lillieskold (SEPA, Sweden)*

- Dealing with uncertainties in climate scenarios *by Jochen Schanze (IOER, Germany)*
- Dealing with uncertainties in the modeling chain *by Claas Teichmann (Max-Planck-Institut für Meteorologie, Germany)*
- Dealing with uncertainties in support of the German adaptation strategy *by Sonja Otto (FEA, Germany)*

Invited response of policymakers and scientists

Dialogue with audience about lessons leaned (do's and don'ts)

10.00-10.30 TEA AND COFFEE BREAK

10.30-12.00 Session 4: Parallel groups

A. Is provision of probabilistic information worth the trouble? *Chair: Ole Bøssing Christensen (DMI, Denmark)*

- The UK probabilistic IVA scenarios *by Roger Street (UKCIP, United Kingdom)*
- Benefits and pitfalls: evaluation of UK scenario use *by Ana Lopez (GRI, United Kingdom)*

Dialogue addressing question:

- What are arguments pro and contra the use of probabilistic information for supporting policy makers and can we provide recommendations on good practice guidance?

B. Visualization of uncertainty information. ***Chair: Arthur Petersen (PBL, Netherlands)***

- Visualization and the potential for influencing perceptions and behaviour: the IMCORE example *by Stefan Gray (University College Cork, Ireland)*
- Addressing uncertainty in climate change impacts and response options using participatory scenario development and visualizations *by Sarah Burch (ECI-Oxford University, United Kingdom)*
- Visualizing uncertainty in maps *by Arthur Petersen (PBL, Netherlands)*

Dialogue addressing question:

- Which do's and don'ts can be identified when visualizing uncertainties?
- This dialogue on this question is stimulated by three practical cases.

12.00-13.00 LUNCH

13.00-15.00: Session 5: Plenary: Synthesis and future collaboration. *Chair: Rob Swart (KvK, Netherlands)*

- Feedback from parallel groups and discussion
- Dialogue with audience on their expectations. Have they been met in this workshop? *(Carin Nilsson, SMHI Sweden)*
- Dialogue on future collaboration: which opportunities can we identify for joint research activities in the area of uncertainty management *(Tiago Capela Lourenço, FFCUL Portugal)*
- Dialogue on possible follow-up on EU uncertainty guidance, scenario harmonization, other
- Plenary: Closing of the workshop.

15.30 Closing of Workshop

4.2. Annex D – Participants

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4.3. Annex C – Presentations

DAY 1 - Thursday, November 11th

Session 1: Plenary opening session. Chair: Annette Münzenberg (DLR, Germany)

- Opening and welcome by Carin Nilsson (SMHI, Sweden) *DOWNLOAD PRESENTATION*
- Different types of uncertainties and their relevance for CCIVA policy questions by Rob Swart (WUR, Netherlands) *DOWNLOAD PRESENTATION*
- Why do policy makers need to know about uncertainties by Nafees Meah (DECC, United Kingdom) *DOWNLOAD PRESENTATION*
- Uncertainties in different elements of cause-impacts-adaptation chain by Ole Bossing Christensen (DMI, Denmark) *DOWNLOAD PRESENTATION*

Session 2: Parallel groups

A. Scenarios in EU IVA research & B. Guidance on uncertainty management for EU research. Chair: Hans Martin Füssel (EEA)

- Use of global, European and regional/local scenarios in European CCIVA research by Tim Carter (SYKE, Finland) *DOWNLOAD PRESENTATION*
- Revised uncertainty guidance for the IPCC AR5 by Kristi Ebi (IPCC WG2 TSU) *DOWNLOAD PRESENTATION*
- Uncertainty guidance of the IPCC and the Netherlands Environmental Assessment Agency: lessons for EU research by Arthur Petersen (PBL, Netherlands) *DOWNLOAD PRESENTATION*

C. (Mis-)use of uncertainty in decision making. Chair: Anna Bratt (County Administrative Office Östergötland, Sweden)

- (Mis-)use of uncertainty in decision making by Anna Bratt (CAOÖ, Sweden)
- 3 practical examples by Rob Swart (KvK, Netherlands) *DOWNLOAD PRESENTATION*

Session 3a: Plenary: uncertainties in practice: policy application. Chair: Annette Münzenberg (DLR, Germany)

- Uncertainties in regional climate change impact assessment with focus on hydrology - Results of the project: Adaption strategies on climate change for the Austrian water management by Klaus Haslinger (ZAMG, Austria) *DOWNLOAD PRESENTATION*
- How do decision makers manage uncertainties when climate-proofing urban planning by Niels Bent Johansen (Copenhagen Energy, Denmark) *DOWNLOAD PRESENTATION*

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Session 3b: Plenary: uncertainties in practice: the supply side. Chair: Marianne Lillieskold (SEPA, Sweden)

- Dealing with uncertainties in climate scenarios by Jochen Schanze (IOER, Germany)
- Dealing with uncertainty in the modeling chain by Claas Teichmann (Max-Planck.Institut fur Meteorologie, Germany) *DOWNLOAD PRESENTATION*
- Dealing with uncertainties in support of the German adaptation strategy by Sonja Otto (FEA, Germany) *DOWNLOAD PRESENTATION*

Session 4: Parallel groups

A. Is provision of probabilistic information worth the trouble? Chair: Ole Bøssing Christensen (DMI, Denmark)

- The UK probabilistic IVA scenarios by Roger Street (UKCIP, United Kingdom) *DOWNLOAD PRESENTATION*
- Benefits and pitfalls: evaluation of UK scenario use by Ana Lopez (GRI, United Kingdom) *DOWNLOAD PRESENTATION*

B. Visualization of uncertainty information. Chair: Arthur Petersen (PBL, Netherlands)

- Visualization and the potential for influencing perceptions and behaviour: the IMCORE example by Stefan Gray (University College Cork, Ireland) *DOWNLOAD PRESENTATION*
- Addressing uncertainty in climate change impacts and response options using participatory scenario development and visualizations by Sarah Burch (ECI-Oxford University, United Kingdom) *DOWNLOAD PRESENTATION*
- Visualizing uncertainty in maps by Arthur Petersen (PBL, Netherlands) *DOWNLOAD PRESENTATION*

Session 5: Plenary: Synthesis and future collaboration. Chair: Rob Swart (KvK, Netherlands)

- Dialogue with audience on their expectations. Have they been met in this workshop? by Carin Nilsson (SMHI Sweden) *DOWNLOAD PRESENTATION*
- Dialogue on future collaboration: which opportunities can we identify for joint research activities in the area of uncertainty management by Tiago Capela Lourenço (FFCUL Portugal) *DOWNLOAD PRESENTATION*

4.4. Annex B – Abstracts

4.4.1. Rob Swart (WUR, Netherlands)

Assessing and Communicating Uncertainties in Climate Change Impacts, Vulnerability and Adaptation

This introductory presentation discusses the kind of questions researchers, practitioners and policy makers have about climate change impacts, vulnerability and adaptation. They tend to require information on variables that have the greatest uncertainties, e.g. projections of the frequency and intensity of extreme weather events at regional and local time scales, within the next few decades at most. Which scenario is the most likely and which solution is the best? Rather than waiting until uncertainties regarding these questions will be resolved, decisions can be made acknowledging that uncertainties exist but cannot all be quantified. It is important to realize that different people frame uncertainty differently, e.g. as a knowledge deficit (a provisional and temporary problem), as something that can be incorporated in an evidence evaluation (scientific consensus building), or as an intrinsic characteristic of a complex system that cannot be removed. For different aspects of the climate problem different types of uncertainty dominate: statistical uncertainty (e.g., observations, probability distribution known), scenario uncertainty (e.g., IPCC SRES) or recognized ignorance (account for surprises). These different types can be addressed in impact assessment by different approaches. A large number of decision-making frameworks exists and a wide variety of methods and tools is available to address uncertainties. Different framing requires different techniques, but for one particular framing perspective several (complementary) techniques are suitable.

4.4.2. Nafees Meah (DECC, United Kingdom)

Climate uncertainty and decision making – What do policy makers want to know?

Uncertainty in climate change science is the cause of an enormous amount of anxiety for many climate change scientists. There are conferences held about it where it is discussed at great length. The IPCC devotes special papers on dealing with uncertainty; and, recently, the InterAcademy Panel wrote a report highly critical of the inconsistent treatment of uncertainty by the three Working Groups the IPCC 4th Assessment Report. Talk of uncertainty seems to be gnawing at the heart of the climate change science enterprise.

Indeed, climate change „sceptics“ have exploited this anxiety to the full. One of the claims against the „scientific consensus“ on climate change is that as the science is all uncertain, then there is no firm basis for political action. The response of scientists has generally been one of defensiveness. That is clear from the „Climategate“ affair and in the response to the criticism of IPCC 4th Assessment Report for the errors found within it.

I think that this defensiveness arises from the belief amongst many scientists that policy makers need clear unambigous statments from them on which the policy maker can then

make clear and unambigous policy decisions. However, that is a caricature of the policy process. Although there are models of policy making which posit a rational process of agenda setting, evidence gathering, assessment of options, implementation, evaluation etc., usual presented as a cycle, the reality is that it is irreducibly „messy". In most areas of policy, particularly in contested areas, the normal situation is characterised by complexity, ambiguity and uncertainty - whether it be prison policy or drugs policy.

The point I want to make is that policy makers deal with uncertainty all the time. It is the „normal" condition of the political process; their „bread and butter". Further, science by its very nature is contingent and provisional and cannot provide this elusive „certainty" in any case. So in answer to the question of „what policy makers want?" , I would assert that it is not certainty nor a spurious quantification saying one is „50% certain" (sic) but confidence in the big picture inferences drawn from the science. It does not follow that from that confidence expressed by the scientific community on a set of propositions about the state of world (or the future world) that action should necessarily follow. What happens next is an irreducibly social process in which the scientific community/ communities is/are but one set of actors, albeit important actors.

4.4.3. Kristi Ebi (IPCC WG2 TSU)

Revised uncertainty guidance for the IPCC AR5

The Co-Chairs of the three Working Groups of the Intergovernmental Panel on Climate Change have developed guidance notes for lead authors of the 5th Assessment Report on consistent treatment of uncertainties. These notes define a common approach and calibrated language that can be used broadly for developing expert judgments and for evaluating and communicating the degree of certainty in findings of the assessment process. These notes refine background material provided to support the Third and Fourth Assessment Reports; they represent the results of discussions at a Cross-Working Group Meeting on Consistent Treatment of Uncertainties convened in July of 2010. They also address key elements of the recommendations made by the 2010 independent review of the IPCC by the InterAcademy Council. Each Working Group will supplement these notes with more specific guidance on particular issues consistent with the common approach.

4.4.4. Arthur Petersen (PBL, Netherlands)

Exploring the quality of evidence for complex and contested policy decisions

Policy decisions on complex environmental risks often involve contested science. Typically there are no 'facts' that entail a unique correct policy. The evidence that is embodied in scientific policy advice requires quality assessment. Advice should be relevant to the policy issue, scientifically tenable and robust under societal scrutiny. In 2003, the Netherlands Environmental Assessment Agency adopted a standardized method, referred to as 'guidance', whereby key quality aspects of knowledge production and use are exhibited through a checklist for uncertainty assessment and communication. Although the guidance is not fully used within all projects yet, it is increasingly used, attitudes towards dealing with uncertainty in performing and reporting environmental assessments have changed, and communication on

uncertainty in the agency's reports has improved over the past five years. In this letter, we present results from the application of the guidance to controversies on the risks of ambient particulate matter. The active deliberation on uncertainty in the policy–advisory setting brings about a joint learning process for advisors and policy makers, which leads to a deeper understanding and increased awareness of the phenomenon of uncertainty and its policy implications.

4.4.5. Ana Bratt (CAOO, Sweden)

(Mis-)use of uncertainty in decision making

Practitioners need to make decisions concerning climate change adaptation now. In Sweden they work under the 16 National Environmental Objectives. The practice is spatial planning at municipal level, public health at regional level, land based production on either short term, as in agriculture or horticulture, or forestry at long term scale. Risk and vulnerability requires decisions in both civil emergency planning and crisis management, as do environmental management when authorities assess permits and perform controls. In the practice of nature conservation decisions are also taken based on actual conditions in relation to assumed conditions in the future. These decisions will be taken regardless how uncertain research results are.

The decisions are based on results, policies and local conditions, all with their respective agendas. Research results are to a degree based on practitioners needs, but to a higher degree based on an academic agenda of funding opportunities and corresponding call objectives, what is a pertinent research questions within the researchers field, and what method is possible or interesting to develop. Politicians are dependent on their mandate as well as their period of office, which gives a shorter time perspective in combination with the long list of demands they try to satisfy within their terms of power. The local conditions set an agenda with local knowledge about micro climate, historic weather events, political culture and routines. Not to mention local land-use management and its effects and consequences for economic impact.

In many cases the practitioners' decisions are dependent on robustness in the results. The democratic decision making process is often long, and a later up-date that changes conditions can be difficult to communicate.

A concern is that while a political decision on limits on discharge release has not been made, who decides what scenarios are used in modelling?

Issues to discuss

- Who is responsible?
- The risk of over/under adaptation?
- What are the long term effects?
- Will the issue of adaptation be better managed under the umbrella of Sustainable Development or under Risk management?
- How do we communicate that climate uncertainties are like other uncertainties?

4.4.6. Rob Swart (KvK, Netherlands)

(Mis-)use of uncertainty in decision making: 3 practical examples.

The presentation introduces three cases to generate a discussion on the use and possible misuse of uncertainty in decision-making. How should scientists or policy advisors best act? The first case addresses the question if the IPCC WG2 AR4 Lead Authors legitimately included almost exclusively examples of negative impacts in the IPCC AR4 WGII report at the summary level and associated those with climate change alone, while the underlying report also provides positive impacts and also notes other stress factors. Is the argument that the negative climate impacts are the most relevant to policymakers justified? The second case addresses the question of how should scientists should react when policy makers use scientific information selectively or use (or ignore) prevailing uncertainties to motivate or defend political "science-based" decisions. An example is used of the design discharge for flood protection measures which are often at least as much based on political priorities at the time as on evolving scientific insights. The third and final case addressed the question of how serious scientists should identify themselves in their role as "honest broker" to inform policy makers in a balanced fashion. Should they respond to incorrect or unbalanced statements in the media or political debates, e.g. by climate deniers, and if so how?

4.4.7. Klaus Haslinger (ZAMG, Austria)

Uncertainties in regional climate change impact assessment with focus on hydrology - Results of the project: Adaption strategies on climate change for the Austrian water management

In fall 2009 the ZAMG and the TU-Wien were commissioned by the Federal Ministry of Agriculture, Forestry, Environment and Water Management to compile a study with adaption strategies on climate change for the Austrian water management. In this presentation an overview of the results for two sections of this report shall be given, first the climatological part and second the part concerning surface water stream flow. The ZAMG contributed with an investigation of past climatologically behaviour bases on multiple observation datasets and the future on the basis of Global Circulation Models (GCMs) on one hand and especially Regional Climate Models (RCMs) on the other hand. The main topics included the analysis of observed trends and descriptive statistics of precipitation and temperature, as well as the projected change in the future derived by RCMs for the period 2021-2050. An important part of the analysis was the assessment of the model bias and to find a procedure for the hydrologic modellers of the TU-Wien how to deal with this bias. Under these circumstances the colleagues of the TU set up different methods for rainfall-runoff modelling, to approach the change in stream flow in the future from different methodological directions. A further aim was not only to quantify the magnitude of change, but also to find out about the mechanism that drive the change and how sensitive the hydrological cycle reacts using different methods.

4.4.8. Jochen Schanze (IOER, Germany)

Dealing with uncertainties in climate scenarios

Uncertainty of climate change projections is tremendous and results from various sources. Impact assessment in addition needs to consider societal change which provides further sources of uncertainty. Accordingly, decision makers request for advice on how to deal with uncertain regional climate change, its impacts and the decision space for adaptation measures.

Against this background a scenario-based method has been developed which allows for the formulation and analysis of so-called *futures*. The aim of the approach is to project possible natural and societal boundary conditions of a regional system and to analyse and evaluate their impacts on the system's performance ex ante. Hereby the futures combine both autonomous scenarios of climate and societal change as well as strategic alternatives of policy interventions as bundles of individual management options. They specify narrative assumptions and policies to scientific system parameters which ensure model-based impact assessment.

The approach is currently being tested in the region of the city of Dresden under the REGKLAM research project funded by the German Federal Ministry of Education and Research. As a first step a regional climate sensitive system has been defined as reference for change projections and impact assessment. Delineation and description of the system draw on key processes sensitive to climate impacts and have been adjusted with experts from science and practice. Scenarios of change are currently derived based on regional storylines and consider a wide spectrum of climate change projections resulting from different SRES scenarios and downscaling models as well as projections of demographic, economic and land-use change. In contrast to the involvement mainly of experts for the scenario formulation, adaptation measures and their assignment to strategic alternatives are originated and discussed within a comprehensive network of regional actors from relevant sectors and levels of the society. This extensive stakeholder involvement will lead to a high applicability of the results.

In the next phase both scenarios and strategic alternatives are combined to parameterised futures to simulate their impacts on the system performance. As a result policy makers will receive not only information on expected risks and opportunities due to climate change. Beyond specific criteria are used to display uncertainties such as robustness of measures under different climate and regional change conditions. The talk in this respect will present results from a previous research project and their use in authorised spatial plans for instance as band width for zoning uncertain flood prone areas.

4.4.9. Sonja Otto (FEA, Germany)

Uncertainties in the German Climate Change Policy – Experiences and Reflections

In general, uncertainties in CC policy can be differentiated into normative and informative uncertainty. Normative uncertainty is based on uncertain goals and actions also including different perceptions of acceptable risks. They can be reduced by participatory decision processes. Informational uncertainty is due to limited knowledge. For climate change policy, this knowledge relates mainly to the projections of climate change and its impacts, which can only be reduced to a limited amount by research.

To deal with uncertainties in climate change policy, policy has to be regarded as a circular process and should be based on adaptive management: planning, implementing and revising adaptation activities is regularly be done on basis of new research results, regular monitoring and evaluation. At each step of the policy cycle, the decision makers face uncertainties and seek therefore scientific advice:

Some steps are directly connected with informative uncertainty and scientific questions, e.g. identification of adaptation options, whereas other steps are mainly based on normative decisions which are in the responsibility of the policy makers, e.g. which policy objectives and priorities have to be set.

Also the German Adaptation Strategy (DAS) process is connected with normative and informative uncertainties. KomPass is supporting the DAS by providing scientific knowledge and advice for different steps in policy cycle, connected with informative uncertainties, e.g. by realisation of climate change (impact) projects (extreme events in regional climate models). To address the uncertainties connected with regional climate change projections, the results of four different regional climate models where used in the DAS. They show the range of possible climate futures in Germany.

In a decision process some uncertainties are larger than others and often the decision connected with normative uncertainties are larger than the ones related to informational uncertainty. Additionally, decision makers are not only dealing with climate change but also other threats with own uncertainties, e.g. in regard to globalisation, urbanisation, changes in society, etc., and have very many decision criteria (e.g. funding for adaptation measures, ethical / social justice criteria, regional / local development, winning the next election, etc.), out of which only few might be concerned with facing adaptation to climate change.

4.4.10. Roger Street (UKCIP, United Kingdom)

The UK probabilistic IVA scenarios

Climate information for adaptation should be seen as a credible response to the need to better inform adaptation decision and policy making.

Most of those using climate information for these purposes will find climate information challenging and few have the time nor capabilities to use available climate information

Decision and policy makers are also challenged by the need to integrate uncertainties

Provides some insight into targeted efforts to support the use of climate information and into innovations introduced as understanding and experience with using that information have increased.

It is proposed that shared learning and further innovations are necessary to enhance the utility of the projections if the target when providing them is to continue to better inform the changing scope of users and their evolving needs.

4.4.11. Ana Lopez (GRI, United Kingdom)

Is probabilistic climate change information necessary to inform adaptation to climate change?

The UK probabilistic climate scenarios are amongst the most ambitious perturbed physics and muti-model ensembles available to date. They represent an important step towards the goal of generating probabilistic climate change projections at scales relevant to quantify the impacts of anthropogenic climate change. However these projections are based on the current understanding of the climate system, and on climate models that are known to have many limitations even on their ability to simulate some of the well known physical processes. Therefore, the probabilistic projections are conditional on the assumptions and structure of the modelling approaches used to generate them.

It has been argued that probabilistic climate change information is required by different stakeholders in order to adequately evaluate and plan adaptation pathways. On the other hand, some circumstantial evidence suggests that on the ground decision making rarely uses well defined probability distributions of climate change as inputs.

Within this context, we discuss the possible drawbacks of supplying information that while seemingly robust, is highly conditional on the model data and statistical methodology used to construct it, and consequently might change in the future. We present some examples of the

possible effects of the uncertainty in the probability distributions themselves and how these can lead to under or over adaptation if the information provided is misinterpreted or used incorrectly.

What then are the alternatives? The answer will depend on the context of the problem at hand. The approach to follow has to be strongly informed by issues such as the timescale of the given planning decision, and the consideration of all the non-climatic factors that have to be taken into account in the corresponding risk assessment. Using as an example a water resources system in the UK, we illustrate possible alternative approaches to deal with these challenges and make robust adaptation decisions today.

4.4.12. Stefan Gray (University College Cork, Ireland)

Visualization and the potential for influencing perceptions and behavior: the IMCORE example.

Participants in the IMCORE project have found that a difficult yet vital step in the process of adaptation to climate change in coastal zones is to communicate the urgency of the need for adaptation action to high-level coastal stakeholders. Policy makers typically require absolute ‘certainty’ in the advice they receive before embarking on any course of action, yet the constraints of the scientific method and the behaviour of complex adaptive systems preclude such blanket assurances. To overcome this barrier to effective communication between the realms of science and policy, the IMCORE project has opted to take an innovative approach, employing visualisation and scenario planning methodologies to stimulate debate, broaden perceptions, and garner the long term engagement of the high-level stakeholders and policy makers which the project is seeking to influence.

In the case of the Cork IMCORE case study area, a strong historical legacy of storm surge and precipitation induced coastal flooding has acted as a catalyst for the creation of an interactive

visualisation tool based on computer gaming technology. Presenting a highly realistic rendition of the city, the tool is capable of visualising flooding to any depth the user chooses, and can thus serve to communicate a wide range of potential climate related flood impacts. By employing such a tool to visualise flooding of the city under existing conditions, a 'low level' climate impact regime, and finally a 'high level' climate impact regime, a facilitated scenario workshop exploring the future of flood management in Cork can thus be rendered contentious and highly engaging. Utilised in this way, the tool might serve to trigger debate among participants as to what level of flooding the city can expect in the future, allowing the facilitator to explicitly introduce the subject of uncertainty regarding the interplay of the many complex factors that will determine future flooding in Cork. The aim of this discussion is not to diminish the level of uncertainty pertaining to the 'low' or 'high' climate impact regimes, but to instead communicate that any conception of the future flooding of Cork is fraught with uncertainty – including one predicated on the perpetuation of current conditions. Given such systemic uncertainty, the aim of the exercise is to engender an adaptive ethos to the formulation of coastal management policy, such that management decisions are robust under a range of potentially plausible futures, and that 'win-win' adaptation options become the norm in coastal management.

4.4.13. Sarah Burch (ECI-Oxford University, United Kingdom)

Hot in my backyard: Addressing uncertainty in climate change impacts and response options through participatory scenario development and visualization

Climate change research is largely global in focus, aims at enhanced understanding, and is driven by experts, all of which seem to be insufficient to anchor climate change action in regional and local contexts. Efforts are intensifying, however, to design effective climate change strategies that make use of the wealth of resources and latent capacities associated with action at the local level. Municipalities are subject to a host of challenges and barriers to action, revealing the critical need for sophisticated participatory processes in support of decision-making under conditions of considerable uncertainty.

Results will be presented from a participatory scenario-based study conducted in collaboration with the municipalities of Delta and the District of North Vancouver, in southwestern British Columbia, Canada. This study applies a participatory capacity building approach for climate change action at the local level: the scale at which climate change is most meaningful to decision-makers and stakeholders alike. This work employed an iterative, collaborative, and multi-stakeholder approach to produce visions and computer-generated 3D images of local climate change futures. The process appeared to forge communicative partnerships, which may improve the legitimacy and effectiveness of the climate change response discourse, and may lead to locally-specific and integrated climate change response strategies.

Of particular importance was the participatory dimension of understanding climate impacts and response options at the local scale, including the integration of multidisciplinary/local knowledge, in order to overcome significant data gaps and uncertainties at the local scale. Visualizing low probability, high magnitude events highlights critical questions surrounding the need to strike a balance between scientific defensibility and visual drama. Lessons learned from this process will be presented, including the potential for application of these methods in the European context.