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Communicating uncertainty in climate information: Insights from the behavioural sciences

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Multiple sources of uncertainty in climate information

For example: Model formulation, model initialisation, large scale forcings, the impact of future human activities….

•Models are formulated probabilistically.

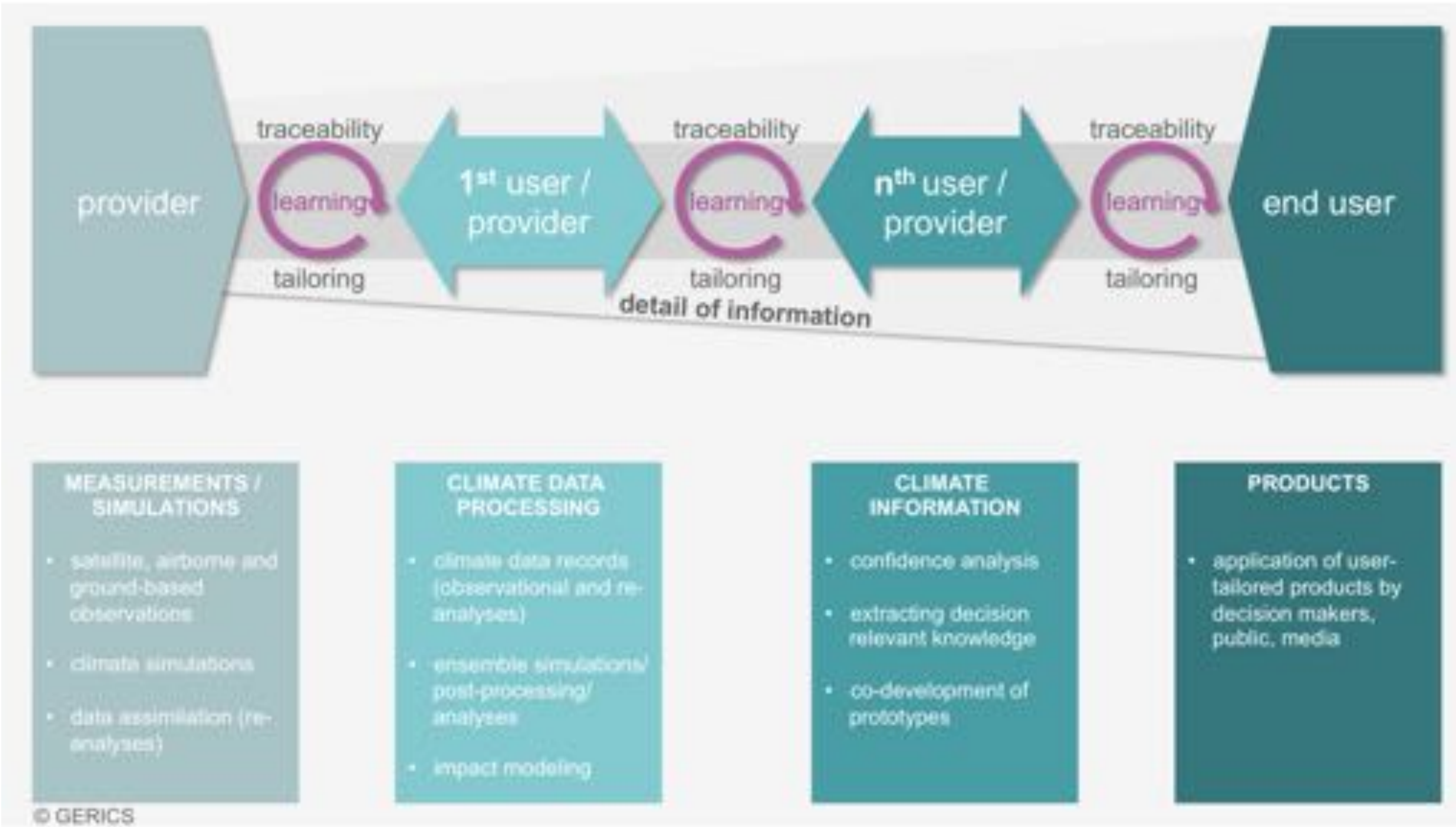
•Forecast performance reflected in measures of reliability and skill.

•Multi-decadal projections are scenario based.

If uncertainty is not adequately communicated then this may lead to:

- A false sense of certainty (e.g. Brezis, 2011)
- Proliferation of erroneous assumptions in future stages of data processing (e.g. Otto et al., IN PRESS)
- Maladaptive decision making (Macintosh, 2013)
- Reduced trust in information providers (e.g. LeClerc and Joslyn, 2015)

However users of climate information are diverse in both their needs and the their expertise.



Taken from Otto et al. (IN PRESS)

Communication Challenges

- Uncertainty aversion and preferences for deterministic information (e.g. Taylor et al., 2015)
- The same information being interpreted in different ways
  - *"What does a 40% chance of rain actually mean"?* (e.g. Gigerenzer, 2005)
- Misrepresentation of what uncertainty means (Oreskes, 2004)
- Differences in ability to use complex statistical data (e.g. Taylor et al.,2015)
- Time pressure limits ability to attend to complex information (e.g. Huber and Kunz, 2009)
- Even amongst experts, terminologies differs….

For a more in depth review of this literature see Taylor et al. (2014) EUPORIAS Deliverable 33.2 Report summarising review of existing approaches for communicating confidence and uncertainty ***www.euporias.eu/system/files/D33.2_Final.pdf***

"When thinking of systems, I relate reliability to the fail-operational behaviour where a system must keep operating even if part of it has failed…." **Computer Science**

"Gives a reproducible result in different but related empirical contexts." **Economics**

"How often something works against how often it doesn't work" **Engineering**

"An observation that predictably occurs following the manipulation of specific variables" **Cognitive psychology**

"What does the word "reliability" mean to you?"

A quick survey of colleagues at Leeds University Business School

"Repeatable across different occasions/ times and researchers (avoiding subject error, subject bias, observer error, observer bias, measurement error etc)" **Sciences** and **Management** (multiple disciplines)

"A reliable result in an empirical study is one that is not likely to have arisen by chance and can be replicated). Similarly, a reliable measuring instrument is one that gives the same reading when the same thing is measured twice within an acceptable margin of error. " **Psychology**

"Replication and consistency in measurement. For example, if I get the same result, each time I measure the length of my desk with a ruler, the ruler should be reliable." **Risk Communication** (Multiple disciplines)

Establish processes for "validating communication"

- The methods needed to do this effectively will differ depending on the nature of the user group.
  - e.g. iterative one-on-one development, interviews, surveys, or large experimental studies
- Identify where misunderstandings occur and address them (e.g. terminology, design features).

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Examples from EUPORIAS Work Package 33

"Test the effectiveness of different approaches to communicating the confidence and uncertainty associated with S2D predictions."

EUPORIAS

European Provision Of Regional Impacts Assessments on Seasonal and Decadal Timescales

http://www.euporias.eu/

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EUPORIAS Work Package 33 partners

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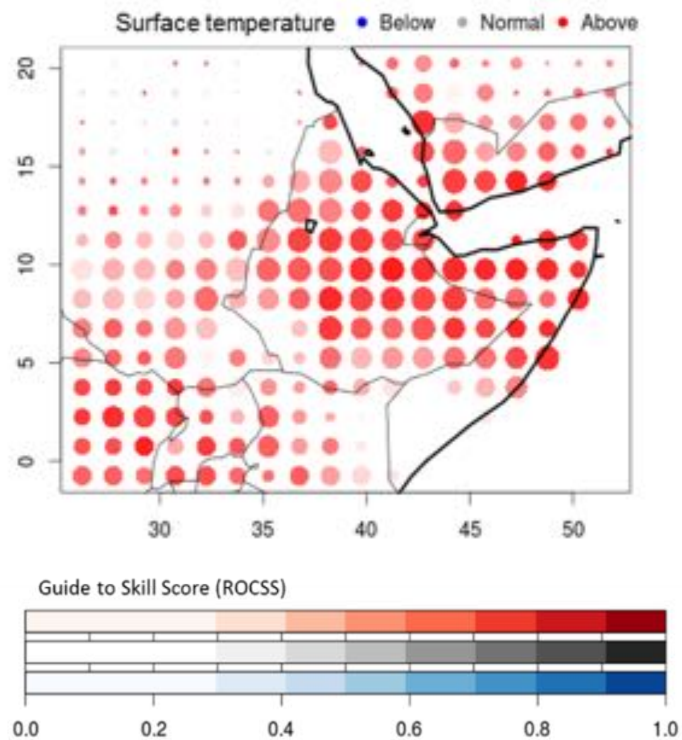
- The Bubble Map was generally well understood by technically experienced users when skill was high.
- However, far fewer responded correctly when there was no skill.
- We hadn’t sufficiently explained what ‘blank space’ indicated.

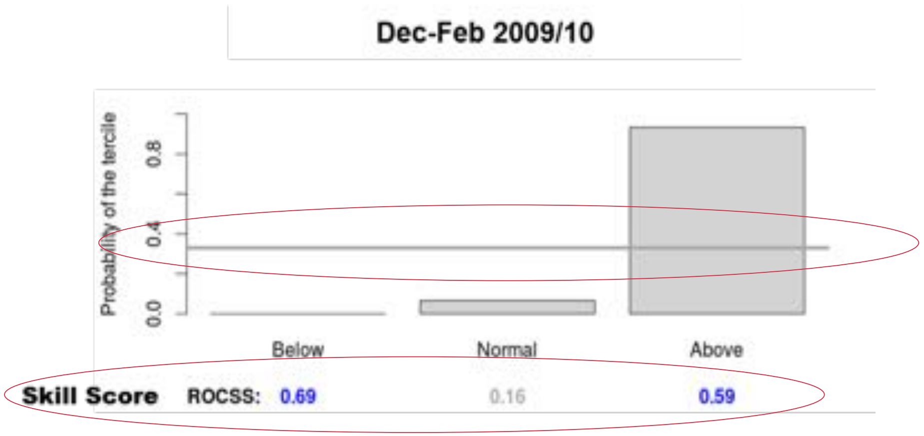


Visualsation data: Sample surface temperature data retrieved from ECOMS -UDG (https://meteo.unican.es/trac/wiki/udg/ecoms). Predictions are retrieved from System 4 (15 ensemble members) and observations from WFDEI (Weedon et al., 2014).

See Appendix of Taylor et al. (2015) for accompanying R code: http://euporias.eu/system/files/D33.3.pdf

See Taylor et al. (2016) for key EUPORIAS Work Package 33 findings: http://www.euporias.eu/system/files/D33%205_Final.pdf

- Those with less experience of using statistics struggled with this graph.
- Skill scores and the climatology line were being mistaken for probabilities.
- Had we not inspected errors we would not have identified these misunderstandings.



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Other key findings

- Preference does not always denote better understanding (Lorenz et al., 2015; Taylor et al., 2016).
- "Evaluative categories" can aid understanding of complex numeric information (Peters et al., 2009; Taylor et al., 2016).
- "Framing" affects responses to uncertainty in climate projections (Ballard and Lewandowsky, 2015)
- "Progressive disclosure of information" can be one solution to the varying needs and expertise of users (Kloprogge et al. 2007)

Recommendations

- In developing communications consider user expertise, time pressure, framing effects, uncertainty avoidance.
- Tailored communications developed through a process of iterative interaction with users are optimal (e.g. http://www.project-ukko.net/)
- Where these are not possible due to the size and diversity of the user group then consider a “progressive disclosure of information” strategy.
- Identify where misunderstandings of terminology or design features may occur.
- Validate communication!

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http://lubswww2.leeds.ac.uk/cdr/

Climate Change Adaptation Group

http://www.see.leeds.ac.uk/research/sri/climate-change-adaptation-group/

Thank you!

Some references that may be of interest to climate information providers communicating with….

Users across the value chain

•Otto, J., C. et al. (In Press) Uncertainty: Lessons learned for climate services. Bull. Amer. Meteor. Soc. doi:10.1175/BAMS-D-16-0173.1 **(Focus: Multiple)**

End users / Decision Makers

•Lorenz, S., Dessai, S., Forster, P. M., & Paavola, J. (2015). Tailoring the visual communication of climate projections for local adaptation practitioners in Germany and the UK. Phil. Trans. R. Soc. A, 373(2055), 20140457. (**Focus: Climate projections**)

•Taylor, A. L., Dessai, S., & de Bruin, W. B. (2015). Communicating uncertainty in seasonal and interannual climate forecasts in Europe. Phil. Trans. R. Soc. A, 373(2055), 20140454. **(Focus: Seasonal forecasts)**

• Taylor, A.. L. et al (2016) EUPORIAS Deliverable 33.5: Strategies for communicating levels of confidence in seasonal predictions: Recommendations and Lessons Learnt. www.euporias.eu/system/files/D33%205_Final.pdf **(Focus: Seasonal forecasts)**

Public audiences

•Ballard, T., & Lewandowsky, S. (2015). When, not if: the inescapability of an uncertain climate future. Phil. Trans. R. Soc. A, 373(2055), 20140464. **(Focus: Climate Change Projections.)**

•Bruine de Bruin, W., & Bostrom, A. (2013). Assessing what to address in science communication. *Proceedings of the National Academy of Sciences*, *110*(Supplement 3), 14062-14068. **(Focus: General Science)**

•LeClerc, J., & Joslyn, S. (2015). The Cry Wolf Effect and Weather‐Related Decision Making. *Risk analysis*, *35*(3), 385-395. **(Focus: Weather Forecasting)**