Assessing and Communicating Confidence Levels and Uncertainties in the Main Conclusions of the NCA 2013 Report: Guidance for Authors and Contributors[1]

Executive Summary

This guidance recommends an approach to standardize uncertainty characterization and communication (UCC) in the National Climate Assessment (NCA). The steps summarized here are described in greater detail below. A bibliography and a checklist for major conclusions are included at the end of the document.

1. Frame a manageable number (3-4) of key questions or issues that address the most important information needs of stakeholders.

2. Evaluate the available information, considering the type, amount, quality, and consistency of evidence, summarizing the level of evidence as strong, fair, or weak if you wish.

3. Formulate well-posed conclusions that can be confirmed or falsified, being aware of a tendency for assessment teams to converge on a conclusion and become overconfident in it. Quantitative summaries of your opinions and uncertainties are helpful to users of the report and you are asked, wherever possible, to estimate a 90 percent confidence interval, to describe consequential outliers that may fall outside this range, and then to develop a "best estimate" if appropriate.

4. Identify key uncertainties and briefly describe what monitoring, research, etc., is needed to improve the information base.

5. Assess your confidence by considering (i) the quality of the evidence and (ii) the level of agreement among experts with relevant knowledge and experience. Use the confidence rating and associated graphic in reporting your finding.

6. Especially for findings that identify potential high consequence outcomes, estimate uncertainty probabilistically (i.e., provide a likelihood that the outcome could occur under a stipulated scenario or conditions).

7. Prepare a traceable account of describes the main factors that contributed to the conclusion and level of confidence.

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Guidance Document

Introduction

These summary guidelines recommend an approach to standardize uncertainty characterization and communication (UCC) among assessors and authors contributing to the National Climate Assessment (NCA). The guidelines are written in a condensed, summary style intended to provide practical advice to assessment participants. More detailed guidance is available from a variety of sources listed in a short bibliography at the end of the document.

Effective UCC is more than quantification of uncertainties in model results or reporting uncertainties documented in existing studies. UCC needs to incorporate systematic stakeholder participation, clear question (or problem) framing, identification of useful quantitative indicators or metrics when possible, appraisal of the knowledge base, evaluation of relevant uncertainties in the context of the question or problem that has been framed, and reporting of sources of confidence and uncertainty. UCC depends on an overall NCA assessment process that systematically reviews the available information, incorporates multiple perspectives, and is transparent in describing the information used, the standards of evidence applied, and the confidence of the authors in their results. This broader approach to UCC is necessary to develop socially robust knowledge for climate change decision making that is appropriate for the diverse stakeholders and high decision stakes associated with this issue. This approach to UCC will enable users of the information to have an understanding of its reliability.

Recommended UCC Process

1. *Frame a manageable number (3-4) of key questions or issues that address the most important information needs of stakeholders.* This can be done either through direct consultation or by review of prior assessments that have documented stakeholder information needs. Consider the specific issues or decisions that stakeholders are facing so that the question and subsequent answers are useful. You might consider these as the main questions you will include in the executive summary or your report or that you would recommend for inclusion in the NCA 2013 synthesis report. Careful framing of the question or problem will distinguish uncertainty from ambiguity in the issue being addressed. Teams preparing technical inputs for the NCA process are likely to have more opportunity to interact with stakeholders than the NCA 2013 report chapter authors and are strongly encouraged to do so as part of the framing process.

2. *Evaluate the available information*, considering the type, amount, quality, and consistency of evidence. You may wish to summarize the level of evidence as strong,

fair, or weak. This initial evaluation will help in deciding how to approach developing a conclusion and identifying an appropriate level of precision.

- What types of information are available? Examples: research-quality observations, data for operational purposes, theories, model results, elicitations, expert judgment, survey data.
- How much information is available? Example considerations: independent studies, multiple data sets, model ensembles.
- How good is the information? Example criteria: accuracy and completeness of observational data, model evaluations (of completeness, etc.), use of widely accepted methods, transparency and thoroughness of documentation, peer reviewed journal articles or reports.
- How consistent is the information? Example considerations: similar conclusions persistently reached in the literature, assumptions controlled (e.g., use of similar scenarios), standardized methods or reporting.

3. *Formulate well-posed conclusions* that can be confirmed or falsified. Incorporate diverse science-based perspectives and apply available information deemed to be of sufficient quality.

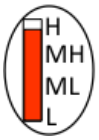
- State your conclusions clearly and specifically. For example, "the number of extreme rainfall events will increase" is not well posed without additional information. This conclusion should include a quantitative definition of extreme rainfall, the location, season, and time period for which the statement applies, and the climate scenario (or level of climate change) assumed.
- Be aware of a tendency for assessment teams to converge on a conclusion and become overconfident in it. A strategy some groups have used to minimize this problem is to have each individual write down his or her conclusions to the key questions before starting work as a group.
- For quantitative estimates, estimate the 90 percent confidence interval – use of a standardized confidence interval across the report will improve communication of results to users. Describe consequential outliers that may fall outside this range. Only then develop a "best estimate" if appropriate.

4. *Identify key uncertainties* and briefly describe what monitoring, research, etc., are needed to improve information.

- Sources of uncertainty vary depending on the topic and thus no single typology can be provided as a guide for NCA authors. Report uncertainty in important information sources (e.g., observations, data, model projections), or problem framing (e.g., disagreements over concepts or indicators).
- Focus your evaluation on how uncertainties affect the base of information for decision making. Not all uncertainties will have significant effects on estimates of outcomes, costs, or risks.
- Discuss what new research, data collection, or modeling would address these uncertainties

5. *Assess confidence* by considering (i) the quality of the evidence and (ii) the level of agreement among experts with relevant knowledge and experience.

- Evaluation of confidence is a subjective process, and it must be based on systematic evaluation of the type, amount, quality, and consistency of evidence and the degree of agreement among experts with relevant knowledge and experience.
- Different combinations of factors affecting the strength of evidence and level of agreement can be associated with each confidence level.
- Use the assigned confidence level and its associated graphical confidence index[2] to report your findings.



Confidence Level	Combinations of factors that could contribute to this confidence evaluation
High	Strong evidence (established theory, multiple sources, consistent results, well documented and accepted methods, etc.), high consensus
Medium High	Fair evidence (several sources, some consistency, methods vary and/or documentation limited, etc.), medium consensus
Medium Low	Fair evidence (a few sources, limited consistency, models incomplete, methods emerging, etc.), competing schools of thought
Low	Weak evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.), disagreement or lack of opinions among experts

[2] Acknowledgement to Dan Albritton, who developed the confidence index to communicate ozone and climate science to policymakers.

6. *Estimate uncertainty probabilistically,* e*specially for findings that identify potential high consequence outcomes,* (i.e., provide a likelihood that the outcome could occur under a stipulated scenario or conditions).

- Report subjective likelihoods for high consequence, low probability events, providing a thorough explanation of your level of confidence and its rationale. Use the standardized ranges below if you wish. Likelihoods can be based on evaluation of model results, statistical sampling methods or other quantitative analyses, elicitations, or expert judgment. This information will be important for risk framing.

- A recurring debate among authors of assessments is whether there is "sufficient" information available to quantify likelihoods. What constitutes sufficiency is a value judgment by the authors related to their level of comfort in reporting findings at a particular point in time before evidence meets an often-unspecified confidence level. Scientists almost always want to have more information than is available and need to consider whether the information available to them is sufficient to inform a better decision.

7. *Prepare a summary "traceable account"* (a few sentences to a paragraph) that describes the main factors that contributed to the conclusion and level of confidence. Describe evidence used, its quality, ranges of estimates or interpretations in the literature, assumptions, and the level of agreement. For descriptions of projected impacts, specify the scenario of climate change being used. Consider preparing a more extended traceable account to include in an appendix

Example: (under development)

Please complete this checklist for each major conclusion.

Brief statement of conclusion, referenced to report or chapter:
1. Framing and stakeholder information needs Consulted users and framed conclusion to meet their decisionmaking needs. Fully Partially Limited extent
2. Initial evaluation of evidence Evaluated type, amount, quality, and consistency of evidence. Strong Fair Weak
3. Application of information and preparation of conclusions Incorporated diverse science-based perspectives, estimated 90 percent confidence interval, described important outliers, provided best estimate if appropriate. Fully Partially Limited extent
4. Key uncertainties identified Evaluated sources of uncertainty, e.g., limited data, process knowledge gaps, incomplete models, inherent variability of the system, etc., and identified how additional monitoring, research, etc., will improve information base. Fully Partially Limited extent
5. Confidence assessed using evidence and agreement Assigned a confidence level, recognizing that different combinations of factors affecting evidence and agreement will influence your confidence. High Med High Med Low Low
6. Likelihoods estimated for potential high consequence outcomes Estimated likelihood using evaluation of model results, statistical sampling methods, other quantitative analyses, elicitations, or expert judgment. Yes No
7. Traceable account included to describe factors that contributed to conclusion and level of confidence Described reasoning, evidence used, scenario assumptions, etc. Yes No

Bibliography and Resources

This short bibliography includes references consulted in preparing these guidelines, additional resources for authors, and contributions to the decision analysis research literature and its application to climate science that may be of interest. This is far from a complete list of relevant references and is not intended as a catalog of relevant information.

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