Communicating about Uncertainty in Climate Change, Part I

The Intergovernmental Panel on Climate Change (IPCC) guidelines for their 2007 report stipulated how its contributors were to convey uncertainties regarding climate change scientific evidence, conclusions, and predictions. Budescu et al.'s (2009) empirical investigation of how laypeople interpret verbal probability expressions (e.g., "very likely") in the IPCC report revealed several problematic aspects of those interpretations, and a paper I have co-authored with Budescu's team (Smithson, et al., 2011) raises additional issues.

Recently the IPCC has amended their guidelines, partly in response to the Budescu paper. Granting a broad consensus among climate scientists that climate change is accelerating and that humans have been a causal factor therein, the issue of how best to represent and communicate uncertainties about climate change science nevertheless remains a live concern. I'll focus on the issues around probability expressions in a subsequent post, but in this one I want to address the issue of communicating "uncertainty" in a broader sense.

Why does it matter? First, the public needs to know that climate change science actually has uncertainties. Otherwise, they could be misled into believing either that scientists have all the answers or suffer from unwarranted dogmatism. Likewise, policy makers, decision makers and planners need to know the magnitudes (where possible) and directions of these uncertainties. Thus, the IPCC is to be commended for bringing uncertainties to the fore its 2007 report, and for attempting to establish standards for communicating them.

Second, the public needs to know what kinds uncertainties are in the mix. This concern sits at the foundation of the first and second recommendations of the Budescu paper. Their first suggestion is to differentiate between the ambiguous or vague description of an event and the likelihood of its occurrence. The example the authors give is "It is *very unlikely* that the meridonial overturning circulation will undergo a *large abrupt* transition during the 21st century" (emphasis added). The first italicized phrase expresses probabilistic uncertainty whereas the second embodies a vague description. People may have different interpretations of both phrases. They might disagree on what range of probabilities is referred to by "very likely" or on what is meant by a "large abrupt" change. Somewhat more worryingly, they might *agree* on how likely the "large abrupt" change is while failing to realize that they have different interpretations of that change in mind.

The crucial point here is that probability and vagueness are distinct kinds of uncertainty (see, e.g., Smithson, 1989). While the IPCC 2007 report is consistently explicit regarding probabilistic expressions, it only intermittently attends to matters of vagueness. For example, in the statement "It is likely that heat waves have become more frequent over most land areas" (IPCC 2007, pg. 30) the term "heat waves" remains undefined and the time-span is unspecified. In contrast, just below that statement is this one: "It is likely that the incidence of extreme high sea level[3] has increased at a broad range of sites worldwide since 1975." Footnote 3 then goes on to clarify "extreme high sea level" by the following: "Excluding tsunamis, which are not due to climate change. Extreme high sea level depends on average sea level and on regional weather systems. It is defined here

as the highest 1% of hourly values of observed sea level at a station for a given reference period."

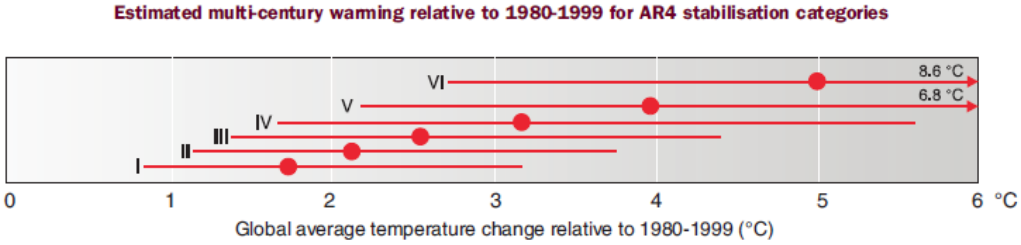
The Budescu paper's second recommendation is to specify the sources of uncertainty, such as whether these arise from disagreement among specialists, absence of data, or imprecise data. Distinguishing between uncertainty arising from disagreement and uncertainty arising from an imprecise but consensual assessment is especially important. In my experience, the former often is presented as if it is the latter. An interval for near-term ocean level increases of 0.2 to 0.8 metres might be the consensus among experts, but it could also represent two opposing camps, one estimating 0.2 metres and the other 0.8.

The IPCC report guidelines for reporting uncertainty do raise the issue of agreement: "Where uncertainty is assessed qualitatively, it is characterised by providing a relative sense of the amount and quality of evidence (that is, information from theory, observations or models indicating whether a belief or proposition is true or valid) and the degree of agreement (that is, the level of concurrence in the literature on a particular finding)." (IPCC 2007, pg. 27) The report then states that levels of agreement will be denoted by "high," "medium," and so on while the amount of evidence will be expressed as "much,", "medium," and so on.

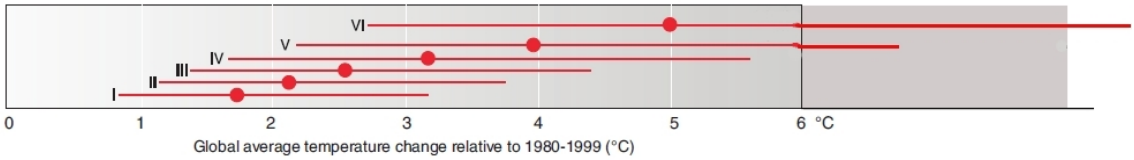
As it turns out, the phrase "high agreement and much evidence" occurs seven times in the report and "high agreement and medium evidence" occurs twice. No other agreement phrases are used. These occurrences are almost entirely in the sections devoted to climate change mitigation and adaptation, as opposed to assessments of previous and future climate change. Typical examples are:
"There is *high agreement* and *much evidence* that with current climate change mitigation policies and related sustainable development practices, global GHG emissions will continue to grow over the next few decades." (IPCC 2007, pg. 44) and
"There is *high agreement* and *much evidence* that all stabilisation levels assessed can be achieved by deployment of a portfolio of technologies that are either currently available or expected to be commercialised in coming decades, assuming appropriate and effective incentives are in place for development, acquisition, deployment and diffusion of technologies and addressing related barriers." (IPCC2007, pg. 68)

The IPICC guidelines for other kinds of expert assessments do not explicitly refer to disagreement: "Where uncertainty is assessed more quantitatively using expert judgement of the correctness of underlying data, models or analyses, then the following scale of confidence levels is used to express the assessed chance of a finding being correct: very high confidence at least 9 out of 10; high confidence about 8 out of 10; medium confidence about 5 out of 10; low confidence about 2 out of 10; and very low confidence less than 1 out of 10." (IPCC 2007, pg. 27) A typical statement of this kind is "By 2080, an increase of 5 to 8% of arid and semi-arid land in Africa is projected under a range of climate scenarios (*high confidence*)." (IPCC 2007, pg. 50)

That said, some parts of the IPCC report do convey disagreeing projections or estimates, where the disagreements are among models and/or scenarios, especially in the section on near-term predictions of climate change and its impacts. For instance, on pg. 47 of the 2007 report the graph below charts mid-century global warming relative to 1980-99. The six stabilization categories are those described in the Fourth Assessment Report (AR4).



Although this graph effectively represents both imprecision and disagreement (or conflict), it slightly underplays both by truncating the scale at the right-hand side. The next figure shows how the graph would appear if the full range of categories V and VI were included. Both the apparent imprecision of V and VI and the extent of disagreement between VI and categories I-III are substantially greater once we have the full picture.



There are understandable motives for concealing or disguising some kinds of uncertainty, especially those that could be used by opponents to bolster their own positions. Chief among these is uncertainty arising from conflict. In a series of experiments Smithson (1999) demonstrated that people regard precise but disagreeing risk messages as more troubling than informatively equivalent imprecise but agreeing messages. Moreover, they regard the message sources as less credible and less trustworthy in the first case than in the second. In short, conflict is a worse kind of uncertainty than ambiguity or vagueness. Smithson (1999) labeled this phenomenon "conflict aversion." Cabantous (2007) confirmed and extended those results by demonstrating that insurers would charge a higher premium for insurance against mishaps whose risk information was conflictive than if the risk information was merely ambiguous.

Conflict aversion creates a genuine communications dilemma for disagreeing experts. On the one hand, public revelation of their disagreement can result in a loss of credibility or trust in experts on all sides of the dispute. Laypeople have an intuitive heuristic that if the evidence for any hypothesis is uncertain, then equally able experts should have considered the same evidence and agreed that the truth-status of that hypothesis is uncertain. When Peter Collignon, professor of microbiology at The Australian National University, cast doubt on the net benefit of the Australian Fluvax program in 2010, he attracted opprobrium from colleagues and health authorities on grounds that he was undermining public trust in vaccines and the medical expertise behind them. On the other hand, concealing disagreements runs the risk of future public disclosure and an even greater erosion of trust (lying experts are regarded as worse than disagreeing ones). The problem of how to communicate uncertainties arising from disagreement and vagueness simultaneously *and* distinguishably has yet to be solved.

References

Budescu, D.V., Broomell, S. and Por, H.-H. (2009) Improving the communication of uncertainty in the reports of the Intergovernmental panel on climate change. Psychological Science, 20, 299–308.

Cabantous, L. (2007). Ambiguity aversion in the field of insurance: Insurers' attitudes to imprecise and conflicting probability estimates. *Theory and Decision, 62*, 219–240.

Intergovernmental Panel on Climate Change (2007). *Summary for policymakers: Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Retrieved May 2010 from http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf.

Smithson, M. (1989). *Ignorance and Uncertainty: Emerging Paradigms*. Cognitive Science Series. New York: Springer Verlag.

Smithson, M. (1999). Conflict Aversion: Preference for Ambiguity vs. Conflict in Sources and Evidence. *Organizational Behavior and Human Decision Processes*, 79: 179-198.

Smithson, M., Budescu, D.V., Broomell, S. and Por, H.-H. (2011) *Never Say "Not:" Impact of Negative Wording in Probability Phrases on Imprecise Probability Judgments*. Accepted for presentation at the Seventh International Symposium on Imprecise Probability: Theories and Applications, Innsbruck, Austria, 25-28 July 2011.