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Improving communication of uncertainty in the IPCC reports

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Background

Results of scientific studies and projections of models in various domains are inherently uncertain. Accurate communication of these uncertainties to the general public and to policy makers is critical. The language of uncertainty may itself be a source of confusion. Uncertainties can be communicated as precise values (e.g., *there is a 0.5 chance*), as ranges (e.g., *the probability is between 0.3 and 0.6*, or *the probability is at least 0.75*), as phrases (e.g., *it is not very likely*), or by combining some of these modalities.

People, overwhelmingly, prefer to communicate uncertainty by using verbal terms because they are perceived to be more natural and intuitive. Most people tend to avoid the use of precise numerical values because they can imply a false sense of precision. Research also shows that people's interpretations of probability phrases vary greatly (see Wallsten & Budescu, 1995). The naïve under-appreciation of the natural variability in people's intuitive understanding of phrases used to convey uncertainty can create "an illusion of communication" and undermine the quality of subsequent decisions.

Given this problem many organizations have developed "standardized lexicons of uncertainty". Indeed, this is the approach that was taken by the IPCC (see Mastrandrea et al., 2010), which has adopted a conversion table that links a finite set of phrases with specific (overlapping) ranges of probabilities (e.g., *unlikely* < 33%; *very likely* > 90%). All contributors to the reports are instructed to refer to this table when making probabilistic pronouncements. The table is also included in all IPCC reports to help readers make sense of the assessment.

Probability words and / or numbers?

It is natural to ask whether the readers of the assessment reports interpret it probabilistic pronouncements as intended by the authors. My colleagues and I have conducted a large scale multi-national study to test the public's understanding of these expressions. We administered the survey in 25 samples and 17 languages and obtained almost 11,000 valid responses. Participants saw 8 sentences from IPCC reports (including the terms *very unlikely*, *unlikely*, *likely* and *very likely*) and provided their numerical estimates of the probability, as well as lower and upper bounds of the sentences' intended meaning. *In all the samples the public interprets the probabilistic statements in the IPCC reports as less extreme – much closer to 50% - than intended by the authors!*

Participants were randomly assigned to one of two experimental groups. One group saw the IPCC statements, as they appear in the report along with its translation table. The *Verbal – Numerical* group always saw the verbal terms and their numerical ranges simultaneously. For example, when the sentence "It is **very likely** that hot extremes, heat waves, and heavy precipitation events will continue to become more frequent" was shown to respondents in this N group, uncertainty was described as **very likely (greater than 90%)**.

Budescu, Por, Broomell and Smithson (2014) found that *the new communication format was highly beneficial: (a) the level of correspondence between the public's interpretation of the terms and the IPCC guidelines increased significantly (See Figure 1); (b) the terms were better differentiated by the readers; and (c) the range of values associate with the various terms was reduced. These qualitative patterns were remarkably stable across all samples and languages. Remarkably, (d) the joint presentation format makes the meaning of the terms more similar across languages facilitating international communication. Remarkably, (d) the joint presentation format makes the meaning of the terms more similar across languages facilitating international communication.*

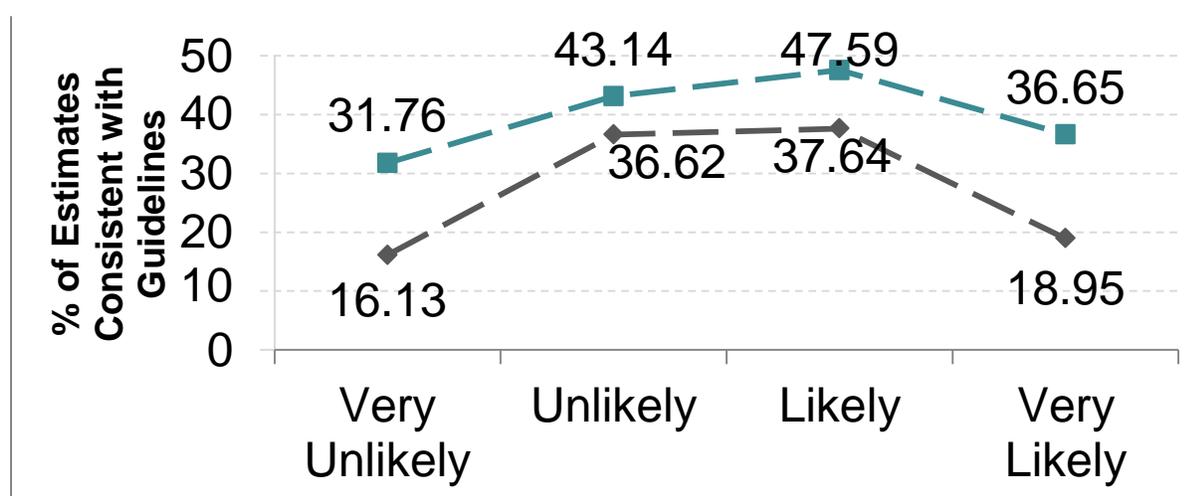
Optimal definitions of the probability words' meaning

Another problem with the current conversion table is related to choice of the cut-off points that differentiate between the terms. These values do not match most people natural and intuitive usage of the

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terms. Ho, Budescu, Dhami and Mandel (In press) have illustrated the superiority of evidence-based communication lexicons using data from the same survey. The participants were asked to indicate the numerical meanings they assign to the same four phrases in their daily use, without specifying any particular context. We used standard statistical techniques to analyze the estimates of the US sample and derived cutoff points to maximize the agreement in meaning across all respondents. It is crystal clear that the IPCC's ranges for *very unlikely* and *very likely* are much too narrow and too extreme (closer to the end points, 0 and 1) by comparison with the respondents' intuitive and natural interpretations of these phrases.

In order to compare how effectively the evidence-based lexicon and the IPCC guidelines convey information about uncertainty, we re-analyzed evaluations of the phrases in the eight IPCC sentences, using the responses of the Australian and U.K. samples. The mean consistency rates in these samples were around 40%, and clearly outperformed the current IPCC lexicon, which has a consistency rate of 26%. *The effectiveness of communication of uncertainty can be easily improved by revising the definitions of the terms, in line with people's natural understanding of these phrases.*



Recommendations

These results provide strong justification for revising the way the IPCC communicates uncertainty to the public and policy makers. I recommend continuing the use of the 7 verbal categories used in AR5 (Mastrandrea et al., 2010), but:

1. Change the thresholds defining the bounds of the categories to
 - a. Reflect the general public's intuitive and natural interpretation of the 7 words, and
 - b. Generate a partition (mutually exclusive and exhaustive categories) of the probability scale, excluding overlapping categories.
2. Whenever one of the probabilistic terms is used, it should always be accompanied by a range of numerical values.
3. The default range for each term should be the one listed in the translation table (see point 1 above), but if the authors are sufficiently confident about a certain event, they should be allowed to narrow the range, as long as it is consistent with the table. For example, if by default Likely is mapped into the 60% - 85% range, authors should have the option to use a narrower range (for example, Likely (65% -75%), if the data warrant such determination.

These changes would improve the effectiveness of the communication by appealing to readers who prefer different communication modes, would facilitate communication across cultural and linguistic bounds and would allow IPCC authors more flexibility.

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