PART 8. COMMUNICATING UNCERTAINTY

It is often argued that one should not try to communicate about uncertainty to non-technical audiences, because laypeople won't understand and decision makers want definitive answers – what Senator Muskie referred to as the ideal of receiving advice from "one armed scientists"[33].

We do not agree, non-technical people deal with uncertainty, and statements of probability all the time. They don't always reason correctly about probability, but they can generally get the gist (Dawes, 1988). While they may make errors about the details, for the most part they manage to deal with probabilistic precipitation forecasts from the weather bureau, point spreads at the track, and similar probabilistic information. The real issue is to frame things in familiar and understandable terms.

There has been considerable discussion in the literature about whether it is best to present uncertainties to laypeople in terms of odds (*e.g.*, 1 in 1000) or probabilities (*e.g.*, p = 0.001) (Fischhoff *et al.*, 2002). Baruch Fischhoff provides the following summary advice:

- Either will work, if they're used consistently across many presentations.
- If you want people to understand one fact, in isolation, present the result both in terms of odds and probabilities.
- In many cases, there's probably more confusion about what is meant by the specific events being discussed than about the numbers attached to them.

[33] The reference, of course, being to experts who always answered his questions "on the one hand…but on the other hand…," the phrase is usually first attributed to Senator Edmund Muskie.

Ibrekk and Morgan (1987) reached a similar conclusion in their study of alternative simple graphical displays for communicating uncertainty to non-technical people, arguing for the use of more than one display when communicating a single uncertain result. They also report that "rusty or limited statistical knowledge does not significantly improve the performance of semi-technical or laypersons in interpreting displays that communicate uncertainty." (Morgan and Henrion, 1990)

Patt and Schrag (2003) studied how undergraduate respondents interpret both probabilities and uncertainty words that specifically relate to climate and weather. They found that these respondents mediated their probability judgments by the severity of the event reported (*e.g.*, hurricane versus snow flurries). They conclude that "in response to a fixed probability scale, people will have a tendency to over-estimate the likelihood of low-magnitude events, and under-estimate the likelihood of high-magnitude events." This is because, "intuitively people use such language to describe both the probability and the magnitude of risks, and they expect communicators to do the same." They suggest that unless analysts make it clear that they are not adjusting their probability estimates up and down depending on the severity of the event described, policy makers' response to assessments are "…likely to be biased downward, leading to insufficient efforts to mitigate and adapt to climate change." (Patt and Schrag, 2003)

The presence of high levels of uncertainty offers people with an agenda an opportunity to "spin the facts." Dowlatabadi reports that when he first started showing probabilistic outputs from Carnegie Mellon's Integrated Climate Assessment Model (ICAM) to staff on Capitol Hill, many of those who thought that climate change was not happening or was not important, immediately focused in on the low impact ends of the model's probabilistic outputs. In contrast, many of those who thought climate change was a very serious problem immediately focused in on the high impact ends of the model's probabilistic outputs.

This does not mean that one should abandon communicating about uncertainty, there will always be people who wish to distort the truth. However it does mean that communicating uncertainty in key issues requires special care, so that those who really want to understand can do so.

Recipients will process any message they receive through their previous knowledge and perception of the issues at hand. Thus, in designing an effective communication, one must first understand what folks who will receive that message already know and think about the topics at hand. One of the clearest findings in the empirical literature on risk communication is that there is no such thing as an expert who can design effective risk communication messages without some empirical evaluation and refinement of those messages with members of the target audience.

In order to support the design of effective risk communication messages, Morgan *et al.* (2002) and colleagues developed a "mental model" approach to risk communication. Using open-ended interview methods, subjects are asked to talk about the issues at hand, with the interviewer providing as little structure or input to the interview process as possible. After a modest number of interviews have been conducted, typically twenty or so, an asymptote is reached in the concepts mentioned by the interviewees and few additional concepts are encountered. Once a set of key issues and perceptions have been identified, a closed form survey is developed which can be used to examine which of the concepts are most prevalent, and which are simply the idiosyncratic response of a single respondent. The importance of continued and iterative empirical evaluation of the effectiveness of communication is stressed.

One key finding in this literature is that there is no such thing as an expert in communication – in the sense of someone who can tell you ahead of time how a message should be framed, or what it should say. Empirical study is absolutely essential to the development of effective communication.

Using this method, Bostrom *et al.* (1994) and Read *et al.* (1994) examined public understanding and perception of climate change. On the basis of their findings, a communication brochure for the general public was developed, and iteratively refined using read-aloud protocols and focus group discussions (Morgan and Smuts, 1994). Using less formal ethnographic methods, Kempton (1991; Kempton *et al.*, 1995) has conducted studies of public perceptions of climate change and related issues, obtaining results that are very similar to those of the mental model studies. More recently Reiner *et al.* (2006) have conducted a cross-national study of some similar issues.

While the preceding discussion has dealt with communicating uncertainty in situations in which it is possible to do extensive studies of the relative effectiveness of different communication methods and messages, much of the communication about uncertain events that all of us receive comes from reading or listening to the press.

Philip M. Boffey (quoted in Friedman *et al.,* 1999), editorial page editor for *The New York Times*, argues that "uncertainty is a smaller problem for science writers than for many other kinds of journalists." He notes that there is enormous uncertainty about what is going on in China or North Korea and that "economics is another area where there is great uncertainty." In contrast, he notes:

> With science writing, the subjects are better defined. One of the reasons why uncertainty is less of a problem for a science journalist is because the scientific material we cover is mostly issued and argued publicly. This is not North Korea or China. While it is true that a journalist cannot view a scientist's lab notes or sit on a peer review committee, the final product is out there in the public. There can be a vigorous public debate about it and reporters and others can see what is happening.

Boffey goes on to note that "one of the problems in journalism is to try to find out what is really happening." While this may be easier than in some other fields, because of peer-reviewed articles, consensus panel mechanisms such as NRC reports, "there is the second level problem of deciding whether these consensus mechanisms are operating properly…Often the journalist does not have time to investigate…given the constraints of daily journalism." However he notes:

> …these consensus mechanisms do help the journalist decide where the mainstream opinion is and how and whether to deal with outliners. Should they be part of the debate? In some issues, such as climate change, I do not feel they should be ignored because in this subject, the last major consensus report showed that there were a number of unknowns, so the situation is still fluid….

While it is by no means unique, climate change is perhaps the prototypical example of an issue for which there is a combination of considerable scientific uncertainty, and strong short-term economic and other interests at play. Uncertainty offers the opportunity for various interests to confuse and divert the public discourse in what may already be a very difficult scientific process of seeking improved insight and understanding. Combine this with the limited scientific background of many reporters, the tendency of the press to seek conflict and report "on the one hand, on the other hand" and do so in just a few words and with very short deadlines, it is small wonder that there are problems.

Chemist and noble laurite Sherry Roland (quoted in Friedman *et al*., 1999) notes that "…scientists reputations depend on their findings being right most of the time. Sometimes, however, there are people who are wrong almost all the time and they are still quoted in the media 20 years later very consistently."

Despite continued discourse within scientific societies and similar professional circles about the importance of scientists interpreting and communicating their findings to the public and to decision makers, freelance environmental writer Dianne Dumanoski (quoted in Friedman *et al.*, 1999) is correct when she observes that "strong peer pressure exists within the scientific community against becoming a visible scientist who communicates with the media and the public." Combined with an environment in which there is high probability that many statements a scientist makes about uncertainties will immediately be seized upon by advocates in an ongoing public debate, it is small wonder that many scientists choose to just keep their heads down, do their research, and limit their communication to publication in scientific journals and presentations at professional scientific meetings.

The problems are well illustrated in an exchange between biological scientist Rita Colwell (then Director of the National Science Foundation), Peggy Girsham of NBC (now with NPR) and Sherry Roland reported by Friedman *et al.* (1999). Colwell noted that when a scientist talks with a reporter they must be very careful about what they say, especially if they have a theory or findings that run counter to conventional scientific wisdom…"it is very tough to go out there, talk to a reporter, lay your reputation on the line and then be maligned by so called authorities in a very unpleasant way." She noted that this problem is particularly true for women scientists, adding "I have literally taken slander and public ridicule from a few individuals with clout and that has been very unpleasant…" NBC's Girsham (now with NPR) noted that in a way scientist in such a situation cannot win "because if you are not willing to talk to a reporter, then we [in the press] will look for someone who is willing and may be less cautious about expressing a point of view." Building on this point, Rowland noted that in the early day of the work he and Mario Molina did on stratospheric ozone depletion "Molina and I read *Aerosol Age* avidly because we were the 'black hats' in every issue. The magazine even went to far as to run an article calling us agents of the Soviet Union's KGB, who were trying to destroy American industry…what was more disturbing was when scientists on the industry side were quoted by the media, claiming our calculations of how many CFCs were in the stratosphere were off by a factor of 1,000…even after we won the Nobel Prize for this research, our politically conservative local newspaper…[said that while the] theory had been demonstrated in the laboratory…scientists with more expertise in atmospheric science had shown that the evidence in the real atmosphere was quite mixed. This ignored the consensus views of the world's atmospheric scientists that the results had been spectacularly confirmed in the real atmosphere." Clearly, even when a scientist is as careful and balanced as possible, communicating with the public and decisions makers about complex and politically contentious scientific issues is not for the faint hearted!

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