Room for doubt

Uncertainty

"Consensus science can only provide an illusion of certainty."

Roger A. Pielke Jr

Who really killed John F. Kennedy? How many whales inhabit the oceans? How will climate change? Does God exist? Strive as we might, answers to such questions cannot be known with certitude. Uncertainty means that more than one outcome is consistent with our expectations. Expectations are a result of judgement, sometimes based on technical mistakes and interpretive errors, and shaped by values and interests. Because uncertainty is a characteristic of every important decision, it is no surprise that society looks to science and technology to help clarify our expectations in ways that lead to desired outcomes.

Decision-making is forward-looking; consequently, decision-makers in governments and other organizations have traditionally looked to science and technology to quantify and if possible reduce uncertainties about the future. In many cases, particularly those associated with closed systems — or systems that can be treated as closed — understanding uncertainty is a straightforward technical exercise: probabilities in a card game, error analysis in engineering and manufacturing, or the actuarial science underlying many forms of insurance, for example. But in many other circumstances, systems are not closed, and understanding uncertainty in an open system is considerably more challenging. Many scientists have taken on the challenge of understanding such open systems — global climate, genetic engineering, and so on. And the process of securing the considerable public resources to pursue this challenge often results in their explicit promise to "understand and reduce uncertainties".

Conventional wisdom holds that uncertainty is best understood or reduced by advancing knowledge, an apparent restatement of the traditional definition of uncertainty as "incomplete knowledge". But in reality, advances in knowledge can add significant uncertainty. For example, in 1990 the Intergovernmental Panel on Climate Change (IPCC) projected that a doubling of CO_2 in the atmosphere would result in a 1.5 to 4.5 °C mean global temperature change. In 2001, after tens of billions of dollars of investment in global-change research, the IPCC now concludes that a doubling of CO_2 will result in a 1.5 to 6.0 °C temperature change. Even as the IPCC has become more certain that temperature will increase, the uncertainty associated with its projections has also increased. Why? Researchers have concluded that there are many more scenarios of possible population and energy use than originally assumed, and have learned that the global ocean–atmosphere–biosphere system is much more complex than was once thought. Ignorance is bliss because it is accompanied by a lack of uncertainty.

Science and technology can also make the certain uncertain. Consider, for example, the invention of nuclear power, chlorofluorocarbons and genetically modified organisms (GMOs). In seeking to reduce uncertainties related to power generation, refrigeration and agriculture, each invention created new uncertainties: radiation disasters, ozone depletion and ecosystem response, respectively. From this perspective, a key difference between the critics and the champions of science and technology is that the former focus on new uncertainties (the glass half-empty), the latter on reduced uncertainties (the glass half-full).

The apparently successful policy response to chlorofluorocarbon-induced ozone depletion rests on an effective mix of science and technology and decision-making, with the role of the latter under-appreciated. Without careful attention to this mix — and particularly its effects on our expectations — society may take the responsibility for reducing uncertainty out of the hands of science and technology, as has been the case with nuclear power (and seems to be occurring with GMOs), possibly limiting potential benefits from new technologies for ever.

Consider once again global climate change. For many years, policy debate has centred on the degree of certainty that decision-makers ought to attach to competing visions of the future climate. Lost in this doomed enterprise is the point that climate will certainly have an increasingly strong effect on the environment and society, simply because of growing vulnerability related to factors such as population, wealth and use of land. If a goal of climate policy is to reduce the effects of climate on the environment and society, then effective action need not wait until we are more certain about details.

Seen in this light, efforts to reduce uncertainty via 'consensus science' — such as scientific assessments — are misplaced. Consensus science can provide only an illusion of certainty. When consensus is substituted for a diversity of perspectives, it may in fact unnecessarily constrain decision-makers' options. Take for example weather forecasters, who are learning that the value to society of their forecasts is enhanced when decision-makers are provided with predictions in probabilistic rather than categorical fashion and decisions are made in full view of uncertainty.

As a general principle, science and technology will contribute more effectively to society's needs when decision-makers base their expectations on a full distribution of outcomes, and then make choices in the face of the resulting — perhaps considerable — uncertainty. ■

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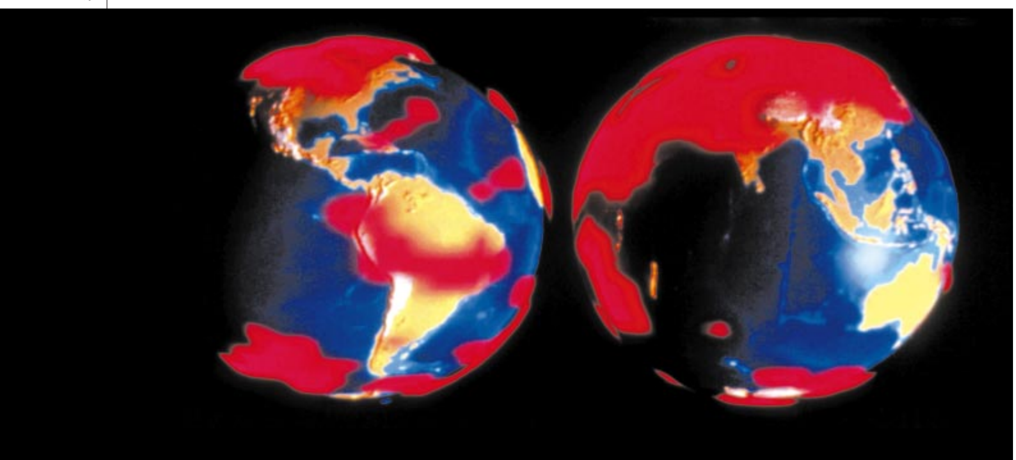

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Degrees of uncertainty: more research has led to wider projections for the effect of CO_2 on temperature.

FURTHER READING

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