Responsible scientific advice about climate change is about risk management, not scare-mongering

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DISCLOSURE STATEMENT

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We should decide how to act based on how risky something is, and how bad the consequences will be.dybarber/Flickr

A popular misconception in the public mind is that science "proves" things by turning them from ideas and theories into absolute "facts". This more or less confuses science with mathematics. *Mathematical* theories can be proven; in *science*, nothing is absolutely certain. Scientists apply statistical criteria: they conclude theories are well-established if they have less than a 1-in-20 or 1-in-100 chance of being wrong. These are referred to as the 95% or 99% confidence levels.

In practice people have to act on scientific theories, implicitly taking account of the probabilities. The acceptable probability is a value judgement – it depends on the consequences. A 10% chance of rain in a weather forecast may encourage a person to carry an umbrella but still go for a walk. But a 10% chance that an aircraft might crash would encourage few people to fly.

What is concerning about potential human-induced climate change is that it is likely to have adverse effects on humans and ecosystems. Whether we do something about climate change by reducing global greenhouse gas emissions, or choose to adapt to it, depends on the potential costs and benefits. It is a matter of risk management, with risk being defined as the probability multiplied by the consequences. What we decide to do is a value judgement, based on the best estimates of both the probability and the potential consequences.

There is a common engineering example illustrating probability and consequences, using the different standards for engineering design which are applied to culverts, versus bridges, versus large dams.

A culvert, where the consequences of an overflow would be minor flooding of a street, is built to cope with around a 1 in 10-year flood. That is, it has a 10% chance of failure in any given year.

A bridge, where failure could mean inconvenience or at worst some loss of life, is built to cope with something like a 1-in-100-year flood. That is, it has a 1% chance of failure each year.

A large dam, where failure could mean loss of thousands of lives, is built to cope with a 1-in-1000-year, or even a 1-in-10,000 year flood. That is, it has a 0.1 or 0.01% chance of failure.

Similar reflection on probabilities, risk and consequences applies when we consider coping with climate change. Take a change in rainfall. If the chance of a dangerous amount of rainfall change is very small we might ignore it. But if there was a 50%

chance and the consequences were serious floods or water shortages, we might take account of that in decision-making. We might decide to adapt to the risk by building flood control levee banks or dams. Or we may try to lower the likelihood of serious climate change by cutting global greenhouse gas concentrations.

In the case of providing advice on potential climate change, scientists have had to depart from the traditional pure science criterion, where we only discuss what is accepted at the 95% or 99% probability level. We have had to take the consequences into account and make statements relevant to risk management.

The Intergovernmental Panel on Climate Change (IPCC) has rightly adopted the position that scientific advice should be "policy relevant but not policy prescriptive". This means scientists should address the issue of risk management, even for outcomes less than 95% certain.

In other words, we should state the risks, provide response options and their consequences, but not tell governments what to do. This recognises that scientific advice is just one input to a policy decision.

I believe that is what the IPCC has done. Given that some outcomes are difficult to quantify, scientists argue about what is a credible risk. One example in the IPCC's Fourth Assessment Report in 2007 was the estimated range of uncertainty regarding global sea-level rise.

The quantifiable elements were thermal expansion of the ocean waters and the melting of mountain glaciers, for which data were available. But, for the possibility that much of the ice in the huge ice sheets of Greenland and Antarctica might melt or slide into the sea, several glaciological processes were just being identified, and were yet to be well quantified.

So, the IPCC Fourth Assessment Report stated the sea-level rise by 2100 as a range of 18 to 59 cm, with a caveat that processes yet to be quantified could increase this estimate by another 10 to 20 cm. Subsequent estimates put this extra contribution from Greenland and Antarctica even higher. The Arctic sea ice has melted faster than expected, and several outlet glaciers in Greenland and Antarctica have accelerated. So IPCC was hardly scare-mongering – if anything it was being rather conservative.

Policy is value laden, while science can only tease out the possibilities and probabilities. Some have now agreed we need to avoid a global average warming of more than 2°C. But this "limit" is uncertain and value laden. What is "dangerous" to

someone living near the coast in Vanuatu may be quite different from what someone in Russia or inland Australia might consider dangerous. Many of us think a 2°C limit may not be strict enough to avoid a dangerous degree of climate change. But that is a value judgement made under uncertainty. Only time will tell what is an acceptable risk, and to whom.