Keeping prediction in perspective

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In their efforts to make climate information more useful for adaptation decisions, scientists will need to be clear about the limits of climate prediction.

Decision-makers from 155 nations agreed last month to establish the world's first framework for 'climate services', an effort that will supply on-demand climate predictions to governments, businesses and individuals.

By providing tailored information on how climate change will affect certain regions and sectors, the Global Framework for Climate Services will help the world "better adapt to the challenges of climate variability and change"[1]. Such was the promise issued by the World Meteorological Organization in Geneva on 4 September, following its World Climate Conference.

Underlying the climate-services vision is an assumption that increased research investment in modelling will yield more skilful climate prediction, which will facilitate better adaptation decisions. This vision is ultimately of a new era in climate science, one in which seasonal weather forecasting and long-term climate projections will merge seamlessly, giving rise to decadal climate predictions that have the skill and reliability of weather forecasts. Provision of this data to local planners and policymakers will be a service to society. Speaking to delegates in Geneva, Jane Lubchenco, head of the National Oceanic and Atmospheric Administration (the government body that is to lead US climate services) gave voice to that vision: "Imagine farmers being able to determine what to plant and where based on drought forecasts three to five years out."

But evidence that climate predictions can provide precise and accurate guidance about how the long-term future may evolve is fundamentally lacking. Scientists and decision-makers alike should treat climate models not as truth machines to be relied upon for making adaptation decisions, but instead as one of a range of tools to explore future possibilities. A recent example[2] from the Australian state of Victoria highlights the perils of relying on the predict-then-adapt mode of planning. In 2005, the Victoria government conducted a study to develop water-supply scenarios for its capital city Melbourne to 2020 under conditions of human-caused climate change. Before then, water planning in Victoria had been done with little consideration of the potential effects of climate change. The exercise resulted in a range of forecasts implying a 3-per-cent decline in storage under a 'mild' effects scenario and an 11-per-cent decline under a 'severe' scenario. The study concluded that the existing plan put into place in 2002 "provided [a] sufficient buffer... across the full range of climate change and alternative demand forecasts considered in this case study" out to 2020.

If nature has a sense of humour, it is a vicious one. In 2006, water supply to Melbourne dropped to a record low level of 165 gigalitres (Gl), well below

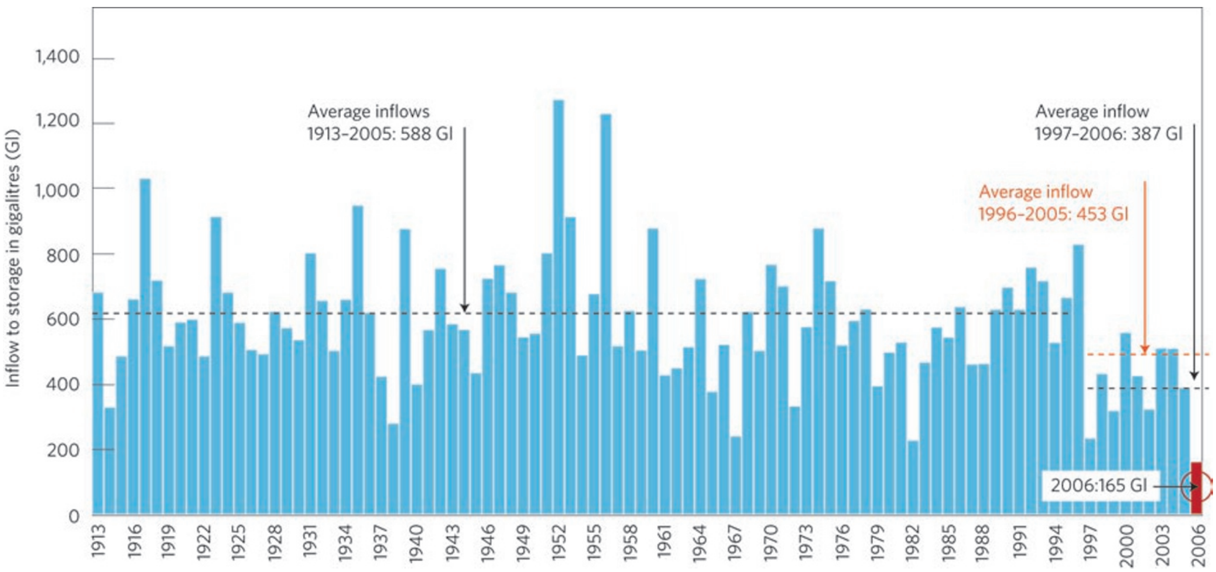

Figure 1 Total surface water inflow in the state of Victoria, Australia, from 1913 to 2006. The state commissioned a 2005 modelling study that projected a decline in average annual flow by 2020 of between 3 and 11 per cent, and concluded that measures in place "were an adequate buffer". Yet the average flow for the three years since 2005 was nearly 50 per cent below the 1913–2005 average, prompting an entirely new investment strategy. Source: *Our Water Our Future: The Next Stage of the Government's Water Plan* (State of Victoria Department of Sustainability and Environment, 2007).

the 1913-2005 average of 588 Gl and the recently lower average of 453 Gl from 1996 to 2005 (Fig. 1). In the three years since the 2005 modelling study, the average water supply level was less than half the long-term average and well below the estimated outcome for the 'severe' scenario considered in the study.

This tale is not unique. Examples of seasonal and longer-term forecasts that go bust are fairly common. And even in those cases where such forecasts are skilful in a formal statistical sense, communicating the uncertainties associated with them (whether seasonal, decadal or centennial) is far from straightforward. There are, of course, circumstances in which predictions can be relied upon for decision-making[3]. Experience of using predictions and forecasts for Earth-system processes shows that they are most useful for estimating the outcome of near-term events in circumstances where predictive skill is known, where decision-makers understand how to use predictions and understand the outcomes of various courses of action, and where there are limited alternatives to using predictions.

Unfortunately, predictive skill is unknown for climate at the decade-to-century timescale. Unlike weather forecasts, whose value in informing decision-making can routinely be tested over time by comparison with observed weather patterns, there is currently no such empirical evidence with which to test the skill of climate predictions. Moreover, as knowledge of the climate system and how it responds to greenhouse gases improves, model predictions will change, as will their probability distributions. Because decision-makers lack experience in using climate predictions, there is a risk that they will place too much confidence in the results.

However, alternatives to the predict-then-adapt approach do exist, one of which is robust planning for various plausible futures. A case in point is that of adapting to sea level rise. The rate and magnitude of future sea level rise remains deeply uncertain, and currently there is no proven way of establishing the predictive skill of sea level forecasts for the next 100 years or more. Robust adaptation planning should therefore rely on interpreting existing trends and allowing for some additional change on the basis of current sea level science. Rather than irreversible strategies that force them to try to judge which of the various and constantly changing sea level predictions or probability distributions may be correct, planners could choose flexible and adaptive strategies with incremental adjustments to allocated head room throughout future decision cycles.

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For scientists, the lesson here is clear. Caution is warranted when promising decision-makers a clarified view of the future. Guaranteeing precision and accuracy over and above what science can credibly deliver risks contributing to flawed decisions. We are not suggesting that scientists abandon efforts to model the behaviour of the climate system. Far from it. Models as exploratory tools can help identify physically implausible outcomes and illuminate the boundaries where uncertain knowledge meets fundamental ignorance. But using models in this way will require a significant rethink on the role of predictive climate science in decision-making. In some cases the prudent course of action will be to let policymakers know the very real limitations of predictive science. For decision-makers, the lesson is to plan for a range of possible alternatives. Instead of seeking certainty, decision-makers need to ask questions of scientists such as 'What physically could not happen?' or 'What is the worst that could happen?'

We applaud the World Meteorological Organisation for seeking to make climate information accessible across multiple scales, attuning decision-makers to the inherent variability of climate and to the prospects of possible new climate risks emerging in the future. But for the climate-services vision to be realized (to make better use of climate information for improving human welfare (transparency is needed about the limits of climate prediction in informing adaptation decisions. Building a climate-resilient future is about much more than straining to know the unknowable.

After water levels dropped to unforeseen lows in Melbourne, Australia, what did decision-makers do? They embarked on a massive campaign to increase water supply, including planning for a new desalinization plant, modernization of irrigation infrastructure and planning for enhanced trans-basin transfers, which together will add 240 Gl to the water supply. Melbourne's water planners have decided to make the city robust in the face of future variability and change in climate. They will no longer be dependent on the accuracy of specific climate predictions.

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