

# Crossing the threshold

Avoiding dangerous climate change is an increasingly formidable challenge. Diplomats meeting next month in Durban must propose a persuasive alternative if they are to end the Kyoto Protocol.

At the end of November, world leaders will gather in Durban, South Africa to discuss — yet again — the ground rules for international regulations that will replace the Kyoto Protocol when its first commitment period ends next year. Whatever political beast emerges from the ashes of Kyoto phase I, its overarching mandate will be the same: to avoid dangerous human interference with the climate system — a stated goal of the United Nations (UN) Framework Convention on Climate Change since its inception almost 20 years ago.

Yet defining dangerous climate change has proven to be a difficult task. That's in part because of uncertainty about how much the climate warms in response to emissions. Danger is also — by nature — subjective, its definition informed by perceived and real threats, and the measures available to cope with those threats. Despite these difficulties, dangerous climate change is now largely taken to mean a global average temperature rise of more than 2°C above the pre-industrial level. Indeed at last year's UN negotiations in Cancun, participating countries agreed — for the first time in an official UN accord — to aim to keep temperature rise within this threshold. They also formalized the national mitigation pledges first proposed in Copenhagen in 2009 to achieve this goal.

Whether a 2°C temperature threshold will stave off the most serious impacts of climate change, and whether it is a plausible mitigation target, remain two of the most important questions for climate policy. As a global average, the 2°C threshold glosses over the fact that some regions will experience a greater degree of warming — and more severe impacts — than others, even within a 'safe' range. It also fails to acknowledge that natural climate variability will inevitably drive temperatures above the threshold temporarily — perhaps only for a year — before such an increase becomes the global average. An anomalous season or year can be enough to cause crop failure or to signal species to shift elsewhere. Scientists and diplomats alike have thus advocated lowering the acceptable upper limit to 1.5°C, and the participants who enacted the Cancun Agreements gave this

the nod in agreeing to a future review of national commitments in line with a 1.5°C threshold.

How nations intend to keep within a 2°C threshold, let alone consider at 1.5°C threshold, is unclear in light of current progress. Despite Europe being on target to meet its Kyoto commitments, global carbon dioxide emissions are still on the increase having spiked by 45% since 1990 to reach a record level of 33 billion tonnes last year. Highlighting the urgency and scale of the challenge of staying below 2°C, Joeri Rogelj and colleagues provide the latest and most robust analysis of the mitigation efforts needed to achieve that goal (page 413). Extending research that was first commissioned by the UN Environment Programme in the wake of the Copenhagen negotiations, they analyse 193 'feasible' emission scenarios from the literature — two-thirds of which are mitigation scenarios — to produce a set of extremely informative findings. What their analysis reveals is that to stay below 2°C throughout this century, annual emissions will have to come down by about 4 billion tonnes of carbon dioxide equivalent from the present day level to about 44 Gt of carbon dioxide equivalent in 2020. Even then, there is just a 66% probability of staying within the 2°C threshold by 2100. Out of the nearly 200 scenarios studied, only three give a 90% probability of staying below 2°C this century, and all of those rely on commercially unproven technologies to capture and store carbon-based greenhouse gases. Even with the use of these technologies, there is at best a 50% probability of staying below 1.5°C this century. Worryingly, if we wait until 2030 for emissions to peak, we're more likely to be looking to avoid 3°C this century than 2°C. In short, the 2°C threshold is steadily slipping of reach, and 1.5°C already seems unachievable.

A separate analysis by Manoj Joshi and colleagues (page 407) further highlights the speed at which dangerous climate thresholds could be crossed at the local level. They show that on regional scales, the 2°C threshold will probably be exceeded over large parts of Eurasia, North Africa and Canada by 2040 if emissions continue to rise — well within the lifetime of many people living now — and

that most of the world's land surface will likely reach the 2°C threshold by 2060. More stringent mitigation could delay this by several decades. What is clear is that for large tracts of the planet's inhabited regions, dangerous climate change could be seen within decades.

In light of these revelations, the scale of the challenge for negotiators in Durban is formidable. A crucial question will, of course, be whether to extend the existing protocol to a second period of commitment or to kill it once and for all and replace it with other political measures to curb emissions, such as the Cancun Agreements. This includes mitigation targets for all major polluters, including emerging economies, but it lets rich nations out of legally binding emissions cuts. Either course of action could be argued for, given the current state of play. The Kyoto Protocol may be the only legally binding international instrument for regulating greenhouse-gas emissions, but it hasn't — as of yet — proven up to the task. Not only are global emissions rising, but one of the protocol's key instruments for incentivizing investment in climate-friendly technologies in developing countries, known as the Clean Development Mechanism, has repeatedly been shown to be flawed in its efforts to reduce emissions (*Nature* **445**, 595–596; 2007 and **477**, 517–518; 2011). The protocol's failure to axe emissions from developing countries, or to effectively offset them elsewhere, has made its renewal an unpopular choice.

Nevertheless, some argue that with the lessons learnt from phase I, a second round of the Kyoto Protocol would be more fruitful. And unless the protocol is renewed, the UN's eight-year-old carbon market, currently worth US\$7.8 billion, and its policy instruments will come to an end next year, spelling the end of global carbon regulation. The obvious alternative is the agreements reached in Cancun. Alone, these will be ineffectual at avoiding dangerous climate change. Negotiators must now propose real — and politically or commercially proven — means of implementing the mitigation targets already on offer and of strengthening them in the future. Only then can we afford to consider stepping away from the commitments made in Kyoto. □