Nature
Published online: 01 December 2004; | doi:10.1038/432551a

ARTICLE SOURCE
nature

The blame game

Myles R. Allen[1] & Richard Lord[2]

[1] Myles R. Allen is in the Department of Physics, University of Oxford, Oxford OX1 3PU, UK.

[2] Richard Lord is at Brick Court Chambers, 7–8 Essex Street, London WC2R 3LD, UK.

Who will pay for the damaging consequences of climate change?

Last year one of us (M.R.A.) wrote a Commentary in *Nature*, asking if it would ever be possible to sue anyone for damaging the climate[1]. At the time, this was largely a thought experiment, as the scientific and legal arguments were too immature to provide a satisfactory answer. But in this week's issue, Peter Stott, Daithi Stone and M.R.A. provide some scientific justification for revisiting that question[2]. Their paper considers how much human influence on climate could be 'to blame' for the southern European summer heatwave of 2003.

After the cold and wet summer of 2004, this might seem a bit of a mug's game. But for scientists, the contrast between these two summers graphically illustrates the role of chaos and chance in climate. Stott and colleagues show that using risk and probability analysis makes it possible to quantify a link between external inputs (such as greenhouse gases) and specific weather events.

Linking responsibility for damage directly to greenhouse-gas emissions has always been a taboo subject in the climate-change debate. But some of us may, unwittingly, already be paying the costs of adapting to climate change. As emission targets for greenhouse gases will take decades to have any discernible effect, the critical issue for most people today is not climate treaties, but working out who will pay the costs of adaptation[3], and compensation for those who cannot adapt.

Playing the odds

Stott and colleagues do not suggest that 'but for' past greenhouse-gas emissions the 2003 heatwave could not have occurred, nor that such heatwaves will now happen every year. The immediate cause of the heatwave was a persistent anticyclone over northwest Europe[4] — no one could sensibly claim that greenhouse gases caused that particular anticyclone. Instead, Stott *et al*. argue that we have loaded the weather dice — that human influence on climate has increased the risk of an anticyclone causing a heatwave like that of 2003 by around a factor of four. They also estimate with higher confidence (a 10% chance of being wrong) that more than half the risk of such a heatwave was due to human influence, primarily greenhouse gases. That may sound frustratingly convoluted, but uncertain estimates of relative risk are all that will ever be scientifically defensible.

BBC NEWS

Climate risk 'to million species'

By Alex Kirby
BBC News Online environment correspondent

Climate change could drive a million of the world's species to extinction as soon as 2050, a scientific study says.

The authors say in the journal Nature a study of six world regions suggested a quarter of animals and plants living on the land could be forced into oblivion.

They say cutting greenhouse gases and storing the main one, carbon dioxide, could save many species from vanishing.

The United Nations says the prospect is also a threat to the billions of people who rely on Nature for their survival.

Seeking cooler climes

In a report, Extinction Risk From Climate Change, the scientists describe their study of the six biodiversity-rich regions, representing 20% of the Earth's land area.

The study used computer models to simulate how the ranges of 1,103 species - plants, mammals, birds, reptiles, frogs, butterflies and other invertebrates - are expected to move in response to changing temperatures and climate.

The scientists considered three different possibilities - minimum, mid-range and maximum expected climate change, on the basis of data from the Intergovernmental Panel on Climate Change.

They also assessed whether or not animals and plants would be able to move to new areas.

Mission improbable

They concluded that from 15 to 37% of all the species in the regions studied could be driven to extinction by the climate changes likely between now and 2050.

Species at risk include:

- Boyd's forest dragon, an Australian lizard likely to lost at least 20% of its range
- South Africa's national flower, the king protea, and its relatives
- *Virola sebifera* , a Brazilian tree whose entire range is likely to have vanished by 2050
- the Scottish crossbill, found only in Scotland: its survival could demand an improbable migration to Iceland.

trade is allowed only among Annex B countries, however, permit prices under the same Kyoto requirements are projected to range from $3-74 per metric ton of CO2 (2000$) depending on the study, with an average of $27 ($11-$271/mtce, with an average of $99/mtce).

4.4 Carbon Scenarios in Utility Integrated Resource Planning

The private sector is also beginning to recognize the risk of future carbon regulation. For example, an increasing number of utility integrated resource plans are describing carbon risks, and analyzing those risks. We review treatment of carbon risk in some of these plans, which are in the public domain, below. Other private energy sector firms, such as oil companies, are also beginning to consider carbon risk, though their assumptions and analysis are typically not in the public domain.

- The PacifiCorp 2003 IRP, for example, modeled a variety of scenarios of possible future *cap and trade* regulations. PacifiCorp's base-case assumption presumes a carbon cap at year 2000 levels that takes effect in 2009, with allowance costs starting at $8 per ton of CO2 ($29/mtce), escalating at 2.5% per year. Other modeled scenarios include: (1) no cap, (2) $2/ton-CO2 ($7.3/mtce) beginning in 2013, with a cap at 2000 levels, (3) $25/ton-CO2 ($92/mtce) beginning in 2008, with a cap at 1990 levels, and (4) $40/ton-CO2 ($147/mtce) beginning in 2008, with a cap at 1990 levels.
- Idaho Power's 2004 IRP filing, meanwhile, analyzed carbon regulations equivalent to $12.30 per ton of CO2 ($45/mtce) in the base-case scenario beginning in 2008, and conducted sensitivity analysis on carbon values of $49.21 per ton of CO2 ($180/mtce) beginning in 2008. Idaho Power estimates a 30% probability of a zero carbon tax, a 50% probability of a $12.30/ton tax, and a 20% probability of a $49.21 tax.
- In Colorado, Xcel/PSCo's 2004 IRP estimated the impact of carbon dioxide regulations at both $6/ton of CO2 and $12/ton levels ($22-$44/mtce), starting in 2009.
- Portland General Electric's 2002 IRP analyzed a carbon tax scenario, using a value of $10 per ton of carbon dioxide ($37/mtce).
- Avista's 2003 IRP prepared one carbon tax scenario in their IRP, consistent with Northwest Power Planning Council assumptions, with prices of $1.32 per ton of CO2 in 2004 and increasing to $11 per ton of CO2 in 2023 ($5-$40/mtce).
- In a preliminary draft document released in 2004, the NWPPC has proposed – in its base portfolio analysis – the following probabilities for carbon regulation: zero percent until 2008, 10 percent in 2008, increasing every four years to 50 percent in 2024. Through 2015, offset costs for any future having some level of carbon control range with equal probably from zero to $15/ton-CO2 ($55/mtce). Following 2015, the upper bound increases to $30/ton-CO2 ($110/mtce). Across all cases, the mean value is $0.75/ton-CO2 in 2008 ($2.75/mtce), increasing to $7.5/ton-CO2 in 2024 ($27.5/mtce).
- A 2004 California Public Utilities Commission (CPUC) consultant report authored by Energy and Environmental Economics, Inc. also assesses the range of possible future scenarios of carbon regulation and associated costs, and concludes that a conservative and reasonable estimate of carbon costs is a trend of $5 per ton of CO2 in the near term, $12.5/ton by 2008, and $17.50/ton by 2013 (the time-discounted value is ~$8/ton, or

calculation based on the EPA analysis suggests that the cost of these reductions to the U.S. economy would be around $9 billion annually but, depending on the availability of international and noncovered domestic reductions, the cost could be 10 times higher or lower. On a $12 trillion economy forecast for 2010, $9 billion is less than one-tenth of 1% of the gross domestic product.

The range of uncertainty arises because the quoted EPA estimates consider reductions from all U.S. sources in 2010, including both covered and noncovered sources as defined by McCain-Lieberman. If the noncovered sources (particularly methane and sequestration opportunities) are not sufficiently encouraged to reduce emissions by the bill's crediting provisions, the cost could be 10 times higher. However, other EPA estimates in the same report suggest an equivalent international supply of emissions reductions at one-tenth the cost of domestic reductions—a supply we assume is not realized in our analysis. Adding to the potential overstatement of costs, our perpetual use of cost estimates for 2010 ignore the added availability of inexpensive reductions in later years as more capital is replaced and technology has advanced further, something we do not quantify.

What does $14 per ton of carbon dioxide mean?

Using the EPA estimates, if firms were required to purchase allowances at $14 for each ton of carbon dioxide they emit (or for the equivalent volume of gasoline they produce), this would add about 13¢ per gallon of gasoline, 77¢ per thousand cubic feet of natural gas, and $32 per short ton of coal. Based on current national average prices of $1.45 per gallon of gasoline, $3.78 per thousand cubic feet of natural gas, and $33 per short ton of coal, payment of $14 for each ton of carbon dioxide would effectively raise the cost of using gasoline by 9%, the cost of using natural gas by 20%, and the cost of using coal by 100%.

Another consequence of $14 per-ton carbon dioxide is that the allowances created by the emissions-trading program would be valued at roughly $75 billion. In this way, the allocation of allowances under this program has a greater potential to create significant winners and losers than the direct cost of the program.

Perspective

The McCain-Lieberman bill creates a single trading program covering more than 70% of all carbon dioxide and industrial greenhouse gas emissions. It includes offset provisions for emissions that are not covered, allows for biological and geological sequestration credits, and permits sources to buy allowances in other countries that have their own trading programs. Allowances can be traded freely among gases and sectors, and banked for future use. Allowances are allocated with attention placed on consumer impacts and transitional assistance as well as equity among firms. If domestic methane reductions and sequestration options are fully realized, EPA estimates suggest that an allowance price of $14 per ton of carbon dioxide, costing about $9 billion annually, could achieve the reduction goal through 2016, even absent international emissions reductions.

The broad coverage and flexibility of the trading program make this bill one of the most cost-effective domestic proposals to date (even more so than the European Union trading system). The level of control, particularly the achievement of 1990 emissions levels by 2016, will undoubtedly fire up the debate among those who believe it is insufficient given the environmental risk and those who believe it is excessive given the economic cost. Yet, the fact that this debate can occur in the context of a flexible, economywide emissions-trading program represents a significant step forward.