

Human-Induced Climate Change: The Limits of Models

Assessing the Impacts of Climate Change on Natural Resource Systems edited by Kenneth D. Frederick and Norman J. Rosenberg. Dordrecht: Kluwer Academic Publishers, 1994. Pp.219. £76 (hardback). ISBN 0 7923 3211 3

Managing the Global Commons: The Economics of Climate Change by William D. Nordhaus. London: The MIT Press, 1994. Pp.ii + 213; index. £27.50 (hardback). ISBN 0 262 14055 1

The Politics of Global Atmospheric Change by Ian H. Rowlands. Manchester: University Press, 1995. Pp.xxiv + 276; index. £40 (hardback); £14.99 (paperback). ISBN 0 7190 4094 9 and 4095 7

Much attention at the prospect of human-induced climate change has focused on the natural sciences, as Rowlands notes – almost exclusively so up until the late 1980s, and again in the Intergovernmental Panel on Climate Change (IPCC) reports [Houghton *et al.*, 1990; 1992; 1995]. However, the switch of concern to economics has been dramatic in recent years, not merely for the rate of increase in the literature but also because of the range of economists who feel they can contribute something. Sceptics might put this sudden attraction down to the budgetary incentives offered by government research bodies, and they would be partially correct. However, climate change has also become a respectable topic for mainstream economists bound by a neo-classical remit (for example, 1991 issues of the *Economic Journal* and the *American Economic Review*). In this regard Nordhaus represents a commonly cited and invited author from the orthodox camp. Frederick and Rosenberg are more sober in their criticisms of a purely economic outlook and favour fully integrating ecological and economic models. There are distinct divergences apparent in the two works by these authors which takes on added significance in light of Rowlands' appraisal of the role of economists in the international politics of greenhouse gas control.

Frederick and Rosenberg collected together 17 North American researchers in the area of physical and socioeconomic impact assessment, concentrating upon issues in the United States. A workshop was held in March 1993 and the same papers were later published in the journal *Climatic Change*. Contributions are clearly written, easily accessible and usefully (if selectively) referenced, although the presentation is in journal format without an index or bibliography. This is basically a volume reviewing attempts at modelling impacts on forestry, grassland-grazing systems, and water resources; each topic has individual chapters on physical models and on socioeconomic approaches. There is a welcome emphasis on methodology, rather than merely listing likely damages, which is bolstered by two overview chapters offering different views on impact assessment.

A repeated plea is made for integrated assessments which link socioeconomic, climatic ecosystem and atmospheric chemical models and which provide for feedbacks between these four components. Frederick believes: 'The Holy Grail would be a closed system, either a fully integrated model or set of linked models, that account for all important linkages and feedbacks among all four components of the system.'

Such a system would provide a turn-key set of linked, nested models and modules capable of answering all relevant policy questions about the implications of climate change' (pp.9–10). Now this is an interesting claim even with the disclaimer that such an integrated assessment is likely to remain elusive for the foreseeable future. The extent to which systems have been regarded as closed has been part of the problem in economics and the very reason why environmental critics of the mainstream have recommended opening models out to include ecosystem feedbacks. The state of the art shows that socioeconomic and ecological models have only been linked up in simplistic ways far from integration, e.g., setting initial conditions or providing one-way links (pp.79–81). The belief in this Holy Grail of impact assessment militates against going even further into the realms of politics, sociology, and philosophy. Fundamentally the Grail approach requires a belief in an absolute truth which will be revealed with time, and thus encourages a general optimism.

More specifically, non-market valuation is seen to be an exciting new area and monetary valuation is claimed to be applicable to health effects, wildlife, preferences for warmer climates, endangered species, and ecosystems boundaries (p.29). A narrowly defined view of economics is presented by some contributors, for example, utility functions implicitly excluding altruism, compassion, and empathy, because individuals are claimed to have no economic incentive to incur costs solely to benefit the global commons (p.6). This approach sits uneasily with the notion that economic value can derive from just reading about an environmental good or service (p.34). Mendelsohn and Rosenberg seem to prefer avoiding such issues with a strictly anthropocentric viewpoint suggesting preservation of the top of ecosystem pyramids (p.35) while unfortunately neglecting the foundations. They are also in confusion being both in favour of leaving unmanaged ecosystems alone (pp.276–7) and managing them (p.37). More generally the approach of the volume represents the view of those believing in equilibrium based models (especially in economics), with risk as an acceptable approach to uncertainty and intergenerational issues noted as an issue and then neglected; Nordhaus has much in common with these assumptions.

This is not to say all the authors concur or that the volume fails to be of interest to those concerned with climate change. The concluding chapter leaves the reader in no doubt as to the limits of impact assessment modelling and is a very frank summary of many of the difficulties raised in the book. Rogers provides a highly critical viewpoint on the ability to predict future water provision due to socio-economic and political uncertainty. The contributions by both Rogers and by Riebsame et al. refer to chaos theory, although very briefly. The latter provide an overview to impact assessment modelling which contrasts with the preceding one by Mendelsohn and Rosenberg by rejecting optimisation as an explanatory paradigm; calling for the inclusion of behavioural, cultural and political factors, perceptions and beliefs; and recommending political economy. However, these minority views are quietly neglected in the introductory and concluding chapters. One point which does come through is the need to conduct impact assessment on a local/regional scale in order to consider the general vulnerability of human systems to a dynamically changing environment.

In contrast, Nordhaus is concerned with global aggregates. Abstract neoclassical modelling is to Nordhaus where our future lies, rather than in the stars (p.6). He presents an updated version of his cost-benefit work on the enhanced greenhouse effect, which previously estimated impacts in the US at 0.25 per cent of GNP under a CO₂ doubling. Here an optimisation model is presented which is deliberately designed to run on a personal computer (p.23); a stark contrast with the scientific input to the issue which employs Cray supercomputers to run General Circulation Models and yet

still gets criticised for being too abstract and simple. Complex models are rejected in favour of 'transparency'.

The optimisation model requires 'developing' the scientific information to obtain 'highly simplified aggregate relationships' (p.23). The resulting gross simplification of a complex problem means no policy relevance should be attributed to the results; although Nordhaus claims that these studies suggest eschewing a massive effort to slow climate change. A range of dubious assumptions is made in constructing the model on both the physical science and economic sides. The deep ocean is assumed to be an infinite carbon sink. Climate change is represented by global mean surface temperature although a better range of variables for impact assessment are precipitation, soil moisture, sea level rise and measurement by seasonal patterns, rate of change and variance (rather than mean). Most attention is paid to CO₂ on the basis that it contributes 80 per cent of global warming (p.15), although the IPCC only attributes 55 per cent of warming to this gas [*Houghton et al., 1992*]; methane and nitrous oxides are considered to be external to the Nordhaus model. Without much explanation a mixture of IPCC scenarios [*Houghton et al., 1990*] is chosen for the no action base case; thus CO₂ and N₂O are business as usual, CFCs are phased out under the IPCC accelerated policies scenario, and methane emissions occur at the low level scenario.

Economic model assumptions include all countries having competitive industries, producing perfect substitutes, with identical Cobb-Douglas production functions, all of which apparently has no effect on major conclusions (p.8), although one result would be no need for international trade. Other problems have been noted in Nordhaus' previous work and remain in this edition, for example, see Ayres and Walter [*1991*], Daily *et al.* [*1991*], Hanley and Spash [*1993*]. However, the only critic addressed is Cline who has adopted a similar cost-benefit approach to Nordhaus and whose results are stated to come to largely the same conclusions (p.56) and are used for validity in Table 4.3. This validation is strange given the extensive criticism Nordhaus levels at Cline's assumptions about impacts (p.57) and the discount rate (pp.131-3), and his claim that Cline has biased his results in favour of control (p.97), and the controversy between the two noted by Rowlands.

Chapter 4 is key to the estimate of a 1.33 per cent decline in world output as a result of a 3°C mean global temperature rise under double CO₂ (a five fold increase over some of his earlier damage estimates). World estimates of damages are extended from estimates for the United States economy, and regional distributions are largely ignored. Impacts are restricted to agriculture, coastlines, energy and 'other' and then bounded in model runs by the percentage of GNP these sectors are judged to contribute to the economy, for example, agriculture is valued at 2.52 per cent of 1981 GNP. A change in the value of any sector due to increasing relative scarcity is ruled out by assuming constant relative prices. There is discussion of difficult to calibrate catastrophic scenarios ... 'which might be equivalent to the damages from a major war, or from a half century of Communist rule' (p.115). Rather than unknown surprises, catastrophes are then treated as known thresholds, at which large losses of GNP occur, which can therefore be avoided. If Roger's contribution to Frederick and Rosenberg is compared we find one recent hurricane alone caused damages of approximately 0.5 per cent of US GNP and 30 lives lost. No discussion is given of how damage estimates are calculated and, as with other issues, the reader is referred to the authors' published articles (copies should be obtained before reading the book). The 'other' sector includes damages to ecosystems function and structure, wildlife and wetlands, with a total loss amounting to 0.71 per cent of GNP. This is derived from the judgement that

the total loss in the US is around one per cent for double CO₂, which is itself '... a precautionary guess as to the magnitude of "surprises" from climate change that are likely to occur in the non-farm sector' (p.53). Reference is made to a survey of experts for validation of judgements at several points and in the sensitivity analysis. Interestingly only the median of this data set is used for comparison (pp.58, 152-4) and when the mean is reported in Table 7.2 three percentiles are given excluding the top ten per cent; a notable divergence between mean and median can be observed with the increasing percentage of the sample, which suggests a large variance with some extreme outliers being hidden.

Discounting is given a chapter and the 'ethical logic' (p.118) is advanced that future generations are compensated for the greater control costs of global warming in the future by economic growth. Nordhaus rejects Cline's criticism that the future is cut off in his model but uses a six per cent discount rate so that varying the time period has no effect. 'The only runs for which shorter horizons produces some inaccuracies are those with extremely low rates of time preference (less than 0.5 per cent per annum)' (p.122). Nordhaus accepts that 'most economists and political philosophers find it hard to defend a pure rate of time preference on ethical grounds' (p.123). However, this leaves discounting on the basis of the opportunity cost of capital and in any case he believes the appropriate rate should be empirically estimated and accepted regardless of ethics. He criticises Cline's use of a 1.5 per cent discount rate and, after degenerating into a collection of rhetorical questions, he rather weakly states (p.132): 'If we consider all the ramifications of this issue, we quickly see that if we decide to override market prices because of ethical objections, this raises countless paradoxes and contradictions.' This implies free markets with no government intervention on anything approaching ethical grounds.

A considerable effort is put into sensitivity analysis and the inclusion of uncertainty as risk. Here the optimism about uncertainty found in Frederick and Rosenberg also comes through. We are told that many of the uncertainties are ones that can be resolved by further study or at least by the passage of time (p.169). Such a narrow viewpoint can be questioned on several grounds: uncertainty is persistent due to measurement errors and differences in interpretation of given 'facts'; the methodological problem that evidence can only disprove but never prove a theory; the existence of irreducible ignorance; the lack of any single metric for damage assessment; and unknown cause-effect relationships.

The overall outcome is for Nordhaus to recommend an optimal policy which leads to a 3.1°C global temperature rise by 2100. The model seems to be set up to provide justification for a political position. In the preface, preserving nature at the expense of economic growth is termed 'ultraconservative', and nature is seen as a threat potentially dealing us a nasty hand. Developing countries and future generations are marginalised and distributional issues generally ignored. Rowlands (p.138) refers to the earlier work by Nordhaus as a prescription to the US to avoid co-operative action which commanded significant respect and currency in that country.

Rowlands presents an interesting and readable history of stratospheric ozone and global warming negotiations. His analysis of explanations as to why ozone depletion has led to international action while climate change remains largely intractable has grown out of his doctoral thesis. Four hypotheses are qualitatively analysed: (i) a scientific consensus on cause-effect is required; (ii) all key actors require positive net private benefits to act; (iii) North-South equity issues must be resolved; and (iv) any of four catalysts can increase the prospects for cooperation, namely political entrepreneurs, non-governmental organisations, issue tangibility and a conducive

international environment. He finds moderate support for all explanations in the case of ozone but for global climate change the equity, tangibility and conducive environment arguments are inconclusive.

The structure of the hypotheses suggests a correlation with disciplines: (i) with natural sciences, (ii) with economics and (iii) with politics. However, such a simple division of labour is rejected (p.257). This links up with the criticism of a linear relationship between science and politics (pp.90–91). The idea of an objective search for facts which is apparent in the other two books is questioned here because, the agenda of science is politically set and scientists are politically active, and because ideas of chaos and complexity, and the cultural relativism of interpretations of facts render the notion of objectivity problematic. The extent to which economists offering simple models to evaluate scientific facts for policy makers can have political influence comes through in the chapters on hypothesis (ii). As Rowlands states (pp.152–3): 'The ways in which actors perceive the costs and benefits of alternative courses of action are important. Indeed, without such information, it would be difficult to make sense of much of the politics of ozone layer depletion and climate change.' The discussion of benefits, as in other areas, touched upon many key issues but perhaps of necessity avoided detailed analysis of specific problems, for example, methods for calculating ecosystem values. Overall, I found this an interesting and often insightful journey through the processes of international negotiations on atmospheric pollutants.

In the final analysis, the limits of scientific and economic models must be accepted. The pretence that simple abstract models can represent complex global issues in a policy relevant fashion must be avoided. Unfortunately, there is much here which suggests economists currently provide politicians with a façade of objectivity with which to implement their predetermined policies.

CLIVE L. SPASH
University of Cambridge

REFERENCES

- Ayres, R.U. and Walter J. (1991), *The Greenhouse Effect: Damages, Costs and Abatement, Environmental and Resource Economics*, Vol.1, No.3, pp.237–70.
- Daily, G.C., Ehrlich, P.R., Mooney, H.A. and A.H. Ehrlich (1991), *Greenhouse Economics: Learn Before You Leap, Ecological Economics*, Vol.4, pp.1–10.
- Hanley, N. and Spash, C.L. (1993), *Cost-Benefit Analysis and the Greenhouse Effect*, in Hanley, N and Spash, C.L., *Cost-Benefit Analysis and the Environment*, Aldershot: Edward Elgar.
- Houghton, J.T., Jenkins, G.J. and J.J. Ephraums (eds.) (1990), *Climate Change 1990: The IPCC Scientific Assessment*, Cambridge: Cambridge University Press.
- Houghton, J.T., Callander, B.A. and S.K. Varney (eds.) (1992), *Climate Change 1992: Supplementary Report to the IPCC Scientific Assessment*, Cambridge: Cambridge University Press.
- Houghton, J.T., Meira Filho, L.G., Bruce, J., Lee, Hoesung, Callander, B.A., Harris, E. and K. Markell (eds.) (1995), *Climate Change 1994: Radiative Forcing and Climatic Change: An Evaluation of the IPCC IS92 Emissions Scenarios*, Cambridge: Cambridge University Press.