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Upscaling adaptation studies to inform policy at the global level

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Abstract

Anthropogenic climate change is conventionally categorized as an environmental pollution issue. However, this definition is incomplete and has a distorting effect on policy. The reduction of greenhouse gas emissions and the stabilization of greenhouse gas concentrations in the atmosphere are essential actions and so is adaptation; it is necessary to adapt to inevitable climate change which is now too late to prevent. This paper identifies four approaches that might facilitate a transformation of the way in which climate change is socially constructed: (1) The qualitative accumulation of case study evidence; (2) meta-analysis; (3) adaptation modeling; and (4) the integration of adaptation with mitigation in both case studies and in models.

Keywords: adaptation, mitigation, climate change

1 The Adaptation Imperative

From the outset anthropogenic climate change has been regarded as an environmental pollution issue. This view, as espoused by the film "An Inconvenient Truth" and by most climate activists, also dominates the international negotiations on climate change. The definition of climate change as an environmental pollution issue is not entirely wrong, but it is incomplete, resulting in a distorting effect on policy. The reduction of greenhouse gas emissions and the stabilization of greenhouse gas concentrations in the atmosphere are essential actions, as too is adaptation; it is necessary to adapt to the inevitable climate

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change which it is now too late to prevent. Climate change has also to be recognized as a development issue, and as an equity issue. In this paper, we identify and briefly explore four approaches that might help to bring about this transformation of the way in which climate change is socially constructed. The four approaches are: 1) the qualitative accumulation of case study evidence, 2) meta-analysis, 3) adaptation modelling, and 4) the integration of adaptation with mitigation in case studies and in models. The four approaches listed are not mutually exclusive and might be combined in various ways.

The pollution perspective evolved from experience with acid precipitation and stratospheric ozone layer depletion. Having successfully addressed the acid rain issue by curbing emissions of sulphur dioxide and the ozone layer depletion problem by the phasing out of chlorofluorocarbons, it was natural to focus on the reduction of greenhouse gas emissions, especially carbon dioxide, as the dominant approach to climate change. By itself this perspective fails to recognize the distinctive and more complex characteristics of climate. People have always had to cope with climate. The story of human evolution and development includes a very successful record of adjustment and adaptation to a wide variety of climates. Humans as one of the most adaptable species have spread all over the earth, and created flourishing societies from the sub-arctic to the margins of hot deserts, and from high mountains to low coasts. The climate of this planet varies as much or more over space than over time. In theory at least, there is therefore a strong case to be made for adaptation to anthropogenic climate change. Human societies can and do adapt to and benefit from climate variety as demonstrated over millennia with much less advanced technology than is available today. To be sure there are constraints on adaptation such as the cost of some measures (Dutch-style dykes are probably beyond the financial reach of Bangladesh), and the acceptability of some policies (restricting the use of flood plains or coasts or accommodating large numbers of climatically displaced refugees) will be neither popular nor easily achieved, but given the political will there is little doubt that the financial resources and the technology could be made available to substantially reduce the impacts of climate change through adaptation in both developed and developing countries. Given the more extreme and long-term projections of climate change there are ultimate limits to adaptation but they are still far out of sight. The U.N. Framework Convention on Climate Change does recognise the importance of adaptation, and contains clauses which if fully implemented could go a long way to redressing the imbalance. For such a change to be achieved, better understanding of the meaning and value of adaptation has to be realized and communicated effectively to the policy process.

So why has the preoccupation with the reduction of greenhouse gas emissions and the neglect of the adaptation option been so hard to correct? Without doubt one reason is that having initially defined climate change as a pollution problem, adaptation has been regarded as at best a distraction but more seriously as an impediment to the mitigation agenda. Making the case for adaptation has often been ridiculed as no more than collusion with the big carbon emitters. Now adaptation is not only practicable and desirable it has become an imperative.

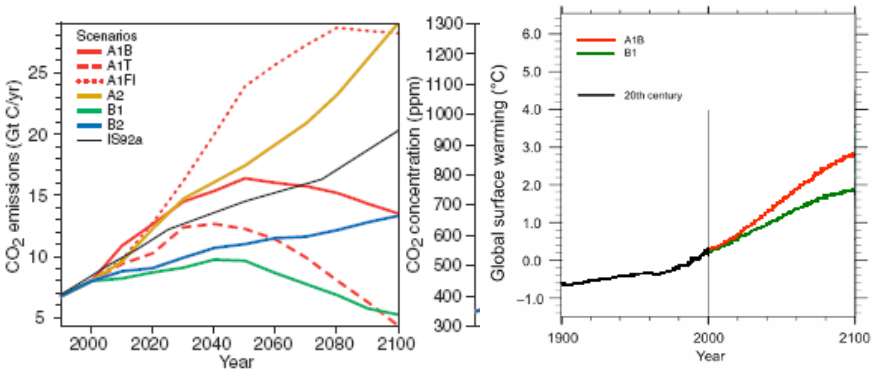

Figure 1: The Adaptation Imperative: With the "best case" emission scenario (B1 green line) global surface mean temperature continues to rise up to and beyond the end of the century.

Aggressive efforts to reduce greenhouse gas emissions will have little effect in reducing climate change for decades and even with the most optimistic of the IPCC SRES scenarios global mean surface temperature will continue to rise to the end of the century and beyond (Section 1). The problem is that the conventional view of the climate change issue as entirely, or almost entirely, an environmental pollution problem is a serious misconstruction. Finally, after some 15 years of research, debates and negotiations it is being more widely accepted that coping with climate change requires a mixed portfolio of both adaptation and mitigation measures.

A second reason for the relative neglect of adaptation has been that it is much more difficult to capture its significance in global environmental terms. On the mitigation side there is a simple baseline measure, namely level of greenhouse gas concentrations in the atmosphere. The increase in concentrations over time can be directly related to the global sum of emissions, and these emissions can be traced to their sources. It is convenient to have such a single metric by which to measure performance. Reducing emissions directly affects the level of concentrations and such steps towards the stabilization of greenhouse gas concentrations in the atmosphere yield global environmental benefits. In the case of adaptation there is no such measure. It is not possible to state in clear quantitative terms how well adapted human activities are to current climate. Adaptation yields benefits in the form of losses prevented. Many of these benefits fall locally in the places where the adaptation measures are adopted, and cannot be readily cumulated into some aggregate global total in terms of a single metric or set of metrics. Therefore, there is a need to explore and promote improvements in "upscaling".

Upscaling adaptation refers to:

1. Adding value to, or increasing the size of, the adaptation knowledge base,

and/or

2. Scientifically or technically moving from local or regional level adaptation to global level adaptation

2 The Qualitative Accumulation of Case Study Evidence

The conventional approach has been to look for ways of drawing upon the rich number and diversity of specific impact and adaptation case studies in such a way that adaptation can be presented alongside mitigation as an essential part of a mixed portfolio of responses to climate change. This approach has met with modest success both at national and international levels, and helps to upscale adaptation by increasing the knowledge base in the field. Individual studies can provide valuable insight into the possibilities of adaptation and actual adoption process in particular places, but the insights are not easily cumulated into generic conclusions that can inform the wider policy process.

In Canada, for example, the national assessment "From Impacts to Adaptation: Canada in a Changing Climate 2007" has been completed . As in other national assessments or country studies a lot of attention is given to impacts and much less to adaptation in a systematic way, although the assessment is uncovering a rich array of anecdotal examples of past, present and potential future adaptations. A list of ten examples has been selected and is presented in summary form in Table 1. The selection illustrates the wide variety of adaptation activities and shows the wide range of localities and sectors in which they are found. A detailed description of each of the cases has been prepared, but they clearly do not provide a basis for generic conclusions to be drawn about the pace and character of adaptation in Canada, Perhaps a much more comprehensive list of adaptation measures underway or proposed would be more helpful. Such a list could be web based, and grouped or classified by sector and locality and level of decision-making, and could include specific information about costs and benefits, the source of ideas, information, motivation and so forth.

Table 1: A selection of current adaptation actions in Canada.

	Year	Decision Makers	Future prospects for adaptation diffusion
Winter road maintenance strategy	2006	Department of Public Works and Services (Municipal government body)	This program is ongoing indefinitely. The strategy will likely be replicated, with locality-specific adjustments, as winter wheather becomes more variable and extreme
Tank-loading facilities	2004	County of Athabasca; Agriculture and Agri-Food Canada (Federal government body); Department of Agriculture (Provincial government body)	Four facilities are complete, with two more in construction. Many other water supply projects are in development nationwide, but continued expansion will require the commitment of more funding
Ice monitoring program	2004	Kativik Regional Government; University of Laval; Ouranos Consortium (joint government and private research initiative)	Program officially ends in 2008, and continuation thereafter will depend on community initiative. Program is replicable throughout northern coastal communities
Whistler 2020 and economic diversification	2004	Resort Municipality of Whistler	Economic diversification is a strategy already being pursued by other ski resorts to varying degrees of success. Sustainability plans like Whistler 2020 should be long-term goals for every municipality
Heat-health alert system	2000	Toronto Public Health (municipal government body); Toronto Atmospheric Fund (municipal government fund); Climate Change Action Fund (federal government fund)	The alert system is an ongoing, indefinite program. It was designed based on pre-existing programs in other locations, and will very likely be replicated further

	Year	Decision Makers	Future prospects for adaptation diffusion
Thermosyphons in Inuvik Health Centre	2001–2002	Environmental Adaptation Research Group (federal government research initiative); EBA Engineering Consultants (private sector)	Design and construction of the health centre is complete. Thermosyphons and EARG's screening tool are already used in many permafrost engineering projects.
Storm Surge Mapping	1998	Clean Annapolis River Project (non-profit community-level initiative	The maps are complete, and initial small-cale adaptations are in place. Similar exercises should be performed in most coastal towns to establish vulnerability. Assistance is required for further adaptation.
Yellowstone-to-Yukon	1997	A non-governmental network of over 290 collaborating organizations	The organization's land acquisitions are in their infancy. The concept of wildlife corridors apply universally to protected areas and should be considered in parks planning.
High Floatation Tires	1984	Forest Engineering Research Institute of Canada (FERIC)(non-profit research initiative; Forestry companies (private sector)	The tires have already permeated the Canadian forestry and agriculture industries, so further domestic diffusion is unnecessary. However, these tires could be a component of technology transfer to developing countries.
Distributed Generation using Photovoltaics	1950s	Provincial electricity generation and distribution bodies; Solar technology industry (private sector), building owners (private sector)	The PV industry is still in its infancy in Canada, and will very likely continue to grow. Distributed generation as an adaptation is a concept that can apply to other energy initiatives. PVs could also be a component of technology transfer to developing countries.

Such a widely accessible data base of examples of adaptation might provide useful examples that could encourage the wider adoption and diffusion of adaptation to climate change. The United Kingdom Climate Impacts Program (UKCIP), based in Oxford, England, has attempted the formation of such a compilation with their "Adaptation Action" database (UKCIP, 2006). This online, searchable database is comprised of adaptation case studies from around the United Kingdom. The examples are cross-categorized by region, sector, and adaptation type, and by April 17, 2007, there were 249 examples listed. While the site is maintained by staff, there is an interactive feature that allows any users from outside UKCIP to submit ideas and text to be included as a case

study. This tool provides a platform for the identification of climate change measures that are spread across sectors and governed by a wide array of administrative bodies. It facilitates the categorization of spontaneous and planned adaptation, and as the database grows in scope, it may well help to identify the early adapters in the country.

A second example is drawn from the international level, specifically the recently completed Assessment of Impacts and Adaptations to Climate Change (AIACC) Project funded by the GEF, implemented by the United Nations Environment Programme and executed by the START Secretariat in Washington and the Third World Academy of Sciences (TWAS) in Trieste. The project consisted of 24 climate change assessments (case studies) in Africa, Asia, Latin America, the Caribbean, India, and the Pacific Ocean regions. More than 350 scientists, experts and stakeholders from 150 institutions in 50 developing countries and 12 developed countries participated in the assessments (Leary et al., 2007). A collective effort to synthesise the findings with respect to adaptation generated a common list of nine lessons. The list is as follows:

1. Adapt Now! There is no need to wait for further evidence of climate change before starting to act. There is already an adaptation deficit and measures to adapt can and should be taken starting now.

2. Create the necessary conditions to enable adaptation. Numerous obstacles block the adoption of adaptation measures. These include competing priorities, poverty, lack of knowledge, weak institutions, degraded natural resources, inadequate infrastructure, lack of financial resources, distorted incentives and poor governance.

3. Integrate adaptation with development. The goals and methods of climate change adaptation and development are strongly complementary. To be effective the integration of climate risks into development needs to engage ministries that are responsible for development, finance, economic sectors, land and water management and the provision of public health and other services.

4. Increase awareness and knowledge. Nearly all the case studies highlighted the need for greater knowledge and awareness as a high priority.

5. Strengthen institutions. In many case studies key functions for managing risk were found to be absent or inadequate.

6. Protect natural resources. Degradation of natural resources is common and this detracts from the adaptive capacity of communities relying on those resources

7. Provide financial assistance. The magnitude of financial needs for adaptation is much greater that the current level of assistance.

8. Involve those at risk. Participatory approaches are essential for the adoption of effective adaptation.

9. Use place-specific strategies. Notwithstanding the previous 8 conclusions adaptation need to be based on recognition of the individual circumstances of each place.

These generic lessons from many case studies are unexceptional (Leary et al., 2007), and they provide little specific guidance to the policy process. No doubt the execution of the studies themselves and their publication and dissemination of results play a role in increasing awareness and understanding. On the other hand the accumulation of evidence is slow and qualitative and contributes only in a modest way to the generation of more vigorous and proactive adaptation policy at the international level. Impact from the studies at the national level is also likely to be low since the 24 assessment case studies were spread over 50 countries. In some cases there may have been significant local impacts, limited to the places where the studies actually took place.

3 Meta-Analysis

In some areas of research it has proved possible to go beyond the qualitative accumulation of case study evidence and bring the studies together in a quantitative way through meta-analysis, in the sense of "beyond analysis" or "analysis of analysis". The meta-analysis of adaptation has the potential to scientifically upscale adaptation by taking preliminary or local studies and upscaling them to comprehensive or global studies. For example, in the area of urban air pollution (air quality) and public health many case studies have been carried out in particular cities using local data on air quality and public health statistics in order to establish relationships between exposure and incidence of mortality and morbidity (Schwartcz, 1994; Saez et al., 2001; Bell et al., 2005; Zhao et al., 2006). These studies can then be studied collectively in a meta-analysis to formulate generic relationships to help inform public policy and the setting on national and international standards.

Meta-analysis requires the ability to statistically synthesize similar data in order to quantitatively be able to pool and analysis the results. The pooled studies require the same methodology and procedural structure in order for the meta-analysis to be accurate. In theory it would be useful to apply this approach to adaptation to climate change. In practice however the set of adaptation case studies in the literature cover such a wide range of topics and employ data of such diverse character that a meta-analysis poses a dilemma. There has yet to be a meta-analysis of adaptation studies. For this to be achieved it is necessary that such an analysis be completed in similar geographic regions or for identical adaptation studies to be undertaken in differing regions but using identical methodologies.

A meta-analysis may be achievable if limited sets of adaptation studies were conducted on much more specific and comparable topics such as adaptation to drought in agriculture, or even more specific such as adaptation to drought among wheat farmers in sub-humid continental interiors in the mid latitudes.

Another option would be to use the same adaptation process model (for instance TEAM, Julius & Scheraga, 2000); where the output from these and other analogous models across similar or varying regions could be pooled and meta-analyzed given that the methodology and data input would be statistically comparable. The more specific and comparable the adaptation situations examined the more practical meta-analysis becomes and the less its value in forming generic understanding of adaptation across sectors and regions.

4 Adaptation Modeling

The shortcomings in the qualitative accumulation of case studies on adaptation, and the difficulty of carrying out a meta-analysis on the data collected, suggests that there may be more to be gained from a quantitative modelling approach. In recent years, models that incorporate mitigation have been rapidly developed and arguably have helped to gain greater recognition and understanding of mitigation as a policy option; helping provide some common background for negotiations about the desirable rate at which greenhouse gas emissions should be reduced. It is true that this has not yet led to a lot of action to reduce emissions, but at least mitigation is strongly on the agenda.

Without comparable information it is proving difficult to factor adaptation into the policy negotiations in a similar way to that achieved with mitigation. The recent Stern Review (Stern, 2006) makes use of computational models (Dickinson, 2007) to describe the potentially catastrophic economic consequences of failure to reduce greenhouse gas emissions; however, adaptation was not fully considered in the models. The impacts identified on the global economy, therefore, take little account of the potential to adapt. In other words, the consequences that have attracted so much public attention neglect to consider how much lower they might be given a sufficiently aggressive adaptation strategy. Adaptation models can help correct this misconception and demonstrate, in objective terms, the value of adaptation. Adaptation modeling falls into both categories of upscaling: initially, models can escalate the knowledge base of adaptation; subsequently, they have the potential to upscale the technical and scientific modeling studies from local to global levels.

To illustrate the use of adaptation models, in Hope et al. (1993) the PAGE model was used to assess the value of policies relating to climate change. The output demonstrated that mitigation is not sufficient as a standalone measure. Aggressive adaptation is required. The study examined two extremely different policies for adapting to climate change, where in the first scenario, the policy implemented no adaptation, and in the latter, aggressive adaptive measures were pursued. By including an equation for the cost of adaptation, thus, investment in adaptive measures (e.g., the building of sea walls; development of drought resistant crops) can decrease the vulnerability to climate change before economic losses occur and also reduce the intensity of both non-economic and economic impacts (Hope, 2006). The model output demonstrated that at a 5% discount rate, the costs of adaptation (ECU 0.3 trillion) is easily justifiable, since the total

climate change damages were calculated to be ECU 17.5 trillion (the benefits from the reduction in economic impacts, less adaptation). Adapting to climate change is effective at decreasing world-wide impacts (Hope et al., 1993).

Another model AD-DICE, in its first application, lead to the conclusion that choosing an agenda that focuses solely on adaptation results in a higher utility than only mitigation focused agenda. Adaptation was therefore more cost effective. The model also was able to show that the net benefits of mitigation up to 2050 are negative. When applied optimally the model demonstrated that adaptation could reduce gross damages of climate change by on average 35%. The findings from the model support the statement that applying only adaptation is more beneficial than applying only mitigation, confirming the importance of adaptation as a control option in combating climate change up until 2100, where thereafter mitigation reduces damages (de Bruin et al., Forthcoming).

Conversely, what is the economic cost of not adapting? Recent publications (de Bruin et al., Forthcoming) have used adaptation modeling to highlight the ability of adaptation to decrease the negative impacts of climate change in the next 50 years; along with allowing for beneficial opportunities in new sectors and the preservation of markets that without adaptation would be detrimentally impacted by climate change.

At the present time, adaptation models are still in the initial discovery stages, mainly relying on theoretical data and assumptions which for greater practical application should be shifted to usage of empirical data. There are also several types of adaptation models (Dickinson, 2007) that lack a common metric, which mitigation avoids. This may never be completely resolved since adaptation options to climate change are so diverse; however, there may be some arguments in favour of using monetary units as the common metric in adaptation models. With all of that stated, for adaptation modeling to truly reach its potential it will require translation to those outside the modeling community.

5 Integration with Mitigation.

An approach to upscaling that is dependent on the success of either modelling, or case study analysis (or both) is the integration of adaptation with mitigation studies; this approach provides added value to adaptation. The idea is simply that closer integration of adaptation with mitigation might make the case for combined strategy or portfolio more acceptable in the policy process and negotiations than the two taken separately. The idea is suggested thematically in Figure 2 where the flow of benefits over time from mitigation and adaptation is compared. Although the exact plot of the curves is not agreed it is accepted that adaptation measures can yield net benefits in the short term and that mitigation benefits will be delayed.

This dichotomy has led to the suggestion that new insights can be gained by the combination of local level place-based mitigation and adaptation studies in the context of sustainable development. A series of studies, which have now been completed, in British Columbia, under the name of the AMSD (Adaptation

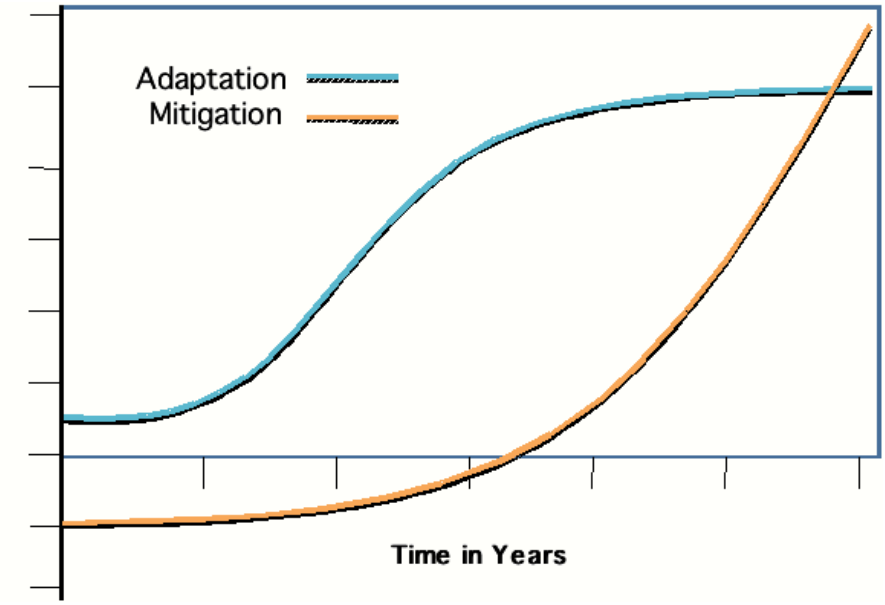

Figure 2: Short term adaptation benefits and longer term mitigation benefits.

and Mitigation in the context of Sustainable Development and the approach has been formulated in a number of papers. (Bizikova & Cohen, 2006; Bizikova et al., 2007, 2008).

6 Bridging the Gap and Advancing the Adaptation Negotiations

Adaptation is recognised as an important part of climate change policy agenda, but it has received less attention and support than mitigation for a variety of reasons having to do with the social construction of climate change as an environmental pollution issue. It is suggested that if this situation is to be changed and a more balanced portfolio developed some improvements are needed in adaptation research. Reliance upon the qualitative accumulation of case study evidence is not sufficient by itself to bring about the required redress. This does not mean that such studies should be abandoned. Detailed local studies involving stakeholders and those at risk are an essential component of adaptation. In addition to the strengthening of place-based adaptation research three other options have been considered leading to the following six conclusions and recommendations.

1. Improve local place-based studies of adaptation by making them more widely available as examples for demonstration purposes. This could be

achieved by the creation of a publicly accessible web based data base, classified by region, by sector, and by type of adaptation.

2. Assemble sets of case studies that are sufficiently similar in topic, focus, and method to investigate and develop the possibilities of meta-analysis. Where feasible carry out one or more pilot meta-analyses of adaptation.

3. Further develop adaptation modeling, both of stand-alone adaptation, especially examining the adaptation process and also adaptation in IAMs.

4. Develop a set of joint case studies of adaptation and mitigation in the same locality in the context of sustainable development, and organize this as a programme on an international level.

5. Consider how these four approaches to adaptation studies might be developed in concert and explore the possibilities for synergy and mutual benefit.

6. Translation and communication of adaptation research results to those outside the research community, and especially into the policy process.

7 Bibliography

Bell, M., Dominici, F. & Samet, J. (2005), 'A meta-analysis of time-series studies of ozone and mortality with comparison to the national morbidity, mortality and air pollution study', *Epidemiology* **16**(4), 436–445. 32

Bizikova, L. & Cohen, S. (2006), International workshop: Climate change adaptation, mitigation and linkages with sustainable development, Final report, Environment Canada and University of British Columbia. 35

Bizikova, L., Neale, T. & Burton, I. (2008), *Canadian communities' guidebook for adaptation to climate change. Including an approach to generate mitigation co-benefits in the context of sustainable development*, First edn, Environment Canada and University of British Columbia, Vancouver. 35

Bizikova, L., Robinson, J. & Cohen, S. (2007), 'Linking climate change and sustainable development at the local level', *Climate Policy* **7**(4), 271–277. 35

de Bruin, K. C., Dellink, R. B. & Tol, R. S. J. (Forthcoming), AD-DICE: An implementation of adaptation in the DICE model, Working paper FNU-126, Hamburg University and Centre for Marine and Atmospheric Science. Forthcoming in Climatic Change. 34

Dickinson, T. (2007), *The compendium of adaptation models for climate change*, First edn, Adaptation and Impacts Research Division, Environment Canada, Ottawa. 33, 34

Hope, C. (2006), 'The marginal impact of CO_2 from PAGE2002: An integrated assessment model incorporating the IPCC's five reasons for concern', *Integrated Assessment* **6**(1), 19–56. 33

Hope, C., Anderson, K. & Wenman, P. (1993), 'Policy analysis of the greenhouse effect: An application of the PAGE model', *Energy Policy* **2**, 327–338. 33, 34

Julius, S. & Scheraga, J. (2000), *The team model for evaluating alternative adaptation strategies*, Mathematical Systems, Springer, Berlin. 33

Leary, N., Adejuwon, J., Barros, V., Burton, I. & Lasco, R. (2007), *Climate change and adaptation*, Earthscan, London, UK. 31, 32

Saez, M., Figueiras, A., Ballester, F., Pérez-Hoyos, S., Ocaña, R. & Tobias, A. (2001), 'Comparing meta-analysis and ecological-songitudinal analysis in time-series studies. a case study of the effects of air pollution on mortality in three Spanish cities.', *Journal of Epidemiological Community Health* **55**, 423–432. 32

Schwartcz, J. (1994), 'Air pollution and daily mortality: A review and meta-analysis', *Environmental Reseoarch* **64**, 36–52. 32

Stern, N. (2006), *Stern review report on the economics of climate change*, HM Treasury. http://www.hmtreasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm. 33

UKCIP (2006), '(United Kingdom Climate Impacts Program) Adaptation Actions'. http://www.ukcip.org.uk/resources/tools/database.asp. 30

Zhao, Y., Wang, S., Aunan, K., Martin, H., Seip, M. & Hao, J. (2006), 'Air pollution and lung cancer risks in China—a meta-analysis', *Science of the Total Environment* **366**, 500–513. 32