Avoiding Dangerous Climate Change

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FOREWORD

10 DOWNING STREET
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The Rt Hon Tony Blair, MP
UK Prime Minister

Climate change is the world's greatest environmental challenge. It is now plain that the emission of greenhouse gases, associated with industrialisation and economic growth from a world population that has increased six-fold in 200 years, is causing global warming at a rate that is unsustainable.

That is why I set climate change as one of the top priorities for the UK's Presidency of the G8 and the European Union in 2005.

Early in the year, to enhance understanding and appreciation of the science of climate change, we hosted an international meeting at the Hadley Centre in Exeter to address the big questions on which we need to pool the best available answers:

'What level of greenhouse gases in the atmosphere is self-evidently too much?' and 'What options do we have to avoid such levels?'

It is clear from the work presented that the risks of climate change may well be greater than we thought. At the same time it showed there is much that can be done to avoid the worse effects of climate change.

Action now can help avert the worst effects of climate change. With foresight such action can be taken without disturbing our way of life.

The conference provided a scientific backdrop to the G8 summit. At the Gleneagles meeting the leaders of the G8 were able to agree on the importance of climate change, that human activity does contribute to it and that greenhouse gas emissions need to slow, peak and reverse. All G8 countries agreed on the need to make 'substantial cuts' in emissions and to act with resolve and urgency now.

There was agreement to a new Dialogue on Climate Change, Clean Energy and Sustainable Development between G8 and other interested countries with significant energy needs. This process will allow continued discussion of the issues around climate change and measures to tackle it and help create a more constructive atmosphere for international negotiations on future actions to reduce emissions.

This book will serve as more than a record of another conference or event. It will provide an invaluable resource for all people wishing to enhance global understanding of the science of climate change and the need for humanity to act to tackle the problem.

Tony Blair

MINISTERIAL ADDRESS BY Rt Hon MARGARET BECKETT, MP

It is a great pleasure for me to meet so many distinguished climate scientists and in such an impressive new building, which among other things houses the Hadley Centre.

At the time of the Hadley Centre's inception in 1990 the IPCC was in its infancy and the climate change convention had not even been born! Since then it has become one of the world's leading institutes for climate research.

In 1990 carbon dioxide levels were 354 parts per million – now they are at around 377 parts per million and still rising. Since 1990 global temperatures have increased by about 0.2°C and the ten warmest years in the global record have occurred. Absolute temperature records for the UK were broken in 2003 as we passed the 100°F mark.

What the non-specialists have always wanted to know is whether these effects really were connected. In 1990 the first assessment of the IPCC could not unequivocally show that the observed rise in temperatures was linked to increasing greenhouse gases and not just natural variation, even though it was consistent with modelled projections. But by 2001 the IPCC was able to say that 'there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities'.

You are all familiar with the IPCC projections of warming over this century of between about 1.5°C and almost 6°C due to increased greenhouse gases. No doubt they will be refined further but what is clear is that temperatures will go on rising. Indeed, I understand that the warming expected over the next few decades is virtually unavoidable now. Even in this timeframe we may expect significant impacts and so we need to act now to ensure that we limit the scale of warming in the future to avoid the worst effects.

Recent events show that even wealthy modern societies struggle with extreme events, and developing societies are particularly vulnerable to catastrophe. Extreme weather events can be costly, not only in both in human lives and suffering but also in terms of sheer economics. The flooding which swept Europe in 2002 not only caused 37 deaths but cost US$16 billion in direct costs; the European heat-wave in 2003 led to 26,000 premature deaths and US$13.5 billion in direct costs.

Such events can be expected to become more frequent as a result of climate warming. And there are some signs that extremes are increasing in scale and frequency. Recent work published by Hadley Centre has shown that the risk of extreme warmth, such as that of the summer of 2003 over Europe, is now four times greater than 100 years ago and that that increased risk is due to the elevated levels of greenhouse gases in the atmosphere.

The Climate Change Convention's objective, 'to stabilise greenhouse gases in the atmosphere at levels which avoid dangerous anthropogenic climate change', is a protection standard for the global climate, analogous to national and international environmental standards for air quality or critical loads for sulphur or nitrogen.

But for climate operationalising that objective is no mean feat because responsibility is shared across the world. Common, even though differentiated. All countries contribute to the problem to varying degrees but no one country can solve the problem by acting alone. So an international approach is essential. Defining how much climate change is too much is a political, as well as a scientific, question but one which needs to be guided by the best objective information that science can give. That is why we have called this conference. When he announced it in September, the Prime Minister posed these questions, 'What level of greenhouse gases in the atmosphere is self-evidently too much? What options do we have to avoid such levels?' I hope that your discussions here will help society consider these questions.

We need to begin a serious debate to understand how much different levels of climate change will affect the

world as a whole, specific regions and particular sectors of society. How fast will change occur and, more significantly, how can we avoid the worst effects? We may not be able to do much to reduce climate change over the next few decades, but what we do now will affect how much and how quickly climate changes. That is why we also need this meeting to look at possible solutions. We in the UK have already committed ourselves to a 60% reduction in carbon dioxide emissions by 2050. We urge others to commit themselves to take comparable steps.

But we should not underestimate the scale of the task. Since 1990, global emissions of CO_2 alone have increased by 20%. By 2010 without the Kyoto Protocol emissions could have risen to 30% above 1990 levels. Nothing less than a radical change in how we generate and use energy will be needed and there will not be one solution but a whole portfolio of measures. Kyoto, which only has targets for developed countries, will shave some 2-3% off the projected emissions. That is very much a first step; but it provides the opportunity to try novel approaches such as giving carbon a value that can be traded to ensure the most economical ways of reducing emissions. The clean development mechanism provides a novel way to slow the growth in developing country emissions whilst at the same time providing resources and new technologies which will aid development.

By comparison to the potential cost of damage due to climate change, the cost of long-term global action to tackle climate change is likely to be short-term and relatively modest. But the level of such costs depends above all on clear long-term signals from government. International action can provide the clarity and confidence that business needs to invest, and to unleash the power of markets to create a low carbon future – both in the developed world and in emerging economies such as China and India where there is such a strong demand for new energy investment.

The UK experience demonstrates that decarbonisation need not be damaging to economic growth. Between 1990 and 2003 our greenhouse gas emissions fell by around 14% while our GDP rose by 36% over the same period.

As the Prime Minister said last week, we need to involve the world's largest current and future emitters in tackling climate change. Also businesses can and must play an absolutely central role in delivering a low carbon economy. To do so industry and investors need the long-term signals to incentives investment in new technology. This is why a clear scientific picture is essential and why your work here is so important.

So what is next? We can all play a part in dealing with the problem but Governments must provide leadership and be prepared to drive change. In Buenos Aires in December, the world took a first small step to looking at what we do beyond 2012, the end of the Kyoto period. This will be a long road but it will help enormously to have at our disposal science which has addressed the questions that this meeting will address, that shows clearly the risks of delay and too little action, and shows us very clearly what the options are to achieve stabilisation. I very much hope that this conference will send a clear message to leaders and decision makers about the scale, the urgency and the necessity of the task before us, that it will encourage more scientists to explore the issues raised and that it will provide through your papers and deliberations helpful guidance to our G8 presidency and important input to the 4th assessment report of the IPCC.

This meeting provides a tremendous opportunity for you as scientists to influence the debate and to help the world to move to a sustainable future and to avoid the worst effects of anthropogenic climate change. I wish you well in your deliberations.

Hadley Centre, Exeter, 1 February 2005

PREFACE

The Meaning and Making of This Book

The International Symposium on Stabilisation of Greenhouse Gas Concentrations, Avoiding Dangerous Climate Change, (ADCC) took place, at the invitation of the British Prime Minister Tony Blair and under the sponsorship of the UK Department for Environment, Food and Rural Affairs (Defra), at the Met Office, Exeter, United Kingdom, on 1–3 February 2005. The conference attracted over 200 participants from some 30 countries. These were mainly scientists, and representatives from international organisations and national governments.

The conference offered a unique opportunity for the scientists to exchange views on the consequences and risks presented to the natural and human systems as a result of changes in the world's climate, and on the pathways and technologies to limit GHG emissions and atmospheric concentrations. The conference took as read the conclusions of the IPCC Third Assessment Report (TAR) that climate change due to human actions is already happening, and that without actions to reduce emissions climate will continue to change, with increasingly adverse effects on the environment and human society.

In particular the scientists were asked to address the following questions:

- What are the key impacts – on regions, sectors, and the world as a whole – of different potential levels of anthropogenic climate change?
- What would such levels of climate change imply in terms of greenhouse gas stabilisation levels and emission pathways required to achieve these levels?
- What technological options are there for implementing these emission pathways, taking into account costs and uncertainties?

By all standards (topicality of contributions, novelty of results, quality of presentations, intensity of discussions) and all accounts (feedback from participants, media coverage, stakeholder reactions and reflections, reverberations in the scientific community), the ADCC Conference was a highly successful event. As a consequence, the conveners were urged by numerous individuals and organisations to summarise the ground covered during the meeting in a self-contained book that makes the pertinent results conveniently accessible to a wider audience. In order to satisfy this demand, Defra established an international Editorial Board (EB) and launched an energetic review and production process.

This book consolidates the scientific findings presented at the Conference and is a resource intended to inform the international debate on what constitutes dangerous climate change. The message coming out of the book is clear – that climate change is happening, that impacts of the change are likely to be more serious than previously thought, and that there are already technological options that can be used to ultimately stabilise the concentration of greenhouse gases in the atmosphere at appropriate levels.

The conference did not attempt to identify a single level of greenhouse gas concentrations to be avoided. The intricacies of climate change prohibit the identification of one single atmospheric concentration that can avoid dangerous levels of climate change on the basis of scientific evidence alone. Indeed consideration of the question requires value judgments by societies and international debate. The conference does however go some way to providing the scientific evidence that could inform such a debate. There is a clear difference between presentation and interpretation of evidence. Scientific evidence is generally restricted to revealing (i) causal aspects of the climate change problem; (ii) the characters, magnitudes and interrelations of the values at stake; and (iii) the potential costs and benefits of the available response strategies. It would be expecting too much of the scientific community to act as the arbiter of society's preferences as reflected in the valuation metrics actually employed and the decision processes actually implemented.

The process of putting together this book has spared no pains in ensuring the scientific quality and credibility of the material presented. All contributions had to survive a four-fold filtering and amendment procedure. Firstly, the submissions to the conference in response to the 2004 open call for papers as well as about ten invited keynotes were scrutinized by the International Scientific Steering Committee on an extended-abstract basis. Secondly, the invited and selected presentations were intensively discussed by the Conference itself and in numerous individual conversations, providing the authors with numerous valuable suggestions and criticisms. Thirdly, all the presenters were invited by the EB in the spring of 2005 to submit an amended version of their Conference contribution that took into account comments from the participants and was restructured for inclusion in this book. Finally all the re-submissions (whether originally invited or selected) were subjected to independent peer review as the basis for a final acceptance or rejection decision by

the EB. This process also allowed for some amendment by the authors of their original papers in the light of the reviewers' comments.

We feel that the outcome was well worth the efforts of hundreds of experts, stakeholders and staff involved in this enterprise. We would like to express our deep gratitude to all those involved and in particular to the referees for their invaluable reviews and to the authors of the papers for delivering under brutal time constraints.

The resulting material is organised in seven sections that span all aspects of the problem, starting with climate system analysis and ending with an assessment of the technological portfolio needed for global warming containment. We hope that this book will make a significant contribution to the scientific and policy debates on the ultimate rationale for and level of climate protection, in terms of breadth of coverage, topicality, scientific quality and relevance.

Hans Joachim Schellnhuber (Chair)
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