

Global Warming and the resulting climate change is one of the most serious environmental problems facing the world community. *Global Warming: the Complete Briefing* is the most comprehensive guide available to the subject. A world-renowned expert, Sir John Houghton explores the scientific basis of global warming and the likely impacts of climate change on human society, before addressing the action that could be taken by governments, by industry and by individuals to mitigate the effects. The first edition received excellent reviews, and this completely updated new edition will prove to be the best briefing the student or interested general reader could wish for.

Sir John Houghton CBE, FRS is co-chairman of the Scientific Assessment Working Group of the Intergovernmental Panel on Climate Change and chairman of the UK's Royal Commission on Environmental Pollution. He was Chief Executive of the UK Meteorological Office from 1983 to his retirement in 1991. He is author of *The Physics of Atmospheres* and *The Search for God: Can Science Help?*, and has published numerous research papers and contributed to many influential research documents. Sir John and his wife Sheila live in Wales.

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The Complete Briefing

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Co-chairman of the Scientific Assessment Working-Group of the
Intergovernmental Panel on Climate Change

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**To my grandchildren, Daniel, Hannah, Esther, Maxwell
and Jonathan and their generation**

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Introduction to the First Edition

Climate change and global warming are well up on the current political agenda. There are urgent questions everyone is asking: are human activities altering the climate? Is global warming a reality? How big are the changes likely to be? Will there be more serious disasters; will they be more frequent? Can we adapt to climate change or can we change the way we do things so that we can slow down the change or even prevent it occurring?

Because the Earth's climate system is highly complex, and because human behaviour and reaction to change is even more complex, providing answers to these questions is an enormous challenge to the world's scientists. As with many scientific problems only partial answers are available, but our knowledge is evolving rapidly, and the world's scientists have been addressing the problems with much energy and determination.

Three major pollution issues are often put together in people's minds: global warming, ozone depletion (the ozone hole) and acid rain. Although there are links between the science of these three issues (the chemicals which deplete ozone and the particles which are involved in the formation of acid rain also contribute to global warming), they are essentially three distinct problems. Their most important common feature is their large scale. In the case of acid rain the emissions of sulphur dioxide from one nation's territory can seriously affect the forests and the lakes of countries which may be downwind of the pollution. Global warming and ozone depletion are examples of global pollution – pollution in which the activities of one person or one nation can affect all people and all nations. It is only during the last thirty years or so that human activities have been of such a kind or on a sufficiently large scale that their effects can be significant globally. And because the problems are global, all nations have to be involved in their solution.

The key intergovernmental body which has been set up to assess the problem of global warming is the Intergovernmental Panel on Climate Change (IPCC), formed in 1988. At its first meeting in November of that year in Geneva, the Panel's first action was to ask for a scientific report so that, so far as they were known, the scientific facts about global warming could be established. It was imperative that politicians were given a solid scientific base from which to develop the requirements for action.

That first scientific report was published at the end of May 1990. On Monday 17 May I presented a preview of it to the then British Prime Minister, Mrs Margaret Thatcher, and members of her Cabinet at 10, Downing Street in London. I had been led to expect many interruptions and questions during my presentation. But the thirty or so Cabinet members and officials in the historic Cabinet room heard me in silence. They were clearly very interested in the report, and the questions and discussion afterwards demonstrated a large degree of concern for the world's environmental problems.

Since then the interest of many political leaders has been aroused – as has been shown by their attendance at two important world conferences concerned with global warming: the Second World Climate Conference in Geneva in 1990 and the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992. The Rio conference with over 25,000 people attending the main sessions and the many side meetings, was the largest conference ever held. Never before had a single conference seen so many of the world's leaders, and for that reason it is often referred to as the Earth Summit.

Much of the continuing assessment of climate change has been focused on the IPCC and its three working groups dealing respectively with science, impacts and response strategies. The IPCC's first report published in 1990 was a key input to the international negotiations which prepared the agenda for the UNCED Conference in Rio de Janeiro; it was that IPCC assessment which provided much of the impetus for the Framework Convention on climate change signed at Rio by over 160 countries. As chairman or co-chairman of the Science Working Group I have been privileged to work closely with hundreds of scientific colleagues in many countries who readily gave of their time and expertise to contribute to the IPCC work.

For this book I have drawn heavily on the 1990 and 1992 reports of all three working groups of IPCC. Further, in putting forward options for action I have followed the logic of the Climate Convention. What I have said I believe to be consistent with the IPCC reports and with the implications of the Climate Convention. However, I must also emphasize that the choice of material and any particular views I put forward are entirely my own and should in no way be construed as the views of the IPCC.

During the preparation of both IPCC reports so far there has been considerable scientific debate about just how much can be said about likely climate change next century. Some researchers initially felt that the uncertainties were such that scientists should refrain from making any estimates or predictions for the future. However, it soon became clear that scientists have a responsibility to communicate the best possible information about the likely magnitude of climate change, along with clear statements of the assumptions made and the level of uncertainty in the estimates. Like weather forecasters, their results will not be entirely accurate, but can provide useful guidance.

Many books have been published on global warming. This book differs from the others because I have attempted to describe the science of global warming, its impacts and what action might be taken in a way which the intelligent non-scientist can understand. Although there are many numbers in the book – I believe the quantification of the problem to be very important – there are no mathematical equations. I have also used the minimum of jargon in the main text. Some technical explanations which would be of interest to the scientifically trained are included in some of the boxes. Others contain further material of specific interest.

I am grateful to many who have helped me with the provision and preparation of particular material for this book and to those who have read and helpfully commented on my drafts. There have been those who have been involved with the IPCC: Bert Bolin, the IPCC Chairman, Gylvan Meira Filho, my co-chairman on the IPCC Science Working Group, Robert Watson, co-chairman

of the IPCC Working Group on Impacts and Response Strategies, Bruce Calander, Chris Folland, Neil Harris, Katherine Maskell, John Mitchell, Martin Parry, Peter Rowntree, Catherine Senior and Tom Wigley. Others I wish to thank are Myles Allen, David Carson, Jonathan Gregory, Donald Hay, David Fisk, Kathryn Francis, Michael Jefferson, Geoffrey Lean and John Twidell. The staff at Lion Publishing, Rebecca Winter, Nicholas Rous and Sarah Hall, have been most helpful in preparing the book for publication, especially in ensuring that it is as attractive and readable as possible. Finally, I owe an especial debt to my wife, Sheila, who gave me strong encouragement to write the book in the first place, and who has continued her encouragement and support through the long hours of its production.

Introduction to the Second Edition

Since the publication of the first edition nearly three years ago, interest in the issue of Global Warming and concern about it has continued to grow. The Framework Convention on Climate Change (FCCC) agreed at the Earth Summit in 1992 has been ratified and machinery for its implementation is gradually being developed. At the end of 1995, the IPCC produced a further comprehensive report updating the 1990 report. Although the main conclusions have not changed, much has been added to the detail of our knowledge regarding all aspects of the issue, the science, the impacts and the possible response. This revised edition takes into account this further information from the 1995 IPCC reports.

In the first edition I included a chapter, chapter 8, with the heading ‘Why should we be concerned?’ which addresses the question of the responsibility of humans for the Earth and for looking after the environment. In it I presented something of the basis for my personal motivation as a Christian for being concerned with environmental problems. Although I believe that it is important that science is presented in the broad context of human values, I realised that the inclusion of such a chapter was something of a departure and wondered how it would be received.

Some have expressed surprise that in the middle of a science book, there should be, unusually, a chapter of this kind which deals with ethical and religious issues. However, it has been pleasing that scientific colleagues and reviewers of the book have referred favourably to the chapter stressing the value and importance of placing environmental science in the context of the reasons for its pursuit. For instance, John Perry, in the *Bulletin of the American Meteorological Society*, writes:

Many scientists, including avowed agnostics such as myself, will find this forthright declaration of religious belief and divine purpose a bit startling in an otherwise rigorously scientific volume. However, in a line of argument that I have no difficulty whatever in supporting, Houghton demonstrates that the domains of science and religion are simply complementary ways of looking at truth. The former deals with how the world works and the latter with why. In Houghton’s framework, we and the earth are each other’s reasons for existence in a divine plan that we must struggle to understand but must inescapably follow. Thus, Houghton holds that we have no choice but to care for the earth solicitously as its ‘gardeners’ in a ‘partnership with God’. His lucid précis of the complex factual substance of global warming is an authoritative guide to the issue’s scientific dimensions; his inspiring synthesis of science, faith and stewardship is an even more illuminating handbook to its moral and ethical dimensions. Together, they constitute a uniquely valuable Baedeker to one of the most important issues of our science and our time.

In revising chapter 8 for this edition, I have been somewhat more objective and less personal – which I felt was more appropriate for student readers from a wide range of disciplines, for whom the edition is particularly suited. As a didactic aid I have also included a number of problems and questions for discussion at the end of all the chapters.

Some of my colleagues sometimes comment on how formidable is the task of stewardship of the Earth feeling that it is perhaps beyond the capability of the human race to tackle it adequately. I feel optimistic about it, however, for three main reasons. Firstly, I have seen how the world's scientists, coming from very different countries, cultures and backgrounds, have worked closely and responsibly in the IPCC to provide a consensus presentation of the science of global warming. Secondly, the technologies required to provide for greater efficiency in the use of fossil fuels and for their replacement with renewable sources of energy are available and, when developed on the necessary scale, also affordable. Thirdly, my belief in God's commitment to the material world coupled with his offer of partnership in caring for it, makes stewardship of the Earth an especially exciting and challenging activity.

In the preparation of this revised volume I wish to express again my gratitude to the scientific colleagues with whom I have worked in the ongoing activity of the IPCC and from whom I have learnt much. My thanks are also due to John Twidell and Michael Banner who have commented on particular chapters, and to Catherine Flack, Matt Lloyd and other staff of the Cambridge University Press for their competence, courtesy and assistance in the preparation of the book.

John Houghton
1997