CLIMATE CHANGE: BIOLOGICAL AND HUMAN ASPECTS

In recent years climate change has become recognised as the foremost environmental problem of the twenty-first century, and a subject of considerable debate. Not only will climate change affect the multi-billion dollar energy strategies of countries worldwide, but it could also seriously affect many species, including our own. Written in an accessible style, this textbook provides a broad review of past, present and likely future climate change from the viewpoints of biology, ecology and human ecology. It is thoroughly referenced, allowing readers, if they wish, to embark on their own more specialist studies.

A fascinating introduction to the subject, this textbook will be of interest to a wide range of people, from students in the life sciences who need a brief overview of the basics of climate science, to atmospheric science, geography and environmental science students who need to understand the biological and human ecological implications of climate change. It will also be a valuable reference for those involved in environmental monitoring, conservation, policy-making and policy lobbying.

JONATHAN COWIE has spent many years conveying the views of biological science learned societies to policy-makers. His earlier postgraduate studies related to energy and the environment, and he is a former Head of Science Policy and Books at the Institute of Biology (UK). He is author of *Climate and Human Change: Disaster or Opportunity* (Parthenon Publishing, 1998).

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Biological and Human Aspects

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Introduction

This book is about biology and human ecology as they relate to climate change. Let's take it as read that climate change is one of the most urgent and fascinating science-related issues of our time and that you are interested in the subject: for if you were not you would not be reading this now. Indeed, there are many books on climate change but nearly all, other than the voluminous Intergovernmental Panel on Climate Change (IPCC) reports, tend to focus on a specialist aspect of climate, be it weather, palaeoclimatology, modelling and so forth. Even books relating to biological dimensions of climate change tend to be specialist, with a focus that may relate to agriculture, health or palaeoecology. These are, by and large, excellent value provided that they cover the specialist ground which readers seek. However, the biology of climate change is so broad that the average life-sciences student, or specialist seeking a broader context in which to view their own field, has difficulty in finding a wide-ranging review of the biology and human ecology of climate change. Non-bioscience specialists with an interest in climate change (geologists, geographers, atmospheric chemists, etc.) face a similar problem. This also applies to policy-makers and policy analysts, or those in the energy industries, getting to grips with the relevance of climate change to our own species and its social and economic activities.

In addition, specialist texts mainly refer to specialist journals. Very few university or research-institute libraries carry the full range. Fortunately the high-impact factor and multi-disciplinary journals such as *Science* and *Nature* do have specialist climate papers (especially those relating to major breakthroughs) and virtually all academic libraries, at least in the anglophone world, carry these publications. It is therefore possible to obtain a grounding in the biology (in the broadest sense) of climate-change science from these journals provided, that is, one is prepared to wade through several years' worth of copies.

This book hopefully scores with its broad biological approach, its tendency to cite the high-impact journals (although some specialist citations are also included) and its level of writing (hopefully appropriate for junior undergraduates and specialists reading outside their field). It should also be accessible to bioscientists as well as those outside of the life sciences. However, here is a quick word of advice. Familiarise yourself with the appendices at the back before you start reading!

Even so, this book can only be an introduction to the biology and human ecology – past, present and future – of climate change. Readers seeking more specialist knowledge on any particular aspect should seek out the references, at least as a starting point.

This book's style is also different to many textbooks. Reading it straight through from start to finish one may get the feeling that it is a little repetitious. This is only *partly* true. It is true in the sense that there are frequent references to other chapters and subsections. This is for those looking at a specific dimension, be they specialists putting their own work into a broader climate context, students with essays to write, or policy analysts and policy-makers looking at a special part of the human–climate interface. In short, this book is written as much, if not more, for those dipping into the topic as it is as a start-to-finish read.

There is another sense in which this book appears repetitious, although in reality it is not. It stems from one particular problem scientists have had in persuading others that human activity really is affecting our global climate. This is that there is no single piece of evidence that by itself proves such a hypothesis conclusively. Consequently those arguing a contrary case have been able to cite seemingly anomalous evidence, such as that a small region of a country has been getting cooler in recent years or that the Earth has been warmer in the past, or that there have been alternating warm and cool periods. All of this may be true individually but none of it represents the current big picture. So, instead of a single, all-powerful fact to place at the heart of the climate-change argument, there is a plethora of evidence from wide-ranging sources. For instance, there is a wealth of quite separate geological evidence covering literally millions of years of the Earth's history in many locations across the globe. This itself ranges from ice cores and fossils to isotopic evidence of a number of elements from many types of sediment. There is also a body of biological evidence from how species react to changes in seasons to genetic evidence from when species migrated due to past climate change. Indeed, within this there is the human ecological evidence of how we have been competing with other species for resources and how this relates observed changes in both human and ecological communities with past climate change.

This vast mass of evidence all points to the same big picture of how changes in greenhouse gases and/or climate have affected life in the past. Then again there is the present and the evidence used to build up a likely picture of what could well happen in the future. Here again, the evidence seems to be very largely corroborative. Therefore, to readers of this book it can seem as if the same ground is being covered when in fact it is a different perspective being presented each time that leads to the same concluding picture.

Indeed, because there is so much evidence contributing to the big picture, some may well find that evidence from their own specialist area of work is not included, or, if it is included, is covered briefly. This is simply because the topic is so huge and not due to a lack of recognition on my part of the importance of any particular aspect of climate-change science.

That there are similar themes running through specialist areas of climate-change science and the relating biology is in once sense comforting (we seem to be continually improving our understanding and coming to a coherent view) but in another it is frustrating. Over the years I have spoken to a large number of scientists from very disparate disciplines. Part of this has been due to my work (policy analysis and science lobbying for UK learned societies and before that in science journal and book management) and in part because I enjoy going to biosphere science as well as energy-related symposia. (There is nothing quite like looking over the shoulders of a diverse range of scientists and seeing what is happening in the laboratory and being discovered in the field.) The key thing is that these individual specialist, climate-related scientists all tend to say similar things, be they involved with ocean circulation, the cryosphere (ice and ice caps), tropical forests and so forth. They say the same as their colleagues in other specialist areas but equally do not appear to really appreciate that there is such a commonality of conclusion. For example, a common emerging theme is that matters are on the cusp. Change is either happening or clearly moving to a point where (frequently dependent on other factors) marked change could well happen. It is perhaps a little disappointing that more often than not such specialists seem to have a limited awareness of how their counterparts in other disciplines view things. (I should point out that, in my view, this has more to do with pressures from how science is undertaken these days, and not due to the high level of competence these specialists have within their own field. Scientists simply are not afforded the time to take several steps back from their work and view the larger scientific panorama.) That science is so compartmentalised tends to limit wide-ranging discussions, yet these, when properly informed by sound science, can be exceptionally fruitful.

By now you may be beginning to suspect what has been motivating my researching and writing of this book. The question that remains for me is

whether this book will have any effect on your own motivations and understanding? As it is quite likely that I will encounter at least some of you over the coming years, I dare say I will find out. Meanwhile, I hope you find this topic as fascinating as I do.

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This book also owes a lot to some research bodies. In the UK we are quite bad at making data from tax-payer-funded research publicly available (even for education and policy purposes). This is not so in the USA and so I greatly valued the open access that the National Oceanic and Atmospheric Administration give to their palaeoclimate-related data (which I have used to generate a number of the figures). Interested readers can visit their website at www.ncdc.noaa.gov/oa/ncdc.html. I am also extremely appreciative of the UK Environment Agency's current (2006) Chief Executive, without whom Figure 6.5 simply would not have been presented! Then there are the many who sent paper off-prints (e-mailed pdf files). There are too many to mention but be assured all are referenced.

Talking of references, as mentioned in the Introduction as far as possible I have taken either major reports, many of which are available on the Internet, or used high-impact-factor journals that can be found in most university libraries (these in turn cite papers in more specialist publications). However, I have also used a number of World Health Organization (WHO) press releases. This comes from my background in science policy, and the WHO have been sending me these for the best part of two decades. You will not find

these in university libraries but fortunately you too can seek these out, on www.who.int/mediacentre/news/en.

A mention also has to go to the friendly and helpful librarians of Imperial College London, whose work really is appreciated. Then there are all those who have facilitated my site and field visits in the UK and abroad, be they to power stations (fossil, hydroelectric and nuclear), sites of special scientific interest (in the literal and not just the UK technical sense of the term) and educational institutions.

A thank you also goes to Peter Tyers for the cover picture. This is the second time he has done this for me, but then he is a good photographer.

Finally I must specifically thank Cambridge University Press and freelance copy-editor Nik Prowse for work on the manuscript. I like to think that I have long since found my feet with words, but any capability for editorial spit and polish has always eluded me. Nik has also greatly helped standardise the referencing and presentation. I therefore really do value good editors (and so should you) and especially those who appreciate those who try to do things a little differently. With luck you will notice.