

BOOK REVIEW

A. J. McMichael, A. Haines, R. Slooff, and S. Kovats (eds.): 1996, *Climate Change and Human Health*, World Health Organization, Geneva, 297 pp.

It is commonly recognized, perhaps trivially obvious, that climate impacts on human health in various, sometimes profound ways. Beyond simple assertions of associations, however, lie difficult and pressing problems concerning how and at what rates temporal or spatial changes in climate and weather may alter exposure risk, disease expression, and a healthy existence. Herein lies the central scientific dilemma and justification for this book. The recent popularization of 'emerging' diseases combined with increased concern over widespread habitat destruction have fueled interest in the globalization of disease-environment interactions. Apprehension has grown, in both popular and professional corners, over the prospect that global climate change might negatively impact numerous aspects of our well-being. To address these concerns, and begin raising the associated policy and research implications, a handful of symposia reports or books recently has appeared that attempt to deal with these complicated issues. *Climate Change and Human Health* is unquestionably the most comprehensive, informative, and thought-provoking to date.

This volume represents, as the sub-title states, 'An assessment prepared by a Task Group on behalf of the World Health Organization, the World Meteorological Organization and the United Nations Environment Programme'. The multidisciplinary and complex nature of the subject demands a diversity of experts from many fields, and many are represented in this effort. Unlike most multi-authored, edited books in which individuals are acknowledged as responsible for each chapter, the four editors and eight others listed as 'task group' members of this book appear as conjoint authors for the entire work. An additional 16 scholars are named for their contributions to the text, as are more than 30 others who made substantial review comments. The input of so many, from such varied disciplines, has been remarkably well integrated into a text that is uniformly easy to read. The unevenness across chapters that is so often apparent in edited volumes is surprisingly absent here.

The components of this book are arranged in a logical and easy-to-follow manner. After an introductory chapter that summarizes the context and nature of climate change and health, information is grouped into nine chapters that address contemporary climate change (Chapter 2), various kinds of associated health effects (Chapters 3–8), implications for research and monitoring (Chapter 9), and recommendations and conclusions (Chapter 10). This systematic organization of information, thoughtful use of headings and subheadings, and a standard outline for

each chapter partly compensate for the unfortunate absence of an index that would have facilitated searches for particular topics.

Chapter 1 introduces the recent history of concern and inquiry over climate change and possible adverse health outcomes. Governmental and scientific efforts to define the problem and stimulate investigation are summarized. The scientific and political climate is described in the context of concerns over the physical one. This sets the stage for Chapter 2, which is a concise but complete overview of the climate system and how human activity is now seen as having begun the processes of global climate change. Readers of this journal may view the treatment of this material as oversimplified or naive. That, however, is likely to be the reaction of specialists from other disciplines as they consider chapters that discuss temperature and human physiology, agriculture and nutrition, vector-borne disease, or radiation and cancer. Herein lies the difficulty faced by any exposition that attempts to summarize diverse information from various disciplines: how to be comprehensive, accurate and integral in a style that is understandable to a wide range of readers from various intellectual backgrounds, who have dissimilar needs and interests. This volume has done an outstanding job in meeting that challenge.

Health and associated climate impacts are defined broadly, which is reflected in the range of topics in the next six chapters: temperature and air pollution, biological disease agents, food production and nutrition, weather extremes, sea level rise, and ozone depletion. Perhaps the most obvious consequences on health, addressed in Chapter 3, involve the direct effects of ambient temperature, wind and relative humidity on regulation of human body temperature. Following a summary of traditional views of temperature, comfort and health, the 'synoptic' approach to stressful conditions developed by Kalkstein and colleagues is presented. Various studies are described to illustrate how this approach provides insight into the importance of multiple interacting variables. Extreme heat events result in elevated mortality, but it is recognized that these occasional, acute events tend to be followed by fewer than expected deaths. Thereby, they may be hastening the death of already very susceptible people rather than killing those who are otherwise healthy. Our ability to compensate for such events by air conditioning or early warning may offset impacts over the long term.

Unlike the mostly direct health effects of climate change on body temperature, Chapter 4 attempts to tackle the much more complicated problem of predicting outcomes that are mediated through other biological organisms. These animals include the arthropods ('vectors' such as mosquitoes, tsetse flies, ticks, etc.) that transmit disease-causing microbes, pests such as rodents or cockroaches, and water-borne or food-borne disease agents whose abundance or distribution are affected by weather. This, the largest chapter in the book, addresses a wide diversity of environment-microbe-disease interactions, and is necessarily more speculative than any of the others. Considerable attention is devoted to a few simulation models aimed at predicting how increased average temperature may permit arthropod vectors to expand their current distribution, thereby possibly placing more people

at risk of vector-borne diseases such as malaria, dengue, or trypanosomiasis. One problem with the forecasts of studies such as these is that extrapolations are derived from existing distributions, contemporary environmental tolerances, and current transmission frequencies, and typically do not consider what other changes in transmission dynamics also are likely to occur. Indeed, this is the principal dilemma that most such predictive efforts face: how to account for climate change impacts on the distribution, abundance, and behavior of infectious agents, but also on their vectors, or non-human reservoirs, or competitors, or symbionts, or predators. The few published simulations are well described in the chapter, but generally in an uncritical manner. Perhaps more than any other part of the book, the words 'may', 'could' and 'possibility' are used. While it is admitted that such forecast predictions are probably imprecise, of greater concern is whether they are grossly inaccurate.

Predictions of climate change impacts on food production are summarized in Chapter 5, with the health consequences being manifested through reduced nutrition. Current global warming scenarios predict changes in conditions that are suitable for particular crops, livestock and fisheries, and indicate that the greatest negative results are likely to occur in already vulnerable areas. The need for complex climate-agriculture models is well presented in this chapter, however the link to health effects is not as clearly articulated. Here again, forecasting is limited to predictions of how changing conditions impact on the growth of biological organisms (crops, livestock, etc.). Whether and how human nutrition and health also are affected can only be evaluated through analysis of the social and economic policy and action that will be modified as well.

The consequences of extreme weather events, including floods, droughts, hurricanes, or tornadoes, is addressed in Chapter 6. Such disasters generally are considered to impact on health through indirect pathways in which housing, food production, drinking water, or social infrastructure are compromised. Increased need for disaster mitigation would result if climate change leads to greater or more frequent extreme weather events. This chapter adequately presents most of the important issues, and suggests the kinds of responses that should be anticipated.

Chapter 7 considers the likely impacts of sea level rise by first addressing historical trends in sea level, and then summarizing probable consequences on coastal wetland ecosystems. The analytic procedures for assessing vulnerability are discussed, as are estimates of the extent of economic and ecologic impacts that might result. Most anticipated health consequences of sea level rise are considered to be very speculative, and involve other processes such as extreme weather events, contamination of the potable water supply, or population displacement. Reduced food availability and altered vector-borne disease risk also may occur with rising sea level. Although the economic and ecologic outcomes of the projected flooding of coastal areas probably will be enormous, it must be remembered that change will take place over decades to centuries, allowing time for adaptation to new conditions.

Another aspect of climate change, the depletion of stratospheric ozone, is recognized to have increased ultraviolet radiation (UVR) that reaches ground-level, and both the direct and indirect impacts of this on health are succinctly described in Chapter 8. Direct health effects include reduced immunity and increased risk of infection, various kinds of damage to the eye, and elevated risk of skin ailments, including cancer. The extent and quality of available evidence is nicely summarized, as are mechanisms that underlie the processes. Indirect effects of UVR on health are more speculative, and include impacts on plant and animal growth and reproduction. Again, the authors have carefully described the possibilities in a manner that reflects such uncertainty. They have clearly presented information in a manner that is easily understood.

The last two chapters consider research and monitoring needs (Chapter 9) and recommendations and conclusions (Chapter 10). The scientific research and monitoring needs to better define and predict health impacts of climate change are enormous, in part due to the large area over which events will occur, the diversity of biological and physical systems involved, the long time-frame over which processes and predictions are taking place, and the uncertainty inherent in these interactions and their forecasting. Chapter 9 discusses the epidemiological and analytic tools that are available, including simulation modeling and GIS, and illustrates their use with examples where they are being applied. The authors persuasively argue for an ecologically-based approach to health surveillance and evaluation that will permit analysis of environmental change aimed at prediction and control. This chapter covers a large number of topics, repeating issues that were addressed in earlier parts of the book, but in a manner that illustrates points or presents concrete applications. Perhaps more than any other chapter, this one could stand alone as a resume of concerns and needed effort to address these problems. A summary and set of recommendations are presented in Chapter 10, with the principal argument being support for new, multidisciplinary forms of research, enhanced monitoring, and design of prevention strategies. Long-term planning, it is argued, must integrate health economics into development schemes, while considering the possible confounding effects of climate change.

The authors have amassed a wealth of information, condensed it efficiently, and communicated it in a manner that tends to be easily accessible to the less informed reader. In order to highlight examples or summarize related information, small pieces of text are clearly placed in boxes throughout the book. Tables and figures are effectively employed to help conceptualize interactions or emphasize important variables or processes. What initially seems as oversimplification usually ends up as a succinct and informative synopsis when considered in the context of the accompanying text and overall objectives of the volume. Chapter-by-chapter summaries provide outlines of the principal issues. With roughly 800 references, the book is exhaustively documented, allowing readers to pursue issues that are sometimes superficially addressed. An extensive and accurate glossary defines most

terms with which a non-specialist is likely to be unfamiliar. Even experts working in these fields will appreciate the list of abbreviations and acronyms.

This volume will serve as a practical text in various college and graduate-level courses, as a resource for concerned citizens, and as a reference for professionals in the diverse fields that these problems encompass. Policy makers will find the book especially useful in developing research priorities, surveillance programs, and economic development plans. Hopefully, researchers will gain insights into what new observations are needed, and how their scientific pursuits can be undertaken in ways that lend insights to these complex and perplexing interactions.

Implicitly and sometimes explicitly, this treatise highlights an urgent need for new approaches to research on health-environment interactions, for innovative conceptual and analytic tools, and for training of research scientists who will acquire a breadth of knowledge that transcends traditional academic disciplines. The special characteristics of many infectious diseases that have strong links to the environment create particular problems for epidemiological and ecological research and information gathering. Classical laboratory experiments aimed at demonstrating survival, multiplication, or transmission of such agents cannot fully replicate the diverse conditions that occur under natural climate variation. Thus, long-term field data gathering and surveillance become especially important if studies are to identify seasonal and inter-annual variation in disease associated with those in climate. Without systematically-gathered epidemiological records, we lack the basic information needed to track and retrospectively analyze changes in disease patterns.

This book also demonstrates that, as information needs change, so must the design of future observations, the tools used to gather these data, and the analytical approaches applied to interpret patterns. Unfortunately, shrinking research budgets, and an increasingly narrow focus on simple experiments that produce rapid results, have meant that long-term prospective observations have declined. We need a renewed commitment to and respect for naturalistic observations and eco-epidemiological experiments aimed at understanding the mechanisms by which environmental impacts influence infectious disease risk. Prospective multi-year monitoring designed to test hypotheses concerning climate and health patterns is sorely needed. Critical environmental measures associated with particular diseases should be identified for more detailed, micro-environmental studies. For example, growth rate responses to changing temperatures or population shifts from increased competition due to an invading species may not be obvious without experimental intervention designed to quantify or enumerate interactions. Furthermore, the recognition that complex interactions among physical, biological, and socio-economic variables determine infection risk argues that multidisciplinary studies, including dynamics of multivariable systems, be encouraged in the health and environmental sciences. These could involve, for example, theoretical studies of complex dynamic behavior, spatial statistical investigations of disease ecology during environmental change, or integrative modeling of socioeconomic develop-

ment impacts on pathogen transmission. The analysis of multivariable interactions that may have spatio-temporal fluctuations, non-linear rates of change, thresholds, or time-lags requires different conceptual foundations and non-traditional analytic tools. In particular, methods for the analysis of interactions among qualitatively different kinds of variables are needed to address the complex processes that occur as climate change impacts on health.

In presenting a useful synopsis of the current state of knowledge and speculation on long-term climate-related health effects, *Climate Change and Human Health* illustrates how technically and conceptually difficult analysis is, and reminds us of the many unanswered questions that lie ahead. However, concern over possible future health effects that may occur through the course of the next century should not take precedence over the many pressing environmentally-associated health problems that plague people worldwide today. More research, analysis and intervention must address contemporary diseases resulting from present patterns of deforestation, agricultural development, inadequate nutrition and hygiene, urban crowding, and unequal access to resources. Many of these diseases and processes have climate and weather underpinnings, and addressing these current problems will complement the more theoretical efforts to predict future effects.

*Departments of Biology and Epidemiology,
The University of Michigan,
Ann Arbor, MI 48109,
U.S.A.*

MARK L. WILSON