

---

# Understanding Environmental Health

## How We Live in the World

---

**Nancy Irwin Maxwell, DSc**

Associate Professor

Department of Environmental Health

Boston University School of Public Health



**JONES AND BARTLETT PUBLISHERS**

*Sudbury, Massachusetts*

BOSTON    TORONTO    LONDON    SINGAPORE

*World Headquarters*

Jones and Bartlett Publishers  
40 Tall Pine Drive  
Sudbury, MA 01776  
978-443-5000  
info@jbpub.com  
www.jbpub.com

Jones and Bartlett  
Publishers Canada  
6339 Ormindale Way  
Mississauga, Ontario L5V 1J2  
Canada

Jones and Bartlett Publishers  
International  
Barb House, Barb Mews  
London W6 7PA  
United Kingdom

Jones and Bartlett's books and products are available through most bookstores and online booksellers. To contact Jones and Bartlett Publishers directly, call 800-832-0034, fax 978-443-8000, or visit our Web site, www.jbpub.com.

Substantial discounts on bulk quantities of Jones and Bartlett's publications are available to corporations, professional associations, and other qualified organizations. For details and specific discount information, contact the special sales department at Jones and Bartlett via the above contact information or send an e-mail to [specialsales@jbpub.com](mailto:specialsales@jbpub.com).

Copyright © 2009 by Jones and Bartlett Publishers, LLC

All rights reserved. No part of the material protected by this copyright may be reproduced or utilized in any form, electronic or mechanical, including photocopying, recording, or by any information storage and retrieval system, without written permission from the copyright owner.

This publication is designed to provide accurate and authoritative information in regard to the Subject Matter covered. It is sold with the understanding that the publisher is not engaged in rendering legal, accounting, or other professional service. If legal advice or other expert assistance is required, the service of a competent professional person should be sought.

**Library of Congress Cataloging-in-Publication Data**

Maxwell, Nancy Irwin

Understanding environmental health : how we live in the world / Nancy Irwin Maxwell.

p. ; cm.

ISBN-13: 978-0-7637-3318-6

ISBN-10: 0-7637-3318-0

1. Environmental health. I. Title.

[DNLM: 1. Environmental Health. 2. Environmental Pollutants—adverse effects. 3. Environmental Pollution—adverse effects. 4. Environmental Pollution—prevention & control. WA 30.5 M465u 2009]

RA565.M383 2009

613'.1—dc22

2008011316

6048

**Production Credits**

Publisher: Michael Brown

Production Director: Amy Rose

Associate Editor: Katey Birtcher

Associate Production Editor: Sarah Bayle

Marketing Manager: Sophie Fleck

Manufacturing and Inventory Control Supervisor:

Amy Bacus

Composition: Cape Cod Compositors, Inc.

Cover Design: Kate Ternullo

Cover Image: © TebNad/Shutterstock, Inc.

Printing and Binding: Malloy, Inc.

Cover Printing: Malloy, Inc.

Printed in the United States of America

12 11 10 09 08 10 9 8 7 6 5 4 3 2 1

# In memory of

Benjamin L. Maxwell, Scott R. Maxwell,  
and Edward J. Murphy,  
whose experiences brought home  
the human cost of environmental illness



# Contents

<b>Preface</b> .....	<b>vii</b>
<b>Acknowledgments</b> .....	<b>ix</b>
<b>Chapter 1</b>	
<b>A Preview of Environmental Health</b> .....	<b>1</b>
<b>Chapter 2</b>	
<b>The Science and Methods of</b>	
<b>Environmental Health</b> .....	<b>5</b>
2.1 The Fate and Transport of Environmental Contaminants .....	9
2.2 Toxicology: The Science of Poisons .....	18
2.3 Exposure Assessment: An Applied Science .....	28
2.4 Epidemiology: A Quantitative Research Method .....	37
2.5 Risk Assessment: A Regulatory Science .....	49
2.6 Risk Management: From Assessment to Action. ....	56
2.7 Risk Communication: Sharing Knowledge .....	58
2.8 The Precautionary Principle in Environmental Health .....	61
Study Questions .....	63
References .....	63
<b>Chapter 3</b>	
<b>Living with Other Species</b> .....	<b>67</b>
3.1 Infectious Disease .....	68
3.2 Poisons in Nature .....	92
3.3 Allergy and Asthma .....	94
Study Questions .....	96
References .....	96
<b>Chapter 4</b>	
<b>Producing Energy</b> .....	<b>99</b>
4.1 Energy from Fossil Fuels .....	101
4.2 Electricity from Nuclear Fuel .....	131

4.3 Alternatives to Fossil and Nuclear Fuels . . . . .	153
Study Questions . . . . .	167
References . . . . .	168
<b>Chapter 5</b>	
<b>Producing Manufactured Goods . . . . .</b>	<b>175</b>
5.1 Synthetic Organic Chemicals . . . . .	178
5.2 Toxic Metals . . . . .	189
5.3 Nanotechnology . . . . .	192
5.4 Physical Hazards . . . . .	192
5.5 Asthma-Causing Agents in the Workplace . . . . .	198
5.6 Social Disparities in Exposure to Industrial Pollution . . . . .	199
5.7 Regulation of Industrial Pollution . . . . .	202
Study Questions . . . . .	209
References . . . . .	209
<b>Chapter 6</b>	
<b>Producing Food . . . . .</b>	<b>217</b>
6.1 Modern Crop Production Practices . . . . .	219
6.2 Modern Livestock Production Practices . . . . .	230
6.3 Impacts of Modern Agricultural Practices on Global Climate . . . . .	244
6.4 Modern Fishing Practices . . . . .	244
6.5 From Source to Table . . . . .	246
6.6 Organic Farming and Locally Grown Foods . . . . .	248
6.7 Regulation of Food and the Activities That Produce It . . . . .	249
Study Questions . . . . .	256
References . . . . .	256
<b>Chapter 7</b>	
<b>Living in the World We've Made . . . . .</b>	<b>263</b>
7.1 The “Metabolism” of Communities . . . . .	264
7.2 Management of Sewage Wastes . . . . .	269
7.3 Sources and Treatment of Drinking Water . . . . .	280
7.4 Solid Waste and Its Management . . . . .	288
7.5 The Urban Environment . . . . .	298
7.6 Hazards of Modern Life . . . . .	306
7.7 Sharing Global Impacts and Resources . . . . .	319
Study Questions . . . . .	322
References . . . . .	322
<b>Appendix . . . . .</b>	<b>331</b>
<b>Glossary . . . . .</b>	<b>333</b>
<b>Index . . . . .</b>	<b>363</b>

# Preface

An introductory text like this one, which frames environmental health for a broad group of public health students, should leave its readers with a permanent awareness of environmental influences on health, as well as an appreciation of the societal roots of those influences. Further, it should prepare students who are not focusing in environmental health to engage the environmental health issues that will cross into their professional lives in other domains of public health.

Like many other schools of public health, the Boston University School of Public Health offers two introductory courses in environmental health. One is required of Master of Public Health (MPH) students who are concentrating in environmental health, and also of doctoral students in environmental health. A different course, which I have taught many times, introduces environmental health to MPH students concentrating in other areas—from social and behavioral sciences to biostatistics to health policy and management. These students are a mix of recent college graduates and experienced professionals. And, although the course is designed for MPH students, some undergraduates also seek it out. Thus students bring a wide range of professional and educational experiences to this beginning environmental health course. In particular—and this creates a challenge for both student and teacher—some students have done graduate work in science or medicine, while others have only modest backgrounds in college-level science.

Here are the distinctive features of this textbook. First, it is *brief* than most introductory environmental health texts. It provides all essential information about environmental health for the MPH student and is designed to stand alone in an introductory course for students in concentrations other than environmental health. At the same time, the brevity of the book gives instructors flexibility to customize their course content by assigning additional readings if they wish to do so. Thus, with supplemental readings this book is appropriate for a unified introductory course in environmental health for MPH students in all concentrations, as offered in some schools and programs in public health. This brief book is also suitable as the environmental health text in a survey course in public health—and in a variety of interdisciplinary courses spanning other fields.

In light of the varied science backgrounds of public health students, this text's *treatment of science content* is designed for readers who have different starting points yet need to end up with the same understanding of the subject matter. An early chapter presents the fundamental science and methods of environmental health, much of which may be unfamiliar even to students with strong science backgrounds. In the rest of the text, sidebars present small bites of general science information at the point where it is first needed to understand an environmental health issue. This format directly addresses the challenge of the varied science preparation of the students, allowing each reader to fill in along the way whatever gaps in background knowledge he or she may have.

The book's *organization* also reflects its intended readership. Environmental health is a sprawling and diverse field, embracing many topics. Traditional topics in the field reflect professional specializations or regulatory domains; as a result, these topics are a mix of hazards (such as toxic chemicals or ionizing radiation), settings (such as occupational health), and environmental media (such as air or water pollution). For those outside the field—a core audience for this textbook—these categories do not easily add up to a coherent whole.

To provide that coherence, this text, more than most, tells a connected narrative, with chapters on the various things people do, as individuals or societies, that create environmental health hazards. After a brief introductory chapter and a substantial chapter on the science and methods of environmental health, there are chapters on the hazards of living with other species, including infectious disease; producing energy from fossil fuels, nuclear fuels, and alternative sources; producing manufactured goods, with the associated pollution; producing food through an industrialized agricultural system; and living in communities, from local to global. Traditional environmental health topics fit easily in this larger framework; as an aid to instructors, a table in the Appendix locates traditional topics within this book's chapter structure. The book's organization gives instructors considerable flexibility in allocating class time to chapters or chapter sections over the course of a semester.

Finally, this text offers a number of pedagogical features that serve both instructor and student. The *writing style* is direct and free of jargon, weaving together narration, explanation, and science. With the nontechnical reader in mind, the text makes explicit many assumptions and connections that are often left implicit, thus guiding the student through unfamiliar territory. *Key terms* serve as stepping-stones for the reader and appear in an extensive glossary of more than 500 items. *Learning objectives* and *study questions* are provided for each chapter, and *supplemental materials* for both instructor and student are available online. The text is enriched by photographs and supported by diagrams, graphs, and tables that summarize or explain important concepts and processes. One series of tables, building chapter by chapter, sets out the complex U.S. regulatory framework for environmental health.

I hope this book will leave students not only with a basic understanding of environmental influences on health, but also with an appreciation of the ways in which we all make the environment we live in.

Nancy Irwin Maxwell  
Boston



# Acknowledgments

In writing this text, I have benefited greatly from the wisdom and generosity of my colleagues at the Boston University School of Public Health who reviewed draft chapters: Richard Clapp, ever my first reader and formerly a teacher of the introductory environmental health course; Wendy Heiger-Bernays, teacher of the more intensive survey course for students focusing in environmental health; Michael McClean, a committed teacher and insightful critic; and Roberta White, my department chair, who supported this endeavor in ways large and small. As graduate teaching assistants in the introductory environmental health course, Gregory Howard, Patricia Janulewicz, Jessica Nelson, and Megan Romano gave helpful feedback as we used this text in manuscript form. More recently, my colleague Madeleine Scammell has generously used the full manuscript in teaching the same course. Needless to say, any errors that remain are my own.

I thank the many students to whom I have taught environmental health, because they in turn taught me what this textbook should be like. And thanks are also due to Mike Brown, publisher for Jones & Bartlett, who had a long wait for my manuscript but didn't give up; to the anonymous reviewers who provided feedback on the manuscript; and to the editorial staff who turned the manuscript into a book.

Finally, I thank my husband, Keith Maxwell, who has been a sounding board, critical reader, and voice of encouragement throughout the writing of this book. I would not have reached the end of this long road without his support.

