



Preface

Renewed Passion for Environmental Science

A new energy is invigorating the environmental movement. Analysts once said that environmentalism is dead, but now a diverse, savvy, and passionate movement is taking shape. The need for environmental science education has never been greater as the mounting evidence of environmental threats has become impossible to ignore. Meanwhile, scientists are finding better ways to interpret and explain research results, activists are discovering new approaches for shaping public policy, and the general public is awakening to the importance of clean water and clear air. In the United States, hundreds of colleges, communities, and local governments are working to reduce carbon emissions and to use energy efficiently. More than 400 bills have been passed in 40 states to require renewable energy or to otherwise combat climate change.

Environmental science is truly a global concern. Even people in developing countries are demanding better protection of environmental quality. The Chinese government, for example, responding to thousands of citizen protests, has promised new policies that will promote renewable energy, clean surface waters, and improve air quality. It remains to be seen how well these ambitions will be met, but the dramatic changes in rhetoric, technology, and creativity are remarkable. Most importantly, environmental concern is not just a fringe movement involving efforts to protect and improve our common environment: it is business leaders finding ways to reduce costs by reducing waste, insurance companies concerned about rising sea levels, and inner-city communities trying to lower asthma rates in children. Major changes are occurring across the globe in the quest to save the critical resources that provide life and health to the environment. It's a wonderful time to be studying these issues and to prepare to play a role either as a practitioner or an informed citizen.

What Sets This Book Apart?

A Positive, Balanced Viewpoint

If students are to take the ideas of environmental science to heart, they need positive messages about ways all of us can contribute to a more sustainable world. This book presents the positive developments through introductory **case studies** at the beginning of each

chapter, illustrating an important current issue to demonstrate how it relates to practical environmental concerns. Most of these case studies present optimistic examples in which people are working to find solutions to environmental problems. These stories also help to demystify scientific investigation and help students understand how scientists study complex issues. In addition to these introductory stories, case studies and examples of how scientists investigate our environment appear periodically throughout the book to reiterate the practical importance of these issues.

Integrated Approach Emphasizing Sustainability

Environmental problems and their solutions occur at the intersection of natural systems and the human systems that manipulate the natural world. In this book we present an **integrated approach** to physical sciences—biology, ecology, geology, air and water resources—and to human systems that affect nature—food and agriculture, population growth, urbanization, environmental health, resource economics, and policy. Although it is tempting to emphasize purely natural systems, we feel that students can never understand why coral reefs are threatened or why tropical forests are being cut down if they don't know something about the cultural, economic, and political forces that shape our decisions.

Current and Accurate Data

Throughout this book, we present up-to-date tables and graphs with the most current available data. We hope these data will give students an appreciation of the kinds of information available in environmental science. Among the sources we have called upon here are geographic information systems (GIS) data and maps, current census and population data, international news and data sources, and federal data collection agencies. Every chapter in this book has numerous updates that reflect recent events in energy, food, climate, population trends, and other important issues.

Active Learning and Critical Thinking

Learning how scientists approach problems can help students develop habits of independent, orderly, and objective thought. But it takes active involvement to master these skills. *Principles of Environmental Science* integrates numerous learning aids that will encourage students to think for themselves. Data and interpreta-

tions aren't presented as immutable truths, but rather as evidence to be examined and tested.

- **Exploring Science** essays promote scientific literacy by demonstrating the methodology scientists use to explore complex environmental questions.
- **What Can You Do?** boxes encourage students to “make a difference” by assuming personal responsibility for environmentally friendly decisions. The text offers many examples of how scientists and citizens have worked to resolve environmental questions, both basic and applied.
- **Data Analysis** exercises conclude each chapter to give students further opportunities to apply skills and put into practice the knowledge they've gained. We pay special attention to graphing techniques in these boxes because data display is such an important part of scientific information delivery. We don't limit this discussion to simple pie charts and line plots, we use this space to demonstrate a variety of ways to display and analyze data.
- **Critical Thinking and Discussion**, a challenging, open-ended set of questions at the end of each chapter, encourages students to think more deeply and independently about issues and principles presented in the chapter. These questions make excellent starting points for discussion sections. They also could be used to practice for essay exams, or might even serve as an essay exam themselves.

What's New in This Edition?

Google Earth™ Placemarks

Throughout this book we've identified interesting and important geographical places that help in understanding environmental issues. Icons in the text identify these places and direct the reader to placemarkers on our web page that take you directly to those places in Google Earth™. You can zoom in for a close view or up to a higher altitude to gain an overall perspective. We believe the exercises we've created around these placemarkers will help students gain a global perspective and will be useful for concept review, class discussion, and lecture enrichment.

Active Learning Exercises

Active Learning exercises encourage students to practice critical thinking skills and apply their understanding of chapter concepts to propose solutions.

Learning Outcomes

Each chapter opens with a list of learning outcomes that will help students organize study priorities. Rather than being imperative requirements, these outcomes have been changed to more friendly questions that lead rather than command.

End-of-Chapter Study Tools

For this edition, we've changed the review questions to practice quizzes to help students prepare for exams. This edition also has a number of new Data Analysis exercises, critical thinking and discussion questions, and conclusions that draw together key ideas in each chapter.

New Chapter Content

- Chapter 1 has been reorganized to engage students more quickly with a major emphasis on environmental problems and progress. A revised presentation of environmental history puts issues in context while a strengthened discussion of critical thinking and sound science helps students analyze information.
- Chapter 2 has improved presentations on systems, nutrients, isotopes, and ecosystems. A new Data Analysis box invites students to explore nutrient flow in a wetland.
- Chapter 3 has a new Exploring Science box on evolution of cichlids in Lake Victoria and a new What Can You Do? box on working locally for ecological diversity. It also has a revised section on human-caused ecological disturbances. A new Data Analysis box on the classic species competition studies of G. F. Gause gives students some historical background and invites them to learn to read graphs.
- Chapter 4 opens with a new case study on successful family planning in Thailand. The chapter goes on to a new discussion of ecological footprints along with updated world population and demographic data. It ends with a new Data Analysis box on communicating with graphs.
- Chapter 5 includes a modified introduction to biodiversity, an updated discussion of the Endangered Species Act, and a new Active Learning box on climate graphs.
- Chapter 6 has a new case study on British Columbia's Great Bear Rainforest, a major new section on world parks and preserves, and a new Exploring Science box on rangeland conservation in New Mexico.
- Chapter 7 has been extensively revised to include a section that emphasizes dramatic changes in food production and hunger in the past 40 years, an individual's relationship to food production, a new discussion of cheap food policies in the U.S., a new section on locavores, and other sustainable activities. It also includes a new Data Analysis exercise and two new Active Learning exercises.
- Chapter 8 opens with a new case study on successful Guinea worm eradication. It has an added section on the role of environmental factors in global disease and a revised section on conservation medicine including recent disease outbreaks. New information about methicillin-resistant Staph A has been added together with a new section on hormesis and epigenetics.
- Chapter 9 is among the most completely updated in the book. It has a new case study on ocean stabilization (geoengineering) as well as a new discussion of data from ice cores in

correlation with historic climate shifts. It also includes a new Active Learning box on calculating carbon reductions, an updated section on clean air legislation, and a new Data Analysis exercise on graphing air pollution.

- Chapter 10 opens with a revised case study on saving the Chattahoochee. It also has a revised section on water availability correlating with the drought in the southern United States. A new box on China's South-to-North water diversion project has been added as well as an updated section on water privatization and the conflict over water resources. Also included is a new Exploring Science box on the Gulf "dead zone."
- Chapter 11 opens with a revised case study about the problems associated with coal-bed methane wells. This chapter also provides a brief overview of the flooding in June 2008 that occurred in the Midwest. It ends with a new Data Analysis box on exploring recent earthquakes and evaluating erosion on farmland.
- Chapter 12 has a new emphasis on personal energy use and costs, as well as a new Active Learning box on the costs of driving. It includes a new table on energy use and an expanded discussion of Hubbert's peak and peak oil. The energy-efficient building and design section has been expanded and a new section on biomass fuels has been added to reflect changes in policy and technology.
- Chapter 13 has a new section on landfill methane and an expanded discussion on the export of e-waste to poor countries. This chapter also includes a new section on disposal problems for the 300 billion bottles of water consumed annually worldwide.
- Chapter 14 has a revised introduction to urban environments and economics. It also has a new Active Learning box on microlending.
- Chapter 15 opens with a new case study on greening in China. It contains a new section on the emerging grassroots movement to find solutions to global warming and a new section on sustainability that is tied to the opening story on economic development in China.

Acknowledgements

We express our gratitude to the entire McGraw-Hill book team for their wonderful work in putting together this edition. A special thanks to Janice Roerig-Blong (publisher), Rose Koos (developmental editor), and Ashley Zellmer (editorial coordinator) who oversaw the developmental stages and made many creative contributions to this book. Cathy Conroy has done a superb job of copy editing, correcting errors, and improving our prose. Lori Hancock and LouAnn Wilson found excellent photos for us. Peggy Selle managed the project through production. Marge Kemp (executive editor) and Tami Petsche (marketing manager) have supported this project with their enthusiasm and creative ideas.

This text has had the benefit of input from more than 400 researchers, professionals, and instructors who have reviewed this book or our larger text, *Environmental Science: A Global Concern*. These reviewers have helped us keep the text current and focused. We deeply appreciate their many helpful suggestions and comments. Space does not permit inclusion of all the excellent ideas that were provided, but we will continue to do our best to incorporate the ideas that reviewers have given us. In addition, all of us owe a great debt to the many scholars whose work forms the basis of our understanding of environmental science. We stand on the shoulders of giants. If errors persist in spite of our best efforts to root them out, we accept responsibility.

The following individuals provided reviews for this book. We thank them for their suggestions.

Fifth Edition Reviewers

- Gary A. Beluzo
Holyoke Community College
- Xianfeng Chen
Slippery Rock University of Pennsylvania
- Doreen Dewell
Whatcom Community College
- Kenneth Engelbrecht
Metropolitan State College of Denver
- Colleen Garrity
Arizona State University—Tempe
- Barbara A. Giuliano
Chestnut Hill College
- Daniel Habib
Queens College
- Kerry E. Hartman
Fort Berthold Community College
- Tara Jo Holmberg
Northwestern Connecticut Community College
- James Hutcherson
Blue Ridge Community College
- John M. Lendvay
University of San Francisco
- Thomas R. MacDonald
University of San Francisco
- John B. McGill
York Technical College
- Dr. Kiran P. Misra
Edinboro University of Pennsylvania
- Dan Pettus
Columbia College Online Campus
- William Roy
University of Illinois—Champaign
- Daniel Vogt
University of Washington
- Paul Weihe
Central College

Fourth Edition Reviewers

Marilynn Bartels

Black Hawk College

Ruth E. Beattie

University of Kentucky

Geoffrey L. Buckley

Ohio University

Catherine W. Carter

Georgia Perimeter College

Richard Clements

Chattanooga State Technical Community College

Nancy A. Dalman

Cuesta College

Terese Dudek

Kishwaukee College

Robert Harrison

University of Washington

Barbara Hollar

University of Detroit—Mercy

Charles Ide

Western Michigan University

Walter A. Illman

University of Iowa

Robert G. Kremer

Metropolitan State College of Denver

Ernesto Lasso de la Vega

Edison College

Tammy J. Liles

Bluegrass Community and Technical College

Jeanne Linsdell

San Jose State University

Timothy Lyon

Ball State University

Allan L. Markezich

Black Hawk College

Edward A. Martinez

California State University—Sacramento

Linda Mueller Fitzhugh

Gulf Coast Community College

Bruce Olszewski

San Jose State University

Thomas E. Pliske

Florida International University

Greg Pryor

Francis Marion University

Dawn Ranish

Broward Community College

Carlton L. Rockett

Bowling Green State University

Bruce A. Schulte

Georgia Southern University

Roy Sofield

Chattanooga State Technical Community College

Jana H. Svec

Moraine Valley Community College

Lynda Swander Ochs

Johnson County Community College

S. Kant Vajpayee

The University of Southern Mississippi

Jeff White

Lake Land College

Ray E. Williams

Rio Hondo College

J. Michael Wright

Truckee Meadows Community College