

An aerial photograph of a wind farm situated on rolling green hills. Numerous white wind turbines are scattered across the landscape, with some clusters and others more isolated. The hills are covered in lush green grass, and the overall scene is bathed in a soft, golden light, suggesting either early morning or late afternoon. The perspective is from a high angle, looking down at the turbines and the undulating terrain.

DANIEL D. CHIRAS

# ENVIRONMENTAL SCIENCE

CREATING A SUSTAINABLE FUTURE

SIXTH EDITION





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University of Denver



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www.jbpub.com

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London W6 7PA  
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Cover Photo: © Jim Sugar Photography/CORBIS  
Artwork: Precision Graphics, Magellan Geographix, Graphic World Publishing Services  
Photo Research: Sharon Donahue  
Editorial Production Service: Kathy Smith  
Indexing: Linda Stuart  
Composition: Graphic World, Inc.  
Cover Manufacturer: Henry Sawyer Company  
Book Manufacturer: Courier Kendallville  
On the cover: Windmills near Altamont Pass, California, one of the windiest places in the state.  
This abundant and clean energy source has low environmental costs.

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

Chiras, Daniel D.

Environmental science : creating a sustainable future / Daniel D. Chiras—6th ed.

p. cm.

Includes bibliographical references and index.

ISBN 0-7637-1316-3 (alk. paper)

1. Environmental sciences. 2. Sustainable development. I. Title

GE140.C48 2001

363.7—dc21

00-065512

Printed in the United States

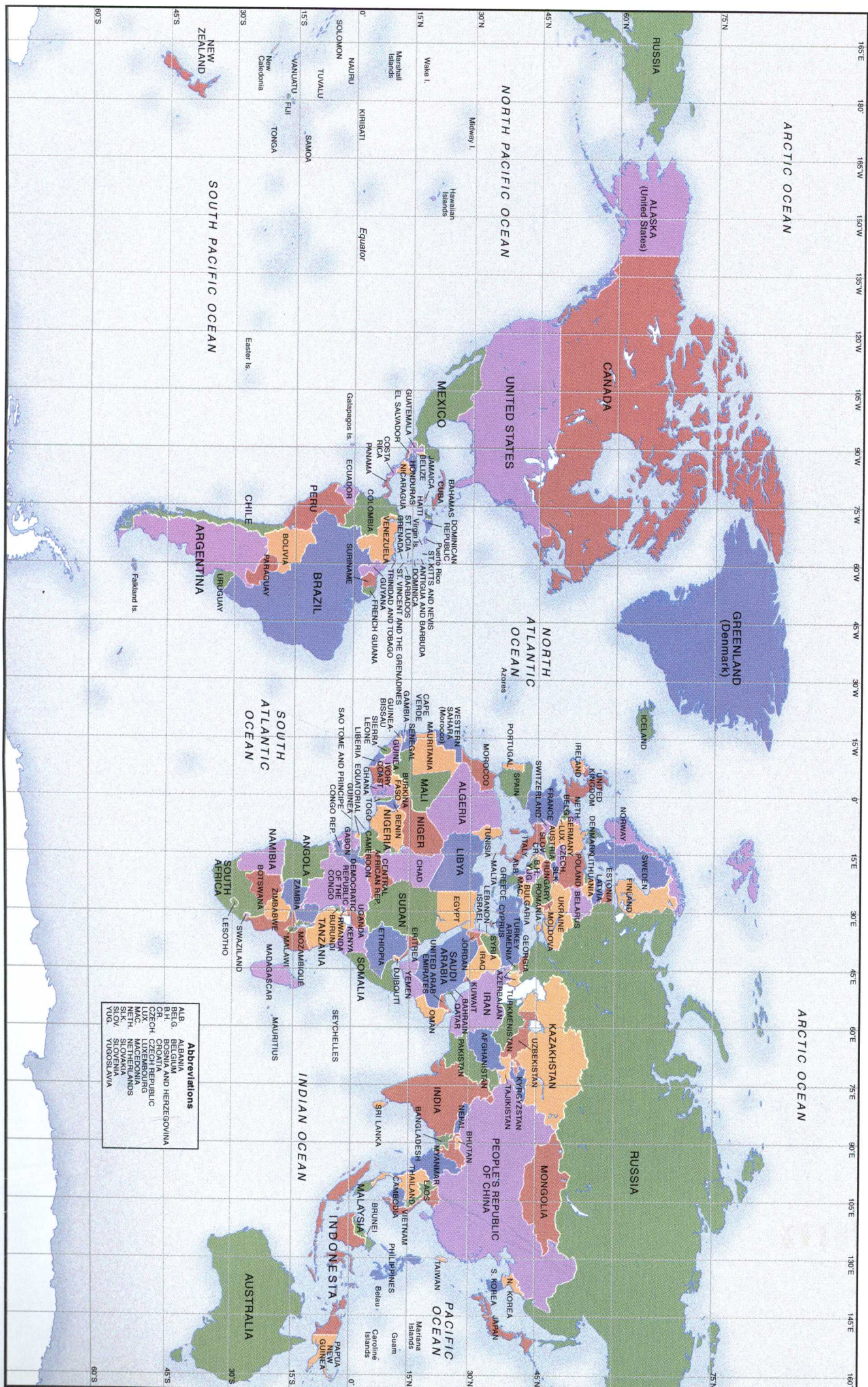
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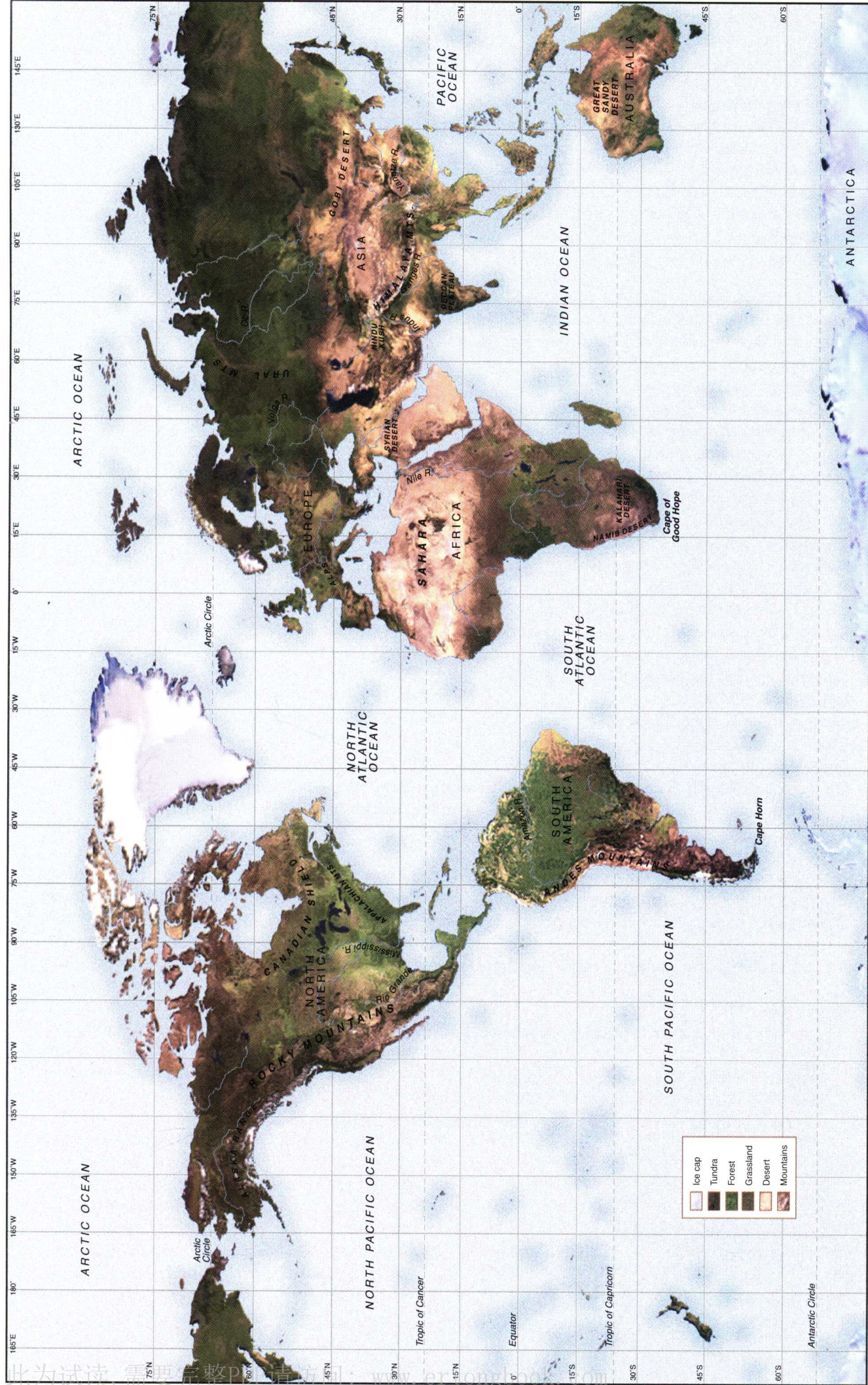
Printed on recycled paper













## Preface to the 6th Edition

Environmental science courses vary widely. Some professors prefer to teach more of the basic science. That is, they prefer to discuss basic science before they delve into environmental issues such as air pollution, water pollution, global climate change, species, and extinction. Other professors delve more into ethics, economics, and other aspects of various topics. In between these two approaches are a wide range of options.

This book is meant to serve the diverse approaches of professors. Like other textbooks on the subject, this one offers an in-depth look at the environmental problems facing the world. It also offers a variety of solutions—some of the more traditional ones, but also a new generation of policies and actions that could help us achieve lasting results. They're solutions that involve all stakeholders: businesses, governments, and individuals.

This book has evolved dramatically over the past 20 years in response to profound changes in my thinking. Perhaps the most important change has been the shift toward a more comprehensive and more systematic way of viewing environmental problems. One of the useful discoveries I and many others have made over many years of study is that most environmental problems spring from a common set of root causes. This book discusses the common root causes and ways to address them.

Over the past decade and a half, many of us have discovered that we've been addressing environmental problems a bit superficially. That is to say, most efforts have been stopgap measures that treat the symptoms while tending to neglect the underlying root causes. In recent years, it has become clear to environmental scientists and others that to create lasting solutions we must address root causes. One of the root causes is that the systems we depend on for food, energy, materials, water, waste treatment, and other services are unsustainable. To solve environmental problems and create an enduring human presence (a sustain-

able future), we must rethink and restructure basic human systems, such as transportation, energy, waste management, water supply, industry, and housing. This book shows the reader how this can be done.

Another important realization I and many others have made is that to be sustainable solutions to environmental problems must make sense from social and economic perspectives, not just an environmental one. One-sided solutions don't work. This shift to solutions that make sense from all three perspectives will take enormous creative energy on our part in the years to come.

It is with these shifts in perception that I revised this text. In this edition, I have also added new material, updated statistics, and polished the writing. As just noted, I have also shifted the emphasis of the book to reflect a pressing need for sustainable solutions—measures that confront the root causes of the environmental crisis and create a society that meets its needs without bankrupting the Earth. This edition also includes discussions meant to help students understand why systems need to be revised and how we should go about this challenging task.

As in the first five editions, I wanted this text to be user-friendly, not bogged down with irrelevant statistics or endless detail. My goal was to continue to present the most important facts and concepts in a clear and exciting fashion. As always, I wanted to minimize my own biases by presenting both sides of the issues and by offering Point/Counterpoints on controversial issues. Even though this text presents a strong case for sustainability and systems reform, it is left to you, the reader, to make up your own mind as to the need and desirability of such an approach. My efforts to make this book as unbiased as possible support my objective of letting students make up their own minds about our predicament and ways to extricate ourselves from it. Critical thinking skills presented in the book also help students learn to analyze issues and make up their own minds.

## Themes

All textbooks have a central theme or, in some cases, a set of themes that shape the presentation. This book is no different. It is molded by six central ideas: focus on key principles, sustainability, addressing root causes, systems reform, critical thinking, and action.

*Focus on Key Principles* Environmental science is a vast field, requiring many years to master. Most students, however, can become proficient in the subject much more quickly when they are taught key concepts. Although I've always tried to focus the text on key principles, in this edition I've highlighted the prin-



ciples in special Key Concepts boxes at the end of each section. They encapsulate the material covered in each section and provide an excellent tool for studying.

**Sustainability** The main theme of this book is that the long-term well-being of this planet and its inhabitants is in jeopardy and that to create an enduring human presence we must make a massive course change. We must transition to a sustainable society. A sustainable society seeks balance between human and ecological needs. Its economic systems serve people and the planet. Creating a sustainable society may be our only realistic hope for surviving on a finite planet, but it will not evolve without foresight, planning, and action.

**Addressing Root Causes and Systems Reform** Creating a sustainable future will require serious efforts to understand and confront the root causes of the environmental crisis. This book outlines those causes and shows ways to address them. Part of this struggle will involve efforts to revamp human systems—make sustainable systems to provide energy, transportation, and waste management, for example.

**Critical Thinking** This text also stresses critical thinking skills—learning to think critically about issues, a task that is essential to create a sustainable society.

**Action** Finally, this text emphasizes an often overlooked point, that building a sustainable future requires actions by all of us. Air pollution is not just caused by inadequate laws or corporate neglect, it is the result of our own often wasteful lifestyles. Because we are all part of the problem, we must all be part of the solution. Individual action is as essential as responsible corporate and government policies and practices.

## Organization

This book is divided into six parts.

**Part I** introduces students to four of the principal themes of this book: sustainability, addressing root causes, restructuring human systems, and critical thinking. It lays an important foundation for the rest of your study.

**Part II** introduces the student to basic principles of ecology necessary for understanding environmental issues. These chapters elaborate on six operating principles of sustainability—ideas that will help us revamp modern society one system at a time.

**Part III** begins the discussion of environmental issues, dealing with one of the most pressing of all, the population crisis. This part examines the impact of rapid population growth—one of the root causes of mod-

ern environmental problems—and explores culturally acceptable ways of slowing it down.

**Part IV** deals with a variety of resource issues, such as wildlife extinction and energy, and outlines strategies for solving them sustainably. In this material, I attempt to show how we can revamp some of the vital human systems such as energy and waste management.

**Part V** discusses pollution and legal, technical, and personal solutions for it, including both traditional and sustainable strategies.

**Part VI**, the capstone of the book, attempts to place the population, resource, and pollution crises in a social context. It reexamines ethics and explores economics and government in more detail.

## Special Features (What's New, too!)

Over the years, this book has undergone some dramatic changes to help make the study of environmental science more interesting, more meaningful, and more memorable. Below is a list of features students should find helpful:

### Study Skills

Immediately following the preface is a brief section on study skills. The study skills section includes numerous simple but effective tips that help students improve their memory, note-taking skills, reading abilities, test-taking abilities, and much more. Study skills can help all students, even A students, become more efficient learners. Skills learned here will carry over to virtually every other course students take and will be helpful throughout life.

### Foundation Tools

This book offers several Foundation Tools, conceptual models that help students understand how the world works. These models are designed to encourage systems thinking and help students organize facts into a solid conceptual framework. Below is a brief description of each model.

**Population, Resources, and Pollution** This model shows how populations of organisms, like ourselves, affect their environment and how their actions, in turn, affect the populations themselves.

**Impact Analysis** This model shows the various impacts that humans have on various components of the environment.

**Risk Analysis** This model presents an overview of a process called *risk assessment*.



**Root Causes** This model shows the many factors that contribute to the crisis of unsustainability and helps students identify key leverage points for change.

### Examining Both Sides of the Issue

In keeping with my long-standing belief that students must examine all sides of an issue, I have continued to present information from opposing viewpoints. You will find this approach exercised in the text itself, where I examine contradictory positions, and in the Point/Counterpoints.

**Point/Counterpoints and Viewpoints** Complex environmental issues often result in hotly contested debates:

- Should wolves be reintroduced into the wild?
- Is population growth good or bad for us?
- Are current laboratory tests for carcinogens valid?
- Is the spotted owl worth saving?
- Should private landowners be reimbursed by the government for restrictions on land use required to save an endangered species?
- Is extinction of wild species something we should worry about?
- Are cancer risks overstated?

These and many other timely issues are debated in Point/Counterpoint essays or discussed in Viewpoints written by such luminaries as Amory and Hunter Lovins, Norman Myers, Garrett Hardin, the late Julian Simon, Lewis Regenstein, David Eaton, Dave Armstrong, and others. These editorials can stimulate individual thinking as well as classroom discussion on complex problems. They're also a perfect avenue for developing one's critical thinking skills. I've added three new Point/Counterpoints in this edition.

### Spotlights on Sustainable Development

To give students further insight into timely issues of our day, I've included numerous case studies throughout the text called "Spotlights on Sustainable Development" and have included some exciting new ones. These sections highlight examples of what individuals, businesses, and governments are doing to create a sustainable future. They provide guidance and hope. I've added a couple new Spotlights in this edition.

### Key Concepts (New to the Sixth Edition!)

In this edition, key concepts are highlighted in boxes at the end of each section. These brief encapsulations are designed to help students understand the crucial concepts that form the foundation of envi-

ronmental science. They serve as a great tool for reviewing chapters as well and studying for tests. Read them before you read the text, after completing a chapter, and while you're studying for tests. They're the glue that holds this book together and form a lifetime of understanding.

### Key Facts (New to the Sixth Edition!)

In this edition, I've also highlighted key facts in the book. Key facts represent some of the most important statistics in the book. They're the ones most worth memorizing.

### Critical Thinking

As pointed out earlier, critical thinking is one of the central themes of this book. Critical thinking enables students to discern fact from fiction. It helps them analyze complex issues and make rational decisions.

A number of important critical thinking rules are discussed in Chapter 1. Each chapter also begins with a brief critical thinking exercise, which asks students to critically analyze an issue, a research finding, or an assertion. Students are also asked to exercise critical thinking skills after Point/Counterpoints, and many of the discussion questions at the end of each chapter call on students to put their knowledge and their critical thinking skills to use.

### Focus on Sustainability and Systems Reform

This book has been thoroughly revised to integrate the ideas of sustainability and sustainable development, systems reform, and root causes. While the main focus of the book is environment, not development, I attempt to show how development must be revamped to become sustainable. I describe basic human systems and why they are unsustainable. Moreover, I outline a variety of ways that we can make them environmentally, socially, and economically sustainable.

### Expanded Basic Science (New to the Sixth Edition!)

In this and the last edition, I have expanded the coverage of basic science, especially information to help students understand global climate. You'll find detailed discussion, for instance, of weather, ocean currents, aquatic ecology, and other important facts that help you better understand the world we live in.

### Updated Coverage (New to the Sixth Edition!)

The sixth edition has been thoroughly updated with new discoveries, new concepts, new environmental laws, and the most recent statistics on resources, pop-



ulation, and pollution. New photographs and tables have been added as well.

### Personal Actions (New to the Sixth Edition!)

In each chapter, you'll find a table of actions, entitled "Individual Actions Count" that list a wide assortment of things you can do to help build a sustainable future.

### Revised Art Program (New to the Sixth Edition!)

Constantly striving to offer the best illustration program on the market, the publisher and I have redrawn many figures, simplifying some, making others more complete. New drawings have been added as well to help illustrate complex subjects.

### Global Focus and Expanded Coverage of Canadian Issues and Solutions (New to the Sixth Edition!)

Environmental problems affect us locally, in our own homes and towns and cities. They affect larger regions, too, often covering many states or provinces. And, of course, they often span the globe. As in previous editions, I present a wealth of information on local, regional, and global problems and solutions. But special efforts were made to include examples from Canada and Europe, Asia, and Africa.

## Supplements

### Instructor's ToolKit CD-ROM

The Instructor's ToolKit CD-ROM contains a suite of programs and files to help professors teach their courses. All of the materials are cross-platform for Windows and Macintosh systems.

- The Image Bank program provides full-color art files of the text's 200 illustrations in formats appropriate for computer projection and for making overhead transparencies.
- The Computerized TestBank helps professors choose an appropriate variety of questions, create multiple versions of tests, even administer and grade tests on-line.
- A complete set of PowerPoint™ Lecture Outline Slides provides a template for building lecture presentations.
- Electronic text files of the Instructor's Manual offer a complete alternative for the printed version of this ancillary.

### Instructor's Manual with Test Items

Mark Aronson from Scott Community College has updated and expanded the Instructor's Manual and TestBank for this edition. The Instructor's Manual contains chapter outlines, objectives, and key terms as well as lecture outlines and suggestions for presenting each chapter. The TestBank has over two thousand questions in a variety of formats. We have also included sample syllabi to demonstrate a few of the many approaches that can be taken to an environmental science course.

### Environmental Science, 6th Edition Web Site

The sixth edition is linked to an extensive web site, <http://environment.jbpub.com/>, developed exclusively by the author and Jones and Bartlett Publishers. Students will find a variety of study aids and resources, all designed to explore the concepts and controversies of environmental science in more depth.

**Environmental Science: Creating a Sustainable Future**  
By Daniel D. Chiras

**Welcome TO THE STUDENT WEB SITE**

**Educators**  
[Click here](#) for more information.

**Students**  
**eLearning:** Each chapter page includes a Chapter Review, a Study Quiz, Flashcards, and a chapter specific Point/Counterpoint.  
**Point/Counterpoint:** For each Point/Counterpoint in the text, we provide links to web sites that address the differing sides of the issue.  
**Individual Actions Count!:** Links to Software for Sustainability, Environmental Activities, Environmental Careers, and a list of Environmental and Governmental Organizations.  
**Links to Your Region:** Links to organizations that deal with environmental issues in your own area of the country.  
**Learn More:** Related links for each chapter.

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- The Point/Counterpoints in the book are enhanced with additional questions and links to related web sites that provide information on both sides of the issue. Students can evaluate the arguments more fully and clarify their own opinions. We've provided a brief description of each link.
- Individual Actions Count builds upon the same feature in the text by providing links to environmental/government organizations, career information, freeware, and activities.
- Learn More lists links to web sites that offer additional coverage of material discussed in the book.
- Links to Your Region provides links to regional web sites so that students can learn more about environmental issues specific to their own area of the United States or Canada.
- Each day the top environmental news stories from Environmental News Network appear on the main page.

**Environmental Science: Creating a Sustainable Future**  
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**eLearning**  
**Chapter One**

CHIRAS HOME | CHAPTER LISTING

QUICK JUMP TO CHAPTER:  
Select

Chapter Review  
Study Quiz  
Learn More...

Flash Cards  
• Identify Term  
• Identify Definition

Point/Counterpoint

SEARCH THE GLOSSARY

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- The central learning component of the site, eLearning is an on-line interactive study guide with a variety of activities that will help students review class material. Students will find quizzes, virtual flash cards, chapter outlines, and chapter objectives in this section of the web site.



## Acknowledgments

Although I have spent thousands of hours researching and writing it, this book is really the product of thousands of researchers and scholars in anthropology, biology, chemistry, demography, natural resources, political science, economics, ecology, and dozens of other disciplines. Their findings and their thoughts form the foundation on which this book rests. To them, a world of thanks!

A genuine thanks also to the staff at Jones and Bartlett. A very special thanks to Brian McKean, my editor, who has offered moral support and encouragement throughout the project. Thanks also to Dean DeChambeau, Jenny Angel, Sharon Donahue, and Anne Spencer for their work on the manuscript. Their creativity, bright ideas, and hard work have been vital to the success of this book. Thanks also to Kathy Smith for her assistance with copyediting and a host of oth-

er tasks. As always, it has been a pleasure to work with Kathy and the Jones and Bartlett staff in this complex and sometimes tedious production. Also a special thanks to my research assistant, Linda Stuart, who helped update the book. Her persistence and attention to detail were much appreciated. Updating statistics can be tiring, frustrating, and at times overwhelming and I'm forever thankful for her assistance. Also, a word of thanks to the many people in government agencies and nonprofit groups who shared articles, reports, and data with us. Although they are too numerous to mention here, their part in this project is much appreciated.

Finally, many manuscript reviewers provided helpful and constructive criticism on all editions of this book. I am very thankful for their helpful comments.

Daniel D. Chiras  
Evergreen, Colorado

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## About the Author

Dan Chiras received a Ph.D. in reproductive physiology from the University of Kansas Medical School. In 1976, he accepted a teaching and research position at the University of Colorado, Denver, where he taught a variety of courses, including general biology, cell biology, histology, reproductive biology, and endocrinology. Over the years, Dr. Chiras developed a number of courses on the environment, including a graduate course on global environmental issues and the environmental and health effects of pollution. He has also taught undergraduate science modules on air pollution, nuclear power, noise pollution, impacts from coal development, and strategies for sustainability.

While at the university, Dr. Chiras worked on several EPA projects, including a study of the health impacts of chlorinated organics from wastewater treatment and the impacts of coal mining in the West. He also prepared an assessment of the impacts of shale oil development in Colorado for the Department of Energy.

In 1981, Dr. Chiras resigned his full-time position at the university to pursue a writing career. Since that time, he has published 200 articles in journals, magazines, encyclopedias, and other publications, including *Environment*, *American Biology Teacher*, *The Amicus Journal*, *Solar Today*, *Natural Home*, *Sustainable Futures*, *Colorado Outdoors*, *Home Power*, and *Environmental Carcinogenesis and Ecotoxicology Reviews*.

Dr. Chiras has written the environment section for World Book Encyclopedia's *Science Year* since 1993. He wrote an extensive article entitled "The Population Explosion" in *Science Year* 1998. Dr. Chiras has written articles on ecology, the environment, environmental issues, air pollution, and population articles for *Encyclopedia Americana*.

Dr. Chiras has published fifteen books. Included in this list are a college-level textbook entitled *Natural Resource Conservation* (with John P. Reganold) and a high-school textbook entitled *Environmental Science: Framework for Decision Making*. Dr. Chiras has also published two college-level biology textbooks: *Human Biology: Health, Homeostasis, and the Environment* and *Biology: The Web of Life*. Both books have a strong environmental theme.

Dr. Chiras has also written several books for a more general audience, including *Beyond the Fray: Reshaping America's Environmental Response*, which offers advice on building a truly effective response to the environmental crisis, and *Lessons from Nature: Learning to Live Sustainably on the Earth*, which outlines ways to build a sustainable future. He has also

assembled an anthology entitled *Voices for the Earth: Vital Ideas from America's Best Environmental Books*. This book includes 14 essays summarizing the key ideas of books nominated by a national committee as America's best environmental books.

Dr. Chiras's most recent book is *The Natural House: A Complete Guide to Healthy, Energy-Efficient, Environmental Homes*. It discusses natural building techniques and sustainable systems for creating extremely low-impact housing. He is currently working on a book on green building and another on passive solar heating and passive cooling.

Dr. Chiras is currently an adjunct professor of environmental policy and management at the University of Denver, where he teaches a course entitled Sustainable Environment Policy. Dr. Chiras has also served as a visiting professor at the University of Washington in Seattle, where he taught the introductory environmental science course.

Besides teaching and writing, Dr. Chiras has played an active role in the environmental movement. He has served on the Board of Directors of the Colorado Environmental Coalition for five years and was president of this coalition of 40 environmental groups for two years. In 1988, he cofounded Friends of Curbside Recycling, which was instrumental in convincing the city of Denver to begin a curbside recycling program. In 1989, he cofounded Speakers for a Sustainable Future, which offered slide programs on recycling, water conservation, and sustainability. In 1993, Dr. Chiras cofounded another nonprofit organization, the Sustainable Futures Society. He is currently on the board of directors of the Advanced Technology Environmental Education Library, which has produced a Web site that serves as a repository for environmental information.

Dr. Chiras has spoken to a wide range of audiences, including the National Association of County Agricultural Agents; the American Society of Interior Designers; the American Home Economics Association; Architects, Designers, Planners for Social Responsibility; the Colorado Renewable Energy Society, and others.

In addition to his active scientific pursuits, Dr. Chiras is a gardener, musician, songwriter, river runner, and bicyclist. He lives with his two children, Skyler and Forrest, in a nearly 100% self-sufficient solar home in the Colorado Rockies, where he practices what he teaches.



## Study Skills

College is a demanding time. For many students, term papers, tests, reading assignments, and classes require a new level of commitment to their education. At times, the workload can become overwhelming.

Fortunately, there are many ways to lighten the load and make time spent in college more profitable. This section offers some helpful tips on ways to enhance your study skills. It teaches you how to improve your memory, how to become a better note taker, and how to get the most out of what you read. It also helps you prepare better for tests and become a better test taker.

Mastering these study skills will require some work, mostly to break old, inefficient habits. In the long run, though, the time you spend now learning to become a better learner will pay huge dividends. Over the long haul, improved study skills will save you lots of time and help you improve your knowledge of facts and concepts. That will no doubt lead to better grades and very likely a more fruitful life.

### General Study Skills

- Study in a quiet, well-lighted space. Avoid noisy, distracting environments.
- Turn off televisions and radios.
- Work at a desk or table. Don't lie on a couch or bed.
- Establish a specific time each day to study, and stick to your schedule.
- Study when you are most alert. Many students find that they retain more if they study in the evening a few hours before bedtime.
- Take frequent breaks—one every hour or so. Exercise or move around during your study breaks to help you stay alert.
- Reward yourself after a study session with a mental pat on the back or a snack.
- Study each subject every day to avoid cramming for tests. Some courses may require more hours than others, so adjust your schedule accordingly.
- Look up new terms or words whose meaning is unclear to you in the glossaries in your textbooks or in a dictionary.

### Improving Your Memory

You can improve your memory by following the PMC method. The PMC method involves three simple learning steps: (1) paying attention, (2) making informa-

tion memorable, (3) correlating new information with facts you already know.

**Step 1** Paying attention means taking an active role in your education—taking your mind out of neutral. Eliminate distractions when you study. Review what you already know and formulate questions about what you are going to learn before a lecture or before you read a chapter in the text. Reviewing and questioning help prime the mind.

**Step 2** Making information memorable means finding ways to help you retain information in your memory. Repetition, mnemonics, and rhymes are three helpful tools. /niːməˈnɪk/ ˈrɪzɪŋ

- Repetition can help you remember things. The more you hear or read something, the more likely you are to remember it, especially if you're paying attention. Jot down important ideas and facts while you read or study to help involve all of the senses.
- Mnemonics are useful learning tools to help remember lists of things. I use the mnemonic CARRRP to remember the biological principles of sustainability: conservation, adaptability, recycling, renewable resources, restoration, and population control.
- Rhymes and sayings can also be helpful when trying to remember lists of facts.
- If you're having trouble remembering key terms, look up their roots in the dictionary. This often helps you remember their meaning.
- You can also draw pictures and diagrams of processes to help remember them.

**Step 3** Correlating new information with the facts and concepts you already know helps tie facts together, making sense out of the bits and pieces you are learning.

- Instead of filling your mind with disjointed facts and figures, try to see how they relate with what you already know. When studying new concepts, spend some time tying information together to get a view of the big picture.
- After studying your notes or reading your textbook, go back and review the main points. Ask yourself how this new information affects your view of life or critical issues and how you may be able to use it.



## Becoming a Better Note Taker

- Spend 5 to 10 minutes before each lecture reviewing the material you learned in the previous lecture. This is extremely important!
- Know the topic of each lecture before you enter the class and spend a few minutes reflecting on facts you already know about the subject that's going to be discussed.
- If possible, read the text before each lecture. If not, at least look over the main headings in the chapter, read the topic sentence of each paragraph, and study the figures. If your chapter has a summary, read it too.
- Develop a shorthand system of your own to facilitate note taking. Symbols such as = (equals), > (greater than), < (less than), w/ (with), and w/o (without) can save lots of time so you don't miss the main points or key facts.
- Develop special abbreviations to cut down on writing time. E might stand for energy, AP might be used for air pollution, and AR could be used to signify acid rain.
- Omit vowels and abbreviate words to decrease writing time (for example: omt vwls & abbrvte wrds to dcrrs wrtng tme). This will take some practice.
- Don't take down every word your professor says, but be sure your notes contain the main points, supporting information, and important terms.
- Watch for signals from your professor indicating important material that might show up on the next test (for example, "This is an extremely important point ...").
- If possible, sit near the front of the class to avoid distractions.
- Review your notes soon after the lecture is over while they're still fresh in your mind. Be sure to leave room in your notes written during class so you can add material you missed. If you have time, recopy your notes after each lecture.
- Compare your notes with those of your classmates to be sure you understood everything and did not miss any important information.
- Attend all lectures.
- Use a tape recorder if you have trouble catching important points.
- If your professor talks too quickly, politely ask him or her to slow down.
- If you are unclear about a point, ask during class. Chances are other students are confused

as well. If you are too shy, go up after the lecture and ask, or visit your professor during his or her office hours.

## How to Get the Most Out of What You Read

- Before you read a chapter or other assigned readings, preview the material by reading the main headings or chapter outline to see how the material is organized.
- Pause over each heading and ask a question about it.
- Next, read the first sentence of each paragraph. When you have finished, turn back to the beginning of the chapter and read it thoroughly.
- Take notes in the margin or on a separate sheet of paper. Underline or highlight key points.
- Don't skip terms that are confusing to you. Look them up in the glossary or in a dictionary. Make sure you understand each term before you move on.
- Use the study aids in your textbook, including summaries and end-of-chapter questions. Don't just look over the questions and say, "Yeah, I know that." Write out the answer to each question as if you were turning it in for a grade, and save your answers for later study. Look up answers to questions that confuse you. This book has questions that test your understanding of facts and concepts. Critical thinking questions are also included to sharpen your skills.

## Preparing for Tests

- Don't fall behind on your reading assignments, and review lecture notes as often as possible.
- If you have the time, you may want to outline your notes and assigned readings. Try to prepare the outline with your book and notes closed. Determine weak areas, then go back to your text or class notes to study these areas.
- Space your study to avoid cramming. One week before your exam, go over all of your notes. Study for two nights, then take a day off that subject. Study again for a couple of days. Take another day off from that subject. Then make one final push before the exam, being sure to study not only the facts and concepts, but also how the facts are related. Unlike cramming, which puts a lot of information into your brain for a short time, spacing will help you retain information for the test and for the rest of your life.



- Be certain you can define all terms and give examples of how they are used.
- You may find it useful to write flash cards to review.
- Be certain you can define all terms and give examples of how they are used.
- You may find it useful to write flash cards to review terms and concepts.
- After you have studied your notes and learned the material, look at the big picture—the importance of the knowledge and how the various parts fit together.
- You may want to form a study group to discuss what you are learning and to test one another.
- Attend review sessions offered by your instructor or by your teaching assistant, but study before the session and go to the session with questions.
- See your professor or class teaching assistant with questions as they arise.
- Take advantage of free or low-cost tutoring offered by your school or, if necessary, hire a private tutor to help you through difficult material. Get help quickly, though. Don't wait until you are hopelessly lost. Remember that learning is a two-way street. A tutor won't help unless you are putting in the time.
- If you are stuck on a concept, it may be that you have missed an important point in earlier material. Look back over your notes or ask your tutor or professor what facts might be missing and causing you to be confused.
- If you have time, write and take your own tests. Include all types of questions.
- Study tests from previous years, if they are available legally.
- Determine how much of a test will come from lecture notes and how much will come from the textbook.

- Purchase a study guide, if one is available, and use it to review material and test your knowledge.
- Check out your instructor's web site or the author's web site. They often have valuable study aids, such as review questions and practice quizzes.

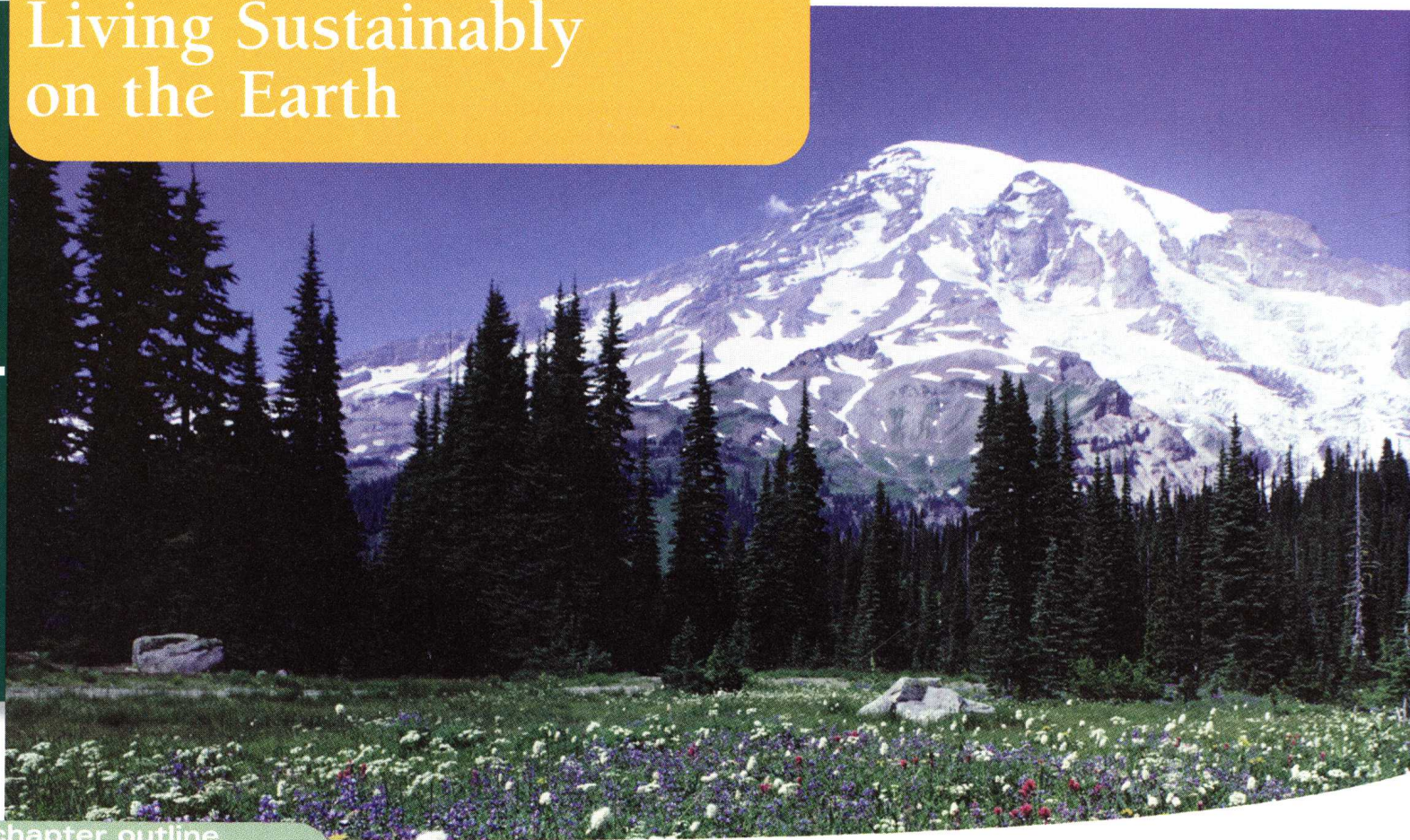
### Taking Tests

- Eat well and get plenty of exercise and sleep before tests.
- Remain calm during the test by breathing deeply.
- Arrive at the exam on time or early.
- If you have questions about the wording of a question, ask your professor.
- Skip questions you can't answer right away, and come back to them at the end of the session if you have time.
- Read each question carefully and be sure you understand its full meaning before answering it.
- For essay questions and definitions, organize your thoughts first on the back of the test before you start writing.

Now take a few moments to go back over the list. Check off those things you already do. Then, mark the new ideas you want to incorporate into your study habits. Make a separate list, if necessary, and post it by your desk or on the wall and keep track of your progress.



# Living Sustainably on the Earth



## chapter outline

- T.1** Encouraging Signs/  
Continuing Challenges
- T.2** Environmental Protection  
and Sustainable  
Development
- T.3** Meeting Human Needs  
while Protecting the  
Environment

Spotlight on Sustainable  
Development 1-1: The  
Netherlands' Green  
Plan Revolutionizes  
the Way Industries  
Function

*There are no passengers on spaceship earth.  
We are all crew.* —Marshall McLuhan

If you are like most people, you've probably heard a lot of conflicting information about the environment and environmental issues. Teachers, friends, news reporters, writers, and scientists may have warned you of serious problems. Others may have offered an opposite view, saying things are not nearly as bad as some people would have you believe. What is the truth?

In this book, you will find ample scientific evidence to suggest that the problems are real. In fact, a survey of U.S. environmental trends covering the past 30 years showed that the vast majority (nearly 70%) of environmental indicators are pointing in the wrong direction. They're moving us away from a stable, healthful relationship with the planet we call home. Although there are some very encouraging signs of improvement—about 20% of the trends showed improving conditions—there is still cause for serious concern and action.

I invite you to explore the issues in this book with an open mind, looking carefully at all aspects of each one. We'll examine the scien-



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