

# ENVIRONMENTAL ECONOMICS

*Theory, Application, and Policy*



**DUANE CHAPMAN**



# Environmental Economics: Theory, Application, and Policy

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*Cornell University*

 **ADDISON-WESLEY**

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*Environmental Economics: Theory, Application, and Policy* is written for the broad diversity of students interested in environmental economics who major in economics, business, natural resources, environment, engineering and science, liberal arts, and agriculture. The goal of this text is to provide an introduction to environmental issues as well as environmental economics by analyzing not only the hypothetical approach to world oil use or air pollution but also by introducing the students and readers to the actual data and methods used by experts working in each field. In order to do this, it is necessary to give greater emphasis to science and multidisciplinary background than is usually the case with economics texts. Biodiversity, climate change, air pollution, forestry: all require some modest understanding of the subject matter as well as the methods of economic analysis.

The text is crafted to reflect the diversity and challenge of the nature of the subject, from biodiversity to air pollution, from commercial forestry in the United States to protected areas in Africa, from oil resources to environmental justice. Throughout, the objective is to introduce the methods used to analyze issues. It is a preparation for understanding the different perspectives in making effective environmental policy. It is an introduction to the use of economic tools to make a contribution to environmental policy.

A unique feature of the book is the way in which chapters interact. Cross-references between theory and application foster overall integration of subject matter. In addition to the extensive review of the basics on air and water pollution control, forestry, agriculture, environmental accounting, benefit-cost analysis, and the literature in the valuation of externalities, there is considerable material on emerging major subjects in the field. These new subjects include macroeconomics and trade, agriculture, ecological economics, sustainability, issues in equity, and the relationship between legislation and environmental economics.

The text is also intended to reflect the healthy tension between environmental economics and ecological economics. Each of the two professional groups—the

Association of Environmental and Resource Economists (AERE) and the International Society for Ecological Economics (ISEE)—has its own professional association and its own professional journal. In my view, AERE has a somewhat greater focus on quantitative methods of analysis and on economic concepts and theory. In contrast, ISEE gives a degree of emphasis to policies for environmental protection, the role of values in economics, and transdisciplinary work. Their divergence of emphasis and interests is legitimate and important, but they share a common commitment to the use of objective methods of analysis in pursuit of environmental protection and economic efficiency. Richard Bishop, past president of AERE, has co-authored Chapter 20 on sustainability. Richard Norgaard, president of ISEE, has contributed the foreword to the text.

Finally, I want to note that I have attempted to prepare a text that is essentially positive in its outlook, assuming that past gains in environmental protection will be maintained and that future progress is both desirable and possible. It is pro-environment but also pro-business.

## Organization

Our first goal in studying environmental and resource economics is to show that economics matters in actual application. The second goal is to describe the tools that economists use in moving from theory to application.

The book is organized into six sections and an appendix. Part 1 on economic theory, concepts, and methods includes six chapters. Chapter 1 covers the basic concepts of competition, monopoly, externalities, and economic welfare and shows the basic consequences of each type of economic organization or theory in terms of its relationship both to economics and to the environment. Other chapters in this section introduce environmental accounting (Chapter 2), methods of valuing the non-market aspects of environmental protection (Chapter 3), benefit-cost analysis and discounting (Chapter 4), equity and environmental justice (Chapter 5). The last chapter in the section (Chapter 6) provides a more mathematical introduction to the basic theory in renewable resources such as fisheries and forests and to the theory of resource depletion as applied to finite resources such as oil, coal, iron and steel, and so on.

Part 2 focuses on two chapters particularly related to individual consumer decisions. One (Chapter 7) is on personal and household energy as it relates to both the economic and the environmental impact arising from different approaches in heating and lighting and the gains that have been made in this area. The second chapter, Chapter 8 (written with Matt Schwartz), deals with renewable energy as it relates to the economic environment for solar energy and to alternative vehicles and the pollution impact of each.

Part 3 takes up the issue of global resource limitations. The theory of depletion is applied to actual data on world oil resources, both proven and undiscovered (Chapter 9). The limits to growth question is discussed as it relates to broad industrial resource availability (Chapter 10). The Meadows literature on global limits is critically evaluated. Recycling, world population, and income growth are each addressed as it relates to this issue.

Part 4 addresses four important areas in which environmental policy in the United States has had major successes in the sustainable use of renewable environ-

mental resources. Air pollution control (Chapter 11), water quality (Chapter 12), agriculture (Chapter 13, written with Brent Sohngen), and forestry (Chapter 14) are each considered, and the major policy issues in each are taken up.

Part 5 looks at the global environment, in particular biodiversity and endangered species (Chapter 15), the Kruger National Park in South Africa (Chapter 16), the broad global issue of macroeconomics, trade, and the environment (Chapter 17), and climate change (Chapter 18). Whether the subject is the spotted owl program, the ban on ivory trade, the Environmental Kuznets Curve, or the Kyoto Protocol, the focus is on the nature of using economics to understand the making of environmental policy.

Finally, Part 6 consists of two contributed chapters. The first, Chapter 19, on ecological economics by Jon Erickson, is a critique of mainstream environmental economics and an advocacy of a different perspective on the use of economics. This chapter may be viewed as, in part, a criticism of the mainstream assumptions of the text itself. The last chapter, Chapter 20, on sustainability by Richard Bishop and Richard Woodward, takes on the difficult challenge of translating sustainability into workable concepts. They apply their ideas to global warming and biodiversity as well as providing a discussion of the safe minimum standard.

The book concludes with an appendix (written by Andrea Kreiner) on the evolution of environmental policy and legislation, an important influence on the modern growth in environmental economics and environmental resource management.

## **Pedagogy**

Chapter 1 (Competition, Monopoly, and Social Welfare) has been developed to work both as an introduction to economics for students without prior economics courses and as a review for students with some knowledge of economics. Twenty-seven terms (externality, marginal revenue, etc.) are highlighted in italics as they are introduced and are summarized in a chapter glossary that repeats the definitions.

Each chapter ends with a series of questions for discussion and analysis that offer opportunities to apply the chapter's material through class discussion or individual analysis of economic concepts, environmental issues, and through the use of quantitative problems.

## **Flexibility**

For class organization, in general I would not recommend the use of all 20 chapters in a semester introductory course. (It would be possible, perhaps, for a junior-senior course in which all of the students had prerequisites in intermediate microeconomics.) Different emphases are appropriate to reflect the academic interests of students and instructors. For example, an economics department will desire a different chapter organization than does a business management department. An environmental studies department might want a third approach. In addition, different geographic areas—for example, Western United States versus urban Eastern United States—will each lead to different chapter organization. (For the instructor, different examples of organization of the material for these different objectives are included in the Instructor's Manual.)

The book is designed to be used without requiring calculus and advanced mathematics. However, for classes and instructors with the capability and interest in doing so, calculus can be used to enhance understanding, in particular the appendix to

Chapter 1 on microeconomic theory and Chapter 17 on macroeconomics, trade, and the environment. Notably, Chapter 6 on economic theory and environmental resources makes use of basic calculus to introduce the subjects of the bioeconomics of renewable resources and the theory of exhaustible resource depletion.

## Supplements

The Instructor's Manual provides several resources to assist the instructor in using the text. A summary distills each chapter's important concepts and highlights connections to other chapters. In addition, there are tips for sparking discussions, answers to the in-text questions for analysis and discussion, representative homework assignments, and sample tests. The manual offers illustrative syllabus schedules oriented toward different academic interests: a one-quarter course in an economics department and a semester course in an environmental studies program. There is discussion of areas where intermediate economics and the use of calculus can be productive and suggestions for instructors teaching environmental economics as the first economics course for most students. In addition, the manual provides transparency masters of each figure in the text, a very practical feature. The manual is available to qualified U.S. instructors that adopt the text, but in some cases it may not be available to international adopters.

A Web site located at [www.awlonline.com](http://www.awlonline.com) encourages interaction between instructors, students, and the author. The primary purpose is to discuss aspects of courses and their subject matter and also to communicate and discuss new developments in environmental economics and environmental policy. To this end, the Web site has numerous links to Internet resources in environmental economics. It will be possible to exchange e-mail communications with the author; a message board will also allow students and professors to exchange ideas. Finally, the Web site offers information about three types of material that can be of assistance to instructors and students. First, there are suggestions for video segments that demonstrate the nature of environmental problems and methods of analysis used in environmental economics. Second, the Web site carries suggestions about field trips that can be undertaken in association with courses in environmental economics. Finally, there are suggestions about guest lecturers from business, government, and citizens' groups and some tips on securing their enthusiastic participation in a course.

## Acknowledgments

In closing, please note my strong "thank you" to individuals whose support was essential in developing this text. In particular, I'd like to thank Jean Agras, Roger Beck, Amy Chapman, Natalie deCombray, Neha Khanna, Una Money Penny, Andrew Novakovic, William Tomek, and Susan Weitz. In addition, special thanks to the individual contributors to the text, Richard Norgaard, Matt Schwartz, Brent Sohngen, Jon Erickson, Richard Bishop, Richard Woodward, and Andrea Kreiner. (A brief professional biography of these contributors follows the foreword.) Finally, I would like to acknowledge the careful and constructive work of many environmental economists who worked with Addison Wesley Longman in providing constructive and valuable criticism in previous drafts of this text, and especially Brent Sohngen, who tested the final manuscript in his class prior to publication.

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## WHY ENVIRONMENTAL ECONOMICS?

BY RICHARD B. NORGAARD

Duane Chapman has produced an environmental economics text that looks outward rather than inward. He realizes, for example, the critical difference between environmental economics as rationalization of the status quo and environmental economics as a way of exploring the problems of our economy and seeking better solutions. He has prepared an especially eye-opening textbook by breaking and expanding the mold in many important dimensions.

Chapman starts out with central economic concepts developed in the context of petroleum markets. The discussion takes us right into the real-world issues of competition and monopoly power, profits, and rent, followed shortly after by pollution costs imposed on others and national defense as a public good. Nothing is minced to make reality more palatable here.

Subsequent chapters develop criteria for making economic decisions from both public and private perspectives, providing readers with sufficient historical context so that we can see the conditions under which economic concepts were initiated and developed over time and hence how they may need to change again. Importantly, economic problems are also addressed early in the text as equity problems as well as problems of efficiency. The big questions of sustainability are addressed early and elsewhere in this text, and they are considered in depth in the concluding chapters. In addition, and in a way that is unlike other mainstream texts, alternative approaches to economics are explored to give us new ideas with which to work. Chapman takes us directly into the complex world of economic thinking applied to our real economy. Plan on going through some of this material several times. Fortunately, it is worth it.

Chapman breaks the mold in additional ways. Acknowledging that the Industrial Revolution was an energy transition that coevolved into complex linkages between

fossil fuels, economic and political power, environmental pollution, and global warming, he elaborates on energy economics and the possibilities for switching to renewable energy and increasing the efficiency with which we use energy. Acknowledging that we are in another major round of macroeconomic restructuring and globalization, Chapman directs specific attention to what we think we know and what we do not know about these issues. The hammers and saws of economics, particularly methods of environmental valuation, come with instructions for their safe use.

Most importantly, Chapman rarely discusses economics in the abstract. He provides environmental and technical production data on their own terms and supplements the data with sound case studies. The data and examples continually validate that there is a world out there, beyond economic reasoning and language, that needs to be addressed by economics—addressed on its own terms. Occasionally, Chapman goes one step farther by providing intriguing personal narratives, in effect insisting that economics also must be true to our personal experiences and values.

Chapman's goal was to bring good science into an environmental economics text, to author a book that combines scientific and economic interpretations of our worldly problems so that students become knowledgeable about both. At the same time, he included other economists as authors with perspectives more "ecological" than his own (Bishop and Woodward, Erickson, Sohngen, Schwartz, and even me).

These are not minor recarvings of the dominant environmental textbook mold. Chapman's new, bigger mold establishes a new direction, setting at least one strand of environmental economics texts on a solid, new course. Like economics itself, however, the text is a construction in process in which we can all join. Today's students have the opportunity—no, the obligation—to assure that they learn and apply environmental economics, as well as questioning and participating in its continued advance, in a manner that supports environmental sustainability and a future with human dignity.

## ABOUT THE AUTHOR

Duane Chapman worked as an economist for the National Park Service and the Atomic Energy Commission before joining the faculty at Cornell University in 1971, where he is now Professor of Environmental Economics.

He earned a Ph.D. from the University of California at Berkeley and a B.A. from Michigan State University. He has worked as a consultant to banks and citizen groups, energy companies, and international organizations. In the early 1970s, he (with colleagues Tim Mount and Tim Tyrrell) did pioneering work on energy-demand forecasting and conservation. In the late 1970s, he led a research effort for the U.S. Senate on the structure and performance of the petroleum industry.

In the 1980s, Chapman, working for the EPA, organized a computer simulation of the economic response of electric utilities to federal policies to reduce acid rain emissions.

During both decades, he continued studying the economics of nuclear power, including work with the Pennsylvania Senate (on economic aspects of the Three Mile Island accident), the State of New York (on the nuclear waste problem at West Valley), and on the nuclear problems at the Washington Public Power Supply System.

He has worked for the World Bank and USAID in the 1990s, and at the Universities of Zimbabwe (in Harare), and of Natal (in Durban, South Africa). His research is reflected in 150 publications in these fields, in journals, books, monographs, and congressional testimony.

Chapman's lifelong interest in the environment led him, in late October of 1976, to backpack alone across the High Sierra and the High Peaks–Mount Whitney region from Lone Pine to Mineral King. As an amateur mountaineer, he climbed the 14,000-foot Mount Sill. With Richard Norgaard, who wrote the foreword to this text, he challenged the rapids of Tuolomne, a Class 4 river on the western slope of the Sierra Nevada range. He has twice canoed the full 130 miles of the undammed part of the Missouri River on the famous Lewis and Clark route. He has traveled

from the Congo's copper belt, through Zambia and Zimbabwe, to Johannesburg and Durban. Currently, he enjoys subzero winter camping and wrestles with the preservation and management issues related to his 165-acre stand of old-growth woods. The woods are rich in commercial timber value, but are home to hermit thrushes, shrikes, jumping mice, flying squirrels, wild turkeys, great horned owls, bobcats, bears, and coyotes.

## ABOUT THE CONTRIBUTORS

- ▲ **Richard C. Bishop** recently completed a two-year term as president of the Association of Environmental and Resource Economists. He has worked on economic issues associated with the California condor and the bald eagle as well as the Exxon Valdez oil spill and ground and surface water pollution. He has been particularly interested in the economic dimensions of sustainability and safe minimum standards. Bishop is a professor and the chair of the Department of Agricultural and Applied Economics, University of Wisconsin, Madison.
- ▲ **Jon Erickson** is an assistant professor in Economics at the Rensselaer Polytechnic Institute, which began the first Ph.D. program in ecological economics. He has played a leading role in the Adirondack Research Consortium, an interdisciplinary organization focused on the sustainable development and preservation of the Adirondack Park. His other research includes community quality of life and climate change.
- ▲ **Andrea Kreiner** is past chair of the Board of Directors of the National Pollution Prevention Roundtable. Kreiner is currently managing the Office of Business and Permitting Services for the Delaware Department of Natural Resources and Environmental Control, encompassing environmental justice, permitting assistance, and pollution prevention programs.
- ▲ **Richard B. Norgaard** is president of the International Society for Ecological Economics. Among the few to know the Glen Canyon of the Colorado River before Lake Powell, he also was the first to raft the Tatshenshini River in Canada and Alaska. Norgaard's work on coevolution and sustainability as intergenerational equity has had a major impact on the growth of ecological economics. He is a professor of Energy and Resources and of Agricultural and Resource Economics at the University of California at Berkeley.

- ▲ **Matthew Schwartz** has worked with the United States Department of Energy in the Office of Alternative Fuels. Formerly with Industrial Economics, Inc., an environmental consulting firm, Schwartz was enrolled in the M.B.A. program at M.I.T. as this book went to press. He is particularly interested in environmental management.
- ▲ **Brent Sohngen** is an assistant professor at Ohio State University. Sohngen is a member of a governor's commission on water quality in Ohio. He has been a leading contributor to research on U.S. and global forest management, conservation, and climate change, in the *American Economic Review* and elsewhere.
- ▲ **Richard T. Woodward** is an assistant professor at Texas A & M University. His research focuses on issues of economic sustainability, environmental amenities, uncertainty, and the quantitative methods used to study these issues.

# CONTENTS

*Preface* xi  
*Foreword* (by Richard B. Norgaard) xvi  
*About the Author* xviii  
*About the Contributors* xx

## **PART I: ECONOMIC THEORY, CONCEPTS, AND METHODS 1**

**Chapter 1: Competition, Monopoly, and Social Welfare 3**  
Introduction: Why Study Economics? 3  
The Theory of Competitive Markets 5  
Monopoly Pricing and Economic Rent 9  
Environmental Externalities, Public Goods, and Economic Welfare 13  
Questions for Discussion and Analysis 18 • Appendix A: Glossary of Economic Concepts 19 • Appendix B: Mathematical Illustration 21 • Notes to Chapter 1 23

**Chapter 2: Measuring Economic Welfare and Environmental Quality 25**  
GDP, GNP, and IPP: Is World Income Increasing? 25  
Inflation, Real Income, and the Environmental Kuznets Curve 27  
Environmental Accounting and the Index of Sustainable Welfare 31  
Questions for Discussion and Analysis 35 • Notes to Chapter 2 36 •  
References 37

**Chapter 3: Valuing the Environment and Benefit-Cost Analysis 39**  
Preface: One Historical Perspective 39  
Measuring Environmental Benefits: Prospect Theory and Relative Gain 40  
Contingent Valuation: The Economic Value of Environmental Benefits 42  
The Travel Cost Method 45  
Valuing Environmental Quality's Impact on Real Estate: The Hedonic Approach 47  
The Value of Life, Health, Risk, and Safety 48  
Conclusion and Summary 52  
Questions for Discussion and Analysis 54 • Notes to Chapter 3 55

## Chapter 4: Benefit-Cost Analysis and Discounting 57

Benefit-Cost Analysis: History and Applicability 57

Discounting and Interest Rates 58

Present Value or Annual Discounting? 60

The “Best” Efficient Level of Pollution Control 62

Social Versus Private Discounting 62

Eternity Discounting; Inflation and Real Interest Rates 66

Summary 66 • Questions for Discussion and Analysis 67 • Appendix: Discounting and Interest Rate Relationships 68 • Notes to Chapter 4 68

## Chapter 5: Equity, Environment, and Economics 71

What Is, or What Ought to Be? 71

Economic Philosophy: Pareto and Compensation, Benefit-Cost Analysis, Rawls, and the Polluter Pays Principle 71

The Coase Theorem: Who Pays for Safe Water? 73

Environmental Justice and Economics 78

Summary 80

Questions for Discussion and Analysis 81 • Notes to Chapter 5 82

## Chapter 6: Economic Theory and Environmental Resources: An Introduction 85

Renewable Biological Resources: A Question of Sustainability 85

Finite Resources: Use and Depletion 93

Optimizing the Balance: Environmental Protection and Degradation 100

Summary 103

Questions for Discussion and Analysis 105 • Notes to Chapter 6 106

## **PART II: RENEWABLE ENERGY ECONOMICS AND CONSERVATION 109**

### Chapter 7: Personal and Household Energy: Economics and Environment 111

Introduction: Economics Has Promoted Conservation 111

Keeping Warm 112

Economics and Lighting 118

Economic Obstacles to Cost-Effective Conservation 120

Air Pollution and Home Heating 122

Questions for Discussion and Analysis 123 • Appendix 124 • Notes to Chapter 7 125



## Chapter 8: Renewable Energy Economics (by Matthew Schwartz and Duane Chapman) 127

### Solar Energy 128

*Residential Solar Electricity* 130 • *Developing Countries and Residential Solar Electricity* 131 • *Large Solar and Renewable Electric Plants* 132 • *Research or Development? Scale Economy, Technological Innovation, and Policy* 133

### Renewable and Alternative Transportation Fuels 135

*Ethanol* 136 • *Natural Gas* 138 • *Electricity* 138 • *Alternative Transportation Costs* 138 • *Annual Fuel Cost* 139 • *Total Annual Cost* 139 • *Economic Incentives* 140

### Policies and Economics 142

### Questions for Discussion and Analysis 143 • Notes to Chapter 8 143

## **PART III: THE QUESTION OF GLOBAL RESOURCE LIMITATIONS 147**

### Chapter 9: World Oil: A Strategic Limited Resource? 149

#### The Geologists' Approach 151

#### The Economists' Approach 153

#### Competition, Monopoly, or a Hybrid? 155

#### The Security Dimension, Hybrid Competition, and Game Theory 159

#### Can the Price of Oil Be Predicted? 162

#### In Conclusion: A Summary and a Very Brief Opinion-Editorial 164

#### Questions for Discussion and Analysis 164 • Notes to Chapter 9 165

### Chapter 10: The Limits to Growth Question: Industrial Resources, Depletion, Recycling, and Population 169

#### The "Limits to Growth" Theory 170

#### Scarcity or Abundance: Metals and Energy Fuels 173

#### Recycling and Waste Disposal Economics 177

#### Population, Economics, and Environment 182

#### Summary and Conclusion 185

#### Questions for Discussion and Analysis 186 • Notes to Chapter 10 186

## **PART IV: RENEWABLE ENVIRONMENTAL RESOURCES: AIR AND WATER QUALITY, AGRICULTURE, AND FORESTRY 191**

### Chapter 11: Air Pollution Control: Economics and Policy 193

#### A Success Story: Reduced Pollution Emissions 193

#### Concentration Levels and Health Standards 194