

EBAN S. GOODSTEIN

ECONOMICS AND THE ENVIRONMENT

Third Edition



THIRD EDITION



Economics and the Environment

Eban S. Goodstein

Lewis & Clark College



JOHN WILEY & SONS, INC.

New York / Chichester / Weinheim / Brisbane / Singapore / Toronto

ACQUISITIONS EDITOR Leslie Kraham

MARKETING MANAGER Charity Robey

SENIOR PRODUCTION EDITOR Valerie A. Vargas

SENIOR DESIGNER Harold Nolan

PRODUCTION MANAGEMENT SERVICES Ingrao Associates

COVER PAINTING Marc Chagall (1887–1985) “Noah’s Ark” © ADAGP/ARS.

Photo by Gerard Blot. Musee National-Messia-Bibliotheque-Marc Chagall. Courtesy of Reunion des Musees Nationaux/Art Resource.

This book was set in Times Ten by Pine Tree Composition, Inc. and printed and bound by Malloy Lithographers. The cover was printed by Phoenix Color Corp.

This book is printed on acid-free paper. ♾

Copyright 2002 © John Wiley & Sons, Inc. All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning or otherwise, except as permitted under Sections 107 or 108 of the 1976 United States Copyright Act, without either the prior written permission of the Publisher, or authorization through payment of the appropriate per-copy fee to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, (978) 750-8400, fax (978) 750-4470. Requests to the Publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012, (212) 850-6011, fax (212) 850-6008, E-Mail: PERMREQ@WILEY.COM.

To order books please call 1(800)-225-5945.

Library of Congress Cataloging in Publication Data

Goodstein, Eban S., 1960–

Economics and the environment / Eban S. Goodstein—3rd ed.
p. cm.

Includes bibliographical references.

ISBN 0-471-39998-1 (cloth : alk. paper)

1. Economic development—Environmental aspects. I. Title.

HD75.6 .G66 2001

333.7—dc21

2001017834

Printed in the United States of America



Preface

This edition of *Economics and the Environment* retains the three interrelated advantages of its earlier incarnations: broad content; pedagogical clarity; and timely, well-integrated examples. There are a few significant changes in the order of presentation (the advanced topic chapters have been placed more logically as appendices), and there are a couple of major additions. Information and examples have been updated throughout. For a chapter-by-chapter analysis of what is brand new in this edition, please see the *Instructor's Manual*, online at www.wiley.com. Highlights include:

- Game theory and the Safe Minimum Standard
- An indifference-curve approach to WTP–WTA disparities
- A hybrid tax-permit system for greenhouse gas control
- A diagrammatic exposition of travel-cost analysis
- The latest economic research on the Acid Rain Program, LA Basin trading, the Kyoto Protocol, and the “double-dividend” debate

In terms of content, the book provides a rigorous and comprehensive presentation of the “standard analysis,” including the property-rights basis of environmental problems, efficient pollution control, benefit-estimation procedures, and incentive-based regulation. However, *Economics and the Environment* also incorporates broader topics as separate chapters, notably, the ethical foundations of environmental economics, an introduction to ecological economics, a safety-based approach to controlling pollution, the economic critique of growth, the potential for government failure, the promotion of “clean technology,” and opportunities for sustainable development in poor countries.

The second major advantage of the book is clarity. *Economics and the Environment* is centered around four cleanly focused questions:

1. How much pollution is too much?
2. Is government up to the job?
3. How can we do better?
4. How can we resolve global issues?

These questions are introduced through a detailed case study of a “big” issue with which many students are familiar—global warming. The first section of *Economics and the Environment* then explicitly sets up the normative question, How much pollution is too much? It employs the tools of welfare economics and benefit–cost analysis to explore three possible answers.

The first is the efficient pollution level. The concept is explained, and students are introduced to the fundamentals of benefit and cost estimation. The book also features a detailed look at the use of benefit–cost analysis at the EPA. This edition includes an updated discussion of the static general equilibrium efficiency impacts of pollution taxes, and the implications for a “double-dividend.”

The second pollution standard the book considers is a “safety” standard, which in fact continues to drive much environmental policy. The latter is placed solidly in the context of the economic growth debate, drawing on authors such as Hirsch, Daly, and Mishan.

The third standard is “ecological sustainability” as proposed by the ecological economics school. This standard is contrasted in an opposing chapter with “neoclassical sustainability”—dynamic efficiency presuming automatically rising social welfare. I shied away from doing this kind of comparison in the first edition because ecological economics was really just launching itself; by the second edition it had been around long enough for me to attempt a characterization. I have refined it a bit in this version, and I have added a game-theoretic interpretation of the Safe Minimum Standard.

Finally, in this first, normative section of the book, one also finds a vital discussion that is missing from other texts: the utilitarian ethical basis for the normative analysis, and its relation to an “environmental ethic.” Most students come into an environmental economics course thinking that saving whales is very important, without knowing exactly why. The explicit welfare-based analysis in this chapter asks students to confront the assumptions underlying their own and others’ world views.

The text fills a second major void in the second section, “Is Government up to the Job?” Most existing texts simply note that “government failure” is a potential problem when correcting for market externalities. In *Economics and the Environment*, the question of government’s ability to effectively regulate pollution is carefully examined. The section begins with a discussion of the two primary obstacles to effective government action: imperfect information, and the opportunity for political influence over government policy. It then moves on to provide a succinct review of existing legislation and accomplishments on air, water, solid and hazardous waste, toxic pollution, and endangered species. Part II ends with a chapter on the often neglected subject of monitoring and enforcement.

The third section of the book, “How Can We Do Better?” tackles the (more) positive aspects of pollution regulation. Two chapters are devoted to the theory and practical application of incentive-based regulation—marketable permits and Pigouvian taxes. Appendices focus on instrument choice under uncertainty, and incentive-compatible regulation.

From here, the book examines an argument that attributes the root source of pollution to market failure in technological development, rather than in the arena of property rights. We consider the view that the market often fails to generate incentives for investment in “clean technology,” as well as the feasibility of proposed solutions to this problem. In-depth discussion focuses on areas such as energy policy,

pollution prevention, alternative agriculture, recycling, life-cycle analysis (including an appendix on input–output approaches), and “green” labeling.

Finally, *Economics and the Environment* devotes an entire section to the resolution of global pollution and resource issues. Part IV is centered around a definition and discussion of sustainable development, as put forward by the Bruntland Commission. Topics covered include the preservation of natural capital; population and per-capita consumption pressures; the relationship between poverty, sustainable development, and environmental protection in poor countries; international trade and the environment; and global pollution control agreements.

Economics and the Environment will appeal to three groups of instructors. The first are economists who are simply looking for a clear and concise presentation of the conventional approach to environmental and resource economics. The four-question format developed in the text provides a much simpler pedagogical handle than is available elsewhere. In addition, the book provides a wealth of examples from the current literature, as well as an explicit consideration of the government’s role in environmental policy not available in competing works. Finally, the appendices cover advanced theoretical topics, ensuring that there is enough standard material to fill out a one-semester course.

The book will clearly appeal, however, to those with an interest in expanding the scope of environmental economics. *Economics and the Environment* moves beyond the standard analysis in five important areas. It provides a rigorous normative analysis of environmental goals; an in-depth evaluation of ecological economics; serious attention to the potential for government failure in pollution control; substantial discussion of dynamic issues of path dependence and technological change; and a sophisticated presentation of sustainable development in poor countries. The book seeks to incorporate into a well-developed economic analysis ideas that have emerged in the environmental and ecological sciences over the past few decades.

Given this orientation, instructors in environmental studies courses will also find this text to be unusually user friendly. Chapters on measuring the value of nonmarket goods, cost–benefit analysis, markets for pollution rights, incentives for investment in appropriate technology, the governmental role in pollution control, population and consumption pressures, global bargaining, and conservation in poor countries provide accessible material for environmental studies courses with a social-science focus.

Ultimately, the test of any textbook comes in the classroom. *Economics and the Environment* was written with students in mind. It addresses important questions raised in their lives and introduces them to the economist’s view of some solutions.

Acknowledgments

First thanks go to Dallas Burtraw, who is still keeping me up to date, and Bob Berrens and Dennis Palmmini, who provided especially helpful comments for this edition.

Laurie Johnson, Matt Kahn, Rich Howarth, Nick Gomersall, Blair Sandler, Cynthia Browning, Rene Rosenbaum, Mariano Torras, Yeon-Su Kim, and Kurt Schwabe provided excellent comments as this revision was in progress. Many of their suggestions have found their way into the final version of the book.

A synthetic work such as this depends on the contributions of the hundreds of economists and environmental scholars working in the field. Some of their names ap-

pear in the list of authors cited at the end of this book; undoubtedly many important contributors were omitted due to the scarce resource of space. Here, I would like to acknowledge helpful feedback and discussions with the following individuals:

Frank Ackerman	Tufts University
Dean Baker	Center for Economic and Policy Research
John Buell	College of the Atlantic
Steve Colt	University of Alaska, Anchorage
Peter Dorman	The Evergreen State College
Faye Duchin	Rensaleer Polytechnical Institute
Richard England	University of New Hampshire
Matthew Forstater	Gettysburg College
Sharman Haley	Merrit College
Darwin C. Hall	California State University, Long Beach
Jonathan Harris	Tufts University
Debra Holt	U.S. Department of Justice
David Goodman	University of California, Santa Cruz
Neva Goodwin	Tufts University
Robert Gottfried	University of the South
Douglas Greer	San Jose State University
Ann Ingerson	Sterling College
Kent Klitgaard	Wells College
Gunnar Knapp	University of Alaska, Anchorage
Michael Krasner	Queens College
Thea Lee	AFL-CIO
Rick Lostspeich	Indiana State University
William Moomaw	Tufts University
Janusz Mrozek	Georgia Tech
Carl Pasurka, Jr.	U.S. Environmental Protection Agency
Steve Polasky	University of Minnesota
Daniel Press	University of California, Santa Cruz
J. Barkley Rosser, Jr.	James Madison University
Peter Schwarz	University of North Carolina
Brett Snyder	U.S. Environmental Protection Agency
Eileen Van Ravensway	Michigan State University
Seid Zekavat	Loyola Marymount

Finally, thanks to my editor at John Wiley & Sons, Leslie Kraham, as well as Cynthia Snyder, Suzanne Ingrao/Ingrao Associates, and to Kathy Anderson and Vika Salnikova.



Contents

PREFACE xi

INTRODUCTION 1

CHAPTER 1 Four Economic Questions about Global Warming 3

- 1.1 How Much Pollution Is Too Much? 7
- 1.2 Is Government Up to the Job? 10
- 1.3 How Can We Do Better? 11
- 1.4 How Can We Resolve Global Issues? 13
- 1.5 Summary 15

PART I: HOW MUCH POLLUTION IS TOO MUCH? 19

CHAPTER 2 Ethics and Economics 21

- 2.0 Introduction 21
- 2.1 Utility and Utilitarianism 22
- 2.2 Social Welfare 24
- 2.3 Summary 27

CHAPTER 3 Pollution and Resource Degradation as Externalities 30

- 3.0 Introduction 30
- 3.1 The Open Access Problem 32
- 3.2 The Public Goods Problem 37
- 3.3 Summary 39

CHAPTER 4 The Efficiency Standard 43

- 4.0 Introduction 43

4.1	Efficiency Defined	43
4.2	Efficient Pollution Levels	46
4.3	Marginals and Totals	49
4.4	The Coase Theorem Introduced	51
4.5	Air Pollution Control in Baltimore: Calculating the Efficient Standard	52
4.6	The Ethical Basis of the Efficiency Standard	54
4.7	Summary	55
CHAPTER 5 The Safety Standard		60
5.0	Introduction	60
5.1	Defining the Right to Safety	61
5.2	The Safety Standard: Inefficient	63
5.3	The Safety Standard: Not Cost-Effective	65
5.4	The Safety Standard: Regressive?	66
5.5	Siting Hazardous Waste Facilities: Safety versus Efficiency	69
5.6	Summary	73
CHAPTER 6 Sustainability: A Neoclassical View		78
6.0	Introduction	78
6.1	Measuring Sustainability: Net National Welfare	80
6.2	Natural Capital Depreciation	83
6.3	Future Benefits, Costs, and Discounting	89
6.4	An Example of Discounting: Lightbulbs	91
6.5	Choosing the "Right" Discount Rate for Pollution Control	92
6.6	Is Net National Welfare Growing?	95
6.7	Summary	98
CHAPTER 7 Sustainability: An Ecological View		104
7.0	Introduction	104
7.1	Malthus and Ecological Economics	106
7.2	Measuring Sustainability	109
7.3	The Daly Rule	111
7.4	Markets, Governments, and the EIS	116
7.5	The Ecological-Neoclassical Debate in Context	120
7.6	Summary	122
Appendix 7A: Game Theory and the Safe Minimum Standard		127
CHAPTER 8 Measuring the Benefits of Environmental Protection		130
8.0	Introduction	130
8.1	Use, Option, and Existence Value: Types of Nonmarket Benefits	131

8.2	Consumer Surplus, WTP, and WTA: Measuring Benefits	132
8.3	Risk: Assessment and Perception	135
8.4	Measuring Benefits I: Contingent Valuation	138
8.5	Measuring Benefits II: Travel Cost	140
8.6	Measuring Benefits III: Hedonic Regression	142
8.7	The Value of Human Life	143
8.8	Summary	146
	Appendix 8A: WTA and WTP Redux	151

CHAPTER 9 Measuring the Costs of Environmental Protection 155

9.0	Introduction	155
9.1	Engineering Costs	156
9.2	Productivity Impacts of Regulation	157
9.3	Employment Impacts of Regulation	161
9.4	Monopoly Costs	169
9.5	General Equilibrium Effects	170
9.6	Summary	175

CHAPTER 10 Benefit–Cost in Practice: Implementing the Efficiency Standard 181

10.0	Introduction	181
10.1	Doing Benefit–Cost: Lead Standards	183
10.2	Doing Benefit–Cost: Landfill Regulation	190
10.3	Political Influence in Benefit–Cost	194
10.4	Is Benefit–Cost Up to the Job?	197
10.5	Summary	198

CHAPTER 11 Is More Really Better? Consumption and Welfare 202

11.0	Introduction	202
11.1	Money and Happiness	203
11.2	Social Norms and the Rat Race	204
11.3	Positional Goods and Consumption Externalities	208
11.4	Welfare with Social Consumption	210
11.5	Controlling the Impact of Consumption	211
11.6	Summary	215

PART II: IS GOVERNMENT UP TO THE JOB? 219

CHAPTER 12 The Political Economy of Environmental Regulation 221

12.0	Introduction	221
12.1	The Process of Environmental Regulation	222

12.2	Regulation under Imperfect Information	224
12.3	Bureaucratic Discretion and Political Influence	226
12.4	Who Wins the Influence Game?	229
12.5	Political Reform of Regulation	232
12.6	Lessons from Communism	235
12.7	Summary	237

CHAPTER 13 An Overview of Environmental Legislation 242

13.0	Introduction	242
13.1	Cleaning the Air	243
13.2	Fishable and Swimmable Waters	246
13.3	Hazardous Waste Disposal on Land	249
13.4	Chemicals and Pesticides	252
13.5	Endangered Species Protection	256
13.6	Summary	258

CHAPTER 14 The Regulatory Record: Achievements and Obstacles 262

14.0	Introduction	262
14.1	Accomplishments of Environmental Regulation	262
14.2	Normative Criticisms of Regulation	267
14.3	Cost-Effectiveness Criticisms of Regulation	268
14.4	Beyond Regulation? Promoting Clean Technology	270
14.5	Summary	273

CHAPTER 15 Monitoring and Enforcement 277

15.0	Introduction	277
15.1	The Economics of Crime	277
15.2	The Economics of Punishment	280
15.3	The Compliance Record	283
15.4	The Political Economy of Enforcement	285
15.5	Citizen Enforcement	289
15.6	Cost-Effective Enforcement	290
15.7	Summary	290

PART III: HOW CAN WE DO BETTER? 297

CHAPTER 16 Incentive-Based Regulation: Theory 299

16.0	Introduction	299
16.1	The Cost-Effectiveness Rule	300
16.2	IB Regulation and Cost-Effectiveness	303

16.3	IB Regulation and Technological Progress	307
16.4	Potential Problems with IB Regulation	309
16.5	Summary	313
	Appendix 16A: Imperfect Regulation in an Uncertain World	318
	Appendix 16B: Incentive-Compatible Regulation	323
CHAPTER 17	Incentive-Based Regulation: Practice	328
17.0	Introduction	328
17.1	Lead and Chlorofluorocarbons	329
17.2	Trading Urban Air Pollutants	330
17.3	Marketable Permits and Acid Rain	334
17.4	Pollution Taxes in the United States and Europe	339
17.5	Indirect Pollution Taxes: The Case of Energy	342
17.6	Other Incentive-Based Approaches	343
17.7	Summary	345
CHAPTER 18	Promoting Clean Technology: Theory	351
18.0	Introduction	351
18.1	Path Dependence and Clean Technology	352
18.2	Clean Technology Defined	353
18.3	If You're So Smart, Why Aren't You Rich?	357
18.4	Picking the Winning Path	361
18.5	Promoting Small-Scale CTs	364
18.6	Promoting Large-Scale CTs	367
18.7	Summary	370
CHAPTER 19	Promoting Clean Technology: Practice	375
19.0	Introduction	375
19.1	Pollution Prevention in Manufacturing	376
19.2	Alternative Agriculture and Pesticides	380
19.3	Recycling Solid Waste	388
19.4	Summary	396
	Appendix 19A: Input-Output Models and Life-Cycle Analysis	403
CHAPTER 20	Energy Policy and the Environment	411
20.0	Introduction	411
20.1	The Current Energy Picture	412
20.2	Technology Options: Electricity and Heat	414
20.3	Policy Options: Electricity and Heat	421
20.4	Technology Options: Transport	426

X Contents

20.5	Policy Options: Transport	431
20.6	Slowing Global Warming at a Profit?	435
20.7	Summary	436

PART IV: CAN WE RESOLVE GLOBAL ISSUES? 445

CHAPTER 21 Poverty, Population, and the Environment 447

21.0	Introduction	447
21.1	Poverty and the Environment	449
21.2	The Population Picture in Perspective	453
21.3	An Economic Approach to Family Size	456
21.4	Controlling Population Growth	458
21.5	Consumption and the Global Environment	463
21.6	Sustainable Development in Costa Rica?	465
21.7	Envisioning a Sustainable Future	469
21.8	Summary	472

CHAPTER 22 Environmental Policy in Poor Countries 478

22.0	Introduction	478
22.1	The Political Economy of Sustainable Development	479
22.2	Ending Environmentally Damaging Subsidies	482
22.3	Establishing and Enforcing Property Rights	485
22.4	Regulatory Approaches	488
22.5	Sustainable Technology: Development and Transfer	493
22.6	Resource Conservation and Debt Relief	497
22.7	Trade and the Environment	501
22.8	Summary	505

CHAPTER 23 The Economics of Global Agreements 512

23.0	Introduction	512
23.1	Agreements as Public Goods	513
23.2	Monitoring and Enforcement	514
23.3	The Ozone Layer and Biodiversity	516
23.4	Stopping Global Warming: Theory	522
23.5	Stopping Global Warming: Reality	525
23.6	Summary	527

Author Index	531
---------------------	-----

Subject Index	537
----------------------	-----



Introduction



Four Economic Questions about Global Warming

1.0 Introduction

Last weekend, I drove from my home in Portland, Oregon, to Smith Rocks State Park to go rock-climbing with a friend. We put about 300 miles on the car; less visibly, we pumped some 290 pounds of carbon dioxide (CO_2) into the air. This was our small daily share of the more than 25 billion pounds people around the world contribute annually from the burning of carbon fuels such as coal, oil, natural gas, and wood. Carbon dioxide is a **greenhouse gas**—a compound that traps reflected heat from the earth's surface and contributes to **global warming**. Other greenhouse gases include nitrous oxide from natural and human-made fertilizers; methane gas emitted from oil and gas production and transport, and from rice production and the digestive processes of cows and sheep; and chlorofluorocarbons (CFCs), once widely used for air-conditioning, refrigeration, and other industrial applications.¹

As a result of industrialization and the ensuing rapid increase in greenhouse gases in our atmosphere, most scientists agree that the earth's surface temperature will rise over the next few decades. The extent of the warming is uncertain: Assuming no controls on greenhouse gas emissions, low-end estimates suggest an increase in the earth's average surface temperature of 1.5 degrees Fahrenheit by the year 2100. The official high-end prediction from the UN's International Panel on Climate Change is 11 degrees over this time period. To put that number in perspective, during the last ice age, the earth's average surface temperature was only 9 degrees Fahrenheit colder than it is today.² Over the course of 250 to 300 years the outlook is obviously worse.

¹Chlorofluorocarbons also deplete the earth's protective ozone shield, a separate issue from global warming discussed in more detail in Chapter 23.

²"A Shift in Stance on Global Warming Theory," *The New York Times*, 10/26/00 p. A18.

A mid-range estimate over the long term, assuming no efforts to curtail use of fossil fuels, is a warming of 18 degrees Fahrenheit.³

The potential consequences of this warming range from manageable to catastrophic. The first major impact will be on **agricultural output**, a direct effect of changing temperature and rainfall patterns. Rainfall has a dominant impact on agriculture. More northerly regions may actually experience an increase in precipitation and yields, but the current grainbelts of the United States and central Europe will become drier and agricultural output in these regions will probably fall. The net global effect through the mid-century is expected to be, on balance, negative, and will be particularly harsh in many Third World countries, which lack resources for irrigation and other adaptive measures. One study has estimated that an additional 30 million people worldwide will be at risk of hunger due to climate changes by 2050.⁴

Second, **natural ecosystems** will also suffer from climate change. The U.S. Environmental Protection Agency has estimated that by the year 2050 the southern boundary of forest ecosystems could move northward by 600 kilometers, yet forests can migrate naturally at a much lower pace. Several major vegetation models predict large-scale forest die-backs in, among other places, the southern and eastern United States, and the Amazon Basin. Massive disruption of the ecosystems and species extinction is thus a distinct possibility. Diseases and pests are also likely to thrive in a warmer climate.⁵

The third concern is the possibility of a **sea-level rise** as ice caps in northern latitudes and Antarctica begin to melt. An increase in sea level of three feet—well within the realm of possibility—would flood many parts of Florida, Louisiana, Boston, and New York City, as well as much of low-lying countries like Bangladesh and the Netherlands (unless they were protected by dikes). As many as 1 billion people live in areas that might be directly impacted.⁶

Global warming is an environmental reality that presents stark choices. On the one hand, substantial, short-term reductions in the human contribution to the greenhouse effect would require substantial changes in western lifestyles. In particular, our casual reliance on fossil fuels for transportation, heat, and power would have to be dramatically scaled back and new, clean energy sources developed. On the other hand, the consequences of inaction are potentially disastrous. By continuing to pollute the atmosphere, we may be condemning the next generation to even greater hardship.

This book focuses on the economic issues at stake in cases like global warming, where human actions substantially alter the natural environment. In the process, we will examine the following four questions.

1. **How much pollution is too much?** Many people are tempted to answer simply: Any amount of pollution is too much. However, a little reflection reveals that

³Cline (1991); Hall (1997).

⁴For an optimistic assessment of the impact on U.S. agriculture, see Mendelsohn et al. (1994); for a critique, see Cline (1996); and for an overview of agricultural issues, see Hall (1997), and UK Meteorological Office (1998).

⁵UK Meteorological Office (1998); Nielson et al. (2000).

⁶Rosenberg et al. (1989). The IPCC (1996) estimates suggest a sea-level rise of up to a meter by 2100 (but not stopping at that date!), with a best guess of 50 cm.