

Brief Contents

Detailed Contents	vi
Preface	xviii
1 Visions of the Future	1
2 Valuing the Environment: Concepts	13
3 Valuing the Environment: Methods	31
4 Property Rights, Externalities, and Environmental Problems	59
5 Sustainable Development: Defining the Concept	84
6 The Population Problem	98
7 Natural Resource Economics: An Overview	122
8 Energy	135
9 Water	162
10 Agriculture	187
11 Biodiversity I: Forest Habitat	211
12 Biodiversity II: Commercially Valuable Species	234
13 Environmental Economics: An Overview	257
14 Stationary-Source Local Air Pollution	281
15 Acid Rain and Atmospheric Modification	306
16 Transportation	334
17 Water Pollution	359
18 Solid Waste and Recycling	386
19 Toxic Substances and Hazardous Wastes	406
20 Development, Poverty, and the Environment	434
21 The Quest for Sustainable Development	459
22 Visions of the Future Revisited	493
Glossary	504
Index	520

Detailed Contents

Preface xviii



1 Visions of the Future 1

Introduction 1

The Self-Extinction Premise 1

Future Environmental Challenges 2

Climate Change 2

EXAMPLE 1.1 Historical Examples of Self-Extinction 3

Water Accessibility 4

Meeting the Challenges 4

How Will Societies Respond? 5

The Role of Economics 6

The Use of Models 6

DEBATE 1.1 Ecological Economics versus Environmental Economics 7

The Road Ahead 7

DEBATE 1.2 What Does the Future Hold? 8

The Issues 9

An Overview of the Book 9

Summary 10

Key Concepts 11 ■ Further Reading 11 ■

Additional References 12 ■ Discussion Questions 12



2 Valuing the Environment: Concepts 13

Introduction 13

The Human Environment Relationship 13

The Environment as an Asset 13

The Economic Approach 15

Normative Criteria for Decision Making 16

Evaluating Predefined Options 16

DEBATE 2.1 Should Humans Place an Economic Value on the Environment? 18

EXAMPLE 2.1 Valuing Ecological Services from Preserved Tropical Forests 20

Finding the Optimal Outcome 24

Static Efficiency 25

Dynamic Efficiency 26

Applying the Concepts 26

Pollution Control 26

EXAMPLE 2.2 Does Reducing Pollution Make Economic Sense? 27

Summary 29

Key Concepts 29 ■ Further Reading 30 ■ Discussion Question 30



3 Valuing the Environment: Methods 31

Introduction 31

Risk Assessment 31

Valuing Benefits for Risk Management 32

Types of Values 33

Classifying Valuation Methods 33

EXAMPLE 3.1 Valuing the Northern Spotted Owl 34

EXAMPLE 3.2 Valuing Damage from Groundwater Contamination Using
Averting Expenditures 38

EXAMPLE 3.3 Valuing Diesel Odor Reduction by Contingent Ranking 40

EXAMPLE 3.4 The Value of Wildlife Viewing 41

DEBATE 3.1 Is Placing a Monetary Value on Human Life Immoral? 42

Issues in Benefit Estimation 44

Approaches to Cost Estimation 44

The Treatment of Risk 45

Choosing the Discount Rate 47

EXAMPLE 3.5 The Historical Importance of the Discount Rate 48

A Critical Appraisal 49

Cost-Effectiveness Analysis 50

Impact Analysis 52

EXAMPLE 3.6 NO₂ Control in Chicago: An Example of Cost-Effectiveness Analysis 52

Summary 53

Key Concepts 54 ■ Further Reading 54 ■

Additional References 55 ■ Discussion Questions 58



4 Property Rights, Externalities, and Environmental Problems 59

Introduction 59

Property Rights 60

Property Rights and Efficient Market Allocations 60

Efficient Property Right Structures 60

EXAMPLE 4.1 Pollution in Centrally Planned Economies 61

Producer's Surplus, Scarcity Rent, and Long-Run Competitive Equilibrium 64

Externalities as a Source of Market Failure 64

The Concept Introduced 64

Types of Externalities 66

Incentives and Property Rights Systems 66

Other Property Rights Regimes 66

EXAMPLE 4.2 Shrimp Farming Externalities in Thailand 67

Public Goods 70

EXAMPLE 4.3 Public Goods Privately Provided: The Nature Conservancy 72

Imperfect Market Structures 73

Divergence of Social and Private Discount Rates 73

Government Failure 75

The Pursuit of Efficiency 76

Private Resolution through Negotiation 76

The Courts: Property Rules and Liability Rules 77

Legislative and Executive Regulation 79

An Efficient Role for Government 80

Summary 80

Key Concepts 81 ■ Further Reading 81 ■

Additional References 82 ■ Discussion Questions 83

5 Sustainable Development: Defining the Concept 84

Introduction 84

A Two-Period Model 85

Defining Intertemporal Fairness 89

Are Efficient Allocations Fair? 90

EXAMPLE 5.1 The Alaskan Permanent Fund 91

Applying the Sustainability Criterion 92

EXAMPLE 5.2 Nauru: Weak Sustainability in the Extreme 93

Implications for Environmental Policy 94

Summary 94

Key Concepts 96 ■ Further Reading 96 ■

Additional References 96 ■ Discussion Question 97

6 The Population Problem 98

Introduction 98

Historical Perspective 99

World Population Growth 99

Population Growth in the United States 99

Effects of Population Growth on Economic Development 102

The Population/Environment Connection 108

DEBATE 6.1 Does Population Growth Degrade the Environment? 109

Effects of Economic Development on Population Growth 109

The Economic Approach to Population Control 111

EXAMPLE 6.1 Achieving Fertility Declines in Low-Income Countries:

The Case of Kerala 117

EXAMPLE 6.2 Income-Generating Activities as Fertility Control: Bangladesh 118

Summary 119
Key Concepts 119 ■ Further Reading 120 ■
Additional References 120 ■ Discussion Questions 121



7 Natural Resource Economics: An Overview 122

Introduction 122

A Resource Taxonomy 123

Efficient Intertemporal Allocations 126

The Two-Period Model Revisited 127

The N-Period Model 127

Transition to a Renewable Substitute 129

Exploration and Technological Progress 129

Market Allocations 130

Appropriate Property-Right Structures 130

EXAMPLE 7.1 Technological Progress in the Iron Ore Industry 131

Environmental Costs 132

Summary 132

Key Concepts 133 ■ Further Reading 133 ■

Additional References 134 ■ Discussion Questions 134



8 Energy 135

Introduction 135

Natural Gas: Price Controls 136

EXAMPLE 8.1 Hubbert's Peak 137

Oil: The Cartel Problem 140

Price Elasticity of Demand 141

Income Elasticity of Demand 141

Non-OPEC Suppliers 142

Compatibility of Member Interests 142

Oil: National Security Problem 144

DEBATE 8.1 How Should the United States Deal with the Vulnerability
of Its Imported Oil? 146

Transition Fuels: Environmental Problems 148

Conservation and Load Management 151

EXAMPLE 8.2 Electricity Deregulation in California: What Happened? 154


EXAMPLE 8.3 Tradable Energy Certificates: The Texas Experience 155

The Long Run 156

Summary 158

Key Concepts 159 ■ Further Reading 159 ■

Additional References 159 ■ Discussion Questions 161



9 Water 162

Introduction 162

The Potential for Water Scarcity 163

The Efficient Allocation of Scarce Water 166

Surface Water 166

Groundwater 167

The Current Allocation System 167

Riparian and Prior-Appropriation Doctrines 167

Sources of Inefficiency 169

DEBATE 9.1 What Is the Value of Water? 172

Potential Remedies 173

EXAMPLE 9.1 Using Economic Principles to Conserve Water in California 174

EXAMPLE 9.2 Protecting Instream Uses through Acquiring Water Rights 175

EXAMPLE 9.3 Water Pricing in Zurich, Switzerland 179


EXAMPLE 9.4 Politics and the Pricing of Scarce Water 181

DEBATE 9.2 Should Water Systems Be Privatized? 182

Summary 182

Key Concepts 183 ■ Further Reading 183 ■

Additional References 184 ■ Discussion Questions 186



10 Agriculture 187

Introduction 187

Global Scarcity 188

Examining Global Scarcity 189

Outlook for the Future 191

The Role of Agricultural Policies 196

EXAMPLE 10.1 Do Mandatory Labels Correct Externalities? 198

A Summing Up 199

Distribution of Food Resources 199

Defining the Problem 199

DEBATE 10.1 Should Genetically Modified Organisms Be Banned? 200

EXAMPLE 10.2 Are Consumers Willing to Pay a Premium for GMO-Free Foods? 201

Domestic Production in LDCs 202

The Undervaluation Bias 203


Feeding the Poor 204

Feast and Famine Cycles 205

Summary 207

Key Concepts 207 ■ Further Reading 207 ■

Additional References 208 ■ Discussion Questions 210



11 Biodiversity I: Forest Habitat 211

Introduction 211

Characterizing Forest Harvesting Decisions 212

Special Attributes of the Forest 212

The Biological Dimension 213

The Economics of Forest Harvesting 214

Land Conversion 217

Sources of Inefficiency 218

Perverse Incentives for the Landowner 218

Perverse Incentives for Nations 220

Poverty and Debt 221

Sustainable Forestry 222

Public Policy 223

Changing Incentives 224

EXAMPLE 11.1 Producing Sustainable Forestry through Certification 225

Debt-Nature Swaps 225

Extractive Reserves 226

Conservation Easements and Land Trusts 226

The World Heritage Convention 227

Royalty Payments 228

EXAMPLE 11.2 Does Pharmaceutical Demand Offer Sufficient Protection to Biodiversity? 229

EXAMPLE 11.3 Trust Funds for Conservation 230

Summary 228

Key Concepts 231 ■ Further Reading 231 ■

Additional References 232 ■ Discussion Questions 233

12 Biodiversity II: Commercially Valuable Species 234

Introduction 234

Efficient Harvests 235

The Biological Dimension 235

Static-Efficient Sustained Yield 237

Appropriability and Market Solutions 239

EXAMPLE 12.1 Open-Access Harvesting of the Minke Whale 240

Public Policy Toward Fisheries 241

EXAMPLE 12.2 Harbor Gangs of Maine 241

Aquaculture 242

Raising the Real Cost of Fishing 243

Taxes 245

Individual Transferable Quotas (ITQs) 246

Marine Reserves 249

EXAMPLE 12.3 The Relative Effectiveness of Transferable Quotas and Traditional Size and Effort Restrictions in the Atlantic Sea Scallop Fishery 250

The 200-Mile Limit 251

Preventing Poaching 251

EXAMPLE 12.4 Local Approaches to Wildlife Protection: Zimbabwe 252

Summary 253

Key Concepts 253 ■ Further Reading 254 ■

Additional References 254 ■ Discussion Questions 256



13 Environmental Economics: An Overview 257

Introduction 257

A Pollutant Taxonomy 258

Defining the Efficient Allocation of Pollution 259

Fund Pollutants 259

Market Allocation of Pollution 262

Efficient Policy Responses 263

EXAMPLE 13.1 Environmental Taxation in China 264

Cost-Effective Policies for Emission Reduction 264

Defining a Cost-Effective Allocation 264

Cost-Effective Pollution Control Policies 266

Emission Standards 266

Emission Charges 267

Transferable Emission Permits 269

DEBATE 13.1 Should Developing Countries Rely on Market-Based Instruments to Control Pollution? 271

Other Policy Dimensions 272

The Revenue Effect 272

Responses to Changes in the Regulatory Environment 272

EXAMPLE 13.2 The Swedish Nitrogen Charge 273

Instrument Choice under Uncertainty 274

Product Charges: Another Form of Environmental Taxation 275

EXAMPLE 13.3 The Irish Bag Levy 276

Summary 275

Key Concepts 277 ■ Further Reading 278 ■

Additional References 278 ■ Discussion Questions 280



14 Stationary-Source Local Air Pollution 281

Introduction 281

Conventional Pollutants 282

The Command-and-Control Policy Framework 282

DEBATE 14.1 Should the New Source Review Program Be Changed? 285

The Efficiency of the Command-and-Control Approach 286

DEBATE 14.2 The Particulate and Smog Ambient Standards Controversy 287

Cost-Effectiveness of the Command-and-Control Approach 289

EXAMPLE 14.1 Controlling SO₂ Emissions by Command-and-Control in Germany 291

Air Quality 292

Innovative Approaches 293

The Emissions Trading Program 293

Smog Trading 295

The Effectiveness of Emissions Trading 296

Emission Charges 297

Hazardous Pollutants 298

EXAMPLE 14.2 Technology Diffusion in the Chlorine Manufacturing Sector 301

Emissions Fees 301

Summary 302

Key Concepts 303 ■ Further Reading 303 ■

Additional References 303 ■ Discussion Questions 305

15 Acid Rain and Atmospheric Modification 306

Introduction 306

Regional Pollutants 307

Acid Rain 307

EXAMPLE 15.1 Adirondack Acidification 308

EXAMPLE 15.2 The Sulfur Allowance Program 311

EXAMPLE 15.3 Why and How Do Environmentalists Buy Pollution? 313

Global Pollutants 314

Ozone Depletion 314

Climate Change 316

EXAMPLE 15.4 Tradable Permits for Ozone-Depleting Chemicals 317

Negotiations over Climate Change Policy Options 320

DEBATE 15.1 Should Carbon Sequestration in the Terrestrial Biosphere Be Credited? 320

International Agreements on Climate Change 321

EXAMPLE 15.5 The European Emissions Trading Scheme (EU ETS) 323

Complementary Strategies 323

The Case for Emissions Trading 324

Controversies 325

DEBATE 15.2 Is Global Greenhouse Gas Trading Immoral? 325

The Timing of Policy 326

Creating Incentives for Participation in Climate Change Agreements 327

Summary 328

Key Concepts 329 ■ Further Reading 330 ■

Additional References 330 ■ Discussion Questions 333

16 Transportation 334

Introduction 334

The Economics of Mobile-Source Pollution 336

Implicit Subsidies 336

Externalities 336

The Consequences 337

Policy Toward Mobile Sources 337

Some History 337

Structure of the U.S. Approach 339

EXAMPLE 16.1 Project XL—The Quest for Effective, Flexible Regulation 342

European Approaches 342

An Economic and Political Assessment 343

EXAMPLE 16.2 Car Sharing: Better Use of Automotive Capital? 344

Technology Forcing and Sanctions 345

Differentiated Regulation 345

Uniformity of Control 346

The Deterioration of New-Car Emission Rates 346

Lead Phaseout Program 347

Possible Reforms 348

EXAMPLE 16.3 Getting the Lead Out: The Lead Phaseout Program 348

Fuel Taxes 349

Congestion Pricing 350

EXAMPLE 16.4 Innovative Mobile-Source Pollution Control Strategies: Singapore 351

Private Toll Roads 350

CAFE Standards 350

DEBATE 16.1 CAFE Standards or Fuel Taxes? 352

Parking Cash Outs 352

Feebates 352

Pay-As-You-Drive (PAYD) Insurance 353

EXAMPLE 16.5 Modifying Car Insurance as an Environmental Strategy 353

Accelerated Retirement Strategies 354

EXAMPLE 16.6 Counterproductive Policy Design 355

Summary 354

Key Concepts 356 ■ Further Reading 356 ■

Additional References 357 ■ Discussion Questions 358



17 Water Pollution 359

Introduction 359

The Nature of Water Pollution Problems 360

Types of Waste-Receiving Water 360

Sources of Contamination 360

EXAMPLE 17.1 Incidents of Groundwater Pollution 361

Types of Pollutants 362

Water Pollution Control Policy 365

Traditional Water Pollution Control Policy 365

Early Legislation 365

Subsequent Legislation 366

The TMDL Program 368

The Safe Drinking Water Act 368

Ocean Pollution 369

Private Enforcement 369

Efficiency and Cost-Effectiveness 370

Ambient Standards and the Zero Discharge Goal 370

National Effluent Standards 371

EXAMPLE 17.2 Effluent Trading and the Cost of Reducing Waste Treatment
Discharges into Long Island Sound 374

Municipal Waste Treatment Subsidies 375

Pretreatment Standards 376
Nonpoint Pollution 376
EXAMPLE 17.3 Cost-Effective Pretreatment Standards 377
Oil Spills 378

EXAMPLE 17.4 Anatomy of an Oil Spill Suit: The Amoco Cadiz 379
Citizen Suits 380
An Overall Assessment 380

Summary 382

Key Concepts 382 ■ Further Reading 383 ■
Additional References 383 ■ Discussion Questions 385



18 Solid Waste and Recycling 386

Introduction 386

Efficient Recycling 386

Extraction and Disposal Costs 386

EXAMPLE 18.1 Population Density and Recycling: The Japanese Experience 387

Recycling: A Closer Look 388

EXAMPLE 18.2 Lead Recycling 389

Waste Disposal and Pollution Damage 390

Disposal Costs and Efficiency 390

The Disposal Decision 390

Disposal Costs and the Scrap Market 392

Subsidies on Raw Materials 392

Corrective Public Policies 392

EXAMPLE 18.3 Pricing Trash in Marietta, Georgia 393

Pollution Damage 395

EXAMPLE 18.4 Implementing the Take-Back Principle 396

Tax Treatment of Minerals 397

Product Durability 398

Functional Obsolescence 398

Fashion Obsolescence 399

Durability Obsolescence 399

Summary 401

EXAMPLE 18.5 The Bet 402

Key Concepts 403 ■ Further Reading 403 ■

Additional References 404 ■ Discussion Questions 405



19 Toxic Substances and Hazardous Wastes 406

Introduction 406

The Nature of Toxic Substance Pollution 407

Health Effects 407

Policy Issues 408

Market Allocations and Toxic Substances 410

Occupational Hazards 410

EXAMPLE 19.1 Susceptible Populations in the Hazardous Workplace	411
Product Safety	412
Third Parties	413
Current Policy	413
Common Law	413
EXAMPLE 19.2 Judicial Remedies in Toxic Substance Control: The Kepone Case	414
Criminal Law	415
Statutory Law	416
International Agreements	420
An Assessment of the Legal Remedies	420
The Common Law	420
EXAMPLE 19.3 Regulating through Mandatory Disclosure: The Case of Lead	421
The Statutory Law	425
EXAMPLE 19.4 Weighing the Risks: Food Additives	426
Performance Bonds: An Innovative Proposal	428
EXAMPLE 19.5 Performance Bonds for Brominated Flame Retardants	429
Summary	428
Key Concepts	430 ■ Further Reading 430 ■
Additional References	431 ■ Discussion Questions 433

20 Development, Poverty, and the Environment 434

Introduction	434
The Growth Process	435
The Nature of the Process	435
Potential Sources of Reduced Growth	436
The Natural Resource Curse	438
EXAMPLE 20.1 The "Natural Resource Curse" Hypothesis	439
Environmental Policy	438
EXAMPLE 20.2 Jobs versus the Environment: What Is the Evidence?	440
Energy	440
Outlook for the Near Future	442
Population Impacts	442
The Information Economy	442
The Growth-Development Relationship	443
Conventional Measures	443
Alternative Measures	445
Growth and Poverty: The Industrialized Nations	448
The Effects on Income Inequality	448
Poverty in the Less Industrialized Nations	449
The Appropriateness of the Traditional Model	450
Barriers to Development	451
Summary	454
Key Concepts	455 ■ Further Reading 456 ■
Additional References	456 ■ Discussion Questions 458



21 The Quest for Sustainable Development 459

Introduction 459

Sustainability and Development 460

Market Allocations 462

Efficiency and Sustainability 463

EXAMPLE 21.1 Resource Depletion and Economic Sustainability: Malaysia 464

Trade and the Environment 466

EXAMPLE 21.2 Has NAFTA Improved the Environment in Mexico? 469

DEBATE 21.1 Should an Importing Country Be Able to Use Trade Restrictions to Influence Harmful Fishing Practices in an Exporting Nation? 472

A Menu of Opportunities 473

Agriculture 473

Energy 474

Waste Reduction 474

Managing the Transition 475

Prospects for International Cooperation 476

EXAMPLE 21.3 Controlling Land Use Development with TDRs 477

Opportunities for Cooperation 478

Restructuring Incentives 479

Forced Transition 484

Defining the Target 484

EXAMPLE 21.4 Disclosure Strategies for Pollution Control in Indonesia 485

Institutional Structure 485

Administration 487

Summary 487

Key Concepts 488 ■ Further Reading 489 ■

Additional References 489 ■ Discussion Questions 492



22 Visions of the Future Revisited 493

Addressing the Issues 493

Conceptualizing the Problem 494

Institutional Responses 495

EXAMPLE 22.1 Private Incentives for Sustainable Development: Can Adopting Sustainable Practices Be Profitable? 496

Sustainable Development 498

EXAMPLE 22.2 Public/Private Partnerships: The Kalundborg Experience 501

A Concluding Comment 502

Key Concept 503 ■ Discussion Questions 503

Glossary 504

Index 520