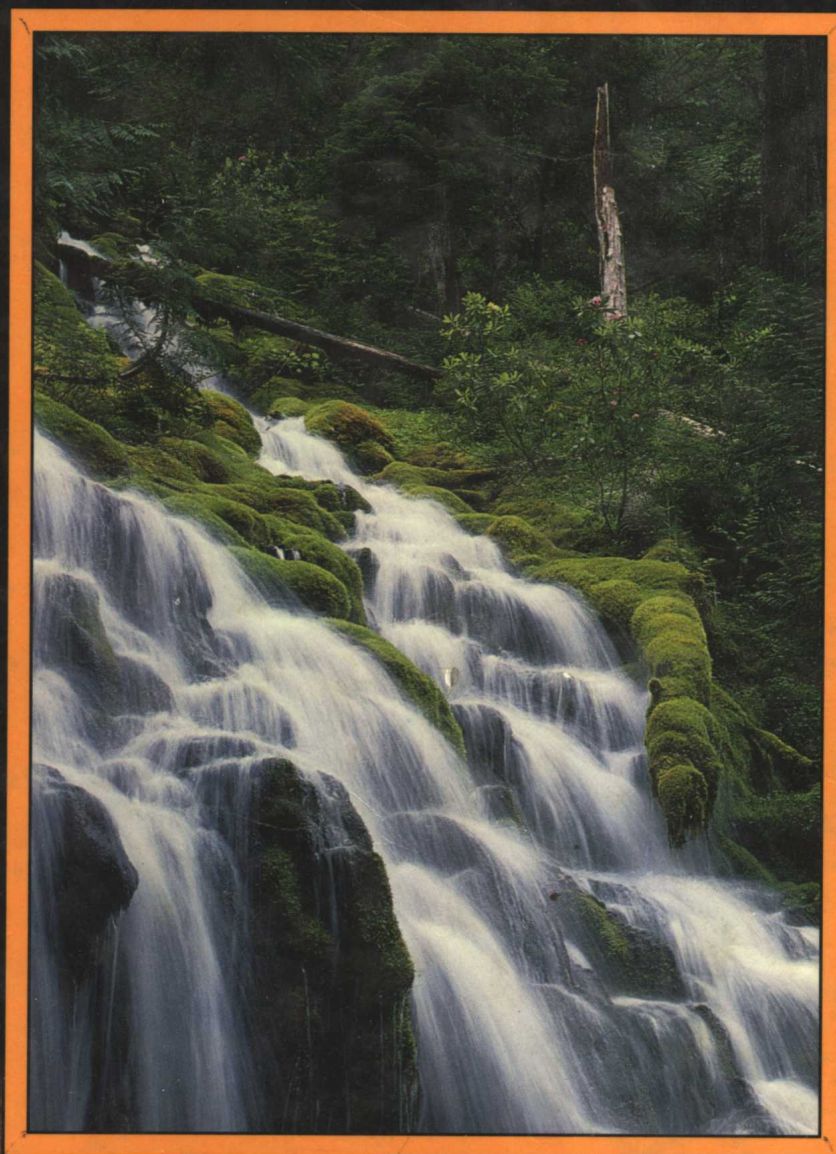


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# ENVIRONMENTAL SCIENCE

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**ARMS**



# ENVIRONMENTAL SCIENCE

*Karen Arms*



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# Preface

Grasses and flowering plants on a dune.



We live in extraordinary times, witnesses to an event that has never happened before and will never happen again: the human population of the earth has tripled in less than a century. This staggering growth has affected the planet on which we live in ways that we are only beginning to understand, but understand them we must if the earth is to support us all in the twenty-first century. Courses that introduce students to environmental science have sprung up all over the world—for majors, for nonmajors, for scientists, for artists. It is reassuring that so many students are now studying this subject because learning about our environmental problems is the first step toward solving them.

Environmental science, the study of how humans affect and are affected by their environ-

ments, was given a tremendous boost by writers who warned that we are not merely altering the earth but are rendering it unfit for human habitation. Unless we change our ways, said people such as Rachel Carson, Garrett Hardin, and Paul Ehrlich, we face a decline in living standards, and eventually, the extinction of the human species. Is this true, or do these prophets of doom exaggerate? People wanted to know, and so the study of environmental science was born.

Like many modern disciplines, environmental science is a hybrid between established academic subjects. It relies on geology and meteorology to describe the physical nature of the world we live in. It draws on political science, demography, anthropology, archeology, economics, and psychology for an understanding of how people function, separately and in groups. And ultimately, it tries to fit this information into a framework of ecology, the biological study of how living things interact with their environments. No course can possibly expose the student to every aspect of this rapidly growing field. The aim of this book is to point students toward an educated approach to the environmental questions that confront us every day. First, students are introduced to our major environmental problems. Second, they are encouraged to analyze public pronouncements on the subject. Many of the examples we study are depressing. But we are not inevitably doomed by our environmental problems. For every country suffering from massive deforestation, we can find another that

has replanted its forests; for every country suffering the hardships of rapid population growth, we can see another that has restrained growth and revived its economy. The message of this book is that people can learn and change extraordinarily rapidly.

A solid scientific basis is vital if the content of an environmental science course is to remain useful over the years. The student must be introduced to some of the scientific methodology used by researchers if this is to be more than a “current affairs” course. But science is not enough. When we consider famine relief or a battle over conservation, some understanding of economics, demographics, and politics is necessary to understand the problem and its possible solutions.

You can hardly open a newspaper or turn on the television without being exposed to dramatic announcements on environmental subjects: CFCs destroy the ozone layer; acid rain kills trees; drought causes crop failures. These are pseudoscientific conclusions. They suggest experiments demonstrating cause and effect. But have these experiments really been done? Or is there non-experimental evidence that leads to the same conclusion? The answers to these questions are important because they determine whether we can do anything about the ozone layer, dead trees, or crop failures.

As responsible members of society, we must try to judge the evidence for environmental statements, but we must go further and ask a question: so what? A parent, told that we are consuming all the oil in the world and there would be none left for our children replied, “It’s our oil. We found it. If they want oil, let them find their own.” Now we are in the realm of ethics—our values. Do we care if there is oil for our children? Shall we try to feed the millions dying of starvation? Our ethical systems determine the answers, and the answers are going to be at least slightly different for each one of us. Assuming we do care, and assuming that we do want to alter the course of events, how can we do so? We have to consider economics, law, and politics if we are to discover the most effective ways of changing the world.

All these different questions and approaches are part of environmental science, making it the complex and fascinating subject that it is.

### Organization

Part 1 of this book provides an overview of environmental science, including the history of how environmental problems have multiplied and

those aspects of human nature that affect how we tackle them.

Part 2 contains the scientific principles that affect environmental problems and their solution. Because we are animals, completely dependent on other organisms for our survival, environmental affairs are most directly affected by the principles of ecology. Two chapters are devoted to this subject.

Many will consider Part 3, the study of populations, to be the most important in the book. Population growth underlies most of today’s environmental problems. Why is this so and what does the future hold?

Part 4 turns to the resources with which the earth supplies us, the ways human activities are depleting these resources, and some of the consequences of depletion.

Part 5 focuses on pollution: what it is, how it threatens life and comfort, and what can be done about it.

Finally, Part 6 introduces the social context: the ethical, economic, and political systems that cause environmental problems in the first place and without which we cannot solve them.

### Features

The book is organized to be flexible. Each of us has a somewhat different syllabus for this course and the chapters will be taught in various orders. Each chapter can be read independently and important terms are defined in more than one chapter. Cross references to other chapters point to background material for the subject under discussion. In addition, the book contains a number of features designed to make it easier to study.

### ILLUSTRATIONS

Figures on soil erosion may impress you, but they do not stun you as an aerial view of the avalanche of topsoil washing into the Gulf of Mexico stuns you. Full color photographs and illustrations are used throughout this book to illustrate facts and figures and to explain natural phenomena and technology.

### MAPS

A fuelwood shortage in Sudan, fish for aquaculture from Lake Baikal—where are these places? Inside the front cover are maps showing the location of the countries, towns, regions, lakes, rivers, and oceans, mentioned in the text. Other maps throughout the book permit you to find places mentioned in particular chapters.

**KEY CONCEPTS**

The details of environmental situations change from day to day, but the central problems and ideas remain. These, rather than the details, are what stay with you from a study of environmental science. The main concepts developed in each chapter are listed below each chapter heading.

**TAKE-HOME MESSAGES**

Psychologists say that after listening to a lecture or reading a chapter, each of us takes away just a few new ideas. These central ideas are boxed as "take-home messages" within the text. As you review a chapter, a glance at these messages will remind you of the chapter's main points.

**CHAPTER SUMMARIES**

Each section is summarized at the end of the chapter in which it appears.

**QUESTIONS FOR DISCUSSION**

At the end of each chapter are questions arising from the topics discussed in the chapter. Many of them can be used as essay questions. A number of them ask you to expand on views discussed in the chapter. For instance, there are economists who argue that population growth is a good thing and does not create economic or environmental problems. What do you think of this? Do you agree with those who argue that the free market, rather than governmental regulation, should control activities such as mining, lumbering, and urban development?

**BOLDFACE TERMS**

Each chapter contains key terms in boldface type. Technical terms are in boldface where they are first defined. Boldface is also used for key words which should be noted as important vocabulary in the subject under discussion.

**CLOSE-UPS**

Most chapters contain boxed essays that are separated from the main body of the text. These cover material that is not central to the theme of the chapter but provides more detail or explanation. Some Close-Ups explain particular technologies. Some describe specific examples, such as the Alaska oil spill and the regulation of Alar and pesticides. Some detail several points of view on a particular controversy.

**REFERENCES AND FURTHER READING**

Many of the reference sources used in this book contain information that applies to many chapters. These are listed as general sources of information; references that are particularly appropriate to each chapter are listed separately.

**APPENDIX ON UNITS AND MEASUREMENTS**

"1984 dollars, gigajoule equivalents of coal"—what are they? If your interest in environmental science leads you to delve into the massive literature on the subject, you will come across many measurements expressed in unfamiliar units. This appendix will help guide you through the maze.

**GLOSSARY**

A glossary at the end of the book gives you one list where you can look up many terms. Instead of the vague descriptions found in most glossaries, it gives technically accurate definitions.

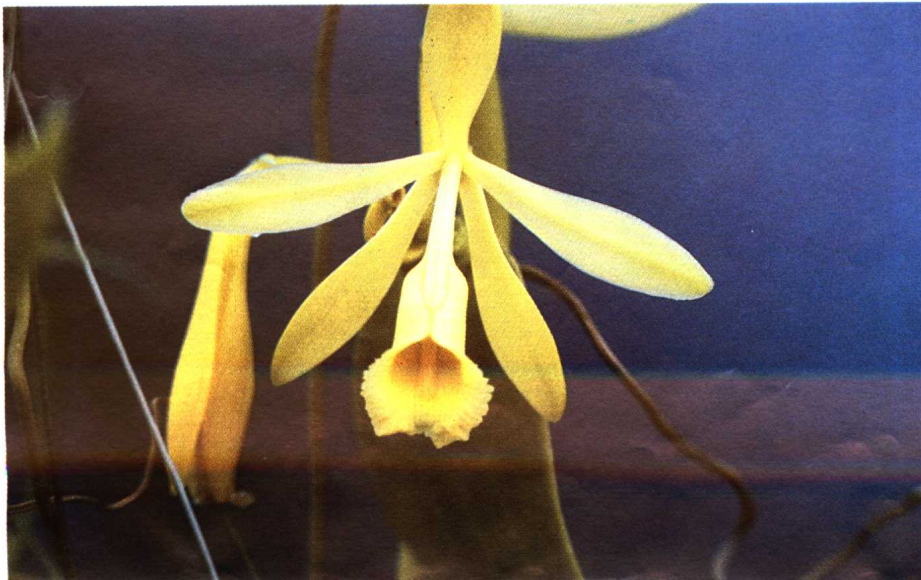
Writing about environmental science has proved a fascinating experience. I hope that this book will launch many newcomers on a voyage of discovery that will prove as rewarding.

*Karen Arms*

*Savannah, August 1989*

# Contents Overview

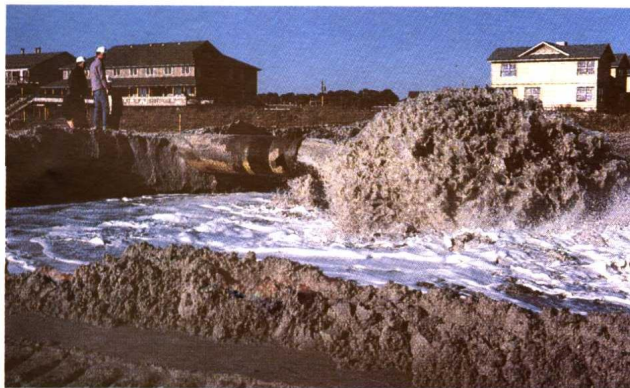
<b>Part 1 OVERVIEW</b>	<b>1</b>		
Chapter 1 Science and Environment	2	Chapter 11 Fresh Water	212
Chapter 2 How Humans Affect Their Environment	14	Chapter 12 The Oceans	230
Chapter 3 Solving the Problems	34	Chapter 13 Mineral Resources	248
<b>Part 2 SOME BASIC ECOLOGY</b>	<b>53</b>	Chapter 14 Agricultural Land	262
Chapter 4 Energy, Chemistry, and Climate	54	Chapter 15 Food and Hunger	281
Chapter 5 Biodiversity and Habitats	74	Chapter 16 Wilderness and Forest	299
Chapter 6 Ecosystems and How They Change	100	Chapter 17 Species and Extinction	317
<b>Part 3 POPULATIONS</b>	<b>121</b>	Chapter 18 Urban Land Use	340
Chapter 7 Natural Populations	122	<b>Part 5 POLLUTION</b>	<b>357</b>
Chapter 8 Human Populations	142	Chapter 19 Pollution and Water	358
<b>Part 4 NATURAL RESOURCES</b>	<b>165</b>	Chapter 20 Air Pollution and Noise	376
Chapter 9 Energy from Nonrenewable Sources	166	Chapter 21 Toxic and Solid Waste	397
Chapter 10 Conservation and Renewable Energy	191	<b>Part 6 SOCIETY AND ENVIRONMENT</b>	<b>417</b>
		Chapter 22 Politics, Economics, and Ethics	418
		Chapter 23 Toward a Sustainable Future	433



*Vanilla planifolia*, an orchid from the South American rain forest. (Carolina Biological Supply Company)

# Contents

Beach renourishment. (Karen Roeder)



<b>Part 1 Overview</b>	<b>1</b>
CHAPTER 1 SCIENCE AND ENVIRONMENT	2
1-A A Sustainable World	3
1-B Population	4
1-C Resources	5
Types of Resources	6
1-D Pollution	7
1-E Thinking Internationally	8
1-F Research and Education	10
1-G Economics and the Environment	10
The World Bank	11
Guns or Butter	12
CHAPTER 2 HOW HUMANS AFFECT THEIR ENVIRONMENT	14
2-A A Little History	15
2-B Human Evolution	18
Our Primate Relatives	18
Human Origins	20

The First Tools	21
Colonization of Colder Areas	22
2-C Hunter-Gatherer Populations	22
Stone Age Extinctions	23
2-D The Agricultural Revolution	23
Origins of Agriculture	28
Do Complex Human Societies Destroy Their Environments?	29
2-E The Industrial Revolution	30
2-F Cultural Evolution	31
Close-Up 2-1 <i>How Organisms Evolve</i>	16
Close-Up 2-2 <i>Naming and Classifying Organisms</i>	26
CHAPTER 3 SOLVING THE PROBLEMS	34
3-A The Technological Fix	35
3-B The Tragedy of the Commons	35
The Lifeboat and Foreign Aid	37
3-C Solutions to the Tragedy of the Commons	37
Social Behavior and Altruism	37
Political Systems and Environmentalism	38
3-D No Single Solution: Tree Death from Acid Rain	41
3-E Costs, Benefits, and Risks	42
Cost-Benefit Analysis	43
Tacoma's Copper Smelter	43
Risk Assessment	43
Perception of Risk and Gain	43
Voluntary Risk and Inadequate Data	45
3-F Planning for the Future	48
Communications	48
Economics	48



3-G The Economics of Improving the Environment 50  
 Close-Up 3-1 *Environmental Impact Statements* 40  
 Close-Up 3-2 *Pesticides and Cancer: Risk and Decisions* 46

Wetlands in the southeastern United States. (Karen Roeder)



**Part 2 Some Basic Ecology 53**

CHAPTER 4 ENERGY, CHEMISTRY, AND CLIMATE 54  
 4-A The Laws of Thermodynamics 55  
 4-B Elements and Molecules 56  
     Bonds Between Atoms 57  
     Electrical Charge and Pollution Control 59  
     Chemical Reactions 60  
     Solutions, Acids, and Bases 60  
 4-C How the Earth Got its Atmosphere 61  
 4-D Solar Energy and Climate 63  
     Temperature and Wind 63  
     Precipitation 65  
 4-E Human Impact on Climate 65  
     Ozone Depletion 65  
     The Greenhouse Effect 66  
     Methane 67  
     Carbon Dioxide 68  
     Global Warming 68  
     What Can We Do? 72  
 Close-Up 4-1 *The Rising Sea* 71  
 CHAPTER 5 BIODIVERSITY AND HABITATS 74  
 5-A Protists and Algae 75  
 5-B Sea Creatures Without Backbones 80  
 5-C Vertebrates of the Sea 81  
 5-D Life on Land 82  
 5-E Land Animals 82  
 5-F Land Plants 84  
     Lower Plants 85  
     Gymnosperms 85  
     Flowering Plants 85

5-G Bacteria and Fungi 86  
     Bacteria 87  
     Fungi 87  
 5-H Biomes, Climate, and Vegetation 88  
 5-I Tropical Biomes 89  
 5-J Desert 92  
 5-K Temperate Biomes 93  
 5-L Taiga 96  
 5-M Tundra 97  
 Close-Up 5-1 *Plants That Changed History* 78

**CHAPTER 6 ECOSYSTEMS AND HOW THEY CHANGE 100**

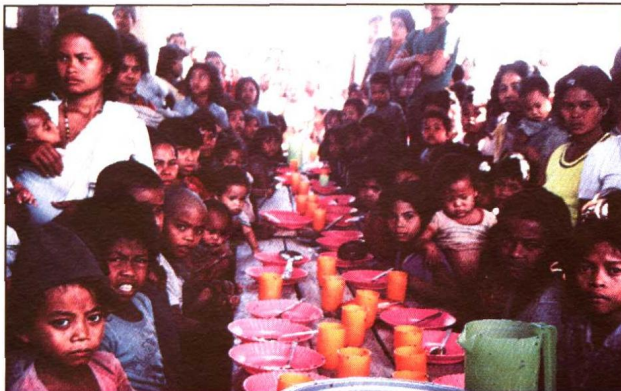
6-A The Components of an Ecosystem 101  
 6-B Food Webs 102  
     Trophic Levels 102  
     Concentration of Poisons in a Food Chain 103  
     DDT 103  
     Why So Few Trophic Levels? 106  
 6-C Productivity 106  
     Primary Productivity 107  
     Secondary Productivity 108  
 6-D Mineral Nutrient Cycling 109  
     The Carbon Cycle 109  
     The Nitrogen Cycle 109  
     Nitrogen Fixation 110  
     The Phosphorus Cycle 111  
 6-E How Ecosystems Change 112  
 6-F Secondary Succession 113  
     Patches and Fugitive Species 114  
     The Importance of Preserving Patches 115  
 6-G Primary Succession 115  
     Soil Formation 115  
 6-H Fire-Maintained Communities 116  
 6-I Disturbances with Long-Term Effects 117  
 Close-Up 6-1 *Salt Marsh and Seafood* 104

**Part 3 Populations 121**

CHAPTER 7 NATURAL POPULATIONS 122  
 7-A Species Diversity 123  
     Chobe National Park 124  
     Species Turnover 125  
     How Is Diversity Maintained? 126  
     Are Complex Ecosystems More Stable? 126  
 7-B Habitat and Niche 127  
 7-C Population Size and Growth 128  
 7-D Carrying Capacity 129  
 7-E How Density Affects Population Regulation 131  
     Density-Dependent Regulation 131  
     Density-Independent Factors 131

7-F	How Competition Limits Population Size	131	<b>Part 4 Natural Resources</b>	<b>165</b>	
	Competition Between Members of the Same Species	132	<b>CHAPTER 9 ENERGY FROM NONRENEWABLE SOURCES</b>	<b>166</b>	
	Competition Between Members of Different Species	133	9-A	Renewable and Nonrenewable Energy Sources	167
7-G	How Predation Limits Populations	134	9-B	Worldwide Fuel Use	168
7-H	Control of Pest Populations	135		Electricity	168
	Pesticides	136	9-C	Evaluating Energy Sources	170
	Integrated Pest Management	137		Energy Efficiency	171
	Biological Controls	137		Useful Energy Yield	171
	Genetic Engineering and Pest Control	140	9-D	Oil	172
Close-Up 7-1	<i>Chemical versus Biological Pest Control</i>	138		Running Out of Oil	173
<b>CHAPTER 8 HUMAN POPULATIONS</b>		<b>142</b>	9-E	Natural Gas	174
8-A	World Population and Its Distribution	143	9-F	Coal	176
8-B	Population Forecasts	144		Synfuels	176
	Age Structure	145		The External Costs of Energy from Coal	176
	The Dependency Burden	146	9-G	Controlling Damage from Fossil Fuel Use	178
	Survivorship	147	9-H	Nuclear Power	180
	Fertility Rates	147		Nuclear Fission Reactors	180
	Doubling Time	149		Breeder Fission Reactors	184
8-C	Declining Death Rates	149		Nuclear Fusion Reactors	184
	Life Expectancy	153		The Future of Nuclear Energy	185
8-D	The Demographic Transition	153	9-I	Economics, Conservation, and the Future	188
	The Demographically Divided World	155	Close-Up 9-1	<i>How Electrical Energy Reaches Us</i>	169
8-E	Fast-Growth Countries and Sustainable Populations	155	Close-Up 9-2	<i>Oil, Taxes, and Conservation</i>	186
8-F	Economics and Population	157	<b>CHAPTER 10 CONSERVATION AND RENEWABLE ENERGY</b>	<b>191</b>	
	Political Causes and Effects	158	10-A	Planning for the Future	192
8-G	Controlling Population Growth	159	10-B	Conservation	193
	Eradication of Smallpox	159		Changing Wasteful Habits	193
	Population Policy	159		Investing in More Efficient Buildings	194
	International Family Planning	162		Energy-Efficient Transportation	195
Close-Up 8-1	<i>Birth Control</i>	150	10-C	Solar Energy	196
Close-Up 8-2	<i>Environmental Refugees</i>	160		Passive Heating and Cooling	196
				Active Solar Heating	197
				Photovoltaics	198
			10-D	Geothermal Energy	199
			10-E	Energy from Wind	200
				Storing Electricity	200
			10-F	Power from Water	201
				Tidal and Wave Power	202
				Wave Power Plants	202
				Ocean Thermal Energy Conversion	202
				Inland Solar Ponds	203
				Hydrogen Fuel from Water	203
			10-G	Biomass	204
				Burning Biomass	204
				Biomass in the Waste We Produce	205
				New Gas Turbines	205
				Biofuels	206

African relief center. (Visuals Unlimited/R.F. Ashley)




10-H	Conclusions	207
Close-Up 10-1	<i>The Energy-Efficient House of the Future</i>	196
<b>CHAPTER 11 FRESH WATER 212</b>		
11-A	Properties of Water	213
11-B	Availability and Uses of Fresh Water	214
11-C	The Water Cycle	214
11-D	Ground Water	215
	Aquifers	215
	Wells and Springs	216
	Contamination of Ground Water	217
11-E	The Water Shortage	218
	Water Use in the United States	218
	Water Shortages in the United States	218
	World Picture	219
11-F	Solutions to Water Shortages	220
	Wasting Less Water	220
	Reducing Evaporation	220
	Legal and Economic Solutions	220
	Towing Icebergs	221
	Desalination	221
	Cloud seeding	222
11-G	Waterways	222
	Rivers	222
	Floods	222
	Deforestation	224
	Dams	224
	Channelization	225
	Urbanization	227
Close-Up 11-1	<i>Water That Kills</i>	223
<b>CHAPTER 12 THE OCEANS 230</b>		
12-A	Our Ocean Resources	231
12-B	The Open Ocean	232
12-C	Reefs	232
12-D	The Edges of the Ocean	234
	Coastal Wetlands	235
12-E	Depleted Fisheries	236
	Large-Scale versus Local Fisheries	238
	Managing our Fisheries	238
	Monitoring Ocean Productivity	239
12-F	Mineral and Energy Resources	239
12-G	Pollution	239
12-H	International Cooperation	241
	Cleaning up the Mediterranean	241
	The Law of the Seas	244
	Multispecies Management in the Southern Ocean	245
Close-Up 12-1	<i>The Arctic and Antarctic</i>	242
<b>CHAPTER 13 MINERAL RESOURCES 248</b>		
13-A	Processing Minerals	249
	Aluminum and Gallium	249

Strip mining can pollute soil and water with toxic materials. (Visuals Unlimited/R.F. Ashley)



13-B	The Minerals We Use	250
	Prehistoric Mineral Use	250
	Modern Mineral Use	251
13-C	Reserves and Resources	252
	Effect of Supply and Demand	252
	Increasing Reserves	253
13-D	Environmental Problems from Extracting Minerals	253
13-E	Energy and Mineral Shortages	255
13-F	Worldwide Use and Distribution of Minerals	257
	Stockpiles	258
13-G	Recycling	258
13-H	Conservation and Substitution	259
	Conservation	259
	Substitution	259
Close-Up 13-1	<i>Polymers and Materials Technology</i>	256
<b>CHAPTER 14 AGRICULTURAL LAND 262</b>		
14-A	Farmland and Soil	263
	Soil Structure	263
14-B	How Tilling and Fertilizing Affect Soil	265
14-C	Unsustainable Agriculture	265
14-D	Irrigation	265
	Salinization	265
14-E	Soil Destruction in Arid Regions	270
	Traditional Agriculture in the Sahel	270
	Desertification	271
	Drought and Famine	271
14-F	Preventing and Reversing Desertification	273
	Tree Planting	274
	Reclaiming Desert	274
14-G	Tropical Forest and Laterization	275
14-H	Soil Erosion in North America	275
14-I	Soil Conservation	277
14-J	Roads and Urbanization	278
14-K	Conclusion	279

CHAPTER 15 FOOD AND HUNGER	281	17-F Genetic Resources	330
15-A Nutrition	282	New Uses for Old Species	330
Macronutrients	282	Preserving Germ Plasm	332
Micronutrients	283	17-G Harvesting Wildlife	332
Minerals	284	17-H Zoos and Preservation	333
15-B Malnutrition and Diet	284	17-I The New Wildlife Preserves	334
15-C The Foods We Eat	284	Biosphere Reserves	335
15-D Cereals and Potatoes	285	Biocultural Restoration	337
Wheat	286	Close-Up 17-1 <i>The Politics of Conservation</i>	322
Rice	286	Close-Up 17-2 <i>Conservation in Panda- monium</i>	336
Maize (Indian Corn)	287	CHAPTER 18 URBAN LAND USE	340
Potatoes	288	18-A Urban Growth	341
15-E Livestock	288	Urbanization in Developing Countries	342
15-F Aquaculture	290	18-B The Urban Crisis	344
15-G Meat or Crops?	291	Urban Structure	345
Energy and Food Production	291	18-C Transportation	346
15-H The Green Revolution	293	Individual Transit	346
15-I Subsistence, Organic Farms, and the Future	294	Motor Vehicles	347
The Chinese Model	295	Mass Transit	347
15-J The Politics of Hunger	297	18-D Urban Planning	349
Close-Up 15-1 <i>Looking for New Food Plants</i>	292	Tokyo	350
CHAPTER 16 WILDERNESS AND FOREST	299	Suburban Sprawl in the United States	350
16-A Why Should We Care?	300	New Towns	351
16-B Disappearing Tropical Forest	301	18-E Urban Regeneration	352
Agriculture	302	18-F Urban Open Spaces	353
Logging	303	Green Belts	354
Fuelwood	303	Parks	354
Ranching	304	Odd Urban Spaces	355
16-C Forest Peoples	304		
16-D Temperate Forest	305		
16-E Managing Forest	306		
Forest Conservation in the United States	306		
Harvesting Methods	307		
16-F Reforestation	309		
Research	309		
Private Reforestation	310		
State Programs	311		
16-G Wilderness Preservation	312		
Forest Wilderness	312		
Prairie	313		
Desert	313		
Close-Up 16-1 <i>The Nature Conservancy</i>	314		
CHAPTER 17 SPECIES AND EXTINCTION	317		
17-A What is a Species and How Do Species Form?	319		
Sympatric Speciation	319		
How Quickly Do New Species Form?	320		
17-B Extinction	321		
17-C The Red Data Books	324		
17-D Why Are Some Species Endangered?	324		
17-E Legislation	327		
The 1988 Endangered Species Act	328		
		One of several endangered species of giant tortoise found on the Gal- apagos. (Carolina Biological Sup- ply Company)	
			
		<b>Part 5 Pollution</b>	<b>357</b>
		CHAPTER 19 POLLUTION AND WATER	358
		19-A Pollution	359
		Point and Nonpoint Sources	359
		Ground Water	360

Burning fossil fuels contributes to world pollution and the greenhouse effect. (Karen Roeder)



Surface Waters	360	Cancer from Environmental Pollution	385
Lake Ecosystems	360	Teratogenic Effects	388
19-B Types of Pollutants	362	20-D Effects of Pollution on Ecosystems	388
Pathogens and Nutrients	363	Lichens as Monitors of Pollution	388
Biochemical Oxygen Demand and Pathogens	364	Nutrient Enrichment	389
Coliform Bacteria	365	Planting Trees for Cleaner Air	390
Nutrient Pollution and Eutrophication	365	20-E Indoor Air Pollution	390
19-C Sewage Treatment	366	Air Conditioners	391
Primary Treatment	367	Formaldehyde	391
Secondary Treatment	368	Carbon Monoxide	391
Heavy Metals and Persistent Chemicals	368	Radon	391
Tertiary Treatments	368	Smoking	392
19-D Physical Pollutants	369	Asbestos	393
19-E Toxic Chemicals	369	20-H Noise	393
Mercury	370	Close-Up 20-1 <i>The Human Respiratory System</i>	386
Chlorine	370	Close-Up 20-2 <i>How We Hear</i>	394
Pesticides	371		
19-F Regulation and Cleanup Programs	371	CHAPTER 21 TOXIC AND SOLID WASTE	397
Lake Ontario	372	21-A Why Some Wastes Are Toxic or Hard To Get Rid Of	398
The Economics of Pollution Control	373	Toxic Chemicals and Regulation	399
19-G What Can Individuals Do?	373	Pesticides and Toxicity	399
Close-Up 19-1 <i>Resistance to Toxic Metals</i>	363	Plastics	400
CHAPTER 20 AIR POLLUTION AND NOISE	376	Heavy Metals	400
20-A Pollutants	377	Polychlorinated Biphenyls (PCBs)	401
Sources of Pollutants	377	21-B Solid Waste and Its Disposal	401
Industrial Emissions	378	Landfills	402
Motor Vehicle Emissions	379	Incineration	403
Wood Smoke Pollution	381	Ocean Dumping	404
20-B Pollution, Climate, and Topography	382	21-C How We Dispose of Toxic Waste	404
How Pollutants Travel Around the World	383	Love Canal	405
20-C Health Effects of Air Pollution	383	The Cost of Disposal	405
Chronic Health Effects	384	Producing Less Hazardous Waste	406
Epidemiology	384	Detoxification	406
		Incineration	406
		Land and Ocean Disposal	406
		European Integrated Management	407
		21-D Regulation of Hazardous Substances	408
		Pesticide Use	408
		Accountability	408
		Inadequate Regulation	409
		21-E Resource Recovery	409
		Bottle Bills	410
		Composting	410
		Municipal Composting Programs	410
		21-F Biotechnology and Solid Waste	411
		PCB Decomposers	411
		Fungi and Selenium	411
		Degradable Polymers	412
		21-G A Vision of the Future	413
		Producing Less Waste	413
		Sorting and Recycling	414
		Developing New Waste Treatment Plants	414
		Regulation and Enforcement	415

A toxic waste site. (John Cunningham/Visuals Unlimited)



**Part 6 Society and Environment 417**

CHAPTER 22 POLITICS, ECONOMICS AND ETHICS 418

22-A How Do Ethics Come into It? 419

    Western Philosophy 419

    Ethical Compromise 420

22-B Tolerating Poverty 421

22-C Military Expenditure 422

22-D Political Systems 423

    Voters Know More than Politicians Realize 424

    Political Reorganization Needed 424

22-E Economics 425

    Hidden Costs of Resources 426

22-F Politics and Economics 426

    Agriculture 427

    Pollution 427

    Bhopal 427

22-G International Institutions 430

22-H Conclusion 430

Close-Up 22-1 *The Alaska Oil Spill and the Choices We Make* 428

CHAPTER 23 TOWARD A SUSTAINABLE FUTURE 433

23-A Nuclear War 434

    Nuclear Proliferation 434

    Nuclear Winter 435

23-B If We Fail To Change 436

23-C Sustainable Development 437

    Planning and Priorities 437

    Imaginative Habitat Conservation 438

    Policy Changes: Costa Rica 438

    Swapping Foreign Debt for Conservation 439

    Slowing the Loss of Biological Diversity 439

    International Cooperation 440

    Education 441

    Private Actions 441

23-D A Vision of the World in 2040 442

23-E Conclusion 445

APPENDIX A MEASUREMENTS AND UNITS 447

APPENDIX B REFERENCES, FURTHER READING, AND SOURCES OF INFORMATION 450

GLOSSARY 461

INDEX 1.1

# PART 1

## Overview

Autumn colors in Acadia National Park,  
Maine. (John G. Widmaier, Jr.)



# C H A P T E R 1

## Science and Environment

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**KEY CONCEPTS** ■ The goal of environmental science is learning how to produce a sustainable world. ■ Our basic environmental problem is ever-increasing numbers of people living in a closed system. ■ The huge human population is depleting our resources and polluting the environment. ■ Solving our environmental problems requires research, education, international cooperation, and the spending of money in new ways.

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*"In the middle of the twentieth century, we saw our planet from space for the first time. Historians may record that this vision changed the way we think. From space, we see a small, fragile ball dominated not by human activity and edifice but by a pattern of clouds, greenery, and soils. Humanity's inability to control its numbers and to fit its activities into that pattern is changing our planet and the way we live. Human history has become a race between education and catastrophe."*

United Nations Report on Environment and Development





Our lives are affected by environmental science every day. We take it for granted. We assume that somebody ensures that our food and water are safe to consume, that the nearest nuclear power plant is not endangering our health, and that the local dump site is not poisoning the neighborhood. When we petition the county council to stop a factory from spewing foul-smelling clouds over the town, we assume that the technology to prevent the smell is available. We assume that a study will have been done to check that a new road will not destroy wildlife or harm the fishing and hunting. We vote for the tax increases necessary to upgrade our sewage treatment plant. In all these ways we show that we believe society has the knowledge and technology to protect our surroundings from damage that would lower our standard of living or endanger our health.

This knowledge and technology are the products of **environmental science**, the study of how humans interact with their environments and of what can be done to improve these interactions. **Environment** is a broad term. It encompasses all that surrounds us, both the natural world in which we live and all the things produced by people.

The goal of environmental science is a **sustainable world**, a world in which human populations can continue to exist indefinitely with a high standard of living and health. The “pure” side of environmental science is research—discovering the threats to a sustainable world and what can be done about these threats. The problems studied may be scientific (“how can we increase the local water supply while ensuring enough water will be

available in the next century?”) or social and economic (“what factors determine how much water people use?”). The “applied” side of environmental science develops technical solutions to the problems that have been identified.

Environmental science cannot produce a sustainable world. It can only tell us what we must do to reach that goal. The rest of the solution requires political, social, and economic action. It is up to us to tell our governments how much money to spend on missiles and foreign aid and whether to enact recycling legislation or enforce laws on how to dispose of toxic waste. We shall see that enormous amounts of research are needed. Although the solutions to many of our environmental problems are known, they are not being acted on because people and politicians do not understand them or have other priorities. By learning something of environmental problems, we can contribute to creating a sustainable world instead of being part of the problem.

### 1-A A SUSTAINABLE WORLD

A sustainable world is one that can go on indefinitely. This does not mean an unchanging world; it means a world containing enough of the things that people need to support human life forever (Figure 1-1). In practice, in a sustainable world, we would produce enough food each year to feed the human population, while keeping the soil fertile so that agriculture could produce just as much food in every future year. We would supply clean



**Figure 1-1** Some of the resources that sustain life. People need clean air, trees, and fresh water. These are among the resources we must ensure remain available to us if we are to build a sustainable world.