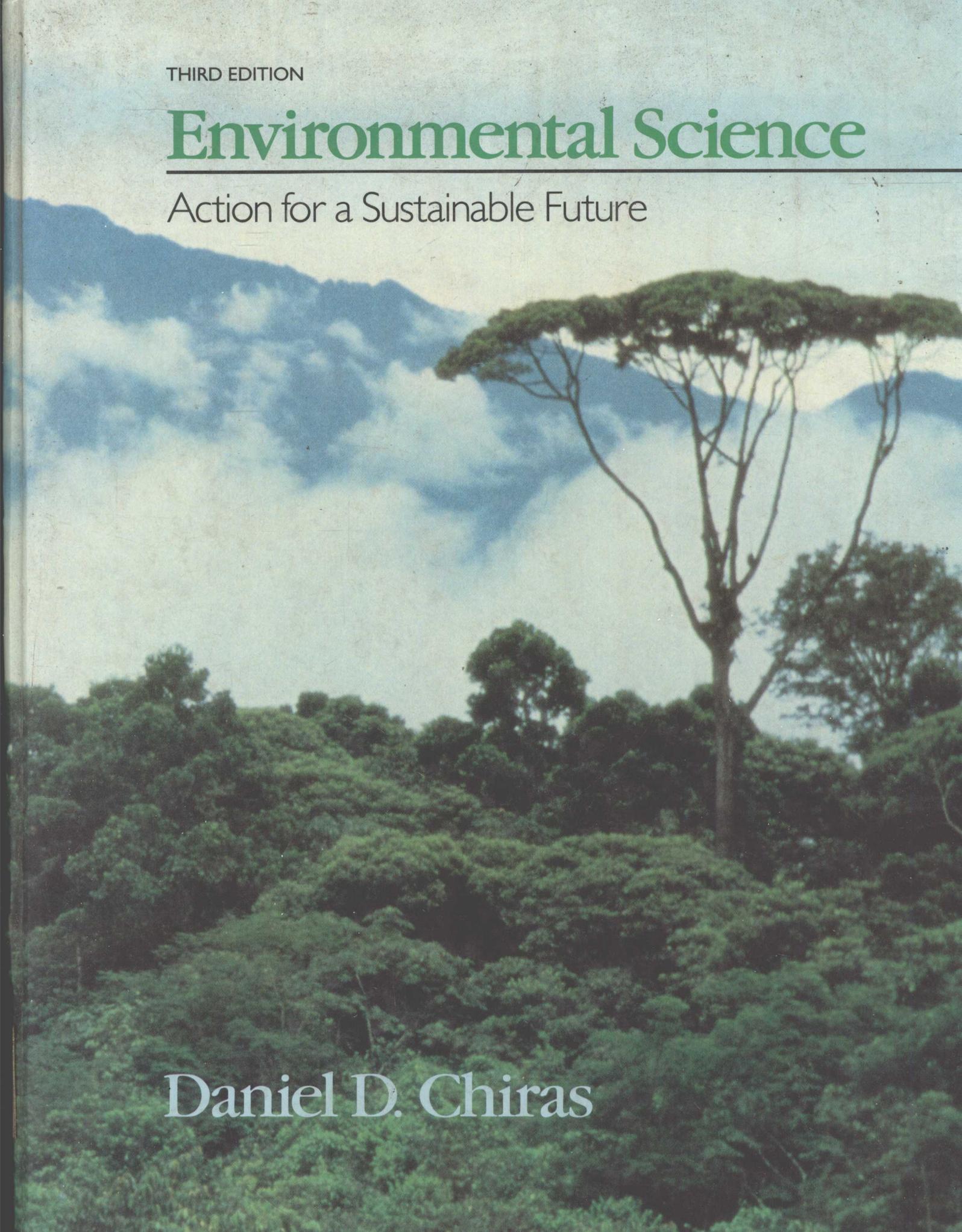


THIRD EDITION

Environmental Science

Action for a Sustainable Future

Daniel D. Chiras

The cover features a photograph of a lush tropical forest. In the foreground, there is a dense canopy of green trees. A single, tall tree with a wide, flat, umbrella-shaped canopy stands prominently in the middle ground. The background shows rolling hills or mountains under a sky with soft, white clouds. The overall color palette is dominated by various shades of green and blue.



ENVIRONMENTAL SCIENCE

Action for a Sustainable Future

THIRD EDITION

DANIEL D. CHIRAS



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Preface

The first and second editions of *Environmental Science: A Framework for Decision Making* reached a large audience. Feedback from users and reviewers helped me prepare this third edition. My goal for the new edition was to add new material, update statistics, and polish the writing—in short, to make this the most interesting and readable book on the market.

As in the first two editions, I wanted the book to be user friendly, not laden with irrelevant statistics. I wanted to continue to present important facts and concepts in a clear and exciting way and to minimize bias by presenting both sides of issues and by including Point/Counterpoints on important, controversial issues. My objective was to write a book that helps students learn the facts behind environmental issues and solutions so that they can make up their own minds about what should be done.

This book provides a broad overview of the many environmental problems facing humanity and describes a wide range of solutions. The chapters contain important information on ecology, anthropology, evolution, earth science, biology, ethics, economics, and other areas to enable students to understand more fully the sometimes overwhelming assortment of environmental problems facing the world. The melding of these disciplines results in new ways of looking at our environmental problems and opens up many avenues for solving them.

Themes

The central theme of this book is that time for action is running short; overpopulation, resource depletion, pollution, and indifference are rapidly catching up with us.

The second major theme is that the long-term well being of this planet and its inhabitants requires the devel-

opment of a sustainable society—one that conserves natural resources, recycles, relies on renewable resources whenever possible, reduces pollution, and controls population growth. Such a society, based on the lessons from ecology, may seem foreign or even unattainable, but it remains our only realistic hope for prosperity in the long term. Careful planning and implementation will usher in a sustainable future.

Finally, this book stresses that we are all part of the problem and must therefore be part of the solution. Air pollution is not just a problem of inadequate laws or corporate neglect, but also the result of our own wasteful practices. Individual action is essential. Solving these problems need not mean reverting to old-fashioned ways or even making tremendous sacrifices. It does mean using energy and other resources much more wisely, conserving all resources, recycling all that we can, using renewable resources, and limiting our family size. Numerous suggestions are given in each chapter and in the Environmental Action Guide that accompanies this text for such personal solutions.

Organization

This book is divided into five parts and organized around three central issues—population, resources, and pollution. Part 1 provides a base of knowledge in ecology, earth science, chemistry, biology, evolution, and human social development. Part 2 covers population growth, the impact of population, and population control. Part 3 deals with a variety of resource issues and outlines a plan for developing a sustainable society. Part 4 discusses pollution and the legal, technical, and personal solutions for it. Part 5, the capstone of the book, places the population, resource,

and pollution crisis against a social backdrop by looking at ethics, economics, and politics. It suggests ways to make the transition to a sustainable society.

Special Features

The following special features from the first and second editions have been retained to keep this text informative and useful and to increase student interest and involvement:

Models

One of the key features of this book is the use of conceptual models, which in this edition have been integrated in appropriate chapters. These models are easy to understand and are designed to encourage holistic thinking, emphasizing the systems approach to environmental problems. Below is a brief description of each model:

- *Population, Resource, and Pollution Model*: presents a fuller view of the human niche, and helps students see the way we affect our environment and vice versa.
- *Multiple Cause and Effect Model*: helps students analyze the causes of many of our current environmental dilemmas by exhibiting the web of cause and effect.
- *Impact Analysis Model*: shows the various impacts that we have on the environment and the ways in which we are affected by our own actions.
- *Risk Analysis Model*: examines the risks and benefits associated with today's new and existing hazards.

Chapter Supplements

Chapter supplements, found at the end of some chapters, provide more detailed coverage of important topics and provide an added degree of flexibility. Such topics of current interest include acid rain, indoor air pollution, stratospheric ozone depletion, radiation pollution, nuclear war, and environmental law.

Point/Counterpoints and Viewpoints

As might be expected, complex environmental issues often result in hotly contested debates:

- Is outer space the answer to our population and resource problems?
- Are we responsible to future generations?
- Is population growth good or bad for us?
- Does environmental protection cost us jobs?
- Are we losing the war against cancer?
- Are we playing God with nature?

These and many other important and timely issues are debated in Point/Counterpoint or discussed in Viewpoint by such luminaries as Norman Myers, Ben Bova, Garrett Hardin, Julian Simon, Amory and Hunter Lovins, Frederic Krupp, and others. These editorials can stimulate individual thinking as well as classroom discussion on many complex problems.

Color Galleries

Four color galleries are included in this book to emphasize some of the key concepts and issues. They are: the earth, the biomes, endangered species, and resource misuse.

Case Studies

To give students insight to the timely issues of our day, this third edition includes new case studies written by leaders in Environmental Science. Examples of topics discussed include tropical deforestation, genetic engineering, Yellowstone's controversy over fire control, the protection of Antarctica, and solid waste control.

Chapter Summaries

Each chapter is followed by a succinct summary of the important concepts and terms, designed to reinforce the key points. These summaries may also be valuable study tools.

Coverage of the Basic Sciences

I've added more information from the basic sciences to help students better understand environmental issues. The formation of the earth, the evolution of life, geological processes, chemistry, and other fundamental topics are covered in Chapter 2 and integrated in other chapters.

New in the Third Edition

Updated Coverage

The third edition has been thoroughly updated with new discoveries, new concepts, new environmental laws, the most recent statistics on resources, population, and pollution, and new suggested readings. New essays, viewpoints, photographs, tables, and line drawings have been added as well.

Global Orientation

To help make the book even more global, numerous examples have been added from both third world and

developed countries. Examples include preservation of the rainforests in Belize and Brazil, depletion of the ozone layer in the Arctic, sustainable agricultural practices in third world countries, family planning efforts in India and the impact of whale hunting in Japan. In addition, I have incorporated more examples of Canadian environmental issues. These include government support for logging, acidification of lakes and rivers, and preservation of Canada's fishing industry, forests and fuel reserves.

Critical Thinking

New to this edition is a section on Critical Thinking skills. Critical Thinking enables students to discern fact from conjecture and will help them analyze complex issues and make decisions. Beginning with an introductory exercise on the scientific method, this feature is carried throughout many chapters. Students will be asked to exercise critical thinking skills after reading case studies, viewpoints, and point/counterpoints.

Supplements

Environmental Action Guide

A concern of environmental science instructors is that their students leave this course with a sense of what the individual can do to effect change. To address this need, this edition is published with a new and unique manual, *The Environmental Action Guide*. Written by Ann S. Causey of Auburn University, this resource provides information on environmentally sound products, investments, careers, community action groups, letter writing campaigns, and an overall low-impact lifestyle.

Instructor's Guide

Ann S. Causey and I have completely updated and revised the instructor's guide. It includes chapter outlines and test questions. (Black-line transparency masters will be packaged separately.) In addition, we include more case studies and critical thinking problems for further class discussion.

Laboratory Manual

The third edition laboratory manual is by Dr. Merle Alexander, Director of Environmental Studies, Baylor University. This manual includes 14 lab exercises, each designed to be conducted in a single class section. Students learn to apply textbook theory to practical application in the areas of community composition and species, population, resources and pollution, among others.

Acknowledgments

This book is the offspring of a great many people, for whom a mere thanks seems terribly inadequate. First and foremost are the thousands of scholars in anthropology, biology, chemistry, demography, natural resources, political science, economics, ecology, and dozens of other disciplines. Their ideas, their research, indeed their lives, form the foundation on which this book rests. To them a world of thanks and an enormous debt of gratitude.

A warm and very special thanks to my friend and colleague, Teresa Audesirk, who reviewed the second edition and helped make it more accurate and more readable and who helped supply me with mounds of reference material needed in the update.

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Evergreen, Colorado

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Prologue

In an outlying village in Ethiopia, two children are lowered into a communal grave that houses the bodies of others who have died in recent days. Villagers stare vacantly at the men who cover the bodies with dirt; to the friends and relatives of these children who watch, death has lost much of its significance. Against the constant hunger and death, few mourn another child's passing.

Worldwide, 700 people will die from starvation, extreme malnutrition, or infectious disease stemming from food shortages in the half hour it takes you to watch the evening news. This year alone, the death toll from hunger and associated diseases is estimated to be 40 million people. This is the equivalent of 300 jumbojets, each carrying 400 passengers, crashing with no survivors every day of the year. Almost half of the victims are children. Despite an outpouring of aid from the rich nations, hundreds of millions more will die in years to come.

A False Sense of Security?

For Africans of the southern Sahara, the future looks bleak. Long-term drought, overpopulation, continued misuse of the land, and political struggles all create spreading deserts that swallow farmland at an alarming rate. In this dilemma, nature dictates an extreme solution: people must die to reestablish the balance.

But what about those of us in the wealthy nations of the world? Need we worry? To many people, the answer is no. Resource shortages are a thing of the past. Newspaper headlines assure us of an "oil glut" that has forced the oil-producing countries to slash prices, a move that has helped ensure economic stability in many countries. Some critics believe that our sense of security is illusory. But why not feel secure; with an ally as powerful as technology, how could we not prosper?

Part of the answer may lie in the way we mistreat our soil, perhaps our greatest resource of all. In the United

States, for example, farmers currently cultivate 170 million hectares (421 million acres) of land. According to estimates by the Department of Agriculture, nearly one half of the United States' farmland is eroding faster than it can be replaced by natural processes. Making matters worse, there is very little land in reserve to replace the prime land now eroding away. Some experts believe that crop production could fall by 10% to 30% in the United States in the next 50 years if soil erosion continues unchecked. Costs of food will rise as good farmland is destroyed. The United States may lose its position as a leading food exporter. Grain shipments to hungry nations may be reduced as well, unless something is done . . . quickly.

Consider also one of our most valuable resources, oil, thought by many to be the lifeblood of industrial societies. Oil's economic importance to developed nations became clear in the 1970s when per-barrel prices jumped from \$3.00 to over \$35. A whirlwind of inflation began, perilously gripping the industrial world, nearly halting industrial production. The American economy was driven to its knees. Millions of workers were laid off as inflation brought industrial production to a near standstill.

Despite current, short-term gluts and falling prices, the long-range future of oil is dim. Estimated worldwide oil supplies will last only 65 more years at current consumption. Should consumption rise, as expected, even fewer oil years await us. Clearly, time is running out for oil.

Long before our wells run dry, however, the rich, oil-dependent nations could begin to flounder. By some estimates, somewhere around 2000 or 2010 global oil production will fall short of demand, sending prices sharply upward. The inflation of the 1970s will seem like warm spring breezes compared to the hurricane winds of global inflation.

You and I, and millions of people like us, will very likely see the end of oil within our lifetimes. The time is ripe for charting new paths, but this nation and others

are sitting back, doing very little to develop alternative fuels and cut existing waste.

Declining resources are only part of the threat to modern society. Pollution and development also threaten to destroy the delicate web of life. Foremost on the list of pollutants is acid rain and snow.

Today, over 245 ponds and lakes in the Adirondacks have lost their aquatic life because of acids from industry and transportation. Deposited by rain and snow, these acids kill fish, algae, and aquatic plants. In southern Sweden 20,000 lakes are without or soon to be without fish because of widespread acid deposition. In Canada, 100 lakes have met a similar fate. But the effect of acid rain is felt much wider. For instance, much of the once-rich Black Forest in Germany has been poisoned by this toxic rain.

As these examples suggest, the environment is in trouble—and so are we. Despite more than 20 years of effort and significant gains in environmental legislation, most of our environmental problems are growing worse. Consider some examples:

- Since 1970, world population has increased by 1.6 billion people, climbing from 3.7 billion to 5.3 billion. Today, we're adding nearly 90 million people to the world population each year.
- Since 1970, the number of species on the official list of endangered and threatened species has increased from 92 to 539 (in 1989).
- Since 1970, annual global carbon dioxide emissions have increased from 3.9 billion metric tons to over 5.2 billion tons.
- Since 1970, the number of African elephants has declined from 4.5 million to only about 500,000.

The past 20 years has seen America grow to be a world leader in waste production. Today, Americans throw away 160 million tons of municipal garbage each year. That's enough to fill the superdome two times a day, 365 days a year—the equivalent of about 1300 pounds of trash for every man, woman and child each year.

Each year, American industries produce an estimated 250–280 million tons of hazardous wastes (over 2000 pounds of hazardous waste for every man, woman, and child in this country).

Pollution is choking our cities. According to the Environmental Protection Agency, 110 million Americans live in air considered hazardous to their health. An estimated 50,000 Americans die prematurely each year as a result of air pollution.

The long-term future of the world is in jeopardy. It is not just the poor of Ethiopia or Chad or Sudan who stand to lose, but also the wealthy residents who make up one-fourth of the world's population but consume 80% of its resources. The rich and the poor are locked in a crisis

created by overpopulation, vanishing resources, and excessive pollution.

Tragedy of Our Times

Paul Valery once noted that the tragedy of our times is that the future is not what it used to be. In reality, though, the future is rarely what we think it will be. The tragedy of our times is that few people realize that the future has changed. We are, as a whole, going about our daily lives as if nothing has happened, lulled into complacency by old and fairly unrealistic dreams. Oil gluts, falling gasoline prices, and economic stability have given us a false sense of security at a time when we need, more than anything, three key ingredients: foresight, planning, and action—both individually and collectively.

This book examines the crisis of population, resources, and pollution that engulfs humankind. You will find it a hopeful book, filled with solutions. It views our dilemma in much the same way that the Chinese view crises. Their word for crisis is *wei-chi*. The first part means “beware of danger.” The second part means “opportunity for change.”

In this spirit, I invite you to look at the critical paths we are now on. You will see that the human race can survive the human race and prosper. But changes must be made—big changes in the way we think and the ways we act.

The Secrets of Nature

What alterations in our course are necessary? Experts disagree, but many believe that the key to our long-term survival lies in the widely ignored lessons of nature. Consider these facts: undisturbed ecosystems persist for decades, centuries, even millions of years. The rate of extinction in such ecosystems is low. Human society, on the other hand, now wipes out a vertebrate (backboned) species every nine months and itself faces global extinction after only a relatively short stay on earth. Why is it that nature persists while we deplete and destroy? The secret of nature is that survival hinges on a sustainable system—a system that perpetuates itself without destroying the very things that permit life to continue.

Nature capitalizes on four major strategies to meet this end. The first is recycling. The global ecosystem is a consummate recycler. Water, carbon, oxygen, nitrogen, and all other substances are used over and over. As a result, new generations are built from the old. The long-term future of humankind depends on following a similar direction.

Nature's second secret is the use of renewable resources—resources that renew themselves through natural biological or physical and chemical processes.