

LEARNING MADE EASY



2nd Edition

Environmental Science

for
dummies[®]
A Wiley Brand



Learn how Earth's complex
climate system functions

Identify where environmental
science and social justice intersect

Explore your personal impact
on the environment

Alecia M. Spooner

Author of *Geology For Dummies*

Environmental Science

for
dummies[®]
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2nd Edition

by Alecia M. Spooner

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Environmental Science For Dummies®, 2nd Edition

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Introduction

Environmental science is the study of Earth's environment. To study the environment, scientists draw from many other disciplines, including chemistry, geography, economics, and everything in between. No wonder students new to environmental science often find themselves dizzy at the breadth of information needed to study and solve environmental problems.

Fortunately, you've found *Environmental Science For Dummies*! Regardless of whether you picked up this book to help you through a science class or to begin an independent exploration of environmental science, I hope it's a useful reference for you, providing an introduction to the most important concepts and issues in modern environmental science.

I've written this book to cover as many environmental science concepts as possible, while at the same time helping you understand how these concepts apply to your life. If you're already familiar with some of the topics explained in the book, perhaps this book will help renew your interest in environmental studies and sustainable living. If these topics are completely new to you, I hope it helps you realize that you can take action daily and make choices that affect your environment in a positive way.

About This Book

Environmental Science For Dummies presents an introduction to the core concepts in environmental science and the most important issues studied by environmental scientists today.

The topics in environmental science are so intricately linked that there's simply no way to explain one without explaining a little bit of another as well. In each chapter, I use cross-references to other chapters to help you link together the related concepts and to provide a more complete understanding of the complex topics in environmental science.

Throughout the book, you also find multiple illustrations. These drawings expand on what I've written in places where a visual representation may be helpful. But don't forget to look up from reading once in a while! You have plenty of first-hand experience with the environment. As you read about certain topics or issues, you may find it useful to look at them in the context of your own life.

What You're Not to Read

Throughout this book, you find sidebars highlighted in gray. The sidebars include extra information or particularly interesting tidbits that I thought you might enjoy. I find them interesting — and I hope you do, too — but they aren't required reading to understand the concepts in the book. Feel free to skip these sidebars, as they're not integral to the information presented in each chapter.

Similarly, any portion of text with the Technical Stuff icon beside it indicates that it explains or describes a concept in extra detail, beyond what you need to have a basic grasp of the idea. Feel free to skip these portions or to breeze through them.

Foolish Assumptions

As the author of this book, I've made some assumptions about you, my reader. For instance, I assume that you live on Earth, drink water, breathe air, and use energy for various things such as heating and transportation. I assume that you're familiar with basic geography, such as the location of continents and some countries around the world.

However, I don't assume that you have any background in chemistry, biology, geology, ecology, economics, or any of the other disciplines that are part of environmental science. And you don't need a background in any of these to benefit from the explanations in this book. Wherever the details of another science are important, I provide those details in my explanations.

Each topic in environmental science could fill an entire book of its own, so if you find that something in particular catches your interest, I encourage you to look for books that offer more detail into that topic specifically.

Icons Used in This Book

Throughout this book I use icons to catch your eye and highlight certain kinds of information. Here's what these little pictures mean:



REMEMBER

Anytime you see the Remember icon take notice! I use this icon to highlight important information, often fundamental to the concepts being explained around it or in the same chapter. Other times I use it to highlight a statement meant to help you pull multiple concepts together.



TIP

The Tip icon marks information that may be particularly useful to help you study or prepare for an exam. It often marks a helpful way to remember a certain concept.



CASE STUDY

The Case Study icon brings your attention to real-world examples of particular environmental issues. Case studies are a great way to provide context for the concepts I present in the book.



SOLUTION

Anywhere I describe a potential solution for an environmental problem I mark it with a Solution icon.



TECHNICAL
STUFF

A few places in this book I offer a little extra detail about a particular topic or concept and mark it with the Technical Stuff icon.



CLIMATE
CHANGE

There are places in each chapter where you will see this icon indicating that the topic is closely tied to climate change. As you will see, changes in the climate will affect all of Earth's resources and humanity's ability to survive.

Beyond the Book

In addition to the book you're reading right now, be sure to check out the free Cheat Sheet online. It offers explanations of how to define an ecosystem and how to characterize populations of living things, among other things. To get this Cheat Sheet, simply go to www.dummies.com and enter "Environmental Science For Dummies" in the Search box.

Where to Go from Here

I've written this book to function as a reference that you can open to any page and dive into. If you choose to start from the beginning, you'll find the information organized in what I hope is a logical way that answers your questions as soon as you think to ask them! But you can also browse the table of contents to find topics you're interested in knowing more about and then turn to the chapters on those topics.

If you've never thought much about how you're connected to everything around you, you may want to start with Chapter 6, which explains what an ecosystem is and does. This chapter may dramatically change your perspective!

If you're intrigued by the idea of alternative energy sources, flip to Chapter 15, where I cover many different ways to fuel daily living without using fossil fuels (coal, gas, and oil) or nuclear power. Environmental scientists have found ways to capture or produce energy in cleaner, more efficient ways than have ever been possible before.

For a real wake-up call, turn to Chapter 19 to see how the packaging and convenience of modern life (think bottles of water, to-go containers, and plastic utensils) have resulted in oceans full of trash. In particular, plastic bits that don't decompose are interfering with ocean ecosystems, which is just one of the consequences of waste I describe in that chapter.

And don't skip Chapter 21, in which I describe how Indigenous scientists are working on the frontlines of climate change and environmental destruction to maintain their relationship with the Earth and to teach others what they have known for generations about how to care for the Earth so that the Earth can care for us.

1 Demystifying Science and the Environment

IN THIS PART . . .

Learn how the scientific method shapes the process of learning about the environment.

Explore scientific ideas about what makes up everything around you (atoms, molecules, and compounds).

Track how energy moves through the environment.

Find out how green plants capture energy from the sun and transform it into sugar through the process of photosynthesis.

IN THIS CHAPTER

- » Applying a scientific approach
- » Studying environmental systems
- » Protecting natural resources
- » Reducing pollutants in the air and water
- » Looking forward to a sustainable future

Chapter **1**

Investigating the Environment

In its simplest terms, *environmental science* is the study of the air you breathe, the water you drink, and the food you eat. But environmental scientists study so much of the natural world and the way humans interact with it that their studies spill over into many other fields. Whether you're a student in a college course or someone who picked up this book to find out what environmental science is all about, you'll find that the ideas in this book apply to your life.

Like any living creature, you depend on environmental resources. More importantly perhaps is the fact that humans, unlike other living creatures, have the ability to damage these resources with pollution and overuse. This chapter provides a quick overview of the environment, its systems, and its many resources. It also talks about what humans can do to reduce their impact on the environment today and into the future. After all, maintaining the health of the Earth and its resources at both the local and global level is something everyone has a stake in.

Putting the “Science” in Environmental Science

Environmental science draws on knowledge from many different fields of study, including the so-called hard sciences like chemistry, biology, and geology and the social sciences like economics, geography, and political science. This section offers a quick overview of some of the scientific concepts, such as how to apply the scientific method to answer questions, that you need to be familiar with as you start your exploration of environmental science. I explain these foundational scientific concepts in more detail throughout the rest of Part 1.

Using the scientific method

The *scientific method* is simply a methodical approach to asking questions and collecting information to answer those questions. Although many classes teach it as something that only scientists use, you use it just about every day, too.

You may not write down each step of the scientific method when you use it, but anytime you ask a question and use your senses to answer it, you’re using the scientific method. For example, when standing at a crosswalk, you look both ways to determine whether a car is coming and whether an approaching car is going slow enough for you to safely cross the street before it arrives. In this example, you have made an observation, collected information, and based a decision on that information — just like a scientist!



REMEMBER

The scientific method is a way of learning about the world by asking questions and collecting answers. It helps scientists keep track of what’s known and what’s unknown as they gather more knowledge. This organization becomes particularly important when they study large, complex systems like those found in the natural world. Scientists always have more to learn about the natural world, and using the scientific method is one way that they can follow the path of scientific investigation from one truth to another. Turn to Chapter 2 for more on the scientific method.

Understanding the connection between atoms, energy, and life

Studying the environment includes studying how matter, energy, and living things interact. This is where other fields of study, such as chemistry, physics,

and biology, come into play. Here are just a few of the core ideas from these sciences that you need to understand as you study environmental science:

- » All matter is made of atoms.
- » Matter and energy are never created or destroyed, but they do change form.
- » Living matter, or life, is made up of complex combinations of carbon, hydrogen, and oxygen atoms.
- » Most of the energy at Earth's surface comes from the sun.
- » Energy transfers from one form to another.
- » Living things, or organisms, either capture the sun's energy (through *photosynthesis*) or get their energy by consuming other living things.

Analyzing the Earth's Systems and Ecosystems

Life at the surface of the Earth consists of many different systems that interact with one another on various levels. Some systems are physical, such as the *hydrologic system* that transfers water between the atmosphere and the Earth's surface. Other systems are built on interactions between living things, such as predator-prey relationships.

Scientists recognize that systems can be either open or closed. An *open system* allows matter and energy to enter and exit. A *closed system* keeps matter and energy inside of it. Figure 1-1 illustrates both types of systems.

Very few systems in the natural world are truly closed systems. Scientists view the planet as a closed system in terms of matter (no matter enters or leaves the Earth), but they consider it an open system in terms of energy (energy enters the Earth from the sun). The following sections introduce you to a few of the Earth's other systems that you need to be familiar with. (Part 2 goes into a lot more detail on the different systems on Earth.)

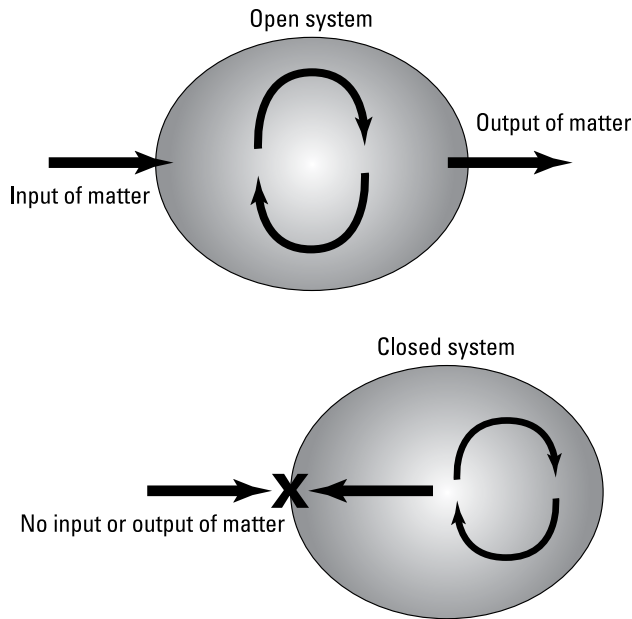


FIGURE 1-1:
Open and closed
systems.

Dividing the Earth into ecosystems

Across the surface of the Earth scientists recognize various ecosystems, or communities of living organisms and the nonliving environment they inhabit. Studying how matter and energy move around ecosystems is at the core of environmental science. Specifically, scientists recognize that

- » Matter is recycled within the ecosystem.
- » Energy flows through an ecosystem.

Whether they're small or large, discrete or overlapping, ecosystems provide a handy unit of study for environmental scientists. Because plants are the energy base of most ecosystems (capturing energy from the sun), the type and number of plant species in an ecosystem determine the type and number of animals that the ecosystem can support. See Chapter 6 for details on ecosystems.

Observing the interactions between organisms within an ecosystem

Scientists called *ecologists* are particularly interested in how living things interact within an ecosystem. Plants and animals compete with one another for access to water, nutrients, and space to live. Evolution by natural selection has resulted in

a wide array of survival strategies. Here are some examples (see Chapter 8 for more details):

- » **Resource partitioning:** When two species, or types of animals, depend on the same resource, they may evolve behaviors that help them share the resource. This is called *resource partitioning*. An example is when one species hunts at night, while another hunts the same prey during the day.
- » **Coevolution:** *Coevolution* occurs when a species evolves in response to its interaction with other species. Scientists have documented multiple cases of insects and the plants they feed on (and help pollinate) evolving to become more and more suited to one another over time.
- » **Symbiosis:** Organisms that benefit from an interaction with another species live in what scientists call *symbiosis*. Symbiotic relationships between organisms may benefit both individuals, benefit only one while harming the other (such as with a parasite), or benefit one without harming the other.

Sorting the world into climate categories

One of the most important and complex systems that scientists study is the climate. The climate system includes local weather systems, but it is actually much larger than that. Climate scientists observe how different parts of the Earth are warmed by the sun to greater or lesser degrees, and they track how heat from the sun moves around the globe in atmospheric and ocean currents.

The movement of heat and water around the Earth sets the scene for living things. Every living plant and animal has a preferred range of temperature and moisture conditions. The patterns of living communities on Earth are called *biomes*. Scientists define each biome according to its temperature and moisture levels and the types of plants and animals that have adapted to live within those limits. Understanding the complex link between climate factors and the distribution of life on Earth has become even more important as scientists document changes in the global climate and predict more dramatic changes to come. Turn to Chapter 7 for details on global climate patterns and biomes.

Influencing climate

These days, biomes are shifting as a result of modern climate change, or global warming. In Chapter 9, I explain how the greenhouse effect on Earth is beneficial and how greenhouse gases, both natural and man-made, change the composition of the atmosphere and affect climate patterns around the globe.

Climate warming due to increased carbon dioxide in the atmosphere is having dramatic effects on global ecosystems and human communities. Regions already water-stressed are now experiencing droughts, sea levels are rising, and marine ecosystems are being disrupted. I describe ways that humans can mitigate, or repair, the damage already done and adapt to a future climate that's very different from anything modern human civilization has experienced before. And I look into Earth's history for examples of what happens to life on Earth when the complex climate system shifts so dramatically.

Supplies Limited! Natural Resources and Resource Management

Environmental scientists do a lot of research to find ways to meet the needs of human beings for food, water, and energy. The environment provides these natural resources, but if their users (namely humans) don't care for them properly, they can be reduced, damaged, or destroyed. Managing natural resources for the use of human beings now while ensuring that the same resources will be available for humans in the future is called *conservation*.

Factoring in food, shelter, and more

People need food, water, air, and shelter to survive. But as human populations have grown into the billions, they've tested the ability of the environment to provide enough food, fresh water, and shelter. In Part 3, I describe methods of sustainable agriculture and water conservation that can help meet the needs of so many people. (So far, there's still plenty of air to go around.)

Other resources that people depend on are less obvious, such as the biological diversity, or *biodiversity*, found in certain regions. Human actions have reduced biodiversity around the world, particularly in *biodiversity hotspots*, or regions with a combination of high levels of diversity and increasing human impacts. In Chapter 12, I explain what biodiversity is and why it's so important.

Thinking about energy alternatives

One of the most critical natural resources that modern living depends on is energy. Energy in most ecosystems streams from the sun every day, but to fuel modern life, humans have tapped into the stored energy of fossil fuels hidden deep in the