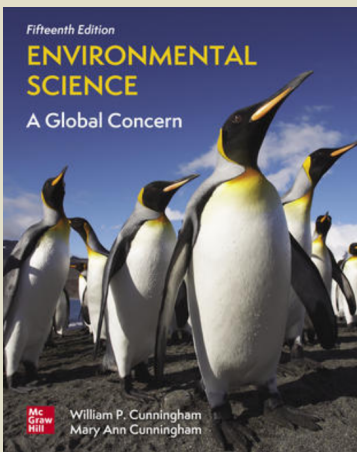


List of Changes



Environmental Science: A Global Concern 15th Edition

Cunningham

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This edition has thoroughly updated data, figures, and tables, as well as 16 new opening case studies that reflect new developments in the field, and over a dozen new "Exploring Science" or "What Do You Think?" boxed readings. We have enhanced our focus on climate action and environmental action, something students in our classes find especially valuable. Brief "benchmark data" tables provide reference values or comparisons that reflect key ideas in the chapter. Systematic discussions review topics such as uncertainty, graphing, statistics, experimental design models, and systems. At the end of each chapter, we conclude with a new section, "Connecting the Dots," that draws together major themes of the chapter.

SEE LIST OF CHANGES ATTACHED.

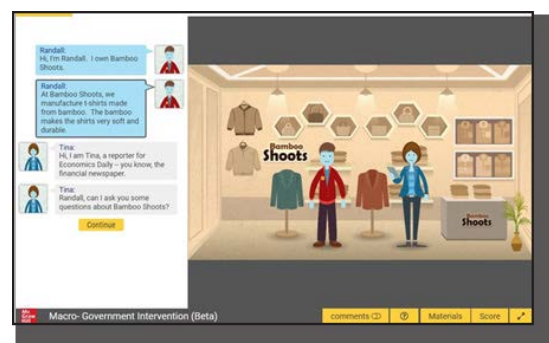
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The Introduction (Learning to learn) explains how each of us can engage with this field. Knowing what you care about is a good way to start connecting your interests to the study of our environment and how it works. We examine the nature of critical thinking, and we emphasize that learning to learn helps students not only in studying but in everyday life.

Chapter 1 presents climate change as an overarching concern. We introduce sustainable development as a topic that runs throughout the book as both a goal and a measure of progress. We discuss new environmental leaders, as well as the idea of planetary boundaries, which define limits of environmental services from major sectors of our environment.

Chapter 2 introduces a new case study on camera traps and citizen science to monitor migratory wildlife in Tanzania's Serengeti National Park. This example illustrates study design as well as ways each of us can contribute to original research. Continuing our discussion of the principles and applications of science, we discuss significance and confidence in data.

Chapter 3 opens with a new case study on the growing hypoxic "dead zone" in the Gulf of Mexico. This case illustrates interconnections in a vast ecological system and shows how chemical elements and energy transfers underlie pollution, wastewater treatment, eutrophication, and other processes. An "Exploring Science" reading reviews the CRISPR gene editing system, including ethics of human embryo editing, in this fast-moving field.

Chapter 4 introduces a new contributor to this book. Dr. Kimberly Byrd, a conservation biologist who has revised this crucial chapter. She has written a new case study on the ecological importance of seagrass meadows, including ideas of ecosystem complexity and "blue carbon." She has added a discussion of complex adaptive systems and system resilience. We hope readers will find her voice refreshing, interesting, and informative.

Chapter 5 has a new case study on climate-driven shifts in species ranges and biomes. These ecosystem changes directly affect lives and livelihoods. Recognizing the adaptations that allow species to adapt helps us understand survival factors for both humans and other species. A new section on human disturbance to biomes and ecosystems addresses the ways we are transforming the world.

Chapter 6 opens with a new case study on invasive Asian carp in the Mississippi watershed. Millions of dollars in sport fishing, recreation, and ecosystem services are at risk, as well as native species. We discuss growth patterns, life history strategies, and intrinsic and extrinsic factors that regulate growth. A new "Exploring Science" box describes methods for estimating population sizes for species, such as carp, that are difficult to count.

Chapter 7 uses a new case study on the rapid aging of China's population to discuss population momentum and factors that influence birth rates. China now has the largest number of senior citizens in the world, and has one of the largest percentages of old people of any country. This phenomenon is becoming global, as world population growth has fallen from about 2.1 percent in 1960 to 0.1 percent today. Half us now live in countries where the birth rate just replaces the death rate. We have long called for this shift, but its implications for societies are not entirely clear.

Chapter 8 has an updated case study on perfluorocarbons, including an \$850 million settlement in 2018 between the state of Minnesota and the 3M corporation for uncontrolled dumping of these persistent chemicals. Developments in contagious diseases among humans and wildlife have necessitated major chapter updates. A new section reviews growing transfer of antibiotic resistance from livestock that threaten human health. Building on the opening case study, we highlight four widely distributed persistent organic pollutants that threaten the health of millions of people. The "What Do You Think?" box on acceptable risk has also been revised. Chapter 9 opens with a new case study on low-cost food security initiatives in Burkina Faso, one of the world's poorest countries. Farmers there are fighting land degradation and hunger using simple, traditional water conservation and farming techniques to improve food production. We also consider dietary diversity. We have new discussions of climate impacts on food production and on Diet for a Small Planet, and eating low on the food chain.

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Chapter 10 has an updated opening case study on farming in Brazil's Cerrado. This case became even more urgent with the 2019 election of Jair Bolsonaro, who aims to expand soy production and reduce protections for Amazonian rainforest. Destruction of the world's largest A new section discusses carbon farming, which could be part of the solution to controlling climate change. tropical forest has dire implications for our climate and for survival of indigenous people. We also have updated the "What do you Think?" box on the environmental benefits of shade-grown coffee and cocoa.

Chapter 11 leads with a new case study on how the reintroduction of wolves, a top predator, has enhanced biodiversity in Yellowstone National Park, with cascading effects through both the food chain and the physical environment. We have emphasized the "climate" component of HIPPO factors in threats to species survival. We have enhanced discussion of the "sixth extinction" and added a boxed reading on the startling crisis of disappearing insects. Studies show losses of 80 percent of the flying insect fauna in some areas, with probably profound impacts on biodiversity more broadly.

Chapter 12 has a new case study on ecosystems in transition. Longer fire seasons and more extreme outbreaks of bark beetles threaten to alter western forests, as climate warming has produced the largest, most intense, and most damaging forest fires in U.S. history. Continuing our survey of landscapes in transition, we have added a new "Exploring Science" box on the effects of palm oil plantations on endangered orangutan populations on Borneo. A new "What Do You Think?" box examines new threats to U.S. national monuments from mining and other extractive industries.

Chapter 13 introduces restoration ecology with a new case study on the science and practice of restoring coral reefs. At least one-third of all coral reefs have been damaged beyond recovery by pollution, overharvesting, ocean acidification, and climate change. Some experts warn there may be no coral reefs anywhere in the world by the end of this century. But restoration ecologists are exploring innovative strategies for protecting and restoring these amazing systems. A new box on the "monarch highway" project describes both the threats to these charismatic insects and efforts to restore their populations.

Chapter 14 begins an environmental geology discussion with a new case study on the proposed Pebble Mine in headwater salmon streams of Alaska's Bristol Bay. This controversial project pits the fate of pristine wilderness and the world's largest sockeye salmon run against the estimated profits and likely environmental damage from a mammoth copper-nickel mine. On one side are about 850 high-paying mining jobs over the expected 20-year life of the mine compared to 12,000 permanent jobs for native people and Alaskan citizens in the salmon fishing industry. This struggle reflects issues in many controversies about earth resources.

Chapter 15 demonstrates leadership in climate action with a new case study on groundbreaking climate policy in California. Challenges are daunting, but solutions are diverse, creative, and exciting. We have enhanced the discussion of jet streams and polar vortex effects on local weather, as well as the latest IPCC report as well as current information about major greenhouse gases as well as the latest news about polar ice melting and warming seas. A new box illustrates the effects of black carbon emissions on climate systems. We also examine options for carbon capture and other efforts to combat climate change.

Chapter 16 provides updated data on air pollution as well as updated discussion of the Montreal Protocol on ozone-destroying substances—including the Kigali Amendment, which accelerates the phase out of refrigerants that are also critical greenhouse gases. This step alone could prevent 0.5 degrees of global warming by 2100. We increase emphasis of the dangers of air pollution particulates smaller than 2.5 μm , and we discuss the problems of air pollution in developing countries.

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Chapter 17 updates the opening case study, “When Will Lake Mead Go Dry?” and the demands for Colorado River water that exceed the river’s flow. We provide recent data on looming water shortages, especially in regions dependent on glacial rivers, as in South Asia. Water is likely to be the most contentious natural resource in the future, but smarter water conservation policies, including pricing, irrigation and farming practices, and low-flow household appliances could reduce these risks. We also discuss China’s expanding dam-building projects, especially on the Mekong River.

Chapter 18 continues the water resource discussion with the example of the Ganges River, on which nearly a billion people in South Asia depend. We know how to prevent water pollution, and we know how to capture and remove pollutants. But finding ways to implement policies and pay for treatment is difficult even in wealthy countries. These challenges are even steeper in developing regions as they struggle to improve health and quality of life.

Chapter 19 presents a new case study on the demise of one of the U.S. coal companies. We emphasize that while fossil fuels still provide most energy, the future of energy is not the past. We update data on production and consumption and discuss the shifting landscape of conventional energy, including growth in China. A new “Exploring Science” box discusses the growing importance of indigenous resistance to new pipelines across their land. We also highlight new debates about nuclear power, which is both expensive and low carbon.

Chapter 20 explores the fast-changing landscape of renewable energy with an updated case study on Germany’s Energiewende, or energy transition from fossil fuels to renewable energy. This chapter is heavily revised to reflect new developments in technology and energy production. Explanations of new systems include a discussion of efficiency and power capacity, as well as battery storage. We examine analysis showing how sustainable energy systems could meet all our needs, often saving money as well as reducing pollution.

Chapter 21 includes an updated case study on the phenomenal amounts of plastic pollution in the world’s oceans. A new section reviews the options for waste disposal and updates both the amounts and types of materials in our waste stream. We examine China’s decision to reject U.S. recycling and what this means for waste management.

Chapter 22 opens with a new case study showing how cities are leading efforts to become environmentally, socially, and economically sustainable. We update data on urban growth, especially in African states, where some cities may have 100 million residents by the end of this century. How will these cities manage pollution, traffic, energy, food, and water supplies? We also examine the plight of sinking coastal cities amid rising seas. A final section discusses ways cities can be livable and sustainable.

Chapter 23 has an updated case study about British Columbia’s carbon tax and notes that when Washington State tried to pass a similar tax, the fossil fuel industry spent \$30 million to block the plan. Will other states be able to overcome this spending power? A new “Exploring Science” box notes that estimates of the value of global ecosystem services have increased from \$33 trillion a few decades ago to \$173 trillion today. Another boxed essay compares rapid job growth in sustainable energy compared to the fossil fuel industry. With interest growing in a Green New Deal, we have added a new “What Do You Think?” box to review this proposal.

Chapter 24 opens with a new case study about the recovery of North American green sea turtles with the help of the Endangered Species Act. In 1978 fewer than 300 sea turtles nested in Florida. By 2017, more than 39,000 turtles came ashore to nest, a major success in species protection. We review the provisions and successes of this and other major environmental policies. A new section discusses problems of regulatory capture in government agencies, as well as debates about how much regulation we want.

Chapter 25 presents a new case study on the history of Earth Day. It is critical that students understand how we got to where we are, and how public involvement with environmental issues has emerged. A new box discusses fossil fuel divestment debates at U.S. colleges and universities. We end the chapter with a review of sustainability as an overarching goal for environmental science.

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