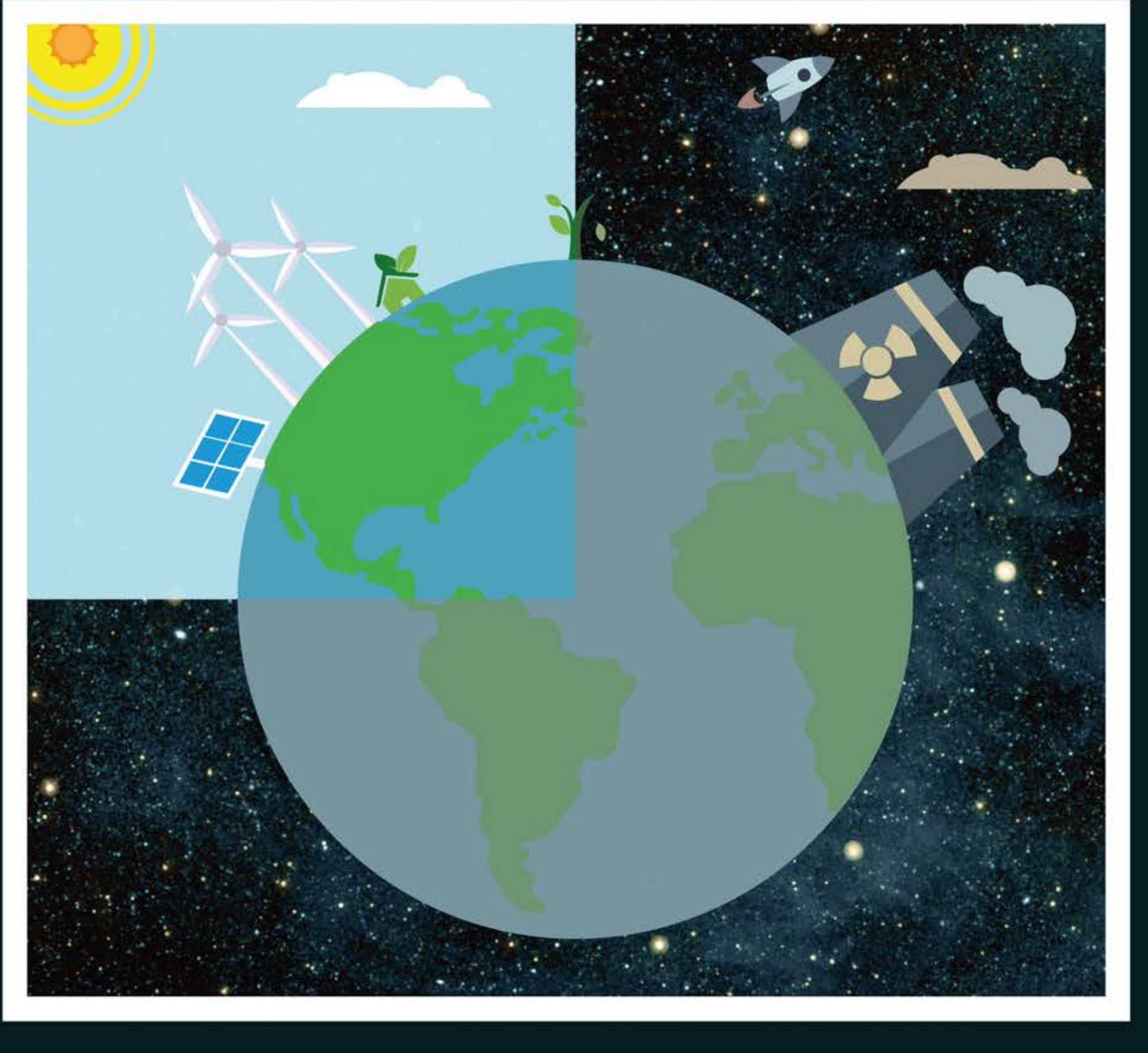
SIXTH EDITION

eRESOURCES

ROUTLEDGE

ENVIRONMENT AND SOCIETY

Human Perspectives on Environmental Issues



Charles Harper and Monica Snowden

Environment and Society

The sixth edition of *Environment and Society* continues to connect issues about human societies, ecological systems, and environments with data and perspectives from different fields. The text looks at the environment from a primarily sociological viewpoint and is designed for courses in Environmental Sociology and Environmental Issues in departments of Sociology, Environmental Studies, Anthropology, Political Science, and Human Geography. Clearly defined terms and theories help quickly acquaint students from various backgrounds with the material.

Every chapter of the sixth edition has been significantly revised with new research, data, concepts, and ideas. Also new to this edition, the end of each chapter features review questions, as well as additional examples and conceptual questions that help make macro-micro links between large-scale issues and lived experiences.

Charles Harper is Professor Emeritus of Sociology at Creighton University in Omaha, Nebraska. A member of the faculty since 1968, he has developed and taught numerous courses in the sociology department. Dr. Harper's teaching and scholarly interests involve the study of social change, globalization, the sociology of religion, social theory, and environmental sociology. He has published papers in a variety of academic journals.

Monica Snowden is Professor of Sociology at Wayne State College in rural Nebraska. Dr. Snowden earned her Ph.D. from the University of Nebraska-Lincoln. She has been teaching environmental sociology for nearly 20 years. Her research interests and publications are in the areas of environmental sociology, social inequalities and theory, teaching pedagogy, and most recently, barriers to access to health care.

Since its first edition, Harper and Snowden's *Environment and Society* has served as the core text in my Environmental Sociology course. It offers an essential, comprehensive and enduring foundation of relevant theory and subject areas in the field. The book lends itself well to interdisciplinary units of study that are easily customized and expanded upon with supplemental material and which students across disciplines are sure to find relevant and engaging.

Heidi Renate Ballard, *Associate Professor, Department of Sociology, Criminology and Justice Studies, Otterbein University*

Harper and Snowden provide lucid, comprehensive coverage of the complex interconnections between the natural environment and the human social world. By deftly incorporating both natural and social scientific ideas and data, their analysis of environmental issues provides an especially valuable contribution to this vital area of study.

Angela G. Mertig, *Professor, Sociology and Anthropology, Middle Tennessee State University*

Environment and Society, Sixth Edition, is an accessible and engaging foundational text for students in environmental studies. With their inclusion of approaches from both natural and social sciences, Harper and Snowden provide excellent content on contemporary environmental issues, from climate change and population growth to globalization and sustainability.

Patricia Stapleton, *Assistant Professor, Social Science & Social Policy, Worcester Polytechnic Institute*

Environment and Society

Human Perspectives on Environmental Issues

SIXTH EDITION

CHARLES L. HARPER
CREIGHTON UNIVERSITY
MONICA SNOWDEN
WAYNE STATE COLLEGE

Routledge
Taylor & Francis Group
NEW YORK AND LONDON

First published 2017 [Fifth edition published 2012]
by Routledge
711 Third Avenue, New York, NY 10017

and by Routledge
2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

Routledge is an imprint of the Taylor & Francis Group, an informa business

Library of Congress Cataloging in Publication Data
Names: Harper, Charles L., author.
Title: Environment and society : human perspectives on environmental issues / Charles L. Harper, Creighton University, Monica Snowden, Wayne State College.
Description: Sixth edition. | New York, NY : Routledge, 2017.
Identifiers: LCCN 2016037052| ISBN 9781138206489 (hardcover : alk. paper) |
ISBN 9781138206496 (pbk. : alk. paper) | ISBN 9781315463254 (ebook)
Subjects: LCSH: Human ecology. | Environmental policy. | Environmentalism.
Classification: LCC GF41 .H383 2017 | DDC 304.2/8–dc23
LC record available at https://lccn.loc.gov/2016037052

ISBN: 978-1-138-20648-9 (hbk)
ISBN: 978-1-138-20649-6 (pbk)
ISBN: 978-1-315-46325-4 (ebk)

Typeset in Bembo Std
by Cenveo Publisher Services

Visit the eResources: www.routledge.com/9781138206496

CONTENTS

PREFACE

Environment and Society: Human Perspectives on Environmental Issues is intended to provide students and interested readers with an introduction to environmental issues. More specifically, it is about human connections and impacts on the environment—and vice versa. There are many specialized research reports and monographs about particular environmental topics and issues, but this book is intended to be an integrative vehicle for many different human and environmental issues.

Stimulated by the enormous growth of interest in environmental issues and problems in higher education, our own classes have a yeasty mix of students from biology, environmental science, the social sciences, and others from education, philosophy, and marketing. We have tried to write a book that is at least understandable to them all. Perceptive readers will note that in some places the book alternates between more elementary and advanced discussion. That is deliberate, because social science students know some things that natural science students do not, and vice versa. This book discusses blocks of material that incorporate contemporary environmental concerns, controversies, and discourses. A pervasive theme is that people and scholars bring very different intellectual views (*paradigms*) to the understanding of human–environmental issues. We think that these different views are not ultimately irreconcilable, but if you do not like attention given to different points of view, this is probably not the book for you.

The sixth edition is different from earlier editions because it has been significantly revised by introducing new research and data, concepts and ideas. The chapter topics are organized the same as the previous editions. But here is the layout of the chapters and the primary updates: Chapter One introduces basic concepts about environments, ecosystems, and human social systems, and various ways that people have understood and interacted with their biophysical environment. It examines how human–environment relations have come to be understood and studied by social scientists, and ends with a summary of the driving forces of human activity that impact the biophysical environment. In this edition, an environmental justice frame is introduced in this chapter as it is an organizing theme and referenced throughout the text. Chapter Two is an overview of the human "footprint" on the planet, which discusses some resources, resource depletion, and pollution issues. It has been significantly updated with new data on soil and land pressures, water scarcity and quality concerns, and pollution problems, including e-waste, recent data on air emissions, and concerns related to animal wastes and pollution. It includes case studies that address transboundary water conflicts, as well as the Flint water crisis in the United States. Chapter Three is about climate change and ozone depletion. Also, newly introduced to this edition are the ideas and concerns associated with planetary boundaries and the era of the Anthropocene. Chapter Three has been the most extensively revised to incorporate the most recent scientific understandings of the problem, points of continued misunderstanding and conflict, and the contribution sociology can make to understanding climate change adaptation and mitigation outcomes and policies. Importantly, it provides a thorough discussion of global climate diplomacy leading up to the Paris Climate Summit and the agreement it produced.

Chapter Four is about the energy systems that underlie all human economic activity, and the prospects for their transformation in the near future. In addition to updating energy trends more broadly, this edition includes new discussions over extreme fossil fuel production, notably hydraulic fracturing (fracking) and the Canadian tar/oil sands. It also provides updated information on advances in renewable energy and the development of smart grids. Chapter Five is about human population growth with special reference to food issues. It also has been updated with newer data about population growth, urbanization and growth of mega-cities, and global migration trends. Notably, the growing number of formally recognized refugees and internally displaced persons, as well as the growing number of persons worldwide displaced by environmental and climate change induced impacts—informally referred to as climate or environmental refugees. Chapter Six examines globalization and the prospects for more sustainable human–environment relations from several contemporary perspectives. It has been updated with new understandings and research on globalization, and global and domestic (mainly the US) inequality, as well as updated on trends and research on sustainability. It includes a new discussion of the growing body of research that shows a decoupling of economic growth and human well-being from energy use, introducing a new measure, the carbon intensity of well-being. Chapter Seven is about economic markets and politics. Upon reviewer recommendations it has been revised to better highlight the role of economic markets and market tools in driving environmental problems, and in policy developed to remedy them. As such, it includes a new discussion of environmental economics and ecological economics as frames for environmental decision making and policy. Also new to this chapter is a discussion of stranded assets, and how variations in the organizational structure of companies (large parent company with many subsidiaries vs. a smaller parent company with fewer subsidiaries) and how state environmental policy influences pollution trends. It also provides a critique of the business-as-usual economic policies and market tools used to address environmental problems, and promising market and political strategies to transition to a low carbon sustainable society.

Finally, Chapter Eight is about environmentalism in regard to ideology and action, and environmental social movements. It has been updated with theories and research on environmental and anti-environmental movement organizing, as well as recent research that looks at the strategies and successes of grassroots, national, and international environmental movement organizations. It also includes new public opinion research on environmental problems, especially in regard to climate change.

To make this a more user-friendly book, each chapter is followed by some review questions, and some questions and issues that attempt to help you make macro–micro links between large-scale issues and the lives of persons (Personal Connections). These personal connections are *not* review questions that summarize chapter content, but opportunities for dialogue between the book and its readers and between readers. They may be points of departure for discussion and argumentation. At the end of each chapter, there are some sources (both print and electronic) for further exploration of each topic (they also have been updated). You will also see web links embedded in each chapter as they relate to specific topics. There is a glossary at the end of the book that defines social and environmental terms used that you may not be familiar with.

It is only fair that you have an idea of what kind of book you are going to be reading and how it is organized. It is about environmental problems themselves, but it has a *social science perspective*, and even more specifically, a *sociological perspective*. Thus, it will be more concerned with how these problems relate to human behavior, culture, and social institutions. The book also examines suggestions for changing the human–environment relationship to a more "sustainable" environment, society, and world order. Finally, it is important for you to know that this book will provide a broad overview that focuses more on the interconnections among a variety of issues rather than on any particular issue in great depth. *Many* other books and research papers provide in-depth coverage of specific topics.

Both of us are sociologists by training and our outlook on environmental issues is informed by environmental sociology, which is a subdiscipline that has developed rapidly over the last 40 years. Even so, no single scholarly discipline has a corner on truth about such a multifaceted and important topic. We have therefore attempted to give attention to the work and perspectives of economists, political scientists, anthropologists, geographers, and policy analysts as they address environmental and ecological issues. That makes this book as more of a social science work than a narrow treatise about environmental sociology. But of these fields, the book will draw most heavily on environmental sociology and economics.

SCIENCE, VALUES, AND LANGUAGE

We have tried to write an objective book about the human causes of and reactions to environmental problems and issues. But the book will not ignore scholarly or public controversy and disagreement. It addresses some outrageously difficult and multidimensional issues as reasonably as possible but—obviously—will not do so to everyone's liking. Like all good social science or indeed, all good science of any kind, sooner or later it connects objective "facts" with things that people find important (values), and with criteria for making normative choices among them. As Thomas Dietz put it while speaking about the prospects for a new "human ecology":

> We must become a normative as well as a positive science. I don't mean that human ecologists, as scientists, need continually to be engaged in advocacy. I do mean that we must use our analytical skills to develop arguments for the proper criteria for making decisions. We must help individuals and collectivities make better decisions by offering methods for handling value problems.
>
> (1996/1997: 50)

There is, in truth, no completely value-free social science or any other kind of science. So, the book will talk about facts and data, but it also exhibits our own values, hopes, and fears about the human predicament. Charlie, for instance, contends that it is impossible (and undesirable) to eliminate one's own opinions and values from scholarly work. But they should be labeled as such, you will see a lot of "we think …" statements in front of those places where it is likely not all would agree. As it turns out, we (Charlie and Monica) agree on most of these issues, but in a few places you may see an "I" statement and then one of us will be identified.

It's fair to warn you that you will be reading a book that details a lot of bad news about human–environment interactions. Reading sustained fare about problems can be very depressing and can generate fatalism. But it is also important to note that we find some compelling reasons for hope (if not optimism) about the possibilities for a more positive future. Those reasons occur mainly in the later chapters of the book, so if what you read initially depresses you, *read on*. The book moves, after the early chapters, from the more physical to the more social dimensions of environmental issues, and from the more depressing litany of facts and problems to examining some possibilities for positive change. I (Charlie) discovered in writing the book, somewhat to my surprise, that if I am a pessimist, I am a hopeful one.

It also should be mentioned that the first five editions of this book were written by Charlie. Monica is just coming on board with the sixth edition. Charlie sought to write the book in an informal and unpretentious style. Hopefully, this tone has been maintained in the sixth edition.

ACKNOWLEDGMENTS

Every intellectual work is in some sense autobiographical. For Charlie his early college education (of many years ago!) was in biology and the physical sciences. But I subsequently pursued graduate studies in sociology, and for years I have been engaged in a professional life that has dealt only peripherally with environmental and ecological issues. This book attempts to put together the pieces of my education as a coherent whole in a way that addresses some important human and intellectual concerns of our times.

For Monica, I dreamt of sailing with Greenpeace to prevent the hunt and killing of whales. Instead, I ended up with a Ph.D. in sociology. As it turns out, I get really seasick, so it all worked out for the best! I am incredibly grateful that Charlie asked me to become a co-author of this book. Similar to Charlie, it has given me the opportunity to bring together my educational background and passions to address the big issues the world confronts.

Intellectual works are not just autobiographical. They involve the insights, encouragement, forbearance, and constructive criticisms from many others, and I (Charlie) need to thank them, particularly my colleagues and students at Creighton University. They contributed substantially to this work and tolerated me while I was working on it. Thanks especially to James T. Ault, who had the patience to read and critically comment on many parts of the book. Thanks to a succession of Graduate School Deans at Creighton University who provided modest but important material support.

I (Charlie) also want to thank an amazing network of environmental social scientists at other institutions who encouraged me through various editions. They include Fred Buttel (University of Wisconsin) before his recent untimely death; Eugene Rosa, Thomas Dietz, Robert Brulle, J. Allen Williams, Paul Stern (National Research Council); and Bruce Podobnik. I am especially indebted to William Freudenburg (University of California-Santa Barbara) and Riley Dunlap (Oklahoma State University) for their friendly criticism and encouragement over the years. I do not, of course, hold any of them responsible for errors of commission or omission.

Monica would like to also thank her students and colleagues that teach in the environmental studies minor at Wayne State College, particularly, Barbara Hayford who shared some of her research experiences from Mongolia to be incorporated in this edition (particularly Chapter Two), and Joe Blankenau and Mark Hammer. In addition, Monica is especially indebted to two former students. Rachel Schmitz (University of Texas Rio Grande Valley) who tirelessly read through drafts of chapters, provided invaluable feedback and edits, and revised the supplemental materials for this edition. And, Joshua Schmitz for helping update images included in this edition. In fact, the cover is his design!

Finally, we would like to thank the anonymous reviewers for their useful comments and suggestions for updates for this edition. Charlie would like to acknowledge an enormous debt of gratitude to former Prentice Hall sociology editor and publisher

Nancy Roberts, who encouraged our efforts in the early editions. We would like to thank Samantha Barbaro, social science editor, and Athena Bryan, editorial assistant at Routledge (Taylor & Francis). Monica is especially grateful to Samantha and Athena for their time and patience in answering her questions, often the same ones repeatedly, to make the transition from the previous publisher smooth, and in bringing me on as a co-author of this edition. They were the human voices of large, and anonymous organizations, who patiently helped to bring order to a complex project. Finally, Charlie would like to thank for her patient and loving support, his wife, Anne, to whom this book is dedicated. Monica would like to thank her family, Joe, Jackson and Amelia, for all the love and support they have always given her.

If you would like to contact Monica to share your comments and reactions to the book and its uses, please do so, at mosnowd1@wsc.edu.

ABOUT THE AUTHORS

Charles Harper is Professor of Sociology at Creighton University in Omaha, Nebraska. As a member of the faculty there since 1968, he has developed and taught numerous courses in the sociology department. Dr. Harper's teaching and scholarly interests involve the study of social change, globalization, the sociology of religion, social theory, and environmental sociology. He has published papers in a variety of academic journals.

Along with *Environment and Society*, Dr. Harper is the author of two other textbooks. Co-authored with Kevin Leicht, his book *Exploring Social Change: America and the World* (Prentice Hall, 2011) is now in its sixth edition. Another book, *Food, Society, and Environment,* originally published by Prentice Hall, is now in its second edition (Tafford Press, 2007). As an undergraduate, Dr. Harper studied biology and the natural sciences. He received a bachelor's degree from Central Missouri State University, a master's degree in sociology from the University of Missouri, and a Ph.D. in sociology from the University of Nebraska at Lincoln. He and his wife, Anne, live close to Creighton's campus near a "clan" of adult children, stepchildren, and grandchildren. He enjoys traveling, bicycling, and reading.

Monica Snowden is Professor of Sociology at Wayne State College in rural Nebraska. Dr. Snowden earned her Ph.D. from the University of Nebraska-Lincoln. She has been teaching environmental sociology for nearly 20 years. Her research interests and publications are in the areas of environmental sociology, social inequalities and theory, teaching pedagogy, and most recently, barriers to access to health care. Several of her publications have been co-authored with her husband Joe Blankenau, a political scientist at Wayne State College. She enjoys traveling, cooking, reading, gardening and hanging out with her husband, and two kids who do not want to hang out as much anymore, as one is now in college, and the other will be soon. She sees new adventures on the horizon.

CHAPTER 1
ENVIRONMENT, HUMAN SYSTEMS, AND SOCIAL SCIENCE

To begin, here is an illustration that links the environmental sciences and the social sciences. Food, for instance, is clearly of paramount importance to maintain human life, and thus a supremely important resource. You can consider food by raising two kinds of concerns. *First*, "Is there enough food to support a healthy life?" If not, humans live with malnutrition or hunger. If there is too much, humans may live with an epidemic of obesity. Either can be fatal. Are there enough fertile soil, water, and varieties of plant and animal species to enable humans to produce the required food by farming, raising livestock, hunting, or fishing? Is there enough energy to cultivate, irrigate, or transport an adequate amount of food? These concerns about having enough food for a large and growing population are most obviously related to nature and the natural world—and to natural and environmental science. *Second*, "What about the *kind* of food and its distribution within a human community?" Is it the kind of food that is not only nutritious, but also which people like because it satisfies their emotional needs, as well as their needs for social belonging and participating in a human society and culture? Do economic markets, political or cultural rules, and subsistence technologies produce an

Figure 1.1 The human impact on our environment is so extensive that we live in a "socialized environment."

adequate distribution of the food that is produced? Is that distribution just? Who owns the resources and systems that produce food? Do particular people have the money or political power to acquire enough food in a given human community or nation? These concerns are more obviously related to the social world—and to the social sciences.

Although each group of concerns is "most obviously" related to either the natural or the social sciences, that is an oversimplification. Both natural and social science concerns—about food and other environmental issues—are closely interconnected. Those connections are not always obvious because they have different perspectives, definitions, and histories. News about the broader connections between the natural and social worlds has not been good in recent decades. Begin with news about the obvious: wilderness and soil and water resources are under stress, forests are disappearing, we are awash in pollution and garbage of our own creation, and the earth's climate is changing significantly. Add to these, in no particular order, concerns about indoor air pollution, landfill overcrowding, low-level nuclear wastes, urban sprawl, unsustainable consumption and population growth, environmentally induced diseases, and the variety of energy issues that we face. This list could continue for a long time, and you have probably heard of them. They are measures of how rapidly and pervasively environmental issues and problems have entered the popular consciousness and political discourse of our times.

This book is about the interconnections between the natural and social worlds, described from the points where the natural sciences (especially environmental science) and the social sciences (especially sociology and economics) intersect. This chapter begins by introducing, in broad strokes (1) ecosystems, (2) human sociocultural systems, (3) some parallels and differences between the evolution of ecosystems and human systems, (4) environmental social sciences, particularly economics and sociology, and (5) some of the human driving forces of environmental and ecosystem change.

ECOCATASTROPHE OR ECOHYPE?

Are all the problems listed earlier just alarmist stuff? How *real* are these problems? Sure, everyone knows that there are environmental problems—with pollution and the rainforests, nuclear energy, and climate change. But is ecocatastrophe really around the corner, or are the problems greatly exaggerated? You probably don't spend much time or energy thinking about these problems. The world seems okay: we get up and go to work and enjoy our family life, farmers continue to grow food that is plentiful and normally tasty, and drinking tap water has not made me ill (not yet, anyway). After 2000, and particularly after September 11, 2001, many of us have a sense of unease, for many reasons. Even so, to many in the richer nations, the biophysical world still seems okay. Perhaps, it is hard to experience directly the environmental devastation depicted here. We are aware, of course, that there *is* human suffering, poverty, disease, and terrorism in the world; and to most of us, the economic, political, and individual causes of human problems and misery seem more direct and obvious than the environmental ones.

Surely you realize that we have been talking about extremely complicated issues and controversies for the human future—if not for you, then certainly for your children and grandchildren. Not "merely" scientific and academic debates, they have become issues and policy dilemmas that reverberate in the political arenas of the United States and the world, where they compete with more traditional ones.

ECOSYSTEMS: CONCEPTS AND COMPONENTS

The most fundamental concept for ecological understanding is the notion of a *system* as a network of interconnected and interdependent parts. An *ecosystem* is the most basic unit of ecological analysis, which includes all the varieties and populations of living things that are interdependent in a given environment. Ecosystem and environment are not the same, even though they are often used interchangeably. The environment includes the earth (rocks, soil, water, air, atmosphere, and living things), but an ecosystem means the "community" of things that live and interact in parts of the geophysical environment. Ecosystems are composed of structural units that form a progressively more inclusive hierarchy.

In addition, ecologists speak about the *biosphere* as the entire realm where life is found. It consists of the lower part of the atmosphere, the hydrosphere (all the bodies of water), and the lithosphere (the upper region of rocks and soil). Combined, the biosphere is a

Table 1.1

Organism	Any individual form of life, including plants and animals (Felix, Fido, you, and me)
Species	Individual organisms of the same kind (e.g., dolphins, oak trees, corn, humans)
Population	A collection of organisms of the same species living within a particular area
Community	Populations of different organisms living and interacting in an area at a particular time (e.g., the interacting life forms in the Monterey Bay estuary in California)
Ecosystem	Communities and populations interacting with one another *and* with the chemical and physical factors making up the inorganic environment (e.g., a lake, the Amazon basin rainforest, the High Plains grasslands in the United States)
Biome	Large life and vegetation zones made of many smaller ecosystems (e.g., tropical grasslands or savannas, northern coniferous forests)

relatively thin, 20-kilometer (12-mile) zone of life extending from the deepest ocean floor to the tops of the highest mountains (Miller, 1998: 92).

Exchanges (or *cycles*) of energy, chemicals, and nutrients are the interconnections that bind the components of ecosystems and subsystems with the physical environment. Among important cycles are the flows of carbon, nitrogen, oxygen, phosphorus, and water. See Figure 1.2, which illustrates the carbon cycle.

These cycles are symmetrical in terms of energy. The ultimate source of the earth's energy is solar radiation, which is built up into complex forms of energy and used by living things. Then it is eventually emitted into the environment, mostly as low-quality heat energy near the earth's surface. Similar to the conservation of matter, the *first law of thermodynamics* says that energy cannot be created or destroyed, only changed into different forms. So, like matter, you can't get something for nothing—energy input always equals energy output. But wait! When you use energy, you can't even break even. Unlike matter, energy can't be recycled over and over. Respiration or burning gasoline in your car permanently degrades useful complex forms of energy (such as that stored in carbohydrates or petrochemicals) to low-grade forms, such as heat, that can't be reused. The *second law of thermodynamics* states that we can't recycle or reuse high-quality energy to perform useful work again. This tendency for energy to run downhill is called *entropy.* Thus, the heat produced from combustion and the respiration processes of living things is eventually diffused over the earth and radiates back into space. Useful energy is never to be recovered until solar radiation builds more over eons of time, and the material remains from combustion and respiration aren't really disposed of, but accumulate in various *sinks* (like air and water). The human implications of this are profound.

The transfer of food energy from its primary producer sources (green photosynthetic plants) through a series of consumer organisms where eating and being eaten is repeated a number of times is called a *food chain.* The greater the number of feeding (or *trophic*) levels, the greater the cumulative loss of usable energy. That explains why larger populations at lower trophic levels are required to support smaller populations at higher levels, and particularly at the top of food chains. Food chains are thus *food pyramids.* This energy-flow pyramid explains why larger populations of people can be maintained if they eat mostly at lower levels on the food chain (by eating vegetables or grains) than at higher levels (by eating cattle fed on grains) (Cunningham et al., 2005: 58–60).

A *habitat* is the location of an organism within an ecosystem, whereas its *ecological niche* is its role in a community of organisms that comprise an ecosystem. Sometimes niches overlap, and two species compete for the same resources. But often different kinds of *resource partitioning* make it possible for different species to share the same habitat without much competition. For instance, species inhabit and feed from different layers of rainforests: Some are ground feeders, some feed on short shrubs, some live and feed in the shady understory, and others live in the high canopy. The droppings of all of these species feed the detritovores that recycle nutrients to the otherwise fragile tropical soil.

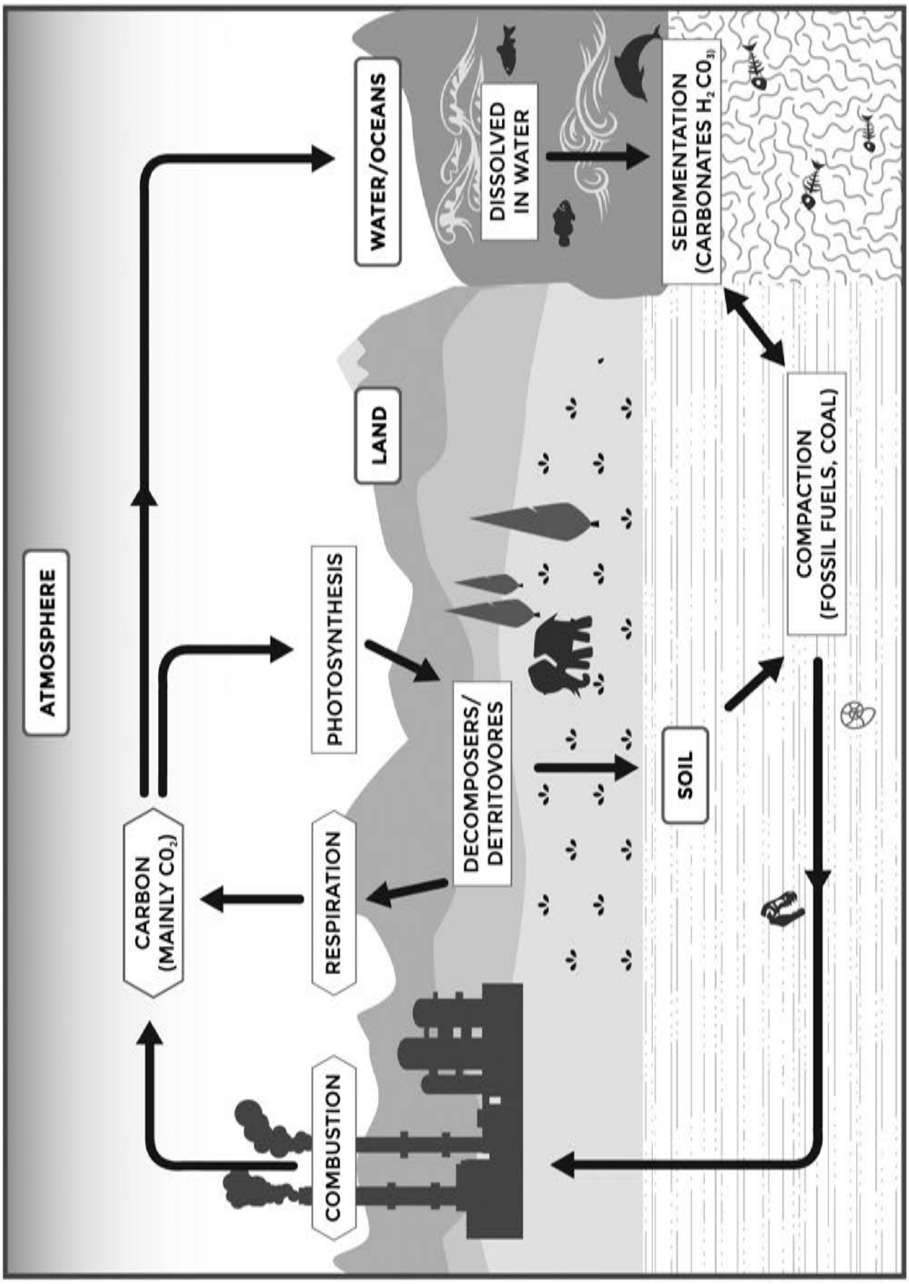


Figure 1.2 The Carbon Cycle
Source: Based on T.G. Miller, Jr., 1998: 114–115.
Image Courtsey of Joshua Schmitz, josh.schmitz@querycreative.net

There are other ways that species "share the wealth" in a given ecosystem. Hawks and owls feed on similar prey, but hawks hunt during the day and owls hunt at night.

Every organism has nutrient needs that the ecosystem and its physical environment must provide for it to thrive. If a population gets too large, the ecosystem is overloaded and cannot provide the basic needs of every organism. When ecosystems are overloaded, populations can become stressed and begin to die back. The concept of ecosystem *carrying capacity* and the possibility that population growth can produce an *overshoot* of available resources is illustrated by Clark's analogy of bacteria in a petri dish. When bacteria are introduced into a nutrient-rich petri dish, exuberant growth follows. But in the limited world of the petri dish, such growth is not sustainable forever. "Sooner or later, as the bacterial populations deplete available resources and submerge in their own wastes, their initial blossoming is replaced by stagnation and collapse" (1990: 1). But you don't have to rely on analogies like this; there are many real cases in which species have outgrown ecosystem carrying capacity, and after such overshoot, population size has collapsed. For example, David Klein's study of reindeer tells of the introduction of 29 animals, minus wolves—their natural predators—to remote Matthew Island off the coast of Alaska. In the next 19 years, they had multiplied to 6,000 animals and then, through starvation, had crashed to 42 in the following three years. When discovered, the 42 reindeer were in miserable condition, all probably sterile (1968: 350–367).

Like other species, humans need space, clean air, water, food, and other essential nutrients to survive and maintain a quality existence. If the human population gets too large relative to its environment, however, the carrying capacity of that ecosystem may be overtaxed, and human welfare may be threatened. Also like animal species, there are numerous real cases of human local and regional overshoot disasters and population crashes in various countries throughout history (see Box 1.1).

BOX 1.1

ENVIRONMENTAL DEGRADATION AND SOCIAL CHANGE

Many people who understand human social evolution as a story of continual progress fail to appreciate the role that environmental degradation has played. Commonly, people believe that the change from food foraging to horticulture and then to agriculture happened because people traded a precarious and insecure way of life for one that was more secure and satisfying. Little evidence exists to support this view. Rather, climate changes that "shrank" livable environments, human population growth, the exhaustion of edible plant and large animal populations, and the discoveries and innovations that made dependence on agriculture possible *all* combined to cause this transformation. Furthermore, fossil records and archaeological evidence confirm that hunter-gatherers did not abandon their lifestyle until forced to do so by the problems, and did so at different times and in widely scattered areas around the world (Lenski and Nolan, 1999; Sanderson, 1995). A similar combination of environmental problems, scarcities, and technological possibilities caused the decline of ancient empires (like the Mayans, Mesopotamians, and Romans) and stimulated the emergence of industrial societies. The growth of innovations and technologies produced more complex and inclusive human systems having ever-larger productive capacities to support human populations. Elites may have benefited from an enhanced ability to extend their control and powers of taxation across larger systems. Non-elites, however, often did not change their lifestyles from positive attractions but rather to survive when they had no other choices (Tainter, 1988; Homer-Dixon, 2006). In the nineteenth and twentieth centuries, established farmers often did not *willingly* move to cities seeking urban employment, but the story of rural to urban migration is also one of progressive rural poverty, bankruptcy, and foreclosed farm mortgages.

The human consequences have included widespread malnutrition, disease, starvation, all kinds of social stress, outmigration, and sometimes war as people compete for scarce resources.

ECOSYSTEM CHANGE, EVOLUTION, AND HUMAN–ENVIRONMENT INTERACTION

Today most scientists think that biological species evolve, and that *natural selection* and *rare genetic mutations* are important mechanisms for the evolution of species. Ecosystems also evolve, and have done so since long before humans arrived on the scene. *How so?* Alfred J. Lotka, one of the founders of ecological science, provided important leads to this question beginning in the 1920s. Viewed ecologically, the competition among species is fundamentally about sources of energy. Competition for available energy (nutrients and food) in their environment triggers changing relationships among different species, often causing ecosystems to evolve into more inclusive systems. When energy is available in the environment, the species with the most efficient energy-capturing mechanisms has a survival advantage. Organisms with superior energy-capturing devices will be favored by *natural selection*, increasing their numbers and their total energy consumption throughout the ecosystem (Lotka, 1922; 1945: 172–185). These processes often result in *ecological succession*, whereby species may replace one another in gradual changes.

Over the earth's long 3-billion-year geological history, ecosystems have evolved by (1) *natural selection*, as described earlier, and (2) *coevolution*, or the reciprocal natural selection that forms relationships between different species, called *symbiosis.* Symbiosis can be mutually beneficial (*mutualism*), or as *parasitism*, only beneficial to one species but not mutually beneficial, as when fungi or micro-organisms infect humans and other species. Interestingly, there are micro-organisms that live in human digestive tracts that appear to be in a mutualistic relation with humans by aiding in the digestive process (Odum, 1971: 271–275).

This relies on the work of renowned ecologist and ecological theorist E. P. Odum, and we note some of his ideas about the relevance of ecological evolution and human–environment interactions. Odum understood the relationships between different kinds of environments and ecosystems as a *compartment model* in which four broad types of natural settings are partitioned according to their biotic function and life cycle criteria. There are (1) environments with young, relatively immature, and rapidly growing ecosystems; (2) ones with more mature, diverse, or climax ecosystems that tend toward protective equilibrium; (3) compromise or multiple-use environments and ecosystems that combine both types and functions; and (4) urban-industrial environments that are relatively *abiotic* in relation to the other types. You can see these four types represented schematically in Figure 1.3.

The important point is that the growth of human settlements and communities obviously decreases the proportion of other types of environments and ecosystems at the expense of the more mature, protective ones. Human activity creates urban-industrial environments, with their vast sprawling growth and their great expansion of simplified growth ecosystems. This happens through the cutting of forests, the expansion of land for agriculture and other uses, and the increase of multiple-use ecosystems that combine some wilderness with fields, towns, or highways, among other factors.

The impact of human activity usually creates simplified-growth ecosystems by producing virtual *monocultures* (areas where primarily one type of organism grows).

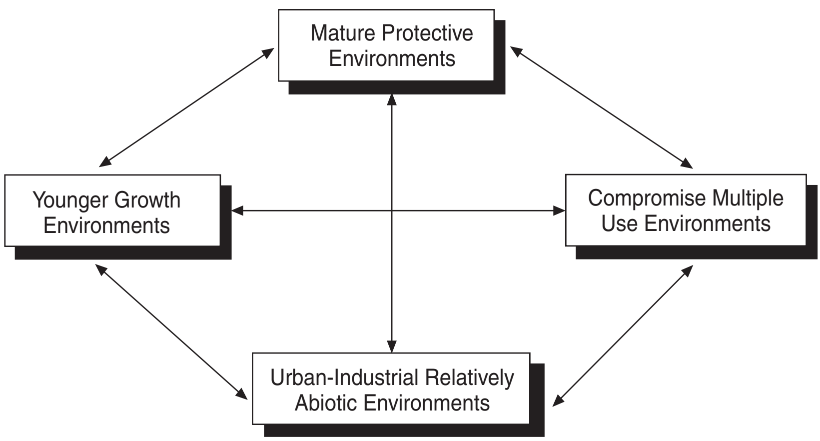


Figure 1.3 Compartment Model of Environments and Ecosystems According to Function and Life Cycle Criteria
Source: Based on Odum, 1971: 269.

Whether cutting trees, plowing prairies for crops, or cultivating grass in a lawn, humans reduce the biological diversity of living things that exist in "wild" ecosystems. A field of corn or soy beans and your lawn (if it is mainly of one kind of grass) is such a monoculture. If you have had to maintain such a monoculture, you know that it takes a great deal of effort in weed pulling and requires herbicides and pesticides to keep other life forms from invading it. The *loss of biodiversity* in monocultures has its price, not only by the addition of chemicals that are very difficult for nature to recycle, but also by the fact that monocultures are much less robust and hardy than more diverse systems. They are notoriously more susceptible to damage by drought and diseases, such as sod webworm that kills blue grass, or the whole range of insect, fungi, and microbe infections that can decimate grain crops and livestock monocultures. The Irish Potato Famine of the 1840s is an example of the devastation that can be caused by the collapse of an agricultural monoculture. A fungus ("blight") infection killed the Irish potato crop for several years, resulting in widespread starvation and civil disorders, and—importantly—triggering massive waves of Irish emigration to countries such as the United States, Canada, and Australia (Harper, 2007: 60, 203).

Odom's observations of the 1970s are still relevant: "Until we can determine more precisely how far we may safely go in expanding intensive agriculture and urban sprawl at the expense of the protective landscape, it will be good insurance to hold inviolable as much of the latter as possible" (1971: 270).

Is there a "saturation limit" for what, how, and how much of the biophysical environment can be appropriated for human use and still provide broadly positive conditions for social life for most of humanity? To what extent can we do this and still value and respect for its own sake the earth's rich and diverse genetic inheritance of species and ecosystems that resulted from 3 billion years of evolution? *Tough questions,* but important ones.

SOCIOCULTURAL SYSTEMS

The Irish Potato Famine of the 1840s was noted to illustrate the biotic vulnerability of agricultural monocultures. The fact that a large number of persons of Irish descent are in the United States, Canada, and Australia partly because of this catastrophe demonstrates in a very graphic way the important connections between humans and the natural world. Humans and human societies are certainly embedded in the ecosphere, but, as is often noted, humans are also unique creatures among all others. Humans are social animals, a characteristic they share with other species, such as bees, gorillas, and dolphins.

For sociologists, a basic abstract organizing concept is the *social system*, which is like *ecosystems* for ecologists. You could simply note the structural units of social system, from small to large and inclusive (e.g., individuals, small groups, communities, bureaucracies, societies, world order), but that wouldn't be very enlightening, particularly because it ignores a whole dimension of human systems that most differentiates *Homo sapiens* from other species: *culture.* Even though the social animals mentioned live in social systems, they lack a cultural dimension. A *sociocultural system* is a network of interdependent actors (individuals, organizations, subsystems) that are in relatively stable patterns of interaction and intercommunication. They share cultural patterns (both material and symbolic), which are distinguishable from those of other such systems. If you are suspicious that this is not exactly on new ground, you are right; a human system is another specific version of the general system concept introduced earlier that is fundamental to both ecology and the social sciences. This is important because it means that for humans as well as other species (1) everything is ultimately connected to everything else, and therefore, (2) you can't ever do *just* one thing without some consequences for other parts of the systems in which you live. Table 1.2 shows the components of human systems, distinguishing some clusters of related elements.

This is a useful and fairly conventional analytical scheme. As will become apparent, however, things are not divided so neatly; others do it a bit differently; see Lenski and Nolan (1999) and Sanderson (1995).

Because the relevance of these human system elements or subsystems may not be quite obvious to you, they need a bit of explanation, particularly as they relate to understanding environmental issues. *First*, you may be wondering how some are different, particularly the difference between a nation state and a society. Today we usually think of them as the same, but they really are not. Real nation states did not even exist much before the 1500s, but *society*, the most inclusive structural unit of human systems, is as old as are *H. sapiens*.[1] There are people, such as the Berbers of North Africa, who comprise a coherent society but who live in several North African nation states (Algeria, Mauritania), as do the Mohawks (whose "territory" straddles the US–Canada border). *Second*, these elements are really not an evolutionary or developmental sequence. For the earliest known *H. sapiens*, and among the few scattered indigenous peoples of the world today, there *is* no operating society beyond the level of families or kinship systems, no larger communities, and no inequality beyond elementary status roles based on age and gender. Furthermore, an authentic world order that has the potential to knit nations and societies into a truly global system of sorts has been emerging for only about the last 500 years, and its features are not yet very clear. *Third*, there are some things left out. There are, obviously, *individual* human organisms, and there are *social networks* that are somewhere in between populations and organized groups in the number and strength of the system bonds between actors.

CULTURE

Surely the most important distinction between *H. sapiens* and other species is the extent to which humans are cultural creatures. Nonhuman animal social behavior is more shaped by the behavioral instructions or codes carried in their genetic makeup—which interact with their environments in complex ways. Human behavior and environmental

Table 1.2 Elements of Sociocultural Systems

Culture	worldviews
	paradigms
	ideologies
	knowledge, beliefs, values
	symbols, language
Social structure	world-system
	society
	nation state
	complex organizations (bureaucracies)
	social stratification systems (based on economic class, ethnicity, kinship, or gender)
	small groups
	kinship systems
	status-roles
Material	wealth (tokens, wives, cattle, money)
infrastructure	material culture, subsistence technologies (plows, computers)
	human population (size and characteristics)
	human–environment relations
	biophysical resources (land, forests, minerals, fish)

adaptation is more flexible, open-ended, and shaped by learning; in other words, it is cultural. *Culture* is the total learned way of life that people in groups share. You can think of it as a sort of humanly constructed software (to use a computer analogy) for what the world is like, for how people should relate to each other, and for how they ought to adapt and "make a living" in the biophysical environment. Since our genetic equipment gives us very little specification about any of this, it is fair to say that much of our behavior and social patterns are shaped by culture rather than by biology. Exactly how much is debatable, and this issue has been at the core of an intense—but not very productive—debate between evolutionary biologists, anthropologists, and sociologists for about a decade.[2] People do not always conform to cultural norms, but we all experience powerful social pressures to conform and often face social sanctions if we don't.

But culture is hard to classify by this three-part scheme (Table 1.2) because it has both symbolic and material dimensions. *Material* technology, for instance, includes the tools, factories, weapons, and computers that relate to economic subsistence. Underlying these "things" are ideas, plans, recipes for doing things, and the innovative processes that are part of *symbolic* culture. To continue the computer analogy, if material culture is the hardware or mainframes, symbolic culture is the software programs of human systems. Such technologies include all the ideas, formulas, tools, and gadgets that people use to convert raw biophysical material resources into goods and services that humans find useful. Viewed as part of the material infrastructure, they relate to "making a living" in the elemental sense of providing sufficient food, shelter, and clothing. But they also include a lot of other "stuff" unrelated to basic subsistence like pet rocks, toenail clippers, computers, and sociology texts, which have economic utilities that would be quite baffling to most humans who ever lived.

SOCIAL INSTITUTIONS

Social institutions are both left out *and* hard to classify by the foregoing scheme. They are nearly universal sociocultural formations, like families, economies, political systems, judicial systems, health care, and so on. Social institutions are both structural and cultural. That is, they include broadly established ideas, values, beliefs, technologies, and structural systems that address some enduring human concern related to collective survival. You can get a sense of the structural *and* cultural sides of institutions by thinking about families (groups organized around kinship). The operative structural units of American families, established by law and custom, are parents and their children (even though other relatives have an important legal and cultural standing). On the cultural side, again established by both law and custom, married spouses are two (only two) people. They *ideally* exhibit an interaction style shaped by the values of positive affection (love) and trust, rather than by economic utility or relations of domination–submission. Children, normatively not more than two or three, are to be valued intrinsically, and not as utilities for family economic or sexual exploitation. Does this picture represent the empirical reality of all families in the United States? Of course not. But social institutions are imperative normative "shoulds" that most people find hard to disagree with, supported as they are by powerful cultural customs and laws. Furthermore, this institutional template is very different from that of families in other cultures (as anthropologists have studied extensively). The point is that social institutions are as much cultural as structural.

SOCIAL STRUCTURE

Elementary structural units of human systems are statuses and roles. Your *status* is the position or "rank" you occupy in a social system. *Status* is a structural term, and *role* is a behavioral or cultural one. The status–role concept is somewhat analogous to the way ecologists use the ideas of *ecological habitats* and *niches*—as the structural locations and functioning of organisms within an ecosystem. Furthermore, it is important for you to note that some other social animals, particularly primates, have almost human-like status–role systems. As our evolutionary cousins, primates (and some other mammals) live not as unorganized mobs but in relatively structured *rank-dominance hierarchies*, usually with the older males in charge of things.

THE DUALITY OF HUMAN LIFE

The cultural uniqueness of human beings has a profound implication. It results in what can be seen as an existential dualism that underlies much of the debate about human–environment relationships, including quarrels about the seriousness of environmental problems. This duality, inherent in the human condition, can be stated simply:

> *On the one hand*—humans and human systems are unarguably embedded in the broader webs of life in the biosphere. We are one species among many, both in terms of our biological makeup and our ultimate dependence for food and energy provided by the earth.
>
> *On the other hand*—humans are the unique creators of technologies and sociocultural environments that have singular power to change, manipulate, destroy, and sometimes transcend natural environmental limits.
>
> (Buttel, 1986: 338, 343)

Biologists and ecologists usually emphasize the first part of this duality, and social scientists typically place more emphasis on the second part. You probably recognize that *both* statements are true in some complicated and partial sense. Yet it makes a great deal of practical difference which assumption we use as a guide to action, choices, and policies. Since the industrial revolution, the second assumption—*humans as an exceptional species*—has been the dominant assumption and viewpoint. It is important to note that humans act on the basis of such viewpoints rather than on the basis of what the world "really is." This is a subtle but important point that requires some elaboration.

WORLDVIEWS AND COGNIZED ENVIRONMENTS

There is obviously a reality external to human beings that we live within. But human choices and policies are more directly related to our *definitions* of that reality than to what reality "really" is. In other words, human social behavior is more directly related to symbolic constructions and definitions of situations than to external environments per se. People *exist* in natural environments, but they *live and act* in worlds mediated and constructed by cultural symbols (Berger and Luckmann, 1976; Schutz, 1932/1967; Thomas, 1923).

Yes, there is an external biophysical environment independent of how people think about it, but people act on the basis of what they *think* the environment to be. To differentiate this imagined environment from the "real environment," scholars have invented a rather awkward term, *cognized environment*, to mean their human definitions and interpretations of the biophysical environment. The very notion of nature itself is a way of *cognizing* the environment that didn't exist much before the eighteenth century. As a cultural conception and idea, nature was invented mainly by English intellectuals in the eighteenth century, particularly Romantic artists, writers, poets, and literati (such as Wordsworth and Ruskin). They sought a metaphor to contrast the "good" pristine natural state with the (presumed) evil artificiality of the cities, mines, and factories of the industrial world. Thus the notion of nature that has come down to us was originally part of the Romantic discourse and critique of the invasion and destruction of all that was "natural" by the barbaric machines of the industrial system (Harrison, 1993: 300; Fischer, 1976, chap. 2). "Mother Nature" is a more obviously gendered and anthropomorphized cognition of the biophysical environment (*anthropomorphized* means that something nonhuman is understood in human terms).

The *worldview* that people share is their totality of cultural beliefs and belief systems about the world and reality. It is a broader concept than their *ideologies*, meaning the parts of worldviews that people purposely use to justify action and choices. Examples of ideology would include individualism, nationalism, or environmentalism. *Cognized environments* are also components of worldviews that are obviously related to ideologies about the environment.

ECOSYSTEM AND SOCIOCULTURAL EVOLUTION: HUMAN ECOLOGY

This chapter began by discussing the components of human systems and continued to discuss some distinctive things about human experience of themselves in relation to their biophysical environments: their dualistic perception of themselves as a species in nature and capability of transcending environmental limitations, the importance of worldviews, ideologies, and cognized environments. Continuing the parallel with ecosystems, we turn to the evolution of human systems, and will highlight some similarities and differences between biological and sociocultural evolution. After long neglect, some scholars are reviving evolutionary thinking about human systems that has the potential to link large- and small-scale processes, explain the emergence of complexity, and link social science to biology without misleading reductionism (Dietz et al., 1990: 155; Maryanski, 1998).

Ecological theorists (Lotka and Odum) argued that ecosystems evolve as different species compete for available energy in the physical environment and selectively survive. If uninterrupted, the result, over time, is a larger, more complex, and inclusive structure of species connected in food chain niches and often in symbiotic relations that range from mutualistic to parasitic. In a parallel way, sociocultural evolution proceeds when humans compete for control over limited resources. As they do so, some persons and groups develop more efficient material infrastructures. Complex relationship systems of statuses and roles emerge that parallel niches in ecosystems. These relationships, and the exchanges of goods, labor, control, loyalty, and symbols on which they are based, parallel *symbiotic relationships* in the biological world. *First*, there are social *exchanges of reciprocity*, which produce egalitarian, mutual benefit relationships in nonhierarchical contexts like mutualism. *Second*, there are social *exchanges of redistribution*, wherein goods and services are shifted "upward" to persons or centers that reallocate them (like profits, plunder, and taxes). These exchanges result in relationships that are asymmetrical in terms of power and equity, and stratified relationships (Polanyi, cited in Rogers, 1994: 45). Reciprocal exchanges predominated among hunter-gatherers, whereas redistributive exchanges became more pronounced as human systems evolved in more complex systems (what we called "civilizations"). Redistributive exchange bears some resemblance to the asymmetry of parasitic and predator–prey relationships.

With the emergence of industrialism, a *third* kind of exchange transformed social systems. Production for *use* became progressively eclipsed by production for exchange for other goods and services. Even human labor became a "commodity for exchange" at a fixed monetary rate. Money as finance capital became the premier material resource of industrial societies. These processes happened within the third form of exchange, in *exchange markets.* Unlike the two mentioned earlier (reciprocity and redistribution), in exchange markets social relationships became embedded in the economy instead of vice versa (Polanyi, cited in Rogers, 1994: 45).

Moving from hunter-gatherers to industrialism, the growing complexity of human technological systems exhibits another parallel with the evolution of ecosystems. Large-scale and complex market exchanges, particularly in industrial societies, dramatically increased occupation specialization (the "division of labor") and other kinds of social differentiation. That is analogous to *speciation*, the evolution of different biological species that use different niches of an environment. Social differentiation represents a kind of *quasispeciation*. In this process, we *H. sapiens*, though remaining a single biological species, use the environment as if we were many species. Different institutions, industries, and occupations use the same biophysical environment in different ways for resources important to their specialized purposes. Thus in a highly complex social order equipped with modern technology, human beings become a *multiniche* species (Hutchinson, 1965; Stephan, 1970; Catton, 1993/94). Why is knowing this important? Well, it illustrates why people in modern societies have difficulty cooperating on problems of common interest without becoming sidetracked by their "special interests."

Hopefully, you can see some parallels between the evolution of ecosystems and sociocultural evolution, but you can't carry these parallels too far, because there are important differences as well. While all animals communicate—that is, transmit behaviorally relevant information—only humans do so extensively through the use of *cultural symbols*. *H. sapiens* share this symbolic capacity with our evolutionary primate cousins, but that of humans is of such greater magnitude that it makes us, in effect, unique among animals. The communication mechanism of other species is largely genetically programmed and innate, unlike the meaning of human symbols, which are *arbitrary* and depend on a consensus of symbol language users (Sanderson, 1995: 32–33).

In biological evolution, the units of transmission and selection are individuals and particular genes that survive (or do not) between generations. In sociocultural evolution, however, the units of transmission and selection may be individuals, a society, or its subsystems. But the generation of sociocultural novelty along with its intergenerational selection and transmission is Lamarckian rather than genetic (Jean-Baptiste Lamarck, Darwin's most famous predecessor, argued that animals could inherit learned behaviors and characteristics). Moreover, "symbol systems can blend, and components can be added to or subtracted from culture, thereby making it difficult to predict what is being inherited or transformed" (Maryanski, cited in Freese, 1998: 29). In this sense, Maryanski argues that human systems do not evolve, but they do change and develop. Most scholars retain the idea of sociocultural evolution but emphasize the accumulation of complex contingencies (such as the generation of novel forms, their transmission and selection over time), which is closer to the biological meaning of the term rather than fixed "stages" of development, common in the early history of the idea (Burns and Dietz, 1992).

These considerations led scholars to abandon earlier strongly deterministic approaches to the evolution of human systems in which environmental and material forces were thought to determine everything else. Earlier generations of anthropologists and geographers coined the notion of *environmental possibilism* for more flexible approaches. These models posit that material and biophysical factors are broad limiting factors for particular human systems, but the most immediate and particular causes of many social and cultural changes are *other* social and cultural factors. Anthropologist Julian Steward, who rekindled interest in sociocultural evolution, used the term *culture core* to describe a society's technology and subsistence economy (earlier referred to as material infrastructure). The biophysical environment has direct interacting effects solely on this culture core, but only indirectly with other elements of human systems. Relationships are two-way interactive ones with feedback, or *cybernetic* ones (Kormondy and Brown, 1998: 45–47). See Figure 1.4.

It is important to note that sociocultural evolution is not a uniform story of more inclusive and technically complex systems. *Devolution* occurred periodically when complex systems like early civilizations collapsed and resulted in smaller, simpler systems. This discussion of ecosystem and sociocultural evolution is not a thorough discussion of sociocultural development, but it has mentioned hunter-gatherer and industrial societies. In what follows industrial societies are discussed in more depth, both because we live in

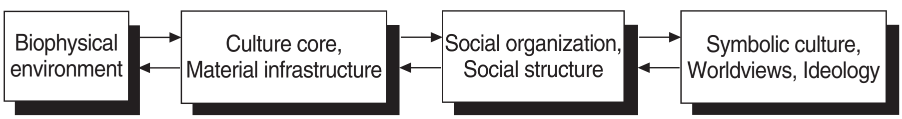


Figure 1.4 Human Ecology Theory: Relationships Between the Biophysical Environment and Sociocultural System Elements

industrial societies and because they are so important in understanding contemporary environmental problems.

INDUSTRIAL SOCIETIES

Industrialization began about 300 years ago in Europe. Like the invention of agriculture, industrialization depended upon some key discoveries and technologies—first in the textile industry in England—that substituted machine production for human and animal labor. Industrial production depended not only on new machines, but also on new energy sources to power them—water power, steam engines, hydroelectric power, fossil fuels, especially coal, and so forth. Like the agricultural revolution, the *industrial revolution* eventually produced a quantum leap in the power to accumulate economic surpluses, and in the scale and complexity of human societies.

Because the new engines and machines were large and expensive, centralized production in factories began to supplant the decentralized "cottage" craft production of earlier times. People began to migrate to cities in unprecedented numbers, not only because the factory jobs were located there, but because the application of industrial techniques to agriculture—such as the introduction of farm machinery and new inorganic chemical fertilizers—reduced the demand for labor in rural areas. In industrial cities, wealth and power began to be associated not so much with control of land—as in agricultural societies—but with ownership and control of industrial enterprises. A new class system based on industrial wealth rather than the ownership of land began to emerge. Increasingly labor became a cash commodity rather than a subsistence activity, with shares as taxes. Work became increasingly separated from family life and bound up with emerging bureaucratic systems of production. Modern complex organizations (bureaucracies) and nation states were significant new social formations of industrialism.

Like the agricultural revolution before it, industrialism stimulated a whole basket of cultural and economic innovations, in transportation and communication, and in medicine, sanitation, and disease control. Prominent among these innovations was the acceleration of the rate of scientific discovery and the application of science-based technologies to economic production. These developments, particularly improved disease control and the rapid accumulation of food stocks, allowed unprecedented population growth and an extension of the human life span. Unlike agricultural societies, in which overpopulation, ecological collapse, and plagues kept global population rates modest (up to about the 1600s), in industrial societies rapid improvements in economic technology and disease control resulted in positive feedback between population growth and accumulating wealth (we will return to population–environment issues in Chapter Five).

However, as with the agricultural revolution, it is arguable whether industrialism improved the life of the ordinary person, at least until after the turn of the twentieth century. Early industrialism as observed by both Charles Dickens and Karl Marx was, for the vast majority, an uprooting from farm life into a bleak new life of misery, industrial hazards, and exploitation in early industrial sweatshops. But, in the longer term, improvements in health and living standards diffused from social elites to ordinary people in the large middle and working classes of industrial societies, if not to those at the bottom. Some scholars argue that after the turn of the twentieth century, industrial societies became more equalitarian than historic agricultural societies in terms of both political rights and the distribution of material well-being (Lenski and Nolan, 1999). Yet this is a slippery argument. Most people live longer, are materially better off, and have more individual freedoms. But have they traded overt forms of social domination and oppression for more subtle forms of control and pervasive alienation unique to the industrial world? Critics of urban industrial societies argue that they have separated humans from nature, destroyed or weakened the bonds of traditional communities (neighborhood, kin), weakened our sense of civic community, and made us dependent on vast international systems (like market economies and treaty organizations) that elicit neither our loyalty nor comprehension. Critics argue urban industrialism produces fragmented ("autonomous") individuals and families with little connection to community at several levels (Young, 1994).

For some time now, a *world-system* of nations with its connected *world market economy* has been evolving. These developments, along with shared cultural traits and aspirations among people in many parts of the world, constitute what is commonly called *globalization*. The world society is characterized by countries' level of development, their wealth and the political influence they hold amongst nations. In simplest terms, a country's level of development is based on whether or not their economy has industrialized and can support the majority of its population above a subsistence level. Several terms are loosely interchanged to refer to nation states. The most-developed countries (MDCs), who are the smallest percentage of the world's population, reside in the Global North and are often referred to as developed countries. They also are the wealthiest and control global trade and finance, which many attribute to their history of imperialism and colonization (we will discuss this further in Chapter Three). The less and least developed countries (LDCs) of the world include the majority of the world's people residing in the Global South and are often referred to as developing countries. They are in various stages of development or underdevelopment, which is linked to their history of being colonized and exploited for raw resources and labor exported to the core.

Importantly, the emergence of a world-system has meant that few hunter-gatherers or agricultural people anywhere on the earth remain untouched by the expansion of the industrial societies. Although the diffusion of industrial technologies, consumer goods, and culture has been uneven, it is now found everywhere. For better or worse, Coca-Cola and Marlboro cigarettes are found in every Chinese village. The polar Eskimos (Inuit people)—those that weren't killed off by smallpox and measles—now zoom around the tundra hunting with snowmobiles and repeating rifles. Gone forever are igloos and dogsleds (except for sport), and their children are now plagued by dental caries from refined sugar in their diets, a problem virtually unknown when they were pristine hunter-gatherers.

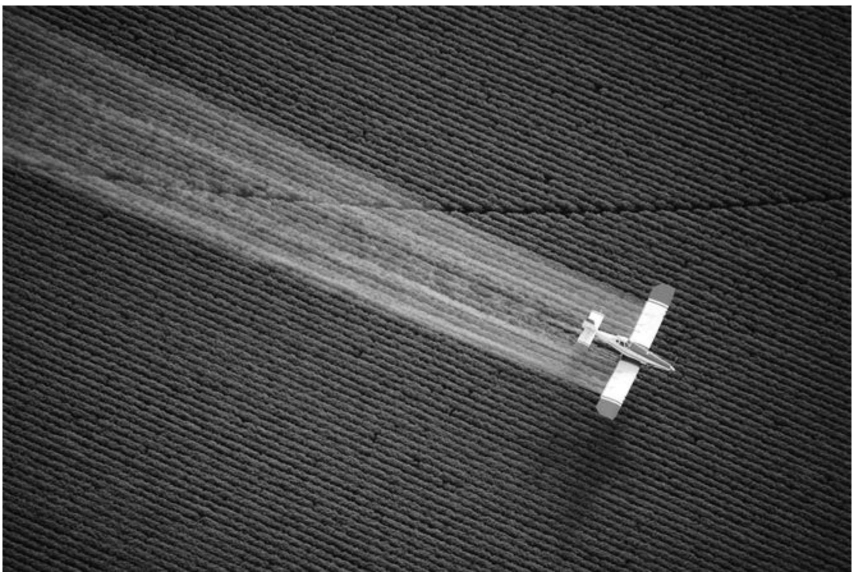
HUMAN–ENVIRONMENT RELATIONS IN INDUSTRIAL SOCIETIES

Like agricultural societies, industrialism dramatically increased human use and withdrawals from the biophysical resource base. The key change in the human–environment relationship was the use of relatively cheap fossil fuels that supported industrialization, more intensive agriculture, and urbanization. This involved much more extensive exploitation of the physical and biotic resource base. It also produced more, and more difficult, pollution as production gradually shifted from natural materials (wood, paper, cotton), which are environmentally benign compared to synthetic materials that break down slowly in ecosystems and may be toxic to humans and wildlife (such as stainless steel, DDT, dioxin, and plastics—chemicals that Mother Nature never knew!).

No evidence yet exists of the weakening or total collapse of an industrial society—for ecological reasons (abundant such evidence exists for historic agricultural societies). This is because the industrial environmental degradation has so far been more than offset by increased investment and technological inputs. Whether this state of affairs will continue to be true in the future is arguable. It is the "big question" taken up in Chapter Six. Here, let us note that it took the Copan Mayans more than 400 years to collapse, and much longer for Mesopotamians. By comparison, industrial societies have only been around for about 300 years, and the growth of world population and technological prowess means that our biophysical impacts are on a much larger scale than in historic agricultural systems.

THE DOMINANT WORLDVIEWS OF INDUSTRIAL SOCIETIES

If the main cognized environment of agricultural societies was that of a garden to be tended, modified, and dominated by humans, that of industrial societies is a dramatic



Shutterstock.com

Figure 1.5 Agricultural monoculture relies on pesticides and herbicides and expensive machinery to increase yields.

extension of this concept. It was amplified particularly by cultural developments of the European Enlightenment period (seventeenth and eighteenth centuries), which emphasized empirical reasoning, science, the world as a giant cosmic mechanism, and the ability of humans to rationally control nature through systematic innovation and experimentation. The earth and other species became cognized as a huge *resource base* and facility to be used, developed, and managed for human needs and desires. Unlike agriculturalists, industrial people not only tended the garden, they also attempted to remake it.

Many scholars have attempted to describe the dominant Western worldview of industrial societies. Although they differ about the details, they agree that industrial worldview amplifies the second part of the human duality already mentioned: that is humans, by virtue of culture and technology, have a unique power to change, manipulate, and sometimes to transcend natural environmental limits. In one way or another, most scholars think that the dominant worldviews of industrial societies have the following themes:

- Low evaluation of nature for its own sake.
- Compassion mainly for those near and dear.
- The assumption that maximizing wealth is important and risks are acceptable in doing so.
- The assumption of no physical ("real") limits to growth that can't be overcome by technological inventiveness.
- The assumption that modern society, culture, and politics are basically okay. (Milbrath, 1989: 119).

Today, environmental sociologists refer to this belief system as the dominant social paradigm (DSP). The DSP is predicated on modern cultural beliefs that individualism, laissez-faire government, and private property rights are inherently good, and unlimited economic growth and progress is always possible (Dunlap and Van Liere, 1984; Dunlap and McCright, 2015).

Some described this worldview as the DSP of free-market or capitalist industrial societies. But it is obvious that the former communist nations of Eastern Europe and the USSR damaged their environments to a much greater degree than did Western market economies. Most now believe that it applies generically to industrial societies. In view of the emergence of the world-system of nations and world market economy, it is also fair to note that this DSP does not affect only the more developed countries of the Northern Hemisphere. Hardly anyone in the world today is immune from it. People in the less developed countries want the things of industrialism (TV, autos, vaccinations, Coca-Cola, and cigarettes). The industrial DSP is diffusing rapidly around the world, where the *desire* for progress is defined largely in terms of increasing material consumption, security, and well-being. This is true even in the poorest less developed countries, where material and health standards are now very low and misery is widespread.

But, it is also important to recognize diversity and change. The DSP does not control everything—there are competing worldviews—and now it is obviously in some kind of flux and transition. Since the beginning of the twentieth century, there *was* concern in the United States about maintaining natural environments (for both utilitarian and aesthetic reasons), which produced turn-of-the-century conservation movements. These movements led to the establishment of protected public lands, national forests, and parks. Similarly, there was concern among agricultural agencies about soil preservation and erosion, which continues today. But increasing popular environmental and ecological awareness was stimulated most directly from environmental problems and *environmental social movements* beginning in the 1960s, in the United States as well as other nations. These topics are the basis of Chapter Eight.

ENVIRONMENTAL SOCIAL SCIENCES

Ecology has been a part of biology since the 1930s, but environmental and ecological social sciences are newer. Their contemporary forms grew mainly in the 1960s and 1970s as scholarly responses to the environmental problems, conflicts, movements, and popular consciousness of those decades. But in fact the social sciences have a long and ambivalent intellectual history in how they think about the environmental embeddedness of human systems. Today almost all social science fields deal meaningfully with environmental issues, almost all contribute to "environmental social science," including anthropology (e.g., in this chapter and Chapter Four), demography and human geography (e.g., in Chapters Five and Six), social psychology and behavioral science (e.g., in Chapters Four, Six, and Eight), and political science (e.g., in Chapter Seven). We will discuss economics and sociology. We begin with economics because it is central to contemporary discourses on environmental problem solving. Sociological perspectives to frame human–environmental issues are introduced in this chapter and will be expanded upon throughout the book.

ECONOMIC THOUGHT

The founders of the field of economics all assumed that the earth's biophysical resources (land, minerals, and living things) were the necessary basis for the economic production of useful goods and services. But, beginning with *Adam Smith* (1723–1790), they argued that *labor,* not nature, was the major source of economic value. Smith argued that the operation of private unregulated *markets* was the best natural mechanism to determine the *economic value* of goods and services and wages. Smith distinguished between market value and moral or social value, separating the latter from economics and thereby initiating the tendency of economic thought to treat the economy in abstraction from the rest of the sociocultural world.

Smith argued that the desire for profits and the "unseen hand" of unregulated markets would produce the best possible economic and social world. It would create a system that reflected "real" economic values and encourage the use of investment, labor, and technology in ways that increase production in response to consumer desires. Smith's view was buoyant and optimistic, reflecting a bustling and successful nation of English traders, shopkeepers, and merchants on the eve of the real industrial expansion that was to come. In the next decades, that optimism would fade. *David Ricardo* (1772–1823), for instance, argued that economic growth and the desire for profits would lead people to bring even marginal resources, such as poor and infertile land, into production. As population grew, it would "become necessary to push the margin of cultivation further" (Heilbroner, 1985: 95). His message was ecological but also moral, for he argued that in the long term only the fortunate landlords stood to gain as their holdings rose in value—not workers struggling to make a living or enterprising capitalists laboring to maintain profits.

Thomas Malthus (1776–1834) argued that increasing production and improved living conditions would lead to population growth. But he argued that population grows exponentially, while material resources such as food supplies increase in an arithmetic way.[3] Malthus predicted that after the boom of initial growth would come the inexorable regression to scarcity, bringing with it the "population checks" of misery, famine, pestilence, war, and social chaos. Malthus not only was an influential figure in economics but also provided an early link among economic, demographic, and ecological thinking.

Karl Marx (1818–1883) like the others is most known for emphasizing how social factors influence production rather than nature. However, he is often described with hyperboles. He has been characterized as an idealist philosopher and utopian theorist, radical, prophet, and of course, a socialist and communist revolutionary. Some fellow scholars, like Max Weber, labeled him an economic determinist suggesting he reduced all of social life to an economic cause. Indeed, Marx emphasized the influence of the economic sphere of life because humans like other animals have to meet their subsistence needs, if not, it is difficult, or impossible to do anything else. It is within the economic institution that humans socially organize their labor to produce their subsistence needs—food, clothing, shelter, and anything beyond. As such, the relationship a person and social groups (referred to as social classes) have to the "means of production" (e.g., land, capital, industrial factories) is fundamental to the social organization of a society and one's experiences within it. He observed that in all societies, other than hunting and gathering, a few individuals own the means of production, such as the kings and queens in feudalism and the bourgeoisie or capitalists (like Bill Gates) in capitalism, while the majority of people, such as the feudal serfs and capitalist workers, through their labor power, produce the owning classes' wealth. According to Marx, the true value of any commodity is the labor power that produces and consumes it. He is thus most well-known for his critiques of capitalism.

The pursuit of profit by owners of the means of production is the motor of capitalism. The main threat to capitalist profits are worker demands for higher wages and benefits, and regulations placed on owners that often have to do with the conditions of the work place (e.g., how many hours of work can be required, compensation for injury at work, a safe work environment) and impact an industry has on the community (e.g., depletion of resources and toxic emissions). Marx recognized the incredible power of industrial technology to deplete resources, generate massive amounts of waste and pollution, and to overproduce commodities, each threatening to lower profits. All in all, the interests of capitalists and workers are in opposition to one another, causing instability and conflict. Thus, like Ricardo and Malthus, he saw chaos at the end of the capitalist era. But he argued that its sources were to be found not in the demographic-economic calculus of Malthus, but in inherent and eventually unmanageable conflicting material interests between economic classes of workers and the owners of the means of production. He believed that their struggle over wages and profits would eventually be resolved through a revolutionary transition to socialism. The creative intellectual accomplishment of these classic thinkers was to move from anecdote to science, to comprehend economic markets as law-abiding systems whose dynamics could be understood and—perhaps someday—predicted. In this quest, they were only partly successful.

As "prophets," one has to admit that they were all a bust: We have not realized the capitalist paradise of Smith; Ricardo's landowners do not dominate the industrial world (certainly not at the expense of finance capital); capitalism has seemingly contained the political apocalyptic demise that Marx predicted (which ironically happened to state socialism in our time); Malthus certainly underestimated the amount of food that could be produced and the number of people who could be supported. But the greatest irony of all was that even though their views gave shape to modern economic thought, they all failed to comprehend the expansionary dynamic of industrial capitalism. They all thought that the growth they were witnessing would be short-lived and that a "dull" steady state economy or system-wide collapse was only a few decades away (Heilbroner, 1985: 305–306). In that assumption, they were dead wrong.

More than the classic thinkers, contemporary economists emphasize the second part of the human–environmental dualism previously described. *Neoclassical theory*, the dominant perspective, views the economy as a circular flow of investment, production, distribution, and consumption, understood in abstraction from the natural environment and rest of social life as well. To put it starkly, in the neoclassical view the economy contains the ecosystem (as resource bases and pollution sinks). Surely a natural scientist would put it the other way around—that the ecosystem contains the economy as well as other human institutions. Neoclassical theory implies that environmental and resource problems cannot be very important ones because the economy is a closed system with a pendulum-like movement between production and consumption. This model is abstracted from the environment: within which the money economy is actually embedded, and there are no connections between money flows and biophysical reality (Rees, 2002: 254).

This prevailing economic model relies on the mechanics of free and open markets to ensure environmental sustainability. The late professor Julian Simon was the most ebullient proponent of the doctrine of "near-perfect sustainability," whereby

> Technology exists now to produce in virtually inexhaustible quantities just about all the products made by nature … We have in our hand now … the technology to feed, clothe, and supply energy to an ever-growing population for the next 7 billion years.
>
> (1996: 342)

They maintain that technological advancements will outpace resource scarcity over the long run and ecological services can be replaced by new technologies. Economic markets work the same to make money and determine prices whether resources are plentiful or scarce. Nor do social values or questions of justice intrude: Markets work whether you are growing corn, producing health services, selling heroin, cleaning up toxic wastes, or selling slaves. Neoclassical economics deals extensively with "efficient" allocation, secondarily with distribution, and not at all with matters of scale. Although construing the world in narrow and abstract terms, neoclassical economics has become enormously influential in industrial societies in shaping debates about social, political, and environmental policy. This is true partly because the theory appears more objective by deliberately ignoring questions of human values and political and ethical considerations. But these are important human questions and considerations that ought not to be "ruled out of court" (Costanza et al., 1995: 60, 80; Daly and Townsend, 1993: 3–6).

As early as the 1950s some economists began to take resource issues more seriously and by the 1960s *environmental economics* became an established sub-discipline. Environmental economists, however, have not significantly recast neoclassical theory (Beder, 2011). Thus, by the 1970s, a small and growing band of *ecological economists* were trying to recast economic theory by finding ways of incorporating both *nature* and *human values* into their economic calculus. They began by viewing the economy not as a separate isolated system but, rather, as an inextricably integrated, completely contained, and wholly dependent subsystem of the ecosphere. In contrast to neoclassical economics, *ecological economics* sees the economy as an open, growing, wholly dependent subsystem of a materially closed, not-growing, finite ecosphere.

> The biophysical fact is that through the technology-driven expansions of the economy, human beings have become the dominant consumer organism in the world's major ecosystems … This poses a serious challenge to the mainstream belief that economic activity is not seriously limited by biophysical constraints.
>
> (Rees, 2002: 259)

See Figure 1.6.

Ecological economists have addressed a new set of problems and dilemmas that are outside the boundaries of conventional economic analyses. Here are two illustrations: (1) How can values ("prices") be assigned to goods that are held in common (the "commons") that are used by many and owned by none, such as the atmosphere,

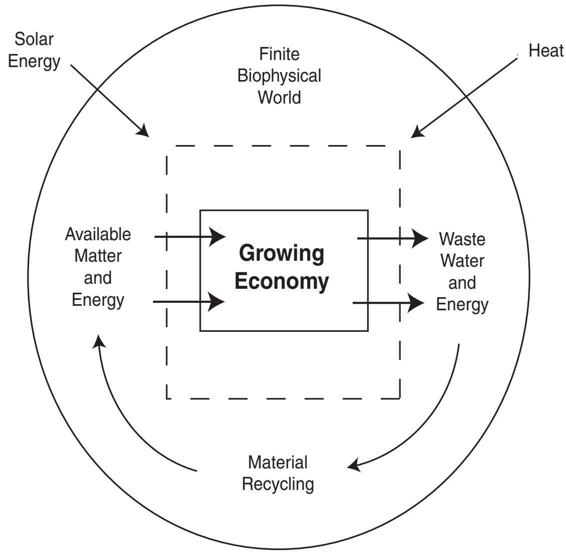


Figure 1.6 Ecological Economics: Growth in a Finite World

rivers, oceans, and public space? They cannot be privately owned in small pieces that can be meaningfully bought or sold, hence there *is* no market for them, and therefore no prices to limit use. The widely recognized problem is that we tend to overuse common as opposed to privately held goods (Hardin, 1968, 1993). (2) How can economic analysis incorporate and assign responsibility for the variety of environmental and social *externalities*, that is, the real overhead or human costs incurred in the production process that are borne not by particular producers or consumers but by third parties, the larger social community, or the environment (Clark, 1991: 404)?

Ecological economics challenges the article of faith of neoclassical economists that human ingenuity and technology will always overcome environmental limits and ecosystem capacities. It also recognizes important matters of value that can't be reduced to price efficiency: "A good distribution is one that is *just* or *fair*, or at least one in which the degree of inequality is limited within some acceptable range" (Costanza et al., 1995: 80). How much inequality is just? As you can see not only *nature,* but also *human values* and *culture* have been reintroduced center stage. Analyses of the causes and consequences of social inequalities and human culture and values happen to be sociological specialties.

The social sciences, however, have historically been marginalized within environmental research and policy, but when incorporated, it is economics, mostly from a neoclassical perspective. In fact, policy that uses economic market tools is the "business as usual" approach to environmental problem solving. Two primary examples are emissions trading schemes and ecological modernization. *Emissions trading schemes* entail assigning producers of wastes and emissions, such as greenhouse gases, tradable "credits" for less environmentally damaging production. These credits can then be traded or auctioned (for money) to greater polluters (per unit of product). An example is "cap" and "trade" policies used to address global climate change. Emissions trading systems are supposed to reverse the typical economic benefits that go to polluting firms, which make money by simply dumping pollutants into the environment (Tietenberg, 2002). Second, *ecological modernization* argues that while modernizing, firms could become more efficient by mimicking an ecosystem with lots of feedback systems and recycling, for instance by using wastes from one process to supply or fuel another economic process (referred to as cogeneration). Ecological modernists adhere to the belief that technology can solve resource scarcity and pollution issues. Ecological modernization, originated among economists and business leaders and elaborated by ecological economists and some environmental sociologists, is now an important framework for research and policy (Mol, 2003; Mol and Sonnenfeld, 2000). Today, some environmental scholars (including ecological economists) and activists argue that the "business as usual" approach is more of a driver of environmental problems than a solution. As such, calls for a new approach and set of tools have been issued. By no means is it suggested that economic conditions and markets tools be ignored or thrown out, but rather a truly interdisciplinary approach that draws upon the knowledge, skills, and experiences of a diverse set of scholars and local community people is said to be needed (Beder, 2011; Dunlap and Brulle, 2015; Klein, 2014). We will return to these issues in Chapters Three, Six, and Seven. For now, let us turn to sociology.

SOCIOLOGICAL THOUGHT

By the 1880s sociological thinking was taking shape across the English Channel in France and Germany. In vast oversimplification, the classic formulations in sociology can be understood in the work of three paramount figures: Karl Marx, Emile Durkheim, and Max Weber. Like the classical thinkers of economics, they sought to establish social analysis by *dissociating* it from the fashionable biological determinism of the day that used biological analogies to understand social phenomena (Buttel, 1986: 340). Classic sociological thinkers did not totally ignore natural and environmental factors, but were focused on showing how society as an external force influences human behavior, and social interactions and processes.

But when the environment became a widely recognized American problem in the 1960s and 1970s (such as with air and water quality, urban pollution, and toxic wastes), some analysts turned to the sociology of environmental issues, and how people perceived and related to them. Some wondered why sociologists were so reluctant to treat physical and environmental variables as important influences on society and culture. In a series of groundbreaking papers, Dunlap and Catton maintained that sociologists had unwittingly adopted a scientific paradigm that prevented them from doing so.

Philosopher of science Thomas Kuhn developed the notion of scientific paradigms to describe the mental image of scientists that guided their theory and research in particular fields (1970). A *paradigm* is a set of implicit assumptions about the "way the world works" or a "lens" through which scholars view their subject and practice their craft. It is not a theory (about relationships between variables) but rather a "fundamental image of the subject matter representing a broad consensus within a discipline" (Ritzer, 1975: 7). Dunlap and Catton also suggested that the dominant paradigm in sociology was shaped—not surprisingly—by their own classical theories and the DSP of industrial and Western society (Catton and Dunlap, 1978; Dunlap and Catton, 2002: 332). They called it the *Human Exemptionalism Paradigm* (HEP) because it assumed that humans are unique among species and that we are exempt from the power of environmental forces.

- Humans are unique among the earth's creatures, for they have culture.
- Culture can vary almost infinitely and can change much more rapidly than biological traits.
- Thus, many human differences are socially induced rather than inborn; they can be socially altered, and inconvenient differences can be eliminated.
- Thus, cultural accumulation means that progress can continue without limit, making all social problems ultimately solvable.

Critical of the notion of human exemptionalism, Catton and Dunlap urged sociologists to "get over it" and move toward another paradigm that would facilitate taking environmental variables seriously in their studies, which they termed the *New Ecological Paradigm* (NEP), with the assumptions contrary to HEP:

- Humans have exceptional characteristics, but they remain one among many species that are interdependent in ecosystems.
- Humans are shaped not only by social and cultural forces, but also by cause, effect, and feedback linkages in the web of nature.
- Humans live in a finite biophysical environment that imposes potent restraints on human affairs.
- Although the powers derived from human inventiveness may seem to extend carrying capacity limits, ecological laws cannot be repealed. (Catton and Dunlap, 1978: 42–43)

When sociologists began to create an environmental sociology, they "mined" the ideas of their classical thinkers (where else could they begin?). Classic sociological theorists, even though underemphasizing the role of the natural world as potent in the shaping and containing of social phenomena, nonetheless created perspectives that had seminal ideas for environmental sociology. For *Marx*, there was a materialist view of reality, which included the notion of a nature–society "metabolism" (Foster, 1999). *Durkheim* used biological analogies to understand societies, even though he rejected the biological and psychological determinism of social phenomena. *Weber* conducted research about natural-resource (or "environmental") factors as shaping differences in power among social groups and classes (Buttel, 2002: 39; Buttel, 1986: 340–343). How did environmental sociology develop?

THE GREENING OF SOCIAL THEORY AND SOCIOLOGY

Karl Marx is an influential scholar, whose ideas are either claimed—or *disclaimed* by scholars in many fields, including sociology. Among his multiple critiques of early capitalism, Marx argued that as capitalism advances the concentration of land ownership and productive resources (including money) will grow, as well as the gap between the wealthy and poor classes, with the wealthy having greater political control. In his view, the dominant ideas and values, laws, philosophies, and worldviews—in other words *culture*—legitimate and maintain the material interests of the dominant economic classes.

Marx fine-tuned his political economy theory in his later writings (1848–1883) and further theorized the dynamics of the human–environment relationship. It is in this later work that environmental sociologist John Bellamy Foster (1999) resurrected Marx's metabolic rift theory. At its core, the theory of metabolic rift sees the process of human labor as a metabolic exchange between human beings and the natural environment, an exchange that is fundamental to human survival. Marx's theory of a metabolic rift attempts to show how human social development and nature coevolve. That is, humans transform nature through their production practices by extracting from nature their subsistence needs and returning to nature the by-products of that exchange. But how humans transform nature is based upon what is inherited from previous generations in both the conditions of their natural environment and their social historical conditions (tools, technology, cultural knowledge and beliefs, and institutional arrangements like being born in a nation state that enforces private property rights) (Foster, 1999, 2013). Marx understood the nutrient cycle introduced at the beginning of the chapter as a constraint imposed on human-societal development, and human-societal development as a constraint imposed on nature.

Marx developed his theory of a metabolic rift by tackling the main ecological crisis of his time, the loss of soil fertility (looked at in Chapter Two) (Foster, 1999). He argued that soil degradation was driven by the antagonism of town and country in capitalism. Industrialization had brought about a rural exodus to the city, causing a metabolic rift—an imbalance—between humans and the natural environment—imposing negative consequences for the development of both. The removal of people from the land that provided for their sustenance deprived the land of human organic wastes needed for its replenishment. Further, raw resources extracted from the land, such as food and fiber for clothing, were shipped from the country to the town for manufacturing and consumption. Once again, the organic waste by-products of the food and fiber were not returned to the soil for nutrient recycling. Thus, by the early 1800s soil depleted of nutrients had become a serious problem. And in the city, the disposal of massive amounts of human and animal excrement was a major pollution challenge.

Soil scientists attempted to fix the problem of soil depletion with technological breakthroughs in fertilizers (referred to as the second agricultural revolution). Yet, the advent of industrial agricultural technology increased dependency on nitrogen fertilizers and agricultural machinery as a means to expand production and meet changing consumer demands, such as the contemporary meat centric diet. Rather than developing sustainable agricultural technologies and social relationships that "restored" the metabolic relation between the land and humans, Marx saw that capitalists would invest in technology for short-term economic gain, causing further environmental (soil depletion, ground water contamination, deforestation) and social problems (displacement of rural labor, concentration of wealth and income, health problems) for current and future generations (Foster, 1999). Today, agribusiness dominates the food system. Animals have been removed from farms to be raised in concentrated animal feeding operations (CAFOs) leading to an overproduction of animal waste that can outstrip the capacity of the land to absorb and recycle the nitrogen. Marx saw how the technology of industrialization can simultaneously create the illusion that humans are exempt from the laws of nature and disrupt fundamental ecological exchanges.

In sociology, Marx's concepts and theory are typically incorporated within perspectives referred to as *conflict theories*, which argue that the most important societal dynamics are diverse processes by which subsystems and social groups with more or less power (i.e., social classes, race/ethnic groups, genders) come into conflict over control of limited material resources *and* the symbolic rewards of society. In many developing societies, material resources still mean biophysical resources like land and minerals, but in industrial societies, they become *money* as an abstract indicator of economic value. Moreover, as Max Weber pointed out in his critique of Marx, conflict can be about control of the symbols of prestige and social honor (who wins the Academy Awards, Olympic Gold, Nobel Prizes, "Green" Awards, or who is the most Patriotic), as well as material interests.

Through various forms of conflict and power struggles, society's subsystems and social groups attempt to protect or enhance their control of resources and values. These processes periodically exhibit visible tensions and conflict, resulting in inequalities of power and resources that biologists would call a *dominance hierarchy* and social scientists would call a *social stratification system*. Even so, the ability of one part to dominate the system is limited by the others with which they must contend, and society itself is likely to be controlled by a coalition of the most powerful subunits. Both social stability and change derive from such ongoing competition and conflict (Collins, 1975; Olsen, 1968: 151).

One of the most notable conflict perspectives in environmental sociology of human–environment interactions is called the *treadmill of production*, initially developed by Allan Schnaiberg (1980). The treadmill of production perspective is a political economy theory that draws from Marx's analysis of the social and environmental contradictions inherent to industrial capitalism. Schnaiberg and Gould (1994) argue that many social analyses of environmental problems have paid too much attention to consumption and too little to the dynamic of production. Competition makes higher profitability a key to corporate survival, and firms must continually grow to produce profits and attract investments. This imperative for continual growth becomes a *treadmill of production* in which each new level of growth requires future growth, and growth in production requires the stimulation of growth in consumption. The contradiction is that *economic expansion is socially desirable, but ecological disruption is its necessary consequence.* Environmental disruption limits further economic expansion and causes social problems. New technology may introduce efficiencies that reduce the environmental impacts per unit produced, but continued increase in total consumption offsets this effect. The deeper threat of the treadmill may not lie in technologies that pollute, but in the competitive logic of economic growth without limit (Schnaiberg and Gould, 1994: 53). Governments are in the ambivalent situation of being expected to encourage economic growth, pay the costs of environmental disruption, and regulate environmental abuse. The first of these outcomes is of overwhelming *political* importance.

Schnaiberg and Gould propose a *societal–environmental dialectic* as the most likely pattern of change:

1. ***The economic synthesis:*** The system of addressing the contradiction between economic expansion and environmental disruption in favor of maximizing growth without addressing ecological problems.
2. ***The managed scarcity synthesis:*** In which there is an attempt to control only the most pernicious environmental problems that threaten health or further production by regulation; governments appear to be doing more than they really are (the situation of US environmental regulation policies since the 1970s).
3. ***The ecological synthesis:*** Major efforts to reduce environmental degradation through specific controls over treadmill production and consumption institutions directed specifically to that end. Curtailment would produce an economy so that production and consumption would be sustainable from the use of renewable resources. This is a hypothetical case with no known examples; it would emerge only when the disruption of the environment is so severe that the political forces would emerge to support it. (Buttel, 1986: 346–347; Buttel, 2002; Schnaiberg, 1980; Schnaiberg and Gould, 1994)

Conflict-based processes that result in such agreements or syntheses may result in different outcomes: (1) the most powerful entities perpetuate the status quo and enhance their domination, (2) a prolonged stalemate occurs between dominant and contending parts of the system, or (3) significant change takes place that redistributes power, wealth, and privilege. *In most historic moments, the first outcome is most likely.*

The treadmill of production theory has been critiqued, expanded, and extensively used as framework for analyzing a wide range of issues associated with environmental problems, including the production of hazardous wastes and emissions, environmental state policy and green criminology (Freudenburg, 2006; Stretesky et al., 2013), climate change (York et al., 2003), coal mining (Bell and York, 2010), and intensive agriculture and aquaculture (Ladd, 2011; Novek, 2003). It has also been adapted to examine the relationship between militarism and environmental problems called the *treadmill* *of destruction* (Jorgenson and Clark, 2015) and consumerism, called the *treadmill of consumption* (Bell, 2004; Bell and Ashwood, 2016). We will be referring to and examining the findings of some of this research in up-coming chapters.

Also under the umbrella of the conflict perspective are theories and bodies of research that look at the relationship between race/ethnic and gender inequality and environmental problems. In environmental sociologist Robert Bullard's groundbreaking book *Dumping in Dixie: Race, Class and Environmental Quality* (1990 [2000]) the terms environmental racism, environmental justice, and environmental equity were introduced to sociology. In *Dumping in Dixie*, Bullard illustrated how African Americans, despite social class, have been unfairly and unequally saddled with environmental risks and harms, and locally unwanted land uses that negatively impact their health and well-being, property values, inheritance, and overall quality of life. Environmental racism has been framed as a civil rights issue, that every person has the "…basic right to live, work, play, go to school, and worship in a clean and healthy environment" (Bullard and Wright, 2012: 19). Environmental racism and (in)justice addresses questions of the distributional inequity of environmental bads and goods, and the underrepresentation of marginalized populations in environmental decision-making. Bullard led a research team that was the first to expose environmental discrimination under the Civil Rights Act when conducting research for a lawsuit against the siting of a landfill in a predominantly black Houston community. At the time, African Americans were only 25 percent of the population but host to all five of the city-owned landfills, and six of the eight city-owned incinerators were in African American neighborhoods (Bullard and Wright, 2012). Bullard is also a founding member and leader of the environmental justice movement, which is focused on ensuring equity and fairness in environmental decision making so that no community is a sacrifice zone. The claim of environmental racism and injustice has ignited debate within scholarly, policy, and lay circles (Chapters Six and Eight).

Overall, a plethora of research has shown that communities of color, low-income people, women, immigrant and indigenous populations are disproportionately harmed by polluting industries, live in degraded and hazardous environments, denied environmental protections, and at times, are forced to relocate to even more precarious natural and social environments (Bell, 2013; Bullard and Wright, 2009, 2012; Harlan et al., 2015; Taylor, 2014; Wildcat, 2014). The environmental justice literature also takes an *intersectional approach* by recognizing that individuals occupy multiple statuses (social class, gender, race/ethnicity) that combine to bestow advantages or disadvantages given the situation. Socially relevant differences intervene, such as age, sexual identity, ability, citizenship and immigration status, and nation, to create distinctive experiences and sensitivities to risks and harms in our social and natural worlds. For instance, disaster preparedness plans that assume people can evacuate by car fail to protect all people within a community. It is disproportionately low-income, people of color, elderly, young and disabled people that do not have access to a personal vehicle (Bullard and Wright, 2012).

Scholars, policy makers, and activists also are addressing climate justice. This research shows that the wealthy countries of the world, which comprise about 15 percent of the global population, release nearly 75 percent of the world's annual carbon emissions, and one very wealthy person may emit about the same amount of carbon as 70,000 individuals in the world's poorest countries. Furthermore, wealthy countries have gobbled up the carbon space—the space available to safely put carbon into the atmosphere by consuming three times their share compared to the poorest 10 percent of the world's population that has contributed less than 1 percent of carbon emissions (Harlan et al., 2015: 127–128). While contributing the least to the problem of climate change, developing countries are disproportionately burdened by current and expected climate change impacts (Ciplet et al., 2015; Harlan et al., 2015).

We will address environmental and climate justice as it relates to topics throughout the book. The environmental justice framework and its principles have been adopted by scholars outside of sociology, policy makers, and nongovernmental organizations, such as the Sierra Club (which issued its first *Robert Bullard Environmental Justice Award* in 2014). The environmental justice frame helps researchers, communities, and policy makers to better understand variations in experiences with the natural environment and environmental problems. There are many reasons to address environmental injustice. First, it violates core human principles of justice and morality. Second, when marginalized populations are sacrificed, it creates additional costs to society. For instance, when a community's tap water is found to be unsafe due to inadequate safety protections, it lowers trust in public tap water more broadly, causing more people to consume bottled water, which incurs negative economic, social, and environmental costs (discussed in Chapter Two). Third, lack of trust in institutions and organizations makes it much more difficult to develop and implement environmental policies that require cooperation and buy-in by community members. Fourth, privileged populations may choose to delay taking action on environmental problems, like climate change (see Chapter Three), which in turn increases the risk of harm for the advantaged and disadvantaged alike.

Another overarching perspective in sociology is referred to as functionalism. *Emile Durkheim* (1858–1917) who was engaged in establishing sociology as a distinct academic field is considered the father of functionalism. The distinctive element of Durkheim's sociology was his emphasis on culture and cultural values (that he came to call "collective representations") as the basic integrative and binding moral force in human societies. He was greatly influenced by the evolutionary thinking of Darwin and he used analogies between biological system and social systems to understand social relations; but, as noted earlier, he vehemently rejected the fashionable "biolologism" of his day (which alleged that biological factors determined everything else), as well as geographic and other environmental determinisms. Durkheim also rejected "great man" theories of history, arguing that society and culture were "sui generis," that is, self-generating systems with their own structure and dynamics. In doing so, he undoubtedly contributed to the dominance of the HEP among later sociologists.

For Durkheim, culture was the most basic force for solidarity in the social world, and he understood human social evolution abstractly as a transition from simple and homogeneous systems with powerfully binding cultural rules (*mechanical solidarity*) to complex and heterogeneous systems with weaker and less binding cultural rules (*organic solidarity*). You can get a concrete sense of this by considering the long evolutionary history of the transition from hunter-gatherers to agricultural "empires," and then to complex industrial societies.

Yet there is a germ of ecological thinking in Durkheim's ideas. Writing at a time when the ideas of Malthus and Marx were in fashion, Durkheim rejected both of their apocalyptic predictions. He argued, to the contrary, that increased population density and the intensification of the struggle over scarce resources were important antecedents to industrialism and the complex division of labor in industrial societies. This increasingly complex division of labor would, he thought, increase the adaptability of more populous and dense societies to their environments by decreasing direct competition over resources and causing cultural innovation—such as science and bureaucracies—that would redefine and effectively expand resources. "The oculist does not struggle with the psychiatrist, nor the shoemaker with the hatter or the cabinet maker, nor the physicist with the chemist, etc." (1893/1964: 262). Occupational specialization in industrial capitalism would produce a "quasi-speciation" much like bottom dwellers and canopy dwellers in tropical rainforest ecosystems, which would not directly compete for the same resources. He thought, in contrast to Marx, that industrialism would mitigate class conflict by reducing scarcity. In his view, the major problems of industrialism would stem from the weakening (cultural) bonds between groups in an increasingly complex division of labor—resulting in rootlessness and cultural confusion (anomie).

Sociologist William Catton contends that Durkheim misread both Darwin and contemporary ecology. The result of the growth of social complexity Durkheim could observe in his time was not a "mutualism of interdependent specialists," but rather a web of unequal power-dependent class relations more akin to "parasitism" that Marx observed (Catton, 1997: 89–138). I'm not sure how devastating this critique is to Durkheimian thought. Although class relations in modern capitalist societies are vastly unequal, they are more equalitarian with regard to both resources and rights than preindustrial ones, as in the empires of the ancient world. Perhaps the point is moot: Predator–prey and host–parasite relations can be symbiotically stable, even if not equitable. Well-adapted predators do not decimate their populations of prey, and a well-adapted parasite doesn't quickly kill its host.

Functionalist theories assume that humans live in sociocultural *systems* that, like all systems, have parts or *subsystems* that work or *function* to keep the entire system going (as the complex division of labor sustains industrial capitalism). To get a sense of this, try a mental experiment: What kinds of processes (functions) are critical to the viability and survival of *any* social system? Some are obvious: (1) producing enough individual people through reproduction, immigration, or organizational recruitment; (2) socializing individuals well enough to be able to live in particular systems; (3) producing enough goods and services to maintain individuals and organizations; (4) maintaining sufficient order and authority to resolve conflicts and allocate goods; and (5) generating enough shared culture to facilitate communication and consensus (see Mack and Bradford, 1979). The particular ways in which such functions are accomplished differ greatly among human societies. Furthermore, note that a sustainable relation between humans and their biophysical environment was *not* a part of this list of functional processes (as understood in the 1950s). Nature was only implied to be "out there" as a resource for economic functioning.

Dunlap and Catton described the functions of the environment differently by suggesting *three functions of the environment* for human society (as well as other species). Ecosystems function as a *supply depot* for human material sustenance. Ecosystems and environmental sinks (like rivers and the atmosphere) function as *waste repositories* for wastes and pollution. In addition, ecosystems provide *living space* for all activities, and overuse of this function produces crowding, congestion, and the destruction of habitats for other species. Moreover, Dunlap and Catton argue that overusing the environment for one function may impair the other functions (as when a waste site makes a neighborhood undesirable for living, or pollutes groundwater resources). Human impacts may become so large that they threaten to be *dysfunctional*, threatening human social viability on a global scale. This impairment may be of such magnitude as to impair the environment's ability to fulfill all three functions, for humans or other species (Catton and Dunlap, 1986; Dunlap and Catton, 2002). See Figure 1.7.

Max Weber (1864–1920) is hardly ever regarded as an ecological thinker, but he was an important early sociological theorist whose ideas have influenced conflict theories and environmental sociology. In contrast to Marx, Weber thought the basic force in society was power itself (not simply the control of wealth). In modern societies, Weber observed, power is increasingly wielded by large-scale organizations and bureaucracies. But, unlike Marx, Weber gave considerable weight to the role of ideas, legitimating ideologies, and myths (broadly, "culture") in historical change and development (Humphrey et al., 2002: 45). Weber argued that the main thrust of Western social development could be understood as the progressive development and diffusion of the cultural complex of "*rationality*"—about linking means and end efficiently—in Western societies, which underlies the development of capitalism, as well as bureaucracy, and empirical science.

Weber's ideas have been extended to environmental sociology in two different ways. One focuses on managers of bureaucratic organizations. Environmental protection involves the government managers and administrators in the process of exercising their power to carry out the intent of environmental protection legislation. Ken Gould (1991), for instance, studied this process by examining the ability of municipalities to enforce water pollution regulations in Canada and the United States. Municipalities differ in size, access to environmental organizations, and dependence on a single local employer. If single industry communities lack access to active environmental

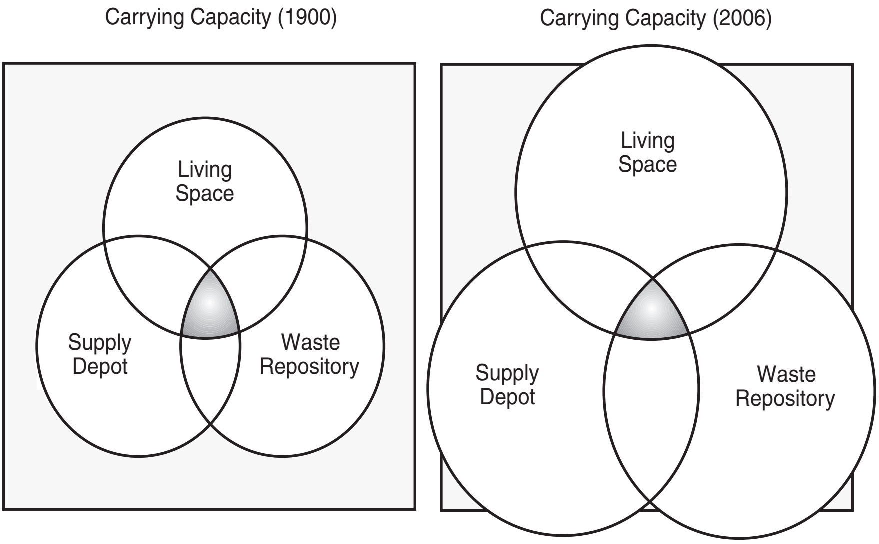


Figure 1.7 The Social Functions of the Environment
Source: Adapted from Dunlap and Catton (2002: 245). Used with permission of Taylor and Francis Group, L.L.C., http://www.taylorandfrancis.com.

organizations, or municipal or state regulators, they will have more limited ability to enforce or manage pollution regulations. Gould found that communities with a more diverse employment base had more political autonomy and, thus, greater managerial control capacity. Greater control capacity meant that regulatory agency managers had more political legitimacy in the community and more effective authority to exercise in environmental management.

The second kind of extension of Weber's ideas helped stimulate *symbolic interactionism* emphasizing the role of symbols, culture, and ideas. It is a social psychological perspective that maintains that self-concepts and behavior are critically shaped by language, symbols, and people's "definitions of the situations." As humans interact, they constantly create, defend, rearrange, and negotiate their identities, social relationships, and cultural meanings (Mead, 1934). An implication of this is that social and cultural reality are, in fact, social constructions, and this gave rise to what were termed *social constructionist* perspectives (Alfred Schutz, 1967; Berger and Luckmann, 1976). They do not deny that real environmental problems exist, but focus on "the process through which environmental claims-makers influence those who have power to recognize environmental problems and accept responsibility for their solutions" (Hannigan, 1995: 55). Social constructionism enables us to understand how environmental concerns vary over time, and how some problems are given a higher priority than others.

This is easily illustrated by the media attention that frames problems like rainforest destruction, or climate change (Leon-Guerrero, 2009: 378). What we take as "things" like organizations, society, culture, social institutions, and even "nature," are really shorthand ways of describing particular historical outcomes of interaction episodes between real human actors. Social construction is a form of social action in which competing groups seek to define issues in terms that support their material interest and thereby reshape underlying material and social processes. The most common application of these perspectives by environmental sociologists is in the study of environmental (and anti-environmental) movements that embody different kinds of "discourses" in American culture about the human–environment relationship (the topic of Chapter Eight).

Seeing the world, and even the environment ("nature"), as a social construction is a subtle but important point. There is, of course, an external biophysical world that exists quite apart from human awareness and perceptions. Humans live in this world and its constraints, but importantly, they do so in terms of how they understand and define it. Furthermore, as noted earlier, people *cognize* the natural world and environment in very different ways at different stages of human development. It should be obvious that the *culture of nature*—that is, the ways we think, teach, talk about, and construct the natural world—is as important a terrain for action as nature itself (Cinnatell, 1999: 294–295; Hannigan, 1995; Wilson, 1992: 87).

CONCLUSION: ENVIRONMENT, ECOSYSTEMS, AND HUMAN SYSTEMS

This chapter ends by summarizing how environments/ecosystems and human systems impact each other, and by emphasizing that every environmental problem is also a social issue.

THE HUMAN DRIVING FORCES OF ENVIRONMENTAL AND ECOLOGICAL CHANGE

Instead of a balance of nature or a "static equilibrium," ecological theory now emphasizes that some change and flux is the normal state of affairs. But environmental and ecological changes today differ from those of the past in at least two ways. The pace of global environmental change has dramatically accelerated, and the most significant environmental changes are now *anthropogenic*, caused by human impacts (Southwick, 1996: 345–348; Stern et al., 1992: 27). Indeed, everywhere you look there are signs of human modifications of the natural world: buildings, roads, farms, human-modified lakes, rivers, and oceans. Even the gaseous envelope surrounding the earth is becoming littered with human refuse—bits and pieces of satellite "junk" now in orbit. As nature recedes into the interstices of the planet, pristine wilderness is becoming so rare that there is concern with preserving the last natural refuges unmodified by human civilizations.

Four types of human variables are *proximate causes* or *driving forces* of environmental and ecosystem change: (1) population change; (2) institutions, particularly political economies that stimulate economic growth; (3) culture, attitudes, and beliefs—including social constructions and environmental problems; and (4) technological change (Stern et al., 1992: 75). Chapter Six discusses another way of understanding environmental impact, as a joint product of population, the level of affluence, and technology (the *I* = *PAT* model).

SYSTEM CONNECTIONS

These human "causes" of environmental change are themselves a complex system that not only produces changes in global ecosystems, but causes changes in each other through complex feedback mechanisms. They are distinct but interdependent. We are unwilling to argue that any one is a "more basic" cause, as some scholars do. We *do* think it is important to distinguish between more proximate causes (such as a particular technology or social forces that produce hunger or civil war) and more distant or underlying levels of causation (such as population pressure or global climate change). Which is more important depends on the time horizons and purposes of analysis.

Within the physical environment, ecosystems and human social systems are interconnected and interdependent, and the scope of human activity is now so vast and

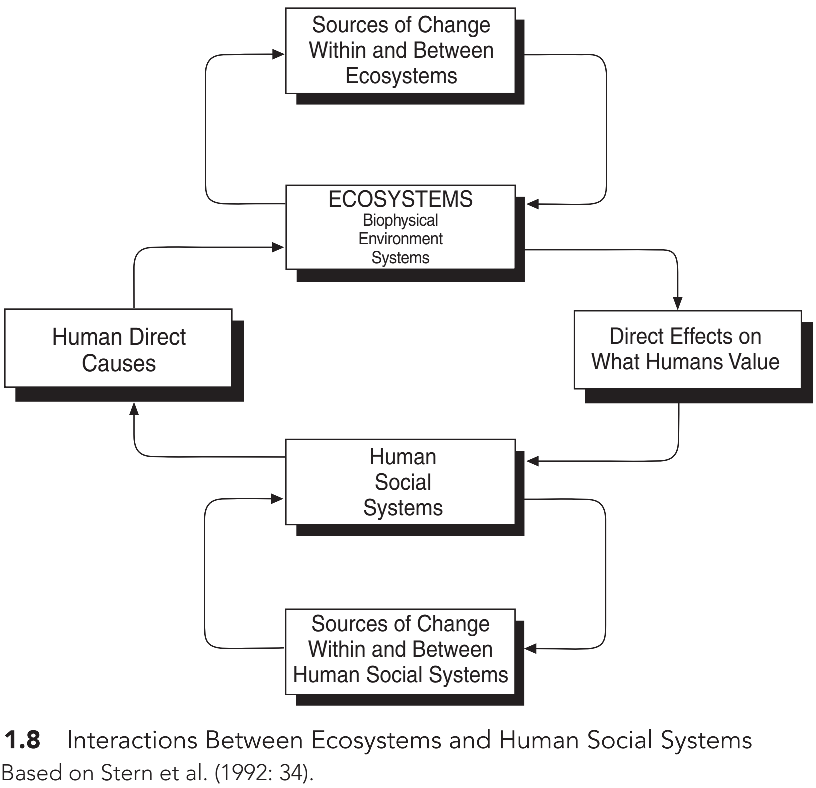


Figure 1.8 Interactions Between Ecosystems and Human Social Systems
Source: Based on Stern et al. (1992: 34).

powerful that hardly any ecosystem in the world is free from human impacts. But each ecosystem has its own internal dynamics of equilibrium and change quite apart from human systems. Similarly, each human system has its own sources of change apart from being embedded in ecosystems. The important thing is to understand the connections by which the dynamics of human societies become the proximate causes of ecosystem change, and the parallel connections between ecosystem change and the things that humans depend on and value. These relationships are summarized in Figure 1.8.

INTELLECTUAL PARADIGMS ABOUT HUMAN–ENVIRONMENT RELATIONS

Scholars from different disciplinary backgrounds have different assumptions about the "way the world works" and thus pose questions a bit differently. Here are three main scholarly paradigms about human–environment issues.

1. Natural scientists emphasize the implications of continuing *growth in scale in a finite world.*
2. Neoclassical economists "frame" the causes of human–environment problems in terms of more proximate causes of *market failure and resource allocation problems.*
3. Other scholars, including some economists, sociologists, and political scientists, frame human–environment problems broadly in terms of other proximate causes, seen as *social inequality and maldistribution.* These include, for instance, national and global patterns involving the vastly unequal distribution of wealth, political power, information, technology, and so forth.

This chapter ends where it began by illustrating the connection between natural science and social science as related to environmental concerns. The varieties of science are also connected to different paradigms. Illustratively the problem of world hunger can be framed as (1) too many people making demands on limited natural and agricultural resources, (2) the overregulation and failure of free markets that make producing food unprofitable compared to other investments, or (3) an adequate total food supply, but hungry people so poor that they cannot afford to buy food and so powerless that governments are unresponsive to their needs (to be revisited in Chapter Five). Such paradigmatic differences are keys to understanding many debates about the seriousness and causes of human–environment problems. Reconciling them as legitimate but different points of view is difficult, but not impossible. Subsequent chapters will return to these paradigmatic differences in various places. *Stay tuned.* Let us end by reiterating what should now be an obvious point. Natural environmental/ecological phenomena and problems are social issues as well. Social questions and controversies arise about, for example, natural resources like fertile land, mineral deposits, pristine forests, and fresh water. Who owns them? Will they be used or left alone? If used, for what, and how fast? Who benefits and who pays the costs? Which people or organizations have a stake in these questions, and whose preferences will prevail? If there is an environmental/ecological problem such as pollution, species extinction, or climate change, who, if anyone, bears the costs of doing something about it? How are such costs distributed? Put more abstractly, "what are called 'natural' resources is in fact social as well as natural; they are products of historical contingent sociocultural definitions just as much as they are products of biochemical processes" (Freudenburg and Frickel, 1995: 8). Now, most scholars are aware that environmental problems and change cannot be understood, much less dealt with, in the absence of substantial contributions of the social sciences (Stern et al., 1992: 24).

PERSONAL CONNECTIONS

QUESTIONS FOR REVIEW

1. What does it mean to say that environmental problems are also social issues? Illustrate concretely.
2. What are the "dominant social paradigm" (DSP) and the "Human Exemptionalism Paradigm" (HEP)? How do you see them operating in our world?
3. How did Malthus and Marx have different views of the causes of environmental problems?
4. What are some differences in environmental perspectives of neoclassical and ecological economists? Similarly, how do the functionalist, conflict, and interactionist perspectives in sociology point to different things and problems about the environment?
5. What are three important functions of the environment for humans? Illustrate concretely. What do these have to do with the notion of an environmental carrying capacity?
6. What are the main human "driving forces" that produce environmental change? Explain.

QUESTIONS FOR REFLECTION

1. What are some of the layers of culture and civilization that tend to insulate you from the natural world? How do they illustrate your embeddedness in nature? Think, for instance, about buying food in a supermarket: That which you normally understand as a consumer actually makes you a participant in vast food chains, energy, and resource transfers that nature never knew. What are some other examples?
2. When do you think about the natural world—when you see it on TV or in books (you know, breathtaking pictures of distant mountains)? Does your daily routine include being in the natural world? Do you normally experience nature with aesthetic appreciation, as a resource to be used, or as an intrusion to be minimized in an otherwise comfortable life?
3. The notion of worldviews is abstract. But look again at the description of the worldview of Western industrial societies in this chapter. Can you see any connection between it and you or your friends' perceptions about "the way the

world works," or values about what is good and bad? How might this be reflected in the behavior of those around you?

4. What kinds of personal inducements are there to keep you or your friends consuming? Pressures from the expectations of others? Time? The media and advertising? What kinds of forces inhibit you and others from adopting more environmentally frugal behavior? What's the connection among recreation, consumption, and waste in your life? How do you "have a good time"?

WHAT YOU CAN DO

"Think globally, act locally" has become a slogan (mantra?) of the environmental movement. If you are concerned about environmental problems, you do need to think globally about them. You also need to act locally, in your own corner of the world. But, you also need to act in ways that have larger-scale relevance. Including a list of things you can do to "walk lighter on the earth" is common in books about environmental issues, and some of these ideas will be mentioned in later chapters. Changing individual lifestyles is important, but not sufficient to address the environmental problems that beset us; powerful institutions and organizations operate beyond individual behaviors. But it does not follow that the actions or attitudes of individuals are irrelevant for larger-scale change. For now, I (Charlie) want to leave you with the notion that the individual matters. This was well put in the novel *Middlemarch*, by the famous British writer George Eliot: "The growing good of the world is dependent on individual acts." Renowned anthropologist Margaret Mead had similar thoughts: "Never doubt that small groups of thoughtful committed citizens can change the world; Indeed, it is the only thing that ever has." Think about how your life does, or could, embody this environmental ethos.

REAL GOODS

Let me tell you about something I (Charlie) have lately come to value, although I didn't for years: *Anne's garden*. My wife, Anne, likes to grow things. We live in an ordinary, older urban neighborhood, with brick and wood-frame houses and big established trees. The trees that shade the backyard are not fancy ones; in fact, a landscaper would call them "weed trees." There's an alanthus (sometimes called the tree of heaven), a mulberry tree, several Chinese elms, and a big cottonwood. I cut the grass—whatever grows, some blue grass and rye grass, but also a variety of weeds and clover that have taken root. By contrast, some of my neighbors spend lots of money having their lawns regularly doused with fertilizer, herbicides, and pesticides, and they have beautifully manicured bluegrass and zoysia monocultures.

Since we first lived there, Anne kept planting and tending flowers and vegetables. There are irises, day lilies, roses, crocuses, and tulips and other flowers, and in various years a mixture of green beans, snow peas, cabbage, broccoli, peppers, and tomatoes. The yard has attracted a variety of creatures: a tribe of entertaining and contentious squirrels, a multitude of bees and pollinators, summer cicadas and other bugs, garter snakes that nest under an upturned corner of an old driveway slab, a variety of birds that nest and feed bats that hunt bugs on summer evenings. Sometimes—if you are very quiet after dusk—a family of hoot owls show up on their nocturnal prowl through the city. Oh yes, there's Jake, a feisty Jack Russell Terrier, who has pretensions to becoming a vicious top carnivore (but not as good at climbing trees as the squirrels).

What's the point? For a long time I just thought it was weird. But more recently it dawned on me that our whole backyard has become a mini-ecosubsystem of its own. A green leafy, vibrant, buggy urban polyculture (compared to the backyard of some neighbors) where something is always blooming and dying. I have come to appreciate why the English word *paradise* derives from a word in an ancient Mideastern language meaning "a small green garden." It is a small corner of the world that I have come to cherish as beautiful in its own right. Every winter I wait for its return.

Can you think of a place you know about that people experience similarly?

MORE RESOURCES

Bullard, R. D. (2000). *Dumping in Dixie: Race, class, and environmental quality* (3rd edition). Boulder, CO: Westview.

Dunlap, R. E. and Marshall, B. (2006). Environmental sociology. In C. Bryant and D. Peck (Eds.), *21st century sociology: A reference handbook*, vol. 2 (pp. 329–340). Thousand Oaks, CA: Sage.

Dunlap, R. E., Buttel, F., Dickens, P., and Gijswijt, A. (2002). *Sociological theory and the environment: Classical foundation, contemporary insights*. Lanham, MD: Rowman & Littlefield Publishers.

Foster, J. B., Clark, B., and York, R. (2011). *The ecological rift: Capitalism's war on the earth*. New York, NY: Monthly Review Press.

McNeill, J. (2000). *An environmental history of the twentieth century world.* New York: W. W. Norton.

Miller, T., and Spoolman, S. (2009). *Living in the environment: Concepts, connections, and solutions* (16th ed.). Belmont, CA: Brooks/Cole.

Ponting, C. (2007). *A new green history of the world: The environment and collapse of great civilizations (updated edition).* London: Penguin Books.

Steiner, F. R. (2016). *Human ecology: How nature and culture shape our world* (2nd ed.). Washington, D.C.: Island Press.

ELECTRONIC RESOURCES

http://www.environmentalscience.org/career/environmental-sociologist.
This website is an excellent resource for environmental science education and career pathways. We have provided the environmental sociology link since we are both environmental sociologists.

https://www.neefusa.org
The National Environmental Education Fund mission is to promote environmental knowledge. It provides a lot of relevant information on current environmental concerns and offers especially good resources on health and environmental concerns.

www.socio.ch/evo/index_evo.htm.
A wealth of research, books, and reports about the evolution of societies by the Sociological Institute from Zurich University in Switzerland (available in English and German).

www.wri.org
The World Resources Institute's accessible and up-to-date reports on various environmental topics (continuously updated)

http://www.worldwatch.org
The Worldwatch Institute provides up-to-date research on pathways to achieving an environmentally sustainable world.

http://www.eldis.org/go/topics/resource-guides/environment.
Offers lots of information on relevant environmental and related topics.

NOTES

1. There were, of course, kings and political empires throughout much of human history. But these were different from modern nation states—with their greatly expanded social functions (e.g., economy subsidy and regulation, public education, and social welfare). Perhaps as important, modern nation states emphasize *sovereignty* as involving the right, not just the coercive power, to rule. Similarly, organizations in the bureaucratic sense are relatively new social inventions that arose at about the same time as nation states. The major difference between modern organizations and those of antiquity is that in modern bureaucratic organizations, accountability and authority are vested in organizational statuses and structures rather than in persons. The importance is that modern organizations have greatly enhanced stability and continuity. The army of Attila the Hun and the pyramid-building crews of the Egyptian pharaohs were both personal empires that did not long survive their founders (the classic formulation of the features of bureaucratic organizations can be found in Weber, 1922/1958).

2. While you should not overdraw the similarities between *Homo sapiens* and other animal species, it would be an equal error to dismiss human rootedness in the biotic world. The relative weights given to biological/genetic programming versus cultural learning as causes of the behavior of humans and other species is a perennial debate that surfaces about every decade in new guises. But this is surely a matter of degrees of difference rather than sharp differences of kind. It is, we think, a matter of "both–and" rather than "either–or." To say that, of course, only concedes an abstract principle and gives no help in knowing specifically how much of which to emphasize in what circumstances. New versions of this heredity–environment debate have been shaped in the subdiscipline of biology that has come to be called *sociobiology*. For more about this, see Barash (1979), Maryanski (1998), Van den Berghe (1977–1978), and Wilson (1975).
3. Linear (arithmetic) growth is additive (1,2,3,4,5,6,7 …), while exponential growth squares each new number (2,4,8,16,32,64 …). If Malthus was correct about this, you could see his point about the inexorable tendency for population to outstrip supply.

CHAPTER 2
HUMANS AND THE RESOURCES OF THE EARTH: SOURCES AND SINKS

In the 1960s, when I (Charlie) was a young man, I took a canoe trip with a friend down the Current River in southeast Missouri. The water was clear and cold, and while the surrounding land was hilly, rocky, and not much good for agriculture except for grazing a few cattle, the river was lined with magnificent forests in the Ozark National Scenic Riverways and the Mark Twain National Forest. Tourism and outfitting canoeists was one of the major industries in the surrounding counties. My father told me that when he was a young man living near the area in the 1920s, the trees had been clear cut by lumber companies and soil erosion had turned the clear spring-fed river into a muddy mess. I marveled at the contrast between the merciless exploitation of resources that had taken place around the turn of the century and the restoration that I witnessed by the 1960s. Although the landscape was certainly not like it was before human settlement, the net effect of human activity over time had in some ways compensated for the damage done at an earlier time, at least in that particular area.

Shutterstock.com

Figure 2.1 Aftermath of deforestation in Madagascar from slash and burn agriculture.

In Chapter One, the contemporary litany of environmental problems was outlined to frame the primary concerns of this book. This chapter returns to some of these problems in more depth and sketches their connections with humans and societies. As an obvious disclaimer, this chapter is not an exhaustive compendium of the state of the planetary resource system. If interested, there are many other sources (scholarly writings and professional literatures) to which you may turn—some suggestions are listed at the end of this chapter and the cited references are another place to begin.

The Earth is a huge system of natural capital, which also serves as a vast recycling system for living things. In narrow anthropocentric terms, you can conceptualize the planet as a series of *sources* (from which resources are drawn) and *sinks* (into which human wastes and effluents go). The chapter discusses the current state and human use of *physical resources:* soil, water, and biotic resources (forests and species diversity). Later chapters address climate and energy resource issues in greater detail. We also discuss *pollution sinks* (of solid wastes and chemical pollutants), or the "supply depots" and "waste repositories" depicted in the previous chapter (Dunlap and Catton, 2002). To tie this chapter with the previous one, think about how each particular resource problem is also a *social issue* and how it connects to the four sociocultural driving forces of environmental and ecological change: Population growth? Social institutions that stimulate economic growth and establish environmental protections? Human culture, attitudes, beliefs, and tastes, such as food preferences? New technologies? Also, an environmental justice frame illuminates how the benefits and costs of current practices that cause environmental harm are distributed as well as who gets to be a part of decision making to address those problems. By using this lens the drivers of ecosystem disruption and opportunities for ecosystem preservation, conservation, and restoration can be clarified. When considering how to address the environmental problems and ecological changes identified, ask yourself if environmental justice is part of that solution?

LAND AND SOIL

Soil is formed from the minerals derived from the breakup and weathering of rocks combined with decaying organic material derived from wastes and the remains of plants and animals. As explained in Chapter One, since soil contains microbes and other detritivores (decomposers), it is not only a variable mix of inorganic and organic compounds, but also a "living layer" of the biosphere. Topsoil layers are particularly rich in the nutrients necessary for primary producers to carry out photosynthesis. Furthermore, land can be degraded and eroded so that it is less productive or even useless for human cultivation. In fact, land is always eroding naturally; topsoil is dissolved or carried away by water or wind, and the rate of this natural erosion varies with local geology, climate, and topography. The *critical question* is the rate of erosion and degradation in relation to the rate of soil formation, and in particular the impact of human activity on the relationship between these two processes. One way to think about this is the connection between soil and food, and in doing so, we outline five key issues.

SOIL AND FOOD

To begin, if human intervention produced a net degradation of soil, how can we explain the enormous increase in food production in recent times—which grew faster than human population? From the beginning of agriculture until about 1950, nearly all the growth of food output came from expanding cultivated land area. Since 1950, a 150–200 percent increase in food output came from increasing *productivity* (Gardner, 2015: 70). Second, while modern "intensive" (also referred to as industrial) agriculture dramatically increased productivity, it nearly destroyed the traditional methods of preserving soil productivity that farmers had learned to practice, such as terracing, contour plowing, crop rotating, using fallow years, using organic fertilizer, and—in the tropics—shifting between agriculture and herd migration. Intensive agriculture encouraged continuous cropping of monocultures without rotation or fallow periods, cropping on hilly and marginal land, and overgrazing in confined pasturelands. In fact, for these reasons, food production is not currently increasing. Grain production was virtually flat in 2005–2006. Grains dominate the world's diet and agricultural landscapes, being planted on half the world's cropland. Per capita consumption, however, increased slightly as countries drew down stocks (what is "left over" between harvests). World cereal stocks continue their long-term decrease (Halweil, 2006b: 22).

Experts have been concerned about the global soil situation for some time (e.g., Eckholm, 1976). In the 1980s, studies of the earth's soils suggested that we could adequately feed the world's population, because there was ample good land that could be used for food production (Crosson and Rosenberg, 1990). However, this optimistic view weakened. Today, land suited for growing food is in short supply. The United Nations Food and Agriculture Organization (FAO) reported that the section around the middle of the earth, which includes countries in the Near East, North Africa, South Asia, Central America, and the Caribbean, has no additional land suitable for cultivation. Africa and South America have some additional land, but it is of marginal quality or is needed for ecological reasons. Keep in mind that many countries in these regions still have growing populations (Gardner, 2015: 70).

Third, the rise in global meat production is creating competition between cattle and people for quality soil and food. Globalization and increasing economic growth and individual wealth, especially in Asia, is shifting dietary preferences away from starch-based diets towards meat and dairy. Since 1800, global meat production has seen a 25-fold increase, outstripping population growth by a factor of 3.6 (Renner, 2014a)! Meat production is heavily reliant on intensive agricultural practices, which require huge quantities of water (discussed later), heavy use of antibiotics, high quality grains for feed, and the use of synthetic fertilizers. Because livestock production requires large amounts of land, its expansion is a significant driver of deforestation and soil erosion from overgrazing. In fact, about 70 percent of agricultural land is used for animal pasture and 10 percent for growing grains as livestock feed. Beef, the most resource-intensive meat, uses three-fifths of the global farmland in exchange for a mere 5 percent of the world's protein and less than 2 percent of its calories (Renner, 2014a).

Fourth, land ownership is tied to who consumes the food grown on it, which is linked to the hierarchies of social class, gender and race/ethnicity. Women grow more than half of the food globally, and in developing countries 60–80 percent of the food is produced by women. They grow mostly staple crops, such as wheat, rice, and maize, which comprise 90 percent of the food consumed by the rural poor. Globally, women make up 70 percent of the 1.3 billion people living in poverty. Their poverty is reinforced by cultural norms and politically restrictive policies that limit their property and inheritance rights. Women own less than 2 percent of the land in developing countries even though they are productive in agriculture and are essential to preserving the land and biodiversity, and to the food security of their families and community. The lack of economic and political power, in addition to low levels of education, are barriers to women receiving extension and research services and adopting new technologies to better manage the soil (Nierenberg and Burney, 2012). Research in the US also shows that women and racial/ethnic minorities do not have equal access to land ownership; African Americans own less than 1 percent and Latinos less than 2 percent. Women and racial/ethnic minorities in the US are finding more opportunities in sustainable agriculture, but as small-scale and lower-income farmers they often lack government support to adopt the best farming practices (Pilgeram, 2011).

A final issue with soil and food is global *land grabbing*—buying or leasing land by foreign investment firms for large-scale agriculture, biofuel production, and government use. Areas most targeted for land grabs are African and Asian countries rich in land or water. Since 2000, the majority of the land grabs, about 42 million hectares (an area about the size of Japan), is for agriculture. The US is the largest land grabbing nation. Land grabs occur for several reasons: a country wants additional resources (land and water) to expand production, or corporations are in pursuit of profits. A spike in land grabbing occurred between 2005 and 2009 in response to a global food price crisis. A key problem with land grabbing is that contracts may not recognize the interests of small-scale farmers who often have been working the land for a long period of time (Gardner, 2015: 70–72).

ADDRESSING SOIL PROBLEMS

To feed a growing global population on increasingly degraded and expensive agricultural resources, we need to increase the productive yield of agriculture while protecting the fertility of cropland soils. That's easy to state, but it is a *formidable* goal, particularly on a global basis. Erosion can be reduced by encouraging terracing, contour plowing, multiple cropping (planting ground cover crops in between rows of corn, for instance), and using low-tillage methods (which leave crop residues on the land for soil binders and organic fertilizer). The use of more organic fertilizer, which is on the rise, reduces the need for chemical fertilizers and increases nutrient recycling.

Many Asian cities systematically recycle human wastes onto the surrounding farmland (Brown, 1988: 50).

Responding to massive soil erosion during the dustbowl of the 1930s, the United States was among the few nations to make soil conservation a national priority. The Conservation Reserve Program (CRP), part of the 1985 Farm Bill, encouraged the conversion of erodible land to grassland or woodland and penalized farmers who didn't manage soil responsibly by denying them the benefits of government farm programs (price supports, crop insurance, and low-interest loans). The good news was that soil losses on erodible cropland were cut by about 65 percent—representing the greatest short-term reduction in erosion in US history. Even with this progress, the Natural Resources Conservation Service (of the US Department of Agriculture) estimated that American soil is eroding 16 times faster than it can form, and the Great Plains states have lost half their topsoil since agriculture began there (Miller, 2005: 280). Experts estimate that the world loses 24 billion tons of topsoil per year (Montgomery, 2010). Reduced vegetative mass on the land also means less carbon is absorbed by the soil, resulting in more carbon in the atmosphere, contributing to climate change (Gardner, 2015).

Contrary to global trends, some propose land reforms that encourage smaller privately owned farms. Small farms gain productivity by using more labor and are less capital- and technology-intensive compared to large industrial farms. Small farmers with secure land ownership are also more likely to care for the land sustainably than are landlords or corporations operating remote large estates. Others also suggest addressing problems of soil (and food) through the application of technology and the advantages of large-scale private management. Indeed, many nations need food price policies that encourage the profitability of agriculture. But land reform and price policy are *political dynamite* because they involve changing the rules about land ownership, may raise the price of food, and produce unintended consequences that pose new problems. For instance, in China it is estimated that 90 percent of grasslands are degraded and the problem is getting worse due to overgrazing and climate change. Researchers, however, have found that the privatization of land and boundary fencing is the driver of overgrazing rather than the sheer number of livestock (Cao et al., 2013). Preserving the soil and increasing the world food supply will require the best efforts not only of agricultural scientists and geneticists, but also of energy planners and economic and political policy makers. This underscores the point made in Chapter One's closing: All environmental problems are also social issues. We will return to food issues in Chapter Five, in connection with population problems.

WATER RESOURCES

Even more clearly than soil, water is the lifeblood of the biosphere and connects all living things. Life is possible because of the solar-driven circulation of water through the *hydrological cycle* from the ocean to the atmosphere, from the atmosphere to the land, and back to the ocean. Water is a renewable resource, but most water circulates from the ocean to the atmosphere and back. A much smaller fraction falls as precipitation over land, and of that, much reevaporates or runs off back to the ocean so that an even smaller amount is available for human agricultural, industrial, and household use. Usable water is *very* unevenly distributed over the earth's surface, so getting enough water has often been a source of political conflict. As water is replenished within the water cycle, we tend to treat it as a renewable, free, and unpriced common good. It is not, however, the volume of water that determines how much is available for use over time, but its renewal or "recharge" rate for groundwater, lakes, and rivers. Worldwide, surface water and groundwater each supply about half of the necessary freshwater, but the recharge rate for groundwater is *very slow*—about 1 percent per year (Cunningham and Cunningham, 2010: 372–373; Miller, 2005: 307–309).

Unlike many resources, there are relatively fixed minimum requirements for water needs. According to the World Health Organization (WHO, 2016), to assure adequate health, people need a minimum of about 20 liters per day for drinking, cooking, and washing. In the global North, however, the average consumption level is 100 liters of water (about 26.5 gal.) per day. Figure 2.2, produced by the FAO shows the global sum of three types of water withdrawals as well as the ratio of water withdrawals by continent. As you can see, globally agriculture (which includes irrigation, livestock, and aquaculture) consumes the majority (69 percent) of freshwater supplies, but there is substantial variation by continent due to climate differences as well as the role agriculture plays in the economy.

There are several pressures placed on water resources worldwide. They include increasing population growth—the world is expected to grow from 7 billion to 9.7 billion by 2050, increasing urbanization and overconsumption, inefficient and poor water

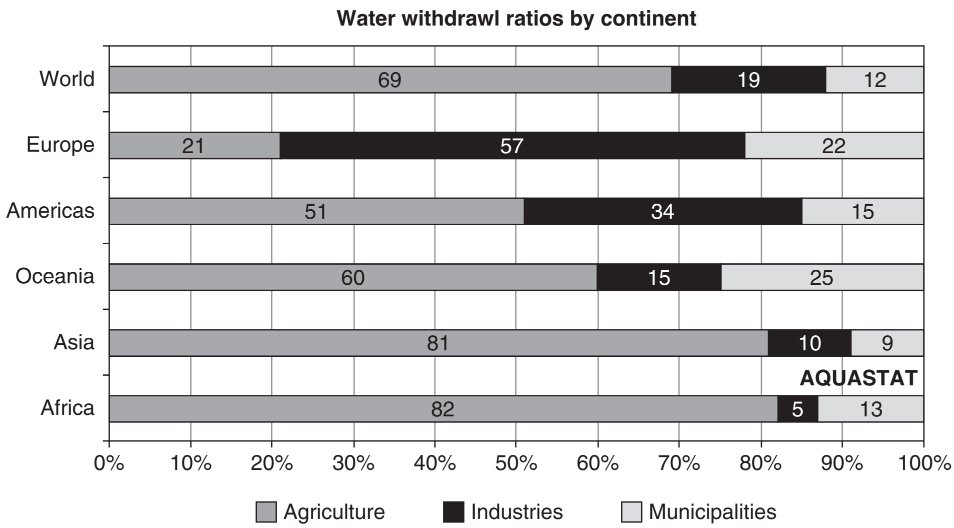


Figure 2.2 Water Ratio Withdrawals by Continent

Source: FAO. 2016. AQUASTAT Website. Food and Agriculture Organization of the United Nations. Available at: http://www.fao.org/nr/water/aquastat/water_use/index.stm. Accessed on June 28, 2016.

management, and climate change (UN Population Division, 2015; Kumar, 2013). The increasing demand for water to meet the needs and expectations of a growing world population results in natural and social system trade-offs. In the next section, we discuss how water scarcity is conceptualized and measured as well as regional variations. Next, we highlight the relationship between agricultural practices, notably irrigation, and water scarcity. We conclude with policy responses that have improved efficiency in water usage and have promoted water security.

WATER SCARCITY AND ITS PROBLEMS

There are two types of water scarcity. First, the problem is *physical scarcity* when there is insufficient water to meet demands. Physical scarcity can be the result of environmental degradation, depletion of groundwater and unequal water distribution. Second, *economic scarcity* occurs when people do not have the financial means to use existing water resources because of a lack of public investment and good management. Approximately, 1.2 billion people, or a fifth of the global population, live in areas of physical scarcity, and 1.6 billion encounter economic scarcities—mostly in LDCs. Hydrologists measure water scarcity by comparing the size of a population with the amount of available water. An area is considered *water stressed* when annual supplies fall below 1,700 cubic meters per person. *Water scarce* areas are those in which annual supplies are less than 1,000 cubic meters, and *absolute scarcity* is when supplies drop below 500 cubic meters (Kumar, 2013).

Regional differences in water scarcity influence a range of issues associated with food security, energy, political unrest and war, economic productivity, and social well-being. Taken as a whole, North America and Europe are not water scarce, having access to renewable water resources. People in these regions, however, consume a large amount of *virtual water*—water that is embodied in the products a population consumes and are traded; around 88 percent of the global flow is in agricultural products (Gardner, 2015). It is estimated that each person in Europe (excluding the former Soviet Union countries) and North America consumes 3 cubic meters per day of virtual water in imported food, compared with 1.4 and 1.1 cubic meters per day in Asia and Africa, respectively (Kumar, 2013). On the other hand, the Asia-Pacific region is not water scarce, but they do live on half of the world's average of annual cubic meters of water resources. Approximately 66 percent of Africa is arid or semi-arid and more than 3 million people each live on less than 1,000 cubic meters of water per person (Kumar, 2013). Figure 2.2 shows that 82 percent of water withdrawals in Africa are for agriculture. As such, land grabs in Africa are amplifying tensions over water and raising environmental justice concerns.

Agriculture is the most inefficient use of water worldwide. Much of the world's food is produced using irrigation. Irrigation has increased food productivity, but it has done so with significant costs. Not only does irrigation cause salinization, waterlogging, and siltation, which all lower the productivity of cropland, approximately 60 percent of the water used for irrigation does not reach its targeted crop (Miller and Spoolman, 2009;

Pimentel et al., 2004). Since irrigation has grown rapidly as a cornerstone of modern agriculture, groundwater supplies are particularly critical.

Globally, it is estimated that about 54 percent of the total area available for irrigation is irrigated with surface water, 5 percent with groundwater, and 41 percent with some combination of both. Moreover, when both sources are combined, less than 15 percent of surface water is utilized (Kumar, 2013). As such, water is pumped from wells much more rapidly than the recharge rates. This "groundwater deficit" is widespread, and as a result water tables are falling in the nations of the world that hold more than half of the people and produce more than half of the grain (including the United States, China, and India). In the shallow northern aquifer that supports China's agriculture, wells that were once dug 20–30 meters deep a decade ago are now dug 120–200 meters deep (Gardner, 2015).

In the US, groundwater depletion has been a concern in California and the Southwest, along the Atlantic coastal plain, and the Gulf plain. The aquifer that supplies water to the nation's "salad bowl" in California's San Joaquin Valley has dropped 10 meters in many places in the last 10 years. The High Plains Ogallala Aquifer, under the Great Plains from Texas to South Dakota, supplies 30 percent of the country's groundwater used for irrigation, and it is being depleted eight times faster than nature can replenish it (Liu, 2006: 104–105; Postel, 2010). At this rate of water consumption, much of the Ogallala Aquifer will be barren in several decades, diminishing 40 percent of the US's beef and grain supplied by that region. As that happens, ripple effects will occur in High Plains economies and communities as they deal with slow depopulation and search for economic alternatives to their traditional agricultural bases. The good news is that the US used 30 percent less water per capita than it did in 1975, according to the data of the US Geological Survey. The lower per capita use stems mainly from increasing efficiency in agricultural irrigation and industries—but not lower household water use. That is still increasing, in spite of regulations that require more efficient toilets and showers. This reduction in per capita water use is good news, but as the US population and economy grows, water use continues to expand even with such efficiencies (Gleick, 2009).

Agricultural policies to decrease global water scarcity dovetail with soil-issue policies. Investing in small-scale farmers, growing diverse crops, and implementing more efficient water use and delivery systems, have each proven effective. A disproportionate share of public investment in agricultural water management has gone to large-scale irrigation systems. Mega-dams have been built around the world in an effort to meet the energy demands of growing populations and for expanding food production through irrigation. Small-scale farmers often operate without relying on irrigation, dams and canals, and thus can reduce water usage. Smart subsidies target producers who otherwise cannot afford to adopt environmentally efficient technologies, such as smaller-scale operations and women farmers. They also can be used to help offset negative impacts of policies, such as restrictions on pumping groundwater (Kumar, 2013; Nierenberg and Burney, 2012).

More efficient irrigation technologies do exist, such as drip irrigation where 90–95 percent of the water used reaches the intended crop. Around the world it is the most expensive irrigation system, and the least used. However, if water were priced to more closely reflect the ecological services it provides, and if government subsidies that encourage water waste were eliminated, it could very well be used to irrigate most of the world's crops (Miller and Spoolman, 2009: 334). To increase water efficiency farmers can use established benchmarks to reduce their green-blue water footprint (rain and irrigation water consumption) and grey water footprint (volume of polluted water such as nitrogen) for specific crops (see, Mekonnen and Hoekstra, 2013). Farmers that follow the global best practices achieve huge savings! But, good management is much more likely when farmers have access to technologies such as drip irrigation, and financing (Gardner, 2015). Finally, agricultural water use is also driven by our diet. In the last 30 years, the global shift to a meat-centric diet has had the greatest impact on water consumption (Kumar, 2013; Renner, 2014a). Today, one-third of 70 percent of the world's water consumed by agriculture is used to grow grain for livestock. Beef is the most water intensive of all meats, requiring 15,415 liters of water per kilogram (the next is sheep/goat using 8,763 liters per kg), and requires far more water than staple foods such as rice (3,400 liters per kg), eggs (3,300 liters), or milk (1,000 liters) (Kumar, 2013; Renner, 2014a). Increasing awareness of the environmental and health impacts of meat consumption, especially beef, is being encouraged by the public health sector and environmentalists—have you heard of the global campaign for *Meatless Mondays?* (See, www.meatlessmonday.com.)

Addressing and managing water problems generates social and political conflict because water is critical to the growing demand for energy, and keeping year-round varieties of food stocked on shelves in grocery markets around the globe. As such, large-scale water development projects are undertaken: dams, irrigation, and river diversion schemes.

The water conflicts in a wealthy nation like the US will be mild compared to those in poorer, drier nations, which have neither the economic wealth nor technological resources to address water problems compared to Kansans or Californians.

WATER AND POLITICAL CONFLICT: TRANSBOUNDARY WATERS

Water does not recognize political boundaries; however, international law treats nations as sovereign entities that have the right to use the water in their territory in their own self-interest (Zeitoun, 2013). *Transboundary waters*—lakes, rivers, inland water and aquifers that are shared by two or more nations—unite nations and pit them against one another. Globally, there are 276 transboundary river basins that account for about 60 percent of the freshwater flow with 148 nations holding territory within them and 21 countries are totally within them (www.unwater.org/topics/transboundary-waters/en). In several regions of the world disputes over transboundary waters have escalated and can amplify historic conflicts between countries over scarce resources. The Jordan River basin is by far the most water-short region, leading to fierce competition between

Jordan, Syria, Palestine (Gaza and the West Bank), and Israel (Miller and Spoolman, 2009: 313; Zeitoun, 2013). When countries negotiate transboundary water rights, trade-offs in the social and ecosystem services of water are often viewed within the upstream–downstream dynamic. Upstream human activities and natural environment and climatic conditions affect downstream water flow and quality, and land, soil, and ecosystems. Often upstream communities or countries have more power given their spatial location. However, political power can override advantages gained from physical location. Also, many countries do not attempt to negotiate, they simply take. Below are two brief case studies to illustrate the relationship between human and natural system influences on conflicts over transboundary water.

First consider the Nile, the world's longest river, which passes through 11 countries. Most recently, it appears as though three of the countries have avoided a "water war." Nile's headwaters begin in the African highlands between Ethiopia and Sudan with the Ethiopian highlands putting in 80 percent of its flow. The most downstream country is Egypt, a desert nation entirely dependent on the river's flow (see Figure 2.3). In March 2015, Ethiopia, Sudan, and Egypt signed an agreement on how they will manage the

Figure 2.3 Nile River Map

newly constructed Grand Ethiopian Renaissance Dam along the Blue Nile. As the largest hydroelectric dam in Africa, Ethiopia will be able to generate enough electricity to meet their own needs, and have surplus to supply to the planned East Africa power grid. Ethiopia claims it has no plans to divert for irrigation, and therefore Egypt, which is dependent on the Nile for irrigating the fields of 40 million farmers, signed the agreement, ending their threat of war over the Nile waters (Gardner, 2015; Pearce, 2015). How is it that Egypt has so much influence on deciding rights to the Nile? What factors are likely to affect the stability of peace along the Nile and ecosystem conservation?

First, a colonial-era treaty created by the British in 1959 granted Egypt most of the Nile flow, and gave only Sudan a small portion of it, ignoring the other countries that share it. Second, Sudan has never extracted its full allotment to the waters under the treaty, which allowed Egypt to exceed their entitlement. Today, Sudan is two countries, and when they split in 2011, they made no agreement on water from the Nile. Egypt is now encouraging South Sudan to tap into its entitlement flow of the White Nile by diverting water away from the Sudd swamp, which is a well-known wetland area rich in biodiversity. Why? Egypt could then strike a deal with South Sudan for more water. Third, the other upstream countries do not recognize the treaty and believe Egypt gets an unfair share of the Nile waters; as a result they periodically push for redistribution of its waters. A fourth factor is climate change, which could increase the Nile's water flow, or dramatically reduce it, by the end of the century (Pearce, 2015; Zeitoun, 2013).

Now consider low-lying Bangladesh, an LDC with a large coastal region that shares 57 transnational rivers, 54 of them with India and three with Myanmar (see Figure 2.4). Most of Bangladesh lies in the delta formed by the Ganges and Brahmaputra rivers, and its very flat, low-lying land is prone to flooding. Water disputes with their more developed and powerful neighbor, India, began in the 1960s when India started damming the Ganges River only miles from their border. Bangladeshi officials viewed this act as a matter of life or death. A water-sharing treaty was signed in 1996, but in 2003 a new conflict emerged with India's Giant River-Link Project (Shamim, 2008). This mega-project, which is supposed to connect 37 rivers through canals, water storage structures, and hydroelectric dams, is just beginning (Howard, 2016). The project's proponents argue it will solve India's problems with flooding, drought, and hunger by creating new irrigated land. India has the second highest number of undernourished people in the world. The project, however, has met resistance from inside and outside of India, due to concerns that potential environmental and social impacts have not been adequately addressed and could lead to ecological and social disaster.

Bangladesh has opposed the project since the beginning, arguing that India has flagrantly ignored international law governing the waters. Second, they raise concerns that altering the hydrological system at such a large scale could worsen drought during the dry season and increase flooding during the monsoon season. It also could cause salinity to gravitate into arable land. These changes pose serious consequences for millions of subsistence

Shutterstock.com

Figure 2.4 Map of Bangladesh

farmers (Shamim, 2008). Third, many point to the risk it poses to the mangrove forests of the Sundarbans, the world's largest remaining coastal forests, which are rich in biodiversity and cultural diversity. Climate change is currently causing the coastline of the Sundarbans to rapidly retreat (Jahan et al., 2013). At the same time, the Sundarbans are a critical defense against climate change for the world and the local forest dwellers—they provide protection from severe storms like tsunamis and cyclones. When healthy, the Sundarbans, like other coastal ecosystems, sequester carbon, which is needed to combat climate change. When degraded, however, they release "blue carbon" stored in the coastal and marine ecosystem sediments, into the atmosphere, contributing to climate change (Pendleton et al., 2012). Furthermore, the Sundarbans' endangered Bengal tiger is put at even greater risk by these changes. If the Sundarbans are to survive, and the rights of ethnic minorities are to be upheld, India and Bangladesh will have to cooperate to protect both (Shamim, 2008).

Some within the international water law community are trying to move negotiations over transboundary waters by adopting a *community of interests* approach (Zeitoun, 2013). A community of interests approach focuses on the mutual benefits of sharing water sovereignty, thereby pursuing a more equitable distribution of water for people and ecosystems. Supporters of this approach believe it effectively addresses the environmental problems of soil degradation, water scarcity, biodiversity, forest preservation, and climate change. It also coincides with the principles of environmental justice, but if it is to be achieved at the international level it will need to occur within nations. In the next section, we discuss the relatively new approach to managing water, privatization. When reading this section, ask yourself: Is access to adequate clean water is a basic human right, or is water a commodity to be sold in the marketplace?

ADDRESSING WATER PROBLEMS: IS PRIVATIZATION THE ANSWER?

In wealthy countries, clean piped water running into homes is a taken-for-granted part of life. Globally, however, approximately 40 percent of people lack reliable access to potable water. In many LDC cities it is not unusual for only upper-income households to have access to municipal piped water. Middle- to lower-income households must then rely on informal water sources (e.g., purchasing water from mostly unregulated small independent suppliers at water kiosks or from delivery providers) where costs are generally higher than if they had access to a piped-water system (Ayalew et al., 2014; Jaffe and Newman, 2013).

Currently, most water resources are owned by governments and managed as public resources for their citizens. However, increasingly, governments are controversially hiring private companies to manage municipal water supplies. They argue that private companies have the money and expertise to manage water resources better and more efficiently than government bureaucracies. As such, transnational corporations are seizing the opportunity to expand their market and are earning major profits from it. Two French-based companies, Suez and Veolia, control about 70 percent of the global water market and are estimated to be worth more than $400 billion. In the global South, the World Bank and International Monetary Fund (IMF) have largely imposed the privatization of water. Beginning in the 1990s, countries were required to open their public utilities for sale, lease or concession as part of a loan package and structural adjustment programs that set the terms for loan repayment. Privatization of municipal water supplies has created a considerable amount of social and political conflict, even "water wars," in places like Bolivia. At the same time, the World Bank has gone on record acknowledging that while privatization has caused social unrest, it has not generated enough profit or new water connections (Jaffe and Newman, 2013: 7).

Privatization efforts have also occurred in the US, especially in cash-strapped cities struggling to sustain aging water utility systems. Similar to the global South, grassroots resistance has led to the cancellation of contracts and the return of water back into the public sphere in cities such as Laredo, Texas; Stockton, California; New Orleans; Atlanta; and Indianapolis. However, the costs of maintaining public water delivery and sewage systems in the US are vast, estimated at $1 trillion over a 20-year period. At the same time, investment in public infrastructure has decreased, and economic insecurity from the Great Recession and public distrust of tap water has increased (Jaffe and Newman, 2013: 8–9).

Public distrust in municipal water supplies has led to a dramatic global increase in bottled water consumption. Four major firms, Nestle, Danone, Coca-Cola, and Pepsi-Cola, control a global market worth at least $65 billion in 2012 (Jaffe and Newman, 2013). The difference in cost between bottled and tap water is staggering: the bottled version costs $500–$1,000 per cubic meter, compared with only 50 cents per cubic meter for quality tap water (Li, 2007). Most of the costs go into production, packaging, transportation, advertising, and corporate profits—not the water itself. At least half of bottled water is treated or filtered tap water and poorly regulated, and many tests show it is no safer than tap water. The life cycle (extraction, processing, packaging, transport, and disposal) of bottled water imposes negative environmental externalities that range from the local to the global level—100 times greater than tap water. Manufacture of the plastic containers involves the extraction of oil and other raw resources; consumption of bottled water takes between 32 to 54 million barrels of oil per year; the plastic bottles do not degrade and most are not recycled (Jaffe and Newman, 2013; Li, 2007; Parag and Roberts, 2009).

The bottled water industry markets their product to a disproportionately middle- to upper-class consumer by promoting health and status. Sociologist Andrew Szasz (2007) uses the concept *inverted quarantine* to explain how individuals attempt to protect themselves from perceived environmental risks through their consumer choices. Bottled water, which appears to be a healthier choice than soda or tap water, has become a status symbol—a sign that an individual has achieved a secure middle-class life earned by making good choices. The inverted quarantine leads to three negative social consequences. First, it dampens public interest in maintaining safe public resources, especially for those who can pay. Second, reduced public pressure and oversight of public water infrastructure creates conditions for increased risks of unsafe tap water, notably for those with the fewest resources. Third, when infrastructure is allowed to decline and treatment regulations are lax or ignored, water quality may be compromised. There have been well-publicized cases of water contamination, which then reinforces the general public's distrust of municipal supplies (Jaffe and Newman, 2013; Li, 2007; Parag and Roberts, 2009; Szasz, 2007).

The bottled water industry has faced push back. Communities at spring water extraction sites, or when firms draw from municipal supplies, have disputed the means by which firms have garnered rights to the water and the conditions of the agreement, such as lacking fair compensation. Local communities and environmental groups also have raised concerns over local environmental impacts, such as water depletion and harm to fisheries (Jaffe and Newman, 2013). Finally, several cities, including San Francisco, New York, St. Louis, Vancouver, Toronto, and Liverpool, as well as more than 50 university and college campuses, now prohibit the sale of bottled water (Jaffe and Newman, 2013; Berman and Johnson, 2015). Nonetheless, the bottled water industry could hold greater potential for future profit than privatizing municipal water networks. First, bottled water has lower investment costs compared to a municipal water system that requires developing or upgrading infrastructure. Second, bottled water is a far more mobile commodity. Third, people can get locked into purchasing bottled water, such as in places

Getty image

Figure 2.5 A mother holds up a baby bottle of contaminated water at congressional hearing on the Flint water crisis.

that lack public investment in water delivery systems, and/or when the water is unsafe to consume, where people have little choice but to find a way to pay for it (Jaffe and Newman, 2013: 21–22). This approach, however, reinforces social and environmental inequities within and between countries. The recent Flint, Michigan water crisis tragically illustrates this point.

On January 12, 2016, Governor Rick Synder directed his state national guard to distribute bottled water to the 99,000 residents of Flint, Michigan. He also announced that between June 2014 and November 2015 an outbreak of Legionnaires' disease occurred in Flint, with 87 reported cases and 10 deaths. Legionnaires' disease can be acquired from water-borne bacteria. Meanwhile, state public health officials declared every child residing in Flint under the age of six—close to 9,000 children—to be treated as *lead exposed* from drinking the city's corrosive tap water (Tanner, 2016). There is no safe level of lead in water, but the EPA sets the limit at 15 ppb. Water with 5,000 ppb is considered hazardous waste. The highest reading in Flint was 13,200 ppb. Children under six and fetuses are at risk for the most severe health effects because their brains and nervous systems are developing (see the World Health Organization, www.who.int/mediacentre/factsheets/fs379/en). Exposure began in April 2014. So, what happened?

Flint had been the hub of GM manufacturing until it downsized in the 1980s. After that, the city lost population and public disinvestment began. Today, Flint is a predominantly African American city (56.6 percent) and economically disadvantaged with over

40 percent of its residents living below the official poverty line. In 2011, Flint was projected to run a budget deficit so the state decided to pursue *austerity*—find public expenditures to cut—and the state-appointed emergency manager chose the water. For decades, Flint's water came from Lake Huron supplied by Detroit. The new supplier would also draw from Lake Huron, but because piping was not yet complete, to save approximately $1 million, in April 2014, the city started to pump water from the Flint River known to be polluted by industrial toxins, sewage, and farm run-off. By August 2014 the bacteria fecal coliform was detected so the water was treated with chlorine, but it became a repeated problem. This led GM in October 2014 to cut a deal with the city to switch to another supplier of Lake Huron water due to concerns that the high levels of chlorine could corrode engine parts. The citizens of Flint were not given the same consideration even though in January 2015, Detroit offered to waive the reconnection fee to their water system. City officials declined the offer due to concerns that rates would go up. As it turns out, Flint River water is difficult to sanitize because it has high levels of chloride, which is corrosive to iron, so chlorine cannot be used to kill pathogens. It also leaches lead out of old pipes, the kind that serviced most of the city. This is how the lead got in the water and why switching to a new supplier would not solve the lead problem (Dickenson, 2016).

Despite complaints to local, state, and national government officials, over the smell and dark sediments in the water, skin rashes, hair and eyelashes falling out, and rising evidence of homes and children testing for elevated lead levels, residents were told the water was fine. Finally, in September 2015 an independent Virginia Tech research team received national media coverage of their findings that 40 percent of Flint homes had elevated levels of lead and that the water in Flint was 19 times more corrosive than Detroit's water. A *slow* response began, the city reconnected with Detroit in October, but water pipes were corroded and leaching lead, and concerns about the water quality persisted (Dickinson, 2016). In April 2016, two state officials and one city official were charged with felonies for misleading regulators about the water. In May 2016 civil lawsuits were filed against two private water corporations, Veolia, and Lockwood, Andrews & Newnam, that were hired to help operate the Flint River treatment plant, for negligence and public nuisance, and Veolia has been accused of fraud (see, http://www.npr.org/sections/thetwo-way/2016/04/20/465545378/lead-laced-water-in-flint-a-step-by-step-look-at-the-makings-of-a-crisis). According to environmental sociologist, Robert Bullard, Flint is another tragic example of environmental racism and injustice because the government failed to protect a predominantly black and low-income community from potential and known environmental harm—their human health and life were sacrificed to attempt to save money (listen to interview at, www.pri.org/stories/2016-02-11/professor-says-flints-water-crisis-amounts-environmental-racism).

Flint offers a heartbreaking example of a trust-destroying event in a vital public good that extends far beyond the impacted community. Several steps can, however, be taken to ensure or regain trust in municipal water supplies. First, transparent oversight and open communication between the experts who set water quality standards and the public is critical. Second, periodic third party checks of implementation and enforcement of water quality standards increases trust more than relying on tests done by the supplier and state regulators—often there are too many conflicts of interest. Third, water quality tests should be routinely reported to the public. If water quality issues are identified, the steps to address them, and follow up on its resolution must occur and be well-publicized. Fourth, public support of tap water can be displayed in multiple ways with signage on water quality, and role-modeling by private and public businesses and actors. For example, some state and city governments do not provide bottled water at their sponsored events (Parag and Roberts, 2009). In sum, huge savings can be achieved by maintaining and improving tap water quality. It is estimated to cost more than $70 million a year in the US to dispose of the plastic bottles (we will discuss this further later in the chapter), and this estimate does not include the costs of collection and trucking (Parag and Roberts, 2009). Of course, protecting the source of municipal water supplies is also important.

CONSERVATION OF FRESHWATER ECOSYSTEMS

Rivers, lakes, aquifers, and wetlands tie social and natural systems together. One way to appreciate the value of freshwater is to identify the myriad benefits to human economies. They provide water for drinking and hygiene, irrigation and manufacturing, and such goods as fish and waterfowl, as well as a host of "in-stream" nonextractive benefits including recreation, transportation, flood control, bird and wildlife habitats,

Shutterstock.com

Figure 2.6 The Taimen Conservation Alliance promotes "catch-and-release" fishing of the giant taimen in Mongolia.

the dilution of pollutants, and aesthetic and spiritual fulfillment. Such in-stream benefits are particularly difficult to quantify, since many public goods are not priced by the market economy. However, not all value is economic. The following case illustrates how freshwater ecosystems enable several "capitals or assets" that are the basis of human social societies, to be exchanged; including economic capital (income and wealth), human capital (individual skills and experiences), social capital (social networks and bonds), cultural capital (knowledge and tastes such as food and religious beliefs), and natural capital (ecosystems and biodiversity).

What do US scientists, Buddhist monks, and fly fishing aficionados have in common?[1] A Mongolian fish called the taimen! Reaching a length of nearly 6 feet and a weight of up to 200 pounds, the taimen, a relative of trout and salmon, is one of the largest freshwater fish in the world. The few remaining populations of the taimen are found in the Eg and Uur rivers of North Central Mongolia. Thanks to Mongolia's Buddhist traditions that prohibit or discourage fishing and the eating of fish, the taimen have remained relatively undisturbed in the region. Yet, urban migration in Mongolia has led to cultural changes, including a new taste for fish. Since the early 1990s illegal fishing and poaching has increased, so fisheries scientists, Buddhist monks, and Sweetwater Travel—a joint Mongolian and US company specializing in fly fishing—collaborated to establish the Taimen Conservation Fund of Mongolia in 2003. Their *community conservation model* (see also Chapter Seven) uses the money generated from Sweetwater Travel's catch and release taimen fishery to support the Buddhist monks' efforts to discourage fishing and poaching of the taimen. Fisheries scientists from Mongolia and three American universities monitor the health of the taimen populations. Their model also was designed to boost the local economy to stave off in-coming mining ventures. Today, the taimen face a new threat; the Mongolian government has secured funding from China to build a massive hydroelectric dam on the lower Eg River. Although considered green energy (see Chapter Four), the dam will stop the upstream/downstream movement of the taimen, which will eventually lead to reduced genetic diversity. Since loss of genetic diversity is an early indicator of eventual declines in populations, the dam poses a significant threat to the future of the taimen in Mongolian rivers (Jensen et al., 2009; www.taimenfund.org). Let us turn now to contemporary concerns over biodiversity loss.

BIODIVERSITY AND PLANETARY BOUNDARIES

Biodiversity includes all the earth's species, their genetic diversity, and the ecosystems they inhabit that sustain all life through the energy flow and nutrient cycle (Miller and Spoolman, 2009). It is likely you have heard about concern over biodiversity loss, which includes species extinction and the reduction in genetic variability of species. Compared to the data noted earlier about soil degradation and water problems, the estimates of biodiversity loss are more uncertain. They are uncertain because nobody knows exactly how many species of living things actually exist and therefore nobody can calculate with any precision the true *rate* of extinction (Simon and Wildavsky, 1993; Wilson, 1990: 49). There have been at least four waves of species extinction in the history of the planet. Previous mass extinctions probably caused 50–90 percent of the earth's species to become extinct. Even so, most scientists think the present human-induced wave of extinction surpasses anything since the wave of extinction that took place during the Cretaceous Age (65 million years ago) that ended the age of dinosaurs (Miller and Spoolman, 2009: 185).

In 2009 in a study published in *Nature*, biodiversity loss (change in biosphere integrity) was identified as the "planetary boundary" that humans have crossed more than any other. A *planetary boundary* is defined as the safe operating space for humanity in regard to nine earth systems (biodiversity, climate change, biogeochemical—the nitrogen and phosphorus cycle, ocean acidification, land use, freshwater, ozone depletion, atmospheric aerosols, and chemical pollution) that are connected to the planet's biophysical subsystems and processes (Rockstrom et al., 2009: 472). The two other planetary boundaries identified as having been exceeded are climate change, and the nitrogen cycle within the biogeochemical subsystem due to burning coal and the over-application of fertilizer on farmland. The phosphorus cycle, however, has not been crossed.

This research shows that the earth has always experienced major environmental change, however, the last 10,000 years have been relatively stable, allowing human societies to grow and thrive. Geologists refer to this era of stability as the *Holocene*. During the Holocene, environmental changes were created by natural system fluctuations, and the earth's systems were resilient and able to maintain conditions suitable for human societies. Some scientists are now suggesting that since the industrial revolution, environmental change is primarily driven by human activities and is pushing the earth's systems beyond their capacity to adapt and maintain current conditions hospitable to human societies. Thus, scientists are proposing a new era, the Anthropocene (also discussed in Chapter Three). If a planetary boundary is crossed, the subsystems may not respond in a predictable or smooth fashion, causing abrupt change. For example, a subsystem such as a monsoon could change by becoming erratic—unpredictable in timing, slowing, or intensifying—causing disastrous consequences for humans (Rockstrom et al., 2009: 472). Once a planetary boundary is exceeded, a tipping point may occur where a small change in the earth system causes catastrophic change because the capacity of other systems to respond is outstripped. The concern is not necessarily destroying the planet, but rather, the extinction of humans. Regardless, after each previous wave of mass extinction, biodiversity made a comeback, but it took many millions of years.

BIODIVERSITY AND FORESTS

Forests are critical ecosystems that house a tremendous biodiversity and absorb carbon from the atmosphere. Two-thirds of the forests that existed historically around the world are now gone. Of the three *major* intact and unfragmented forest biomes that cover about 12 percent of the earth's surface, *boreal* forests circling the northern latitudes (e.g., in Canada, Russia, and Scandinavia) are the largest (about 30 percent of the remaining forests). These are followed by *temperate zone* forests (in the United States and Europe) and *tropical* forests, which cover only about 6 percent of the earth's surface (about the size of the lower 48 of the United States), and just four countries—Brazil, Indonesia, Democratic Republic of the Congo, and Peru—contain more than half of the world's tropical forests. Even with this small area, tropical forests receive more than 50 percent of the world's rainfall and provide habitat for the vast majority of the world's known species of plants and animals. This gives them a unique and strategic importance on the earth as a global system (Myers, 1997: 215–216). *Primary forests* (native or virgin forests) show no signs of human impact, and today they are mostly tropical forests, especially rich in species and ecosystem diversity (Normander, 2011).

While FAO shows that forested areas decreased during 2000–2010 by 1.3 percent or 520,000 square kilometers, the good news is the loss was less than the decade of the 1990s. Forests, however, still declined in the first decade of the twenty-first century, mostly due to deforestation for agriculture. Humans are rapidly destroying both boreal and tropical forests. In the north, commercial logging is a primary cause of deforestation, but in the tropics various proportions by commercial loggers, farmers, and ranchers (both peasant and corporate) contribute to this issue. Chances are that the next hamburger you eat or cup of coffee you drink was produced on land that was formerly a tropical forest. Pollution and climate change also take their toll on forests, and the impacts of both will likely increase in the future (Austin, 2010).

In the temperate zone, forests are now roughly stable in *area,* but in the United States much of the forests are regrown secondary forests after clear-cutting in the Northeast, Midwest, and Southeast before the turn of the twentieth century. They are much more fragmented and less biodiverse. Europe has virtually no primary forests left. In both the United States and Europe, a primary reason for reforestation—even more important than deliberate reforestation programs—has been urbanization, which left only a small fraction of the population living on farms. As agriculture and livestock operations became concentrated on productive soils, the pressure on many previously forested lands decreased. Even though temperate forests are now roughly stable in area and are often being "sustainably" managed, many temperate zone forests exhibit declining growth rates, soil nutrients, and wood quality (Cunningham and Cunningham, 2010: 255).

TROPICAL DEFORESTATION

Will the history of temperate zone forests be repeated in tropical zones? Probably not, as tropical forests have different climates, soil types, and ecosystems. In general, tropical forests are richer in species, faster growing, more fragile, and more vulnerable. To a much greater degree than temperate forests, tropical jungle ecosystems depend on nutrient recycling within the forest itself rather than in the (typically) nutrient-poor tropical soil. Moreover, when cleared of tree cover, heavy tropical rains quickly leach and erode existing soil nutrients, making agriculture unsustainable and forest re-growth difficult (Cunningham et al., 2005: 245–246; Normander, 2011).

Globally, half of the original tropical forests remain, but they are rapidly disappearing; faster than the annual loss for all forests. The FAO estimates that about 13 million hectares of tropical forest are cleared every year. Since about 5.7 million hectares are regrown by planting or new growth, the net forest loss is about 7.3 million hectares per year. Put another way, that's an area about the size of a football field cleared every second (Cunningham and Cunningham, 2010: 251; Normander, 2011)! While the biggest driver of tropical deforestation is the conversion of forests to agriculture land, other contributors include population growth, poverty, government policies, urbanization, building transportation networks, lumber exports, and not valuing the economic and ecological services of standing forests (Miller, 2005: 212; Normander, 2011).

In sum, standing forests supply various human and ecosystem services, such as stabilizing landscapes, protecting soils from erosion, helping them retain moisture, and storing and cycling nutrients. They also serve as buffers against pests and diseases. By preserving watersheds, they regulate the quantity and quality of water flows, and they help prevent or moderate floods and store water against drought in downstream territories. They help keep rivers and seacoasts free from silt. Standing forests are critical to the energy balance of the earth and modulate climate at local and regional levels by regulating rainfall and they shape the sunlight reflectivity of the earth (the "albedo" effect). At planetary levels, they help contain global warming because they store and sequester carbon as part of the earth's carbon cycle (see Figure 1.2). While all forests do these things, many of these functions are more prominent in tropical forests (Myers, 1997: 215–216).

DECLINING BIODIVERSITY

We do, of course, appreciate the value of the species that provide our food, fiber, and wood products, but the value of species diversity in ecosystems is largely unappreciated by people (Wilson, 1990: 49). As noted, tropical forests and the world's wetlands (e.g., swamps, mangrove swamps, and saltwater marshes) are particularly rich repositories of species biodiversity, and they are now widely threatened. Moreover, the problem is not just in tropical forests. Since 1996, the International Union for Conservation of Nature (IUCN) has evaluated 46,677 species of plants, animals, fungi, and protists—protozoans and algae. The IUCN uses a standardized rating system that divides evaluated species into seven categories (least concern, near threatened, vulnerable, endangered, critically endangered, extinct in the wild, and extinct), and the categories, vulnerable, endangered, and critically endangered, are together referred to as "threatened." By 2009, 17,291, or 32 percent, were considered threatened. Species classified as "threatened," which are on the organization's *Red List of Threatened Species*, increased by 2.1 percent in 2009 with 365 species added to it. Only two species have been removed from the list since 1996 (Mulrow, 2010). The world's magnificent coral reefs are in steep decline. These unique assemblages of tiny coral animals and symbiotic plants cover less than 0.1 percent of ocean area but are among the earth's most complex and productive ecosystems. As late as 2009, an estimated 20 percent of the world's coral reefs had been "effectively destroyed" with no immediate prospect for recovery, and 27 percent are listed as threatened and another 20 percent near threatened (Mulrow, 2010). They have been lost mainly because of human pressure—from fishing, mining of coral, coastal development, waste dumping, oil spills, and run-off from inland deforestation and farming. The biggest threat today, however, is climate change, which exacerbates other stresses. Besides providing food for some 30 million people, coral reefs generate significant tourism revenue. Florida's reefs were estimated to bring in $1.6 billion annually (Mastney, 2006: 94; Mulrow, 2010). You can see some illustrations of declines or threatened declines of diversity in Table 2.1. It seems particularly poignant that so many primates, our closest biological relatives, are threatened with extinction—sort of like deaths in the family tree.

Table 2.1 Declining Diversity

Plants	In 2005, data from the IUCN estimated that 70% of plant species it assessed and 3% of *all* plant species are threatened with extinction. Equally alarming was the loss of genetic diversity among domestic (crop) plants.
Reptiles	For the 1,677 species assessed by the IUCN, 28% were either threatened with or in danger of immediate extinction. Of the world's 270 turtle species, 42% are rare or threatened with extinction.
Birds	BirdLife International estimated in 2005 that 12% of *all* bird species fell in the "threatened" category. Among the main threats to birds were intensive agriculture, overexploitation, and pollution.
Fish	One-third of North America's freshwater fish stocks are rare, threatened, or endangered; one-third of US coastal fish have declined in population since 1975. Introduction of the Nile perch has helped drive half the 400 species of Lake Victoria, Africa's largest lake, to or near extinction. Of 4,443 species assessed by the IUCN, 32% were either threatened with or in danger of immediate extinction.
Mammals	Of the 5,490 species assessed by the IUCN, 21% were either threatened with or in danger of immediate extinction.
Carnivores	Virtually all species of wild cats and most bears are seriously declining in numbers.
Primates[a]	The IUCN considers primates the most imperiled order of mammals—50% are threatened with extinction, and another 20% are "near-threatened." While many species are threatened, one species (human beings) continually expands, with a world population of more than 6 billion.

[a] An order of mammals that includes monkeys, apes, lemurs, and humans.

Sources: Carrus (2006: 96); Eckerele (2006: 98); Mulrow (2010); Tuxill (1997: 13; 1998: 128).

THE HUMAN CAUSES OF DECLINING BIODIVERSITY

Conservation biologists use the acronym HIPPCO to summarize threats to biodiversity, which stands for Habitat destruction, Invasive species, Pollution, Population (human), Climate change, and Overharvesting (Miller and Spoolman, 2009: 193). Let us examine in more depth three of these. *First,* the greatest threat to all kinds of wild species is the destruction and fragmentation of habitats as humans occupy and control more of the planet. According to conservation biologists, tropical deforestation is the greatest eliminator of species, followed by the destruction of coral reefs and wetlands—the two other great genetic storehouses of species. To reiterate: Tropical forests alone cover only 5 percent of the earth's surface, but contain more than 50 percent of all terrestrial species (and even higher proportions of arthropods and flowering plants). It is estimated that the current rate of species disappearance from tropical forests is about 4,000 to 6,000 species per year, which is about 10,000 times greater than the natural "background" rate of extinction before humans (Wilson, 1990: 54).

Second, modern agriculture is a powerful cause of declining biodiversity. People have historically used more than 7,000 plant species for food, now reduced to largely 20 species around the world. These are mainly wheat, corn, millet, rye, and rice. Humans encountered these plants haphazardly at the dawn of the agricultural revolution, but they are now selectively bred into a few strains with greatly reduced genetic variability. In Sri Lanka, farmers cultivated some 2,000 varieties of rice as late as 1959. Today only five principal varieties are grown. India once had 30,000 varieties of rice; today most production comes from only 10. In a trip through your supermarket fruit section, you can purchase perhaps five or six varieties of apples; in North America alone, more than a hundred varieties were grown and marketed in the late 1800s. The same sort of reduction in genetic variability has taken place in the herds of domesticated cattle, sheep, and horses. The FAO estimated that by the year 2000, two-thirds of all seeds planted in LDCs were of uniform genetic strains. In addition to the destruction of habitats and the impact of agriculture and aquaculture humans have reduced biodiversity in other ways. These include overfishing, commercial hunting and poaching, predator and pest control, the sale of exotic pets and plants, and deliberate or accidental introduction of alien or nonnative species into ecosystems. Nonnative species—usually highly adaptable plants and animals that spread outside their native ranges, often with human help—can greatly disturb habitats (Auth, 2015; Miller, 2002: 565–70; Tuxill, 1998: 129; Wilson, 1990: 85).

Third, the extent to which the earth's climate warms will cause reduction in biodiversity. It will mean changes in seasons, rainfall patterns, ocean currents, and other parts of the earth's life-support systems. Climate change could cause an increased decomposition of forest biomass, triggering the release of more CO_2 and other greenhouse gases into the atmosphere that would magnify warming trends. For over a decade, North America's conifer forests have been under attack by bark beetles, notably the mountain pine beetle—killing more than 70,000 square miles of trees, an area the size of Washington State (Lemonick, 2013). Bark beetle infestations have increased in severity due to intense drought, and overall warming, so more beetles survive winters and move to higher

BOX 2.1

FRESHWATER BIODIVERSITY IN A VANISHING LANDSCAPE

According to the UN's Millennium Ecosystem Assessment 2005 report, desertification is transforming the landscape of Asian steppe grasslands into deserts. Consequently, less water is available to feed streams, lakes, springs and wetlands, imperiling one of the most endangered communities on earth, freshwater invertebrates (Strayer, 2006). Unfortunately, scientists do not know enough about existing biodiversity to understand the severity of the threats to freshwater ecosystems. Biotic surveys and inventories are important in documenting species as a first step in understanding ecosystems and in determining whether biodiversity is threatened. An international team of biodiversity researchers with the Mongolian Aquatic Insect Survey (MAIS) has made it their mission to document and understand biodiversity of imperiled freshwater fauna. The MAIS project team sampled all types of aquatic habitat in Mongolia from 2003 to 2012 with the goals of documenting diversity of freshwater invertebrates and assessing ecological conditions of streams. Economic development of Mongolia, the most stable democracy in Central Asia, has been at odds with conserving biodiversity, thereby increasing the threats to freshwater invertebrates. Mining, over-grazing, hydroelectric dams and fish hatcheries all imperil freshwater biodiversity. Thus, one goal of the MAIS project has been to train Mongolians in biodiversity research so that they can continue to document species diversity in the face of changing times and ecosystems.

elevations where trees are especially vulnerable to infestations. In normal conditions, most trees can withstand beetle attacks because they have built-in natural defenses, but severe drought breaks down those defenses. Once the beetle infestation has reached "epidemic levels," even when more normal conditions return, the trees are overwhelmed and cannot defend themselves. In the past, species often responded to climate changes by migrating or shifting their ranges, which will be more problematic in today's degraded habitats. In sum, the earth's "wild things," both plants and animals, are caught in a vise between declining diversity of agricultural species, habitation destruction, and the threats of global climate change.

CONCERN FOR BIODIVERSITY: WHO CARES ABOUT WILD CREATURES?

We should care about declining biodiversity for at least three reasons: (1) the natural diversity of living things has great actual and potential value as food, medicines, and other substances commercially important for humans; (2) biodiversity provides ecosystem services that play important roles in different niches in ecosystems upon which all life, including human, ultimately depends; and (3) as the earth's evolutionary and biological heritage, the diversity of species is irreplaceable and valuable. Let's expand on each of these points in more detail.

The first reason, in the most anthropocentric terms, is the great actual and potential economic value of natural species diversity. From tropical forests alone, we get essential oils, gums, latexes, resins, tannins, steroids, waxes, acids, phenols, alcohols, rattans, bamboo, flavorings, sweeteners, spices, balsam, pesticides, and dyes. Many wild plants bear oil-rich seeds with potential for the manufacture of fibers, detergents, starch, and edibles. Plants called euphorbias contain hydrocarbons rather than carbohydrates; hydrocarbons make up petroleum. Of the species that are candidates for "petroleum plantations," some can grow in areas made useless by strip mining. Several tree species—including beech, elm, oak, sycamore, willow, and elder—can clean up urban pollution, particularly sulfur dioxide. They act as air coolants. A 20-meter shade tree can mitigate enough heat to offset three tons of air-conditioning costing $20 a day in the United States.

This highly abbreviated list is just the beginning. Consider chemicals from "wild things" in medicine and pharmaceuticals. More than half of all modern medicines are either derived from or modeled on natural compounds from wild species. For example, "The United Nations Developmental Programme estimates the values of pharmaceutical products derived from developing world plants, animals, and microbes to be more than $30 billion per year" (Cunningham and Cunningham, 2010: 228). Pharmaceutical companies are busy prospecting for useful products in many tropical countries, often without compensating them (a practice called *biopiracy*). Merck, the world's largest biomedical company, paid an institute in Costa Rica $1.4 million for plant, animal, and microbe samples to be screened for medicinal applications. Two cases are most famous: *Taxol*, a compound in the bark of the Pacific Yew, can help people with breast and ovarian cancer, not by curing the disease, but by enabling patients to live longer with less pain. Second, the *Rosy Periwinkle* that is found only in Madagascar, has enabled 9 of 10 children with leukemia to survive a normally fatal disease (Myers, 1997: 263–267). The UN Convention on Biodiversity has called for a more equitable sharing of gains from rich and poor nations (Cunningham and Cunningham, 2010: 229).

Among animals, amphibians have been a good source of medicine and pharmaceuticals, since they are beset by all kinds of predators and diseases. Medicine from an Australian tree frog protects against infections. An Ecuadorian rainforest frog secretes a painkiller with 200 times the potency of morphine. Insects secrete substances that promote wound healing and that fight viruses. An octopus extract relieves hypertension, seasnakes produce anticoagulants, and the menhaden (a fish) produces oil that helps atherosclerosis—hardening or narrowing of the arteries. A Caribbean sponge produces a chemical that acts against diseases caused by viruses, much as penicillin did for bacterial diseases (Myers, 1997: 265).

Consider the value of biodiversity for food and agriculture. Although farmers can now purchase and plant genetically engineered seeds, the productivity of our food supply still depends on the plant diversity maintained by wildlands and traditional agricultural practices (Mungai, 2014). Wild relatives of crops continue to be used to maintain the resistance to disease, the vigor, and other positive traits that produce billions of dollars in benefits to global agriculture. Think about the value for humans of *pollinators*, including honey bees, butterflies, and many other species. Pollination services are provided to cultivated food crops both by wild and managed insects that nest in habitats adjacent to croplands and orchards. According to a UN body, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), pollinators are declining in abundance and diversity at the local and regional scales in both Northwest Europe and the US (Gaffney, 2016). The report stated that 5–8 percent of global agricultural production is the direct result of pollination and worth \$235 to \$577 billion of annual output. While the report did not issue a full-scale threat to global food supplies, it did sound the alarm that protecting pollinators is essential to ensuring stable fruit and vegetable yields, and important to the production of many seed, nut, and oil crops. Furthermore, in the United States the number of managed honey bee colonies has been declining since the 1940s. In fact, in the 1940s there were 5 million honey bee colonies and today there are 2.5 million. This decline has occurred while the demand for hives and pollination services has increased, so colonies are being transported increasingly longer distances (USDA, 2015).

These examples illustrate that humans clearly cannot survive by depending only on a few livestock, managed pollinators, and crop species. The diversity of wild species, whose role is underappreciated, is also vital for humans and the maintenance of ecosystems.

Beyond direct human benefits, a *second important reason* for valuing biodiversity is its *ecosystem services*, that is, how it influences the supply of ecosystem goods and services. Ecosystem services include the important roles in particular niches that a diversity of species play in maintaining the food chains, energy and matter cycles, and population balances of entire ecosystems. Scientists use a term called *cascading effect* to describe the process by which change in one component of an ecosystem produces change in another component, which then affects another and so on. For example, the decline of the global shark population shows how the altered role of one species in an ecosystem can change an entire ecosystem. It also shows the human causes and consequences of decline in biodiversity. From the 1990s–2000s in the US most local shark species declined by at least half, thresher sharks by as much as 75 percent, and 11 species declined to the point of "functional elimination." By 2007 the cascading effects of the collapse of shark populations on the local ecology emerged as sharks no longer fulfilled their role as top predators. This meant a rise in cow-nose rays and increased their consumption of clams, oysters, and scallops, which seriously impacted fisheries. While the global shark catch has declined, it is unclear if that is the result of conservation measures or the overall reduction of fished sharks (Auth, 2015).

A *third reason* for valuing species diversity is very different than for human utility or ecosystem services. The diversity of existing species is an irreplaceable product of an eons-long evolutionary process. Every living thing contains from 1 to 10 billion bits of information in its genetic code, brought into existence by an astronomical number of mutations and episodes of natural selection over the course of thousands or millions

Shutterstock/Ethan Daniels

Figure 2.7 Global shark catches tripled between 1950–2000, driven by the demand for shark fin soup—a cultural symbol of high status (above is a finned blacktip reef shark).

of years. This process has enabled life to adapt to an incredible diversity of physical environmental circumstances. But as species diversity declines, natural speciation will not refill the gap left by extinction in any meaningful human time scale. Biodiversity—the world's available gene pool—is one of the earth's most valued and irreplaceable resources (Wilson, 1990: 50, 58).

Shutterstock/WhiteJack

Figure 2.8 In 2012 the Chinese government prohibited shark fin soup at official Chinese banquets (Auth, 2015).

Indigenous people around the world have long recognized the internal value of biodiversity, which includes humans. Many indigenous languages do not have equivalent words for "resource" or "management." Rather, knowledge held by indigenous people is often referred to as *traditional ecological knowledge* (TEK): "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living things (including humans) with one another and with their environment" (Berkes, 2012: 7). TEK is a spiritual worldview that seeks knowledge of and balance in human–environment relationships. It is not an accident that the remaining global hotspots for biodiversity are in places that are also rich in cultural diversity (see https://www.iucn.org/theme/social-policy/our-work/bio-cultural-diversity). Thus, to preserve biodiversity it is essential to preserve *cultural diversity*—generally measured by the number of languages spoken in a region. The majority of the world's nearly 7,000 languages are spoken in ecoregions of planetary importance, such as tropical forests (Vidal, 2014). Since the 1980s the world has been interested in TEK largely for utilitarian purposes because Western scientists began to recognize that indigenous cultures hold storehouses of knowledge of biodiversity, which cannot be fully captured by the scientific method. Others have also turned to indigenous peoples to teach them a new environmental ethic—one not based on degradation and exploitation of other living things (we will return to this topic in Chapter Eight). However, indigenous people are careful not to simply hand over that which has allowed them and the places they call home to survive for generations. They have, however, been active in trying to lead the world in embracing a new environmental ethic that *transcends* viewing the world in narrowly anthropocentric terms, such as "sources and sinks," related only to human uses of the earth and its creatures (Berkes, 2012).

ADDRESSING DEFORESTATION AND DECLINING BIODIVERSITY

As with soil and water resources, there are many ways that the nations of the world could slow or halt unsustainable forest use. One of the most significant ways of reducing tree harvest rates is by more efficient usage, eliminating waste, and recycling. The United States, for instance, has the world's highest per capita paper consumption, of which half is discarded packaging and only about a third is recycled. Increasing the efficiency of sawmills, plywood mills, and construction could reduce much of the US's wood consumption. Similar steps could be taken in the LDCs by the introduction of more efficient cooking stoves to reduce the demand for fuel wood and lower deforestation rates. Let us note a few specific initiatives to preserve forests and biodiversity:

1. ***Promoting sustainable use:*** *Conservation corridors* (also known as connectivity conservation or network conservation) are corridors for species to migrate and disperse when undergoing short-term stress, such as a drought, or a long-term crisis, such as climate change. Corridors also cross national boundaries, such as the Yellowstone to Yukon (Y2Y) between the US and Canada (Mungai, 2014). Second,

collaborative conservation that brings together a diverse set of stakeholders, such as private land holders, local community residents, scientists, and government and environmental organization representatives to address sustainable use of forests, and other ecosystems, has worked in communities across the globe (Bell and Ashwood, 2016; Mungai, 2014). Third, more governmental and environmental organizations are recognizing that the economic, social, and cultural needs of local communities cannot be isolated from conservation efforts (Mungai, 2014). Biodiversity loss is often driven by people doing whatever it takes to meet their daily needs, or adhering to cultural expectations to achieve status in their society. A key barrier to sustainable ecosystem use is political: Big companies and national governments can turn lumber, cattle, or gold into hard currency (for debt payment) more easily than forest products, which offer more benefit to local people. So, who is going to tell them no? As such, strong leadership at the national and international levels is necessary.

2. ***Debt for nature swaps:*** Participating nations act as custodians for protected forest reserves in return for foreign aid or debt relief. Typically, a private organization pays a portion of the debt and supervises the swap. By 1987, there were 31 debts for nature among 13 nations, reducing debt by more than $187 million (Humphrey et al., 2002: 247). Critics charge that such swaps do little to change the circumstances that led to environmental destruction in the first place, and don't eliminate debt. To address these criticisms, in 2000 Conservation International bought long-term logging "rights" for 81,000 hectares (200,000 acres) of tropical rainforest in Guyana so that the government is getting the same benefits it would get if the land were actually being logged (Cunningham et al., 2005: 249).
3. ***Preserving nature in place:*** Conservationists have long sought to set aside parks and nature preserves. Such nature preserves now account for about 8 percent of the earth's surface. These wilderness preserves cause problems when they conflict with cultural and economic uses. Some are protected from poachers in name only. To date, the best job of protecting tropical forests is in Costa Rica, which in the 1970s set aside 12 percent of its land (6 percent for the exclusive use of indigenous people). In comparison, the United States has only 1.8 percent of its land as wilderness reserves not used for any commercial purpose. Such conservation paid off for Costa Rica. Tourism (especially "ecotourism") provides most of its revenues from outside the country.
4. ***Gene banks and conservatories:*** A major approach to preserving plants and animals has been to remove them from their habitats and protect them in specialized institutions, such as zoos, botanical gardens, nurseries, and gene banks. By one estimate, nearly 25 percent of the world's flowering plants and ferns are now so protected. Gene banks focus almost exclusively on storing seeds of crop varieties and their wild relatives. They arose from plant breeders' needs to have readily accessible stocks of breeding material, particularly after the near disaster of the American corn crop in 1970, noted earlier (Tuxill, 1999: 107).
5. ***Bioprospecting:*** In 1991, Merck & Company paid the Costa Rican Biodiversity Institute $1 million to search for and locate tropical organisms as sources of

pharmaceuticals. In the event that marketable products are found, the company will retain the patent and pay the institute an undisclosed royalty (rumored to be 1 percent to 3 percent of sales). Critics of such arrangements argue that most of the money should go to local or indigenous people, from whose land (and often from whose local knowledge or TEK) such products were developed, rather than only to corporations in industrial nations.

6. ***International treaties:*** In 1973, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) provided a powerful legal tool for controlling international trade in threatened plants and animals. It requires that signatory nations issue permits for a limited number of species exports and imports. As you can see, there is a potentially powerful combination of strategies that could be used to slow or stop the process of species extinction.

WASTES AND POLLUTION

Human economies generate enormous amounts of waste. You probably think of *solid wastes* as municipal garbage, but that is only a small but highly visible portion of the solid wastes produced by industrial societies. The US Environmental Protection Agency and the Bureau of Mines estimate that 75 percent of solid wastes are produced by mining and oil and gas production, 13 percent by agriculture, 9.5 percent by industry, 1.5 percent by municipal garbage, and 1 percent by sewage sludge (Miller, 2005: 533). Yet even the 1.5 percent of total solid waste from homes, businesses, and municipalities represents a *significant* amount of discarded junk. Municipal solid waste (MSW) includes organic material, paper, plastic, glass, metals, and other refuse collected by the municipal authority. Globally, approximately 1.3 billion tons of MSW is produced each year and it is increasing due to urbanization, consumerism, and throwaway lifestyles. The volume of MSW is expected to double by 2025. The US is number one on the list of the top 10 MSW generating countries (Gardner, 2012). Consider that Americans throw away:

- Enough aluminum to rebuild the country's entire commercial airline fleet every three months. The airlines alone threw away enough aluminum cans in 2004 to build 58 Boeing 747 jets.
- Enough vehicle tires to encircle the planet almost three times.
- About 2.5 million nonreturnable plastic bottles each hour.
- Enough disposable diapers per year that, if lined up end to end, would reach to the moon and back seven times.
- 1.5 billion pounds of edible food per year.
- Enough office paper to build a wall 11 feet high across the country from New York City to San Francisco. (Miller, 2005: 534)

Electronic or *e-waste* is all the by-products that make TVs, cell phones, computers, and other electronic devices work as well as solar cells and batteries for electric and hybrid vehicles. It is the fastest-growing solid waste problem in the United States and

Shutterstock

Figure 2.9 It is important to recycle e-waste, but do you know where it ends up?

the world. All of these products include components that contain heavy metals and persistent toxic substances (PTS). Some of the toxins found in e-products include polyvinyl chloride (PVC), cadmium, lead, mercury, and brominated flame-retardants, to name just a few. These chemicals are not biodegradable and can contaminate the air, water, and soil. They pose numerous health risks that can cause irreversible damage

Getty Image

Figure 2.10 E-waste market in Lagos, Nigeria.

to human body systems and organs. In the United States, only 2 percent of e-waste is currently recycled (MCallister et al., 2014: 170-171; Miller, 2005: 534). The US and EU combined produce nearly 12 million tons of e-waste annually and it is estimated that 50–80 percent of that is not disposed of locally, but is shipped to China or India. Africa also receives e-waste from MDCs. The management of e-waste raises concerns over global and domestic environmental justice. E-waste is shipped to LDCs that have the fewest environmental and worker protections in place, which saves money for the companies that have profited and the consumers who have used the items. It also means that the environmental and human health consequences are transferred elsewhere. Much of the e-waste shipped to LDCs ends up in the unregulated informal economy; in India only 3 percent is processed in the formal economy. Often the waste is handled by the most marginalized within the most impoverished social groups, notably migrant workers, women, and children. The workers are tasked with separating out the parts that can be sold for recycling, such as copper wire from cables. This is accomplished by burning off the insulation, directly exposing them to released toxins (MCallister et al., 2014; Minter, 2016).

Think about the fact that one-quarter of India's population lives below the global poverty threshold of $1.25 a day. Someone working in the informal e-waste economy can earn from $2–$5 dollars a day. Thus, in the short term, governments in LDCs are incentivized to see e-waste as a commodity rather than as an environmental and health threat (MCallister et al., 2014; 171–172). In the 1980s the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was negotiated to try to curtail the flow of e-waste from MDCs to LDCs. The United States is a signatory, but because it has never ratified, remains the largest exporter of e-waste. Even if the flow of e-waste from MDCs to LDCs were stopped, LDCs are also producing and consuming electronics. Both MDCs and LDCs must reckon with the equitable distribution of the benefits and costs of electronic production and consumption practices (MCallister et al., 2014; Minter, 2016).

ADDRESSING SOLID WASTE PROBLEMS

In the MDCs, modern sanitary landfills are state-of-the-art constructions vastly different from historic town dumps. They have many technical improvements like barriers and caps to keep *leachate* (dangerous liquid waste residue from the degradation of solid wastes) from seeping into soil and drainage pipes. Still, there are problems, because most eventually *do* leak. Tree roots can perforate the barriers and caps. Leachate, which contains over 100 toxic chemicals, does seep out. Many of America's landfills have wells close by, and most municipalities do not test for leachate. Measurable health problems are correlated with proximity to landfills. If, as noted earlier, mineral production and distribution is related to global social inequality, there is a similar national linkage here. Pervasive evidence shows that landfills are more likely to be found close to lower-income and minority populations (Bullard, 1990, 1993; Bullard and Wright, 2012).

In addition to the environmental, health, and social justice issues that surround solid waste dumps, there are a host of other pressing concerns. One is that the dumps are rapidly filling up. Furthermore, people don't want them nearby, and communities have become more effective in blocking the construction of new waste disposal facilities for both industrial and municipal wastes. Governments and industries have responded by seeking to reduce the volume of the solid waste stream by either incinerating (burning) it or recycling it. But there are problems with both.

Incineration does reduce the volume of solid wastes by about 90 percent. Although it removes many harmful chemicals from wastes and has a potential to produce energy, the capital construction costs of incinerators are very high. Incineration also produces ashes that are rich in significantly toxic amounts of chemicals (dioxins, furnans, hydrocarbons, lead, cadmium, chromium, mercury, and zinc). It does little to discourage the production of such wastes and transfers many of them from one sink (the landfill) to another (the atmosphere).

Recycling has been the most publicized solution to reduce the solid waste stream. Recycling varies significantly by country. In 2010, South Korea topped the list of countries with the highest percentage of recycled share of MSW. For the US, the recycled share of MSW was 34 percent in 2010, up from 10 percent in 1980. In LDCs it is difficult to estimate the recycled share because it often takes place in the informal economy. For instance in China, it is estimated that 20 percent of dumped goods are recovered for recycling by "waste pickers" (Gardner, 2012). The MDCs could boost their recycling of municipal waste from 60 percent to 80 percent. Recycling has transformed from a gesture to help the environment into an industry. The causes of this change are economic growth's increased demand for raw materials and the construction of plants that can process recycled materials (Miller, 2005: 540; Scheinberg, 2003). According to the World Bank, the global market for scrap metal is around $30 billion per year. Recycling helps to preserve virgin material, reduces the environmental impacts of logging and mining, saves energy, and can reduce greenhouse gases. For example, aluminum made from recycled aluminum takes 95 percent less energy than aluminum made from virgin ore, saves more than 15 cubic meters of water, and reduces carbon dioxide and sulfur emissions (Gardner, 2012).

Perhaps the most pressing solid waste challenge is plastics. For more than 50 years, the global production of plastics has continued to climb while recovery and recycling of plastics lags with millions of tons sitting in landfills, or ending up in the ocean—about 10–20 billion tons a year (Gourmelon, 2015). The financial cost is steep, with about $13 billion lost yearly to the damage done to marine ecosystems by plastics. In the ocean, plastics break down into tiny particles, microplastics, and once ingested by sea life, they release harmful chemicals and toxic additives, such as plasticizers, flame retardants, and antimicrobial agents into animal and plant life. Ingestion of microplastics interferes with the physiological processes of marine worms, but also through bioaccumulation if it ends up as a chemical pollutant in the fish consumed by predators, including humans

(Auth, 2015; Gourmelon, 2015). In 2012, only 9 percent of plastic was recycled in the US, and the remaining 32 million tons were thrown away—making up about 13 percent of MSW. Most Western countries, including the US, exported their plastics for recycling to countries with weaker environmental controls. China receives the majority of plastic imports, approximately 56 percent (by weight). Similar to concerns with e-waste, it is unclear how plastic recycling is handled. With so few regulations in place it seems much of it is either disposed of, or incinerated for energy recovery in plants that lack pollution controls (Gourmelon, 2015).

Reuse of materials is more effective than recycling. It extends resource supplies and reduces energy use and pollution more than incineration or recycling. Obvious examples are beverage bottles. Unlike throwaway or recycled cans or bottles, refillable beverage bottles create local jobs related to collection and refilling. But few US bottles are refilled, and by the mid-1990s only 10 states sold refillable bottles. In Germany, 95 percent of the soft drink, beer, wine, and spirits containers are refillable. But Denmark led the world in reuse of beverage containers, banning all that cannot be reused (Miller, 2002: 528).

"Reduce" is the most effective way of dealing with wastes. It also is sometimes called the *dematerialization* of production and consumption (more about this in Chapters Six and Seven). In other words, the most effective reduction of the solid waste stream could be achieved by introducing efficiencies in extraction, production, or consumption so that the economic cycle simply doesn't generate as much solid waste. For consumers, this would mean manufacturing more durable, long-lasting goods (rather than disposable ones), reuse of things like glass bottles (rather than recycling them), and source reductions such as reducing the layers of packaging (rather than recycling them). In regard to plastics, the majority is used for packaging products like appliances, toys, furniture, and utensils; it is 40 percent of the demand in Europe and 42 percent in the US (Gourmelon, 2015). Roughly, a hierarchy of more effective ways to address solid waste problems begins with source reduction, followed by reuse, recycling, incineration, and landfills, in that order.

All of this would require significant modifications in the *throwaway economies* of many industrial nations. In the current system, neither producers nor consumers bear the real costs of the solid wastes they generate—governments (or aggregated taxpayers) do. This means that there are no real incentives that encourage the reduction of material "throughput" because there are no real market signals to particular producers or consumers. As Chapter One noted, the economic process should internalize and particularize the real costs of production, or make the industrial system function more like a biological ecosystem. A solid waste management approach known as the "circular economy" reduces the use of some materials and then reclaims or recycles most of the rest (Gardner, 2012). Many countries are moving in this direction. Japan has made it a national priority and in the United States, municipalities across the country are working towards becoming a zero waste community. A zero waste community recovers

90 percent of what it discards. There are three pathways to a zero waste community that reflect the three R's: (1) maximizing downstream resource recovery (recycling and composting); (2) maximizing mid-stream longevity through reuse (also known as *upscaling*), repair, and durable design; (3) maximizing upstream waste reduction through redesign, zero waste purchasing, and enacting Purchaser Responsibility and New Rules. Establishing a zero waste community has been envisioned as a 10-year strategy and many communities are well on their way (see www.ecocycle.org/zerowaste). Monica's small town has aspirations to become a zero waste community. One measure the city is looking into implementing is a pay-as-you-throw rate for trash collection. Rather than paying a flat rate that provides no incentive to reduce, reuse or recycle, residents are charged by the amount of trash generated so the less you generate, the less money you pay!

MUNICIPAL POLLUTION PROBLEMS

Because industries are usually in human settlements and cities, they directly contribute to the water and air pollution around cities. Municipal pollution, however, also includes pollution from municipal wastes and sewage as well as air pollution from the combustion of fuels in autos, factories, and homes. In LDCs, much of the sewage from human settlements is not treated and is highly contaminated with raw sewage and micro-organisms that carry waterborne diseases such as dysentery, typhoid, and cholera. Poverty often means malnourishment and exposure to soil and water that carry disease. The high incidence of diarrheal diseases in LDCs reflects the lack of safe drinking water and the ingestion of food- and soil-borne microbes that cause disease. One of the most important things that could be done to improve health and nutrition in LDCs would be to provide clean drinking water to more people so that they could absorb the food they have. The problem, of course, is that most LDCs do not have the capital resources to build sewage treatment plants for towns and growing urban areas. And as we already saw with the sad case of Flint, Michigan, even in wealthier MDCs the poor often have greater exposure to such hazards. Partly for such reasons, disadvantaged populations everywhere have lower life expectancies.

Most MDCs have long invested in sanitation and water treatment facilities that reduce the risk from these water-related diseases. *Primary treatment* involves filtration that removes the suspended pollution while *secondary treatment* uses settling basins where aerobic bacteria degrade organic pollutants. Sewage treatment leaves a toxic, gooey sludge that must be dumped or recycled as an organic fertilizer. About 54 percent of such municipal sludge is applied to farmland, forests, highway medians, or degraded land as fertilizer, and 9 percent is composted. The rest is dumped in conventional landfills (where it can contaminate groundwater) or incinerated (which can pollute the air with toxic chemicals) (Miller, 2005: 511). Yet, conventional sewage treatment does not remove many toxic chemicals, nitrates, or phosphates. Special treatment facilities can deal with many of these problems, but because of their costs (twice as much as conventional treatment facilities), they are rarely built.

The focus on environmental problems that developed in the 1960s began with a concern for reducing toxic wastes and water and air pollution, and since that time many MDC governments have instituted antipollution programs.[2] There have been successes. The United States passed the Safe Drinking Water Act of 1974, and from 1972 to 1992 the organic material from sewage and industrial sources dumped into rivers declined significantly. Drinking water generally became safer except that from broad flow run-off of agrochemicals (like nitrates from fertilizer). Agricultural run-off is considered nonpoint pollution as is urban storm run-off, and much more difficult to regulate. Point pollution is federally regulated by the EPA, and is known to originate with an industrial facility. These facilities must obtain permits from the EPA, which oversees the type of pollutant emitted and amount of discharge from each facility. Municipal pollution falls under this category.

The United States Congress also passed Clean Air Acts in 1970, 1977, and 1990 that required the EPA to set national standards for ambient air quality and emission standards for toxic air pollutants. The legislation was successful because between 1970 and the mid-1990s, levels of air pollutants decreased nationally by almost 30 percent, even though both population growth and economic growth continued. Requiring industries to make public their annual release of toxic chemicals promoted their more effective management. The mandatory Toxic Release Inventory (TRI) provides such data. By 2002, the release of 300 chemicals tracked since 1988 had been cut in half (Assadourian, 2005). Lead, in particular, has virtually disappeared from air pollution since it was removed from gasoline. The result has been that 50 million people now breathe cleaner air, and the economic benefits have greatly exceeded the costs. The US spent about $346 billion between 1970 and 1990 to comply with the Clean Air Acts, whereas the human health and ecological benefits in that same period were estimated at between $2.7 and $14.6 *trillion* (in 1990 dollar values). Even so, since the middle of the 1990s, Congress has been under intense pressure from polluting industries to weaken the 1990 Clean Air Act.

Even with progress in the United States, air is still not clean enough and problems remain. Nitrogen dioxide levels have not dropped much since 1980 because of a combination of inadequate automobile emission standards, and more vehicles traveling longer distances. Urban smog remains a problem in many areas. Chapter One described carbon dioxide as the by-product of all respiration and combustion of carbon-based fuels, but there are *many* other chemical by-products of the combustion of fuels. One is suspended carbon particles (soot), which can remain in the air for a long time and contribute to respiratory disease. Another is carbon monoxide (CO), which is the result of incomplete combustion, particularly from cars and trucks. CO is an odorless gas that interferes with the body's ability to absorb oxygen and can exacerbate heart and respiratory disease or even cause death. Sulfur dioxide (SO_2) is produced from the burning of coal and oil and can cause respiratory problems. More important from an ecosystem perspective is that SO_2 combines with water in the atmosphere to form acids (e.g., sulfuric acid) and acid rain, which kills forests (miles away from the sources) and pollutes soil by making it too acidic for optimum plant growth. Wide areas of the United States and Central and Eastern Europe have been affected by acid rain from urban and industrial sources. Nitrous oxides (NO_x) and other volatile organic compounds (VOCs) are also produced from the incomplete combustion of fuels and hydrocarbon compounds from autos and a wide variety of commercial and industrial sources. Furthermore, in the presence of sunlight, SO_2, NO_x, ozone, and VOCs react to form *smog*, a hazy, dirty brown, toxic witch's brew of more than 100 exotic chemicals that hangs in a bubble over most cities in certain weather conditions. Smog is particularly a problem in cities such as London, Los Angeles, and Mexico City, where topography and inverted thermal layers of air (warmer aloft than on the surface) often hold smog to the surface in more concentrated forms. Look for smog if you fly into any major metropolitan center.

Most recently, researchers in a study published in *Nature* noted that it is difficult to estimate the number of premature deaths related to air pollution because in some regions air quality is not monitored and also because the toxicity of particles from different sources varies (Lelieveld et al., 2015). This study used a global atmospheric chemistry model to investigate the link between seven emission sources in urban and rural environments and premature death. They assumed all particles to be equally toxic, but also included a sensitivity study to look at differences in toxicity. Overall, air pollution is causing 3.3 million premature deaths a year worldwide, and they warn that if things don't change, then the yearly death toll will double by 2050 to 6.6 million. China has the most yearly deaths from air pollution (1.4 million) followed by India (645,000) and Pakistan (110,000). In China and India the cause is largely due to residential energy use for heating and cooking. In the US with 54,905 yearly deaths,

Figure 2.11 A thermal inversion forms a thick layer of mid-winter smog over Beijing, China.

soot and smog from power generation and traffic are most important, which is the same for Russia, all of Europe, Japan and South Korea. Perhaps most surprising is that worldwide, *agriculture* is the second leading cause of deaths. In the US, agriculture caused 16,221 deaths compared to 16,929 caused by power plants. Agricultural emissions, such as ammonia air pollution from fertilizer and animal waste, have become a significant health threat (Lelieveld et al., 2015).

CHEMICAL AND ANIMAL WASTE POLLUTION FROM AGRICULTURE

Agriculture generates chemical pollutants in the residues from pesticides and herbicides, from the nitrates and phosphates remaining from the use of chemical fertilizers, and from the salt that accumulates in soil from irrigation water. The *salinization* of land from long-term irrigation is the cause of chemical pollution. Freshwater contains between 200 and 500 parts per million (ppm) of salt. Crops take up the freshwater but leave salt in the soil, and daily irrigation of a plot of land can add literally tons of salt to the soil each year, eventually exceeding the salt tolerance limits of crops. Unless soil is flushed with freshwater periodically—an expensive process in water-short irrigated areas—soil eventually becomes barren and useless. Remember that this was part of the plight of ancient Mesopotamia, Rome, and other agricultural civilizations discussed in Chapter One. As noted at the beginning of this chapter, since the 1950s, growing irrigation around the world increased agricultural yields, but the long-term consequences of soil salinization still pose a threat (Postel, 1992b).

Intensive agriculture relies on chemical inputs to maintain and increase yields. Modern synthetic pesticides and herbicides do indeed increase the productivity of crops. Since the 1950s, pesticide use has increased more than 50-fold, and most of today's pesticides are more than 10 times as toxic as those of the 1950s. Since 1980, nonagricultural uses have increased, and today about 25 percent of pesticides and herbicides are used on places like lawns, gardens, golf courses, and parks. The average American lawn is doused with 10 times as much pesticide as a hectare of American cropland (Miller, 2005: 521). Indeed since the 1940s, the world has been on a *herbicide and pesticide treadmill* that has been very profitable for the agrochemical industry, but they have toxic effects on humans and other species.

Among the most noxious is the wide variety of herbicides, fungicides, and pesticides (mainly insecticides) applied to croplands, which leave residues in the soil and water—as well as on the fruits and vegetables you buy in grocery stores. Although some of the most dangerous chemicals with long-lasting residues (the chlorinated hydrocarbons such as DDT and chlordane) have been banned from use in the United States, they have been replaced with others with equally high toxicity levels but shorter-lived residues (organophosphates such as parathion). Synthetic agrochemicals accumulate in living tissues through various levels of food chains (called *bioaccumulation*). Because of these characteristics they are termed *persistent organic pollutants* (POPs). The "endocrine disruption hypothesis" is widely known, which suggests that POPs can mimic hormones in people, specifically estrogen hormones causing behavioral problems and reproductive pathologies that can be transferred from mother to child through breast milk (Adeola, 2004; Baskin et al., 2001). Swedish researchers found that exposure to glyphosate (the active ingredient in Monsanto's widely used Roundup herbicide) nearly tripled people's chances of getting cancer (non-Hodgkins lymphoma—NHL) (Miller, 2002: 508). More recent research in the US shows pesticides—terbufos, diazinon, and permethrin—to be associated with an increased risk of developing specific subtypes of NHL. Additionally, an association between Parkinson's disease and paraquat and permethrin has been found for pesticide applicators that did not use protective gloves (Agricultural Health Study, 2015). In the US, the negative health effects are particularly severe among Hispanic migrant farm workers who have very high levels of exposure, including their children (Gamlin, 2011). In fact, partly because of exposure to agrochemicals, farming was named the nation's most hazardous occupation, ahead of construction, mining, and manufacturing. Use of the more dangerous agrochemicals has shifted overseas, largely to LDCs, from which the US increasingly imports food. Ironically, the world market economy completes a *circle of toxins* as well as one of goods and services.

As if this weren't bad enough, mounting evidence indicates that in the long run, pesticides are not effective in protecting crops from losses (Shorette, 2012). While insect pests may initially be suppressed by insecticides, they breed and mutate rapidly and tend to develop chemically resistant strains that then require *more* or different chemicals to suppress. Chemicals can also produce more insects by killing the predators (birds) that feed on them.

Another category of agricultural pollutants consists of residues from the application of *inorganic chemical fertilizers* to croplands. These fertilizers unquestionably boost crop yields, but they leave large concentrations of nitrates and phosphates that wash into streams, rivers, lakes, and groundwater. During warm weather, this stepped-up nutrient level

BOX 2.2

BREAKING THE CIRCLE OF TOXINS

Agrochemical companies in the United States and other MDCs manufacture and sell to other countries, usually LDCs, pesticides and herbicides that have been banned, restricted, or never even approved in the country of origin. But what "goes around, comes around" via imported foods. Scientists have tried—without much success—to get the US Congress to ban such exports. In 2000, more than 100 countries developed an international agreement to ban or phase out the use and international sales of 12 especially hazardous organic chemicals. Nine of these were chlorinated hydrocarbon pesticides like DDT. In 2004, this treaty went into effect, an agreement that the United States has not signed (Miller and Spoolman, 2009: 298). Even so, DDT is still used in LDCs because it is one of the few chemicals that effectively suppress the mosquito that spreads malaria.

produces rapid growth of aquatic plants, such as algae, water hyacinths, and duckweed, which for their own respiration use most of the dissolved oxygen in the water. These plants then die and sink to the bottom to decay, along with most of the oxygen-consuming fish and aquatic animals. This process, called *cultural eutrophication*, may leave a body of water that is essentially dead except for the decomposers and the few scavenger species that can live in such an oxygen-depleted environment. A river ecosystem that undergoes cultural eutrophication from a specific point may recover miles downstream, but it is more damaging when it does not derive from a specific point. The 221-square-mile Florida Everglades illustrates this, as this area is being degraded by broad water flows containing nitrates (and pesticides) from the sugar fields and orange groves to the north (Miller, 2002: 651). In the United States, many medium- to large-sized lakes, and more than half of the large lakes near major population centers, suffer some degree of cultural eutrophication. The long-term health risks for adults from exceptionally high nitrates in drinking water are not well understood, but there is some evidence that they are related to high rates of female breast cancer and miscarriages. In very young children nitrates can react with oxygen-carrying hemoglobin in blood, producing a serious illness known as the "blue baby" syndrome (Smith, 2009).

Lastly, concentrated animal feeding operations (CAFOs) or factory farms, utilize relatively new intensive agricultural technology to raise livestock, including beef, poultry, pigs, and more recently, fish. Several environmental sociologists have used the treadmill of production framework (see Chapter One) to analyze the environmental and social impacts of CAFOs on land (Bell and Ashwood, 2016; Edwards and Ladd, 2000; Edwards and Driscoll, 2009; Novek, 2003) and in the sea (Ladd, 2011). CAFO owners are large and often transnational corporations that are vertically integrated with suppliers of feed and antibiotics, veterinary services, and processors, to name only a few (Edwards and Driscoll, 2009; Ladd, 2011; Novek, 2003). And it has meant fewer and much bigger operators. For instance, in Manitoba, Canada, from 1986 to 2000 the number of hogs doubled while actual hog farms declined by more than half, and the average number of hogs per farm more than quadrupled (Novek, 2003). In North Carolina, the forerunner in the US for hog CAFOs, the pork industry saw a fivefold increase in the hog population from 2 million to 10 million head from 1985 to 2000 (Edwards and Driscoll, 2009).

Following an industrial business model, CAFOs seek to control every part of an animal's life with the purpose of achieving maximum output in weight gained over the shortest time period possible (Edwards and Driscoll, 2009; Novek, 2003). The houses can hold upwards of 50,000 hogs, but more typically contain 2,000–5,000 head. For a feeder to finish operation it takes approximately 5.5 months to reach slaughter weight of about 250 lbs, which is broken down into three phases, and by the end of each phase, the pig has no room to move or lie down in their pen. Because the hogs never leave their confinement pen, the floor is configured with slats for urine and feces to drop through to a subfloor, which is periodically flushed out with water, and the "slurry" is then pumped to lagoons. Earthen lagoons store the waste to undergo anaerobic processing. The excess liquid waste that is not evaporated is then sprayed onto fields. Two problems lie here: (1) antibiotics, pesticides, hypodermic needles, blood, afterbirths, and broken bottles are also found in the lagoons; and (2) the scale of the waste being created far outstrips the capacity for a single farm to absorb (Edwards and Driscoll, 2009: 157–161; Novek, 2003).

Clearly, all livestock producers need resources—land, feed, water and energy—and sinks—land, water, and air to absorb the wastes—urine and feces. CAFOs however, encounter the problem of *externalities of scale*—a point at which the social and environmental costs exceed those of a less concentrated operation, and consequently are unsustainable (Edwards and Driscoll, 2009: 161). Hogs produce more waste than humans, although how much more is disputed with ranges estimated from three to five times more and others claiming 10–15 times more waste. The manure and urine contain large quantities of nitrogen, ammonia, and phosphorous. Pollution from CAFOs occurs when waste lagoons leak, rupture or overflow from flooding and heavy rains. Wastes can also contaminate underground aquifers and groundwater. Nutrients, such as nitrogen and phosphorus, and wastes that collect in drainage ditches can move into creeks, rivers, and eventually out to sea. Airborne emissions from houses, lagoons, and sprayed fields emit pollutants, such as methane, hydrogen sulfide, pathogens, endotoxins, and *ammonia*. The environmental impacts that have been documented are eutrophication, massive fish kills, pathogen transfer—notably fecal contamination of waterways and air pollution (Edwards and Driscoll, 2009; Machalaba et al., 2015). The resulting health concerns are salmonella, giardia, "blue baby syndrome," cryptosporidiosis, tapeworms, respiratory and pulmonary disease, headaches and eye irritations, and influenza. The spread of animal disease to humans is also of increasing concern, especially after the H5N1 bird (Avian) flu killed hundreds of people in Asia in the early 2000s. CAFOs produce prime conditions for disease by increasing the density of host populations, heightened contact between animals, the reduction in genetic diversity within populations, and by prioritizing species that are good at converting feed over those that have greater resistance to disease (Machalaba et al., 2015: 110). Avian flu outbreaks result in enormous economic losses because millions of animals must be killed to control it; the 2015 Avian flu H5N2 outbreak, the worst in American history, cost Iowa an estimated $1.2 billion and 8,444 jobs, many of which will not be recovered (Wappes, 2015).

Another concern is the heavy use of antibiotics in CAFOs. Whether or not they are aggravating drug resistance in humans is still debated. But, somewhere between 30 percent and 90 percent of veterinary antibiotics are unmetabolized and excreted after administration. Moreover, antimicrobial-resistant pathogens can be transmitted from animals to humans through multiple routes, such as food consumption, direct contact with treated animals, and in all the other ways pathogens are transferred in waste management, use of manure as fertilizer, and fecal contamination of run-off (Machalaba et al., 2015: 112-113).

As you can see, there are some real health and economic costs associated with CAFOs. Many residents that live near CAFOs have seen their property values and quality of life decline. The smell alone can reduce the quality of life, but also for many communities the introduction and management of CAFOs is divisive (Edwards and Driscoll, 2009; Ladd, 2011; Novek, 2003). There also are environmental justice issues. In North Carolina, CAFOs are concentrated in the eastern portion of the state that is disproportionately low-income, African American, with lower numbers of people with college degrees, and politically and economically marginalized (Edwards and Driscoll, 2009). Finally, factory farming results in a few big economic winners who gain a lot of political influence to lobby government to keep regulations as lax as the public will possibly tolerate (Bell and Ashwood, 2016).

CONCLUSION: THE RESOURCES OF THE EARTH

In the span of a single chapter, we have tried to provide you with a fairly rigorous, but selective reading of the state of some resource issues important for humans (land, water, biotic resources), and how wastes and pollution accumulate in various sinks. So, what is a fair summary of the earth's "vital signs" in this reading? While there is strong evidence of progress in many places, concerns are mounting over the cumulative effects of the overuse of the earth's resources and sinks. Today, popular and scientific ways of understanding environmental problems do not simply focus on specific environmental problems (such as pollution), but rather a more integrated and holistic view of ecological problems is taken. Thus, they can't be considered in isolation, such as the concern with planetary boundaries (Dunlap, 1992; Rockstrom et al., 2009; White, 1980).

To summarize, a last observation is offered. That is, we live mostly in managed or "socialized" nature. In terms of human–environment interaction, it has become an *ecosocial system*—a humanly organized environment. All landscapes, from Los Angeles to Amazonia, are such ecosocial arenas. This doesn't mean that human management of nature has been wholly successful; the boundaries of such control are exposed by the very failures of attempts to extend it indefinitely. Nor does this mean that there are no circumstances from which human beings should attempt to withdraw interventions that affect the environment or try to eliminate side effects. But since all landscapes are ecosocial and we can no longer disentangle what is "really" natural from what is social, we must now deal with environmental/ecological problems not only with appeals to "pristine nature." Chapter One ended by arguing that environmental problems are also social issues layered with questions of fairness and justice. Trying to improve environmental resource problems depends on a consensus of human values that form the parameters of environmental protection. In other words, the criteria to address such problems are not given in nature itself, but in the human values that guide its management, no matter whether we speak of urban areas or of wildernesses (Giddens, 1995: 210–211).

PERSONAL CONNECTIONS

QUESTIONS FOR REVIEW

1. How has producing more food caused environmental problems? To address these, what social and political issues would have to be dealt with?
2. How is water scarcity related to political and social conflicts?
3. What are the key concerns with water privatization? Is access to reliable clean water a basic human right, or is water a commodity to be sold in the marketplace?
4. What are the concerns related to biodiversity loss? What are some ways of addressing the extinction of species, declining biodiversity, and deforestation?
5. What are the greatest challenges in dealing with municipal trash? What are some of the advantages and disadvantages of different methods of dealing with municipal trash (think about the three R's here)?
6. If environmental problems of resource scarcity and pollution were more equitably distributed, what effect might it have on our human production and consumption patterns?
7. What does it mean to say that we live in "socialized nature," or that we live in an "ecosocial system"? Illustrate from the community in which you live.

QUESTIONS FOR REFLECTION

Think about these large-scale issues in terms of the material flows in your daily living patterns.

1. What is the source of water in the community where you live? Are there conflicts about its costs, or about allocating it to business, agriculture, or consumer use? Has there ever been news about impending water shortages or rationing for particular purposes? What local issues are there about water purity? You might call the local utility company or government regulatory agency about this.
2. As we noted in this chapter, most of the solid waste produced in the United States is from municipalities. It is only 10 percent of total waste, but that is still a prodigious amount. About 10 percent of your shopping bills go for packaging costs alone (for highly packaged convenience foods, the proportion is a lot more). The typical family creates two or three large cans of trash each week. Do a two-part mental experiment: (1) Keep track of the trash you create for several days. What is it, mainly? Food wrappers? Newspapers? Soft drink cans? (2) Suppose that instead of having it hauled off, you just let it pile up in your yard. How long do you think it would take to fill your yard?
3. Do you have or use a computer? If so, do you think it has caused you to use more or less paper? What happens to your "waste" computer paper?

WHAT YOU CAN DO

Quite a lot, actually, if you want to. It's hard to know how to limit the possibilities of altering your lifestyle to be more environmentally frugal. There are whole books written on this subject, and you can find them in any library or bookstore. Here are a few tips:

ABOUT WATER

- Don't leave the tap running while you are doing other things unless of course your city has trouble with lead contamination, in which case they may tell you to run it for a minute or more before use.
- If you buy a new washing machine or dishwasher, get an energy-efficient one.
- Take showers rather than tub baths (this uses about a third of the water that a bath does, unless you use the shower for relaxation therapy rather than cleanliness). Take shorter showers (sing shorter songs).
- Put some bricks or a quart bottle full of water in your toilet tank to use less water per flush. When you buy a new toilet, get a water-saving one.
- Install a flow constrictor device on faucets, particularly your showerhead.
- For your garden, rig a hose for drip irrigation rather than spraying with a hose or sprinkler so that much of the water evaporates. Better yet, connect your gutter downspouts to barrels of some sort and use stored rainwater to water your plants.

ABOUT TRASH

- Separate trash into recyclables (aluminum, glass, metal, and plastic) and organic wastes (leftover vegetable peelings and so forth).
- If your city or workplace does not have a recycling program, try to find out why not.
- Compost organic wastes: It's easy; just a frame of some sort outside into which go things like vegetable wastes, eggshells, and leaves. (Don't put leftover meat or bones in your compost in the city—You'll attract vermin and maybe the city health department!) Check out how here: http://eartheasy.com/grow_compost.html.
- When you separate your trash like this, you'll find that most of what you have left is packaging material. That suggests another dimension more important than recycling: Buy things that have less packaging, and if you can, carry them home without a bag from the store or bring your own bag.

REAL GOODS

- Buy durable or repairable goods rather than disposable goods, including disposable cups, pens, razors, and so forth. Where available, buy beverages in refillable bottles.
- Avoid red or yellow packaging; they are likely to have toxic cadmium or lead.
- Choose items that have less packaging. Store things in your refrigerator in reusable containers rather than wrapping them in plastic.

- Want to reduce the amount of junk mail you get? Check out this website: https://dmachoice.thedma.org.
- Share, trade, barter, or donate things you no longer need rather than throwing them away.
- Conversely, if you can find used things and they work, buy them. It used to be that thrift stores were only for the destitute. But they now attract a more diverse clientele. A used car will cost much less than a new one.

As you probably realize, such a list has no logical ending. But you get the idea.

MORE RESOURCES

Bakker, K. (2010). *Privatizing water: Governance failure and the world's urban water crisis*. Ithaca, NY: Cornell University Press.

Berkes, F. (2012). *Sacred Ecology*. (3rd ed.). New York, NY: Routledge.

Hoekstra, A.Y. and Chapagain, A.K. (2008). *Globalization of water: Sharing the planet's freshwater resources*. Hoboken, NJ: Wiley-Blackwell.

Robinson, J. L. (2013). *Contested water: The struggle against water privatization in the United States and Canada (Urban and Industrial Environments)*. Cambridge, MA: MIT Press.

Rudel, T. K. (2005). *Tropical forests: Path of destruction and regeneration in the late 20th century*. New York, NY: Columbia University Press.

Vandermeer, J. and Perfecto, I. (2005). *Breakfast of biodiversity: The political ecology of rain forest destruction (Revised edition)*. Oakland, CA: Food First.

Williams, M. (2006). *Deforesting the earth*. Chicago, IL: University of Chicago Press.

Wilson, E.O. (2016). *Half-earth: Our planet's fight for life*. New York, NY: Liveright Publishing.

ELECTRONIC RESOURCES

http://eowilsonfoundation.org/mission-statement
This website is structured around the thinking of one of America's greatest environmentalists and professor of zoology, E.O. Wilson. It provides an overview of biodiversity and

numerous resources to not only further your knowledge about biodiversity but become actively involved in its preservation.

http://www.watercalculator.org
Calculate your water footprint on this site.

http://waterfootprint.org/en
A water footprint is similar to the ecological footprint discussed in Chapter Six. This website includes many helpful links to work towards sustainable water use.

http://clade.ansp.org/entomology/mongolia/index.html
The Mongolian Aquatic Insect Survey project team has sampled all types of aquatic habitat in Mongolia from 2003 to 2012. Monica's colleague from Wayne State College, Dr. Barbara Hayford, Professor of Life Science, has been involved since its inception and has taken several Wayne State College students to participate in the project. Dr. Hayford is also involved with the following website.

http://www.macrorivers.org
An international consortium of scientists, graduate students, and researchers dedicated to studying the ecology of rivers. They are currently studying the ecology of US rivers, some with high dams, and Mongolian rivers that currently do not have dams, but are planned for, and hope their data will help to preserve them. Lots of great resources on this site.

https://landinstitute.org
A science driven organization to develop and promote alternatives to intensive agriculture.

http://soilerosion.net
The soil erosion site brings together information on soil erosion from a variety of disciplines and sources.

http://apps.npr.org/lookatthis/posts/brazil
A very compelling interactive site that provides a pictorial view of the importance of and struggle to preserve the rainforests.

http://darwin.defra.gov.uk
The Darwin initiative assists countries that are rich in biodiversity but poor in financial resources to meet their objectives under a major biodiversity convention.

http://worldwater.org/conflictIntro.htm
Water resources and international conflict. Updated 2009.

http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/peril_toxins.html
Toxic wastes; NASA, Smithsonian Institute, Environmental Protection Agency.

http://www.iucn.org
The International Union for the Conservation of Nature.

www.scorecard.org
Environmental Defense Fund environmental "score card." Data-rich about environmental problems and pollution from firms, counties, and regions in the United States.

http://www.pbs.org/newshour/bb/in-flint-public-trust-poisoned-by-toxic-drinking-water-crisis-2
A 12-minute video on the Flint, Michigan, water crisis.

http://liquidassets.psu.edu
Supporting website for excellent documentary, *Liquid Assets: The story of our water infrastructure*. You can watch short videos of the main themes of the documentary (water systems, community participation and activism, public health, sustainability, and waste water) at the following link: http://www.pbslearningmedia.org/resource/psu08-liq.sci.wastewater/liquid-assets-wastewater.

http://www.Biodiversityinternational.org
Research and information about agricultural diversity.

http://www.ted.com/talks/johan_rockstrom_let_the_environment_guide_our_development?language=en
Watch this Ted talk with the lead planetary boundary researcher Johan Rockstrom.

NOTES

1. This paragraph and Box 2.1 were provided by Barbara Hayford, Professor of Life Sciences at Wayne State College, and participating scientists in the Mongolian Aquatic Insect Survey team and the MACRO rivers project. She also is the Director of the A. Jewell Schock Musuem of Natural History at Wayne State College, which you can check out on facebook: https://www.facebook.com/AJewellSchockMuseumOfNaturalHistory.
2. In the United States, for example, there are the Clean Air Act (1963), the Solid Waste Disposal Act (1965), the Water Quality Act (1965), and the National Environmental Protection Act (1960), which established the Federal Environmental Protection Agency.

CHAPTER 3
CLIMATE CHANGE, SCIENCE, AND DIPLOMACY

The photo below is a satirical ad posted in Paris during the December 2015 United Nations Climate Change Conference (COP21). Approximately 600 unauthorized satirical ads were posted throughout the city by the British anti-corporate advertising group, Brandalism. Through their mock ads, they sought to expose the contradictory interests of the Climate Conference's corporate sponsors and draw the connection between consumerism, fossil fuel consumption, and climate change threats. Their action was especially meaningful since French Prime Minister, François Hollande, had declared a state of emergency in Paris banning all public gatherings during the talks due to recent terrorist attacks on the city. Typically, it is in the streets and other public places that civil society groups representing the interests of those most vulnerable to climate change, but least represented at the negotiating table, can express their concerns and exert some influence on the proceedings.[1] These groups are more likely to represent the interests of the poor, women and children, people of color, and indigenous peoples around the globe (Carmin et al., 2105; Ciplet et al., 2015; Harlan et al., 2015; Klein, 2014).

The ad illustrates a reality that is rapidly becoming harder to hide from the public eye. Unless the world takes significant steps to curtail global greenhouse gas (GHG)

Figure 3.1 The Last Selfie, Courtesy of Brandalism.org.uk

emissions, runaway climate change could be upon us. Runaway climate change is the point of no return, when no amount of cutbacks in global greenhouse gas emissions can stop potentially catastrophic change—more extreme weather events, rising temperatures, and sea-level rise from melting ice caps. In fact, some natural scientists argue that humans have brought about a new geological epoch referred to as the Anthropocene (Clark, 2014). The premise of the Anthropocene is that humans have fundamentally altered the earth's geophysical systems and cycles through industrial technological developments, such as the burning of fossil fuels, machine production, introduction of chemicals and radioactive materials, and other human actions that cause ecosystem disruptions and environmental harms. Natural systems and human systems are interlinked, resulting in positive feedback loops where change in one system causes change to the other system. The global magnitude of change and the pace and force of the interactions of feedback loops are causing planetary boundaries to be exceeded (discussed in Chapter Two), accelerating toward a tipping point. The risk is the collapse of the earth's life support systems. For example, if accelerated Arctic warming triggers the Greenland ice cap to break up, it could cause sea level to rise rapidly and mega-storms to ravish coastal cities, sinking or sweeping them away to become part of the fossil record (Clark, 2014: 20). The Anthropocene could mean the end of humanity. This sounds like one of the many dystopian novels and movies that have captured our twenty-first-century imaginations and dollars. Is the Anthropocene simply pop culture dystopian fantasy? Or is it an inevitable reality? Is there another way things could play out?

Earlier versions of this chapter dealt with the scientific uncertainties of climate change. For this edition, however, Charlie and I decided the world's climate scientists have spoken; human-induced—also referred to as *anthropogenic*—climate change is here. The uncertainty lies in how much warming will occur and the time frame in which it will happen, given the chosen course of human (in)action. The alarms are blaring, and while some impacts are identifiable, we are also headed down an uncharted path. The possibility to de-accelerate and even transform the catalysts of climate change will require a deep understanding of human agency, social conditions, and institutions. It is through the everyday actions of human beings that we come closer to the edge of the earth's thresholds, but it is also human action that can pull us back.

A rapidly expanding area of research is showing that reducing fossil fuel consumption does not mean sacrificing economic prosperity (Jorgenson, 2015; Weiss, 2015). In fact, independent scientific analyses have indicated an unusual pattern of a slowed global growth rate in carbon emissions in 2014 and the potential for a decline in global emissions in 2015 (Weiss, 2015). This change is largely attributable to China's efforts to move away from coal and invest in renewable energy. Scientists warn that these two years are likely an anomaly, and a much greater reduction in emissions is needed, but it is a good sign. The only other time emissions have lagged is during major economic recessions, which has not been the case in the last two years. According to the Environment America Research & Policy Center, a 100 percent renewable energy economy in the US is not a pipedream; sufficient clean energy sources are available to meet demand, the challenge lies in how to make the transition (Aldern, 2016).

This chapter describes climate change as a geophysical problem of the planet, and how sociology can help to identify the human causes and consequences, and the need for concerted collective action at multiple scales—local, national, and international—to address it. The chapter will discuss (1) the reality and scientific study of climate change; (2) climate (in)justice and the current and expected climate change impacts; (3) opportunities and barriers to enacting and enforcing adaptation and mitigation policies; and (4) global environmental diplomacy on ozone depletion in the upper atmosphere, and climate change.

TURNING UP THE HEAT

Unlike the weather, the world's climate rarely sends clear signals. *Climate* is determined by the large-scale and long-term interaction of hundreds of variables—sunlight, ocean currents, precipitation, fires, volcanic eruptions, topography, human industrial emissions, and the respiration of living things—that produce a complex system that scientists have just begun to understand—and which defies precise forecasts. Indeed, feedback relationships between the biosphere and global climate suggest that life and climate *coevolved*, a process in which close interactions influenced the evolutionary paths of both systems in ways that would not have happened had they not been simultaneously present (Schneider and Londer, 1984; Alexander et al., 1997). Annual weather patterns, however, are so variable that some regions are warmer than normal; some cooler, wetter or drier; and many riddled with "severe weather events" like floods, droughts, and hurricanes. Almost all of these can be understood as within the expansive range of climatic variability. Unlike weather, climate is impossible to directly experience, and is detected and measured only in global (or continental) averages.

Global climate change is deeply intertwined with, and distinctive from, the environmental problems discussed in Chapter Two. Problems with soil, water supplies, deforestation, biodiversity, mineral resources, solid wastes, and water and air pollution do have global ramifications, but they are mainly visible as *ecosystem problems.* There are differences and similarities in the type and severity of these problems among ecosystems, but they are still visible *within* particular ecosystems. By contrast, atmospheric and climate change are *biospheric problems.* As energy and matter circulate atmospherically around the globe, their consequences affect all individuals, societies, and ecosystems, though in varying ways and levels of intensity. In Chapter One, we noted that the environment has complex sets of limiting factors that determine the success and distribution of living things on earth. The physical and chemical nature of the envelope of gases surrounding the earth—the atmosphere—is among the most important, but also has been the most taken for granted.

Problems like climate change also have a unique *phenomenology* in that they are not really directly experienced or studied by humans.[2] Such *megaproblems* are unique in their vast scope, abstract nature, and often long-time horizon over which they develop. Furthermore, they present high-order risks in terms of their consequences. No one is exempt from their effects, and they exemplify a negative side to the rapidly burgeoning human interdependence in the modern world. Yet, a pattern of climate change cannot be conclusively demonstrated from any particular measured weather data at a particular time and place. Moreover, such megaproblems are typically remote from the concrete experience of individuals and seemingly unaffected by individual actions. The very existence of such problems and their remedies are so abstract and complex that people are dependent on cadres of experts and their scientific (social) constructions of the problem. Megaproblems and their solutions have a peculiar counterfactual nature: If the remedies work, we will never know whether the original diagnostic claims were right. With or without remedies, the experts who make diagnostic claims are likely to find themselves branded as merchants of doom (Giddens, 1991: 219). Unless you have been living under a rock, you know that global warming (its reality and appropriate human responses) is debated frequently and often hostilely in contemporary mass media, by citizens, scientists, corporate leaders, and politicians. Whatever your opinions of this "debate," the phenomenology of climate change may be shifting.

According to two independent analyses by the US National Oceanic Atmospheric Administration (NOAA) and the US National Aeronautics and Space Association (NASA), 2015 was the hottest year in the historical record since recording began in 1880 (Gillis, 2016). Additional data from Britain and Japan also showed 2015 to be the warmest year, dating back to when each country first began to keep records, 1850 and 1891, respectively (Gillis, 2016). Not only was it the warmest year, it was shockingly warmer because it broke the record set the year before by 0.23 degrees F and 0.13 degrees C (NASA, 2016). Only once before in 1998 has the new record been this much greater than the previous, but not in back-to-back years. A US climate scientist calculated the odds of two consecutive record-breaking heat years. In a global climate that is not warming, the chance of back-to-back record-breaking heat years is one in every 1,500 years. But in a warming climate scenario, the odds increase to one in every 10 years (Gillis, 2016). Nonetheless, both 1998 and 2015 were powerful El Niño years with warmer tropical waters releasing heat from the Pacific Ocean. Clearly El Niño, which is a natural cycle of warming in the Pacific Ocean, is a significant contributor. But, the heat records would have been broken without El Niño due to the cumulative effect of long-term global warming.

Since the late nineteenth century, the global average surface temperature has risen 1.8 degrees F and 1 degree C (NASA, 2016). This is mainly attributable to increased carbon dioxide and other human-made emissions released into the atmosphere since the late nineteenth century. The majority of the warming has occurred in the last 35 years, and 15 of the 16 warmest years on record have occurred since 2001. In fact, 2015 marked the first time the earth's average temperatures were 1 degree C or

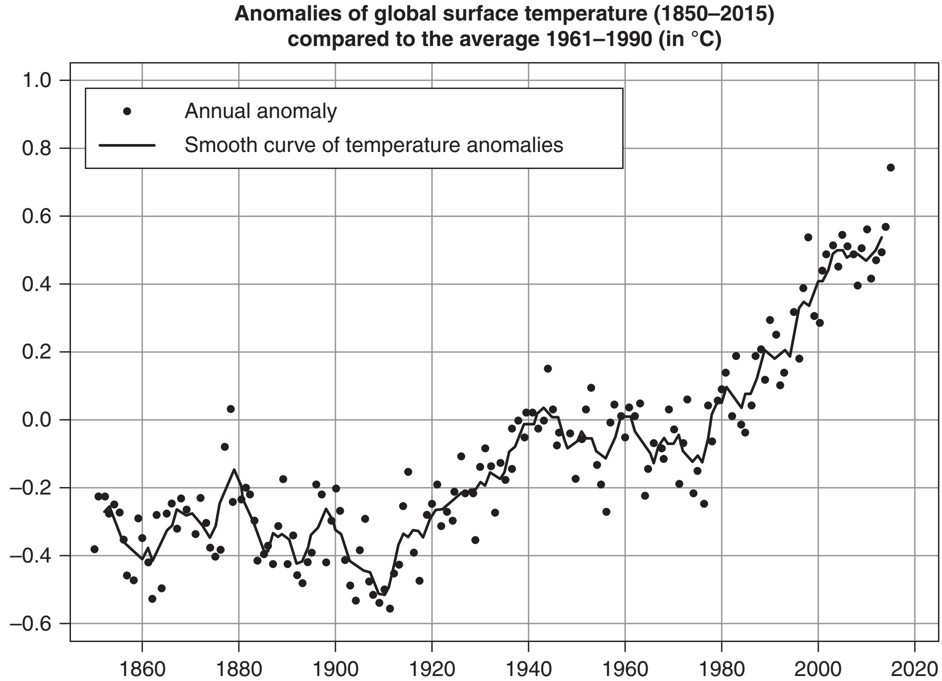


Figure 3.2 Go to the Met Office www.metoffice.gov.uk/news/releases/archive/2016/2015-global-temperature to listen to their chief climatologist explain the data.

more above the 1880–1899 global average (NASA, 2016). For the last 10,000 years the earth's temperature has been relatively stable with some fluctuations, but only by about 1 degree C. Now, we have warmed an additional 1 degree since the late 1800s, and in the absence of significant efforts to reduce emissions, estimates point to 4 or even 6 degrees C of warming by 2100 (Ciplet et al., 2015; Klein, 2014). Thus, some scientists have tried to put an end to climate change denial and skepticism. In 2013, a group of scientists analyzed 4,014 abstracts of climate change research published in peer reviewed journals, finding that 97.2 percent concluded climate change is real and anthropogenic (Vaidyanathan, 2014). This study bolstered the claim that a scientific consensus has been reached. It also inspired President Obama to tweet about it (see Figure 3.3).

Climate skeptics pounced. President Obama, like many other politicians, media pundits, and lay people, did not clarify that the agreement is among scientists who study climate; not necessarily all scientists, or those who publish outside of peer-reviewed scientific journals. Regardless, the vast majority of the leading scientific organizations endorse the consensus among *climate* scientists, such as the American Medical Association and the American Chemical Society, to name a few (see, http://climate.nasa.gov/scientific-consensus). Moreover, current climate change impacts, including more warming, increased frequency of extreme weather events, and rising sea-level, have *exceeded* the

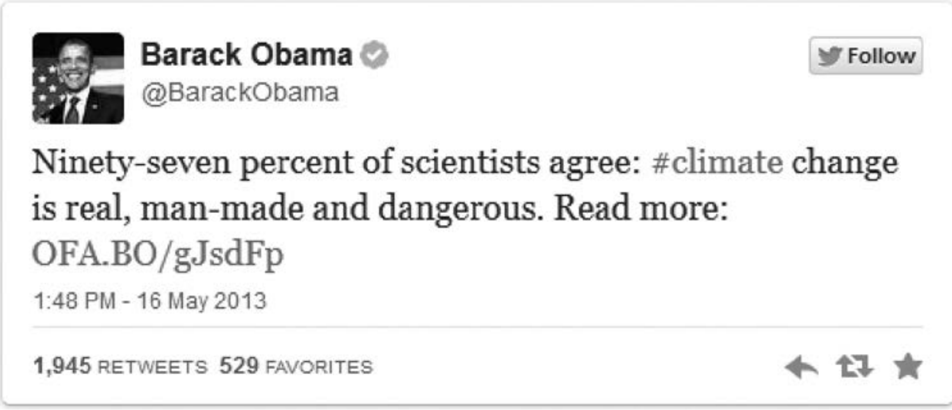


Figure 3.3

projections made in the Intergovernmental Panel on Climate Change 2007 Fourth Assessment Report (Ciplet et al., 2015).

In 2015, the world witnessed South Africa experience its worst drought in 30 years. In the US, the majority of California was in its fourth year of extreme drought, which was intensified by the heat—it was the warmest year on the state record—more than 3 degrees F warmer than the state's average (Stevens, 2015). The drought severely impacted the state's groundwater basins and agricultural production, and the state governor enacted water restrictions. The heat and drought set the stage for two of the most destructive wildfires in the state's history. The state of Washington also exhausted resources fighting the largest incidence of wildfires in their history. Alaska saw its second worst fire season, after 2004, which burned 5.1 million acres of forest (Giordano, 2015). India was struck with its second worst heat wave killing at least 2,700 people. The criteria for classifying heat-related deaths vary between and within countries (see, Klinenberg, 2015), but rough estimates by the Center for Research on the Epidemiology of Disasters in Brussels show 140,000 heat deaths worldwide have occurred in the last two decades (Gillis, 2016). Most of those deaths occurred in the 2003 heat wave in Europe and in Russia in 2010. An estimated 70,000 people died in the European heat wave alone (Klinenberg, 2015).

Climate change skeptics, however, point to late spring freezes or the record snowfall many US states have seen in recent years as evidence that global warming is a hoax. Indeed in March 2015, Boston recorded its snowiest season of 108.6 inches (Fritz, 2015). In January of 2016, a record-setting blizzard named *Snowzilla* hit the Northeastern United States. Yet, January 2016 was the hottest January on record, and the most anomalously warm with the largest margin above the global average of 1.13 degrees C (Plait, 2016).

So, what is going on? Simply put, a warming atmosphere can hold more water vapor, creating the potential for more frequent and heavy precipitation events. In fact, the month before *Snowzilla*, nearly every state east of the Mississippi saw not only record-breaking heat, but also heavy rainfall. Many states along the Mississippi river experienced historic flooding as a result. The UK also saw record-setting December warmth, rainfall, and damaging floods (Carrington, 2016). Let us restate that temperature variations between months, or even a few years, or the occurrence of mega-storms, are not proof of climate change. However, climate scientists will tell you that a warmer climate "loads the dice," increasing the odds for extreme weather events. So, how did it get so warm?

ANTHROPOGENIC GLOBAL WARMING

Gases in the atmosphere play a critical role in trapping enough infrared solar radiation (heat) to keep the mean temperature of the earth fluctuating within relatively narrow limits that make life possible. The most important of such gases are water vapor, carbon dioxide (CO_2), methane (CH_4), nitrogen oxides (NO_x), and tropospheric (low altitude) ozone—caused by the combustion of hydrocarbon fuels. Water vapor and CO_2, the most important of these, account for approximately 90 percent of the heat-trapping capacity. Water vapor is controlled by the water cycle, and CO_2 is regulated by a similar carbon cycle (discussed in Chapter One). These gases are collectively called *greenhouse gases* (GHGs) because the way they warm the atmosphere is analogous to the way that gardeners have long grown plants and germinated seeds in air warmed in glass greenhouses. Have you ever gone to your car on a sunny day with the windows all rolled up? The *greenhouse effect* explains the very cold climate of Mars, where water vapor, a highly efficient greenhouse gas, is virtually absent, as well as the hot climate of Venus, where the atmosphere is so thick with CO_2 and conditions are so hot that life—as we know it—could not exist (Silver and DeFries, 1990: 64). Water vapor is the dominant positive feedback in a warming climate because increased evaporation results in more water in the atmosphere to absorb more heat, which in turn increases evaporation. Thus, it amplifies the greenhouse effect (see, http://phys.org).

After water vapor, CO_2 is the most plentiful and effective greenhouse gas. It occurs naturally as a consequence of the respiration of living things. The atmosphere has so much water vapor that human activity has little effect on it. By contrast, the presence of CO_2 is so small (.036%) that human activity can significantly increase its concentration. Since the industrial revolution, humans have added CO_2 to the atmosphere by burning fossil fuels—natural gas, petroleum, especially coal—and by *deforestation*. The role of deforestation is important because forests take in CO_2, thereby "sequestering" carbon from the atmosphere. This is why forests are often referred to as *carbon sinks*. Carbon sinks are ecosystems that contain plants that absorb CO_2 to use in photosynthesis and some CO_2 is also stored in the soil as plants die and decompose. The oceans are large carbon sinks where marine animals use CO_2 in photosynthesis and some CO_2 dissipates in the ocean waters (Thompson, 2012).

Until more recently, the significance of methane (CH_4) has been overlooked, but it is the second most prevalent greenhouse gas. There is more of it in the earth's atmosphere today than at any time in the last 800,000 years and more than two-and-a-half times preindustrial levels. CH_4 is *25 times* more powerful a greenhouse gas than CO_2 (US EPA, 2015). It is produced by human and natural activities, such as natural gas extraction and transport, in wetlands, garbage landfills, and by the bacterial activity in the digestive tracts of ruminant animals (e.g., cows and sheep)—today large quantities are produced by animal "feedlots" (Goodland and Anhang, 2009).

In the Arctic, temperatures are rising twice as fast compared to the rest of the world, and Arctic permafrost—ground that remains frozen throughout the year—is melting faster than expected. When permafrost begins to melt, buried plants and animals that have been frozen for thousands of years start to decay, releasing carbon dioxide and methane into the atmosphere. As such, a scientific study published in *Nature* has raised

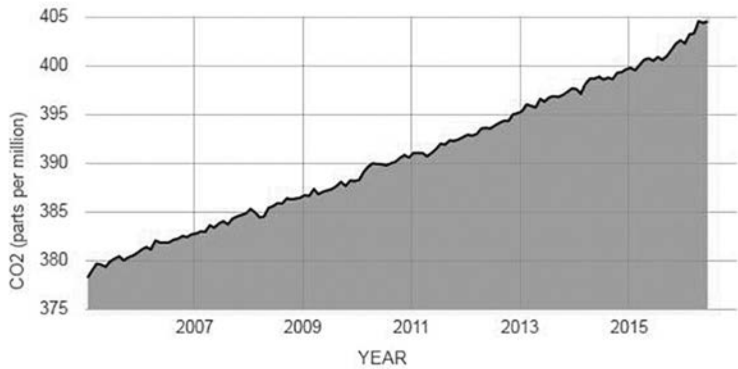


Figure 3.4
Source: National Oceanic and Atmospheric Administration, via NASA

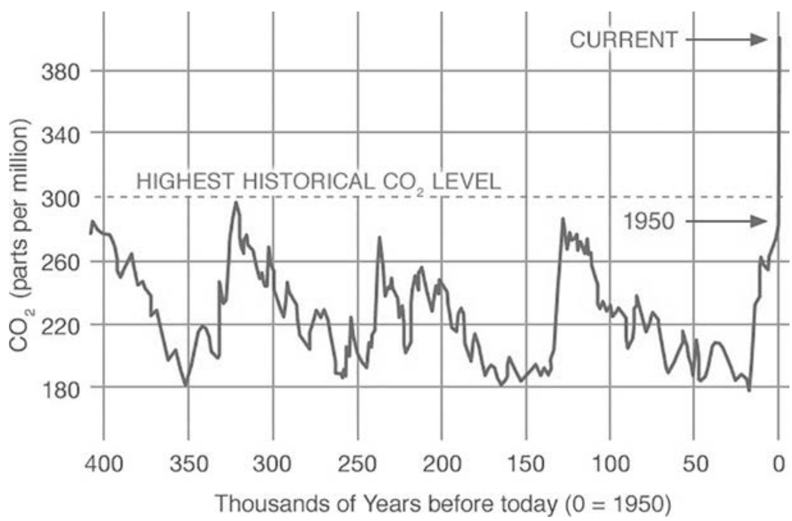


Figure 3.5
Source: National Oceanic and Atmospheric Administration, via NASA

BOX 3.1

ESTIMATING GLOBAL CLIMATE FROM LONG, LONG AGO

There are physical signs that make it possible to estimate the planet's climate throughout geological history. The expansion and contraction of glaciers, for which there are many physical markers, is one fairly good measure of past temperature fluctuations. Other evidence comes from studies of fossilized pollen grains, annual growth rings of trees, and the changing sea levels—as measured by the presence of coral reefs, which live close to the ocean surface because they need light to survive before they die. Cores of sediment extracted from the ocean depths are particularly important, because of their chemical composition and the presence of warm- or cold-water fossil species. Such sediment samples provide clues to changes in ocean temperature and the volume of polar ice caps. The *most* useful ones comes from analyzing ice cores extracted from ancient glaciers in Greenland and Antarctica for changes in the concentrations of gas bubbles (of CO_2 or CH_4) over millions of years (Miller and Spoolman, 2009: 497–498; Silver and DeFries, 1990: 25).

the concern of a global-level feedback loop accelerating climate change (Hollesen et al., 2015). Box 3.1 provides a brief overview of how global climate change is estimated over long periods of time. Overall, atmospheric concentrations of CO_2 have risen from preindustrial levels of 280 parts per million (ppm) by volume to 400 ppm at the time of this writing, illustrated by Figure 3.4. Using reconstructed ice cores, Figure 3.5 illustrates fluctuations in CO_2 levels over the course of the last three glacial cycles.

THE EVOLVING SCIENCE AND CONSENSUS

Speculations about the implications of *anthropogenic* increases in GHGs are not new, having been studied for more than 150 years. French scientist Joseph Fourier was the first to discuss the heat-trapping role of CO_2 in 1827. At the turn of the twentieth century, Swedish naturalist Arrhenius argued increasing concentrations of CO_2 from the burning of fossil fuels would raise the global mean temperature. By 1957, scientists contended that humans had initiated a "…global geophysical experiment that would lead to detectable climatic changes in a few decades" (cited in Krause et al., 1992: 11). In 1957, the systematic measurement of CO_2 began at the Mauna Loa (Hawaii) observatory and at the South Pole. Finally in 1979, the World Meteorological Organization convened a World Climate Conference in Geneva to discuss the issue. Following this conference were a host of international meetings about climate change that led to the first meeting in 1988 of the Intergovernmental Panel on Climate Change (IPCC), sponsored by the United Nations Environmental Programme and the World Meteorological Organization.

The IPCC, composed of thousands of leading climatologists from around the world, assess the evidence from scientific studies on climate change, and the possible social and economic impacts and responses to climate change. Currently, 195 nations are members of the IPCC. The IPCC has produced five comprehensive assessment reports, in 1990, 1995, 2001, 2007, and 2014. The 2014 report synthesized 30,000 scientific peer-reviewed studies on anthropogenic climate change (Fisher et al., 2015). Additionally, panels of scientists from national to international governmental and nongovernmental organizations (NGOs) have examined scientific studies of climate change; such as the US National Academy of Sciences (NAS), NASA and NOAA, and the MET Office—the UK's national weather service—and Future Earth—a nongovernmental international organization for interdisciplinary research on global environmental sustainability.

The most recent Fourth (2007) and Fifth (2014) IPCC Assessment Reports concluded with 90 percent certainty that anthropogenic global warming is real and a significant threat to all living species, including human beings. Warming is taking place too rapidly to be explained by similar fluctuations throughout the geological history of the planet. The Fifth Assessment Report states:

> Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen (IPCC, 2014: 2).

The report also states that while the consequences of climate change impact all continents and oceans, current and future risks associated with it "…are not evenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development" (IPCC, 2014: 13). This inequality is due to variations in ecosystem and biospheric conditions and variations in social conditions.

The geophysical and biological signs of warming are visible in many ways. As discussed in Chapter Two, the earth's coral reefs are under stress due to pollution and warmer water that has caused "bleaching." In April 2016, NOAA said that the current mass bleaching of Australia's Great Barrier Reef is one of three global bleaching events, the first in 1998 and the second in 2002 (Slezak, 2016). Scientists contend that this is much worse than the previous global bleaching events and areas of the reef considered the most pristine and resilient are experiencing bleaching. Scientists attribute this event to record high ocean temperatures from long-term global warming and a powerful El Niño year. Another threat to coral reefs is ocean acidification. Since the industrial revolution, the oceans have helped to slow global warming by absorbing about half of the anthropogenic CO_2, but the ocean's capacity to act as a carbon sink may soon be maxed out (Auth, 2015). The absorption of CO_2 has changed ocean chemistry leading to greater acidity and a reduction in seawater pH. Higher acidity makes it difficult for corals to absorb the calcium carbonate they need to maintain their supportive stony skeletons. As you might imagine, ocean acidification does not only affect corals, but also shellfish and plankton—the core of the ocean ecosystem and food chain. For example, recent mass die-offs of mollusks in the US and Canadian Pacific Northwest are tied to larvae's inability to form a shell in acidifying waters (Klein, 2014).

Growing Antarctic ice, however, has sparked climate skepticism. Understandably, it seems odd that ice could grow in a warming climate. Important here is the difference between land ice and sea ice. *Land ice* has accumulated over thousands of years from snowfall—it is stored up ocean water on land. When it melts it slides into the ocean raising sea levels. The Arctic is clearly losing land ice. In Antarctica, while it appears that some areas have gained land ice while other areas are losing it, the losses outweigh the gains (Plait, 2015).

On the other hand, *sea ice* accumulates in ocean salt water during the winter months, and in Antarctica it melts during the summer, having no measurable impact on sea level. Antarctic sea ice has increased for reasons that scientists are trying to fully understand; however one reason is lower levels of ozone in the region have led to stratospheric cooling and more wind, allowing for open water to freeze (Mathiesen, 2014). In the Arctic, the sea ice lasts nearly all year, decreasing some in the summer, but an ice cover remains. Unlike Antarctica, when sea ice melts in the Arctic more sunlight is absorbed into the water rather than being reflected away, altering the earth's energy balance. Similar to permafrost melt, it raises the concern of another global-level feedback loop accelerating climate change.

A recent study published in *Nature* shows that compared to any time over the last 1,000 years, the temperature has risen much faster in recent decades (Smith et al., 2015). Two important caveats about this research need to be emphasized: (1) 40-year periods were analyzed to control for year to year fluctuations that are not human induced; and (2) future projections are based on IPCC data that took into account human action to limit GHG emissions (McSweeney, 2015). As such, the rate of temperature rise is expected to accelerate over the next 40 years even with actions taken to limit future warming. While the rates of change are increasing for all regions in the world, it is worth restating that Arctic temperature is rising twice as fast.

Global mean sea level has risen 8 inches since the beginning of the twentieth century (Kahn, 2014). While warming ocean waters are not the only contributor, since the mid-1990s it has accounted for more than half of the rise and appears to be accelerating. Faster than expected ice melt, especially in Greenland, increased the IPCC's projections for sea level rise from the fourth to fifth Assessment Reports; the most current estimate is 10 to 38 inches (26 to 97 cm) compared to the 2007 projection of 7 to 23 inches (18 to 59 cm) by 2100 (Fitzpatrick, 2014).

Glacial ice melt in Greenland is particularly concerning, as it contains 680,000 cubic miles of ice sheets that is three miles thick in some places and stretches in all directions across the island (Kahn, 2014). Glaciers in the southeast and northwestern parts of the island have been losing mass, and calving—large chunks of ice breaking off into the sea—to the extent that in the last 20 years, this water has accounted for 15 percent of the global sea level rise. Glaciers in the northeastern portion of the island had been more stable, which is important because they are more deeply connected to the interior ice sheet. Recently, warming ocean surface water and air temperatures are accelerating ice melt in this region. The northeastern glacier Zachariae has receded 12.4 miles from its 2003 position. Compare Zachariae's rate of change to Jakobshavn, a southwestern glacier, which had been considered the fastest changing by retreating 21.7 miles over the course of 150 years (Kahn, 2014).

The impacts of climate change will endure for centuries regardless of human efforts to reduce or stop GHG emissions. It is possible you have heard of the target to limit global warming to 2 degrees C (3.6 degrees F) above pre-industrial levels. Maybe you have heard about the more ambitious target of limiting warming to 1.5 degrees C. The 1.5 C target has been pushed because many places and people around the world are struggling to cope with current climate change impacts and feel the 2 degree C goal is a "death sentence." Perhaps most importantly, we do not really know that 2 degrees of warming is safe. Scientists, however, tell us that exceeding 2 degrees—even 2.1 degrees C—will take us into unknown territory, possibly triggering tipping points (Klein, 2014; Sutter, 2015).

Consider that 2 degrees of warming is expected to increase wildfires in the US by 400 percent to 800 percent; hurricanes will be more intense; Arctic ice will continue to melt; crop yields in the US, Africa, and India will decrease by 10 percent to 30 percent; a range of species will be at risk for mass extinction; and freshwater supplies will decline by 20 percent (Sutter, 2015). Remember 2015 was the first year to see temperatures 1 degree C above pre-industrial levels. According to research conducted by the World Bank, a generally conservative institution, if the world does not uphold its commitments to reduce carbon emissions, we could see a 4 degree C world by 2060 (Ciplet et al., 2015; Klein, 2014).

To summarize, the greenhouse effect and the threat of global warming have been documented for more than a century. However, it was not until the 1950s that the risks began to be taken seriously and only in the 1990s have preventative policy measures been considered. In this next section, we will discuss the role the social sciences have played in climate change research and policy.

THE SOCIAL SCIENCES, SOCIOLOGY, AND CLIMATE REDUCTIONISM

Past and current climate research and policy at multiple levels—global, national, state, and local—has been dominated by the natural sciences, while social science analyses have been marginalized (Brulle and Dunlap, 2015). This has raised the issue of *climate reductionism* (Brulle and Dunlap, 2015; Hulme, 2011). Climate reductionism occurs when climate and natural system forces are assumed to be the primary drivers of climate change, while the social catalysts are treated as an outcome of, or response to, natural and climate forces (Hulme, 2011). This leads to the issue of oversimplification, as the complexity of human–climate interactions is not fully examined or understood.

In all fairness, social science studies of climate change drivers, impacts, and policies did not emerge until the 1990s (Brulle and Dunlap, 2015). More recently, however, social scientists and sociologists have generated a great deal of research on climate change. Interdisciplinary research teams, which include social scientists, have also been created to conduct research and contribute to policy. Highly respected environmental sociologists, Riley Dunlap and Robert Brulle (2015a) are editors of the book *Climate Change and Society: Sociological Perspectives*. This book is the outcome of the American Sociological Association Task Force on Sociology and Global Climate Change. Brulle and Dunlap assess the social sciences' role in interdisciplinary climate change research and policy. They argue that the inclusion of the social sciences has taken three primary forms and each is lacking in providing the most comprehensive and usable data to effectively address the enormity of the problem.

According to Brulle and Dunlap, the most influential effort to include social science research in the study of climate change is within the *Coupled-Human-Natural Systems (CHANS)* framework which led to the development of *sustainability science*. CHANS research examines the reciprocal interactions and their feedback loops between natural and human systems. The critique of CHANS/sustainability science is twofold. First, research questions continue to be framed using the natural science perspective, while the social sciences are lumped together, and the distinct contributions each stand to make are largely ignored, and generally marginalized. Social science theory and research are only viewed as relevant when seen to be addressing a natural science issue or question. Second, CHANS/sustainability science heavily utilizes systems theory (refer to functionalist theory discussed in Chapter One). As such, theories that address social conflict, forms of economic, political, and social power, and human agency are largely unobserved, narrowing the scope of research questions and policy options.

The second way the social sciences are incorporated in climate change research is through economics and psychology using *individual-level analyses*. Economics has had the greatest influence, and generally, the rational actor model, most closely associated with the principles of neoclassical economic theory, is almost always employed (see Chapter Seven). Individual-level analyses are essential to understanding attitudes and behaviors that influence climate change. However, when standing alone, they tend to reinforce American beliefs in individualistic solutions and ignore or minimize the critical influence of macro-level processes as a driver of climate change. A few examples include the following large-scale institutions and social systems: the fossil fuel industry, and capitalism and neoliberalism; religious institutions like the Catholic Church; the military; social conditions like growing wealth and income inequality, and segregation; and dominant cultural beliefs and practices associated with hyper-consumerism or gender role expectations.

The third approach taken is the "post-political" demonstrated in official reports of international and national governmental agencies and some nongovernmental organizations. A "depoliticized" framing of the problem is reinforced by the technocratic and value-neutral approach natural scientists often feel most comfortable employing in their research (Brulle and Dunlap, 2015: 12). This research approach, however, erases an accounting of the vested social, economic, and political interests that reinforce the status quo, thus perpetuating global warming.

Consequently, the overreliance on these three approaches limits researchers, policy makers, and the general public's understanding of future scenarios of social, economic, political, and cultural change; whether or not such changes are directly associated with climate or natural system forces. These social forces work in spite of, and in tandem with, climate change to affect the well-being of humans (Brulle and Dunlap, 2015).

So, what does sociology have to offer? As discussed in Chapter One, sociologists view social systems as having a "nested" nature similar to ecosystems. They are hierarchical, but within each level of hierarchy there are many interconnected subunits; such as a nation is composed of states or provinces, organizations, communities, households, and individuals (Ehrhardt-Martinez et al., 2015: 202). There are three key benefits to a sociological approach. First, it allows researchers and policy makers to examine the interplay between the micro level—individuals and households; the meso level—communities and state organizations; and the macro level—national and international governmental and nongovernmental organizations (Ehrhardt-Martinez et al., 2015: 203). Second, sociology directs our attention to the social conditions that structure the range of choices available to individuals and how those choices are culturally reinforced. For example, if people are to choose low-carbon transportation, the options must be convenient—transportation systems need to be laid out in relationship to where people live and work, and meet the demands of their work–life balance—how much time can be expended on getting from point A to B. They also must be culturally acceptable. The constraints posed by culture, and meso-level organizations, such as a state's Child Protective Services, are real—just ask the Maryland parents labeled as "free-range" and charged with child neglect for letting their ten- and six-year-old children walk alone about a mile from a neighborhood park to their suburban home (see www.today.com/parents/maryland-free-range-parents-cleared-neglect-t27901). Or ask my teenagers (Monica's) how driving a Prius is reinforced by friends in rural Nebraska. Finally, variations in how individuals, social groups, and organizations experience and respond to immediate and potential climate change threats can be understood. We will apply a sociological lens to examine two courses of climate action: adaptation and mitigation.

WHAT TO DO ABOUT CLIMATE CHANGE: ADAPTATION AND MITIGATION

Adaptation efforts focus on how to live and cope with climate change consequences. Mitigation efforts focus on reducing GHG emissions (Carmin et al., 2015; Ehrhardt-Martinez et al., 2015). We begin with a discussion of adaptation and then turn to mitigation; however, keep in mind they are two sides of the same coin.

ADAPTATION AND VULNERABILITY

When scholars and policy makers initially looked at policy options to address climate change, some argued that human systems could adapt to climate change much faster than they occur. As such, an organized governmental response would be superfluous and unnecessary; there is plenty of time. This was a favorite argument of neoclassical economists. They maintained that while the projected increases in CO_2 will take place over the next century, financial markets adapt in minutes, labor markets in several years, and the planning horizon for significant economic and technological change is at most two or three decades (Stern et al., 1992: 110). As such, adaptation was given minimal attention by large-scale institutions and in the early IPCC Assessment Reports (Ciplet et al., 2015). Given current climate change impacts and greater scientific understanding of them, adaptation is no longer a back-burner issue.

According to the IPCC (2012, 2014), climate adaptation refers to "the process of adjustment to actual or expected climate and its effects, which seeks to moderate harm or exploit beneficial opportunities" (as quoted in Carmin et al., 2015: 165). Three dimensions of vulnerability to climate change are exposure, sensitivity, and adaptive capacity. *Exposure* involves identifying risks within natural and human systems to climate change, such as eroding coastal land due to sea level rise. *Sensitivity* addresses variations in how individuals, communities, or nations are impacted by climate change stressors. For example, during heat waves the socially segregated and isolated are more likely to die due to deficits in natural, economic, and social capitals (Klinenberg, 2015). *Adaptive capacity* refers to the ability to accommodate and cope with climate change threats and stressors. Adaptive capacity generates resiliency, which should reduce exposure to risks, and minimize harm and damages associated with climate change threats. Typically, technological, engineered, and ecological system management solutions are highlighted to enhance adaptive capacity (Carmin et al., 2015). Improvements in early warning systems, infrastructure, building and development, and better land management are obviously needed. However, it is equally necessary to address the social conditions in which people interact, make decisions, and provide the bases of social support and cohesion (Carmin et al., 2015; Klinenberg, 2015).

Social vulnerability to climate change risks varies in accordance with the fault lines of society; social inequalities associated with statuses that we each hold, including: social class, race/ethnicity, citizenship or immigration status, gender identity, sexual orientation, age, and physical ability. Geography and place of residence (i.e., rural/urban/suburban) and demography (migration patterns) also affect vulnerability. At the global level, the placement of a country in the world system, and level and conditions of development (i.e., rapid urbanization or post-industrialization) also matter. Tracing variations in social vulnerabilities can assist in identifying differences in how people perceive risks and are likely to respond in the short and long term. If the goal is to build resilient communities, it is the most instructive because diverse knowledge and resource bases can be harnessed. Marginalized populations have long histories and stored up resilience for "…coping with environmental uncertainty, variability and change" (Wildcat, 2014: 1).

The concept of environmental (in)justice was introduced in Chapters One and Two. Similarly, climate (in)justice addresses the issues of equal access to the atmospheric carbon space, the distribution of climate change impacts, and who is at the decision-making table concerning adaptation and mitigation measures (Ciplet et al., 2015; Harlan et al., 2015; Wildcat, 2014). At the global, national, and local level, those who have contributed the least to climate change have experienced the worst outcomes. For instance, the combined historical GHG emissions from the least developed countries make up less than 1 percent of the global total yet they are five times more likely to die from climate-related disasters (Ciplet et al., 2015: 7). Climate injustice also can occur when adaptation and mitigation efforts are taken, resulting in the following examples: forced relocation; increased political, economic, and social insecurity; and loss of culture, and even statehood. Climate change compounds existing stressors for marginalized populations while also imposing new ones (Wildcat, 2014).

In the following section the primary issues associated with exposure, sensitivity, and adaptive capacity to climate change impacts will be highlighted. In reading this section, consider three key points: First, economic and political decisions and policies create social variation in vulnerabilities, including preparedness for climate change impacts. Second, building adaptive capacity requires investment of public resources and political support to implement and enforce policy measures, and this varies dramatically within and between nations. Third, the probability that individuals, communities, and countries will enhance their adaptive capacity is influenced by how important they perceive it to be, their knowledge of threats and options for responding to them, and the resources available for taking action (Carmin et al., 2015).

SOCIETY AND VULNERABILITY TO CLIMATE CHANGE IMPACTS

1. Food security: Many crop yields are intricately dependent on a particular mix of temperatures, soil conditions, and rainfall patterns that are disrupted by climate change. Current and expected impacts on agriculture are mostly negative; especially for wheat, rice, and maize (also known as corn) in tropical and temperate regions (Carmin et al., 2015; IPCC, 2014). The 2015 South African drought devastated its maize crop, a food staple in the region, resulting in an estimated $84 million loss in revenue (Allison, 2015). The drought also adversely affected meat and dairy production. Though large commercial farms are more resilient compared to small farmers because of their greater financial resources, the South African government does not provide subsidies to farmers. As a result, many small subsistence farmers, who in South Africa's racially stratified society are mostly Black, did not survive the drought. Overall, as political and social instability increases, more food is imported and costs and hunger rise.

Food security is critical to the resiliency of diverse cultures and indigenous people. Indigenous people often live in precarious and high risk exposure environments, relying more on natural resources for their livelihood (Wildcat, 2014). For Alaskan indigenous communities, thawing and thinning land, sea, and river ice, and permafrost melt, threaten their food sources. Hunting and harvesting wild foods becomes much more risky due to changes in animal movements, changes in spring run-off, shifting vegetation season, and increased frequency and severity of wildfires (Cochran et al., 2014). In the US and Canadian Northeast and Pacific Northwest, many varieties of berries, a traditional food and medicine source, are integral to the cultural practices of indigenous people. Climate change consequences interact with pre-existing stressors, such as reduced access to territory, pollution, deteriorating health services, and introduction of nontraditional species, to reduce the range, quantity, and quality of culturally traditional species of berries (Lynn et al., 2014). Threats to traditional food sources pose economic, political, and health costs. Increasingly, communities are pushed to purchase prepackaged foods that require modern refrigeration, disposal of packaging materials, and often are less healthy.

2. Freshwater supplies: Rising global temperature is a key factor in threatening water supplies for millions of people and other species, thereby exacerbating the world's existing water problems, which as Chapter Two noted, are substantial. In rural Alaska, thawing permafrost beneath lakes and ponds threatens and compromises access to safe and reliable drinking water and sewage systems (Cochran et al., 2014). Permafrost loss also has allowed beavers, which can carry giardia (a waterborne parasite that causes intestinal infections in humans), to migrate north, living in rivers for the first time since the last ice age (Cozzetto et al., 2014). These changes pose many health risks to indigenous people.

Furthermore, rising temperatures can reduce stream flows and increase pressure on groundwater while worsening the pollution discharge into smaller flows. For example, by 2015 California was in its fourth year of record breaking drought and more than 500 wells in the San Joaquin Valley, the world's richest agricultural region, dried up. This meant that many "poor, unincorporated, predominantly non-white" households had no running water for drinking, cooking, bathing, or flushing the toilet (Bliss, 2015: 3). A history of poor planning, lack of infrastructure investment, racially restrictive covenants, no regulations, low property values, and more disinvestment, rendered these communities uniquely sensitive to the negative impacts of severe drought. They have dealt with unsafe water due to nitrates, arsenic, and a variety of other contaminants for decades. But despite harsh conditions, many in these communities do not want to leave even if they had the resources to do so. They view themselves as self-sufficient and resilient in their ability to cope with their living conditions. The extreme drought, however, has worsened their pre-existing problems and may outstrip their capacity for "individual self-reliance" (Bliss, 2015: 12).

Heavy precipitation events also pose many water challenges, such as increased sediment, nutrient and pollutant loadings, and the capacity of water treatment facilities to ensure safe drinking water may be overwhelmed (IPCC, 2014). In Bangladesh, one of the world's least developed countries and most vulnerable to the full range of climate change impacts, increased flooding is contaminating freshwater supplies. It is estimated that between 35 and 77 million of the 165 million Bangladeshis are at risk for drinking contaminated water (Jahan et al., 2013). Also, in developing countries women are generally responsible for collecting water, so declining water quality, scarcity, and drought forces them to travel much longer distances.

3. Extreme weather events: The economic costs of extreme weather events are enormous. Globally, 2011 holds the record for damage costs from disasters at about $380 billion (Klein, 2014). The human and social costs are devastating. In November of 2012, typhoon Bopha, the strongest ever to hit the Philippines, killed over a thousand people. Then, in November of 2013, super-typhoon Haiyan struck the Philippines, killing more than 6,000, displacing over 4 million people, and requiring several billion dollars for reconstruction (Francisco, 2013). In 2012, Superstorm Sandy hit the Caribbean and the US, notably the New Jersey shore and New York, killing 140 people and costing about $70 billion (Ciplet et al., 2015). Globally, while costs for damages from extreme weather events are rising, many governments have embraced *austerity*—reducing government social spending to offset budget deficits. Cuts in public services lower adaptive capacity, creating a greater need for emergency expenditures.

BOX 3.2

Superstorm Sandy hit New Jersey and New York on October 29, 2012. It was the second costliest storm in US history. The storm surge, flooding, and fires destroyed homes, and took out power for millions. These homes burned to the ground in Far Rockaway, New York.

MISHELLA / Shutterstock.com

Figure 3.6

Public abandonment before a disaster can also cause the most vulnerable in a population to experience a second disaster in its aftermath. Six months before Sandy hit Rockaway, Queens (New York), one of only two hospitals in the area had closed, exacerbating the public health crisis in the aftermath of the superstorm (Klein, 2014). More than a week after Sandy hit the impoverished community of Rockaway, residents, many with disabilities and chronic illnesses, were not only left in old buildings filled with muck from the waters, with no electricity or cell service, but they had no access to medical care (Klein, 2014).

Hurricane Katrina that hit New Orleans and other parts of the Mississippi and Louisiana Gulf Coast on August 29, 2005, is the most expensive storm on record ($135 billion) in the United States, and was socially devastating, killing over 1,800 persons. The impacts of extreme disasters are long lasting. Sociologists Alice Fothergill and Lori Peek's book *Children of Katrina* (2015) has received media attention because few researchers and policy makers have adequately addressed the distinct experiences and needs of children before, during, and after disasters. In the US 25 percent of the population are children and in developing countries that number is much higher. More than 5,000 children were reported missing after Katrina, some for weeks and even months. It displaced about 372,000 children, and years after the storm 160,000 were still displaced. Research showed that five years later children who had been exposed to the storm were five times more likely to have symptoms of serious emotional disturbance compared to their unexposed counterparts. Yet, Fothergill and Peek demonstrate in the book that children do not experience disaster equally nor are they helpless victims or naturally resilient. In addition to age of exposure, the social conditions and networks children live with and have access to in different spheres of their lives (i.e., family, housing, peers, extra-curricular activities, school, and health) affect their vulnerability and resilience. While children's vulnerability to climate change impacts is tied to their family and social conditions, the resiliency of families and communities also relies on the well-being of the children.

Globally, women are disproportionately impacted by climate change due to their greater responsibility to care for the home and dependents—children, elderly, and the sick (Nagel, 2016). Regarding extreme weather events, a study of 141 countries from 1981–2002 found that natural disasters lower the life expectancy of women more than men, and the stronger the disaster, the greater the life expectancy gender gap (Neumayer and Plumper, 2007). Cultural differences in gender role expectations affect women's ability to respond to natural disasters. For example, during a major flood in Bangladesh, women's modest dress, inability to swim and their shame over entering public spaces where unrelated men could be, increased their likelihood of harm and death (Harlan et al., 2015). Women also hold varying levels of economic and political power which affects their ability to protect themselves and children from harm, as women's relative poverty renders them less resilient in the aftermath of a disaster (Harlan et al., 2015; Nagel, 2016; Neumayer and Plumper, 2007).

4. Human health: According to the IPCC (2014), the severity of negative health impacts stemming from climate change will cancel out positive impacts. The health risks include the greater likelihood of the following: injury or death from heat waves and fires; disease infection from food- and water-borne diseases; disease infections from pathogens and parasites; loss of work capacity; and decreased labor productivity among vulnerable populations. By 2100, some areas may experience such high temperatures and humidity levels that common human activities of working outside and growing food will be jeopardized throughout the year (IPCC, 2014). Global warming worsens human health risks as a result of heat stress and more vigorous transmission of tropical diseases over larger areas. Global outbreaks of illness spread by mosquitoes—West Nile Virus, dengue, chikungunya and the most recent, zika—are becoming more common now that mosquitoes have a longer time to breed.

Urban areas are increasingly facing the challenge of the heat island effect—developed areas are hotter than rural areas—so much so that an urban area with one million people or more can be 1 to 3 degrees C or 1.8 to 5.4 degrees F warmer (US EPA, 2015). Not only does this increase the risk of heat-related illness and mortality, but other problems are exacerbated by increasing energy demand and costs, air pollution, increased GHG emissions, and threatening water quality. In the United States, Latinos and African Americans are disproportionately impacted due to a greater likelihood of living in segregated communities in the urban core. In comparison to wealthier white neighborhoods, those who live in segregated urban communities tend to have fewer social networks and other coping resources, trees, parks, swimming pools, and quality housing and air conditioning, which contributes to more heat-related deaths (Harlan et al., 2015; Klinenberg, 2015). As urban areas expand globally, the "heat riskscape" is predicted to become a serious problem (Harlan et al., 2015: 140).

5. Land use and human settlements: Even if warming is contained to no more than 2 degrees C, modest rise in sea level will threaten the coastal settlements in which *half* of humanity lives. They include cities such as Boston, New York, Miami, New Orleans, Los Angeles, Vancouver-British Columbia, as well as Amsterdam, Copenhagen, Tokyo, Osaka, Manila, Shanghai, Guangshou, Mumbai, Lagos, and London. The economic risks to coastal assets are staggering. As such, Vancouver was the first Canadian city to adopt a climate change adaptation plan (Moore, 2013). A study published in *Nature* looked at the flood risk of a .2 to .4 meters rise by 2050 to the 136 largest coastal cities in the world, which included Vancouver, and found that global costs due to losses from flooding could reach $63 billion (Moore, 2013). It is also estimated that without adaptation efforts, the costs could soar to $1 trillion. Vancouver, however, disappears from the list of most affected cities when adaptation measures are considered. Cities in developing countries do not fare as well due to few resources to defend themselves from flooding (Moore, 2013). If warming reaches 4 degrees C by 2100, entire small island states, such as Tuvalu and the Maldives Republic, will sink, and the places listed above could face irreparable consequences from flooding (Klein, 2014).

Also, vulnerability to wildfire hazards is clearly related to development in the wildland urban interface (WUI), residences built in or near natural areas—forests, grasslands, shrub

xuanhuongho / Shutterstock.com

Figure 3.7 Seaside resort in Vietnam combating erosion from rising sea level.

lands, that are prone to wildland fires (Carmin et al., 2015). In the United States, nearly one in three housing units is in a fire prone zone. In Arizona 45 percent of homes are in the WUI (Davidson, 2013). Growing development in the WUI is driven by economic development interests, urban sprawl, growth in second homes, environmental amenity migration, and the belief that a firefighter is only a phone call away (Carmin et al., 2015; Davidson, 2013). More housing in forests increases the opportunity for fire ignition and provides more fuel for burning (Carmin et al., 2015). Wildfires release GHGs and wipe out forests that sequester carbon. With more housing in forests, states and local communities expend more resources to fight fires often from the air and burning fossil fuels. Adaptation measures to decrease the risk of wildfire hazard have financial components and land use policy implications, such as limiting development in WUI areas, emergency preparedness, and involve modifying individual behaviors and beliefs about fire risk.

***6. Migration and climate refugees*:** Estimates vary on the number of people who will be displaced by climate change impacts, but well-cited figures are around 200 million by 2050 (Ciplet et al., 2015; Harlan et al., 2015). Short-term environmental shocks from extreme weather events can produce different migration patterns than slow onset stressors, such as sea level rise, declining soil, and water quality (Carmen et al., 2015). Migration also ranges on the continuums of forced to voluntary migration and permanent displacement to cyclical migration. The majority of environmentally induced migrations take place within nations. Those with greater resources are the most likely to migrate internationally (Carmen et al., 2015). When populations are displaced due to an extreme weather event, the most disadvantaged within the population are the least likely to be able to return to their homes, which has been the case with New Orleans after Hurricane Katrina (Bullard and Wright, 2009; Carmen et al., 2015).

In reality, many people have strong attachments and cultural connections to their local environment and do not want to leave even in the face of increasing risks (Carmen et al., 2015). Globally, the most likely to become climate refugees are residents of small island states, such as Tuvalu in the South Pacific. They are currently losing land to the sea and may sink entirely in the near future. Like residents of other small island states, they represent the displacement of an entire country, and as sovereign nations recognized by the UN, they have legal control over exclusive economic zones (EEZs)—coastal states have the legal authority over marine resources within a certain radius of their shore (Ciplet et al., 2015). If their island sinks, they are stateless people. The United Nations Refugee Convention provides no meaningful protections to climate refugees which has remained an undefined status. Their plight is pushing the world to confront big international and political issues. For instance, will states that host refugees allow them to continue to hold sovereignty over the EEZs or will the host state take control of the EEZs (Ciplet et al., 2015: 126-127)?

***7. Security and conflict*:** A 2003 Defense Department analysis projected widespread rioting and regional conflict in some countries faced with dwindling food, water, and energy supplies, and argued that global warming must "be viewed as a serious threat to global stability and should be elevated beyond a scientific debate to a national security concern" (Miller, 2005: 471– 472). Climate change impacts national security in much the same way it does extreme weather events, it is not the direct single cause, but it does "load the dice." The four-year Syrian drought has been identified as a factor in the Syrian civil war, which caused a global refugee crisis (Miller, 2015). The Syrian drought, the worst the country has experienced, lasted from 2006 to 2009, and led to approximately 1.5 million internal migrants from rural to urban areas. A study published in the *Proceedings of the National Academy of Sciences* argued that the odds of such an extreme drought in Syria were two to three times more likely to occur due to greater aridity in the region (Fountain, 2015). Climate change impacts can overwhelm a country's adaptive capacity, especially when already stressed. In Syria, when the drought hit, they were coping with the influx of Iraqi war refugees.

Given the destabilizing effects of climate change, militarism, and the expansion of the military, is one way to address conflicts and perceived insecurity. The military, however, is the largest institutional polluter on the planet and a major consumer of fossil fuels and producer of GHGs (Jorgenson and Clark, 2016). Jorgenson and Clark argue that the role of militarism as a driver of climate change has received minimal attention by sustainability science researchers. Thus, they use the treadmill of destruction theory (an offshoot of the treadmill of production discussed in Chapter One) to analyze the influence of militarism on consumption-based CO_2 emissions for 81 developed and developing nations. The treadmill of destruction framework looks at the environmental and social effects of the expansionary drive of militaries to increase capitalist profits and state power. Militaries increasingly employ expensive, highly advanced technology and can move personnel, armory, and weaponry across land, sea, and through the air faster than ever before. These advancements have amplified the military's contribution to GHG emissions. For instance, F-15 and F-16 fighter planes consume 1,500–1,700 gallons of fuel per hour and if the planes use afterburners, 14,000 gallons of fuel are burned per hour! By the 1980s nearly a quarter of the global jet fuel was used by the world's militaries. Not only do militaries consume a disproportionate share of the carbon space, and pollute ecosystems with the use of thinners, solvents, pesticides, lubricants, propellants, and degreasers, they also absorb a tremendous share of a nation's budget. Less money is then available to pay for other societal needs. A key finding from their study is that military expenditures as percent of GDP have a *greater effect* on CO_2 emission increases in developed countries than developing countries. This finding reinforces other research discussed in Chapter Six, which shows wealthier nations have a larger ecological footprint compared to poorer nations. In sum, Jorgenson and Clark contend that militarism along with affluence and consumer patterns must be considered in mitigation strategies to combat climate change.

MITIGATION: CONTROVERSY, CONFLICT, AND THE POWER OF KNOWLEDGE

Mitigation to reduce GHGs includes a range of actions at the micro and macro level. At the micro level, reduction in CO_2 emissions can be achieved through changes to individual and household energy consumption, food and transportation choices, and fertility decisions. In the US 38 percent of total carbon emissions can be directly attributable to the behaviors of individual consumers (Ehrhardt-Martinez et al., 2015). Individuals can push for mitigation policies at multiple levels (local, national, global) by voting and by supporting environmental movement organizations. At the meso level, state or subnational and local organizations can enact mitigation initiatives, such as developing transport systems that make low carbon transportation choices easy and accessible to use. At the macro level, the social conditions and characteristics of a country shape their motivation and ability to pursue mitigation measures. International and national governmental bodies, private business, and transnational corporations may be large GHG emitters and wield substantial influence in the formation of economic and political policies. The fossil fuel industry has an extremely powerful lobby, which makes it difficult for politicians to take aggressive climate change action. Also, many NGOs and environmental movement organizations have cozy relationships with industry and government actors and organizations (which we will discuss in Chapters Seven and Eight). As such, they may be more likely to compromise with the biggest polluters—the fossil fuel industry. Given the unique phenomenology of climate change in people's everyday lives, climate action requires the trust of scientists and other expert knowledge bases, which opens the door to politicization and conflicts of interest (Ciplet et al., 2015; Ehrhardt-Martinez et al., 2015).

Studies show that in the wake of an extreme weather event or technological disaster, such as a hurricane or an oil spill, the aftermath is an opportunity for mitigation and adaptation efforts (Carmin et al., 2015; Ciplet et al., 2015; Ehrhardt-Martinez et al., 2015). At these times, doors open to enact changes, but time is limited. Other change-making opportunities arise when shifts in institutional and organizational leadership occur. Some sociologists use the political opportunity structure model to understand how organized interests take advantage of changing institutional and social conditions. Individuals, community groups, and organizations that want to initiate climate action must know when the conditions for change are ripe and be ready to act. This also holds true for those who want to reverse or stall climate action.

For instance, in the United States the 1994 Republican Revolution of Congress opened a door for a countermovement to shape global, national, and local public opinion and climate policy—climate inaction. Global warming went from being a widely accepted social problem in the late 1980s, to the acceptance of climate skepticism and denial by the media, politicians, and the general public by the late 1990s, continuing to this day. The organizational base of the countermovement has been the fossil fuel and associated industries and conservative think tanks, devoted to the belief in laissez-faire capitalism, and more generally, the dominant social paradigm as described in Chapter One (Brulle, 2014; Dunlap and McCright, 2015; McCright and Dunlap, 2000, 2003). They mobilized a small minority of scientists—with real credentials, but who published research on climate change outside of peer reviewed scientific journals—along with some talented writers and media personalities to produce the view that global warming is a pseudo-problem—a "lot of hot air." Playing upon the real scientific complexity of climate change, skeptics argue that networks of radical environmentalists and political liberals have manufactured global warming, calling it a thinly disguised attack on American capitalism and consumerism (Kennedy, 2005; Dunlap and McCright, 2015; Pope and Rauber, 2004). This framing helped to hide harassment of scientists, and the interests of the organizations behind the counterclaims. For example, in January 2006 the top scientist at NASA, Dr. James Hansen, publicly claimed that the administration of President George W. Bush tried to stop him from speaking out since he called for prompt reductions in GHG emissions (Revkin, 2006).

Most recently, in November 2015, the New York attorney general launched an investigation into Exxon Mobil to determine if the company lied to the public about their knowledge of climate change risks and to their investors about the costs it posed to their business operations. Part of the investigation includes the review of a 10-year time period during which Exxon funded outside scientists to create climate skepticism at the same time their own scientists were investigating the consequences of the real risks and uncertainties of climate change (Gillis and Krauss, 2015).

Nonetheless, US climate policy continues to be hampered by climate skepticism. While national and cross-national research shows that education and increasing knowledge about climate change can reduce skepticism and denial for some social groups, for others, especially religious and politically conservative groups, it is much less likely to matter (McCright et al., 2016; Zhou, 2015). Yet knowledge and acceptance of the scientific consensus does not necessarily equate with climate action. Sociologist Kari Norgaard (2006, 2011) illustrates how Norwegians are knowledgeable about climate change and do not deny it, and yet they live their daily lives as if it is not happening and justify their own and their country's lack of action on it. Her research shows that when faced with insecurity and uncertainty, people draw upon cultural narratives about national identity and emotion norms—the socially accepted ways to manage fear and anxiety. In the US, cultural values and norms associated with American individualism and lack of trust in government leave Americans at a loss on how to respond to climate change (Norgaard, 2011). Moreover, US support for environmental protection, including climate change policy, has become divided along partisanship lines. A plethora of research shows Republicans to be more likely to believe in climate skepticism and denial and less likely to support mitigation measures (Shwom et al., 2015).

Sociologist Dana Fisher and her colleagues (2015) examined how the US debate surrounding scientific consensus on climate change continues among policy actors. Using social network analysis to track how information flowed within the "elite climate policy network," comprised of scientists, activists, and persons in government and industry, they asked policy actors if they agreed with the statement: "There should be an international binding commitment on all nations to reduce GHG emissions" (2015: 46). They discovered echo chambers, meaning that an individual's level of agreement or disagreement with the statement mirrored other persons in their individual network with whom they shared information. Echo chambers are formed by people holding a similar viewpoint, and contain transitive triads—a group of three where information is provided by a single source to other actors in the triad both directly and indirectly, thus amplifying agreement around already shared beliefs. Echo chambers allow misinformation to be kept alive and science to be politicized. They also are a significant barrier to moving policy forward.

At the global level, environmental policy formation involves multilateral, international negotiations. Groups that represent private business interests and public interests, such as civil society groups like NGOs and social movement organizations, also seek influence. Civil society groups have called for transparent negotiations in the crafting and enforcing of global environmental treaties, which ensures that public representatives can observe and have a meaningful voice to avoid echo chambers. The *Montreal Protocol* is often considered the most successful global environmental treaty, in which the world recognized a significant environmental threat, and gave up profitable and useful products to avoid significant human and ecological damage. We will discuss ozone depletion and the Montreal Protocol before turning to global diplomacy to reduce GHGs.

OZONE DEPLETION AND ULTRAVIOLET RADIATION

High up in the stratosphere, twice as high as Mount Everest, is a gossamer veil of ozone with a crucial function. Ozone is made of three oxygen atoms combined (O_3), while ordinary atmospheric oxygen only has two (O_2). Ozone is so unstable and reactive that it attacks and oxidizes almost anything it contacts. Low in the atmosphere, where it can react with many things (including plant tissues and human lungs), ozone is a destructive but short-lived pollutant. High in the atmosphere, where ozone is created by the action of sunlight on ordinary oxygen molecules, there is not much to react with, so the ozone layer lasts a long time. There is enough ozone, however, to absorb much of the most harmful ultraviolet wavelength from incoming sunlight (UV-B), which tears apart organic molecules. In humans it can produce corneal damage, reproductive mutations, and skin cancer, while suppressing the immune system's cancer-fighting ability. It damages single-celled organisms and could damage floating micro-organisms (plankton) that are the foundation of ocean food chains. It also stunts the growth and photosynthesis of green plants (Meadows et al., 1992: 141–147). While ozone depletion is not the only cause of skin cancer, the US EPA has estimated the costs of increased UV exposure in the twenty-first century to be $6 trillion. Concerning agriculture, for every 1 percent increase in UV exposure, crop yield will decline by 1 percent. UV radiation also increases the rate of degradation of plastics, paints, and rubbers (Gareau, 2013: 7-8).

DESTROYING THE OZONE LAYER: A CAUTIONARY TALE OF TECHNOLOGY AND PROGRESS

Here is a detour into the social and historical contexts of the problem. It is a dramatic example of the economic, social, cultural, and technological causes and consequences of ozone depletion. It is also a classic illustration about how undeniable progress can result in unanticipated long-term problems (this discussion relies heavily on Stern et al., 1992: 54–59).

Until almost the end of the nineteenth century, refrigerating food and drink depended on ice from natural sources that was chopped from local ponds and stored in warehouses or pits for use in the summer. Households used this ice, but breweries and restaurants were the heaviest users, and stored winter ice was sometimes shipped hundreds of miles to provide refrigeration. This system of using stored winter ice was difficult and expensive, so most food was preserved by chemical additives (most commonly salt, sodium chloride). To increase profits, meatpackers in the 1870s began experimenting with ice-refrigerated railway cars to ship beef, slaughtered and chilled in Chicago, to consumers hundreds of miles away. Soon this new ice storage and delivery technology was used to ship fruits, vegetables, and dairy products across the country. This technology drastically lowered the rate at which food spoiled and made perishable crops available to consumers throughout much of the year. But natural ice was unreliable, and in two warm winters (1889 and 1890) the failure of the natural ice crop encouraged the packers to seek more reliable forms of refrigeration.

The principle of mechanical refrigeration—by which compressed gas is allowed to expand rapidly and lower temperature—had been known since the mid-eighteenth century. Mainly urban brewers used the first commercial adaptation of this process in the late nineteenth century. These early refrigerant systems used ammonia, sulfur dioxide, or methyl chloride as refrigerant gases, but they had serious problems such as toxicity. This led Thomas Midgely, working for General Motors Frigidaire division, in 1931 to develop a new chlorinated fluorocarbon, patented as Freon 12. Freon was chemically stable, nonflammable, nonexplosive, nontoxic, and required less pressure to produce the cooling effect.

Because smaller compressors were required, American consumers could soon have their own "refrigerators." Pre-packaged frozen foods were marketed in the 1950s, as were fresh vegetables and dairy products that became rapidly accepted as part of the American diet. Europeans followed Americans in adopting these technologies. Equally important, Freon made it possible for the refrigeration technology to be applied to space cooling in buildings. Air-conditioning became common to offices and finally to residences. This development had an enormous impact on American social patterns. Air-conditioning promoted urban growth in the American Sunbelt—from Florida to California—and in tropical regions around the globe. For many Americans, it would be difficult to envision life in the summer months or warm climates without air-conditioning in their homes, autos, stores, and offices. It shifted the peak use of electricity from the winter to the summer, when air-conditioning systems use electricity at unprecedented rates.

From the 1950s, the sales of chlorofluorocarbons (CFCs) were increased by other uses, such as nontoxic propellants in aerosol sprays and as solvents for integrated electrical circuits. These technologies had an enormous impact on improving the nutrition, comfort, and physical quality of life for many people. But the very *stability* of CFCs that made them so useful ultimately proved to be their greatest environmental hazard. As they leaked from refrigerators, air conditioners, and spray cans at an ever-increasing rate, they eventually found their way to the stratosphere, where they encountered ozone. The problem with ozone depletion was a direct but long-term consequence of a social pattern—the technical innovations, the search for profitable markets and the residential, consumption, and lifestyle patterns and expectations of people—that evolved in wealthy countries.

DESTROYING THE OZONE LAYER: A HAPPY ENDING?

In 1974, scientific research showed that chlorine atoms in the stratosphere could be powerful ozone destroyers and that chlorine atoms could be increasing as CFC molecules reach the stratosphere and break up to release them. While CFCs were manufactured mainly in Europe and North America, they were mixed throughout the lower atmosphere so that there are as many CFCs over Antarctica as over Colorado or Washington, DC. Researchers surmised that upon reaching the stratosphere, CFCs encounter high-energy ultraviolet light, which breaks them down, releasing their chlorine atoms. These then interact with ozone in a catalytic reaction in which each chlorine fragment converts ozone to ordinary oxygen. But through a series of reactions, each chlorine atom can cycle through this process many times, destroying one ozone molecule each time and becoming like the "Pac-Man of the higher atmosphere, gobbling one ozone molecule after another and then being regenerated to gobble again" (Meadows et al., 1992: 148). Each chorine atom can destroy up to 100,000 ozone molecules before it is finally removed from the atmosphere. Chemicals thought to be most dangerous (CFC-11, CFC-12, and CFC-113) were increasing in the atmosphere by 5 percent to 11 percent annually.

In 1985 an unmistakable sign of the destruction of stratospheric ozone was seen with the discovery of the Antarctic ozone hole, which has been observed in other regions (Gareau, 2013). Even with the scientific evidence about the relationship between CFCs and ozone deterioration, little would have happened without the United Nations Environmental Programme, which prodded the international political process. In 1987, an internationally binding treaty to eliminate ozone-depleting substances, the Montreal Protocol, was ratified by 29 countries and Europe, which included 80 percent of the world's CFC consumers (Gareau, 2013). Today, every country has ratified. Since ratification, 95 percent of CFCs are no longer being produced and CFCs in the atmosphere have leveled off or declined (Gareau, 2013: 10). Scientists predict that in the absence of the Montreal Protocol the Northern Hemisphere would have lost half of its ozone layer and 70 percent would have been lost in the Southern Hemisphere.

However, the treaty will need to be continuously monitored, as CFCs take years to reach the upper atmosphere and last for decades, or even centuries (Gareau, 2013; O'Meara, 2002). Scientists also are trying to understand the relationship between ozone depletion and climate change. An Arctic hole exists as well, and in 2011 it moved into Scandinavia and Greenland. The potential also exists for "ozone-depleted air" to continue to move south with the Arctic polar vortex. It could reach northern Italy, New York, and San Francisco—where it could cause sensitive persons to sunburn in minutes due to the surface intensity of UV radiation. A 2009 study in Spain examined the impact of "ozone mini-holes" that have increased since the 1990s (Gareau, 2013: 6).

Upholding long-term global cooperation to oversee ongoing concerns with ozone-layer recovery and enforcing the non-use of ozone-depleting substances is an arduous task. Several problems have emerged, some threatening the stability of the treaty (Gareau, 2013). First, CFCs have been illegally traded globally along the Asian heroin route. In fact, the illegal CFC-113 used in making methamphetamine has been found in the US. Second, schedules for phasing out ozone-depleting substances must be monitored and the time frames have differed for wealthy and developing countries. For example, phasing out the extremely toxic ozone-depleting substance and greenhouse gas, methyl bromide (MeBr), has been hotly contested by the US. MeBr is a neurotoxin used as a pre-plant fumigant in strawberry and tomato production, quarantine, and shipment (Gareau, 2013: 17). In 2003, the US threatened to pull out of the Montreal Protocol if not granted an extension, arguing it gave an unfair advantage to Mexican strawberry producers that had a longer phase-out timetable. Third, the lag time between phasing out a substance and finding a substitution has been problematic, especially for developing countries. Fourth, some replacement technologies such as hydrofluorocarbons (HFCs) are a powerful greenhouse gas.

While the Montreal Protocol has been a model for green diplomacy, it's a risky predictor of outcomes for other international negotiations. At its signing, there were only about two dozen CFC producers worldwide, and banning production threatened few existing firms or long-developed technical infrastructures. Even with scientific consensus, such changes will be much more difficult (1) if the need for change will require greater alterations in social behavior and lifestyle expectations, (2) when there are many millions of responsible actors, and (3) when the costs and benefits of change are less evenly distributed around the planet (Stern et al., 1992: 59). By these criteria, the impending problem of global warming will be *much* more difficult to address, to which we now turn.

GREENHOUSE DIPLOMACY: A BINDING AGREEMENT?

The 1992 United Nations World Conference on Environment and Development in Rio de Janeiro, Brazil, also known as the Rio Earth Summit, intended to initiate a global greenhouse treaty, much like the Montreal Protocol, but it was much more difficult. At the Rio Earth Summit, a major global divide between states emerged—referred to as the global North–South divide (Ciplet et al., 2015; Schnaiberg and Gould, 1994). The global North represents the most developed countries (MDCs); former colonizers that hold great wealth with diversified economies, and global economic and political power. At the UN climate meetings, they are referred to as Annex 1 nations; such as the United States, Canada, Australia, Great Britain, Japan, European Union (EU) states, and Russia along with their former Eastern bloc countries. The global South (Non-Annex 1) consists of countries in all of Africa, Latin America, and most of Asia that bear the marks of colonialism and neocolonialism. They are in various stages of development and underdevelopment. The global North–South divide resulted in two primary sources of conflict that shaped future negotiations.

First, the global North could not unify or agree on a common agenda for climate policy. Due to a relatively high level of public concern and social movement activism around environmental problems and global warming in their home countries, EU countries hoped to negotiate a binding agreement to reduce GHG emissions (Ciplet et al., 2015). The highest global emitter of GHGs, the United States, refused to commit to quantitative national targets for emission reductions, emerging as a formidable obstacle to a globally binding treaty.

The second fault line appeared from the side of the global South. The conference was titled to address "environment and development," and developing countries came to Rio focused on the latter (Schnaiberg and Gould, 1994). The South was represented by 77 developing countries and China (G77). Over time, countries within the G77 have formed diverse coalitions associated with their level of development, political and economic conditions, natural resource base, and a shared relationship to global atmospheric and ecosystem conditions in their region and home countries. For example, the first IPCC Assessment Report (1990) identified small island states as especially vulnerable to climate change. By Rio, a coalition of 44 countries referred to as the Alliance of Small Island States (AOSIS) had already formed. It also was clear China and OPEC states were becoming high carbon emitters, but Brazil was not heavily reliant on fossil fuels for development. Yet, Brazil was under intense pressure to halt their alarming rate of rainforest destruction. The G77 countries were often at opposing ends of the negotiating table due to their divergent interests. By the end of the meetings, however, they emerged united by the common concern that a binding treaty imposed by the North threatened to disrupt or halt their path to development and prosperity.

The global North–South divide is a by-product of *climate injustice*. Developing countries have argued that the North bears *historical responsibility* for the current level of global warming. The richest fifth of the world contributed 63 percent of total global emissions, while the poorest fifth just 2 percent. In individual terms, the average emissions of 1 American equal those of 7 Chinese, 24 Nigerians, 31 Pakistanis, or hundreds of Somalis (Dunn, 1999: 60). Second, the South pushed the issue of *equity*; do they have equal access to the atmospheric carbon space to develop their economies? The cautionary tale told earlier is a tale of industrial development. Does the global South have the right to develop similar opportunities to provide their people with a more secure and prosperous standard of living? They think so.

The twin concerns of historical responsibility and equity run even deeper. Sociologists use a term "ecological unequal exchange" to explain the processes by which developed countries extract the raw resources (e.g., minerals, lumber) from developing countries at low cost, to export to the developed world (Austin, 2010; Harlan et al., 2015). This process has created many benefits for the North, such as diversified economies that can better sustain economic downturns and allow many to live the life of plenty (you probably have heard of the saying, *first world problems*). However, developing countries have not only lacked the benefits of social development in this system, their future attempts at progress are hampered by being disproportionately burdened with the externalities of production (refer to Chapter One), such as pollution from toxic waste, depleted soil due to deforestation or increased frequency of extreme weather events. In fact, the concepts of "ecological debt" and "carbon/climate debt" have been used by NGOs, such as Christian Aid, to argue that the North should repay the South for their climate debt (Ciplet et al., 2015; Harlan et al., 2015; Klein, 2014). Wealthy countries, however, do not want be held *liable* for historical GHG emissions or for their contribution to other related environmental *and* social problems in the global South.

Regardless, developing countries asserted that they should be *financially compensated* for their mitigation efforts, such as preserving their forests as carbon sinks, or forgoing cheap fossil fuels to develop their economies. If they cannot fully use their natural capital, how can they afford new energy technology and pay for needed development projects, such as improved infrastructure, health care, and schools? The North did not contend with these constraints on their path to prosperity.

In the end, the Rio Earth Summit produced a treaty, the United Nations Framework Convention on Climate Change (UNFCCC), initially ratified by 154 (now 195) countries referred to as Conference of the Parties (COP). Countries agreed to *voluntarily* reduce greenhouse emissions, which ought to be achieved with the guiding principles of "equity" and by recognizing their "common but differentiated responsibility and respective capabilities" (abbreviated to CBDR) (Ciplet et al., 2015: 13). These guiding principles take into account historical responsibility and seek to balance the capacity of a country to contribute to climate change action with their development needs. In doing so, developing countries were promised technology transfers and financial compensation for their mitigation efforts. The UNFCCC Conference of Parties (COP) has met every year since their first official meeting in 1995 in Berlin. For the rest of this section, we will highlight the meetings that have been most pivotal to the world taking action on climate change mitigation and adaptation. We will end with a summary of the most recently brokered Paris Agreement. When reading this section, think about how negotiations have progressed since Rio. We will begin with the COP3 convened in Kyoto, Japan in 1997, which garnered a lot of media attention as the world's first binding treaty on climate change was created.

THE KYOTO PROTOCOL

After 10 days of chaotic, complex, and contentious negotiations that included over 10,000 government officials, industry lobbyists and related organizations, and representatives of environmental organizations, 193 countries signed the *Kyoto Protocol*. The Kyoto centerpiece was an agreement that *committed* all "Annex I" nations to cut their output of climate-altering gases collectively by 5.2 percent below their 1990 levels between 2008 and 2012. While that may not seem significant, it represented emissions levels that were about 29 percent lower than they would be by 2008–2012 without the treaty (United Nations, 1998a). Following the guiding principles of the UNFCCC, developing countries were encouraged to reduce their GHG emissions.

Despite evidence that the majority of Americans supported ratification, and the Clinton Administration was on board, the US Senate unanimously passed the bi-partisan Hagel-Byrd Resolution, stating it would not ratify the climate accord (McCright and Dunlap, 2003). It would not ratify for two key reasons; (1) developing countries were exempt from quantitative goals or timetables; and (2) concern over potential serious harm to the US economy. President Clinton did sign in 1998, pledging a 7 percent reduction in emissions and hoping for its eventual ratification by Congress. But in 2001, newly elected President George W. Bush announced that the US had no plans to ratify. This move sparked international outrage and resentment toward the US, the world's richest and, at that time, largest GHG emitter (McCright and Dunlap, 2003; Norgaard, 2006).

It took seven years to bring Kyoto into action in 2005. In fact, it nearly collapsed until Russia saved the day by ratifying with the support of President Putin. Reportedly, Putin used signing Kyoto as a negotiating wedge with the EU to join the World Trade Organization (WTO), and Russia saw it as an economic opportunity (Walsh, 2004). Herein lies four key weaknesses of Kyoto, which remain issues to this day.

The first problem is weak or lack of commitments to targets for reducing CO_2 emissions. The goal of a 5.2 percent reduction in global emissions was anemic compared to recommendations made by the IPCC. Also, the US never ratified, Australia finally did in 2007, and Canada pulled out in 2011. It also did not adequately garner meaningful participation from the rapidly emerging economies of China and India. Furthermore, the first commitment period was set to end in 2012, requiring negotiations for a second commitment period.

Second, some countries, and fossil fuel industries, were anxious to create flexible market-based provisions—critics call them loopholes—that would make it less expensive to meet the protocol's goals and avoid the need to drastically reduce their domestic CO_2 emissions and keep profits up. An emission trading scheme, such as *cap-and-trade*, is supposed to efficiently trim emission costs, and distribute the burden of addressing the problem among various countries. Essentially, a *cap* or legal limit is determined on the amount of allowable GHG emissions during a certain time period and then carbon permits are issued. Countries who do not reach the cap can *trade* their surplus emissions. Also, emission trading schemes allow for the purchase of carbon offsets for emission reduction projects, such as forest preservation or building a hydroelectric dam that can then be sold for a permit to release emissions elsewhere. Kyoto implemented the Clean Development Mechanism (CDM) to validate and measure projects that reduce emissions as well as fund them. The concept of emissions trading—or hot air trading—became the favored mitigation strategy. It is a good deal for a country like Russia that had already reduced its emissions; but it also allows a country such as the US to purchase its credits for emissions reductions—without reducing their own emissions by one molecule (Flavin, 1998; Perrow and Pulver, 2015).

Critics of emission trading schemes argue they are ripe for cheating. For instance, the environmental benefit of trading carbon offsets rests on the premise of *additionality*—the emissions reductions would not have happened without the added income from selling those reductions. Not only is the system ripe for cheating, it can also create "perverse incentives." For example, the UN-REDD+ program (Reducing Emissions from Deforestation and Forest Degradation) started in 2008 offers carbon credits (funding) to developing countries to preserve forests as carbon sinks. However, REDD+ lacks regulations to prevent corruption and to preserve *virgin* forests. As such, countries could get paid to decimate a virgin forest and replace it with monoculture plantation forests, such as those for palm oil. At best, plantation forests have the capacity to sequester 20 percent of the carbon of virgin forests (Perrow and Pulver, 2015: 81-82).

Third, transparency also is needed to monitor climate finance by tracking the source and usage of funds. Developing countries have argued that climate finance should not replace other pressing development needs, such as funding for education and health care, but should be in addition to already existing funding streams. Developing countries need stable funding to be able to establish a budget to meet mitigation targets and adaptive practices. Voluntary pledges are too often only token amounts or even worse, never delivered (Ciplet et al., 2015).

Finally, the negotiations in Rio and Kyoto almost completely focused on mitigation while adaptation was largely ignored. Ciplet et al. (2015) argue adaptation had been marginalized for four reasons. First, the early IPCC assessment reports paid little attention to adaptation. Second, the UNFCCC limits adaptation actions to anthropogenic climate change and not to climate variability, which can be difficult to sort out. Third, mitigation efforts produce clear benefits to developed countries, while adaption measures are not seen as directly advantageous to their interests. Finally, divisions within the G77 identifying and prioritizing adaptation needs and measures existed. Thus, adaptation did get on the table at the Conference of Parties (COP13) in Bali, Indonesia in 2007.

ONE STEP FORWARD, TWO GIANT STEPS BACK: THE BALI ROAD MAP & THE COPENHAGEN ACCORD

The COP13 in Bali produced an ambitious framework for negotiating the post-2012 Kyoto commitment period. It included the Bali Action Plan, which identified *adaptation* as one of the pillars of global action on climate change, along with mitigation, technology transfer, and financing (Ciplet et al., 2015: 107). The G77 united, drawing a line between the global North and South, known as the Bali Firewall, pushing forward the guiding principles of equity and CBDR into the second commitment phase (Ciplet et al., 2015: 63). The United States continued to oppose ratification, and the conservative anti-global warming countermovement had effectively entrenched climate skepticism. Nonetheless, President Bush's second term was nearing its end and many hoped that the US would alter its course of climate inaction. Thus, in Bali a delegate from the small island state of Papua New Guinea took the floor at the final plenary session and said to the "isolated" United States, "lead, follow, or get out of the way" (as quoted in Ciplet et al., 2015: 62–63).

Due to heightened global concern that the clock was running out on identifying targets for the second commitment phase and new American leadership under Barack Obama, the 2009 COP15 Climate Conference in Copenhagen, Denmark, received the most attention since Kyoto. The stage appeared set for more aggressive global climate action. However, negotiations faltered, civil society groups were largely excluded from conference halls, and it looked like it would end as an abysmal failure. In the end, President Obama did not meet the expectations of those who desperately wanted to enact ambitious mitigation targets. Instead, he arrived at the end of the talks by infamously "busting into" a closed door meeting between the newly formed coalition of rapidly developing nations, Brazil, South Africa, India and China (BASIC), and with them alone, brokered the Copenhagen Accord (Ciplet et al., 2015; Vidal et al., 2009).

All in all, the Copenhagen Accord was a grave disappointment (Ciplet et al., 2015; Vidal et al., 2009). First, it turned Kyoto upside down by eliminating binding targets. It enacted a voluntary pledge and review process with no set timeline for when countries would need to pledge. Second, the new pledge and review approach meant that the commitments of wealthy countries and high emitters could remain weak. However, the Copenhagen Accord did include the commitment by developed countries of "fast-start-finance" of $30 billion a year from 2010 to 2012 and then scaling up to $100 billion a year by 2020 for *adaptation* and *mitigation* measures in developing countries (Carmin et al., 2015; Ciplet et al., 2015; Vidal et al., 2009). It also accepted the principle of *additionality*, meaning adaptation funds are to be in the form of "new and additional resources," separate from other aid, development projects, and/or loan packages a country is already receiving.

Critics argued that the weak emissions goal and the new pledge and review process sentenced the world's poorest children to endemic poverty and for many an early death. Entire cultures and nations could be decimated (Klein, 2014; Vidal et al., 2009). The "most vulnerable" countries to climate change impacts pushed for emission cuts that would limit the global temperature rise to 1.5 degrees C over pre-industrial levels. The 2 degrees C target came a year later at the COP16 in Cancun. A year after, the Durban Platform for Enhanced Action put forth the goal of keeping the global temperature "to 1.5 or 2 degrees C" and accepted that in Paris in 2015 another legally binding treaty would be adopted and then implemented by 2020 (Ciplet et al., 2015). To achieve the 2 degree C target, developed countries will need to reduce their GHG emissions by 85 percent and developing countries by 50 percent (Perrow and Pulver, 2015: 83). This is no small task. Before turning to the Paris Agreement, we will summarize four key talking points that have come about through 20 years of UNFCCC negotiations, evolving science, and human experience with climate change. They also will serve as a reference point for assessing the Paris Agreement.

1. The Ambition Gap: First, a gap exists between emission reduction goals and current action. Taken as a whole, the voluntary pledges made after Copenhagen are not sufficient to reach the less ambitious 2 degrees C goal by 2100. Second, a significant finance gap exists. Notably, the scaled-up $100 billion for mitigation and adaption has not materialized (Carmin et al., 2015; Ciplet et al., 2015). With passing time, impacts mount and the social, economic, political, and environmental costs rise. It is highly unlikely that emerging economies (or rapidly developing countries) will be able to meet reduction targets without subsidized technology transfer. There are existing technologies that can dramatically reduce carbon emissions—by 90 percent or more—but they are costly and emerging economies are unlikely to invest in them over development needs (Perrow and Pulver, 2015).

2. Keep it in the Ground: This slogan has been adopted in conjunction with the goal to achieve a net-zero carbon future. Scientists have found that our global fossil fuel reserves contain about three times the acceptable amount of GHG emissions if warming is to be held to 2 degrees C or below (Carrington, 2015). In fact, within the year prior to Paris, research published in *Nature* showed how much of each fossil fuel type would need to be left in the ground; 82 percent of coal; 49 percent of gas; and 33 percent of oil. For the major coal producing countries, the US, Russia, and Australia, over 90 percent will need to be left unburned (Carrington, 2015). An outcome of the post-political approach to climate change discussed earlier in the chapter is seen in government and IPCC assessment reports which fail to identify polluting industries and what they have at stake. Instead, calls for aggressive action are put forth as market incentives and green initiatives have been the primary tool to move the fossil fuel and related corporations in the desired direction. So far, the research shows it has not worked, at least not at a large enough scale to make a substantial difference. The fossil fuel industry remains extremely profitable, since it is profitable to pollute (Perrow and Pulver, 2015).

3. Loss and Damage: At the 2012 annual climate conference, a coalition of low-income states, including the AOSIS, and civil society groups, forcefully argued for a new mechanism to provide "loss and damage" compensation for repairable or permanent loss due to climate-induced disasters and slow onset sea rise. Loss and damage gained momentum largely because of the two devastating typhoons that hit the Philippines in back-to-back years. In 2013, developed countries agreed to it, but the details were left undecided (Ciplet et al., 2015).

4. Common but Differentiated Responsibility (CBDR) and New Global Coalitions: The Durban Platform for Enhanced Action states that a binding global agreement will negotiate common action for *all* countries. After all, GHGs are stable or declining in developed countries while they are projected to rise significantly in developing countries, especially the rapidly developing countries. In fact, in 2007 China emerged as the world's largest emitter surpassing the US. However, this only holds true if looking at total annual emissions, but if looking at per capita emissions for the top 10 emitters then Canada ranks number one, the US is second, China, seventh and India, tenth (Ge et al., 2014). In fact, Canada, the US, and Russia emit more than double the global average per person, and only two countries, Mexico and India, fall below, with India emitting only one-third of the global average.

Copenhagen fractured the Bali Firewall with the new coalitions BASIC and BRIC (Brazil, Russia, India, and China). The most vulnerable countries can no longer rely on

BOX 3.3

Hundreds of thousands of people marched on November 29, 2015, in cities across the world. In Ukraine the slogan was "Change the system, but not climate!"

Valerii Iavtushenko / Shutterstock.com

Figure 3.8

the more powerful developing countries to support their interests. Some countries in the G77 have called on China to make its own emission reduction commitments. China has been taking more of a leadership role in global environmental diplomacy. China is the second largest global economy and now holds the largest share of other nations' debt (Ciplet et al., 2015; Gareau, 2012). In 2014, the Presidents of the US and China laid out their plans to reduce national emissions and signaled to the world they were prepared to come to Paris to work towards closing the ambition gap. China has taken steps to reduce its emissions by decreasing its use of coal, expanding use of non-fossil fuel energy sources, and implementing fuel efficiency standards for individual vehicles. The US pledged to reduce its emissions by 2025 to 26–28 percent below its 2005 levels going into Paris (Henderson et al., 2015). Also, through executive action President Obama authorized the US EPA's Clean Power Plan aimed at reducing CO_2 emissions from power plants by 32 percent below 2005 levels by 2030. The US and China however do not want a binding treaty. In this case, China aligns itself with the rest of the G77 arguing they do not bear the same responsibility as the developed, Annex 1 countries. For the US, the President would need to involve Congress whose position on a binding treaty has not changed since withdrawing from Kyoto. The most strident advocates of a binding treaty are the most vulnerable countries, notably the AOSIS and least developed countries, and the EU. But, the EU also tends to align with other wealthy countries when it comes to climate finance issues.

Similar to Rio, Kyoto, and Copenhagen, the eyes of the world were on Paris for the COP21 held during the first two weeks of December 2015. Professional and public opinion regarding accomplishments in Paris has been mixed. On the positive side, it got quite a bit of media attention and a record number of high profile government and public figures attended, such as Presidents Obama and China's Xi Jinping, and Bill Gates and Mark Zuckerberg. Gates and Zuckerberg have joined 27 other billionaires to form the Breakthrough Energy Coalition pledging to "invest early, broadly, boldly, wisely and together" in "zero emission energy innovation" (Geewax, 2015). The signing of the legally binding Paris Agreement by 195 nations has been interpreted by some as a clear signal to the global market to transition away from fossil fuels and invest in renewable energy, even proclaiming the end of the fossil fuel powered economy.

Most people rely on the mainstream media to understand global diplomacy, such as the Paris Agreement. So, it is necessary to look at how the American press covered the talks. Analysis of the four highest circulation newspapers in the US found 424 articles (*The New York Times*—249*, Los Angeles Times*—106*, USA Today*—37*, and The Wall Street Journal*—32) published during the two weeks of negotiations (Gurwitt and Roberts, 2015). However, the majority of the coverage went to broad updates on negotiations, and the world leaders and international figures that attended. Other than the large emerging economies of India, China, and Brazil, only seven articles mentioned Africa and developing countries. The papers gave scant attention to the issues that a successful agreement hinged upon, beginning with how to close the ambition gap for emission targets and finance, loss and damage, and whether or not climate justice will be upheld (Gurwitt and Roberts, 2015).

THE PARIS AGREEMENT

1. The Ambition Gap Part 1: Reducing CO_2 Emissions: First, the Agreement keeps the 2 degree target but includes the new phrasing of ***well below*** 2 degrees C and states that 1.5 degrees C should be the pursued target. Second, the voluntary pledge and review process was maintained. Timetables for commitments are more or less ambitious with no formal enforcement mechanism in place. Included are two new mechanisms, one to determine if voluntary reductions are being met—called *stock-taking*, and the second, to encourage more ambitious reduction targets in the future—called *ratcheting*. Stock-taking will take place every five years and the first one will be held in 2023. Ratcheting, however, is implied in the Agreement with the language of "updating and enhancing" after the "global stock-take." Third, the Agreement does not explicitly include a *net-zero carbon* goal, however, it states that global GHG emissions must peak as soon as possible, and then after 2050, anthropogenic emissions will need to be balanced with removal by carbon sinks. It specifically identifies conservation of forests while also

Courtesy brandalism.org.uk

Figure 3.9 In contrast to the media coverage of the Paris climate talks, Brandalism sought to draw attention to the urgency of climate justice.

leaving room for geo-engineering technologies to absorb carbon emissions. Finally, China and India aligned with developing countries to block third party oversight of whether or not countries were keeping emission reduction promises. A common framework of transparency was agreed to, and also recognizes that developing countries may need assistance to reach their goal (Meyer, 2015).

2. The Ambition Gap Part 2: Climate Finance and Loss-and-Damage: First, no language in the Paris Agreement recognizes or addresses the scaled-up $100 billion a year promised to developing countries by 2020. Second, language was removed that allowed countries to request climate funds on the basis of additionality. Third, no separate mechanism to provide compensation for loss-and-damage was included. Finally, a new climate finance measure encourages middle-income countries, such as South Korea, China, Kuwait, and Mexico, to provide monetary support to poorer countries for mitigation and adaptation efforts. Prior to Paris, China had already pledged $3.1 billion to developing countries (Roberts and Weikmans, 2015).

3. CBDR and New Global Coalitions: CBDR was interjected in nearly every debate on provisions in the Agreement, and India and China fought hard to defend the line developing countries had drawn in Rio (Meyer, 2015; Sinha, 2015; Taraska, 2015). Three key outcomes can be summarized here. First, differentiated responsibility was maintained in all key elements of the Agreement (Sinha, 2015). Second, no reference to "historical responsibility" appears in the Agreement, which some see as a victory for rich countries (Sinha, 2015). Third, the terms Annex 1 (developed) and Non-Annex (developing) countries are not used. Some argue that the movement away from the developed–developing country divide is actually more reflective of current global economic and political conditions, and climate action. For example, China is adopting cap-and-trade, and India is developing solar energy faster than the US (Meyer, 2015).

Adopting the Paris Agreement is a positive step forward. The Agreement was signed at the United Nations in New York City on Earth Day, April 22, 2016 by 175 countries. Another positive sign came when several countries pushed to fast track the timeline for bringing the agreement into force before the target date of 2020 by legally joining the agreement (i.e., countries have domestic approval). A move that increases the odds of securing the 2 degrees C goal and keeping the 1.5 target within sight (Goldenberg, 2016). President Obama used his executive authority to join, and amazingly, the Paris Agreement was brought into full force by the UN Climate Conference (COP22) in November 2016! At the time of this writing, however, the world is on edge because US President-elect Donald Trump, a well-known climate denier, promised to "rip it up" during the campaign. Yet, by President Obama singing on, it is supposed to lock the US into at least four years of compliance, although a Trumpa administration could find a way out (Wernick, 2016).

The most vulnerable countries to current and expected climate change impacts, however, lost on climate finance issues, which limits their ability to enhance their adaptive capacity and pursue the most beneficial mitigation strategies. New energy regimes designed to decarbonize the economy also present climate justice issues. For example, the development of hydroelectric dams and forest sinks has resulted in the eviction or displacement of indigenous people in Africa, Latin and Central America, and Asia, including India and China (Ciplet et al., 2015; Harlan et al., 2015). Excluded from the Agreement were "innovative" approaches to generating revenue, such as a global carbon tax, or taxes on aviation, international shipping fuels, or currency transactions. These are the only type of funds that can be ensured to be additional (not taking money from other needs), predictable, and politically sustainable because they do not filter through any one government (Roberts and Weikmans, 2015). A global carbon tax is also a market mechanism that encourages keeping fossil fuels in the ground.

AVOIDING RUNAWAY CLIMATE CHANGE: REASONS FOR SUSPICION AND HOPE

Climate change is a global environmental problem and will require global diplomacy and action. Interestingly, the Montreal Protocol was signed despite resistance from the chemical industry and without the level of scientific consensus that exists today on global warming (Gareua, 2013). When the Montreal Protocol was signed, world leaders were more willing to act on a precautionary ethic (Gareau, 2013). Since the 1990s, however, global economic and political power relations have shifted, and world leaders have adopted a neoliberal approach to climate change diplomacy and policy. First, world leaders have favored market-based solutions to global environmental risks. Second, the embrace of austerity—decreasing government spending on social and environmental goods by world leaders and governments—has seriously limited the implementation and enforcement of mitigation and adaptation measures. A third factor is a stalwart faith in technological solutions, such as geoengineering.

Private and public funds have been invested in *geoengineering strategies,* which employ technological measures to counteract climate change. Geoengineering proposals have included several ways of reducing temperature increases by screening sunlight (e.g., space mirrors, stratospheric dust or soot, reflective stratospheric balloons, stimulating cloud condensation), as well as stimulating plankton growth to increase the uptake of CO_2 by the oceans. Forest preservation or reforestation, already mentioned, is a *sort* of geoengineering project. Geoengineering options have the potential to affect global warming on a substantial scale, and some are relatively inexpensive, but all have large unknowns concerning possible environmental side effects (Klein, 2014). Do we really know enough to reengineer the earth on such a scale? And can markets respond fast enough to establish needed strategies? And if governments are cutting revenue streams and spending, how much can they or will they help? For instance, carbon capture and storage has the potential to eliminate most of the 36 percent of CO_2 emissions that come from coal-fired power plants, but it has not developed and investments have stalled (Perrow and Pulver, 2015).

Geoengineering will play a role in mitigation strategies. However, geoengineering along with market solutions, such as trading carbon offsets, offer little, if any, incentive to keep fossil fuels in the ground. The fossil fuel industry has deeply entrenched interests in maintaining the status quo. There is plenty of evidence that they are willing to move to more "extreme" fossil fuel extraction practices for short-term profit. Firms representing the fossil fuel and nuclear industries along with a host of other corporations such as IKEA sponsored the COP21. Brandalism's subversive ad campaign called it out as greenwashing, a topic we will take up in Chapter Seven. Nonetheless, powerful corporations and business leaders clearly have greater access to the negotiating halls than civil society groups. The exclusion of civil society does not favor transparency or justice, and is more likely to produce echo chambers that support the status quo (Ciplet et al., 2015; Gareau, 2013). If a net-zero carbon future is to be achieved, and done so justly, it will require significant, if not radical, political, economic, and social change. Some have compared the institutional and ideological changes needed to avoid runaway climate change to ending slavery (Ciplet et al., 2015). I (Monica) actually see this as a positive analogy because even though the fight for racial equality and justice continues, slavery in the Americas was toppled. I encourage my students to focus on what can be gained from pursuing change of this magnitude. In the rest of the book, we highlight further the ways in which we can avoid runaway climate change and the many benefits it can bring to us. For instance, in the next chapter we discuss new energy regimes and how individuals and households can reduce their energy consumption.

CONCLUSION

Current and expected climate change impacts unite us in a multitude of ways. However, for some people climate change feels like a harsh reality while others feel unaffected. More privileged populations may pursue an inverted quarantine approach (refer to Chapter Two), but individual protections have their limits. Megastorms do not follow zip codes and mosquitoes do not abide by social norms in whose flesh they target. We have common interests in taking action to avoid runaway climate change. Moreover, addressing climate change is critical in resolving a host of other problems such as stabilizing biodiversity, improving problems of urban air pollution and acid rain, enhancing energy efficiency and security, and promoting international cooperation on deforestation and land reform, and probably the alleviation of the most wretched global poverty. In other words, addressing global warming could be a way to unify separate issues focusing on human–environment problems and preserving the "global commons."

PERSONAL CONNECTIONS

QUESTIONS FOR REVIEW

1. What are examples of evidence about how much and how fast climate change is taking place?
2. What are the most important "greenhouse gases"? How are they produced and concentrated in the atmosphere? What is the concern with positive feedback loops?
3. What is the IPCC? Why is it important? How have some of their major conclusions evolved? What are its most current major conclusions?
4. Why is the inclusion of sociology and other social sciences needed in climate change research and policy? How can sociology help to address the causes and consequences of climate change? Provide examples.
5. What are some of the ways that climate change could change the earth and human societies over the next century? How does this affect different human populations in varying ways and why?
6. What does adaptation to climate change include? Discuss at least three factors that erode adaptive capacity and three factors that can build adaptive capacity.
7. Discuss at least three measures that can be taken to mitigate climate change. What are three key barriers to implementing mitigation strategies? What are three possibilities for implementing mitigation strategies?
8. Compare and contrast green diplomacy to address ozone destruction with climate change.
9. How has green diplomacy to curtail climate change progressed? Do you think the Paris Agreement will do enough to avoid runaway climate change?
10. What is the significance of the global North–South divide in green diplomacy? What is climate (in)justice? Is climate justice necessary to avoid runaway climate change?

QUESTIONS FOR REFLECTION

1. Ask some of your acquaintances of different ages, education levels, or other social circumstances what they think about climate change by asking them if they know about the scientific consensus that climate change is human-induced, the target to keep warming well below 2 degrees C, and the *keep it in the ground* campaign. If they haven't heard of one or more of these, tell them what you know, and note how they respond. If they have heard of one or more, ask them what they think about them. Did their responses surprise you? Why or why not? What do you think about these issues?
2. Given that climate change impacts are occurring, can you identify ways in which you have been directly and indirectly impacted? Evaluate your adaptive capacity. Think about how you have coped with current direct or indirect impacts, and how you will cope with potential future impacts. Keep in mind your adaptive capacity is connected to your community, and the policies enacted and enforced by local, state, and national organizations and governments.
3. Many people who argue that climate change is not real, or if real, it does not pose that big of a threat to the American way of life, say it is not worth it to invest in adaptation and mitigation. How do you respond to this sentiment?
4. A huge number of North Americans live in coastal regions where global sea levels are rising and as the chapter noted, the threats to these areas are significant. Compare and contrast your experience with current and expected climate change threats based on whether you live in a coastal region or not. In either case, you will bear a share of the costs, like higher costs for goods and services, higher property insurance premiums, and taxes for state and federal disaster relief programs. Now complete this exercise by imagining yourself a resident of one of the most vulnerable countries.
5. Think about where you access information about important topics such as climate change. Did you learn about climate change in any of your K–12 classrooms? Ask some of your friends and classmates where they have learned about climate change. Are we doing enough in America to educate people on the issue? How is public opinion shaped by media framing on important topics like climate change? During the negotiations of the Paris Agreement, the media focused on the celebrities, business elites like Mark Zuckerberg, and government officials in attendance. Does this distract the public from gaining a thorough understanding of the problematic issues associated with climate change?

WHAT YOU CAN DO—REAL GOODS

1. *Ceiling fans.* Eco-friendly technology's answer to air-conditioning, ceiling fans, cool tens of millions of people in developing countries. Air-conditioning, found in about two-thirds of US homes, is a real electrical "juice hog" of electrical energy. Ceiling fans, on the other hand, are simple, durable, repairable, and take little energy

to run. They run at very low speeds (summer and winter) and help even out the "layers" of room temperature. A fan over your bed circulates enough air that you may not have to run your air conditioner as much.
2. *The reel-type push lawnmower (without a gas engine).* They're back! And, they cost about one-fourth of the cost of a self-propelled power mower, and probably a sixth of the cost of a riding mower. They are made with lighter metal alloys that are easier to push than historic versions. No gas, tune-ups, smoke, pollution, or noise. There is only a quiet click, click, click as it moves.
3. *Compact fluorescent light bulbs, or even better go for the LED light bulbs.* They are three or four times as efficient as regular incandescent bulbs. One 18-watt compact fluorescent light bulb provides the light of a 75-watt incandescent bulb and lasts 10 times as long. Currently they are pretty pricey but should get cheaper as more people use them. Even so, over the life of its use, an 18-watt compact bulb can keep more than 80 pounds of coal in the ground and about 250 pounds of CO_2 out of the atmosphere. The LEDs are better because they do not contain mercury like the CFLs. You do not want to dispose of your CFL bulbs in the trash. Contact your garbage collector or recycling company to see if they take them for recycling, or most stores like Home Depot will take them from you for recycling.

MORE RESOURCES

Ciplet, D., Roberts, J.T., and Khan, M. R. (2015). *Power in a warming world: The new global politics of climate change and the remaking of environmental inequality*. Cambridge, MA: MIT Press.

Dunlap, Riley E. and Robert J. Brulle (Eds.). 2015. *Climate change and society: Sociological perspectives* (Report of the ASA Task Force on Sociology and Global Climate Change). New York, NY: Oxford University Press.

Klein, N. (2014). *This changes everything: Capitalism vs the climate*. New York, NY: Simon and Schuster, Inc.

Nagel, J. (2016). *Gender and climate change: Impacts, science and policy*. New York: Routledge.

Norgaard, K.M. (2011). *Living in denial: Climate change, emotions and everyday life*. Cambridge, MA: MIT Press.

Schwagerl, Christian. (2014). *The Anthropocene: The human era and how it shapes our planet*. Santa Fe, NM: Synergetic Press.

Speth, J. G. (2004). *Red sky at morning: America and the crisis of the global environment.* New Haven, CT: Yale Nota Bene, Yale University Press.

ELECTRONIC RESOURCES

www.350.org
Website for climate activism at the grassroots, national, and international level; lots of good resources on how to transition to a low carbon and more just and sustainable future.

www.epa.gov/globalwarming/news
EPA site about global warming.

http://www.carbonbrief.org
Great resource for keeping abreast of climate change science.

http://www.nationalgeographic.com/climate-change/special-issue
National Geographic interactive website on climate change, how do we know what is happening, what can we do to fix it, and how can we live with it.

www.eldis.org/go/topics/resource-guides/climate-change
More than 1,000 links to information about climate change.

http://thischangeseverything.org
This site promotes the documentary *This Changes Everything* based on Naomi Klein's book on climate change. It has many resources for taking action on climate change.

http://www.pbs.org/video/1305543836
PBS *Water World*: looks at climate change in Bangladesh, a country identified as most vulnerable to climate change impacts.

NOTES

1. Civil society represents a variety of collective interests organized outside of government and the economic sector, such as faith-based organizations, grassroots and social movement organizations, and non-governmental policy organizations.
2. Phenomenology is a philosophical term that means how humans experience something.

CHAPTER 4
ENERGY AND SOCIETY

Chapter One noted the ideas of the famous Austrian biophysicist Alfred Lotka, who proposed in the 1920s that the evolution of ecosystems is shaped by how efficiently various species of life appropriate the energy in the environment. In fact, general increases in human living standards have been possible only because of substantial increases in the amount of energy consumed. But growth in energy consumption is not only connected with human progress. The modern carbon-based energy system is connected with air pollution, oil spills, and, as Chapter Three noted, scientists are convinced that it is the primary human driver of global warming. By 1990, the total energy consumption by humans around the world was 14 times larger than it was in 1890, early in the industrial era. Growth in energy consumption vastly outstripped population growth, which doubled during the same time period. But, the human use of energy—mining, refining, transportation, consumption, and polluting by-products—accounts for much of the human impact on the environment (Holdren, 1990: 159). Earlier chapters argued that human societies are "embedded" in the biophysical environment. Most fundamentally, in fact, they are embedded in systems of energy production and consumption. In other words, energy mediates between ecosystems and social systems and is a key to understanding much about the interaction between humans and environmental systems.

Energy is basically a physical variable—measured variously as calories, kilowatt-hours, horsepower, British Thermal Units, joules, and so forth. But energy is also a social

Christopher Halloran/Shutterstock

Figure 4.1 Hydraulic fracturing (fracking) pump jacks in Kern, California. The United States leads in natural gas production and methane gas (CH_4) emissions.

variable, because it permeates and conditions almost all facets of our lives. To drive a car, buy a hamburger, turning on your computer, or going to a movie can all be described in terms of the amount of energy it took for you to do each of those things. A kilowatt-hour of electricity, for instance, can light your 100-watt lamp for 10 hours, smelt enough aluminum for your six-pack of soda or beer, or heat enough water for your shower for a few minutes (Fickett et al., 1990: 65). All of social life, from the broad and profound things to the minutiae of everyday life, can be described in terms of energy.

It may well be that energy mediates between ecosystems and human systems, but that's a very abstract way of putting the human–energy–environment relationship, and its implications may not be clear to you. So before we clarify the agenda of this chapter, let us provide a concrete illustration of this statement by taking you on a historical detour, back to the 1970s.

A HISTORICAL DETOUR: RECENT ENERGY CRISES

In most of the industrial world, the winter of 1973 was an awful one, and not because of the weather. The reason was a sudden change in the availability and price of energy supplies. The world market for oil, which had become the industrial world's premier source of commercial energy, was very tight, meaning that in previous decades the global consumption of petroleum products had almost outgrown the world's capacity to produce, refine, and distribute them. The US domestic oil production was declining. The more developed countries (MDCs) were increasingly dependent on the oil reserves of the less developed countries (LDCs), such as Nigeria, Venezuela, and particularly the nations around the Persian Gulf, which possessed most of the world's known reserves. In September 1973, Japan's prime minister predicted that an oil crisis would come within 10 years. It came in more like 10 days, with the surprise attack that launched a war between Israel and her Arab neighbors that was later called the Yom Kippur War. In retaliation for the Western support of Israel, the cartel of oil-producing nations (OPEC), led by the Arab nations, declared an embargo on the export of oil to the MDCs. Nations and oil companies scrambled to buy, control, and ration existing supplies in storage and in the pipelines around the world. Oil prices zoomed from $2.50 to $10.00 a barrel, and the world economy went into rapid downturn—with price increases of almost everything, rapid inflation, plant closings, and layoffs. Rationing of energy supplies meant sudden uncertainty about the supplies of industrial, heating, and transportation fuels that Westerners had taken for granted as cheap and plentiful (Stanislaw and Yergin, 1993: 82–83). American President Richard Nixon left it to the energy departments of each state government to figure out how to allocate existing fuel. As increased costs of energy percolated through the whole economy, every facet of the American economy and lifestyle seemed threatened.

The crisis continued in 1979, when a revolution in Iran disrupted world supplies and created a panic that drove oil prices from $13 to $33 a barrel. All this seemed to foretell permanent shortage and continued turmoil. Adding to the mood of crisis, a prestigious group of scholars and computer modelers (the Club of Rome) produced studies to show that among other things, the world would be visibly "running out of gas" in the future (Meadows et al., 1972). But none of the worst fears caused by the "oil shocks" of the 1970s really came true. The ability of the OPEC nations to control the world's oil supply declined as non-OPEC production increased at a rapid pace. OPEC's share of the world oil market fell from 63 percent in 1972 to 38 percent by 1985 (Stanislaw and Yergin, 1993: 82–83). People responded by changing the way they lived and worked. They insulated homes and bought more fuel-efficient autos and appliances. All over the world, utility companies began switching from oil to other fuels. By 1992, the people in our home state (Nebraska) consumed 100 million fewer gallons of gasoline than they did in 1973 (Kotok, 1993: 1). Energy conservation, a consequence of both technological and behavioral changes, proved more powerful than expected, so that by the 1990s the combination of reduced demand for oil and increased supplies made its real price cheaper in 1993 than in 1973. Around the world, MDCs tried to establish security measures that would help moderate future crises. These included the creation of the International Energy Agency (IEA), an international sharing system, increased communication, the creation of a global oil futures commodity market, and the establishment of prepositioned supply reserves.[1]

Even with these positive responses to the oil shocks of the 1970s, they were a great historical wake-up call that forever changed our understanding of energy. The 1970s marked a transition in coming to grips with the environmental and sociopolitical costs of energy. Problems of air and water pollution, many of them associated with energy consumption, came to be recognized as pervasive threats to human health, economic well-being, and environmental stability (Holdren, 1990: 158). Indeed, energy problems came—perhaps for the first time in history—to be widely recognized as an integral part of environmental concerns. In addition, consciousness of growing dependence on imported oil graphically demonstrated the growing economic and geopolitical interdependence among nations and continued to shape our foreign policy problems in, for instance, the 1992 Gulf War, and in 2006 the war in Iraq, and America's tensions with Venezuela.

After about a decade of "moderate" energy prices, in mid-1990 a rapid and significant increase in oil prices began that continued in the first decade of the twenty-first century. This led to the familiar—though episodic—process of hand-wringing by politicians and the media about rising oil prices, dependency on Middle Eastern oil, and the absence of a sustained and coherent federal energy policy (Lutzenhiser et al., 2002: 222). Whatever public complacency there was ended quickly after 1999 as oil, gasoline, and natural gas prices increased significantly. When George W. Bush's presidency was inaugurated in 2001, he proclaimed another "energy crisis." The new Bush administration proposed another "supply side" policy to open up public lands, including the Arctic National Wildlife Refuge (ANWR), for drilling and exploitation. This policy proposal contained large subsidies for the fossil fuel and mining industries, with precious little to develop alternative energy sources. After 9/11, energy fears became enmeshed with the expensive, unpopular war in Iraq, which lasted longer than World War II. Even with Republican congressional majorities, the controversial energy bill failed regularly in Congress, faced with opposition for many reasons. Energy was again a contentious and highly visible part of America's political controversies, now connected with the nation's balance of payments problems, and with climate change. In 2005, a version of the energy bill became law (but without drilling rights in ANWR or funds for alternative energy development). After dominating the auto market for a decade, the sales of large autos (particularly sport utility vehicles [SUVs]) slumped, and smaller, fuel-efficient autos were again becoming popular—though not a significant part of America's vehicle fleet.

This historical detour frames some of the ways that energy mediates between human societies and the environment. As you can see, energy "crisis" moods come and go, as do political and media attention to energy problems. If there is no energy crisis, there certainly is an *energy predicament*. A *crisis* is a rapidly deteriorating situation that, if left unattended, can lead to disaster in the near future. But there is an energy *predicament*, that is, an ongoing chronic problem that, if left unattended, can result in a crisis (Rosa et al., 1988: 168). This predicament has a number of dimensions to which this chapter turns, including (1) sources of energy problems; (2) studies about the relationship between energy and society, or what some scholars have termed *energetics*; (3) the current energy system and some possibilities for alternative methods of producing energy; and (4) some policy issues about transforming existing energy systems.

ENERGY PROBLEMS: ENVIRONMENTAL AND SOCIAL

Our energy predicament has four interacting dimensions, or problems: (1) source problems, having to do with energy resource supplies; (2) problems related to population growth and economic growth and development; (3) global policy and geopolitical problems; and (4) sink problems, having to do with energy by-products, health hazards, and greenhouse gas emissions.

SOURCE PROBLEMS: ENERGY RESOURCE SUPPLIES

Since the pessimistic estimates of world oil reserves in the 1970s, estimates of known reserves have doubled (Stanislaw and Yergin, 1993: 88), and energy analysts agree that in the near term the earth's supply of fossil fuels will not be a problem. In 2012, three fossil fuels (oil, natural gas, and coal) supplied about 87 percent of the world's commercial energy needs (Gonzalez and Lucky, 2013). At present consumption rates, known reserves of crude oil and natural gas will last many years, and there is an awful lot of coal in the world, but its use carries extraordinary risks compared to those of oil and natural gas.

Consider oil. There is a rough consensus among energy analysts that at current rates of consumption, about 80 percent of known oil reserves will last for between 40 and 90 years (Miller, 2005: 353). But world oil discovery peaked in the 1960s and has been declining ever since, and experts currently estimate that world oil production will peak sometime between 2010 and 2020 and will decline thereafter (Aleklett, 2006; Podobnik, 1999; Prugh, 2006). The discovery, production, and consumption of energy resources are said to "peak" because they follow a bell-shaped curve, beginning small, rising steadily, and declining unexpectedly to near exhaustion, a pattern first described by Shell Oil geologist oil expert M. King Hubbert in 1956. Like global warming, the concept of an "oil peak" is accepted, but the particulars of timing are controversial (Motavalli, 2006; Roberts, 2004: 171–173; Yeomans, 2004: 106–108). But if you think that new oil discoveries will forever push back resource depletion, consider some stubborn facts. At present (not future) rates of consumption, (1) the estimated crude oil reserves under Alaska's North Slope—the largest ever found in North America—would meet world demand for only six months, or the US demand for three years. (2) With the world's largest oil reserves, Saudi Arabia alone could supply the world's oil needs for only 10 years (Miller, 2005: 229). Hardly anyone thinks that in the future, this much oil will be discovered every 10 years. Oil company executives have known this for some time. Three decades ago, Robert Hirsch, then vice president and manager of research services for Atlantic Richfield Oil Company, urged beginning an orderly transition to alternate energy technologies in the early to middle twenty-first century (Hirsch, 1987: 1471).

Similar to projections about other scientific questions like global warming, projections of how long it will take to deplete fuel and mineral reserves are expert guesstimates, notoriously dependent on assumptions and contingencies. To mention a few in particular, if trends toward greater MDC energy efficiency resume with full force, declining demand could stretch out supplies many years beyond current estimates. On the other hand, depletion-time estimates could shorten because of the lack of success in exploring likely geological sources, or unexpected growth in either the world market economy or the economic development in the LDCs. The point is that even if constraints are not as strong as thought in the 1970s, supply concerns continue. Moreover, new concerns have emerged over *extreme fossil fuel energy*—tapping unconventional fossil fuel sources, such as hydraulic-fracturing (fracking) to extract natural gas from shale deposits, deep water drilling, and extraction of oil/tar sands. These are capital-intensive technologies that pose many known and unknown environmental and social risks.

POPULATION GROWTH, ECONOMIC DEVELOPMENT, AND DISTRIBUTION PROBLEMS

In 2000, the world's 6 billion people consumed almost 14 terawatts of energy (a terawatt is a trillion watts, and equal to the energy in 5 billion barrels of oil). But that world consumption statistic hid very unequal consumption among nations. MDCs have about one-fifth of the world's people but consume almost three-fourths of the world's energy. Even among MDCs, North Americans consume more energy per capita or per dollar of

GDP than do other MDC people. Americans drive bigger cars and drive them farther; live in bigger houses and heat, cool, and light them more; and work in buildings that use substantially more energy per square meter than do Europeans (Joskow, 2002: 107).

If projections for future energy demands and population growth hold true—and we keep our current disregard for energy efficiency—by the year 2100, by most estimates the world's 10 billion people will need about 50 terawatts of electricity, or around four times what we produce today. That is a staggering amount of power. Generating it would require an energy infrastructure far larger and costlier than any that exists today (Roberts, 2004: 223). Furthermore, if the large numbers of Chinese, Indians, and others in LDCs were to become energy consumers living even remotely close to the present living standards of MDC people, that would place enormous strains on the supply of global energy resources, and the resulting environmental degradation, toxic wastes, and heat-trapping greenhouse gases would be intolerable.

POLICY AND GEOPOLITICAL PROBLEMS

As noted earlier, the momentum toward greater energy efficiency stalled by 1990. Even though some of it lasted, there were disturbing signs of increasing per capita energy consumption (Klare, 2002: 101). The rebound in energy consumption was partly a consequence of the marketing of gas-guzzling SUVs and pickup trucks that made up about half of all US new car sales. At a deeper level, the rebound in consumption was a consequence of public policy. Recent US energy policy can be described as *supply-side policies* promoting an increased supply of energy resources at a low price. Such policies undercut much of the potential for conservation to have an effect on energy markets. Chapter One discussed that "economic externalities," and energy markets have some significant costs—ones not directly paid for by either energy producers or consumers. Here are some important ones, emphasizing oil markets:

- Government subsidies and tax breaks for oil companies and road builders
- Pollution cleanup
- Military protection of oil supplies in the Middle East (at least $30 billion a year not including the Iraq war)
- Environmental, health, and social costs such as increased medical bills and insurance premiums, time wasted in traffic jams, noise pollution, increased mortality from air and water pollution, urban sprawl, and harmful effects on wildlife species and habitats (Miller, 2005: 384)
- Various costs in US deficit balance of payments between exports and imports (more than one-third of which are due to energy imports) (Kingsley, 1992: 119)

If you really want to get a sense of some of these, imagine factoring into the price of each gallon of gasoline you buy *a share* of other costs. Think about your share of the total and cumulative costs of US military and foreign aid in the Middle East to maintain relations with oil suppliers—including the wars in Iraq and Afghanistan. Indeed, if all of the health, geopolitical, and environmental costs of oil were internalized in its market price and if government subsidies from production were removed, oil would be so expensive that much of it would quickly be replaced by improved efficiency or other fuels.

Demand-side policies that evolved during the 1990s created similar problems. By avoiding price controls, rationing, and energy-allocation policies of the 1970s, government energy policy was focused on responding to market imperfections and breaking down regulatory barriers. This resulted in moderating prices and significantly increasing energy consumption. Unsurprisingly, fossil fuel consumption (coal, natural gas, and oil) continued to grow throughout the first decade and into the second of the twenty-first century. However, there have been shifts in the relative weight of each as an energy source. Overall, consumption of coal has grown the most, but it is expected to be the slowest growing fuel in the decade to come.

Geopolitical relations and conflicts as well as internal social and environmental conditions, play a role in how the energy mix shakes out. For instance, armed conflict in eastern Ukraine, and European Union (EU) sanctions against Russia in 2014, led to renewed interest in Europe in exploiting shale gas to reduce foreign energy dependence. But other factors such as difficulty of recovering deep deposit shale gas, legal issues such as ownership of mineral reserves, taxation, and large environmental and safety concerns have inhibited production (Friedeburg, 2015). Also, the IEA's World Energy Outlook 2015 report warns that the recent plummeting of global oil prices could cause the world to once again become heavily reliant on Middle East reserves. Most vulnerable today, however, to foreign energy dependence are Asian countries, especially India, which is taking over China as the largest consumer of all sources of energy—oil, gas, coal, renewable, and nuclear (IEA, 2015). Abstractly, energy is an important part of the patterns of world trade and politics that will determine who is poor and who is affluent, and who is well fed and who is hungry. It is unthinkable to try to understand either current world tensions or environmental problems without considering the importance of the production and distribution of energy around the world.

The important point is not that fossil fuels are becoming absolutely exhausted, but that the era of relatively cheap and easily accessible fossil fuel is ending (Hagens, 2015). Meeting energy needs in the future will require much greater investments than in the recent past. It means extracting fuels from increasingly difficult and marginal sources, such as deep water deposits and shale gas, to accommodate the needs of a growing human population, and paying the geopolitical overhead costs of an orderly energy market in a world system of nations. These costs don't even include the costs of increased environmental damage (Hagens, 2015; Klare, 2002; Motavalli, 2006: 29).

SINK PROBLEMS: ENERGY AND ENVIRONMENT

Although energy supplies are thought to be less constraining now than in the 1970s, environmental problems caused by the present energy system are more severe and getting worse (Flavin and Dunn, 1999: 24; Motavalli, 2006; Roberts, 2004; Stanislaw and Yergin, 1993: 88). Stated abstractly, the most pressing problems may not be source problems, but sink problems.

Burning fossil fuels is a major source of anthropogenic CO_2, a major heat-trapping greenhouse gas. Burning oil products also produces nitrous and sulfur oxides that damage people, crops, trees, fish, and other species. Urban vehicles that run almost exclusively on petroleum products cause much urban pollution and smog. *Oil spills* and leakage from pipelines, storage, transportation, and drilling sites leave the world literally splattered with toxic petroleum wastes and by-products. The ecosystem disruption from oil spills can last many years, and spread widely through ocean currents. Oil slicks coat the feathers and fur of marine animals, causing them to lose their natural insulation and buoyancy, and many die. Heavy oil components sink to the ocean's floor or wash into estuaries and can make bottom-dwelling organisms (e.g., crabs, oysters, and clams) unfit for human consumption. Such accidents have serious economic costs for coastal property and industries (such as tourism and fishing).

In 1989, the large tanker *Exxon Valdez* went off course, hit rocks, and spilled 11 million gallons of oil in Alaska's Prince William Sound, resulting in unthinkable damage to ecosystems and local human communities. It wound up costing $7 billion (including cleanup costs and fines for damage). By 1998, virtually all merchant marine ships had double hulls, but only 15 percent of oil supertankers did, even though in theory the Oil Protection Act of 1990 regulated supertankers to reduce the danger of such oil spills. To get around the law, many oil carriers shifted their oil transport operations to lightly regulated barges pulled by tugboats, a reduction in oil-spill safety that led to several barge spills. In 2002, the oil tanker *Prestige* sank off the coast of Spain and leaked twice as much oil as did the *Exxon Valdez*.

But the gargantuan environmental disaster was not oil spilled from tankers, but about 100 miles off the coast of Florida in the Gulf of Mexico, where in 2010 a British Petroleum deep sea drill rig—the Deepwater Horizon, was drilling for oil on the floor of the Gulf of Mexico. When the drill pipe broke apart about a mile deep in the ocean, as much as 50 million of barrels of oil (a barrel of oil is about 40 gallons) began spewing into the Gulf. It continued for weeks after repeated efforts to stop the flow failed, and released more oil per week into the Gulf than total spill from the Exxon Valdez. A *vast* oil slick spread throughout the Gulf both on the surface and in deeper water. It measurably stretched across the US gulf coastal regions from Louisiana to Florida, and Gulf "loop currents" threatened to move it to the east around the tip of Florida and up the Atlantic coast. It produced damage to wildlife, coastal wetlands, fishing and shrimping industries, beach property, and tourism, as well as the US economy. It cost BP billions of dollars in penalties and liability claims, which were initially estimated to be $20 billion, but soared to a final estimated cost of $62 billion five years later. Deep sea drilling has resumed in the Gulf. Given that the US gets about 30 percent of its oil from the region, no one seriously thought deep water

Figure 4.2 In June 2013, one of Thailand's most popular white sand tourist beaches was abandoned as crews worked to clean up oil coming on shore. A faulty transfer operation between a tanker and seabed pipeline caused 50,000 liters of oil to spill into the sea.

drilling would be abandoned (National Public Radio News, 2010; Bomey, 2016). The industry, however, claims it is safer today. Environmentalists and industry watchdogs contend that damage to ecosystems can be conveniently "externalized." Though government regulators require disaster "contingency plans," one risk assessment expert, sociologist Lee Clark, termed them "fantasy documents" when it comes to big oil spills (Bruno, 2010).

Because they are such graphic media topics, oil tanker and pipeline accidents and drilling blowouts get the most publicity. But experts estimate that between 50 percent and 90 percent of the oil reaching the oceans comes from the land, when waste oil dumped on the land by cities, individuals, and industries ends up in streams that flow into the ocean (Miller and Spoolman, 2009: 549–550).

Coal is hazardous to mine and the dirtiest, most toxic fuel to burn. Mining often devastates the land, soil, and water tables, whether by digging tunnels or by stripping the land (soil, trees, etc.) to get at seams of coal. Mountaintop removal, the most environmentally devastating form of strip mining, triggers a cascade of eroded mountains and polluted rivers that is impossible to repair. Miners work in hazardous conditions, and often die from black lung disease. Burning coal produces larger amounts of particulate matter and CO_2 than burning other fossil fuels, and electric power generation (mostly from coal) is the second largest producer of toxic emissions in the United States. Burning coal alone accounts for more than 80 percent of the SO_2 and NO_x injected into the atmosphere by human activity. In the United States alone, air pollutants from coal burning kill thousands of people each year (estimates range from 65,000 to 200,000), contribute to at least 50,000 cases of respiratory disease, and result in several billion dollars in property damage. The most threatening by-products of coal-burning power plants are particles of toxic mercury.

In 2000, the National Academy of Science estimated that 60,000 babies a year might be born with neurological damage from mercury exposure in pregnant women who have consumed mercury-laden fish. Also, burning coal releases thousands of times more radioactive particles into the atmosphere per unit of energy produced than does a normally operating nuclear power plant. Damage to the forests of Appalachia, the northeast United States, eastern Canada, and Eastern Europe can largely be attributed to coal-fired industrial plants. Reclaiming the land damaged by coal mining and installing state-of-the-art pollution control equipment in plants substantially increase the costs of using coal. As with petroleum, if all of coal's health and environmental costs were internalized in its market cost and if government subsidies from mining were removed, coal would be so expensive that it would be replaced by other fuels (Fulkerson et al., 1990: 129; Miller, 2005: 365). In Chapter Three, we noted that President Obama took executive action authorizing the EPA to reduce carbon emissions from coal-fired plants by 32 percent below 2005 levels by 2020. He also announced in January 2016 no new coal mining releases would be issued on public lands. Although, companies will be able to mine until the end of their current lease, which for some could last twenty years (McKibben, 2016). Reductions in CO_2 gained from these actions are at the crux of the US climate pledge to reduce greenhouse gas (GHG) emissions by 26 percent to 28 percent from 2005 levels by 2025.

But, the US has a new problem. It is the invisible and odorless gas, *methane* (CH_4), an even more powerful GHG than CO_2, *25 times more powerful*. In February 2016, a study released by a team of Harvard researchers convincingly demonstrated that the US had leaked massive quantities of methane into the atmosphere between 2002 and 2014. The study concluded that the US methane emissions alone account for 30 percent to 60 percent of the spike in methane in the *planet's atmosphere*. The spike in methane emissions is the result of increased natural gas production. If the US continues to release this amount of methane into the atmosphere it will cancel out the reductions in GHG emissions from coal to meet the climate pledge. For years, the EPA has denied warnings by other scientists that methane gas released from natural gas storage facilities was greater than anticipated. Methane seepage can occur at each stage of oil and gas production—from the drill well, at the processing plant, from storage tanks, pipelines, and at the point of consumption, in homes and commercial facilities. In January 2016, Governor Jerry Brown of California declared a state of emergency because of methane that had been leaking from a well at a San Fernando Valley natural gas facility for more than 10 weeks. Thousands of families who lived nearby the facility

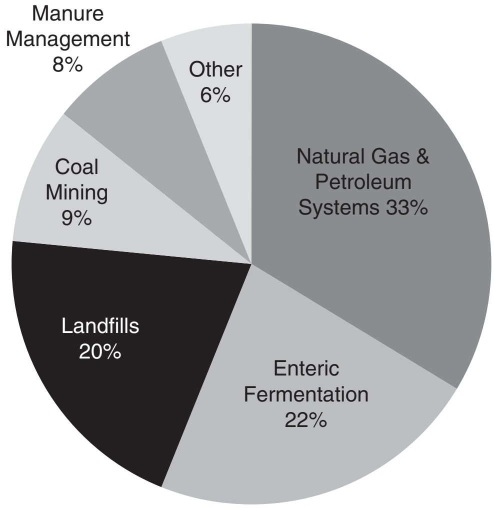


Figure 4.3 This chart shows that natural gas and oil production is the largest contributor to methane (CH_4) emissions in the US between 1990 and 2014 (see, https://www3.epa.gov/climatechange/ghgemissions/gases/ch4.html). The EPA, however, in 2016 faced criticism and scrutiny for underestimating CH_4 emissions from natural gas.
Source: United States Environmental Protection Agency.

were voluntarily relocated and approximately 2,000 children were reassigned schools due to experiencing symptoms of bloody noses and difficulty breathing. In March 2016, President Obama along with Canadian Prime Minister Trudeau, pledged to cut methane emissions from oil and gas by 40–45 percent from 2012 levels by 2025 (Ponsot, 2016). The US is the global leader in natural gas production and Canada is the second largest producer, but it is a distant second (Friedeburg, 2015). Both the US and Canada have pursued extreme fossil fuel production in response to rising gas prices in the 1990s and early 2000s.

The US has led in natural gas production because two new technologies made it possible to exploit unconventional sources (shale gas, tight gas, coal bed methane, and methane hydrates). The first is *hydraulic-fracturing* also known as *fracking* of largely shale deposits. Fracking is accomplished by pumping water, a mix of chemicals, and a proppant (usually sand) down an oil or gas well under high pressure to force open fractures, or channels, in the rock. This allows the trapped gas to flow to the well bore, which is held open by the sand. The second is horizontal drilling. It entails drilling down to an oil or gas deposit and then turning to drill horizontally along the length of the deposit, recovering more from it (Hagens, 2015). The largest shale deposits in the US are in Texas (Barnett and Hanesville shales), Louisiana (Hanesville shale), Arkansas (Fayetteville shale), and Pennsylvania (Marcellus shale) (Union of Concerned Scientists, n.d.).

Fracking has also moved offshore. In 2013, the Center for Biological Diversity initiated a campaign to stop fracking of old oil wells off the Californian coast. They argue it threatens the marine ecosystem and species dependent on it, such as blue whales, elephant seals, sea otters, and leatherback sea turtles. In 2014, they petitioned the EPA to ban disposal of the chemical wastewater into the ocean. The industry has been allowed to dump 9 billion gallons of wastewater every year. After a short-lived moratorium, it seems the federal government has given the green light for offshore fracking in California (see Center for Biological Diversity at www.biologicaldiversity.org/campaigns/offshore_fracking/).

While there is no scientific consensus that fracking is environmentally hazardous, it is associated with earthquakes, methane leaks, air pollution, and chemical contamination of freshwater. The earthquakes are linked with water concerns. A lot of the water (it requires a huge amount) used to pump chemicals and sand into the wells comes back to the surface after injection. Because the water contains a mixture of chemicals and can pick up radiation underground, it must be collected and disposed of to avoid contamination of freshwater supplies. This means wastewater must be transported to storage sites, causing concern over their safe handling. In Oklahoma, wastewater is stored in deep underground wells that have been linked to earthquakes. For the last five years, the state has seen an unprecedented spike in earthquakes, and the number of quakes registering greater than 4.0 has increased (in 2015, 30 did). Scientists say that natural fault lines are being stirred by the billions of gallons of stored wastewater (Yardley, 2016). Critics also contend that fracking has been shrouded in secrecy, which raises issues about its safe regulation (McKibben, 2016). For instance, the injection chemicals are an industry "trade secret," so no one knows for sure what the chemical mix contains. Industry says they do not pose a health risk and only a small amount of chemicals is used when fracking a well. Critics question the cumulative effects given that a well may be fracked numerous times. Another problem with exploiting unconventional sources is acquiring legal permits, which involves getting consent from private land holders and cooperation of states. The contention over fracking is worldwide. Several countries have a moratorium on fracking and at the time of this writing so does New York State.

Canada has pursued extreme fossil fuel that has also sparked a great deal of controversy by extracting oil from the *tar sands*, also referred to as *oil sands*. The goal is to extract and separate bitumen—an oil that is too thick and heavy to flow or be pumped without being diluted or heated—from a mixture of sand, water, and clay that lies beneath the earth. Oil sands are found in the US, Russia, Venezuela, and Canada. In Canada, the bitumen lies beneath the muskeg and boreal forests of Alberta, an area rich in biodiversity and vital to the planet's biosphere. Tar sands is the name originally used in Canada during its first boom in the 1960s and 1970s, before it was stranded (production stopped). Exploitation of the tar sands resumed in the mid-1990s and accelerated in the early 2000s. Resistance to tar sands extraction caused the industry and its proponents to begin to use the term oil sands. We will just stick with tar sands. Numerous environmental and social concerns are associated with extraction of tar sands oil.


chris kolaczan/Shutterstock

Figure 4.4 Slash and burn forest clearing has been used to develop the tar sands in Northern Alberta.

First, it is "dirty" oil that is energy intensive to extract and refine because of its sludgy composition, generating 17 percent more CO_2 emissions than conventional oil. Bitumen, which is a very hard substance, can lie 200 feet from the surface, but most often, it is much deeper underground. There are two methods for extracting and separating bitumen. One is open pit mining on the surface. The other involves *in situ* wells that coax out the bitumen from deep underground by injecting steam and chemical solvents. In 2011, 1.6 million barrels of oil were produced with the majority coming from *in situ* extraction. Second, development of the tar sands has resulted in deforestation, destroyed wetlands, and threatens wildlife, including caribou, bears, wolves, and migratory birds like the endangered whooping crane. Third, water depletion and contamination are large issues. It takes 2.4 barrels of freshwater for every barrel of tar sands produced. The primary water source is the Athabasca River. Overdraw of the river is a concern because most of the water is too contaminated to return to it. The sludge-like wastewater is stored in huge open pools called tailings ponds, and there is leakage of toxins from them into the Athabasca. Fourth, transporting hundreds of thousands of barrels of oil daily out of Alberta is problematic no matter if it's carried by rail, truck or pipelines. Typically, the oil is sluiced and piped elsewhere in Canada, or the US, for processing and marketing. The long-term goal is to get the oil to the Pacific Rim (Dorow and O'Shaughnessy, 2013: 125; Greenfield, 2015).

Tar sands oil spills are more difficult to clean up using traditional methods. In 2010, more than 800,000 gallons spilled into Michigan's Kalamazoo River costing $1 billion after five years of cleanup efforts. A fifth concern is tar sands refineries produce the by-product petroleum coke (petcoke), which is a black residue. Conventional oil also produces it, but the tar sands oil produces more. When the petcoke is left in massive piles on sites, as it has been at a refinery in Chicago's Southeast side, the wind blows it, posing a health risk to surrounding communities (Greenfield, 2015). Thus, a final concern is environmental justice. Working class and communities of color like those on Chicago's Southeast side are disproportionately hit with the negative externalities of tar sands production and distribution. Many indigenous communities live near extraction sites or downriver. Much of their livelihood is based on hunting, fishing, trapping, and gathering of berries. These communities have felt the negative effects of tar sands developments on their resource base, and their health, putting the continuance of their way of life in jeopardy (Westman, 2013; Greenfield, 2015).

The tar sands and several planned pipelines have been met with fierce opposition. It is possible you are aware of the fight to stop construction of TransCanada's Keystone XL pipeline slated to run through the US (including Charlie and Monica's home state of Nebraska) to the Gulf, and another, the Northern Gateway pipeline, running across Canada's western province, British Columbia, to a northwest coast export terminal. Both pipelines ignited a defiantly strong alliance of indigenous peoples and Canadians and Americans, many from impacted communities (but not all), to halt construction to protect their local environment, and to keep the dirty oil in the ground (Klein, 2014). Bold Nebraska formed to represent the resistance of local farmers, ranchers, and Native communities. Some within their group have referred to themselves as the "The Cowboy and Indian Alliance." In 2014, they joined the national US climate movement's protest against the pipeline and the tar sands, in Washington, D.C., riding horses into the city and setting up camp in Tipis near the White House. After seven years of review, President Obama in November 2015 denied a permit for the Keystone XL pipeline. TransCanada has filed legal challenges, one under the North American Free Trade Agreement (NAFTA), vowing it will be built. Bold Nebraska says no way (learn more at, www.boldnebraska.org).

Summarizing, our energy predicament includes future source constraints and the ways in which the present energy system is intimately connected with environmental degradation, population and economic growth, climate change, and the global equity and geopolitical tensions that plague the world. Later in this chapter, we will turn to some of the possibilities and options for transforming the present system to address our energy predicament. But there are some clues about these from the relationship between energy and society, and studies of that relationship by scholars, to which we now turn.

THE ENERGETICS OF HUMAN SOCIETIES

The ultimate source of *all* the world's energy is radiant energy from the sun. Fundamental to understanding the energy flows of both ecosystems and human social systems, autotrophic (green) plants transform solar radiant energy into stored complex carbohydrates by the process of photosynthesis. These are then consumed and converted

Mark Wilson / Staff/ Getty

Figure 4.5 The Cowboy and Indian Alliance joined the protest in Washington DC against the Keystone XL pipeline in April 2014.

into kinetic energy through the respiration processes of other species. Energy filters through the ecosystem as a second species consumes the first, a third the second, and so on. Unlike matter, energy is not recycled but tends to degenerate through the process of *entropy* to disorganized forms such as heat, which cannot be used as fuel for further production of kinetic energy or to sustain respiration. Such inefficiency means that only a portion of stored potential energy becomes actual kinetic energy.

Of course, this inefficiency is a great benefit, because we are now living off the stored energy capital of millions of years ago, but it is also true that the second law of thermodynamics (entropy) means that the relatively plentiful supplies of these fuels are ultimately exhaustible. More precisely, we will never absolutely use them up, but they can become so scarce and low grade that the costs of the energy and investment necessary to extract, refine, and transport them exceed the value of their use. We will have to squeeze the sponge harder and harder to get the same amount of energy, and the damage to the environment will increase as we do so.

LOW- AND HIGH-ENERGY SOCIETIES

All human societies modify natural ecosystems and their energy flows, but they vary greatly in the extent to which they do so. Human respiration alone requires enough food to produce about 2,000–2,500 calories a day, but people in all human societies use vastly more energy than this minimum biological requirement to provide energy necessary for their shelter, clothing, tools, and other needs.[2]

Table 4.1 Per Capita Energy Consumption in Different Types of Societies

Society	Kilocalories per Day per Person
MDC (U.S.A.)	260,000
MDC (other nations)	130,000
Early industrial	60,000
Advanced agricultural	20,000
Early agricultural	12,000
Hunter-gatherer	5,000
Prehistoric	2,000

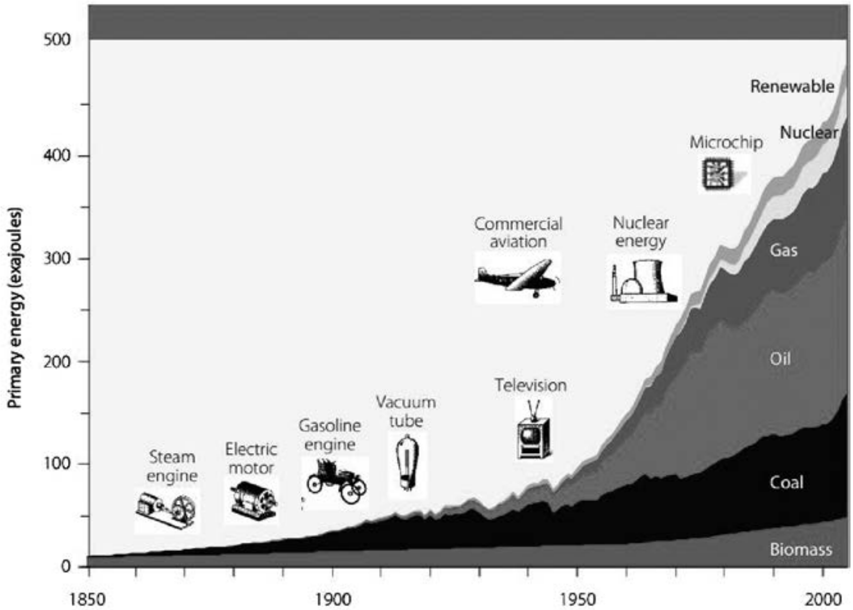
Source: Adapted from Miller (2002: 333).

Table 4.1 illustrates the prodigious growth of world energy consumption since the beginning of the industrial era and the increasing human dependence on petrochemicals. By contrast, the traditional fuels of preindustrial societies (e.g., wood, dung, plant wastes, and charcoal) are still the energy mainstays of many people in poorer LDCs. While the aggregate energy consumption of the world has grown, it is also important to note that most of that growth is accounted for by the MDCs as high-energy societies. Indeed, a typical suburban household of an upper-middle-class American family consumes as much energy as does a whole village in many LDCs!

INDUSTRIALIZATION AND ENERGY

Industrialization was possible because new technologies of energy conversion were more efficient than traditional fuels. During the first phase in the early nineteenth century, the dominant technology depended upon coal mining, the smelting and casting of iron, and steam-driven rail and marine transport. The system's components were closely intertwined, and the creation of integrated mining, smelting, manufacturing, and transportation infrastructures made industrialization possible. By the beginning of the twentieth century, the system was being radically transformed again—by electric power, internal-combustion engines, automobiles, airplanes, and the chemical and metallurgical industries. Petroleum emerged as the dominant fuel and "feedstock" for the petrochemical industry.

Withdrawals of so much energy from nature in the United States and other MDCs required substantial modifications of natural energy flows. Industrial cities alter ecosystems radically, requiring enormous amounts of energy from remote reserves of fossil fuels to power industry, heating, lighting, cooling, commerce, transportation, waste disposal, and other services. Cities become inert and relatively abiotic. Wastes



United Nations, World Economic and Social Survey 2009: Promoting Development, Saving the Planet. Sales No. E.09.II.C.1.c

Figure 4.6 Growth in Energy Consumption in the Industrial Era

are no longer naturally absorbed but must be transported to waste treatment plants (Humphrey and Buttel, 1982: 139). In addition, industrial farmers use machinery, fertilizer, and fuel manufactured by urban industries, and food is no longer consumed mainly on farms. MDCs thus have integrated agricultural-industrial consumption systems that use enormous amounts of fossil fuels and vastly modify natural ecosystems and energy flows. Since energy plays such a powerful role in connecting and modifying both ecosystems and social systems, it is therefore an important topic for the social science understanding of human–environment relationships.

SOCIAL SCIENCE AND ENERGETICS

Remarkably, in spite of how obvious the last sentence in the preceding paragraph is, in early social science there were only fragmentary attempts to understand the energy–society relationship (Carver, 1924; Geddes, 1890; Ostwald, 1909; Soddy, 1926; Spencer, 1896).[3] Beyond the notion that energy is the crucial linkage between societies and their biophysical environments, about the only generalization that remains from these early analyses is that increases in energy production and efficiency are related to increases in the structural complexity and the scale of human societies (Lutzenhiser et al., 2002: 223). That represents very little in terms of cumulative development of understanding the environment–energy–society relationship!

After World War II, prominent anthropologist Leslie White (1949) rekindled interest in energetics by describing the resource and technological bases for social evolution, and sociologist Fred Cottrell developed the notion that available energy limits the range of human activity. He tried to demonstrate the pervasive social, economic, political, and even psychological change that accompanied the transition from a low-energy society (preindustrial) to a high-energy society (industrial), and argued that the vast social change to modernity could ultimately be traced to energy conversion (Cottrell, 1955; Rosa et al., 1988: 153).

MACROLEVEL STUDIES OF LOW-ENERGY SOCIETIES

In the 1960s, anthropologists conducted meticulous empirical studies about environment–energy–society interactions in diverse ecological settings among such cultures as the Tsembaga Maring people of the central New Guinea highlands (Rappaport, 1968), the Eskimos of Baffin Island, north of Canada (Kemp, 1971), the !Kung Bushmen of the Kalahari Desert in Southwest Africa (Lee, 1969), and the rural Western Bengali (Parrick, 1969). For a summary, see Kormondy and Brown (1998: chap. 14). Armed with such detailed empirical evidence, scholars for the first time could compare energy flows between societies and look for orderly patterns. Anthropologist Marvin Harris made the most significant attempt to do so and to recast older ethnographic evidence in energetic terms (1971, 1979). Application of this formula to societies with diverse food production technologies—hunter-gatherers, hoe agriculture, slash-and-burn agriculture, irrigation agriculture, and modern industrial agriculture—revealed several patterns.

First, while confirming the central insight of historic energetic theories (about the relationship between energy efficiency and societal size and social complexity), these studies cast doubt on the argument of early analysts that increased technological efficiency led to increased available energy, which in turn led to larger populations and greater social complexity. The newer anthropological evidence suggested that population pressure was often the driving force of this process, promoting increased technological efficiency of energy conversion to meet rising demands (for a recent confirmation of this, see Boserup, 1981). *Second*, anthropological studies suggested that high-energy societies would typically replace or assimilate low-energy societies whenever they came into contact. The most obvious example for Americans is the outcome of contact between Europeans and Native Americans, but evidence of this replacement around the world is compelling.[4] *Third*, these studies questioned the long-term outcomes of the process of energy intensification. The recurrent response to population pressures was an upgrading of consumption, and preindustrial societies often overburdened their environments, depleting essential resources faster than they could be regenerated, and disrupting ecological cycles—and their own long-term sustainability. Anthropological and other literatures are replete with evidence in preindustrial societies about ecological collapse (Diamond, 2004; Ponting, 1991, 2007). Importantly, this evidence provides a historical context for our contemporary energy predicament: problems with growing energy/resource consumption and social and environmental sustainability (Rosa et al., 1988: 157).

MACROLEVEL STUDIES OF HIGH-ENERGY SOCIETIES

Analysis of energy flows in complex MDCs is no easy matter. Economists dominated energetic research after the oil shocks of the 1970s, and they emphasized the importance of energy to the economic performance of societies. Longitudinal research within societies and comparative analyses all suggested a strong relationship between the growth of energy production and the increase in measures of economic growth, such as the gross national product (GNP) (Cook, 1971).

These studies interpreted economic indicators such as the GNP as indicative of social well-being, and since economic growth represented improvements in societal well-being, it was but a short step to infer that energy growth was essential to societal well-being (Mazur and Rosa, 1974). The implication was that constraints placed on energy consumption would lead to a decline in wealth, although much room remained for increased efficiency of energy use.

But note: When MDC market economies were separated from the LDCs and nonmarket socialist economies, this relationship virtually disappeared. Many studies supported this finding. These included cross-national longitudinal studies; studies examining the energy use of countries with similar living standards; case study comparisons (such as between the United States and Sweden); and cross-national studies of the relationship between energy intensity, social structure, and social welfare (Rosa et al., 1981, 1988; Schipper and Lichtenberg, 1976). Studies showed "looseness" between energy consumption and GNP, meaning that there was quite a bit of variability between level of energy consumed and gains in GNP.

Macrolevel studies and historical data point to the same conclusion: that economic development in the MDCs went through two phases, from (1) rapid industrialization and consumption being highly dependent on increased use of energy from fossil fuels to (2) economic growth becoming less energy-intensive. In the latter phase, economic growth and social well-being can increase with decreasing energy intensity because of shifts in production from industrial to service sectors and because of the adoption of more efficient technologies. In other words, a threshold level of high-energy consumption is probably necessary for a society to achieve industrialization and modernity, but once achieved, there is a wide latitude in the amount of energy needed to sustain a high standard of living. Given that latitude, industrial societies could choose slow-growth energy policies without great fear of negative, long-term consequences to overall welfare (Reddy and Goldemberg, 1990: 113; Roberts, 2004: 215). More recent research shows a decoupling between energy consumption, economic growth and well-being, which has many positive implications for sustainable development. We will discuss this literature in some depth in Chapter Six.

But for now, it is important to see that this evidence has not had much impact on political debates and discourse about energy. For instance, Amory Lovins had a significant impact by popularizing energy frugality through his prolific publications and media appearances. He emphasized different energy "paths" that could be pursued: A "hard path" organized highly around fossil fuels produced in very centralized ways, and a "soft path" organized around alternative energy sources (such as renewables like wind power, solar, and increasing efficiency) produced in more decentralized ways.

Public opinion surveys have shown support for "soft path" alternatives (Farhar, 1994; Shwom et al., 2015). To the extent that we have moved somewhat away from a "hard path" trajectory (in small increments)—it is due partly to Lovins's considerable persuasive abilities—resulting in what some have called a "mostly hard" hybrid system (Lutzenhiser et al., 2002: 238). But for social scientists, the most interesting elements of the soft path are the claims made for its sociopolitical impacts. These include an increased viability of society, economic self-sufficiency, better satisfaction of basic human needs, public health benefits, the growth of human values, environmental protection, and an end to the chronic "crisis mentality" and fears about resource wars. Let us turn now to the science research literature about microlevel energy consumption.

MICROLEVEL STUDIES: PERSONAL AND HOUSEHOLD ENERGY CONSUMPTION

The oil shocks of the 1970s stimulated microlevel studies of energy consumption as well as macrolevel studies. The main goal of these studies was to develop a scientific understanding of whether people could significantly reduce their energy consumption without deterioration in their quality of life. Technical experts concluded that they could save half the nation's energy consumption (Ayres, 2001: 31; Ross and Williams, 1981). Since individuals and households consumed about a third of the nation's energy—roughly evenly divided between transportation and home needs—they were viewed as a vast untapped potential source for energy conservation that would be responsive to social policy.

Engineering perspectives guided early microlevel studies, assuming that energy consumption could be easily explained by physical variables such as climate, housing design, and the efficiency and stock of appliances and vehicles (Rosa et al., 1988: 161). As applied to vehicles and transportation, the design of more efficient vehicles caused effective energy savings in the 1980s and early 1990s. The fuel efficiency of American cars and trucks doubled as the cumulative result of many engineering changes significantly contributed to increasing the nation's energy efficiency. Changes such as installing catalytic converters to reduce urban air pollution also addressed other environmental concerns (Bleviss and Walzer, 1990: 103, 106). These were engineering modifications that over time changed the machines driven and the composite fleet of cars and trucks, but not alternations or curtailments in the driving behavior of Americans. The only successful behavior change of the era was the one mandated by law, lowering the federal interstate speed limit from 75 to 55 mph (later, as you know, it was raised back to 65 mph, and 75 mph in some states). Overall, attempts at creating *voluntary* behavior changes, such as driving less, carpooling, bicycling, walking, or making greater use of mass transit, were dismal failures—at least on a scale large enough to make much difference.

As with transportation, energy conservation in housing was dominated by energy engineering perspectives emphasizing physical variables like climate, housing design, and the number and efficiency of household appliances. Unlike transportation, however, the assumption that reengineering homes and appliances would significantly reduce energy use was not confirmed. For instance, the Princeton University Twin Rivers Project, a massive and detailed five-year field research effort, found that townhouses in similar housing tracts with similar square footage, number of rooms, and appliance packages varied enormously in energy consumption, when occupied by families of similar size. The energy use of new occupants could not be predicted from that of the previous occupants and the impact of lifestyle on household energy consumption was dramatic (Rosa et al., 1988: 161; Socolow, 1978). Furthermore, other studies of nearly identical units occupied by demographically similar families have reported 200 percent to 300 percent variations in energy use, and in particular end-use levels. Vastly different amounts of energy were used for appliances, household heating and cooling, hot water, and so on. The "average consumer" in energy analysis is somewhat mythical (Lutzenhiser et al., 2002: 240).

Much of this research was not guided by a particular concept or theory and sought commonsense ways of asking people to reduce household energy consumption, such as turning down their thermostats, closing off unused rooms, or taking shorter showers. As policy-oriented research, early post-oil shock studies provided information and education programs about conserving energy, including home energy audits. They were consistently unsuccessful, and their only successes focused on giving consumers better feedback information about their consumption. They did, however, recognize a particularly difficult barrier to the self-monitoring of energy use in households: that energy is largely invisible.

Unlike early studies, later studies of household energy consumption were guided by two conceptual models: an *economic-rationality model*, favored mainly by economists and engineers, and an *attitude-behavior consistency model*, favored by social psychologists. The economic model emphasized that humans "rationally" respond to changing energy prices, given the presence of more efficient technologies. While escalating energy prices and efficient technologies played an important role in energy conservation, a large body of research suggested that economic analyses exaggerate their importance, while underestimating the effects of noneconomic behavior in shaping energy flows (Lutzenhiser, 1993). Partly because of the relatively constant (or "inelastic") nature of energy demand, behavior is slow to respond to price changes, and many energy-use behaviors remain unexplained by price changes.

Furthermore, the acquisition of accurate and reliable *information* about energy use, prices, investment costs, expected savings, and other nonprice factors is assumed, but ignored by a simple economic-rationality approach (Gardner and Stern, 1996: 100–124; Rosa et al., 1988: 162–163). Even when consumers claim to be well informed about energy and believe they are acting in an economically rational way, they may be mistaken. Since energy use is invisible and intrinsically difficult to quantify and analyze (even for experts), people are forced to develop ad hoc ways of accounting that—quite reasonably—overestimate the cost of conservation investments. Because people must pay attention to larger goals and tasks, many routine energy-related actions simply go unnoticed. For example, studies about household energy-related behavior that asked people to keep diary records reported that people were surprised at how often they "caught themselves in the act" of doing things like opening doors, peering into the refrigerator, or running hot water (Lutzenhiser et al., 2002: 246–247).

In contrast, attitude-behavior approaches seek to discover the effect of attitudes on energy problems and consumption. Researchers understood attitudes broadly as having cognitive, affective, and evaluative dimensions and focused on how education and information could change energy-use behavior. But studies often found discrepancies between attitudes and behavior. Attitudes may not overcome barriers to change, price and affordability, lack of knowledge, or energy-use conditions that are found in society rather than personal choices (such as the kinds of homes and autos being marketed). One study of household energy-use curtailment analyzed the interaction of price and attitudinal factors. It found that as the kind of energy-saving activity went from easy and inexpensive (such as changing temperature settings) to difficult and expensive (such as insulation and major furnace repairs), attitudes became less powerful as predictors of energy use (Black et al., 1985, cited in Gardner and Stern, 2002: 77). The conclusion reached by many studies is that while prices and other economic factors play a significant role in household energy behavior and decisions, they can be limited by social, psychological, and marketing factors, such as the vividness, accuracy, and specificity of information; the trustworthiness of sources of information; institutional barriers to investment; and other noneconomic factors (Stern and Aronson, 1984).

Other studies about values and attitudes that more carefully controlled for differences in information found powerful effects of personal values—moral obligations to change—that often outweighed the power of price incentives (Heberlein and Warriner, 1983). Still others suggested the importance of involvement in civic and neighborhood organizations as predictive of energy conservation behavior by households, particularly in the contexts of community conservation programs (Olsen and Cluett, 1979; Dietz and Vine, 1982). Importantly, studies found that socioeconomic status shapes the modes of energy conservation behavior. More affluent households invest in energy efficiency, while poorer households cope with energy problems by lifestyle modifications and curtailments (Dillman et al., 1983; Lutzenhiser and Hackett, 1993).

Taking together the macrolevel and microlevel studies of energetics, one thing is obvious: Energy behavior and consumption are far too complex to be accounted for by either a simple economic-rational or an attitude-behavior model. Scholars need an integrated conceptual framework that combines economic, social, and attitudinal factors (Stern and Oskamp, 1987). One does not now exist, but summaries of research literatures provide some clues. Economic incentives for energy conservation are likely to be effective when

1. They are directed at specific external barriers, such as costs, access to credit, tax relief, or "inconvenience."

2. Significant barriers are not located in the larger social system. These might include urban sprawl with large distances between work, home, and shopping, the "inconvenience" factor, or the unavailability of super-insulated houses or efficient autos if they are not on the market.
3. They are not counterproductive, such as raising energy prices (without compensatory policies) that force low-income or elderly people to choose between heating homes and buying food in the winter.
4. They are combined with other influence techniques, such as information, public campaigns, curbside recycling programs, and moral and ethical arguments (Gardner and Stern, 2002: 120–122).

Similarly, information and attitude change programs are more effective when they provide

1. *Accurate feedback* that ties information directly to people's behavior. One of the successes of early household energy conservation programs was to provide people with information about current energy use.
2. *Modeling* that provides illustrations about effective energy-use curtailments (rather than simply discussing the problem). Studies have, for instance, shown people videotapes about effective methods of energy-use curtailment rather than resorting simply to moral persuasion.
3. "*Framing*" messages to be consistent with people's worldviews and values. North Americans, for instance, are more receptive to arguments about improving "energy efficiency" than to those framed in terms of energy conservation. (Gardner and Stern, 2002: 83–88)

Despite the different approaches to understanding energy consumption, there seems to be a consensus that better ones must be more directly concerned with the *social contexts of individual action*—a recognition that behavior is inherently social and collective. Individual consumers often pursue social (and often noneconomic) ends when making energy-related decisions. This means that factors such as status display, ethical consumption, and pollution reduction influence how consumers assess incentives. Furthermore, various groups of consumers evaluate incentives differently (Stern et al., 1986: 162). A better approach to understanding energy consumption will require understanding how economic, attitudinal, and social processes interact to represent the complexity of real-world energy consumption. It will also require analysts to understand how technologies diffuse, as well as social networks and organizations. This becomes obvious when you think about it. Energy consumers get goods, services, information, housing, automobiles, and so forth through social networks and organizations that affect energy demand, use, and the environment. These include networks and organizations of architects, builders, subcontractors, code officials, automobile dealers, utility company representatives, appliance salesmen, and so on. They regulate and mediate the structure of relationships between consumers and manufacturers, and usually such intermediaries have few incentives to pursue energy efficiency (Lutzenhiser et al., 2002: 248, 255;

Stern and Aronson, 1984). Taken together, research about energy consumption (going as far back as the Princeton University Twin Rivers research) reaffirms what was noted in Chapter One, that social and cultural factors (e.g., lifestyles, family traditions, group affiliations, marketing, social networks and institutions) are powerful conditioners of energy consumption, in comparison to economic incentives or physical factors alone. There are more clues about dealing with the present energy predicament in the world's present energy system, to which we now turn.

THE PRESENT ENERGY SYSTEM AND ITS ALTERNATIVES

It was noted earlier that most (84 percent) of the world's present energy needs are supplied by finite or nonrenewable resources, and that most of that comes from three fossil fuels: oil, coal, and natural gas. Renewables such as hydropower, solar, wind, and biomass supply the remainder. Traditional biomass fuels such as wood, crop refuse, and dung are important fuels in poorer LDCs, where they may be commercially traded or obtained by foraging outside commercial markets. Let us now turn to look at each major energy source today.

FOSSIL FUELS

This chapter discussed supply issues and other problems with most of the fossil fuels earlier. There are, however, some advantages and additional issues to note. *Oil* is relatively cheap and easily transported, and it has a high yield of *net useful energy.* Net useful energy is the total useful energy left from the resource after subtracting the amount of energy used and wasted in finding, processing, concentrating, and transporting it to users. Oil is a versatile fuel that can be burned to propel vehicles, heat buildings and water, and supply high-temperature heat for industrial and electricity production. However, as you can see from the pie chart in Figure 4.7 it does not contribute much to electricity production today.

Coal is everybody's least favorite fuel, but there's an awful lot of it. Known and probable coal deposits could last the world between 200 and 1,125 years, depending on the rate of usage (Miller, 2005: 364). Burning coal produces a high useful net energy yield, and because its mining and use is highly subsidized and many costs are externalized, it is the cheapest way to produce intense heat for industry and to generate electricity. Germany, the world's fourth largest economy, aspires to be a leader in transitioning away from fossil fuels, having set the goal to get a full 80 percent of its electricity from renewables by 2050. But, coal is holding Germany back from meeting its global GHG emissions reduction target by 2020. This is because Germany leads in production of lignite (brown coal), which they have in abundance. Lignite is dirtier than hard coal and emits more CO_2. Germany could replace it with other energy sources (hard coal,

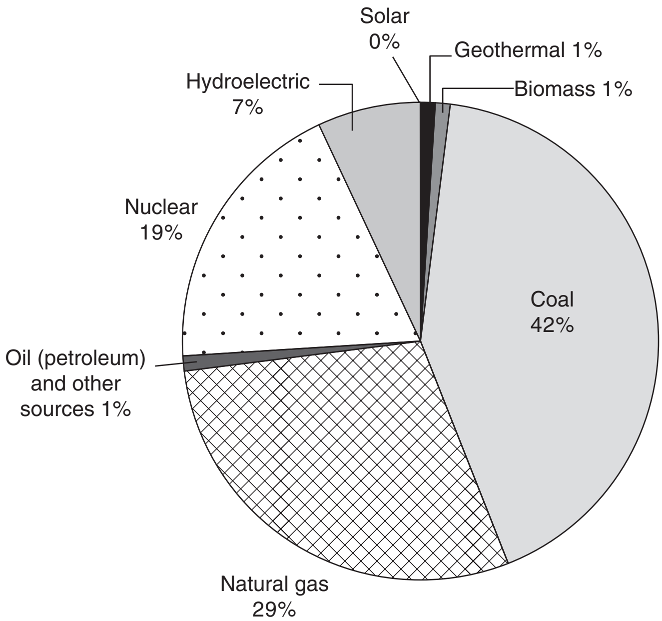


Figure 4.7
Source: U.S. Energy Information Administration, Electricity Data Browser.

natural gas, nuclear), but electricity prices have fallen, pricing out the others (Kunzig, 2015). Abundant and cheap coal, once a blessing, especially for MDCs that burned it with abandon for nearly two centuries, is now a curse. Keeping it in the ground is the challenge of the twenty-first century.

Natural gas is a naturally occurring geological mixture of methane, butane, and propane. In contrast to coal, it is clean burning, efficient, and flexible enough for use in industry, transportation, and power generation. It generates fewer pollutants, particulates, and CO_2 than any other fossil fuel: Natural gas releases 14 kilograms (kg) of CO_2 for every billion joules of energy produced, while oil and coal release 20 and 24 kg, respectively. But methane emission from leakage and incomplete combustion is a heat-trapping greenhouse gas which, as previously noted, is much more potent than CO_2. Like oil, natural gas is concentrated in a few parts of the world. Conventional supplies of natural gas and unconventional supplies (shale gas, tight gas, coal bed methane, and methane hydrates) are expected to last from 62 to 125 years, depending on how rapidly its use grows and the feasibility of recovering supplies. The "fracking revolution" led the US to be the global leader in natural gas production even though production from conventional supplies fell by the end of 2013. It appears that Russia has the largest natural gas reserves followed by Qatar, but it largely boils down to the technical feasibility of recovering resources. When taking feasibility into account, China, Argentina, Algeria, Canada, the US, Mexico, and Australia are more likely producers, but much rests on what can truly be recovered (Friedeburg, 2015).

While natural gas can be shipped by pipeline cheaply on the same continent, it must be converted into *liquid natural gas* and shipped in refrigerated tankers to move it across the oceans—at present a difficult, dangerous, and expensive undertaking (Miller and Spoolman, 2009: 381–382). Incidentally, coal can be used to produce synthetic natural gas by gasification or liquidification, resulting in what is called "syngas." But its production and use produces about 50 percent more greenhouse emissions. Without huge government subsidies, most analysts believe that syngas has a limited future (Miller and Spoolman, 2009: 386).

The share of electricity from natural gas production in the US increased as it became cheaper, from a low of 16 percent in 2000 to a high of 30 percent in 2012 (see pie chart in Figure 4.7). This increase in the share of electricity from natural gas caused a decline in coal share, which was 52 percent in 2000. Natural gas is forecasted to topple coal in total energy share by 2040. There is some concern, however, over the US expanding its export market, which will raise the costs of production, which in turn could increase domestic prices (Friedeburg, 2015).

As previously stated, opposition to fossil fuels, especially extreme fossil fuels, is growing worldwide (Harlan et al., 2015; Klein, 2014). The climate injustice of fossil fuel extraction is an issue of environmental injustice. People of color and low-income communities are more likely to be negatively impacted at all stages of the life cycle of coal and oil. For example, coal mining communities in Appalachia "have righter rates of birth defects, cancer, and mortality, even after controlling for such variables as income and education" (Harlan et al., 2015: 138). Political instability and corruption are another consequence of a fossil fuel dependent economy. Too many cases of human rights abuses exist. These include the propping up of violent and authoritarian regimes, to mass displacements and killing of civilians in developing countries where oil companies, such as Chevron, Unocal, and Shell, have sought access to cheap oil (Harlan et al., 2015).

To summarize, even with the problems presented by fossil fuels, we have an enormous *sunk investment in infrastructures* to produce, process, and use them. In Fort McMurray, Alberta, Canada, the extraction of oil from the tar sands includes approximately 100 active sites of production that involve several dozen companies, many of them foreign-owned. It is a capital-intensive program with $133.6 billion having been invested by 2011 and an estimated $200 billion expected to be invested by 2030 (Dorow and O'Shaughnessy, 2013: 125). Transitioning away from fossil fuels will result in stranded assets, meaning fossil fuel energy infrastructure and resource reserves will become a liability for shareholders. In Chapter Seven, we will discuss economic and political policy tools that can be employed to help fossil fuel industries strand assets without causing widespread economic hardship, and social and political upheavals. It will have to be done, if the target to keep global warming below 2 degrees C can be met. Maintaining the fossil fuel system has short-term, but very real advantages for both individuals and the powerful corporate interest groups that profit from them. Historically, a set of tax biases and subsidies encourage the use of fossil fuels and favor

BOX 4.1

DIRTY COAL AND CLEAN ENERGY?

Coal is dangerous to mine, toxic to miners and consumers, destructive of the land, and the greatest producer of greenhouse gases of all fossil fuels. Experiments to capture (or "sequester") the carbon emissions from coal plants by injecting them into porous layers of rock or shale have not been encouraging. Experiments are underway between China and the United States, which together produce 40 percent of the world's greenhouse gases, to produce energy from coal without the emissions. Coal *can* be used in less dangerous ways, and *must* be since there is really no substitute, in spite of the progress in developing wind, solar, and other alternative sources noted below. Coal-fired plants produce about half of the electricity in the United States and the world. Experiments with "clean coal" could use postcombustion technologies that inject emissions into rock after it is burned, or precombustion technologies that chemically treat coal to produce a flammable gas with lower carbon content than untreated coal. Needless to say, the scientific and technical means to do this are daunting. Yet the Chinese were working on just such plants, with American assistance.

A large-scale partnership is emerging between China and the United States. Why China and the United States? Partly because they are two different societies, and neither could do this on the necessary scale alone. The United States is more of a "bottom up" capitalist system with many different companies and government agencies that are not always focused on a few most hopeful strategies. China, by contrast, is a "top down" centrally controlled society, in which stable policy can flow from the central government to energy producers throughout the nation. While there are many virtues of the American system, it takes years for a single innovative new energy plant to be licensed, while the Chinese can build a new energy plant in 21 months. There is no way that the United States could transform its energy system with the speed, the scale, or the policy stability as could the Chinese. The cooperative effort would use the Chinese ability for the rapid construction of a different national energy system, and the American scientific knowledge of energy technologies and infrastructure. By 2010 that joint effort was visible, and the US DOE created a consortium that included three universities, three national science laboratories, two nongovernmental energy agencies, and six companies, including General Electric and Duke Energy, two of the largest electric corporations in the United States (Fallows, 2010).

present operating costs rather than long-term investment in alternatives. The "fossil fuel age" is coming to an end (Flavin, 2005: 30; Goodstein, 2004; Roberts, 2004). What could replace fossil fuels? Twenty years ago, most experts would have said with little hesitation, nuclear energy.

NUCLEAR ENERGY

Nonmilitary uses of nuclear energy produce electricity. In a nuclear fission reactor, neutrons split Uranium 235 and Plutonium 239 to release a lot of high-temperature heat energy, which in turn powers steam turbines that generate electricity. In principle, nuclear fission reactions are the same kind used in the atom bombs of World War II. The complicated systems required to regulate, modulate, contain, and cool such reactions make nuclear plants much more complex to operate than coal plants. You likely know this is a very controversial way of producing energy.

In the 1950s, researchers predicted that nuclear energy would supply 21 percent of the world's commercial energy. After almost 60 years of development and enormous government subsidies, and trillions in private investment around the world, the share of nuclear energy in global power production peaked in 1996 at 17.6 percent, then steadily declined to 10.8 percent in 2013. Only five countries rely heavily on nuclear energy, the United States, France, Russia, South Korea, and China, together accounting for 68 percent of all nuclear power generated worldwide (Renner, 2014b). In 2010, new nuclear construction reached its highest since the 1980s. At the same time, 12 of the 65 reactors under construction worldwide in 2010 had been under construction for more than 20 years. Incredibly long delays are not unusual at enormous cost. Furthermore, the share of power generated from nuclear is offset by temporary closings, or plant decommissioning and permanent closures (Lucky, 2011). In the United States, no new nuclear power plants have been ordered since 1978, and all of the 120 plants ordered since 1973 were canceled. To promote a variety of alternatives to carbon-intensive energy, President Obama in 2010 declared more than $8.3 billion in federal loan guarantees to build two nuclear reactors in Georgia (Lucky, 2011). But, not much has happened. Globally, nuclear energy is attracting far less investment than wind and solar energy. Between 2000 and 2013, nuclear investments averaged $8 billion per year compared to $37 billion for solar photovoltaic cells and $43 billion for wind. While different countries have distinct energy priorities, in no country does nuclear energy investment play a major role (Renner, 2014b). Given the original expectations for nuclear energy, it has been a disappointment. Why?

First, national security reasons are well known. Nations that have the technical capacity for nuclear power can also build nuclear weapons. So the diffusion of nuclear energy contributes to the potential proliferation of nuclear weapons and geopolitical tensions. Several international rogue nations, such as Iran and North Korea, have not been open to international inspection, and are widely suspected of using the development of nuclear electricity as a cover for developing a covert nuclear weapons capability. In 2010, the tensions between the MDCs and these nations continued to be intense and politically destabilizing.

Second, and equally well known, are the risks of nuclear meltdowns and accidents that tarnish the public image of the nuclear option. Some became household words:

Three Mile Island (TMI), a US nuclear plant in Pennsylvania that allowed radioactive gases to escape, and Chernobyl, a plant in the former USSR (now Ukraine) that experienced a complete meltdown. At TMI, partial cleanup, lawsuits, and damage claims cost $1.2 billion, almost twice the reactor's $700 million construction cost. The Chernobyl meltdown burned uncontrollably for 10 days, releasing more radiation into the atmosphere than the Hiroshima and Nagasaki bombs combined. Prevailing winds and rain sent radioactive fallout over much of Europe, and was measured as far away as Alaska (Charman, 2006: 12).

Japan experienced nuclear disaster after a 9.0 magnitude earthquake and tsunami hit in March 2011, causing a triple meltdown at the Fukushima Daiichi Nuclear Plant. Five years later, an army of workers are still employed to try to control radiation-contaminated water, and continue the cleanup. Substantially more people (about 7,000) are employed at the plant today than before the disaster. On the upside, by late 2014, 1,500 spent fuels rods were removed from a damaged storage tank, and workers are expected to be able to enter some plant areas without full-body protective gear soon. But, it is expected to take 40 years (the government's optimistic timetable) to complete a full cleanup, which will entail removing melted uranium fuel from the damaged reactor cores. Given Japan's shrinking population, some are worried about attracting labor in the future. One of the biggest cleanup challenges is water. Engineers must keep water flowing through the damaged reactor cores to prevent melted fuel from overheating then recycle it through miles of plastic pipe. But radioactive water leaks out. The buildings at Fukushima are damaged, so

TK Kurikawa / Shutterstock.com

Figure 4.8 The Occupy movement in Japan has sought to draw attention to the on-going environmental threats from Fukushima, and nuclear energy in general.

water collects in basements, and when it rains, more water seeps in. Tokyo Electric captures contaminated basement and ocean water to clean up as much as possible and then releases the water into the ocean. The government says that water released back into the ocean is safe, but environmentalists have questioned their claims and fishing grounds remain closed (Soble, 2016). This is not the complete story of Fukushima, but you get the picture of the scale of such a disaster. To be fair, you also should know that because of built-in safety features, the risk of exposure to radioactivity from nuclear power plants in the United States and most other developed nations is said to be low.

Third, nuclear plants do not produce CO_2 (other than from the cement used to build the large structures) or other greenhouse gas emissions. But they *do* produce long-lived, low-level radioactive waste, which is now accumulating in storage facilities on nuclear plant sites. The federal government has defaulted on its commitment to take back nuclear waste and store it safely in permanent waste repositories. They would need to be secure from corrosion, leakage, earthquakes, or sabotage for a *long* time. Close to where you live, perhaps? Controversy and conflict over the construction of nuclear waste facilities is a major barrier to construction of new nuclear reactors.

Fourth, and less widely appreciated, the planning, construction, and regulation of nuclear plants make them a very uneconomical investment. This has been the greatest barrier to the expansion of nuclear energy. A state-of-the-art coal-fired plant is a much less costly way of generating electricity. Economics may be a more potent barrier to the expansion of nuclear energy than negative public opinion or antinuclear activists. Furthermore, dismantling and securing the world's aging stock of spent reactors and the disposing of nuclear wastes pose safety hazards, political problems, and economic costs that may exceed those of the development and operation of plants (Gibbons et al., 1990: 88). Banks and lending institutions in the United States are leery of financing new nuclear plants, and utility investors have largely abandoned them.

Nuclear energy thus has enormous costs, potential for serious accidents, destabilized geopolitical qualities, and has unresolved problems in disposing of wastes. Even with these imposing problems, research continues about—yet to be perfected—"breeder reactors" that generate their own fuel. Excitement is building about a different nuclear option, using thorium, a safe and "green" fuel so abundant that it could power the United States for 1,000 years (Martin, 2010). With all its difficulties, electricity demand, improved reactor designs, and climate change fears have revived hope for nuclear energy, but it has not panned out. Even though it has no greenhouse gas emissions and is a "ready" technology, nuclear energy has many unresolved problems as a way to weakening our dependence on fossil fuels. What are the other options worth pursuing?

RENEWABLE ENERGY SOURCES

Renewable energy sources are both the oldest energy sources used by humans and those with the greatest potential to address the many problems created by the present

Figure 4.9 Discharge from a dam in China.

system. Today renewable energy sources collectively constitute about 22 percent of the world and nearly 13 percent of the US electrical energy generation (US Energy Information Administration, 2016; US EPA, 2016). With investment and technological development, renewable energy from water, biofuels, wind, and the sun *could* produce half of the world's energy within the next 50 years, and maybe sooner if combined with comparable investments in energy efficiency. Renewables are the fastest growing sources for electrical generation worldwide.

HYDROPOWER

Hydropower represents the greatest share of energy provided by renewables globally. Hydropower uses water from dammed reservoirs to turn turbine engines that generate electricity. In 2011, hydropower was 6.4 percent of the world's total energy flow (Musolino, 2013). South and Central America are the most dependent on hydroelectric power, but China leads in capacity to produce energy, followed by Brazil, the US, Canada, and Russia. Hydropower dams produce no greenhouse emissions or other pollutants, and they have an operating life span of two to three times that of coal or nuclear plants. *Large dams* can be used to regulate irrigation and to provide recreation and flood control, but they are not cost free, either for humans or for the environment. They rot plants on flooded land which produces greenhouse gas emissions and methane, decrease the natural fertilization (the re-silting) of prime agricultural land, destroy wildlife habitats and uproot many people, and reduce fish harvests below dams (Li, 2006). GHG emissions are also produced from the large amount of concrete needed for construction. Hydropower projects have generated social and political unrest by the displacement of local and indigenous peoples where they are constructed, and are adversely affecting downstream communities (Ciplet et al., 2015; Harlan et al., 2015; Musolino, 2013).

These problems make large-scale hydro systems controversial and inappropriate in many parts of the world, particularly in the LDCs. Regardless, new mega-dams are planned and others have come on-line, or will soon, in Brazil, China, India, and Ethiopia (see Chapter Two). Small hydropower installations—plants with an installed generating capacity below 10 megawatts, are growing in popularity. They are cost-effective for expanding energy access. The majority of these projects are in LDCs, 68 percent in Asia, 3 percent in South America and 0.5 percent in Africa. Finally, growing in popularity is pumped storage hydropower, which essentially involves pumping water uphill to a reservoir for release when needed. These facilities make up nearly 99 percent of all energy storage capacity worldwide (Musolino, 2013).

BIOFUELS

Biofuels refer to bio-energy derived from biomass—animal and plant matter. It ranges from gathered fuel wood and animal dung to the industrial production of ethanol and biodiesel. As noted at the beginning of the chapter, about 38 percent of LDC residents burn *traditional biomass fuels* for cooking (Prugh, 2014). Such fuels have a low net energy yield and are dirty to burn, producing a lot of carbon particulate, carbon dioxide, and carbon monoxide as by-products. Heating a house with a wood or charcoal stove produces as much particulate matter as heating 300 homes with natural gas. While people in LDCs may buy wood or charcoal, the great human virtue of traditional fuels is that most people who use them do not purchase them. In rural areas, women and children usually gather twigs and branches or animal dung for cooking fuel instead of buying wood. In principle, biomass fuels are renewable and environmentally benign. But often the pressure of growing populations has stripped the land of trees and vegetation in the search for fuel wood, contributing to deforestation and desertification. The forests of China have been cut down for centuries, and the search for fuel wood today exacerbates desertification, soil erosion, and environmental degradation in much of Sub-Saharan Africa, Nepal, and Tibet. Biomass can be used to produce other fuels. In many LDCs, *biogas digesters* use anaerobic bacteria to convert biomass to methane gas that can be used for lighting or cooking. After the generation of methane, the solid residue can be recycled for fertilizer for food crops or trees. The supply of biomass fuelstock often varies seasonally, and if used in biogas generators, it reduces its availability for its usual use as crop fertilizer (Reddy and Goldemberg, 1990). Regardless, in 2012, approximately 48 million biogas plants were constructed in China and other parts of Asia to provide electricity to rural areas (Prugh, 2014).

Ethanol is now being produced from corn and plant residues, and in the United States is, as you know, being added to gasoline to "stretch" petroleum supplies and lower greenhouse emissions. Not surprisingly, Midwestern corn farmers see this as a bonanza for the sluggish farm economy. In Brazil, ethanol is refined from sugarcane. In 2012, Brazil and the United States controlled most of the world ethanol market with the US accounting for the largest share (61 percent). However, the US total production of ethanol was down from 2011 due to severe drought in the Midwest in 2012. Biodiesel fuels are processed from fats and vegetable oils. The US also leads in biodiesel production

(Prugh, 2014). Other methods can produce ethanol more efficiently from shrubs, sycamores, and prairie grasses like switchgrass. It can even be produced from green algae, with an astonishing productivity given the technology to do so.

At any rate, ethanol is not a panacea for our fuel problems. If you consider the energy it takes to clear land, grow corn, and to refine it to ethanol, it is not that much better for the environment than gasoline. Furthermore, if you used the whole US corn crop to produce ethanol, it would satisfy the US need for gasoline for about six months! Even so, existing technologies and vested economic interests will make it difficult for the United States to shift to other ways of producing ethanol.

An important problem with ethanol fuel (as now produced) is an *ethical one.* In a world where many lack food, do we use agricultural resources to produce fuel? The growth of ethanol distilleries in corn-belt states has been an economic boom for farmers, who need to make a living. But, the more corn we use for fuels means driving up the price of meat and anything that has fructose (corn sugar) such as most canned goods and beverages. As we use agricultural resources for fuel, we consequently make the problem of human nutrition more difficult and "pricy" where many have difficulty affording enough food. The UN Food and Agriculture Organization reported that the rising demand for biofuels alone increased the price of food between 8 percent and 13 percent in various nations around the world (Monfort, 2009). It also is especially controversial in LDCs where land grabs (Chapter Two) for biofuel production often displace small farmers, stress local food supplies, raise food prices, and increase rural poverty, especially for women and children (Ciplet et al., 2015; Gardner, 2015; Lappé and Collins, 2015). You can approach the food–fuel tradeoff ethically ("What is the most defensible compromise for how we use our resources?") or politically ("Which interest groups, agribusiness, or transportation, will 'win' in the market and policy debate?"). If not a "zero sum game," who will benefit and how much? This issue is being widely discussed, but as an eater or energy consumer, you will probably never get to vote!

WIND POWER

Wind generators basically hook modern windmills to electric generators to produce power directly. Such power can be produced only in areas with enough wind. When the wind dies down, you need backup electricity from a utility company or some kind of energy storage system. Furthermore, unlike coal or oil, which pack a lot of energy in a small amount of fuel, the amount of wind that blows across each square meter carries only a little bit of power. It takes the combined effort of *many* wind generators installed across large areas of land to produce as much energy as a single fuel-burning power plant. Even with these limitations, wind power has *vast* potential. In 2004, Stanford University engineers mapped the global potential for wind energy, and their data indicate that capturing only one-fifth of the wind energy at the world's best sites could generate more than seven times the amount of electricity now used in the world and thus help phase out energy-wasting coal and nuclear plants (Miller and Spoolman, 2009: 419–420).

BOX 4.2

BIODIESEL?

Diesel fuel is an old idea. Rudolf Diesel, who invented the diesel engine, ran his demonstration model on peanut oil. Diesel engine fuel can be made from a variety of vegetable oils, including soy, palm, rapeseed (canola), and sunflower oil. Such biodiesel is cheaper and more environmentally friendly than petroleum diesel. Biodiesel fuels (from all sources) produce net greenhouse gas reductions like ethanol made from sugarcane and corn. By one estimate, biodiesel typically reduces CO_2 by 41 percent, more than three times the reduction from corn ethanol. But, there are problems. For instance, Brazil's production of biomass ethanol requires just 3 percent of its agricultural land. But to supply 10 percent of the US needs from biomass and biodiesel fuels would require 30 percent of its agricultural land. To supply palm oil, for instance, Malaysia plans to convert 3 million hectares of its tropical forest (about the size of Massachusetts) into a palm plantation. Opponents say producing biodiesel on a large scale would trash rainforests, deplete water reserves, reduce biodiversity, and raise food prices. While the small-scale production of biodiesel from waste oil and low-level conversion of oil crops could deliver a modest reduction in greenhouse emissions, the environmental benefits don't scale up (*New Scientist*, 2006: 38–40).

Wind and solar energy are the fastest growing renewable energy sources worldwide. Wind power grew between 2000 and 2012 more than 16-fold (Renner, 2014b). Leading in wind energy development is the European Union with 37 percent of the share of global installed capacity, but Asia is right behind at 36 percent. In 2013, China installed more new wind capacity than any other country, followed by Germany, the UK, India, and Canada. Since the Fukushima disaster, Japan is looking at offshore wind development to diversify its energy portfolio. Offshore wind development is also growing with projects becoming larger and moving into deeper waters. The UK is trying to drive down costs for offshore wind production and revitalize old ports and related industries. Because of big technological advances in size, power yield, and enhanced nameplate (maximum output under optimal conditions), wind power is becoming increasingly cost-competitive against new coal and gas-fired plants, even with no support schemes or incentives. These upward trends in the share of energy produced by wind are expected to continue.

Recognizing the economic advantages of wind energy, several large corporations have begun to invest in wind power (General Electric, Royal Dutch Shell) (Miller, 2005: 396–397; Sawin, 2005). Wind power developers are doing best where governments support them. Chinese manufacturers are getting a competitive edge on developing the largest turbines as they are supported by government grants. In the US, production capacity has increased significantly, with wind-related manufacturing taking place in

44 states. However, in 2013 the Production Tax Credit (PTC) for wind development was up for renewal by Congress and got caught in battles over the government's spending budget. This stalled production caused factory closures and layoffs (Konold and Wu, 2014). It has since been renewed and President Obama has pushed to make the PTC permanent to alleviate investor and developer uncertainty.

Some critics have charged that wind turbines suck birds and migratory birds into their blades. But, as long as wind farms are not located along bird migratory routes (which are mapped by very sophisticated studies), most birds learn to fly around them. Studies demonstrate that larger numbers of birds die when they are sucked into jet engines, killed by domestic and feral cats, and crash into skyscrapers, plate glass windows, communication towers, or auto windows (Miller and Spoolman, 2009: 421). The land occupied by wind farms can be used for grazing and other agricultural purposes.

Despite the fact that wind energy produces a relatively small proportion of the world's energy, it is the fastest growing source. It is noteworthy that most of Africa has not seen much growth in wind power production (Konold and Wu, 2014). Technology works for those who can afford it, which is why the least developed countries have fought hard for reliable climate change finance and technology transfers.

SOLAR ENERGY

The direct use of energy from the sun has the greatest potential as an alternative sustainable energy source. An enormous amount of radiant energy falls on the earth's surface, which—if trapped and converted into usable forms—could supply the energy needs of the world. The total potential of *solar power* is enormous but, like wind power, it is variable, only possible where and when the sun shines, needing storage and backup systems. Solar radiation intensity varies by latitude and with the weather, but still, solar energy is available 60 percent to 70 percent of the days in the northern tier of American states, and 80 percent to 100 percent in the southern half of the country (US Department of Energy, 1989). In the sunny regions closer to the equator that include many LDCs the potential for solar energy is enormous and could supply much of the world.

Solar energy is now practical for space and water heating. The technology of using solar collectors for these purposes is relatively simple. For an investment of a few thousand dollars, using skills possessed by the average carpenter, it is possible to *retrofit* an older home to reduce the use of fossil fuels for heating water or rooms. A *passive solar heating system* captures sunlight directly within a structure through windows or sunspaces that face the sun and converts it into low-temperature heat. The heat can be stored in walls and floors of concrete, adobe brick, stone, or tile and released slowly during the day and night. *Active solar heating systems* have specially designed collectors, usually mounted on a roof with unobstructed exposure to the sun. They concentrate solar energy, heat a medium, and have fans or pump systems that transmit space heat or hot water to other parts of a building. The potential is very large for reducing America's combined heat bill this way. On a lifetime-cost basis, solar space and water heating is inexpensive in many parts of the United States. In many warm, sunny nations, such as Jordan, Israel, and Australia, solar energy supplies much of the hot water now, as it does for new housing in Arizona and Florida.

Photovoltaic electricity (PVE) is produced directly when semiconductor cells that create an electric current absorb solar radiation. You are probably familiar with PVE cells that energize small calculators and wristwatches. In many ways, PVE is *the* superb energy source to create electricity. It can operate on any scale, from small portable modules in remote places to multimegawatt power plants with PVE panels covering millions of square meters. Furthermore, most PVE cells are made of silicon, the second most plentiful mineral on the earth's surface. But unlike solar space heating, producing wafer-thin silicon semiconductor solar cells is a high-tech enterprise with considerable costs, and unlike land around wind generators, land occupied by solar panels *cannot* be used for grazing or agriculture. But solar panels can sit on rooftops, along highways, and in sun-rich but otherwise empty deserts. Furthermore, the use of land would not be excessive. Hydropower reservoirs use enormous amounts of land, and coal mining needs more land than solar generators if you include the area devoted to mining.

The main obstacles to the spread of PVE technology had been its high cost (per megawatt), and the significant costs of building an infrastructure of solar panels. But thanks to economies of scale, rising energy conversion efficiencies, and more efficient use of silicon in solar cells, PVE prices are declining. Presently PVE is a rapidly growing portion of world energy flows, with 2013 a record breaking year in the growth of PVE and concentrated solar thermal power (CSP). In fact, in 2013 PVE solar installations almost matched hydropower, and overtook new wind additions for the first time. European nations have made up the largest share of the solar market, but in 2013, Asia took the lead, taking 56 percent of the market share. The US ranked third in PVE installations at this time (Lander and Wu, 2014). PVE generators have found niche markets in the world economy, where they are the cheapest way of delivering electricity to 2 billion rural villagers without having to extend centralized power grids from cities or big regional plants. Increasingly, PVE cells are used to switch railroad tracks; supply power for rural health clinics; operate water wells and irrigation pumps; charge batteries; operate portable laptop computers; and power ocean buoys, lighthouses, and offshore oil-drilling platforms (Resch, 2009: 20).

The future is bright for solar electricity as it is becoming increasingly cost-competitive with the retail price of electricity in many parts of the world. In Australia, Brazil, Denmark, Italy, and Germany, rooftop solar is now less expensive per megawatt-hour than retail electricity (Lander and Wu, 2014). According to a stockbroker with New York's Piper Jaffray, when solar becomes competitive with conventional power "solar power demand is infinite" (cited in Sawin, 2009: 40).

The potential of solar energy to contribute to a diverse clean energy system and create new green jobs is great. However, there are concerns about the management and recycling of chemical by-products from manufacturing the PV cells. To increase transparency and reward the best companies, the Solar Scorecard ranks companies based on such things, like water use, handling of chemical by-products, emissions, and recycling (Nunez, 2014, see http://news.nationalgeographic.com/news/energy/2014/11/141111-solar-panel-manufacturing-sustainability-ranking).

Shutterstock.com

Figure 4.10

HYDROGEN FUEL

If you took high school chemistry and conducted *water electrolysis*, running electricity through water and splitting water molecules into oxygen and hydrogen atoms, you can understand the potential of using *hydrogen gas* as a fuel. An alternative method, often more practical, is to use a reformer (or converter) device that strips hydrogen molecules from other fuels such as natural gas, methanol, ammonia, gasoline, ethanol, or even vegetable oil (Cunningham and Cunningham, 2010: 456). You could make hydrogen using solar, wind, or conventionally produced electricity. It is a clean-burning fuel with about 2.5 times more energy by weight than gasoline. When burned, it produces no heat-trapping greenhouse gases, but combines with oxygen in the air to produce ordinary water vapor. Hydrogen can be collected and stored in tanks like propane is today, or it can be transported by pipeline. It is easier to store than electricity, but as a gas, hydrogen is bulky and explosive. Liquid hydrogen takes up less space than gas, but must be kept below –250 degrees centigrade, not a trivial task for most applications.

Hydrogen will combine with reactive metals to form solid compounds called *hydrides,* which can be stored and heated to release hydrogen as needed. Combining hydrogen and oxygen gas in what are called *fuel cells* could produce electricity to power vehicles or produce heat and light for buildings.

Fuel cells are ideal for many applications: They are highly reliable, have no moving parts, are highly efficient, produce only water as a by-product, and are small. They may be connected or "stacked" in huge arrays that multiply their output, but such a "stack" providing almost all the electricity needed by a typical home (including water and space heating) would be about the size of a refrigerator. They could be scaled up to huge applications. For example, a 45-story office building at 4 Times Square in New York City has two 200-kilowatt fuel cells on its fourth floor that provide both electricity and heat, along with other conservation measures. Such applications exist but are not common because of their imposing technological requirements (Cunningham and Cunningham, 2010: 456).

Gradually switching to hydrogen and away from fossil fuels as our primary fuel resources would mean a far-reaching *hydrogen revolution* on a profound scale. Technical and social transformations required over the next 50 years could change the world as much as did the agricultural and industrial revolutions. A solar-hydrogen economy would be based on resources that are more abundant and evenly distributed than fossil fuels and could reduce the geopolitical tensions and costs produced by dependence among nations.

What's the catch? Well, there are some big ones. *First*, hydrogen (H_2) is locked up in water and organic compounds like the fossil fuels. *Second*, it takes energy and money to produce H_2 from water and organic compounds. Although H_2 has been described here as a fuel, it is not directly a source of energy, but a way of storing energy by using energy from other fuels. *Third*, while fuel cells are the best way to use hydrogen to produce electricity, current versions are expensive. We can use heat and chemical processes to separate H_2 from the complex carbon-based molecules of coal, natural gas, ethanol, or gasoline, but at present, doing so is more expensive and produces as much CO_2 as does using these fossil fuels directly (Miller and Spoolman, 2009: 428–430). In sum, hydrogen power has only theoretical potential, but it is an enormously attractive one.

EFFICIENCY AS A RESOURCE

Even with such an impressive menu of alternatives to fossil fuels, it is important to emphasize that efficiency is the cheapest, easiest, and fastest way to address our present energy predicament. We often forget just how effective energy efficiency is, and how it makes economic sense. The US power sector alone could reduce electricity rates by 40 percent and cut CO_2 emissions in half by upgrading power plants and transmission systems (Roberts, 2004: 220). As Amory Lovins, an outspoken efficiency advocate, pointed out, "Just a 2.7 miles-per-gallon gain in fuel economy of this country's light-vehicle fleet could displace Persian Gulf import entirely" (cited in Roberts, 2004: 215).

Efficiency also makes corporate sense. "Anywhere companies have pursued energy efficiency, they have ended up making money, even if making money wasn't their initial goal" (Goldstein, cited in Roberts, 2004: 225). America has many ways of increasing energy efficiency; and in order of increasing price, they include:

1. Converting to efficient lighting equipment, which would save the United States electricity equal to the output of 120 large power plants, plus $30 billion a year in maintenance costs.
2. Using more efficient electric motors, saving half the energy used by such motor systems, which would save the output of 150 large power plants and repay conversion costs in about a year.
3. Eliminating pure waste electricity, such as lighting empty offices.
4. Displacing electricity now used with better architecture, weatherization, insulation, and solar energy for water and space heating.
5. Making appliances, smelters, and the like cost-effectively efficient.

Amazingly, these five measures could quadruple US electrical efficiency, making it possible to run the economy with no changes in lifestyles and using no power plants, whether old or new (Lovins, 1998). This assessment does not include the energy efficiencies that would result from *cogeneration* (combined heat and power systems). See Box 4.3.

Possibilities for "mining" efficiency are producing a profound shift in thinking. Economists traditionally viewed conservation and environmental protection as involving only economic restraint, higher costs, and curtailment of consumption. But some now envision a vast future market for efficiency as profitable for investors, and the basis for a virtual "second industrial revolution." Nations that fail to develop "greener" economies are likely to lose out economically as well as environmentally (Brown, 2001; Flavin and Dunn, 1999; Hawken et al., 2000; McDonough and Braungart, 2002).

BARRIERS, TRANSITIONS, AND ENERGY POLICY

Our energy *predicament* has intrinsic links to other social and environmental problems. These include pollution, loss of biodiversity, environmental degradation, health problems, urban sprawl/congestion, a large national debt and balance of payments problem, geopolitical costs of maintaining access to oil and gas fields, and a volatile economic dependency that amplifies international instability and sometimes war. In LDCs, the energy predicament is related to deforestation, desertification, and other barriers to development, such as poverty and hunger. Most ominously, our present energy system is the chief culprit in the most serious macrothreat to the future of humanity: anthropogenic climate change.

A 2009 assessment of the potential of a new "mix" of energy sources (including renewables) to provide a way out of this predicament is optimistic. An environmental/civil engineer and a specialist in the economic analysis of sustainable transportation and fuels from Stanford University and the University of California at Davis argue that

BOX 4.3

MINING EFFICIENCY: COMBINED HEAT AND POWER SYSTEMS

Combined heat and power (CHP), a kind of cogeneration, captures waste heat as electricity is produced, and recycles it to provide another energy service (like space or water heating). Conventionally heat is simply dumped into the environment, and more fuel must be provided for that service. There are great efficiency advantages. The average coal-fired power plant had a conversion efficiency of 33 percent, and the most efficient natural gas-fired plant has efficiencies of 60 percent to 64 percent, but CHP systems have efficiencies of between 75 percent and 90 percent, with lower transmission losses because the two processes are spatially close. CHP systems are found in energy-intensive sectors (including paper and printing, chemicals, metal refining, and food production) that account for 80 percent of the world's CHP capacity. In addition to large-scale industrial applications, CHP and power systems can provide both electricity and heat to individual or dense groups of residential buildings. In North America, such systems are most often found in universities and hospitals.

CHP systems are more common in Western and Eastern Europe, where publicly owned facilities are connected to residential districts for heating and cooling. Denmark is the global leader, producing 52 percent of its electricity needs with CHP systems. In Eastern Europe, it produces almost 19 percent, an odd legacy of Soviet-era central planning, which called for widespread cogeneration technology. In the United States, CHP systems presently account for a modest 8 percent of power production. According to the International Energy Agency, CHP could reduce greenhouse emissions by at least 4 percent in 2015, and 10 percent by 2030. With post-Kyoto climate negotiations still on the world's agenda, cogeneration is an energy efficiency "tool of choice" to address climate issues (Chiu, 2009: 50–52).

> A large-scale wind, water, and solar energy system can reliably supply the world's needs, significantly benefiting climate, air and water quality, ecology, and energy security. [The] … obstacles are primarily political, not technical. A combination of feed in tariffs plus incentives for providers to reduce costs, elimination of fossil fuel subsidies, and an intelligently expanded grid could ensure rapid deployment. [With modest and likely policies] … full replacement of the fossil fuel system may take 40 to 50 years.
>
> (Jacobson and Delucchi, 2009: 65)

Needless to say, such a transformation would require heavy investments over decades, and overcoming the economic advantages of the "sunk investments" and managing stranded assets of the existing energy regime (to be discussed in Chapter Seven). But such investments are not "handed out" by governments or consumers, but paid back through the sale of electricity and energy. A decade ago, it was not clear that a global water, wind, and solar system would be technically or economically feasible. Given their analysis, the energy and economic experts Jacobson and Delucchi now think that it is.

BARRIERS TO CHANGE

We have a rich menu of technical possibilities that could, in combination, move the world toward more efficient, affordable, and environmentally friendly energy systems. With these possibilities why, for instance, if renewable energy is so great, does it produce only 22 percent of world electrical generation and 13 percent in the United States? There obviously have been some powerful barriers to change.

First, efficient and renewable energy receives much lower tax breaks, subsidies, and research and development funding than do fossil fuels or nuclear. Public policy makes it a very uneven playing field. If it was leveled, alternative energy would develop rapidly and that would affect economic performance. Economic performance is directly correlated with energy prices. But, *contrary to intuition*, the more costly and highly taxed the energy resources, the more the technological innovation and economic growth. For instance, between 1976 and 1990 researchers found that among industrial nations where energy prices were subsidized and below world market value, both innovation and economic growth lagged significantly behind (Hawken, 1993: 180). By 2009 the world's major industrial nations (G-20) agreed to start a phase out of fossil fuel subsidies, not suddenly, but in the "medium term," and the Waxman–Markey energy/climate bill passed by the US House of Representatives (but not the Senate) would shift some subsidies and investment incentives from fossil fuels to renewables (Mason and Ennis, 2009; Sheppard, 2009).

Second, like many other social problems, the salience of energy problems follows an *issue-attention cycle*, a cycle of rising and falling concern due to energy-related national events and the volume of media coverage they attract (Downs, 1972; Rosa, 1998; Mazur, 1991). When supplies increase and prices moderate, the combination of public concern and media attention that would impel political action is at a low ebb (Joskow, 2002: 105). That has seemingly been the fate of global warming, by going from a premier social problem after the long hot summer of 1989, but which "cooled" in the 1990s (with the help of a well-organized countermovement), only to return slowly to public debate and discourse (Ungar, 1992, 1998). After mild winters, devastating hurricanes, and $3.00 a gallon gasoline, by 2010 both energy and global warming became high-definition social problems once again!

Third, energy policies have been fragmented, contradictory, and often paralyzed. In the United States, energy policy has been separated by fuel type, with different institutional associations, interests, and regulatory bureaus for each, with few attempts at broader coalition building. The Bureau of Mines deals with coal problems and interests, the

Department of Interior with gas and oil, and the Nuclear Regulatory Commission with nuclear energy. Electricity is regulated differently in each of the 50 states. The net result is that government energy policies have intervened in markets with supply-side policies that subsidize costs and increase consumption rather than promote efficiency and alternative fuels (Switzer, 1994: 138).

A *fourth* barrier to effective energy policies is that they need to be articulated on a global basis. Even dramatic improvements in energy efficiency will not be sufficient to protect the global environment if they are confined to the MDCs. Pleas from MDCs to address global environmental and climate problems through energy restraint will fall on deaf ears in the LDCs, unless the MDCs deliver on promised technology transfers and funding for mitigation and adaptation to current and impending climate change impacts.

TRANSITIONS AND POLICY

Even with such powerful barriers to changes in policy, it is important to underscore that the world changes, including the web of connections between energy and societies. This means that, as always, *some kind of energy transition is underway*. Consider two previous world energy transformations.

Before the industrial revolution, people depended for energy on a combination of traditional biomass fuels (like wood and dung), animal power, and water power. Beginning in the 1800s, a new energy regime evolved around coal, which was the foundation for a steam-powered industrial system. (The term *energy regime* means the network of industrial sectors that evolve around a particular energy resource, as well as the consequent political, commercial, and social interactions.) The coal regime diffused around the world in the late nineteenth century; between 1850 and 1913, this single energy resource went from providing 20 percent to more than 60 percent of the world's total commercial energy. Until 1915, petroleum had a niche market for kerosene to light lamps and was between 3 and 12 times as expensive as coal in Europe and North America. But under the stimulus of converting naval ships and military vehicles, a petroleum-based energy regime was established more rapidly than it could have been by private enterprise alone. The share of world energy provided by oil grew from 5 percent in 1910 to over 50 percent by 1973, and after World War II it was the key resource for transportation, electricity generation, and heating in most of the industrialized world (Podobnik, 1999).

THE PRESENT AND THE FORESEEABLE FUTURE

What kind of world energy transition are we in the midst of now? Global appraisals of energy scenarios of the future offer a wide range of estimates of how much renewable sources can contribute and how fast. All the evidence we have reviewed in this chapter clearly indicates that investments in renewables are growing. But is it enough? The International Energy Agency's *World Energy Outlook* (WEO) 2015 report predicts that by 2040 coal and oil will reduce their share of the global energy mix by 9 percent while renewables will grow by 5 percent, and natural gas and nuclear combined by 2 percent (IEA, 2015). This is good, but climate scientists contend the transition away from fossil fuels needs to speed up even more.

For the last decade, many have spoken about a new energy regime that would continue to rely on oil and coal, but also on more natural gas and a rapidly growing decentralized mix of renewables. This new regime was referred to as a "bridge" economy—a transitional phase arresting the worst of the current energy trends while giving us more time and flexibility eventually to create a radically different energy system. The United States would encourage the transitional stage by (1) immediate moves to expand natural gas imports, (2) the rapid deployment of a carbon tax, and (3) dramatically improved automotive fuel efficiency (Roberts, 2004: 313, 315). The US did aggressively pursue natural gas and improved fuel efficiency, but we did not achieve possibly the most important step, implementing a carbon tax. Today, the bridge economy is criticized for sinking costs into extreme fossil fuels (McKibben, 2016).

On the upside, smart grid technology is advancing rapidly. *Smart grids* are electrical transmission and distribution systems that use digital information in real time to improve the reliability and operation of energy systems. Smart meter technology records energy use in short time increments and has two-way communication between the utility provider and its customers. It also has distribution automation. This makes it possible to monitor and control remote distribution systems to automatically fix faults and make adjustments (Gonzalez, 2014). It can better handle intermittent renewable energy sources like wind and solar by pulling from other sources on cloudy or windless days. And it has greater storage capacity for the windy and sunny days that produce excess energy supply. Smart grids do not rely on one large energy facility, but rather use distributed generation by drawing from different technologies (solar, wind, cogeneration, natural gas, etc.) that generate electricity, at or near, where it will be used. It can serve a single structure (home or business) or it may be connected to a microgrid at a larger facility (college campus, military base, or manufacturing plant). It allows more customers to have access to clean, reliable power and reduces electricity loss along transmission and distribution lines (US EPA, 2016). Smart grids also provide protection from attacks to the energy system as well as natural disaster (Gonzalez, 2014).

Smart grid technology is past the pilot stage with large investments being made worldwide. In 2013 China led smart grid investments, and the US was second. In the US smart gird development was jump-started with $3.4 billion in federal funding through the Smart Grid Investment Grant under the American Recovery and Reinvestment Act of 2009. By the time the program was phasing out in 2013, private investors had matched grant funds resulting in 99 projects that included electrical transmission and distribution systems, advanced metering infrastructure, and the installation of 14.2 million smart meters. In addition to China, the rapidly emerging economies of Brazil and India are looking to develop smart grids and many European countries have plans to expand their use of the technology (Gonzalez, 2014).

CONCLUSION: ENERGY AND THE RISKS WE TAKE

What are the risks of continuing with the business as usual energy regime? The *first* is global. It is the real possibility of runaway climate change. To successfully transition to a renewable energy economy will require consistent funding for research and development, and for development and implementation of new energy systems, such as smart grids. This will require shifting market incentives in a new direction and putting new economic and policy tools into play (see Chapter Seven). The *second* kind of risk is social and political. What will be the global consequences of the growing energy dependence among nations, of MDCs on LDC resources, and the aspirations of people everywhere? What kinds of social and political instabilities will result within and between nations, partly driven by the energetic base of social life and the world network of nations (Humphrey et al., 2002: 171)? To fully answer these questions we will need to face the stark realities of climate injustice.

PERSONAL CONNECTIONS

QUESTIONS FOR REVIEW

1. What are the different kinds of interacting concerns about present energy systems? Which energy concerns are thought to be more serious than a few decades, or even a few years, ago?
2. What do the following concepts mean, and how are they important to understand our energy concerns: useful net energy, energy intensity, energy infrastructure, sunk investment, cogeneration, Hubbert's "peak oil," and extreme fossil fuel energy?
3. Even though we have many technological alternatives to the present "fossil fuel based" energy system, what are some of the reasons it is difficult to change?
4. What are the key environmental and social concerns of extreme fossil fuels?
5. Nuclear energy is efficient and does not produce a lot of GHGs. What are the biggest obstacles to its development?
6. What is the cheapest and most technologically ready of the newer renewable energy technologies? What are some difficulties with large-scale hydropower projects (dams)?
7. How are present lifestyles in cities and suburbs founded on certain forms and costs of energy (particularly for transportation)?
8. What are the cheapest and easiest ways of increasing the energy supply for heating and cooling?
9. What are the important long- and short-term risks that we take by staying with our present energy systems?

QUESTIONS FOR REFLECTION

Here are some questions to help you think about your personal relation to energy consumption and a variety of social and environmental issues.

1. Chapter Three argued that our carbon-based energy system is the primary driver of climate change. The average human sends the equivalent of his or her body weight of carbon into the atmosphere for about every $200 spent. That figure is based on a world average: As North Americans, We probably contribute much more. Do the math: How much do you think you, or you and your family, contribute? Multiply by 300 million Americans (deduct some for children when you do).
2. This chapter noted that as nations move from LDCs to MDCs and from early to late industrial (more service-based) economies, they become more energy efficient per unit of economic output. At the same time, there is considerable variation among developed market economies in the relationship between energy input and economic output, with Americans leading the pack in terms of energy inefficiency. Given what you know about conditions and lifestyles in America and other nations, why do you think that is so?
3. Since transportation is such an important part of our energy budget, here's a pointed question: If you drive a car, how much would gasoline have to cost per gallon to induce you to cut your driving by a meaningful amount? How might people with different occupations answer that question differently? What other changes in community life would make it easier for you to do this?

WHAT YOU CAN DO (SOME POINTERS FROM CHARLIE)

Small lifestyle changes that relate to possibilities for greater energy frugality are well known:

- Drive less, keep your car tuned; when possible walk, bicycle, or ride the bus or commuter train; car-pool.
- Insulate your house and turn the thermostat down in winter; adjust to changing temperatures by changes of clothing rather than heating or cooling your house; run appliances frugally, and replace them with more energy-efficient appliances when you can.
- Buy "green goods" that have less stored energy used in their production by the time they get to you. Etc., etc.… (You know the litany of small things you can do. If *many* people did them, they would add up.)

The larger and more meaningful lifestyle changes are more difficult and challenging. They require more planning, investment, and working toward integrated lifestyles. This is what it entails:

- Plan to live close to where you work, reducing both transportation time and costs. Perhaps you can find an appropriate job close to where you live, or move closer to where you now work. Either is likely to be a challenge, and there are some important barriers for most of us.
- Choose a career that enables you to "walk lightly" regarding energy and other impacts on the environment—in other words, one that rewards frugality. Exactly what kinds of careers would those be? We are not sure, but think it's meaningful to pose the question. Buddhism emphasizes the notion of "right livelihood" as an ethical imperative. What would right livelihood mean in an ecological sense?
- In general, try to simplify your life in ways that still support your sense of well-being. Doing this is not easy. It raises issues about how you could do this (if you wanted to—and many don't!). It also forces you to examine the exact sources of your sense of well-being.

REAL GOODS

The bicycle. The bicycle is the most thermodynamic and efficient transportation device ever created, and the most widely used private vehicle in the world. The bicycle lets you travel three times as far on a plateful of calories as you could walking. And it's 53 times more energy efficient—comparing food calories with gasoline calories—than the typical automobile. Nor do bicycles pollute the air, lead to oil spills and oil wars, change the climate, send cities sprawling over the countryside, lock up half of urban space in roads and parking lots, or kill a quarter of a million people in traffic accidents each year. The world doesn't yet have enough bikes for everybody, but it's getting there quickly: Best estimates put the world's booming fleet of two-wheelers at 850 million—double the number of autos, and growing more rapidly than the auto fleet. We Americans have no excuses on this count. We have about as many bikes per person as do the Chinese. We just don't ride them as much.

I (Charlie) admit to being a bike enthusiast (some of my friends have different words for it!). Like many American kids, I grew up riding a bike (a big heavy Schwinn is the one I remember) and didn't discover lightweight bikes with gears until midlife. I found cycling a life-saving form of exercise and a mood enhancer. For many years I enjoyed weekend rides through the green fields of the urban hinterlands and discovering the diversity of urban neighborhoods in a more intimate way than I ever could by driving around in my car. I'm fortunate to live close to my work (about 20 minutes away by bike). Until I had some knee injuries (not from biking!), my car often sat at home in the driveway. Many Americans are connected to work by a nerve-racking four-lane auto umbilical cord.

MORE RESOURCES

Deffeyes, K. (2001). *Hubbert's peak: The impending world oil shortage.* Princeton, NJ: Princeton University Press.

Dorow, S. and O'Shaughnessy, S. (2013). Fort McMurray, Wood Buffalo and the oil/tar sands: Revising sociology of community: Introduction to the Special Issue. *Canadian Journal of Sociology*, 38 (2), 121–140.

Freudenburg, W.R. and Gramling, R. (2012). *Blowout in the Gulf: The BP oil spill disaster and the future of energy in America*. Cambridge, MA: MIT Press.

Geller, H. (2003). *Energy revolution: Policies for a sustainable future.* Washington, DC: Island Press.

Humphrey, C. R., Lewis, T. L. and Buttel, F. (2002). *Environment, energy, and society: A new synthesis*. Belmont, CA: Wadsworth/Thompson Learning.

Jacobson, M. Z. (2009). Review of solution to global warming, air pollution, and energy security. *Energy and Environmental Science*, 2, 148–173.

McKibben, B. (2014). *Oil and honey: The education of an unlikely activist*. New York, NY: St. Martin's Griffin.

Sovacool, B.K. and Drupady, I.M. (2016). *Energy access, poverty, and development: The governance of small-scale renewable energy in developing Asia* (Ashgate Studies in Environmental Policy and Practice). New York, NY: Routledge.

ELECTRONIC RESOURCES

www.energy.gov
US Department of Energy

www.em.doe.gov/index4.html
US DOE; Office of Environmental Management organizations

www.iea.org
The International Energy Agency; about energy, environment, climate change, and sustainable development.

www.awea.org
American Wind Association website.

http://web.stanford.edu/group/efmh/jacobson/Articles/I/WWS-50-USState-plans.html
Mark Jacobson Stanford University Engineer's plan for 100 percent transfer to renewable energy.

http://thesolutionsproject.org
Excellent source on transitioning to renewable energy and it is interactive.

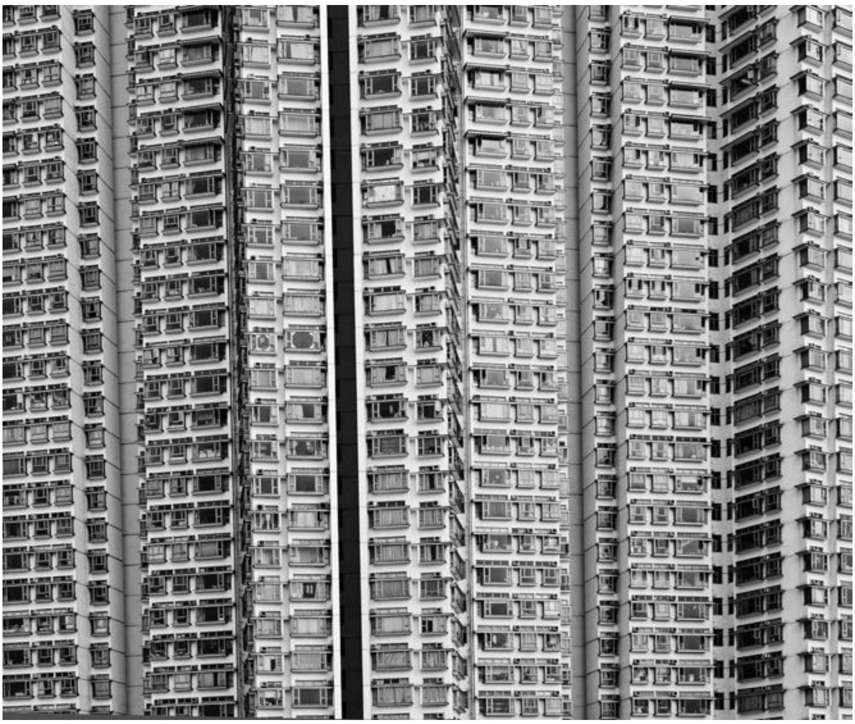
NOTES

1. A future market for commodities is one that attempts to avoid large, unpredictable price swings by allowing investors to commit to buy the commodity at a specified future date for a particular price. They gamble their profits on being right about future prices.
2. A *calorie* is the amount of energy needed to raise 1 gram of water 1 degree centigrade.
3. Sir Patrick Geddes was a Scottish biologist, sociologist, city planner, and cofounder of the British Sociological Society in 1909. Unlike Spencer, he sought a unified calculus of energy flows to study social life (1890/1979). Wilhelm Ostwald and Frederick Soddy were both Nobel Prize-winning chemists in the early twentieth century. T. N. Carver was an American economist, who gave energetic theory an ideological coloration. He argued that capitalism was superior because it was the system most capable of maximizing energy surpluses and transforming them into "vital uses" (Rosa et al., 1988: 150–151).
4. The most meticulous study of contact between high- and low-energy societies is Pelto's 12-year study of the consequences of the introduction of snowmobiles among the Sami people (Lapps) of northern Finland. The introduction of snowmobiles and repeating rifles were the energy and technological means of the gradual absorption of the Samis into Scandinavian societies. They readily adopted these material culture items, and it transformed their life. It vastly increased the geographic mobility of hunters and the amount of game that could be killed. It shortened the workweek of hunters and trappers, increased their leisure time, increased their earnings, and established a new basis for stratification in their communities (based on who owns and who does not own a snowmobile). It also generated a serious ecological imbalance, as populations of snowbound game animals were wiped out. And it increased their dependence on the Finns, Swedes, and Norwegians for gasoline, consumer goods, and so forth (see Pelto, 1973; Pelto and Muller-Willie, 1972: 95).

CHAPTER 5
POPULATION, ENVIRONMENT, AND FOOD

Imagine a human community with 100 people, 50 women, and 50 men. Imagine further that during the next 25 years, each of the women had four children (two boys and two girls) and that each of the girls grew up and also had four children. Thus, the original 50 mothers had 200 children ($50 \times 4 = 200$). Of these, 100 became mothers, giving birth to 400 grandchildren (100×4). Our hypothetical community has now grown from 100 to 700 ($100 + 200 + 400$), a sevenfold increase. This imaginary scenario illustrates *exponential growth*, and, like all living populations, human populations have the capacity to grow at exponential rates. In fact, the human population of the world has grown at a dramatically exponential rate.

For thousands of years, the human population grew at a snail's pace. It took over a million years to reach about 1 billion people by the beginning of the nineteenth



Evgenia Bolyukh/Shutterstock.com

Figure 5.1 Chinese urban developers must respond to the needs of a growing population. Growing populations and urbanization, especially rapidly expanding megacities (more than 10 million residents), put increasing demands on ecosystems for resources and sinks to absorb wastes and pollution.

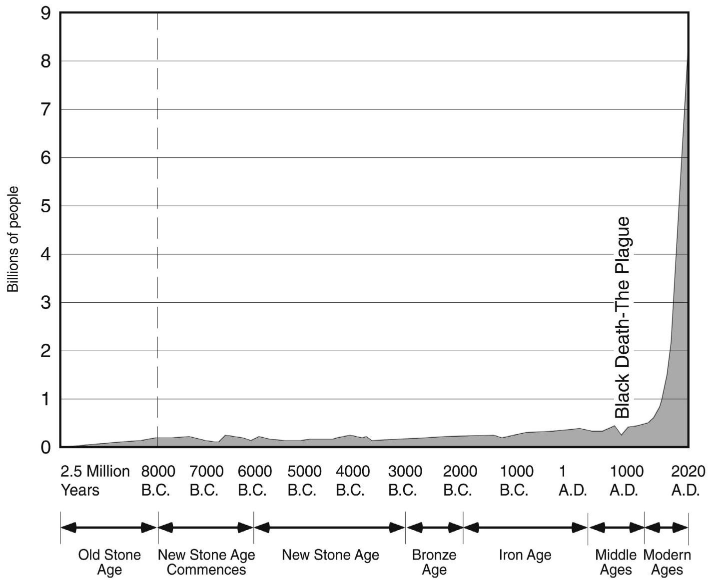


Figure 5.2 World Population Growth Throughout History
Source: M. Kent (1984), *World Population: Fundamentals of Growth.* Population Reference Bureau.

century. But then the pace of population growth quickened: A second billion was added in the next 130 years, a third in the next 30 years, and the fourth billion in just 15 years (McNamara, 1992). By the 1990s, there were more than 5 billion people on the planet and by 2016 there were more than 7 billion (Gelbard et al., 1999; UN Population Division, 2015). See Figure 5.2.

Another way of expressing the rate of exponential growth is by computing the *doubling time*—the number of years it takes for a population size to double. From 1750 to about 1950, the doubling time for the world population was about 122 years. But by 2010, the doubling time was only about 61 years.[1] World average growth rates mask lots of variation between nations: For the more developed countries, the doubling times are 60 to 70 years, and for less developed countries with higher birth rates, they may be as low as 20–30 years. Think about that: About every 25 years a poor nation like Mexico must double its supplies of food, water, housing, and social services just to maintain living standards (Weeks, 2008: 33, 52). In the world's poorest nations such as Haiti, Bangladesh, and Rwanda, the doubling time is even shorter. According to the United Nations Population Division, the world population is growing, but more slowly than in the recent past at 1.18 percent which equates to about 83 million people annually. By mid-2015, the global population reached 7.3 billion. In the most likely scenario, the world will have 8.5 billion people in 2030 and 9.7 billion in 2050 and 11 billion by 2100 (UN Population Division, 2015).

These numbers are truly staggering, and the popular term "population explosion" is indeed a proper description for the demographic history of recent times. If 7.3 billion humans have visibly stressed the environmental carrying systems (as demonstrated in earlier chapters), what impact will 8 to 11 billion have? This chapter will discuss (1) the dynamics of human population change; (2) the controversy about the role of population growth related to environmental and human problems; (3) the relationship among population growth, food supply, and the prospects of feeding a much larger population; and (4) some contentious policy questions about stabilizing the growth and size of the world's population.

THE DYNAMICS OF POPULATION CHANGE

Concern with exponential population growth is not new. Contemporary concerns about population growth are still framed by questions raised by Thomas Malthus (1766–1834) in his *Essay on Population*, first published in 1798. His book went through seven editions and has undoubtedly been the world's single most influential work on the social consequences of population growth. Malthus and other classical economic thinkers wrote at the start of the nineteenth century, when accelerating population and industrial growth were raising demands for food faster than English agriculture could respond. They saw real wages falling and food imports rising. Most classical economic thought emphasized the limits that scarce farmland imposed on agricultural expansion, arguing that applying ever more labor and other inputs to a fixed land base would inevitably encounter diminishing returns. Their argument was that limited productive land as well as limits of the supply of capital and labor would determine how many people could be supported by a nation.

Malthus turned these arguments upside down. He argued that since "sexual passion was a constant," human population would increase exponentially (in his words, "geometrically"), while the supply of land, food, and material resources would increase arithmetically. Thus instead of limited natural resources (land) and labor causing limits to population growth, Malthus believed that population growth caused resources to be overused and the market value of labor to decline. Population growth rather than lack of resources and labor produced poverty and human misery. "Overpopulation" (as measured by the level of unemployment) would force wages down to the point where people could not afford to marry and raise a family. With such low wages, landowners and business owners would employ more labor, thus increasing the "means of subsistence." But this would only allow more people to live and reproduce, living in poverty. Malthus argued that this cycle was a "natural law" of population: Each increase in the food supply only meant that eventually more people could live in poverty.

Malthus was aware that starvation rarely operates directly to kill people, and he thought that war, disease, and poverty were *positive checks* on population growth. Although he held out the possibility of deliberate controls (*preventative checks*) on population growth, he was not very optimistic about their effectiveness. Rejecting both contraception and abortion as morally unacceptable, he believed that only moral restraint (such as sexual abstinence and late marriage) was acceptable.

In sum, Malthus argued that poverty is an eventual consequence of population growth. Such poverty, he argued, is a stimulus that *could* lift people out of misery if they tried to do something about it. So, he argued, if people remain poor, it is their own fault. He opposed the English Poor Laws (that provided benefits to the poor) because he felt they would actually serve to perpetuate misery by enabling poor people to be supported by others (Weeks, 2008: 80–82). Many in our day criticize the government "safety net" and welfare systems on just such grounds. Malthus's ideas were attacked from all sides. We will save these criticisms for later, because they foreshadow many contemporary objections to demographic explanations of environmental problems. Certainly, in the short run, events have not supported the Malthusian view. He did not foresee

> [the] expansion of world cropland to more than double its 1850 acreage; development of agricultural technologies capable of quadrupling yields achieved by traditional farming methods … the diffusion of health services and improved hygiene, lowering death rates and then birth rates. He would never have predicted, for instance, farmers being paid not to plant, in order to cut surpluses and to reverse erosion.… And he would be amazed at the growth in world population.
>
> (Hendry, 1988: 3)

Whether Malthus will continue to be seen in serious error is another matter, as world population and related problems continue to grow dramatically. As you can see from the questions raised here and in earlier chapters, there are plenty of grounds for concern, and indeed, *neo-Malthusians* today are alarmed about population growth as a cause of environmental and human social problems. But before returning to these issues, we will examine the outlines of the way demographers understand population dynamics and change.

THE DEMOGRAPHIC TRANSITION MODEL

One of the most universally observed but still not clearly explained patterns of population growth is termed the *demographic transition*. By the 1960s, George Stolnitz reported that "demographic transitions rank among the most sweeping and best documented trends of modern times … based upon hundreds of investigations, covering a host of specific places, periods, and events" (1964: 20). This model of population change has three stages: (1) primitive social organization, where mortality and fertility are relatively high; (2) transitional social organization, where mortality declines, fertility remains high, and population shows a high rate of natural increase; and (3) modern social organization, where mortality and fertility stabilize at relatively low levels, and near stationary population is possible (Humphrey and Buttel, 1982: 65). See Figure 5.3.

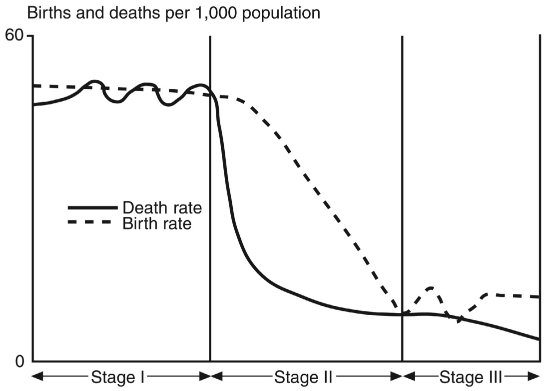


Figure 5.3 Demographic Transition Model

Explanations of this transition vary and are pasted together from somewhat disparate elements, but in general they flow from assumptions about the demographic consequences of modernization and industrialization. First, industrialization upgraded both manufacturing and agricultural productivity so that the economic base could support much larger populations. Second, medical advances in the control of epidemic disease and improvements in public services like urban sewerage, water systems, and garbage disposal contributed to improved health and reduced mortality rates. Third, as populations became increasingly urbanized, family changes occurred. The children of rural peasants are generally an economic asset: They eat little and from an early age contribute substantially to the family farm and household. But urban children—their education and rearing—become more of an economic burden than an asset (Weeks, 2008: 89–91).

Industrialization was also coupled with opportunities for women to work outside the family and eventually improved the status of women. Birth rates were high where the status of women remained low and they were economically dependent on men (Keyfitz, 1990: 66). Industrialization also produced societies that established national social security programs apart from kinship, which meant that parents were less dependent on the support of their children in old age. Industrial modernization had, in other words, a variety of incentives that promoted smaller families. As social and economic incentives changed, cultural norms promoting large families began to weaken. Finally, research demonstrated that while industrialization was inversely related to fertility, it also changed the level of economic equality. In the European nations, "the demographic and economic transitions led to a general improvement in living standards for all persons and a gradual reduction in income inequalities" (Birdsall, 1980). There is good reason to doubt the unique impact of family planning programs as a cause of fertility decline apart from deeper socioeconomic causes, but abundant evidence exists that information about birth control and access to contraceptives have been important factors in fertility declines in all countries (Keyfitz, 1990: 66).

The demographic transition process has meant that beginning with social and economic modernization, death rates declined, and were eventually followed by declining birth rates. But between these events was a period of *transitional growth* when birth rates remained high but death rates rapidly declined. That transitional growth period is what the population explosion since the beginning of the industrial era is all about. As you can see, when applied at a global level, the demographic transition model provides reasons for expecting world population growth to eventually stabilize. It is a broad abstraction that fits the facts of long-term population change in the MDCs, but the variety of causes suggested do not form a very coherent theory about it.

There are at least two other limitations of the demographic transition model. It is *ethnocentric* in assuming that historic processes of demographic change in MDCs can be repeated in the LDCs, when in fact the historical, political, and economic circumstances in which they entered the modern world differ dramatically. Second, the model has not been capable of precisely predicting levels of mortality, or fertility, or the timing of fertility declines at national, much less at global, levels. This is both because the causes of the demographic transition are not well understood, and also because historical events (such as wars or economic collapse) cause unpredictable changes in the stability of demographic projections. Small differences in projected numbers stretched over long periods of time can add up to big differences. That is why agencies that make population projections typically make high, medium, and low ones, letting the user decide which is most reasonable. The UN Population Division reports the medium projection. For the 2015 report, they assumed a decline in fertility for countries where large families are still typical and a slight increase in fertility in several countries *below replacement level fertility* (2.1 children per woman). It also assumes improvement in survival rates for all countries. Nonetheless, questions such as: "How rapidly will global stabilization occur?" and "At what equilibrium number?" cannot be answered with absolute certainty. However, the UN Population Division uses statistical methods that enable them to make statements about the degree of certainty for different projections. For instance, it is expected that global population will be between 8.4 and 8.6 billion by 2030, and 9.5 and 13.3 billion in 2100, with a 95 percent degree of confidence. Thus, they are virtually certain population will rise in the short- to medium-term future, but there is around a 23 percent chance that population could stabilize or fall before 2100 (UN Population Division, 2015: 3).

THE DEMOGRAPHIC DIVIDE: MDCs AND LDCs

As MDC populations went through the period of transitional growth, they expanded into less densely populated frontier areas, rich with land and resources to be developed. This process of European expansion and colonization began in the 1500s, before the industrial revolution. Until 1930, European and North American countries grew more rapidly than the rest of the world. But since then, population growth has slowed and geographic outward expansion has virtually ceased. Today population has stabilized in MDCs as they are well into stage III of the demographic transition (Weeks, 2005: 5).

The UN Population Division places countries into three categories based on their level of fertility: low—below replacement level; intermediate—2.1 to 5 children per woman; and high—more than 5 children per woman. All European countries have low fertility, and many have for several decades. Several countries, including Bosnia and Herzegovina, Bulgaria, Croatia, Hungary, Japan, Latvia, Lithuania, Republic of Moldova, Romania, Serbia, and Ukraine, are expected to see their populations decline by more than 15 percent by 2050 (UN Population Division, 2015).

In the MDCs, demographic transition proceeded on par with internal economic development. But the decline of death rates in LDCs was more related to the rapid introduction of effective techniques of disease control by outsider agencies like the World Health Organization (WHO). Babies born in poor nations today have a historically unprecedented chance of surviving to adulthood, and the average life spans of nations' citizens have converged.

In LDCs, the story is very different. Their rapid transitional growth came later in the twentieth century without the benefit of territorial expansion—that is, without the relatively unpopulated land or colonies to absorb the pressure of population growth. In addition, they have had birth rates and levels of mortality much higher than European MDCs. As a result, LDC populations are growing rapidly, especially in the poorest of the poor nations. However, many LDCs are now low to intermediate fertility countries. Currently, about 46 percent of the world live in low-fertility countries, which include Europe, North America, 20 countries in Asia, 17 in Latin America and the Caribbean, 3 in Oceania, and 1 in Africa (UN Population Division, 2015). The largest low-fertility countries are the United States, China, Brazil, the Russian Federation, Japan, and Vietnam. Another 46 percent of the world's population live in intermediate fertility countries with the largest being India, Indonesia, Pakistan, Bangladesh, Mexico, and the Philippines.

Only 9 percent of the world live in high-fertility countries—21 to be exact. Of these countries, 19 are in Africa and 2 in Asia. Between 2015 and 2050 more than half of the global population growth is expected to occur in Africa, and after 2050, it is projected to be the only major area still experiencing substantial population growth. It is also in Africa where adolescent childbearing (births per 1,000 women aged 15–19) remains the highest at 98 per 1,000 women (UN Population Division, 2015).

Overall, most of the global increase in population between now and 2050 will come from high-fertility countries and those with a large population base. It is expected that half of this increase will occur in nine countries, listed here in order of total growth: India, Nigeria, Pakistan, Democratic Republic of the Congo (DRC), Ethiopia, Tanzania, the United States, Indonesia, and Uganda (UN Population Division, 2015). As you can see, with the exception of the United States, these are all LDCs.

Economic development—with its widespread improvement in living standards, improved education and opportunities for women, incentives for smaller families, and the establishment of national social security systems—has not kept pace in LDCs, and especially in the poorest, least developed countries like Ethiopia, the DRC, and Uganda. Often economic growth can be literally "eaten up" by exploding populations. Cultural and religious norms favoring large families are still powerful in high-fertility countries. The continuation of this demographic divergence between MDCs and LDCs into the next century may increase geopolitical tensions, pressure on migration and refugee flows, and a corresponding social and environmental duality among rich and poor nations. In many LDCs both rural and urban populations are growing rapidly, pressures on natural resources are increasing, and economic and technical resources are often overwhelmed as local and national governments try to provide employment for increasing labor forces and infrastructure for expanding cities, like electricity, clean water, and waste disposal. The divide between the MDCs and LDCs is demographic, but there are many other kinds of forces in operation.

POPULATION REDISTRIBUTION: URBANIZATION AND MIGRATION

So far, we have focused on population growth in terms of the dynamics of demographic transition. Another type of population change is *population redistribution*, meaning the net spatial changes in population as individuals and families move from place to place. The two most important forms of population redistribution are urbanization and migration. Both are related to the pressures of population growth.

URBANIZATION

Most North Americans now live in—and were born in—cities. While we may be attracted to the amenities of cities or curse their problems, we recognize that urban life is the cultural, economic, and political center of modern society. Urbanization, or the redistribution of people from the countryside, is not new but has dramatically accelerated with the explosive transitional growth just described. Compared to rural dwellers, urban dwellers made up only about 11 percent of the world's population in 1850, but 30 percent in 1950, and 48 percent in 2000 (UN Population Division, 2006). After the year 2008, the world passed a milestone when over half of its population was classified as urban.

Cities are, of course, nothing new. They emerged with the agricultural revolution, but those cities were not very large by today's standards. Ancient Babylon might have had 50,000 people, Athens maybe 80,000, and Rome as many as 500,000 (Weeks, 2008: 356). To put this in perspective, Rome, the premier imperial capital of much of the Mediterranean world and hinterlands beyond, was at its peak a bit smaller than Charlie's hometown of Omaha, Nebraska. Ancient cities were unusually dense settlements that were the political, ceremonial, and administrative centers in a diffuse "sea" of rural villagers. Villagers made up perhaps 95 percent of the total population of such societies, and their crops and livestock were the real sources of wealth, on which urban elites lived by imposing taxes. Ancient (and medieval) cities were neither economically nor demographically self-sustaining. Poor sanitation and the rapid spread of epidemic disease (the plagues of ancient and medieval worlds) meant that they had higher death rates and lower birth rates than the countryside. They often had an annual excess of deaths over births, which meant that they had to be replenished by migrants from the countryside. They were not demographically self-sustaining. Urbanization still presents many of the same problems, but they are more concentrated in LDCs (Potter, 2012).

URBANIZATION OF THE MDCs

Industrial era urbanization was fueled not only by expanding urban opportunities, but also by the push of rural overpopulation, poverty, consolidation of land holdings, and declining farm labor markets resulting from the industrialization of agriculture (noted in Chapter Two). As economic development proceeded in Europe and North America, cities grew because they were more efficient. They brought more raw materials, workers and factories, financiers, and buyers and sellers together in one location rather than dispersed in rural production. Furthermore, as industrial societies developed, evolving modes of production continually reshaped the economic base of cities from the commerce and trading centers of the 1600s and 1700s (e.g., Amsterdam, London, Boston) to those centered on factories and industrial production in the late 1800s (e.g., Birmingham, Pittsburgh, Chicago). Since World War II, improvements in technology and the growth of an economy based on "services and information" have meant that the economic base of many cities is no longer manufacturing but, more often, the corporate headquarter locations of far-flung multidivisional and multinational firms and banks (e.g., Minneapolis, Dallas–Fort Worth). Now the largest MDC cities, such as Tokyo, New York, and Los Angeles, are really "world cities" that produce wealth by organizing and controlling international trade, commerce, and finance. By 2011, at least 78 percent of people in MDCs lived in an urban area and by 2050 an estimated 86 percent will be urban (Potter, 2012). The greatest change, however, is occurring in LDCs.

URBANIZATION OF THE LDCs

In 2011, the number of LDC residents living in an urban area stood at 46 percent and by 2050 it is projected that 64 percent will be urban (Potter, 2012). The two regions within the developing world that will see the greatest increases in urbanization by 2050 are Africa and Asia. The main characteristic of Asian urbanization is growth in *megacities* (containing more than 10 million inhabitants). By 2025 the total number of megacities in the world is expected to rise to 37, with 21 in Asia (Potter, 2012). In 1950, only two of the 10 megacities (Shanghai and Calcutta) were located in the LDCs. By 2011, only Tokyo and New York City were among the 10 top megacities, the rest were in the LDCs (Potter, 2012).

As in the MDCs in an earlier era, the explosive urbanization in the contemporary LDCs is fueled by the poverty, hunger, and destitution of peasants pushed off the land and also by the less visible but powerful forces of high birth rates and population pressure. But there are two fundamental differences between the two eras. First, MDC urbanization was also accompanied by the pull of exploding economic opportunities in the industrializing cities. Second, the speed of urbanization is vastly different. It took 150 years for Europe to go from 10 percent urban to 50 percent urban whereas Asia's enormous population is expected to urbanize in 95 years becoming majority urban by 2025 (Potter, 2012). Urbanization in the LDCs is largely a matter driven by rural poverty without the simultaneous pull of dynamic urban economic growth. In other words, the LDCs have developed very rapidly in the post–World War II period, but they have skipped the prolonged period of industrial and manufacturing economic growth the MDCs experienced. LDC cities are unable to keep pace with such rapid change and struggle to provide infrastructure for sanitation, clean water, solid waste removal, and safe housing.

Consequently, large numbers of the urban masses live in slums—places that lack clean water, sanitation, durable living space, and security of stable housing. According to UN HABITAT 2010 data, about 828 million people, or one in three LDC residents, are deemed slum dwellers. Unfortunately, the numbers are expected to grow by about 6 million dwellers a year. The WHO declared the rapid rise in slum populations to be one of the most important issues affecting global health (Potter, 2012). As depicted by Davis in *Planet of Slums* (2007), the exponential growth of slums is driven by population growth, in combination with corrupt leadership, the failure of institutions, and the imposition of the "structural adjustment policies" of the International Monetary Fund (IMF)—which pressured poor nations to use their precious money to pay international debts rather than to invest in urban infrastructures and human well-being. The resulting world urban proletariat—disconnected from industrialization and significant economic growth—is a new development not foreseen by classical Marxist or capitalist (neo-liberal) economic theory. It has resulted in a massive transfer of wealth from the poor to the rich and urban futures that look radically unequal and explosively unstable.

MIGRATION

Urbanization is really a special form of *migration*, which means the relatively long-term movement of an individual, household, or group to a new location outside their community of origin (de Blij, 1993: 114–115). Being cultural foreigners and new claimants for existing jobs and services, their presence in new host communities is usually contentious and difficult. At the same time, internal and international migration can result in positive economic and social outcomes as they are a means of rebalancing labor markets. Countries experiencing low or negative population growth need new workers to support an aging population, while countries with large numbers of young people need jobs. Migrants may send remittances (money) to their nonmigrant kinfolk back home. Migration is also a way for new ideas and technologies to spread (UN Population Division, 2015). Indeed, you need to understand migration as not only the numerical redistribution of people, but also a pervasive *social interaction process* that diffuses and reshapes human cultures—and the distributions of power and wealth.

Migration may be *forced*, as in the case of prisoners that the British shipped to penal colonies in Georgia and Australia. Clearly, it was the case of the African slaves dispersed throughout the New World. Internal migration can also be forced. The Indian Removal Act of 1830 mandated the eventual expulsion of the eastern tribes to Indian Territory west of the Mississippi, to what is now Oklahoma. In 1838 about 17,000 Cherokees were forced to march through the winter to the new territory, known as the "Trail of Tears," as nearly 8,000 died along the way (Snipp, 2012). Migration may also be *voluntary*, as in the case of most Europeans who came to North America in the late nineteenth and early twentieth centuries seeking material improvement and greater opportunities. While they were attracted by better opportunities, many were also fleeing rotten conditions in their homelands. The Irish immigrants to Boston and New York came to escape poverty, famine, and environmental degradation (remember the Irish potato blight and subsequent famine mentioned in Chapter One?). Others fled from wars or political and sometimes religious oppression. The record of historical migrations provides lessons for contemporary migrant flows.

In sum, the legacies of voluntary and involuntary migrations across the globe have shaped contemporary social, political, and economic conditions that are also connected to the environmental landscapes occupied by diverse groups. For instance, in Chapter Three we looked at the unique vulnerabilities and adaptive capacities to climate change impacts faced by indigenous peoples who have a history of being pushed to live in more marginalized natural environments (Wildcat, 2014). Today, we usually think of *internal migration* as "free" in the sense that people are choosing to move in relation to their perception of better living conditions elsewhere. However, internal social and political conflict, and environmental and climate-related disasters, are causing more people to be forcefully internally displaced from their homes and communities either for the short term (weeks to months), long term (more than a year) or even permanently. *International migration* is sometimes free, but today it means stringent entrance requirements must be met. The people who internationally migrate tend to have greater resources than those who migrate internally, or those who migrate illegally, without documents.

EXPLAINING MIGRATION

The most common theory about the causes of migration is what demographers and geographers have called the *push-pull theory*, which says that some people move because they are pushed out of their homelands, while others move because they have been pulled or attracted to a new place. In reality, a complicated mix of both push and pull factors operate jointly to impel migratory behavior. Pushes can include poverty and lack of economic opportunity; fears for personal safety; political, cultural, or ethnic oppression; war, including civil war; and natural disasters such as droughts and floods. Often underlying the push of these concrete factors is population pressure from rapid growth. The pulls are the mirror image of these and are likewise complex: the perception of better economic opportunities, greater social stability, and affiliation (desire to join relatives and friends). At any rate, social science conjures up the migrant as a rational decision maker who calculates the costs and benefits of either pulling up stakes and moving or staying put. This thesis was posed as long ago as 1885 by British demographer Ernest Ravenstein, who studied internal migration in the British Isles (1889).

The common characteristics shared by the emigrants that Ravenstein found are the same today: they are younger than nonmigrants; they are less likely to have families, or if they do, they have fewer and younger children; and they are likely to be better educated (Weeks, 2008: 285). In fact, voluntary migrants are a select population, usually more talented, capable, adaptable, and ambitious than nonmigrants. In addition to personal characteristics such as these, the push-pull causes of migratory behavior are also conditioned by intervening factors or barriers. These include the costs of moving, lack of knowledge about migration options or managing complicated moves, broad themes of the sociocultural environment like established values about the importance of geographic "roots," risk taking, and openness to change. As you can see, in spite of the simple attractiveness of the push-pull thesis, the actual situation is quite complicated and not simple to predict. (See De Jong, 2000, for an ambitious effort to conceptualize the complex causes of migratory behavior.)

OLD AND NEW PATTERNS OF GLOBAL MIGRATION

We do not know exactly how many persons have migrated around the world at any given time, but beginning with the modern era (in the 1500s) there were discrete waves of immigration involving particular locations that accounted for the greatest volume of immigrants. One such stream, you are aware, virtually *constituted* the nations of North America. Except for Native Americans, the citizens of the United States, Canada, and Mexico are *all* descendants of immigrants from somewhere else. In the US, immigrants from Europe (and particularly Britain) were always more welcome. By the 1920s concerns about the flow of "unsuitable" non-Anglo-Saxon immigrants became so great that laws were passed establishing quotas by nations, severely restricting non-European immigration as well as flows from Southern and Eastern Europe.

Before World War II, the main currents of migration were out of the more densely settled regions in Europe and Asia and into North and South America and Oceania. Since the 1960s, that changed so that the net migration flows were back into Europe, out of South America and Asia, and into North America, but increasingly from non-European nations. The pressure of rapidly growing LDC populations since World War II enormously increased the pressure on natural resources and the demands for employment and social services, while in the MDCs a slowly growing population and buoyant economic growth often created a demand for lower-cost workers from the LDCs. Thus "guest" workers flowed into northern Europe from nearby Algeria, Egypt, Turkey, and the Middle East as well as from comparatively less developed southern and Mediterranean Europe and from Eastern Europe. This pattern is not expected to change much between 2015 and 2050. The net receivers of international migrants of more than 100,000 annually are projected to be the United States, Canada, the United Kingdom, Australia, Germany, the Russian Federation, and Italy. While India, Bangladesh, China, Pakistan, and Mexico will undergo net emigration of more than 100,000 annually. Often overlooked are the flows of people between developing countries (UN Population Division, 2015). For instance, did you know that the majority of refugees are hosted by developing countries?

It is likely you have seen some of the desperate images of people fleeing their country by foot, rail, air, and sea. Some are crammed together and smuggled in trucks and ships, and some do not survive the journey. As always, floods of immigrants create conflict and controversy as they raise questions about the political and cultural coherence of nations. As you know, in the United States and many European nations, immigration and the acceptance of refugees have triggered volatile political controversy. But as the United States and Europe, among others, are learning, it is very difficult and costly to stem the tide of desperate people.

After WWII the UN High Commissioner for Refugees (UNHCR) was formed to protect human rights. They oversee relief provided to forcefully displaced persons covered under Article 1 of the 1951 Convention Relating to the Status of Refugees. The Refugee Convention determines the classification of "refugee" status, the rights of the displaced, and the legal obligations of states to protect them. Today, the UNHCR recognizes four groups of forcefully displaced persons. First, *refugees* are persons displaced

In 2011, the Arab Spring inspired protests in Syria, led to a violent government crackdown that spawned a civil war. Since the war began, half the pre-war population of 11 million have been killed, or forced to flee their homes, sparking a refugee crisis. More than half of the Syrian refugees are under the age of 18 (to learn more see, www.mercycorps.org/articles/iraq-jordan-lebanon-syria-turkey/quick-facts-what-you-need-know-about-syria-crisis).

iStock

Figure 5.4

from their home country by generalized violence, conflict, persecution, and other human rights violations. Refugee status implies international migration. Second, *asylum seekers* are persons who have applied for refugee status. Third, *internally displaced persons* (IDPs) remain within the borders of their home country, but cannot safely live in their home community or region. Fourth, a special group of refugees are Arab-Palestinians. Due to their large numbers and unique situation, the UN Relief and Works Agency (UNRWA) was established in the aftermath of the 1948 Arab–Israeli Conflict to provide relief to the Arab-Palestinians (750,000) that were expelled from their homes to the West Bank, Gaza Strip, and neighboring countries. The patrilineal descendants of the originally expelled Palestinians are covered today under the UNRWA.

As noted in previous chapters, the world is seeing more people displaced due to environmental and climate-induced harms and disasters, as well as development projects, such as hydroelectric dams, industrial facilities or biofuel plantations (Ciplet et al., 2015; Renner, 2013). People displaced by disaster or development are not covered under the Refugee Convention, or any other international law. Thus, they are mostly internally displaced, but do not qualify for assistance from the UNHCR. They also are disproportionately in LDCs, but certainly not isolated to them as Hurricane Katrina, and Super Storm Sandy (displaced 1.1 million in US and Cuba) both devastatingly demonstrated. The Internal Displacement Monitoring Centre (IDMC) in Geneva has tracked the number of people displaced by rapid onset disaster (floods, storms, volcanic eruptions, wildfires, and landslides). This definition of rapid onset disaster does not include people internally displaced by drought, which happened in Syria during 2006–2009 (see Chapter Three). The numbers of persons displaced by development is estimated to be 15 million, although some organizations have higher estimates (Renner, 2013; IDMC, 2016). Table 5.1 displays the UNHCR/UNRWA categories of displaced persons worldwide in 2015 as well as estimates of disaster and development displacement by the IDMC.

Table 5.1 Displaced Persons, 2015 (million)

Refugees	16.1
Palestinians (UNRWA)	5.2
Asylum Seekers	3.2
Internally Displaced	40.8
Total	**65.3**
Disaster-displaced	19.2
Development-displaced	15
Total	**99.5**

Source: UNHCR (2016) and IDMC (2016).

Most disturbingly, the UNHCR saw displacement rise to a record high of 65.3 million in 2015 (5.8 million more people than the year before). This is the greatest number of displaced people since the aftermath of WWII! More than half (54 percent) of all refugees worldwide came from three countries, Syria, Afghanistan, and Somalia. In 2015, developing countries hosted 86 percent of the world's refugees, and the least developed countries hosted about 26 percent. Globally, the top five host countries were Turkey, Pakistan, Lebanon, Iran, Ethiopia, and Jordan. It is important to see that the internally displaced are the largest group. They are an especially vulnerable group because they are seeking relief by a government that may be the source of the conflict they have fled and this group is difficult for international agencies to reach. You can also see how the total number of displaced persons grows when estimates of disaster and development displacement are included. The number of disaster-displaced varies quite a lot from year to year. For instance, in 2012, an estimated 32.4 million were disaster-displaced (Renner, 2013). Disaster-displacement overall is expected to rise in coming years due to population growth in places that are most vulnerable to climate change impacts and extreme weather events and where housing is substandard (Renner, 2013). This means that parts of Africa and Southeast Asia are especially vulnerable. World leaders are starting to acknowledge that a coordinated international mechanism is needed to deal with environmental and climate "refugees," but action has been slow at best. This is also why

BOX 5.1

CLIMATE "REFUGEES" IN BANGLADESH

An estimated 200 million climate refugees are predicted by 2050 worldwide and somewhere between 15 and 30 million will likely be in Bangladesh. Even though Bangladesh only emits 0.4 metric tons of carbon per capita (the US emits 17), it will be one of the most impacted countries by a 2 degree C global average temperature rise. Its capital city, Dhaka, has ranked the fastest growing megacity in the world with about 17 million inhabitants. By 2025 it is predicted to be home to around 20 million! Climate change is fueling more extreme weather events, floods, and droughts in Bangladesh. Saltwater intrusion into the low lying coastal and rural areas is impairing freshwater for drinking and agriculture. An estimated 500,000 people internally migrate from rural areas to Dhaka every year, with about 70 percent of the city's 3.5 million slum dwellers migrating due to climate-related events. Dhaka relies on groundwater, which is being depleted by over-pumping by about 3 meters a year. In turn, groundwater depleted over the long term can cause the ground to sink, increasing the risk of flooding and saltwater intrusion. Tensions run high in Dhaka, as chronic water shortages cause protests during the summer months. Tensions also run high between Bangladesh and its neighbor India, which has been busy building a barbed wire fence on their shared border to curtail *illegal* immigration (Banerjee, 2010; McPhearson, 2015; Rana, 2015).

You can watch *Bangladesh Documentary Climate Change* at www.youtube.com/watch?v=RMcEF-6A0f0.

the most vulnerable countries have fought for reliable adaptation funding and loss and damage compensation in climate negotiations (see Chapter Three).

POPULATION, ENVIRONMENT, AND SOCIAL STABILITY

We have discussed types of population change—growth, urbanization, and migration—in some detail. Now we would like to summarize their relevance as hypothetical causes of environmental problems. It has been argued since the time of Malthus that the tremendous population growth of modern times has damaged the environment. It has done so by increasing demands for food, water, energy, and natural resources; most think that this problem will become increasingly acute as the world population increases to 9 or 10 billion. Recall the discussion of soil erosion and water problems in Chapter Two. Population pressure contributes to both migration and urbanization so that the environmental impact of population growth is not evenly distributed. Problems are particularly acute in urban areas where the air, water, and land cannot absorb the wastes and toxic by-products of industry and dense populations. Other than problems of population density, the very *location* of cities causes environmental hazards. Because urban populations and industries need lots of water, they tend to be located along lakes, rivers, and bays. As a consequence, rivers like the Missouri, Mississippi, and Ohio; lakes like Erie and Michigan; and bays like the Chesapeake and New York Harbor become badly polluted (Eitzen and Baca Zinn, 1992: 101). Finally, by creating chaos and hardship in the LDCs, population growth will further accelerate the streams of internal and international migration. However enriching immigration is in the long term, at a given time host nations and communities will find it a socially and politically disruptive burden. Evidence suggests that large flows of refugees are associated with social disruption and civil violence (Homer-Dixon, 1996). This is particularly so when the world economy is sluggish. It is a fantasy to think that because of the demographic divide just noted, the problems associated with population growth will be "contained" in the LDCs. Like it or not, much of the global South is coming to live with us!

In sum, many demographers and ecologists argue that population growth threatens global social stability, human material well-being, and environmental integrity. Population growth may effectively overwhelm the carrying capacity of the planet. That, at least, is the *demographic* and *neo-Malthusian* interpretation of things. But, as noted earlier, it has been a controversial and contentious point of view since the time of Malthus. Many scholars, then and now, have found it fundamentally flawed. How so?

HOW SERIOUS IS THE PROBLEM OF WORLD POPULATION GROWTH?

Most contemporary objections to the Malthusian theory were raised 150 years ago. One of his contemporaries, French political economist Condorcet, foreshadowed contemporary technological optimists by arguing that scientific advance would offset diminishing returns. Condorcet said: "New instruments, machines, and looms can add to man's strength … [and] improve at once the quality and accuracy of man's productions, and can diminish the time and labor that has to be expended on them.… A very small amount of ground will be able to produce a great quantity of supplies … with less wastage of raw materials" (Condorcet, 1795). Then as now, the dominant currents of economic thought discounted natural resource constraints (including population size) to emphasize the adaptability of market-induced substitution and innovation. In another classical objection to Malthusian views that foreshadowed modern objections, Nassau Senior asserted that improved living standards for the poor would not lead them blindly to expand their numbers but to restrict their fertility in order to preserve the gains they had realized (Hutchinson, 1967). So you can see that even though his book was a bestseller for decades, then as now Malthus got it from all sides (Poor Tom!). Even so, scholars have been unable to dismiss completely his haunting forecast of an impending demographic apocalypse.

Few debates in the social and natural sciences have been as heated or protracted as this one about the consequences of population growth. In contemporary discourse, there are three broad positions (the same paradigms that have been referred to since Chapter One). *One* argues that population growth is a severe threat, perhaps *the* most significant underlying cause of environmental degradation and human misery. The *second* argues that population growth is not an important threat because markets will allocate scarce resources and stimulate efficient innovations. A more recent variant of this position, termed *supply-side demography*, argues that population growth may in fact be a benefit because the historical record demonstrates that as world population has grown, human welfare has improved: The more people, the better. The *third position* argues that human misery and environmental problems are caused by maldistribution that results from the operation of social institutions and economic arrangements (global and national inequality, poverty, trade policies, high prices, wars, environmental destruction and climate change) rather than population growth per se. This argument, in effect, turns the tables on Malthus, arguing that structurally induced misery causes both population growth and environmental deterioration, rather than the other way around. Let us elaborate.

NEO-MALTHUSIAN ARGUMENTS

The standard ecological neo-Malthusian perspective is that population growth causes human misery and environmental degradation. This has been the position of many demographers, but particularly of biologists, ecologists, and natural scientists (Ehrlich and Holdren, 1974; Ehrlich and Ehrlich, 1992). Some predictions of global demise have been concrete and dramatic. In 1968, Stanford University zoologist Paul Ehrlich wrote, "The battle to feed humanity is over. In the 1970s the world will undergo famines—hundreds of millions are going to starve to death" (cited in Stark, 1994: 558). There were indeed famines and widespread malnourishment in the 1970s in particular parts of the world, such as Sub-Saharan Africa. But nothing on the magnitude predicted, and global food production continued to outstrip population growth.

Modern history has not been kind to the neo-Malthusians, who have been arguing that "the wolf is at the door" routinely since the 1940s. But the wolf has—so far—failed to materialize. *Or has he?* Neo-Malthusians don't believe that one actually dies from overpopulation, but from other, more concrete causes (disease, war, malnutrition, or famine). They argue that the doubling of the world's population in about one generation is the broad underlying cause of the stress placed on the global environment and human well-being, even though it is manifest in more concrete causes. For example, population growth helps widen income disparities among nations. In the past 20 years, the LDCs as a group have actually raised total economic output more rapidly than have the MDCs. But many of these gains have been offset by higher population growth rates. In per capita terms, the relative gap has narrowed negligibly, while the absolute gap has widened substantially. Compare India and the United States from 1965 to the mid-1980s. Total GNP grew significantly faster in India, but because population grew twice as fast, India's average annual per capita income growth was 1.6 percent, slightly less than that of the United States, 1.7 percent (Repetto, 1987: 13). As population has mushroomed, so have wars. The number of armed conflicts around the world has grown from 12 in 1950 to an all-time high of 50 in 1991, and declined to 25 in 2005 (Renner, 2007–2008: 112). Most were intrastate conflicts, but often having international dimensions and involvement, such as Iraq, Somalia, and Syria.

Neo-Malthusians do not think that other factors (drought, poverty, wars) are unimportant sources of environmental or social stress, only that population growth must be considered primary. If, they think, all other factors could be made environmentally neutral, population growth of this magnitude would still spur resource social stress and environmental degradation (Stern et al., 1992: 76–77). Indeed, they argue that once population has reached a level in excess of the earth's long-term capacity to sustain it, even stability and zero growth at that level will lead to future environmental degradation (Ehrlich and Ehrlich, 1992). These scholars believe that, indeed, there is a carrying capacity and that in the long run, it applies to humans as it does to the bacteria in a petri dish. At some point, there are limits to the physical capacity of the planet to sustain growth.

ECONOMISTIC ARGUMENTS

Neoclassical economic theory maintained that population growth is not a problem, and may be a source of progress (Boserup, 1981; Simon, 1990). It argues that population growth—and other resource problems—stimulates investment in increased efficiency, resource substitution, conservation, and innovation. When resources become scarce, well-functioning markets encourage people to allocate them in the most efficient ways and protect them by raising the price. It is a fact that in the long sweep of human history, population growth has been correlated with growing, rather than declining, resources—as well as with improvements in human health, longevity, and well-being. Today, more people live longer and better than when the human population was much smaller. Even in the rapid post-World War II population explosion, global food production always outstripped population growth. Contrary to neo-Malthusian expectations, shortages—whether the result of population growth, increased consumption, or environmental problems—have left us better off than if shortages had not arisen.

The reason is that the accumulating benefit of intellectual inventiveness (human capital) met and overcame the challenge of shortages. We have found human-made substitutes for natural resources and more abundant natural resources for scarce ones, and we have invented technologies that allow more efficient use of the resources available. Neoclassical economists argue that finding substitutes for scarce natural resources is likely, and they rely on the ability of markets to respond effectively to resource scarcities. In this view, the cause of problems is not growth, but policies and market failures that do not price things realistically and that subsidize waste, inefficiency, and resource depletion. You get what you pay for, and you lose what you don't pay for. Neoclassical economists argue that the neo-Malthusians ignore the role of markets in generating adjustments that bring population, resources, and the environment back into balance (Simon, 1998).

A newer variety of this argument, termed *supply-side demography*, maintains that population growth is not a problem, but a positive benefit (Camp, 1993). In contrast to the Malthusian view of diminishing per capita resources over time, the holders of this view argue that the ultimate resource is human inventiveness, which itself accumulates over time as populations grow, and has multiplied resources as they are available to people. A wide range of illustrations can support this view. When a shortage of elephant tusks for ivory threatened in the last century, celluloid was invented, followed by the rest of our plastics. When whales were almost hunted to extinction in the nineteenth century to produce oil for lamps, petroleum distillates such as kerosene were substituted to fuel lamps and thus created the first petroleum industry. Englishmen learned to use coal when trees became scarce in the sixteenth century. Satellites and fiber optics (derived from sand) replaced expensive copper for telephone transmission. Importantly, the new resources wind up cheaper and more plentiful than the old ones were. Such, it is argued, has been the entire course of civilization (Simon, 1990). To neoclassical economists, the notion of a human carrying capacity is a static population–resource equation that conceals more than it reveals and has no empirical validity. It ignores technical inventiveness and market allocation. Counterintuitive as it may seem, as populations grow, resources multiply rather than become scarce (Simon, 1998). Rather than stressing a finite resource base, it is more correct to recognize that 10,000 years ago only 4 million humans could keep themselves alive, but by the nineteenth century the earth could support 1 billion people and today it can support more than 7 billion. In this view the unique potentials of humans make them almost *exempt* from the physical limits of the earth.

INEQUALITY ARGUMENTS

The inequality (or stratification) argument maintains that human misery and environmental degradation, as well as population growth, are caused by vastly unequal social structural arrangements. This is a more complex and nuanced argument. It is favored by neo-Marxists, but also by a wide variety of other social scientists and sociologists, economists, agronomists, and some biologists. Unlike the neoclassical economists, they argue that population size *is* a problem. It's just that Malthusians have gotten the causation wrong. Their argument is global political and economic structures and inequality cause population growth, human misery and environmental problems rather than the other way around. They argue, for example, that instead of rapid population growth stalling economic development, economic stagnation in the LDCs is caused by poverty, inequitable trade policies, and ongoing dependencies. In other words, continued LDC poverty is maintained by the undemocratic operation of the global economy, and in a condition of deep poverty and stalled development that provides few incentives for smaller families. Children help take care of the elderly who have no retirement, provide needed farm and household labor and other economic support at little added expense to the household (Bell and Ashwood, 2016). High childhood and maternal mortality rates in poor countries further incentivize having large families. Thus, the final act of the world demographic transition is delayed by stalled economic development in the LDCs, not overpopulation.

Those ascribing to neo-Malthusian arguments have tended to support draconian population control policies that coercively enforce birth control, abortion, or even sterilization of people in LDCs (and the poor in MDCs), similar to China's one-child policy. Biologist Barry Commoner (1992) challenged neo-Malthusians' call to limit population growth in developing countries, arguing that on the whole, advanced technology and affluent lifestyles are more environmentally damaging than growing numbers of people. It is not, for instance, the indigenous people and subsistence farmers who are destroying the world's rainforests. It is the lumber companies, large cash crop estates, mining companies and consumerism of the MDCs.

Similarly, others argue that neither malnutrition nor periodic famines in which people actually starve are produced by population growth. The most direct cause of hunger is not too many people, but the lack of money and high food prices. At the *system level* of analysis, hunger and malnutrition are most directly caused by the political-economy of agriculture, which refers to patterns of land holdings, and the structure of global trade, that favor large-scale industrial agriculture, and concentrate wealth in the hands of the few (Norse, 1992; Lappé and Collins, 2015). Globally, the LDCs export more agricultural products and water—virtual water (discussed in Chapter Two)—to the MDCs than they receive in food aid or agricultural subsidies. Consequently, a large portion of the world's population remains stuck in poverty and often hungry (Buttel, 2000a; Lappé and Collins, 2015).

The image of hunger most people are familiar with is of an African child. Indeed hunger and food insecurity is a grave problem in many places in Africa. However, Lappé and Collins (2015) offer a convincing argument that this is not because the African population is outstripping its resource base, but rather it is the result of anti-democratic decision making in multiple spheres of life (family, economy, education, government) and at all levels—local, regional, national, and international. Lappé and Collins point to the fact that between 1990 and 2013 food production in Africa outstripped population growth by 22 percent, not too far from the global average of 29 percent. During the same time period in Sub-Saharan Africa, food production rose by 10 percent while chronic hunger increased by 22 percent. What is happening? Here is Lappé and Collins's answer:

- Land grabs by foreign interests in agriculture and biofuel production displace small farmers and local people to more marginal land (see Chapter Two).
- African governments do not invest in resources that help small and local farmers, such as extending farm credit, building roads, and crop storage facilities (see Chapter Three's discussion of the consequences of drought in South Africa).
- Government resources back export crops as they did during colonial times. For example, in the Ivory Coast, the best cropland is used to grow cocoa and coffee for export while 30 percent of its children are *stunted*.[2] Foreign aid also supports export crops by funding large-scale projects rather than small farmers or pastoralists.
- Small farmers are discouraged from local food production because governments keep food prices low to appease urban consumers, and countries like the US who overproduce grain crops "dump" their surplus on African markets.
- MDC food corporations have shifted urban tastes for food. This is causing African countries to import more food from industrial countries.

Lappé and Collins's conclusion that undemocratic governments and markets are responsible for human misery and hunger, not population growth, is congruent with past research on massive famines (Sen, 1993). Famines do not simply happen overnight, but rather they are most often the end result of a long saga of corruption, local social norms that reinforce inequalities, and the conflict and violence these forces unleash.

The inequality perspective also has recognized the link between gender inequality, poverty, and high fertility rates. The World Bank estimates that 50 percent of households globally are headed by women. Yet, women are overrepresented amongst the world's poor and face barriers of discrimination of varying degrees. As such, the majority of the world's hungry are women and children (Lappé and Collins, 2015). Women have unique experiences with environmental stressors and problems that are often overlooked. Women and children are especially vulnerable to disaster and development displacement. In 2015 half of the world's refugees were children (UNHCR, 2016).

Poverty produces few incentives to delay childbearing or limit family size as children may be essential to meeting household needs. Perhaps more importantly, children are the primary means by which poor women acquire status and sense of meaning in life. Poverty also perpetuates a vicious cycle between environmental degradation and population growth. Poor households are often virtually forced to overuse natural resources daily for subsistence. Thus, desperate farmers grow cassava and maize on highly erodible hillsides. Rural households in fuelwood-deficit countries strip foliage and burn crop and animal residues for fuel rather than using them for fertilizer. This practice also contributes to desertification, since land stripped of trees and plant residues is less likely to hold moisture. Underemployed men in coastal villages overexploit already depleted fisheries (Repetto, 1987: 13). Furthermore, climate change amplifies the pressure of human population on the natural environment. In turn, increased environmental degradation intensifies social and economic hardships.

Controversy about the significance of population growth is not, and never has been, just an academic one. Population issues are so important that the UN has organized several international population conferences. At the 1994 International Conference on Population and Development in Cairo, governments agreed to an ambitious agenda to promote population stabilization. Also, the UN in 2000 established the Millennium Development Goals (MDGs), which incorporated many of the policy suggestions made by the advocates of the inequality perspective. MDGs has focused on: (1) reducing poverty and hunger, (2) achieving universal primary education, (3) promoting gender equality and empowering women, (4) reducing childhood mortality, (5) improving maternal health, (6) combating major health threats like HIV/AIDS and malaria, (7) ensuring environmental sustainability, and (8) developing global partnerships for development (learn more about the MDGs at www.un.org/millenniumgoals).

MAKING SENSE OUT OF THIS CONTROVERSY

If you are a bit confused about the complexity of these issues, you are in good company. They begin to become clearer by recognizing that, like some of the controversies previously discussed, they are not only about facts, but different paradigms.

Physical scientists and ecologists—and many demographers—see the world in terms of problems of growing scale in a world with physical limits. In contrast, neoclassical economists see the world as a largely mutable system of possibilities, because of human technical inventiveness and also because of the capacity of market allocation to adjust to scarcities and stimulate resource substitution. They argue that ecologists simply fail to appreciate the magic of the market.

Ecologists retort that economists miss entirely the environmental "debts" that growth incurs which results in a delayed form of deficit financing. Those who fail to recognize the ultimate physical limits of the planet, says ecological economist Herman Daly, are "treating the earth as if it were a business in liquidation" (in Brown, 1991: 9).

Inequality and stratification arguments are similar to economic ones because they emphasize the importance of human social factors rather than natural limits as causes. But proponents of this view are like the ecologists in seeing both exponential population growth and environmental degradation as real problems. Briefly, in understanding the relationships between population growth and human and environmental problems, neo-Malthusian arguments emphasize *scale issues*, neoclassical economic arguments emphasize *market allocation issues*, and inequality arguments emphasize *distribution issues*. Although these paradigms have very different views of the way the world works, they are each partial—and not necessarily mutually exclusive. It is possible to reconcile some of their differences.

Considering the broad sweep of human history, the neoclassical economists and technological optimists have a better factual argument. There were, to be sure, particular times and cases where population growth contributed to environmental and social disasters, particularly in the preindustrial world. But, in the industrial world as a whole, technological progress has always outrun the pressure of population growth. In sum, the neo-Malthusians have always been wrong about a global demographic disaster: The wolf never *was* really at the door.

In its own way, however, the neoclassical economic paradigm is as static and ahistorical as the physical science notion of fixed limits. It posits an unchanging linear relationship between population size and the ability of technological innovation and markets to overcome problems. It fails to recognize that the enormous *growth in scale* of the human population since World War II has put us much closer to absolute physical planetary limits than ever before in human history. To put it in economic terms, the elasticities of substitution between natural and human-made resources are historically quite variable and are now declining. *Elasticities of substitution* simply ask how much human technical capacities can stretch (are "elastic" enough) to surmount natural limits. If it is high, there is no problem; but if elasticity is low, then beyond a certain point, human inventiveness is not enough to overcome resource limits. We have argued that it is higher in industrial than in preindustrial societies, but is now declining because of absolute population growth and accumulated environmental damage.

Furthermore, there are physical limits beyond which *no* substitution is viable. Wheat, for example, cannot be grown with only labor, or without water. The enormously large world population—like about 9 billion by 2050—means we will have fewer options, less maneuvering room, a more degraded resource base, and less ability to absorb and recover from environmental damage than ever before in history. We may face an "ingenuity gap." That is, the dependability of economic and technological capabilities diminishes relative to the threats of scale posed by the present and future population size. Ecological neo-Malthusian theory should be taken more seriously because the population–environment equation is historically dynamic. The wolf is not yet at the door, but he's certainly in the neighborhood and a lot closer than he was as recently as 100 years ago!

The conflict between neo-Malthusian and inequality arguments is more apparent than real. Neo-Malthusian arguments are more persuasive in the abstract and on the long-term horizon. But stratification arguments are more convincing explanations of human misery and environmental degradation in the concrete here and now. In other words, things like hunger, poverty, and water pollution are more directly and concretely caused by social, political, and economic arrangements than by the underlying specter of overpopulation. Whether you prefer a demographic or a stratification argument may depend on whether you prefer more direct and concrete or more distant and underlying causes. It also depends on whether you emphasize short- or long-term time spans. But as you can see from the foregoing, they do have very different policy implications for how human and environmental problems are addressed.

Finally, contrary to the arguments of the new "supply-side demography," most responsible scholars now believe that in general more people is not necessarily better and quite probably worse. The most damaging evidence came from a review of existing evidence from a panel of experts of the National Research Council (within the National Academy of Sciences), who found little evidence that "lower population densities lead to lower per capita incomes via a reduced stimulus to technological innovation, efficiency, and economies of scale." Regarding the LDCs, the panel concluded that "slower population growth would be beneficial to economic development for most of the developing world, but … a rigorous quantitative assessment of these benefits is context-dependent and difficult" (National Research Council, 1986: 90). In sum, there is a large consensus that virtually all current and future problems with resource supplies, human material security, and environmental integrity would be easier to deal with if world population growth gets slowed more rapidly and stabilized at a lower "equilibrium number" (Repetto, 1987; National Research Council, 1986). It is important, however, to understand this viewpoint because it is tied to assumptions about how to meet the growing demand for food and resolve contemporary environmental problems.

In sum, the emerging consensus among demographers and environmental scientists is that population growth is one among many causes of human misery and environmental deterioration, but not the only one. This is a more complex and nuanced consensus than any of the broad paradigms described earlier.

POPULATION, FOOD, AND HUNGER

Because population growth and food security are tightly intertwined issues that Reverend Malthus speculated so much about 200 years ago, we will take a closer look at the scope of current conditions. To begin, the UN Food and Agriculture Administration (FAO) reports the number of chronically hungry worldwide in 2015 to be about 800 million, a *45 percent decrease* from 1990. They also report that 72 out of 129 countries that have been monitored met the UN Millennium Development Goal to cut the numbers of hungry in half by 2015 (FAO, 2015). Given that population has grown during this time, this is exceedingly good news! However, the FAO's criteria for chronic hunger are limited as it only measures calorie deficiency. Also, it only registers calorie intake over the course of a year so if a person's calorie supplies were sufficient for the year, they are not counted as experiencing chronic hunger. That same person could have experienced periodic or short-term calorie deficiency, which can cause significant health problems. In many developing countries, periodic hunger such as the time period between harvests, or temporary employment, is not uncommon. Nonetheless, based on the FAO's measure, chronic hunger is not just a problem in the developing world; 15 million people suffer from chronic hunger in MDCs. The US has adopted a broader measure of food insecurity, taking into account if someone is unsure when they will eat next. By this criterion one in six Americans are inflicted with food insecurity (Lappé and Collins, 2015).

Earlier versions of this book described global food consumers as comprising three levels or tiers. This picture has changed due to intensified globalization and urbanization. Let us illustrate. *At the bottom* the numbers of chronic hungry have declined, as previously noted, but still too many people are unable to provide themselves with a healthy diet. While chronic hunger may not be as grotesquely visible as massive famine, its consequences are nonetheless devastating. In children it delays physical maturity, impairs brain development, and reduces intelligence, even if replaced by an adequate diet later on. Malnourished adults are unable to work hard or long and have lower resistance to diseases. The danger of epidemics is always high in overpopulated and underfed areas. The *middle level* in the 1990s contained large majorities in the developing world who mainly ate grains, got enough calories and plenty of plant-based protein, giving them the healthiest basic diet in the world. They typically received less than 20 percent of their calories from fat, a level low enough to protect them from the consequences of excessive dietary fat (Brown, 1994). The numbers in this category have decreased substantially as the demand for meat, dairy, and Western processed foods has grown. The rate of increase for overweight and obesity is now 30 percent higher in the low- to middle-income LDCs (WHO). China had been in the middle tier in the 1990s, but by 2013 was the leading global producer of meat (Renner, 2014a).

Table 5.2 Water to Produce Food (liters per kg)

Potatoes	500
Wheat	900
Maize (corn)	1,400
Rice	1,910
Soy beans	2,000
Chicken	3,500
Beef	100,000

Source: Pimentel as cited in Pearce (1997, p.7).

In the 1990s, *the top* was the smallest portion of the world's population, heavily invested in meat-based diets, mainly in Europe and North America, who obtained close to 40 percent of their calories from fat (three times that of the rest of the world's people) (Brown, 1994). Their diet has not substantially changed, but much of the rest of the world is seeking to join in their eating habits. A diet based on meat and dairy is not only less healthy than the middle tier's diet, it also is a driver of food inequity and environmental destruction (refer to Chapter Two). More than 40 percent of the world's production of wheat, rye, oats, and corn is fed annually to cattle (Renner, 2014b). Hence, the simple act of eating less meat could "stretch" the world's grain supplies, making it possible to feed a much larger population and reduce global food inequity. Table 5.2 illustrates how many liters of water it takes to produce 1 kilogram of various foods (the high inputs of fuel and chemicals it takes to produce meat are ignored).

CHANGE AND THE CONTOURS OF WORLD HUNGER

FAO agronomists and development experts agreed that the resources and technical knowledge are available to increase food production by 50 percent in 2030 and 70 percent in 2050—the amounts needed to feed a population that is expected to grow to over 9 billion in 40 years. But whether the food can be grown in the LDCs where the hungry can actually get it, at prices they can afford, is another matter (*New York Times*, 2009). Hunger is concentrated in Sub-Saharan Africa, while North Africa and the Near East have the lowest rate among developing regions. Latin America, the Caribbean, Southeast Asia, and South Asia, particularly the Indian subcontinent, have intermediate levels. The biggest gains in reducing world hunger, however, have been in China, which is at least partly attributable to land reforms (Bell and Ashwood, 2016; Lappé and Collins, 2015).

Currently, public health researchers and agencies focus more on the linkages between nutritional deficiencies and social and environmental conditions that combine to cause negative health repercussions. For instance, children who are well fed are being diagnosed as stunted. Exposure to poor sanitation and unsafe drinking water can cause repeated bacterial infections, which lowers nutrient absorption, leading to developmental stunting (Lappé and Collins, 2015). This is one reason why slums are deemed a major public health threat.

Globally, the *quality of food* is a large concern. Many people suffer from lack of nutrients even when calorie intake is sufficient. For instance, in India, it is estimated that four in five infants and toddlers, and more than half of women suffer from iron deficiency that is potentially life threatening. Doctors note that in some poor rural India villages, people may get enough calories, but a disproportionately high number of them suffer from heart conditions and diabetes (Lappé and Collins, 2015). Moreover, unhealthy eating patterns are outpacing dietary advancements in most parts of the world.

A strange situation has appeared across the globe in developed and developing countries alike, undernutrition and chronic hunger existing alongside obesity, which

Figure 5.5 Family in Nepal taking a lunch break from working a dump.

the WHO refers to as the *double burden of disease* (Bell and Ashwood, 2016; see WHO). According to the WHO, worldwide obesity has more than doubled since 1980. Now being overweight and obese is linked to more deaths worldwide than underweight. In Sub-Saharan Africa, 18.7 percent of women and 36.7 percent of men are obese. Probably less surprising to you is obesity in places like the US where approximately 35 percent of adults are considered obese. In the United Kingdom, 57 percent of women and 66 percent of men are considered overweight or obese (Bell and Ashwood, 2016). The reality, however, is that the wealthy who are obese are more able to access and pay for subsequent medical care.

Getting a handle on the factual contours of chronic hunger, malnutrition, and obesity is relatively easy. Trying to explain why it persists in America and the world is more complex and contentious. Some things related to food disparities are matters agreed on by all observers, regardless of political and ideological differences about food issues. *First*, for the present at least, *chronic hunger is not caused by too many people or too little food*. The world's farmers produce enough grains, meat, and other food products to adequately feed the world's population. Taken together, there is enough to provide 2,900 calories per day per person, well over the minimum daily calorie requirement (Lappé and Collins, 2015; Halweil, 2006b). *Second*, problems of hunger are caused by lacking access to the healthy food that exists (Lappé and Collins, 2015). Third, obesity is driven by factors such as an increasingly sedentary lifestyle, and changes in food consumption, including energy-dense protein foods that are high in fat and highly processed food of marginal nutritional value. Beyond this consensus, the causes of the perpetuation of chronic hunger, malnutrition, and obesity are controversial and contentious. In addition to citing biophysical factors, explanations of hunger and obesity

Food deserts are defined as areas that lack access to fresh and healthy foods because grocery stores, farmers' markets or other healthy food providers and sources are not available. According to the USDA, a "low-access" food community has at least 500 people or 33 percent of the people in their census tract that reside more than a mile away from a supermarket or large grocery store (more than 10 miles for rural areas). In food deserts, people often rely on quick marts or convenience stores, which do not stock healthy fresh food options. See http://americannutritionassociation.org/newsletter/usda-defines-food-deserts.

iStock

Figure 5.6

point to things like inequality and income distribution, an uneven work–life balance, undemocratic governments and agriculture policies and research agendas, population density and growth, social disruptions like wars, social welfare and insurance policies, and agricultural trade and commodity prices. In other words, explanations of hunger, undernutrition, and overnutrition—the overconsumption of nutrients and food to the point that it negatively affects health—and how to address them, are controversial and contentious because they are tied to the dominant social institutions in societies around the world in the twenty-first century.

EXPLAINING WORLD HUNGER

Within academic and food policy circles, there are several styles of thinking to explain why hunger exists, each with different emphases, some supportive evidence, and very different policy implications (Buttel, 2000a). They illustrate and specify the sociological perspectives about environmental problems discussed in Chapter One. *Agricultural modernization* argues that the world hunger problem is caused by not enough food and the poor productivity of traditional agriculture, particularly as it is practiced in the LDCs. This approach, which has great intuitive and popular appeal, is the favorite of Western agribusiness firms and agencies like the USDA. However appealing, it is misleading, since everyone admits that the problem is not that there isn't enough food, but how it is distributed. Furthermore, there is reason to think that if such "modernization" of traditional agriculture were to take place under the aegis of large multinational agribusiness firms, the world would have more total food, but because of poverty, hunger would persist. *Ecological neo-Malthusianism* is the second way of theorizing about the causes of hunger. Its logic seems straightforward: The more people there are, or the faster the rate of population growth, the less food and other materials will be available to other people. But as all food analysts agree, even as rapidly as population has grown, it has been outstripped by total food production increases. Old-fashioned Malthusianism, which viewed population growth as a simple and direct cause of human problems, is very much out of fashion. Neo-Malthusianism, however, which views population as an important underlying condition related to many problems, is very much alive. Population size or growth may not directly cause people to be hungry or die, but it may be a distant and pervasive factor related to more direct causes. Ecological neo-Malthusianism sees population growth in conjunction with the progressive degradation of food-producing environmental resource bases like soil and water. Figure 5.7 illustrates FAO data that shows over the course of the last century global water withdrawal increased 1.7 times faster than world population. On the upside, it also shows that the largest increase in water withdrawal occurred between 1950 and 1960 (4.2 percent per year), but between 2000 and 2010 water withdrawal declined to a smaller level of increase (0.5 percent per year). This decrease occurred in the face of continued population growth. However, problems associated with water scarcity are not evenly experienced throughout the world. Water scarcity is influenced by the climate and environmental conditions of specific areas and the social and institutional capacities of communities and states to manage their water resources. The greatest problems with water scarcity are in some of the poorest regions of the world that also are more arid, which is the case of many African countries (see Chapter Two). The impact of increasing populations in these areas should not be minimized, but it alone cannot explain food and water insecurity.

In its most sophisticated forms, ecological neo-Malthusianism sees environmental sustainability as being more important than population size or growth alone in explaining hunger. This is particularly the case in terms of future threats to food security. Lester Brown, well-known environmental analyst and president of the Earth Policy Institute, argued in his book, *Full Planet, Empty Plates* (2012) that food scarcity is the "new normal" and the greatest threat to national security. Brown and other scholars have long been documenting how gains of the second agricultural revolution in the twentieth century were achieved by environmentally threatening practices and techniques. We discussed many of these, like soil erosion, waste and degradation of water

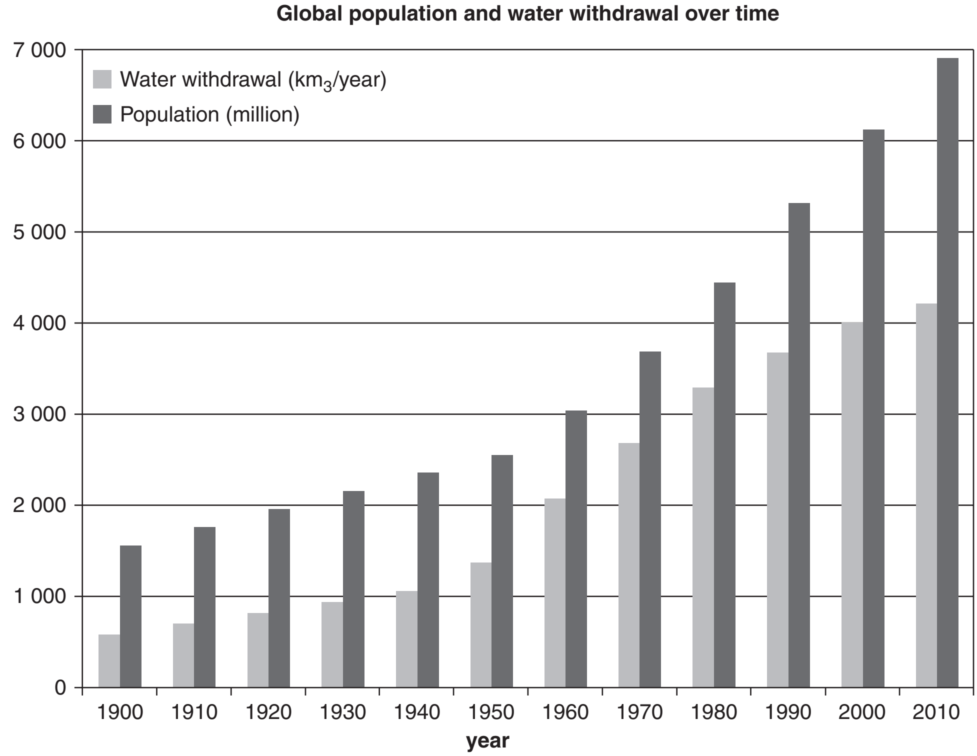


Figure 5.7

Source: FAO. 2016. AQUASTAT Website. Food and Agriculture Organization of the United Nations.

resources, oversalinization from continual irrigation, declining biodiversity, overuse of petroleum resources, climate change, and pervasive pollution from confined animal feeding operations (CAFOs) and agrochemicals.

Moreover, even though there is enough food to go around, *per capita* production—not total production—leveled off in the 1980s and 1990s. Brown explains how *carryover stocks* of grains—the amount stored until the next harvest begins—have declined in the twenty-first century. Carryover stocks of grain represent a basic indicator of food security. From 1986 to 2001, the annual world carryover stocks of grain averaged 107 days of consumption. From 2002 to 2011, carryover stocks of grain averaged 74 days of consumption—a drop of one-third. And, since 2007 the world grain supplies have significantly tightened with virtually *no idle land* to bring into production (refer to Chapter Two). Agricultural resources (fertile soil, water for irrigation, soil, rangeland) are under stress. Although agricultural environmental degradation affects farmers in the United States, analysts recognize that it is particularly threatening to the food status of the poorest rural farmers around the world (Halweil, 2000; Brown, 2012). Due to these constraints, world food prices have risen. The UN Food Price Index is a measure of monthly changes in prices for a basket of food including five items (cereal, vegetable oils, dairy, meat, and sugars) then weighted with the average export shares of each group for the base period of 2002–2004 at 100. Using the UN food price index, Brown notes how it has increased since the base period to 201 by 2012. Americans on average spend 9 percent of their income on food. In many developing countries, people spend 50 to 70 percent of their income on food, and a doubling of food prices can cause social and political unrest (Brown, 2012).

Ecological neo-Malthusianism is a well-established academic viewpoint that has modest influence in food and agricultural policy circles. Cross-national research, for instance, finds population size and growth rates to be less strongly related to hunger than other factors and the significance of population as a driver of hunger is very regionally specific. But there are other reasons why its influence in policy circles is modest. It does not bolster the legitimacy of prevailing institutions by providing reasons to extend Western-dominated world food trade, to "modernize" the world, or to provide technological substitutes for social reform (e.g., as with genetically engineered crops). By contrast, ecological neo-Malthusianism views the limits of the global resource base as constraining consumption and requiring more sustainable forms of agriculture (Brown, 2012). It would require shifts in agricultural technology and practices away from those that have been successful and profitable but environmentally damaging. It also would limit or reconfigure how the affluent consume food. You can see why it is not a dominant perspective explaining hunger. Given its lack of appeal for policy makers and venture capitalists, ecological neo-Malthusianism is a compelling perspective.

Ideas about *inequality and political-economy* (I & PE) represent a third style of explaining hunger, which we discussed earlier in relationship to population growth. It assumes that social inequalities and poverty produced in the developed and developing nations—both locally and globally—cause hunger. In a globalizing era, world markets are organized by large corporations with the support of government subsidies and international regimes like the World Trade Organization. World markets concentrate economic assets and increase the total volume of goods to be sold, but displace and disadvantage small producers and workers in many nations. As noted in Chapter Two, women in developing countries grow the majority of the food for their families and communities, and when displaced from agriculture, poverty and hunger increase for them and their children.

From this perspective, chronic hunger is more directly related to the distribution of food rather than to the total supply. Nobel prize-winning economist Amartya K. Sen (1981, 1993) studied major famines to find that in each instance food was indeed available, but it was not distributed to those in need of it. He emphasized that hunger is related to food *entitlements*, or the ability of individuals and groups to "command food." Entitlements defined by custom, social status, and law shape who eats and who doesn't because they reflect access to social power. Furthermore, many of the difficulties with agricultural modernization ideas in explaining hunger support I & PE explanations:

- *Inequitable land distribution*: When self-provisioning peasants and farmers are driven off the land by modern industrial agriculture, land grabs, and consolidation of land

- *Global export agriculture*: When modernization produces more food for export markets but not for locally displaced and poor people
- *Industrial agriculture*: When investing in more productive technology amplifies hunger by putting people out of work
- *Agro-fuels*: When land is used to grow crops for fuel rather than food for people
- *The affluent diet*: When affluence encourages meat-rich diets, requiring much grain to feed animals that could support the diets of many hungry people

Each of the theories about the causes of hunger has virtues and limitations. The agricultural modernization approach rightly points to lack of capital investment in agriculture and agricultural research and development as related to both poverty and hunger. But while investing in agricultural modernization, attempts to produce food security must take into account environmental sustainability. Ecological neo-Malthusianism reminds us that solutions must be developed within the limits of the biosphere and must be understood from a long-term perspective, but it overemphasizes population and environmental resources as independent causes of hunger rather than in context with the social and political factors that shape hunger. The I & PE approach is best able to incorporate insights of the other three perspectives, while pointing to dynamics that the other three downplay—that the taproots of hunger lie most fundamentally in social relations. However, the I & PE approach does not adequately recognize inequality in the environmental conditions of where people reside. Not all soil or land or ecosystems are equal in their productivity or sensitivity to changing climate conditions (Bell and Ashwood, 2016; Ponting, 2007).

FEEDING 9 BILLION PEOPLE IN THE NEXT 50 YEARS?

Clearly, dealing with inequality, poverty, and social circumstances such as those noted that surround food is the key to addressing world malnutrition in the short term. Though there is theoretically enough food to feed everybody adequately, per capita production has declined and the world's margin of safety regarding food has declined. Even though the "more food" and "population growth as the singular cause" arguments about hunger are flawed, it is still true that we will need more food in the longer term. This feat will challenge the ingenuity of the world's policy makers and farmers under *any* circumstances, and particularly if it is done in a sustainable way. We will need to simultaneously produce more food and halt the destruction of the agricultural resource base. How?

The most obvious way of increasing food supplies is to extend the technologies that have served us so well since the 1950s: Bring more land into cultivation; use more fertilizer, pesticides, and herbicides; irrigate more; and so on. Yet continuing these techniques produces little significant increase in crop yields. The J-shaped curve of early rapid growth slows down, reaches its limits, and levels off, becoming an S-shaped curve. Grain yields per hectare still increase in most nations, but at a slower rate. But not only do the intensive agricultural techniques from the 1950s no longer produce increasing per capita yields, they measurably degrade the resource bases for agriculture (Bender and Smith, 1997: 25–40). It is doubtful whether even current yields of such intensive agriculture as practiced in Europe and the United States are environmentally sustainable throughout this century without considerable modification. It is even more doubtful that temperate zone monoculture agriculture could be successfully exported wholesale to the tropics and subtropics—even if companies and governments were willing to *give it away* or the LDCs had the money to *buy it.* On the scale required, we won't and they don't.

BIOTECHNOLOGY?

Some view new biotechnology (or genetic engineering) as a technological panacea of the coming decades that will give an enormous boost to agricultural productivity, becoming a gene revolution like the green revolution seed hybrids of the 1960s. The *green revolution* refers to a massive global effort to crossbreed species producing crop seeds that are much more productive per unit of cultivated land, thereby increasing total food production. The global diffusion of green revolution hybrids has significantly decreased the genetic diversity of crops around the world. By gene splicing and injection, new genetic engineering techniques could produce new varieties that "Mother Nature never knew"; potentially more pest resistant, earlier maturing, drought resistant, salt resistant, and more efficient users of solar energy during photosynthesis. Because of such potential benefits and their profitability, genetically modified (GM) crops were rapidly entering the American farming/food system by the year 2000, when about two-thirds of soybeans were grown from engineered seed species. Globally, four crops accounted for most GM crops by 2007: 51 percent soybeans, 31 percent corn, 13 percent cotton, and 5 percent canola. The vast majority were grown in just three nations: the United States (the global leader, which accounts for half of the world's GM crop area), Argentina, and Brazil. GM crops are mainly engineered for two traits, herbicide tolerance and pesticide resistance, sometimes combined ("stacked") in the same plant (McKeown, 2009). Not by accident, GM seeds are patented and sold by the same corporations that market herbicides. It is important to note that, in spite of the publicity and hoopla about the "global biotechnology revolution," it has mostly been a few crops with two engineered traits (herbicide and pesticide resistance). So far, the diffusion of GM crops has been deep but very narrow. Outside of these few crops in three countries, very little of the world's crop acres are planted in GM crops. Given that the world's three major food crops are rice, wheat, and maize (corn), there is scarcely a real beginning of such a revolution in the staple crop sectors (Buttel, 2002: 7).

There are ecological reasons for caution about GM crops. Without huge amounts of fertilizer and water, most green revolution crop varieties (of the 1960s) produced yields that were no higher (and sometimes lower) than traditional varieties. Similarly, if genetically engineered crops increase productivity by accelerating photosynthesis, they could also accelerate the loss of soil nutrients, requiring more fertilizer and water. Without ample water, good soil, and favorable weather, new genetically engineered crops could fail. Furthermore, new species would be inserted into natural food chains, predator systems, and mineral cycles with unpredictable results. Weeds might acquire the special defenses or enhanced photosynthetic capacity of a GM crop plant, and crop plants with built-in pesticides might harm many insects other than target pests. Furthermore, new organisms introduced into an environment can themselves become pests. Please don't think this an unimportant issue: In the United States, nonnative plant invaders have caused an estimated $138 billion in damage, including the costs of controlling them (Pimentel, 1999). Historically, more than 120 intentionally introduced crop plants *have* become such weed pests in the United States. Unlike people in the United States, Europeans have demonstrated strong skepticism about the biotechnology industry's claims that no adverse health effects are associated with consuming GM food. Europeans are also wary of the unintentional—and damaging—introduction of genes or substances into the environment. At the turn of the twenty-first century, a serious food trade war between the United States and Europe was brewing about this issue (Halweil, 1999, 2000).

Other reasons why biotechnology is a questionable panacea for malnutrition around the world have to do with economics and institutional contexts. Genetic engineering requires heavy capital and technical investments and is being conducted by large private companies that will hold patents on "their organisms," available to buyers at the right price—rather than cheaply to those most in need of food. So far, biotechnology research has been more driven by the desire for agribusiness sales and profits rather than food for the hungry or agricultural sustainability. Priorities have been, for example, to develop herbicide-resistant crops producing higher sales and profits for herbicide companies. In the most widely known illustration, the Monsanto Company was developing a high-yield seed with a *terminator* gene, meaning that after the crop was grown, harvested seeds could not be regrown. Rather than being saved by farmers, each year's seed had to be purchased anew from the company. Reactions were so negative that the company has abandoned the project, but in corporate circles the race is on. Because of risky but extraordinarily high profit potentials, agribusiness firms now compete vigorously to develop and patent engineered species. The prospect of producing more food cheaply for the world's poor and hungry has so far eluded researchers and—more important—attracted little interest by investors.

None of this means that genetically engineered crop species should be rejected out of hand, particularly if the research agenda could be redirected toward more food and fewer ecological impacts rather than more profits. Doing this would mean shifting some control of research and development agendas to the world's food consumers and farmers. Like many new scientific technologies, genetic engineering has impressive promises mixed with serious and sometimes sinister possibilities—environmental but also economic and political.

BOX 5.2

GOLDEN RICE

Thus far there is only one GM crop that would address the needs of the world's hungry. In 2000, a Swiss research institute was developing a strain of rice that would supply vitamin A (beta carotene) and not block the absorption of iron, both problems among rice-eating populations. The so-called "golden rice" strain was not patented or sold by a multinational corporation, but given to the International Rice Research Institute for distribution in LDCs. Even so, many food experts believe that golden rice has such a minuscule amount of beta carotene that it would not make a meaningful difference. Multinational corporations would use it for public relations to promote GM-based food in poor nations (Miller and Spoolman, 2009: 277–278).

SUSTAINABLE AGRICULTURE: AGROECOLOGY AND LOW-INPUT FARMING?

As the limitations of modern intensive agriculture and the hazards of biotechnology become apparent, agronomists and ecologists are rediscovering some of the virtues of more labor-intensive traditional agricultural practices. These are most obvious for increasing food in tropical LDCs, where rural labor is plentiful but capital and technology are scarce. Although often less profitable in the world market economy, many traditional methods achieve better productivity per hectare when energy inputs and long-term sustainability are considered (Armillas, 1971). Now a newer agricultural paradigm of *agroecology* recognizes that a farm is also an ecosystem and uses the ecological principles of diversity, interdependence, and synergy to improve productivity as well as sustainability (Altieri, 1995). The tools of industrial intensive agriculture are powerful and simple and mean using products like insecticides bought off the shelf. By contrast, agroecology is complex and its tools are subtle. It involves intercropping (growing several crops simultaneously in the same field), multiple cropping (planting more than one crop a year on the same land), crop rotation, and the mixing of plant and animal production—all time-honored practices of farmers around the world (Lappé et al., 1998: 77–78). Agroecology can be combined with *organic* and *low-input* techniques. Farmers can, for instance, recycle animal manures and "green manure" (plant residues) for fertilizer, and they can practice low-tillage plowing that leaves plant residues to prevent erosion and improve soil productivity.

Consider an example. At a 300-acre farm near Boone, Iowa, farmer Dick Thompson rotated corn, soybeans, oats, and wheat inter-planted with clover and a hay combination that includes an assortment of grasses and legumes. The pests that plagued neighboring monoculture farms were less of a problem because insect pests usually "specialize" in one particular crop. In a diverse setting, no single pest is likely to get the upper hand.

Diversity tends to reduce weed problems because complex cropping uses nutrient resources more efficiently than monocultures, so there is less left over for weeds to consume. Thompson also keeps weeds in check by grazing a herd of cattle, a rarity on Midwestern corn farms. Most cattle are now raised in feedlots. Cattle, hogs, and nitrogen-fixing legumes maintain nutrient-healthy soil. Moreover, Thompson is making money. He profits from his healthy soil and crops and the fact that his "input" costs—for chemical fertilizer, pesticides, and the like—are almost nothing (Halweil, 1999: 29).

Such techniques can be highly productive, *but only when human labor is carefully and patiently applied* (see Pilgeram, 2011). Evidence from developing nations is impressive. The agriculture of China, Taiwan, Korea, Sri Lanka, and Egypt is now close to this mode—with high yields to show for it. But it was in Cuba that such alternative agriculture was put to its greatest test. Before the collapse of the communist world, Cuba was a model green revolution style farm economy, based on enormous production units using vast quantities of imported chemicals and machinery to produce export crops while over half the island's food was imported. When, around 1990, Cuba lost trade and subsidies from socialist bloc nations, it was plunged into the worst food crisis in history, with per capita calories dropping by as much as 30 percent. Faced with the impossibility of importing either food or agrochemical inputs, Cuba turned inward to create more self-reliant agriculture based on higher crop prices to farmers, smaller production units, and urban agriculture. By 1997, Cubans were eating almost as well as they had before 1990 (Rosset, 1997).

Urban agriculture is based on the idea of getting urban dwellers to produce food in empty lots, backyards, and other spaces in and around cities. In 1996 such gardeners in

Figure 5.8 These Billy goats reside at a farm in the Atlanta metropolitan area. The farm makes milk, feta cheese and sells some goats for Kosher or Halal butchering.

Havana supplied 5 percent to 20 percent of the city's food. Urban gardening is not a new idea. For instance, during World War II such "victory gardens" produced 40 percent to 50 percent of the fresh vegetables in the United States. Urban agriculture is now a major source of food in the large cities of the LDCs, such as Shanghai and Calcutta, where food security is often a matter of survival. In the United States, organizations have been formed in many cities to support urban gardeners, which meet regularly to sell and swap their produce. Advocates see urban agriculture as one means of helping urbanites to reclaim neighborhoods from crime and pollution; training low-income residents in business skills; and teaching young people about nutritional, environmental, and food security issues (Nelson, 1996). The movement toward community-supported agriculture (CSA) that started in the 1970s included 1,500 farms by 2008 (Cunningham and Cunningham, 2010: 219–220).

Is organic agriculture economically viable? Organic farming is a small but rapidly growing part of a sustainable agroecology. While the area of global agriculture land for organic cropping is smaller (0.85 percent) than for genetically modified crops (2 percent), organic farming increased during the global recession from 2008 to 2009 by 5.7 percent (Beck, 2011). Organic farming has a lot of untapped potential. In part because it conjures up stereotypes of delusional hippies, hysterical moms, and self-righteous farmers or elite "foodies," which turns off some consumer groups to organic foods. It also threatens business as usual food production that is heavily invested in industrial agricultural practices, and many scientists working within this system are skeptical that organic agriculture can meet the world's food needs. As a Cambridge University chemist bluntly put it: "The greatest catastrophe … is not global warming, but a global conversion to organic farming—an estimated two billion people would perish" (Halweil, 2006a: 18). But a number of agribusiness executives, agricultural and ecological scientists, and international agriculture experts believe that a large-scale shift to organic farming would not only increase the world's food supply, but might be the only way to eradicate hunger and lower the impacts of agriculture on the environment. The "external costs" of organic agriculture are lower than conventional production—in terms of soil erosion, chemical pollution of drinking water, the death of birds and wildlife, and toxic agrochemical residues on food.

Many studies from around the world show that organic farming can produce about as much, and in some settings more, food than conventional farms. Where there is a gap, it is largest in MDCs, where lots of agrochemicals and pesticides are used. Looking at data from more than 200 studies in Europe and North America, a Cornell University study found that organic yields were about 80 percent of conventional yields. Reviewing 154 growing seasons' worth of data on US rain-fed and irrigated land, University of California–Davis scientists found that organic corn yields were 94 percent of conventional yields, organic wheat were 97 percent, and organic tomatoes showed no yield difference. Importantly, British researchers at the University of Essex found that in poorer nations where most of the hungry live, the yield gaps completely disappeared, and yields were sometimes higher on organic farms (Halweil, 2006).

Figure 5.9 Community gardens are found in cities throughout the world. They are shared gardens run by local people, but the beauty and serenity of the green space is enjoyed by the larger community. Monica took the photo above of a shared garden in the heart of Paris. You can learn more about American community gardens at, https://communitygarden.org

Whether a complete conversion to a sort of organic utopia could address the world's hunger and environmental problems is the wrong question. Roland Bunch, an agricultural extension agent with decades of experience in Africa and the Americas, points instead to "a middle path" of agroecology, or

> low input agriculture that uses many of the principles of organic farming and depends on a small fraction of the chemicals. Such systems can immediately produce two or three times what small farmers are presently producing, and is less costly per unit of production. More small farmers in LDCs will adopt it rather than going completely organic, because they aren't taking food from their children's mouths. If five farmers eliminate half their use of chemicals, the effect on the environment will be two and a half times as great as if one farmer goes totally organic.
>
> (Bunch, cited in Halweil, 2006a: 23–24)

After noting this compelling evidence and possibilities for change, ironically, US agriculture is *not* presently evolving toward such smaller alternative farming systems, but rather toward larger, chemically intensive monoculture farms owned or controlled by large agribusiness firms. This is true for both grain crops and animals, as illustrated by the huge cattle feedlots and CAFOs that raise hogs and chickens. Agricultural research, state and federal subsidies, and pricing policies have favored such operations

(Pilgeram, 2011). There is, however an organization, The Sustainable Agriculture Initiative, formed by more than 30 of the world's largest corporate food industries that promote sustainable agriculture. In 2010, their global conference was in Belgium (www.saiplatform.org). Altieri, the agricultural scientist who coined the term *agroecology*, observed that "it is clear that the future of agriculture will be determined by power relations, and there is no reason why farmers and the public in general, if sufficiently empowered, could not influence the direction of agriculture toward goals of sustainability" (1998: 71).

STABILIZING WORLD POPULATION: POLICY OPTIONS

The rate of global population growth has indeed slowed. Several causes contribute to the world decline in the rate of growth, which are enormously variable among nations and regions: (1) the socioeconomic development and falling birth rates that complete the demographic transition in some LDCs; (2) the successes of family planning programs; (3) the global diffusion of feminism and women's rights movements; and (4) the increasing malnutrition, misery, and HIV/AIDS that increase the death rates.

There is widespread agreement amongst scholars, policy makers, and development agencies and institutions that the status of women and gender equality are essential components to the stabilization of population growth and development (simply look at the websites of the World Bank and United Nations). In the 1980s, *feminists*—those who advocate for gender equality and ending the oppression of women—organized around the world by forming small NGOs to lobby for improvements in their social, economic, and political circumstances. By the 1990s, women in LDCs were advocating for improvements in family planning programs by getting better reproductive health information, access to family planning services, and encouraging providers to treat clients with respect. Opposition by women's groups to existing family planning programs as well as ethical, scientific, and religious debates about population growth also formed and has remained influential. Nonetheless, in Cairo, at the UN International Conference on Population and Development (ICPD) in 1994, an overwhelming consensus of delegates argued that population growth *is* a serious problem that exacerbates core social and environmental problems, while rejecting the notion that population growth is *the* cause of all human problems (Gelbard et al., 1999: 34). They also tied population problems with development issues, paving the way for the Millennium Development Goals in 2000. The ICPD emphasized the necessity of creating conditions under which couples *willingly* lower the number of children they have, and that three different policies be employed in combination to create those conditions. Those are (1) making strategies of family planning/contraception available to all people, (2) addressing the worst poverty and destitution that amplify population growth, and (3) empowering women. Policies that improve the well-being and social choices of women have been significant in reducing population growth, and will be essential to stabilizing it in the future. There are no known exceptions to this generalization (Camp, 1993: 134–135; Sachs, 1995: 94).

What is the "scorecard" for demographic change a decade after the ICPD? We say, "Mixed." Global decline in fertility rates continued in the 1990s through the first decade of the twenty-first century, and progress in improving the status and social choices of women has been measurable in many nations. But confronting volatile demographic pressures on societies and the environment requires tackling the root causes of population growth head on. This means looking at global development, trade, and food policy. Extending population and family planning programs requires international cooperation and reliable resources. In the United States, dealing with population issues and family planning has been *very* controversial. Under different presidential administrations, the US government has alternately funded, withdrawn, and reauthorized funds for such UN efforts, primarily because population and family planning are connected to the debates surrounding abortion. Similar to the concern over international climate change mitigation and adaptation policy, LDCs need reliable and consistent financial support and technology transfers.

In most places where fertility rates remain high, governments and the people are coping with conditions of crippling poverty, environmental and climate-related stresses, rapid urbanization, and volatile social and political relations as many are in high conflict areas, such as DRC, Uganda, and Afghanistan. The oppression of women and girls and other human rights issues persist in these countries. These issues reinforce one another, and policy to address any one of them must be examined in combination with the others. Moreover, there is inequality in the environmental conditions within which populations are embedded. Development and population policies ought to account for the influence of degraded environmental conditions, and sensitivity to climate change impacts on development and population-related issues. The numbers of people being uprooted due to disasters and development will have to be dealt with as the numbers of internally displaced people are a destabilizing force in the world today.

CONCLUSION

While the signs that the demographic transition is working in some fashion on a global basis provide the basis for some optimism, world population is an enormous problem because of the built-in momentum of absolute growth. Using a metaphor of a semi-truck speeding toward us for population growth, the optimist would note that it has slowed from 80 to 60 miles an hour. The pessimist would note that while we were looking the other way, someone just doubled the weight of the cargo!

PERSONAL CONNECTIONS

QUESTIONS FOR REVIEW

1. What was Thomas Malthus's major prediction about population growth and the human future? Why is his distinction between linear and exponential growth important to understanding population growth and change?
2. What are some of the main causes of the "demographic transition" that nations go through as they develop? What role does immigration play? How have issues associated with immigration stayed the same? How have they changed?
3. What does it mean to speak of the "demographic divide" between more and less developed nations?
4. How has the ongoing interaction between population change and environmental quality been a major controversy? How has this been changed and nuanced by scholars who emphasized matters of scale, allocation, or distribution—related to different paradigms?
5. How has the proportion of hungry people in the world changed since the 1950s? Since the 1990s? What is the double burden of disease and what are some reasons for it?
6. The green revolution changed the production of food, as does the current biotechnology revolution. How were they different, with differing consequences?
7. How do experts assess the potentials of low input farming and agroecology to address the world's food needs?
8. What major policies have United Nations conferences endorsed to stabilize world population growth? Is there anything you would add today?

QUESTIONS FOR REFLECTION

Large-scale population change is so abstract and pervasive that you probably don't think much about your everyday life circumstances, problems, and opportunities as related to it. Here are some leading questions to help you explore the demographic contexts of life:

1. High population density means that people live more closely together, interact more frequently, and compete with each other more intensely for living space and all resources for which supplies are limited. Think of the times when you have lived in a smaller, dense environment with others (in a shared apartment, college dormitory, boarding school, or military base, for instance). How would you describe the experience? What kinds of problems did you and others experience? What kinds of things became important that weren't important in a less densely populated living environment? What kinds of special rules or regulations evolved to deal with problems of increased population density? You might think of all the special rules that college dorm systems and military bases need to deal with problems of living

in such facilities. Not all such rules deal with crowding and density problems, but many do.

2. The stabilization of population growth has been on the world's political agenda for some years, and most notably from the ICPD conference at Cairo. That conference defined strategies for slowing population growth that involved the continuation of established family planning programs, social development in LDCs, with assistance from international agencies, and enhancements in the status of women around the world. How much of a priority do you think this should be, compared to other issues? How urgent should it be for the politicians who collect your tax money? How do your age, family status, education, political attitudes, or religious background shape answers to these questions?

WHAT YOU CAN DO

This chapter's twin concerns were population and food. Food security may be an alien concern to you, unless you're among the minority of Americans whose food supply is chronically in jeopardy. But as noted in the chapter, one in six Americans is food insecure. In the midst of a seeming excess of food in America, what contribution could you make to increase the food security in the world?

1. You could buy food in bulk, uncooked, with fewer layers of packaging. That makes food cheaper per unit of production, likely to be healthier, involves less energy to produce, and creates less trash. More of your food costs go directly to producers and to corporate intermediaries who process it. And by selective buying, you can support natural or organic food production, and local or regional producers. These may be very difficult to do among busy dual-income families, and in food systems increasingly dominated by fast foods, supermarkets, and prepared meals. After all, the food we buy is for ourselves and our family!
2. As to hunger and food security itself: The most obvious way of helping is to give generously to food banks and international food relief agencies. That does help feed people who are desperate, but it does not contribute in any way to increase their ongoing food self-sufficiency. Most food relief agencies, such as Oxfam International, now emphasize contributing to the development of food-producing capacity. You can contribute to both public and private food development programs. If you or your friends want a really challenging but important project, try to organize on behalf of the world's hungry people. Try to get food agricultural development programs to those who directly produce food rather than state ministries or firms. While you're at it, you might try to redefine domestic political priorities at any level—city, state, federal—more toward enhancing the food for the hungry. As you can see, addressing food security issues is not easy, and can be as much political as personal.
3. Among the important personal things you can do is to grow some of your own food in a backyard plot, a window planter, a rooftop garden, or a cooperative community garden. Also reduce your food waste!

4. Even more important is eating "lower on the food chain," meaning eating less meat and more grains, fruits, and vegetables. If this lifestyle change became common, the benefits for environmental problems, dietary health, and food security would be enormous. It would save money and energy and reduce your intake of fats that contribute to obesity, heart disease, and other disorders. It also would reduce air and water pollution, water use, reforestation, soil erosion, overgrazing, species extinction, and emissions of greenhouse gases (methane) produced by cattle. In the United States, animal agriculture pollutes more fresh water than all municipal and industrial uses combined. If Americans reduced their meat intake by only 10 percent, the savings in grain and soybeans could adequately feed 60 million people. More than half of US cropland is devoted to growing livestock feed. Livestock also consume more than half of the water used in the United States, either by direct consumption or by irrigating to grow their feed or processing their manure (Miller, 1992).
5. The beef about beef: I (Charlie) hate to mention this. Particularly since I live in Omaha, which comes close to being the beef capital of the nation. Its hinterlands are loaded with cattle ranches, feedlots, and packinghouses, and the beef industry is terribly important to the local economy. (Have you seen those ads for "luscious" Omaha steaks that could be shipped to you?). In fact, in Nebraska nothing comes closer to sacrilege than encouraging people to eat less beef. But you should. Why? Most obvious are health reasons, because it is high in saturated fat. Beef requires more inputs of feed and other agricultural inputs per pound than any other livestock. It takes about 9 calories of energy input to get 1 calorie of food output from beef. So, you can see that in energy terms, it's a net loss. Most rangeland degradation in the United States is from cattle, not hogs or chickens. Not all the beef we eat comes from the United States. The most ecologically damaging beef is from cattle raised on tropical soils of Latin America.

   After all this, I have to be honest. My family and I still eat meat, including beef, but we often buy "naturally raised" beef from smaller regional farmers. I'd feel a lot better about eating beef if more of it were raised grass-fed on ecologically managed rangeland rather than in crowded feedlots where cattle are usually fattened up with processed food, pumped full of growth hormones and antibiotics, and produce concentrated waste disposal problems. But little American beef is currently produced on open rangeland.

MORE RESOURCES

Birdsall, N., Kelley, A. and Sinding, S. (Eds.) (2001). *Population patterns: Demographic change, economic growth, and poverty in the developed world*. New York: Oxford University Press.

Blockstein, D. and Weigman, L. (2009). *The climate solutions consensus: What we know and what to do about it.* Washington, DC: Island Press.

Brown, L. (2012). *Full planet, empty plates: Geopolitics of food scarcity*. New York: W. W. Norton.

Entwisle, B. and Stern, P. (2005). *Population, land use, and environment: Research directions.* Washington, DC: National Research Council of the National Academy of Sciences.

Lappé, F. and Collins, J. (2015). *World hunger: 10 myths*. New York: Grove Press.

Weeks, J. (2008). *Population: An introduction to concepts and issues* (11th ed.). Belmont, CA: Wadsworth.

ELECTRONIC RESOURCES

http://www.prb.org
The Population Reference Bureau is a great resource providing information on issues associated with population, health, and environment around the world. You can access the Population Bulletin on its website.

http://www.census.gov/2010census.
Gateway to the 2010 US Census.

http://www.stopfoodwaste.ie
Good source to get educated on food waste and how to prevent it.

http://popenvironment.org
Links to a variety of topics about population and environment.

http://www.populationenvironmentresearch.org
Social and natural science research on population and environment.

http://www.fao.org
United Nations Food and Agriculture Organization home page.

http://www.saiplatform.org
The sustainable agriculture initiative, formed by more than 30 large food corporations that promote sustainable agriculture.

http://www.ucsusa.org
The Union of Concerned Scientists. There are many resources on this website, but food and agriculture is especially relevant for this chapter.

http://www.unhcr.org/en-us
The UN Refugee Agency

NOTES

1. The doubling time can be computed by the *rule of 69*—that is, 69 divided by the growth rate per year (expressed in percentage). So at the world growth rate in 2008 of 1.2 percent per year, the doubling time was 58 years. Exponential growth is expressed in logarithms. So to find the doubling time, you must find the natural logarithm (or $\log_e$) of 2 (for doubling), which turns out to be 0.69, which is multiplied by 100 to get rid of the decimal point.
2. Stunting is often thought of as being too short for one's age, but it refers to a child under five that falls two standard deviations below the median height for their reference group. It is caused by nutritional deficiencies of pregnant women or in children. Stunting is also an indicator of significant health problems that depress the immune system and can cause delayed cognitive functioning (see the WHO, http://www.who.int/nutrition/global-target-2025/en).

CHAPTER 6
GLOBALIZATION, INEQUALITY, AND SUSTAINABILITY

When historians write about our times, they will surely describe the last half of the twentieth century and the beginnings of the twenty-first century as eras of *prodigious growth* and *globalization* in practically every dimension of human activity. The "markers" for both of these processes in our everyday lives are easy to find. Check out where the clothes in your closet were made, eat out in any modest-sized American city, and you have quite an international choice of eateries (Chinese, Japanese, Italian, Greek, Korean, Mexican, Vietnamese, and much more). The reverse is also true: You can get a Big Mac in Beijing, Moscow, Guatemala, and more than 100 other countries. We live in an era of unparalleled electronic connectivity and information technology. We fear tropical diseases and the effects of nonnative species from around the world. Our anxieties

Figure 6.1 A famous composite photo from the National Aeronautics and Space Administration taken from an orbiting satellite shows the geographical basis for global environmental problems. What does, "think globally, act locally," mean to you? Or what about "think locally, act globally?" Check out Citizens for Global Solutions at: http://globalsolutions.org to see how others are approaching this question.

about trade deficits, jobs, terrorism, and wars run high. We recognize a growing world market economy, and a loosely integrated but extremely volatile global system that both intrigues and frightens us. Contact between nations around the world is certainly not new, but more so than in the past, the world is becoming one integrated but volatile system. While differences between people in various regions and nations continue, increasingly we share similar ideas, material goods, and problems.

In the previous few chapters, one theme worth reiterating is that of *continual growth*: in population, forests cut, water used, food produced, minerals and fuels consumed, chemical pollutants generated, air pollution, greenhouse gas emissions, depleted ocean fisheries, and urban sprawl. During the last half century, the world economy expanded sevenfold. "Most striking of all, the growth in the world economy during the single year of 2000 exceeded that of the entire nineteenth century. . . . Stability is considered a departure from the norm" (Brown, 2004: 4). The planet has indeed been transformed by the human footprint.

The major concerns of this chapter are the connections between globalization, inequality, sustainability, and the prospects of transformations to achieve sustainability. To begin, we review the two main perspectives that frame the causes and processes of globalization. Second, a broad appraisal of the relationship between social inequalities, globalization, and environmental risks and harm is given. Third, we examine the concept of sustainability and the primary perspectives and research on pathways to achieve it. Fourth, the characteristics of more sustainable societies are illustrated. The chapter ends with a brief discussion of the prospects for large-scale social change toward greater sustainability, which is explored in further detail in the remaining chapters of the book.

SOCIAL SCIENCE PERSPECTIVES AND GLOBALIZATION

How and why did the process of global integration accelerate in the last 100 years? What were some of its driving forces? Three perspectives will get to the heart of these questions, and they can be framed with social science perspectives, discussed mainly in Chapter One.

GLOBALIZATION PERSPECTIVE I: NEOLIBERALISM

One perspective from classic sociology (*functional theory*) maintains that society and change are shaped by the activities and processes required for the viability and survival of society itself. These processes are termed *functions*, and there are also *dysfunctions*, which have the opposite effect. Early functional thinkers were concerned with the evolution from traditional to industrial societies (Durkheim, 1893/1964; Spencer, 1896). But, by the 1950s functional theorizing was dominated by thinking that depicted societies as "equilibrium-seeking structures" that avoided change (Parsons, 1951). More recent functionalist thinking attempts to understand social change by assuming that whenever stresses or strains seriously threaten a society or system, it will initiate "compensatory actions" to counter these disruptions in an attempt to preserve its key features. These may succeed or fail, but in either case they are likely to produce considerable change throughout the system. From this perspective, social survival is a perpetual process of social reorganization (Alexander, 1985; Olsen, 1968: 150–151). Since its beginnings, functionalist thought has been concerned with modernization and development, which meant the spread of Western culture and institutions. It is particularly consistent with neoliberal economic thinking about globalization.

The *neoliberal perspective* embodies the thinking of economists about markets and politics. It is rooted in a simple and dramatic assumption that will sound familiar to you—that the best human system results from individuals being free to pursue their own interests with little government intervention. Until fairly recent times, people and governments assumed that it was right for governments to promote the society's well-being by special export subsidies for national industries and to protect them from foreign competition by import tariffs—just as armies protect from foreign invaders. That policy beginning in the seventeenth century was known as *mercantilism*, when European kings attempted to control commerce and trade to benefit their nations. Today, this is known as *economic nationalism*. By the way, it is not entirely dead as businesses still seek government protection from "unfair" foreign competition.

But economic nationalism was questioned when two world wars with a world depression between them produced prolonged, devastating, worldwide chaos, conflict, and misery. Toward the end of World War II, the world's bankers and economic ministers met at Bretton Woods (a resort in New Hampshire) to prevent similar events in the future and rebuild Europe. They thought that those troubles were caused by excessive economic nationalism that stifled trade, which in turn produced economic and political instability by raising unemployment and consumer prices. They agreed to embark on policies of international free trade. The *Bretton Woods system* envisioned a free system of international trade in open markets without barriers. States should continue to have important roles for economic regulation *within* nations, but free markets were intended to dominate relations *between* nations (Balaam and Veseth, 1996: 16, 42, 50). The international institutions the World Bank and the International Monetary Fund (IMF) were established at this time to promote global development and economic growth, and reduce poverty. While other multilateral banks exist today, these are the dominant global financial institutions. The World Bank focuses on long-term development loans for infrastructure, such as hydro-electric dams, roads, and schools. The IMF is geared towards short-term lending to help debtor countries balance their national budget, so they play a key role in setting the terms of repayment.

The growth of the world market system is consistent with functionalist thinking about the sources of social viability, which requires adaptation to changing conditions. It also has reinforced the goals of investors and corporations to expand their markets and profitability through international trade. For instance, by the end of the 1960s and running through the later part of the 1970s, global profits were threatened by new competitors, such as OPEC, falling prices in commodity markets, and domestic unemployment and inflation, causing a global crisis of "stagflation" (Harvey, 2005). Many wealthy countries, especially the US, and some developing countries, turned to neoliberalism as a solution. Neoliberalism provided the rationale to increase profits through the expansion of global free trade, deregulating industries and the finance system, and pursuing privatization of public goods, both natural (e.g., water and land) and social (e.g., education, energy, infrastructure, health care). It was made possible by the development of new information technologies since the 1970s (computers and the Internet), which decreased the costs of doing business at widely scattered locations around the globe (Castells, 2000). Corporations, especially transnational corporations (TNCs), prospered and the aggregated growth rates of world goods and services mushroomed. *World aggregate economic output has more than quintupled since the 1950s—vastly exceeding population growth rates.*

The *neoliberal* economic approach shapes negotiations between nations. In addition to the World Bank and IMF, many other international organizations and agreements have

Table 6.1 International Trade Organizations

Organization or treaty	Function or what it does:
World Bank	Founded in the 1940s to rebuild war-torn Europe. It has become a large bank to provide financial and development aid to poor nations.
International Monetary Fund	Established by donor nations to regulate the world's currency system so that inflation or recessions in particular countries don't spread throughout the world.
World Trade Organization	Evolved over decades from trade talks ("rounds") that did away with international tariffs, and has become the organization that provides rules about free trade and adjudicates disputes between nations.
North American Free Trade Association	Established in the 1970s by treaties between Canada, the United States, and Mexico that established North America as a tariff-free trade zone.
The Trans-Pacific Partnership	Final proposal in 2016 included 12 countries: US, Japan, Malaysia, Vietnam, Singapore, Brunei, Australia, New Zealand, Canada, Mexico, Chile, and Peru, to create a single market similar to the EU and remove tariffs on most goods (not all) between countries.

been established to manage global trade, such as the World Trade Organization (WTO) and the North American Free Trade Agreement (NAFTA), and most recently the proposed Trans-Pacific Partnership Free Trade Agreement (TPP). These organizations have become so powerful that they often control global markets, policy, and the fates of nations and regions. They also have sparked a great deal of controversy and global protests. See Table 6.1.

Although the world market economy has dramatically increased trade and production and is thus compatible with the needs of TNCs, it is certainly not free of serious problems and contradictions. Growing global integration led by huge TNCs has resulted in a very unlevel negotiating field, even between many nations and the largest corporate players. Neoliberal global integration has been much less compatible with the concrete interests of governments. TNCs often evade national taxes and regulations by investing in tax and regulatory havens, and by shipping products and profits back to consumers and investors where they are headquartered, most often in wealthy countries.

The growing "world economic integration" is also less compatible with the interests of workers, who are often displaced by the new economic technologies and the search for cheap labor around the world. Human labor is often marginalized and resulting

Figure 6.2 The proposed Trans-Pacific Partnership (TPP) is a free trade agreement of the Asia-Pacific region that covers approximately 40 percent of global GDP and 25 percent of world exports (the following link explains the TPP from a positive viewpoint: http://www.brookings.edu/blogs/future-development/posts/2015/12/09-trans-pacific-partnership-benefits-meltzer).

Figure 6.3 Protests against the TPP free trade agreement in Toronto, Canada. You can check this site out for a more critical view of the TPP, http://www.citizen.org/TPP.

unemployment or substandard employment produces social burdens assumed by nations and local communities. "Free trade" neoliberal organizations and treaties have magnified such problems—as well as the inequitable provision of health care, education, food, shelter, and environmental protection. Some now have "side agreements" purporting to deal with these issues. Thus, the neoliberal world market economy has a deep contradiction: growing aggregate production and affluence alongside mushrooming inequality and poverty both within and among nations. Such problems and tensions associated with the emerging world-system have spawned a plethora of social movements, nongovernmental organizations (NGOs), and international nongovernmental organizations (INGOs), collectively known as "civil society," which attempts to address the gaps left by corporations and governments in meeting social needs.

GLOBALIZATION PERSPECTIVE II: WORLD-SYSTEM THEORY

Besides functionalism, another social science perspective (*conflict theory*) suggests that society and change are shaped by conflict and power relationships among groups, organizations, and social classes (the "parts" of society) as they compete to control the distribution of limited values and resources. As most people understand, social conflict can be destructive, but it may also reinforce social stability, or at least an ongoing relationship between the dominant and contending parts of human systems. Furthermore, it can produce a "new deal" of power relationships that bring with them new social arrangements, which benefit a broader—or at least a different—spectrum of people. Conflict between social groups and classes produced parliamentary democracy, for example, when English nobles forced King John to sign the Magna Carta (the earliest democratic constitutional document), giving them certain rights not to be ruled by royal decrees (Collins, 1975; Dahrendorf, 1959). Conflict thinking originated from the ideas of Karl Marx, and one major perspective on globalization (world-system theory) is virtually the extension of Marxist thought to encompass the world.

Conflict perspectives in the social sciences provide a frame for a very different understanding of globalization than neoliberalism. They begin not with assumptions about states and markets, but with the political and economic history of the modern world, beginning in the 1500s. Most of the world has been in contact with modernizing European nations since about 1500, and by 1800 the scope of that contact had increased so that through colonial empires Europeans controlled most world trade. The global diffusion of Western technologies, culture, and values accelerated during this period. Colonial nations imported cheap raw materials from their colonies and re-exported more expensive manufactured goods in markets controlled by colonial administrations. But by 1900, the colonial empires (of the British, Dutch, French, and Germans) began to break up, and political control was replaced with economic control through a system of trade. The world market system mentioned earlier is, in this view, a global economic exchange network divided among competing national entities (corporations as well as governments). But it is a very unequal and stratified exchange system in which the industrially more developed countries (MDCs) provided investment capital and technology, while the less developed countries (LDCs) were the providers of raw material and, increasingly, of cheap labor.

A global hierarchy of the evolving world-system and its division of labor was driven by a highly unequal system of trade between the MDCs (largely in the Northern Hemisphere) and the LDCs (largely in the Southern Hemisphere). MDCs retain decisive control of the world-system because they control finance capital and the terms of trade. LDCs became increasingly enmeshed in the world-system in dependent status as debtor nations, which is precisely how they continued to be "less developed." Thus, MDCs and LDCs evolved together. The policies of the Bretton Woods institutions (the World Bank and the IMF) operate to amplify inequalities and power-dependent relations. Advice by the world's bankers and financial leaders has had a decided "tilt" largely to benefit the already wealthy MDCs—a fact that is now widely recognized around the world. They encouraged LDCs to borrow money for development, to open their economies to domination by TNCs, and to find money to pay external debts by cutting budgets that weaken education and health care (the IMF's term for this was "structural adjustment," mentioned in Chapter Five).

Such trade inequality has been referred to as *dependency theory* by economists (Frank, 1967), but the whole global system of inequality is increasingly known as *world-system theory.* Its theoretical reasoning extended Marxian thought about economic class, conflict, and inequality within societies to understand the world economic and political structure. Hence it is sometimes understood as a "new historical materialism."

Wallerstein, its most articulate advocate, envisioned the structure of the emerging world-system in three tiers. *Core nations*, powerful and affluent MDCs (e.g., the United States, Germany, and Japan), have diversified industrial economies and exercise political, economic, and fiscal control over the world-system. *Peripheral nations*, the most powerless, have narrow economic bases of agricultural products or minerals and often provide cheap labor for TNCs (e.g., Bangladesh, Rwanda, Indonesia, and Ecuador). Somewhere in between are *semi-peripheral nations*, intermediate in terms of their wealth, political autonomy, and degree of economic diversification (e.g., Mexico, Malaysia, Brazil, and Venezuela) (Wallerstein, 1980; see also Chase-Dunn, 1989).

The most obvious difficulties with world-systems theory are that it depicts MDCs as acting too coherently in a complicated world, and it provides wealthy elites in LDCs with a ready set of ideas to blame the MDCs for their plight. Such leaders and elite classes in LDCs are very much involved in the problems of developing nations, from which they often benefit. Moreover, the world-systems perspective is evolving to analyze changing power relations in the world political-economy. We touched on some of these changes in Chapter Three, in regard to the unique role of the rapidly emerging economies of China, Brazil, and India, in climate change diplomacy. Currently, these three countries are about half the global economy (Bell and Ashwood, 2016). China is the second largest global economy, and by some measures is the world's largest, surpassing the US. China also holds the largest share of other nations' debt and makes development loans to developing countries (Ciplet et al., 2015). Also high semi-peripheral nations, such as South Korea, Qatar, Kuwait and Saudi Arabia, are land grabbing in Africa to harness resources to meet rising consumer demands at home (Lappé and Collins, 2015). These countries stand to shape the future of globalization.

GLOBALIZATION AND SOCIAL INEQUALITY

Despite the aggressive pursuit of neoliberalism and amazing technological advancements, social inequalities around the world have widened, and in some places deepened. Social inequality or *stratification* has been mentioned in many places, but now we need to address it in more depth, particularly as it relates to environmental conditions. The most prominent dimensions of social inequalities are socioeconomic (social class), racial and ethnic, and gender inequality. In regard to social class inequality, socioeconomic measures of income and wealth are key determinants of placement in the social class hierarchy. When economic data such as household income first began to be systematically collected in the 1920s, the United States was more economically egalitarian than Europe (Bell and Ashwood, 2016). Clearly, the Great Depression caused tremendous economic hardship, but in its aftermath "New Deal" policies brought about an era of economic growth and shared prosperity between the social classes. During the period between post-WWII to mid-1970s, the incomes of families at all levels of the social class hierarchy were growing (Gilbert, 2014). These trends abruptly reversed in the mid-1970s, when the income and wealth gap began to grow. Since the 1970s real wages have stagnated while gains in economic productivity have shifted up the class ladder. For instance, the real earnings of CEOs at major corporations rose by 1000 percent from 1973 to 2012. The ratio of the average CEO compensation to the average worker rose from about 20 times greater in 1973 to 230 times in 2011 (Gilbert, 2014: 64). By 2010, the richest 20 percent of US households had *more than half* the income generated, but possibly more shocking, 5 percent held more income than 40 percent of the population. To top it off, 1 percent of US households held 19.8 percent of all income generated (Gilbert, 2014). While the concentration of income is seen globally, some countries have a wider gap than others. Today, the US has the most unequal distribution of household income among all wealthy industrial countries (Sweden has the most equal).

Income and wealth are linked to one another but they are different in important ways. *Wealth* refers to a person's total net worth—all assets owned, such as savings accounts, stocks and bonds, land, house, and car—minus debt. Wealth is connected to the environmental resources and conditions that individuals and communities have access to such as land, climate, and water. Wealth is also generational and more unevenly distributed than income. Figures from 2010 show that 400 of the wealthiest Americans have a combined wealth of $1.37 trillion compared to the combined wealth of 60 percent of Americans of $1.26 trillion. Bill Gates is the richest person in the world. In 2014, he was worth $81.1 billion. In 2013, he made more money than a quarter of the countries of the world (Bell and Ashwood, 2016: 36)!

ENVIRONMENTAL INJUSTICE

Economic inequality is strongly connected to racial and ethnic inequality. African Americans, Latinos, Native Americans, and some Asian populations, have lower incomes, higher rates of poverty and unemployment, and significantly less wealth than white Americans. According to the Federal Reserve Board, in 2007 for every dollar that a median white family owned, the median Latino family owned 12 cents and the median black family owned a dime (Martin, 2009). Socioeconomic and environmental inequality is driven by a history of colonialism, racial apartheid, class-based exploitation, and ongoing discriminatory and exclusionary practices that perpetuate social inequalities. The greater likelihood of exposure to environmental hazards in low-income and communities of color causes disproportionately high rates of mental and physical health problems, lower life expectancy, lower property values, and a vicious cycle of public disinvestment (e.g., access to piped and safe drinking water; see Chapters Two and Three). It also reproduces racial/ethnic and social class inequality within and between generations. When people are displaced from their homes due to environmental contamination or disaster, they stand to lose their inheritance—their home—the primary source of wealth for the majority of Americans, and in some cases their land. It also can mean a loss of culture and way of life (Bell, 2013; Bullard and Wright, 2009, 2012; Taylor, 2014).

The groundbreaking 1987 study sponsored by the United Church of Christ (UCC) Commission for Racial Justice showed people of color were two to three times more likely than white Americans to live in communities with hazardous waste landfills

(Bullard and Wright, 2012). This study bolstered claims of environmental racism and injustice. It also sparked decades of controversy and research largely over whether or not socioeconomic variables, or race and ethnicity, are the driver of environmental inequalities. Subsequent research has produced mixed results often connected to differences in how community features are defined and measured. Some research has found social class, specifically low incomes, to be the real source of disparities where a hazardous-waste facility is located, arguing that people of color are simply more likely to be low income. Others have argued that neither race nor class are the real predictors, but rather living in a metropolitan area increases the odds of living near a hazardous facility (Grant et al., 2010). In 2007 the updated UCC-sponsored study *Toxic Wastes and Race at Twenty: 1987-2007* was released. It was the first to use 2000 census data, a national database of commercial hazardous waste facilities, and Geographic Information Systems to assess racial and socioeconomic disparities in facility location, by EPA region, state, and in metropolitan areas (Bullard and Wright, 2012).

The findings of this study showed that 56 percent of people living in neighborhoods within 3 kilometers (1.8 miles) of the nation's hazardous waste facilities are people of color. In neighborhoods with clustered facilities, people of color make up a majority (69 percent) or nearly two-thirds of residents in those communities. Host neighborhoods in the vast majority of the states with hazardous facilities have disproportionately high percentages of Hispanics (35 states), African Americans (38 states), and Asian/Pacific Islanders (27 states). When examining metro areas, 70 percent of host neighborhoods have high percentages of people of color, and 31 percent are majority people of color neighborhoods. Over all, in 2007 people of color were more likely to be concentrated in areas with hazardous waste facilities than in 1987. Even when socioeconomic and other factors were accounted for, race remained a significant independent predictor of the location of hazardous waste facilities (Bullard and Wright, 2012: 23–24).

Additionally, Grant et al. (2010) looked at the predictors of location of chemical plants because they are responsible for a disproportionate share of toxic emissions. They used a data set produced by the EPA, the Risk-Screening Environmental Indictors (RSEI), which accounts for the amounts of chemicals released by individual facilities, the toxicity of chemicals, their environmental concentrations, and the people exposed to them. They analyzed several different models or recipes for how community and facility factors can mix to produce exposure to highly risky emissions or not highly risky emissions. They found that the percentage of African American and Latino residents increases the likelihood of exposure to highly risky emissions. The findings support the claim that *race matters more than class* in the distribution of environmental risks.

In sum, pitting racial/ethnic inequality against social class inequality is not very productive and obfuscates the reality that too many marginalized people live in sacrifice zones. Looking across decades of research on the predictors of environmental injustice, the weight of the evidence shows that racial/ethnic and social class inequalities often combine to shape vulnerabilities to exposure to environmental bads. However, racial inequities in exposure are not simply the outgrowth of a low social class standing, and have independent effects (Bell and Ashwood, 2016; Bullard and Wright, 2012; Grant et al., 2010). Importantly, other inequalities intervene, such as gender, immigrant status, sexual orientation, and age, to shape vulnerabilities to environmental risks and harms.

Women around the world earn lower incomes and have less wealth, are underrepresented in positions of power and decision making, and overrepresented amongst the poor. Globally, women are often the most marginalized within marginalized populations, their experiences hidden and voices silenced. Women do not experience environmental risks and harms as do men. Women's experiences are unique due to gender inequities and their caretaking responsibilities within families. Women, however, are leaders in the environmental justice movement, which will be discussed in Chapter Eight.

The consequences of environmental injustice are real and experienced throughout the world. Global inequality is graphically illustrated in Figure 6.4 by what has come to be termed the "champagne glass of world wealth distribution." The distance between the world's rich and poor has grown over the last few centuries. At the beginning of the industrial revolution in 1879, people living in the fifth of the world's wealthiest nations received nearly seven times the income as the fifth of people living in the world's poorest ones. By 1960, people living in the wealthiest countries commanded 30 times as much as people living in the poorest countries. By 2005, the richest fifth of the world's nations held 66 times as much income as the poorest fifth (United Nations, 1998a; Bell and Ashwood, 2016: 34–35). If income inequality is measured by persons around the world, instead of nations, it is even more striking: The richest fifth of the world's people command at least 150 times the world's income as do the poorest fifth.

To further illustrate the wide global disparities in wealth consider this: *80 billionaires* hold $1.9 trillion in assets—about the same amount as *half the world* or 3.5 billion of the poorest people. Here is another fact: 1 percent of the world's population have as much wealth as 99 percent of the world (Bell and Ashwood, 2016: 34)!

There is some good news. The proportion of the global population that are poor has fallen since 1990. In 1990 a total of 1.9 billion people lived on $1.25 a day or less, which is the World Bank's definition of *extreme poverty.* By 2015 the number dropped to 836 million people (United Nations Development Programme, 2015). This decline is especially encouraging because the world population has risen. However, during this same time period, extreme poverty has grown in some regions in Africa and India. The greatest gains in poverty alleviation have been in China, but the majority at the very bottom have not moved up too far (Bell and Ashwood, 2016: 35–36).

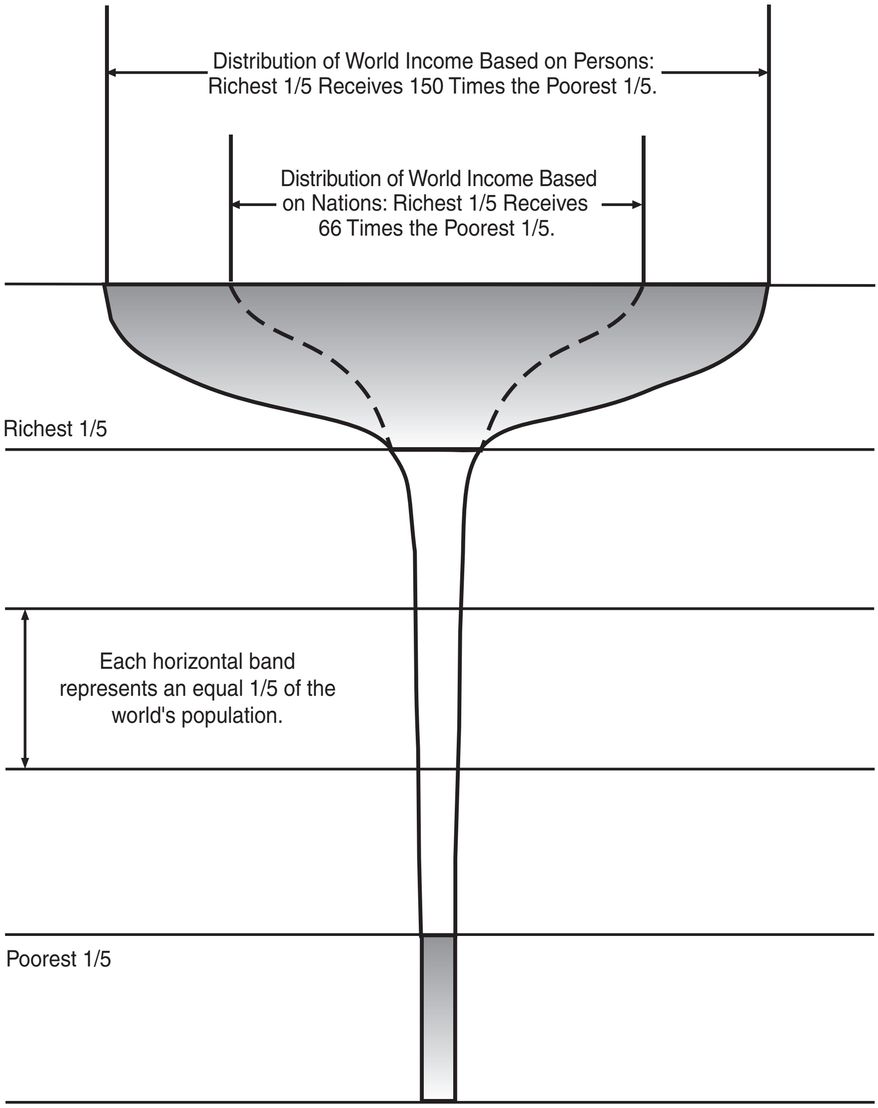


Figure 6.4 Champagne Glass of World Wealth Distribution
Sources: United Nations, 1998a: 219; Bell and Ashwood, 2016: 35.

Furthermore, a stark and equally severe *consumption gap*, with significant implications for differences in lifestyles and well-being, is evident. In the 1990s, compared to an average LDC person, an average MDC person consumed 3 times as much grain, fish, and fresh water; 6 times as much meat; 10 times as much energy and timber; 13 times as much iron and steel; 14 times as much paper; and 18 times as many chemicals (Durning, 1992: 50). Along with the spread of affluent lifestyles, others live in physical deprivation. According to the FAO, between 2012 and 2014 approximately 800 million people were undernourished (about 11 percent of the world's population).

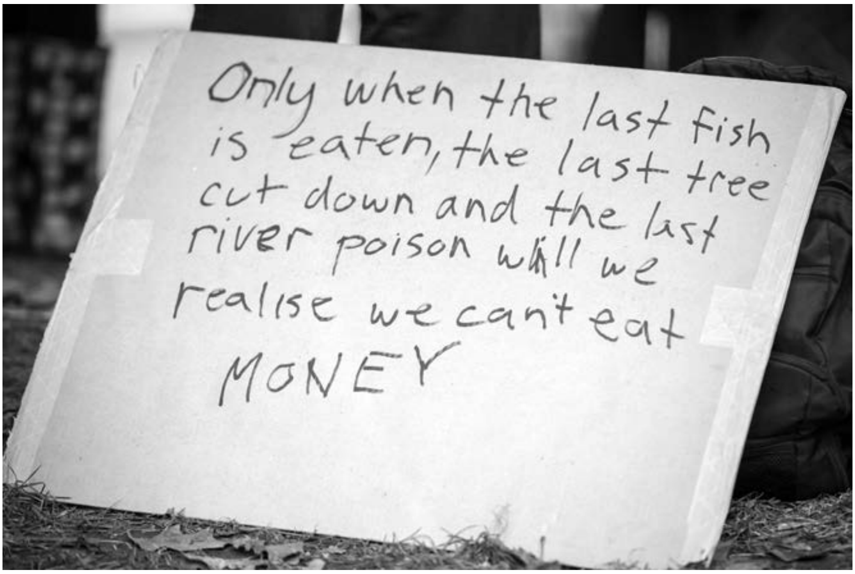


Figure 6.5 This sign was seen at an Occupy protest in Toronto, Canada. The quotation had appeared on a Greenpeace banner in the 1980s.

Also in 2014, 35 countries were in need of external food assistance (Bell and Ashwood, 2016). Moreover, as we discussed, a large number of the world's poor live in slums that expose them to a wide range of environmental hazards ranging from poor weather of all sorts, to degraded housing in hazard-prone areas, raw sewage, rats and other pests. Such conditions increase their vulnerability to landslides, flooding, infectious diseases, electrocutions, chemical contamination, and in some places like Mumbai, when private developers come knocking—your dwelling is simply bulldozed overnight (Bell and Ashwood, 2016; Gratz, 2013). It is estimated that about1 billion people have to defecate in the open. Consequently, about 1.8 billion people drink water contaminated with feces. In 2012, 600,000 children died from diarrheal diseases, often the outcome of these unsanitary conditions (Bell and Ashwood, 2016: 37–38). Poor sanitation is a global health problem!

There also is a global *pollution gap*—the world's affluent populations create more pollution per capita than poorer populations. In Chapter Three we introduced the concept of *ecological unequal exchange* whereby wealthy countries internalize the benefits of global industrial production while externalizing the negative costs to developing countries—toxic wastes, hazardous extraction, and dirty manufacturing. We also discussed climate injustice based on the carbon emissions gap by which wealthy countries emit far more carbon per capita than developing countries which are disproportionately burdened with the impacts of climate change. Even though China produces more CO_2 emissions in total than the US, the reverse is true when adjusting for population: China's per capita emissions are 6.52 metric tons compared to the United States' 17.62 (Bell and Ashwood, 2016: 37).

Figure 6.6 Slum dwellings along a river

INEQUALITY AND ENVIRONMENTAL IMPACT

It might be obvious to you how social and political sustainability is jeopardized by such gaping domestic and global inequality, but not how growing inequality is *itself* a potent and proximate cause of environmental degradation.

Ample evidence shows that people at either end of the income spectrum are more likely than those in the middle to damage the earth's ecological health—the rich because their affluent lifestyles are likely to lead them to consume a huge and disproportionate share of the earth's food, energy, raw materials, and manufactured goods, and the poor because their poverty drives them to damage and abuse the environment. The poorer classes in MDCs damage the environment not because they consume so much, but because they are able to afford mainly older, cheaper, less durable, less efficient, and more environmentally damaging products—autos, appliances, homes, and so forth. Thus such savage inequality means that people not only have greatly different levels of material consumption and security, but also impact and experience environmental problems in different ways. The affluent are able to respond to environmental problems with minimal consequences for modifying their lifestyles. They are able to afford higher prices or energy taxes or to purchase more efficient homes, autos, or appliances. Poor people are less able to do so. Their poverty may pressure them to modify behavior or curtail consumption even more. In other words, the affluent—who can afford the newest and most efficient of everything—damage the environment because of the sheer volume of energy and material they consume. The poor do so because whatever they consume is likely to have a greater per unit environmental impact (Dillman et al., 1983; Lutzenhiser and Hackett, 1993). It is important to note that it is not the *poorest* among the poor—who have no autos, apartments, or appliances of any kind—who are environmentally most damaging. It is rather segments of unskilled workers (working class, or lower middle class) who still have sufficient amenities that impact the environment.

In LDCs, population pressure and inequitable income distribution push many of the poor onto fragile lands where they overexploit local resource bases, sacrificing the future to salvage the present. Short-term practices such as abbreviated fallow periods, harvests exceeding regeneration rates, depletion of topsoil, and deforestation all permit survival in the present but place an enormous burden upon environmental sustainability and future generations (Goodland et al., 1993: 7). In fact, with uncanny regularity, the world's most impoverished regions also suffer the worst ecological damage; maps of the two are almost interchangeable. In China, India, Pakistan, and Afghanistan, for instance, the impoverished live in degraded semi-arid and arid regions or in the crowded hill country surrounding the Himalayas; Chinese poverty is particularly concentrated on the Loess Plateau, where soil is eroding on a legendary scale (Durning, 1989: 45).

Often, the environmentally destructive behavior of the world's poor is connected with highly skewed land ownership patterns. Rural small landholders whose land tenure is secure rarely overburden their land, even if they are poor. But dispossessed and insecure rural households often have no choice but to do so. Hired workers, hired managers, and tenant farmers are not likely to care for land as well as owners do (which is also evident in the United States!). Being landless is in fact a common condition among rural households in many LDCs. While such poverty impacts the environment, the causality is not one way. Even before it is degraded, a marginal natural environment cannot lift its inhabitants out of poverty. Poor areas and poor people can destroy each other. While the indigenous peoples of North America are often not landless, a history of stolen lands, broken treaties, and displacement to marginal land areas perpetuates a vicious cycle of poverty and vulnerability to environmental and climate induced harms (Wildcat, 2014).

Illegal and unregulated resource extraction often comes with highly skewed land ownership patterns. Illegal resource extraction—oil, timber, diamonds, copper—is closely linked to arms trafficking, paramilitary violent conflict, human rights violations and modern day slavery, humanitarian disasters (e.g., famine), and *environmental destruction* and *disaster.* The beneficiaries of such illegal resource extraction are the MDCs, but the burdens of sociopolitical conditions and environmental devastation are shouldered by LDCs and the world's poor (Bales, 2016; Renner, 2002: 149–172). Once again, we have the problem of ecological unequal exchange.

The affluent classes of the MDCs also threaten the global ecosystem, but not because they are desperate with few alternatives. MDCs have consumerist cultures, purchasing powers, and economic arrangements through the world market economy to consume

Figure 6.7 The stark contrast between the rich and poor in Rio de Janeiro

a disproportionate share of the world's resources. They account for a disproportionate share of resource depletion, environmental pollution (including greenhouse gas emissions), and habitat degradation. A world full of affluent societies that consume at such levels is an ecological impossibility (Durning, 1994: 12).

In sum, affluence *and* poverty both threaten the environment, and they do so increasingly as the chasm of social inequalities widens, driven partly by contemporary globalization processes. Reducing social inequality both within and between nations would reduce pressure on the environment (Gareau, 2012). As seen in international climate change diplomacy, it is unlikely that the world's poor or developing nations will agree willingly to preserve or restore their natural environment (usually by lowering their consumption in the near time horizon) unless questions of *equity* are addressed. To those who live in misery, talk of "saving the environment" by the world's wealthy often sounds like a new form of imperialism: *green imperialism.* Some argue that poverty reduction must come before environmental sustainability, while others argue that environmental sustainability is a prerequisite for social sustainability. This is a classic chicken-or-egg question, but how we answer it has important policy implications (Passarini, 1998: 64). It also might not need to be an either/or scenario.

SUSTAINABILITY

Ideas about sustainable societies and development have long and mixed histories. In the last decades, these notions transcended the specialized concerns of scholars to become common goals, or at least irresistible slogans, in public discourse and debate about environmental issues. What is sustainable development? Conceptually and abstractly, the matter is quite simple: *Sustainable* means that the change process or activity can be maintained without exhaustion or collapse; *development* means that change and improvement in human well-being can occur as a dynamic process (Southwick, 1996: 96). It does not mean profligate use of the natural world without regard to the future, but neither does it imply a static condition. In human terms, it means inventing ways of meeting human needs while preserving the capacity of the biophysical environment to do so. A sustainable society "can persist over generations without undermining either its physical or its social systems of support" (Meadows et al., 1992: 209). A sustainable society is one that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987).

Historically, sustainable development probably seemed like a utopian idea. Nor was it necessary to think about it much. After all, human populations were smaller, economic technologies less powerful, and nature's bounty seemed infinite. But now coming to some approximation of sustainability is not just a nice idea; it is imperative to consider it for the future of the world's people—certainly for a future that is materially secure, reasonably equitable, and democratic. Who could really oppose sustainability or development? As an old saying has it, "No one wants to dance with the devil."

Sustainability is often spoken of in terms of the *three E's*—economics, ecology, and (social) equity. It invokes a vision of human welfare that takes into consideration both *inter*- and *intra*-generational equity. It neither borrows from future generations nor lives at the expense of current generations. But lurking just under the surface of these abstractions are substantial conflicts between actors and institutions (Passarini, 1998: 60–63). Consider the conflicts of interest generated by public debate about whether to encourage or discourage material consumption of particular products (like gasoline or inorganic fertilizers). People who sell the products, who immediately benefit from their use compared to those whose health and ecosystems are endangered by their use, are likely to have *very* different outlooks and interests. Similarly, what needs justify the generation of environmental toxins and pollutants? Who should pay the costs of their abatement, or what resources (physical or biotic) should be kept free of human impact, or left for future generations (like virgin forests or wetlands)?

In public discourse, *sustainable development* and associated notions like *carrying capacity* turn out to be universally acknowledged but inherently politicized concepts. The resulting controversy generates different advocacy organizations and movements with different objectives, resources, and political influence. In the United States, for example, the Sierra Club, a large environmentalist organization that has existed for decades, and the Sahara Club have similar names. The Sahara Club was formed in the late twentieth century by American interest groups fed up with "pious environmentalists" trying to take away individual freedoms, and eliminate jobs and weaken the nation's economic strength. In its view, humans are masters of the earth, and its resources are to be exploited for human use (Southwick, 1996: xix).

Scholarly controversy about sustainability goes to the very heart of the paradigm conflicts that have been discussed. Think again about potential conflicts integrating the three E's (economy, ecology, equity). For policy, do we start with developing an economy that is less damaging to nature while maintaining rapacious consumption? Do we begin by preserving ecosystems, even if it means sequestering them from human exploitation and restraining consumption? Do we begin with equity, addressing poverty, and social inequality to produce the cohesion and social sustainability that make agreements about environmental sustainability even possible (Gould, 1998; Passarini, 1998; Redclift, 1987)? Does this have a familiar sound? It should. Paradigms: Resource allocation? Growth in finite systems? Maldistribution and social stratification?

Similarly, the concept of carrying capacity, so useful for population ecologists, is controversial when extended to human systems and the planetary scale. Chapter One discussed the idea that the environment has three functions for humans: as living space, as supply depot, and as waste depository. Dunlap and Catton, as well as others, think that the exponential growth of the human population and their uses of the earth mean that we have already exceeded its long-term carrying capacity (2002). See Figure 1.7 in Chapter One.

In fact, Catton has argued that there is no such thing as sustainable development. It is a rhetorical and ideological term for those who wish to continue destructive growth and "feel good about it" (1997: 175–178). According to theoretical biologist Joel Cohen (1995), concepts like sustainable development or the earth's carrying capacity are important, but not very useful for scientific research. Questions like "How many people can the earth support?" are inherently *normative* and value laden. How many and at what levels of material well-being? With what technologies? Living in what kinds of biophysical environments? With what kinds of cultural values or political and legal institutions? Rather than a benign and participatory sustainability, one could imagine a sustainability of managed scarcity coercively administered by powerful authoritarian elites—resembling a virtual societal slave labor camp (see Heilbroner, 1974; Schnaiberg and Gould, 1994).

It may surprise you to learn that we generally think Cohen is right. Sustainability and carrying capacity are not easily quantifiable concepts. *But please don't misunderstand.* They are critical as normative social facts and helpful to envision worlds we would like, or wish to avoid. In the larger picture, they embody the only policy questions that really matter, but which require citizens, scientists, and policy makers to address difficult normative and value questions. Natural scientists and neoclassical economists are not accustomed to dealing with normative social facts or policies involving complex normative solutions—but those are sociological specialties. Passarini suggested several sociological contexts for research that contribute to understanding sustainability: time horizons, risk analysis, differences between public and private realms, and social change

(1998). We will return to some of these issues (time horizons and social change) toward the end of this chapter.

GROWTH AND SUSTAINABILITY: TWO PERSPECTIVES

Since 1950, the world's human population has tripled to more than 7 billion. Since then, global economic output has quintupled. The cultural ethos of consumerism that favors high economic growth and ever-expanding consumption is rapidly diffusing around the world. At the same time, the chasm of inequality grows and poverty proliferates, while the prospects for greater global equity seem remote. There are signs that most ecosystems and biospheric environmental systems are becoming degraded, coupled with the prospect of runaway climate change.

Suppose these trends continue. Can they do so without devastating the planet? Even if humans can use their ingenuity to survive—under what conditions? Are we ingenious enough to invent and "grow" our way into a sustainable high-consumption world for *very* large numbers of people on the planet? These questions emerged in the last half of the twentieth century and continue to be debated. There are different ways of thinking about the trajectory of humans on the planet, and within scientific and intellectual circles diverse and conflicting theories have their defenders, supporting evidence, and strong critics. We examine two of them, (1) the limits to growth, and (2) ecological modernization.

LIMITS TO GROWTH: OUTBREAK-CRASH

Limits to growth (LG) is a human ecology perspective articulated in the 1970s as a result of the growing popularity of neo-Malthusian ideas about the longer-term global consequences of exponential growth in population, industrial production, and material consumption. The term LG was invented by the *Club of Rome* (a nonprofit research foundation), which commissioned computer simulations of global data about growth over time, stretching from past and projected into the future. Reports based on these studies have been continually updated (Meadows et al., 1972, 1992, 2004; also see www.clubofrome.org). They have suggested that the combination of population growth, exponentially growing per capita economic productivity and consumption, and the resultant pollution would eventually overburden the subsistence base for human societies. This would mean a decline in human population, development, and well-being for people around the world. They hypothesized an "outbreak-crash" model of the human–environment future, a model well known to population ecologists. See Figure 6.8.

Related perspectives arrive at the LG prognosis by different assumptions. Conflict and neo-Marxist perspectives, as applied to the environment, argue that environmental

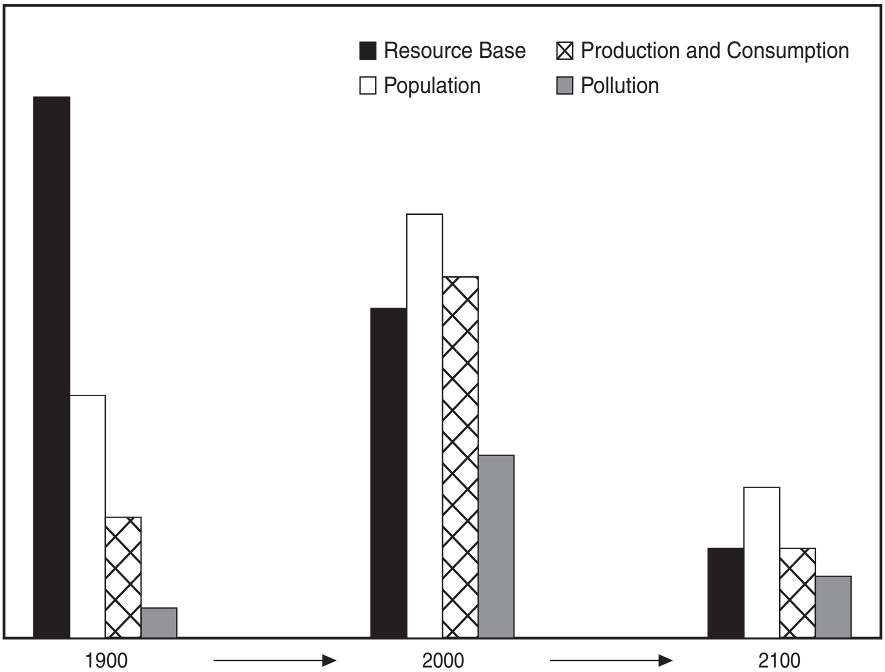


Figure 6.8 The Limits Scenario "Standard Run"
Source: Based on Meadows et al. (2004: 169).

exploitation is driven by the structure of market economies, the institutions of modernity, and the relentless commitment to growth in modern, particularly capitalist, production systems (Benton, 1989; Bookchin, 1982; Roberts and Grimes, 2002; Schnaiberg, 1980). For Schnaiberg and Gould (1994), a "treadmill of production" (mentioned in Chapter One) is the driving force behind modern economies, as well as environmental degradation. To maintain profits, producers must constantly seek to expand production, creating an "enduring conflict" between society and the environment. Expansion is, however, limited because of ultimately finite natural resources. O'Connor described this as the "second contradiction of capitalism," whereby escalating production depletes the natural resources required to sustain production, which escalates costs, resulting in shrinking profits (O'Connor, 1994; York et al., 2003: 286).

LIMITS OF GROWTH: MEASURES, EVIDENCE, AND CRITICISMS

In a famous attempt to capture the relationship between growing population, consumption, and environmental impacts, biologist Paul Ehrlich and energy scientist John Holdren created the $I = PAT$ equation. They argued that the impact (I) of any population or nation upon its environment is a product of its population (P), its level of affluence (A), and the damage done by particular technologies (T) (Ehrlich and Holdren, 1974). Thus:

$$I = P \times A \times T$$

This is an elegantly simple way of illustrating different dimensions of environmental impact as functions of the number of people, the amount of goods (resources) they consume, and the technologies they use to produce those goods. The relative weights of these are subject to debate, but it is methodologically useful for scientific research because it is possible to develop quantitative summary measures for each term of the formula (Dunlap, 1992: 464).

Population size and growth rates are obvious indicators for *P*. For *A*, you could use measures of per capita gross domestic product, or per capita consumption of selected goods (copper, meat, steel, timber, cars, plastics, etc.), and for *T*, per capita kWh of electricity, or some other energy measure of economic productivity. *A* models inequality more broadly, and *T* models a measurable item of material culture, but implies nonmaterial culture (including beliefs, worldviews, and values) more broadly considered. *I* can be measured as hectares of eroded lands or deforestation, depleted ocean fish, pollution, CO_2 emissions, etc. Tom Dietz emphasized that it is *PA* that matters, not just growth in population alone. When considering the human environmental impact, it is useful to think of *biospheric equivalent persons* (*BEP*) who account for the per capita impact rather than just growing numbers of people ($BEP = AT/P$). If we worry about soil erosion, declining biodiversity, greenhouse emissions, and the like, we should worry more about the per capita impact of North Americans and Europeans, rather than only the numbers of Indians or Chinese (Dietz, 1996/1997).

Although useful as a heuristic notion, the IPAT (and its derivatives noted above) is of limited use in hypothesis testing, since it is an accounting equation that must balance by definition. So balanced, it assumes *a priori* that the effects of P, A, and T on I are completely proportional. To address this limitation, York, Dietz, and Rosa (2004) reformulated the IPAT equation in a stochastic form, and studied the interaction of these variables on a sample of nations. They termed this STIRPAT for Stochastic estimate of Impacts by Regression on Population, Affluence, and Technology. Empirical analyses using STIRPAT focused on cross-national analyses of the driving forces of environmental degradation, particularly demographic and economic factors (Dietz and Rosa, 1994). The most striking finding from their research program that spanned more than a decade was that population size is a persistent major factor influencing the scale of national environmental impacts of all kinds. It is not, however, merely a reaffirmation of neo-Malthusian thinking. After controlling for population size, they found dramatic inequality among nations, with wealthy core nations consuming the bulk of the world's resources and emitting the bulk of the world's wastes. National impacts increased proportionately with affluence, providing little support for the "environmental Kuznets curve" hypothesis or Ecological Modernization theory (discussed subsequently) (Rosa and Dietz, 2004; York et al., 2003a, 2003b).

Ecological economist Mathis Wackernagel and his colleagues developed more widely known evidence supporting LG by measuring what they called the human *ecological footprint*—at both the household and national levels (Wackernagel and Rees, 1996; Wackernagel et al., 1999, 2000, 2002; see, www.footprintnetwork.org).

The ecological footprint is the biologically productive land and water required to produce the resources consumed and to assimilate the wastes generated by a given human population. It is an aggregate measure that reflects the fact that land is a basis for the three functional benefits provided to humans by the biophysical environment: living space, source of resources, and sink for wastes. Thus, it includes the amount of land necessary to absorb CO_2 emissions (York et al., 2003a: 282). An advantage of this method is that it does not require researchers to know specifically what each consumed resource is used for, and can capture indirect effects of consumption that are difficult to measure. In mathematical terms, *consumption* = [production + imports] – exports (Wackernagel et al., 2000). The earth's total biocapacity (regenerative capacity obtainable to serve the footprint demand) per capita for humans was calculated at about 2.1 hectares—not accounting for the other animals on the planet. That is, nations with ecological footprints at or below 2.1 hectares per capita could be replicated by all nations without threatening long-term sustainability (if there were no further population growth).

Every two years, the Global Footprint Network, World Wildlife Fund (WWF), and the Zoological Society of London issue the *Living Planet Report* which summarizes research that uses the ecological footprint and other complementary measures to analyze human pressure on the planet, make cross-cultural comparisons, and determine impacts on the natural world. The overarching conclusion of the 2014 *Living Planet Report* is current human demands on the earth are more than 50 percent larger than nature's regenerative capacity. Humanity's ecological footprint has more than doubled since 1961. A disproportionate share of this growth is attributable to carbon emissions, which in 1961 comprised 36 percent of the ecological footprint; by 2010 it was 53 percent. The overconsumption of the earth's resources has resulted in the decline of vertebrate wildlife populations by more than half since 1970. The global average footprint is 2.6 hectares per person, but the biocapacity per person in the world is 1.7 global hectares. It would take the resources of 1.5 earths to produce current demands—this is *global overshoot*—trees are being cut and water is being pumped faster than they can be regenerated, and CO_2 is emitted faster than nature's capacity to sequester it. Remarkably, national footprints range from countries with the smallest, Haiti, Eritrea, and Timor-Leste at under 0.6 hectares per person, to the country with the largest, Kuwait at 10.4 hectares (26 acres) per person. The following countries have the largest ecological footprint: Kuwait, Qatar, United Arab Emirates, Denmark, Belgium, Trinidad, and Tobago, Singapore, United States, Bahrain, and Sweden. The US ecological footprint is 7 hectares (17.5 acres) per person (Living Planet Report, 2014). Overall, a great deal of ecological inequality exists.

Quite a few sociological studies have analyzed the social, economic, and political factors that influence the size of a country's ecological footprint (Jorgenson, 2003, 2005; Howell et al., 2013; York et al., 2009). Jorgenson's (2003) pioneering cross-national study showed that a nation's position in the world-system shapes the size of its per capita ecological footprint. A country's position in the world-system was based on an index that combined measures of a country's relative military power, economic power, and global dependence. He hypothesized that the ecological footprints of core nations would be highest, followed by the high semi-periphery, semi-periphery, and then periphery nations with the lowest. His analysis of a sample of 208 nations confirmed that. Moreover, the position of a nation in the world-system, when combined with the indirect effects of other variables hypothesized to increase consumption (domestic inequality, urbanization, and the literacy rate), explained 77 percent of the variation in a nation's per capita ecological footprint. Note the importance of the other variables considered: Both urbanization and high literacy rates signify higher consumption and the "cultural ideology of consumerism/consumption"; thus as with the STIRPAT research, the size of the ecological footprint is not a simple function of population or gross national product (GDP) (Clapp, 2002).

Most studies that have examined the relationship between ecological inequality, consumption, and environmental degradation have been cross-national. Howell et al. (2013) developed a US domestic model based on Jorgenson's (2003) framework. Ecological footprints only measure national environmental impact so they used the human ecological footprint (HEF), which measures the combined influence of population density, land transformation, human access, and power infrastructure at the county level across the US. In addition, EPA AirData Criteria Air Pollutants Emissions data was used to estimate the cumulative impact on local air quality. Place in the US economy was modeled similar to the world system framework by defining core counties as those with highly urbanized localities, which "command and control" many industries in other places in the nation. Periphery counties were defined as those that are dependent on farming (production of crops or livestock) or the extraction of natural resources through mining. Similar to Jorgenson's findings, place in the US economy (core/periphery) and income inequality affect the HEF. Overall, periphery counties bear a disproportionate negative environmental impact although core counties were more negatively affected by greater CO_2 emissions. This study suggests that internal ecological unequal exchange is another important piece of the sustainability puzzle.

Besides IPAT, STIRPAT, and Ecological Footprint measures, there is a fourth empirical research tradition supporting the LG model that needs to be mentioned. That is materials flow analysis (MFA), first developed by Ayres and Kneese (1968). MFA analyses look at growth in human societies' *material throughput* (i.e., biomass, construction materials, metals, minerals, and fossil fuels). Importantly, most materials remain in the economy for only a short period of time. Thus, demand for ever increasing supplies of throughput results in source problems—ecosystem degradation and resource depletion—and sink problems—pollution and comprised capacity of ecosystems to absorb the dissipated energy. LG thinkers conclude economic growth must be decoupled from throughput (Victor and Jackson, 2015).

Ecological economist Herman Daly and colleagues developed the Index of Sustainable Economic Welfare (ISEW) to capture the good and bad of economic growth by subtracting from GDP the value of negative social and environmental externalities, such as commuting costs, "defensive" health expenditures, pollution, and resource depletion, and adding the value of activity that promotes well-being, such as unpaid household labor. From 1950 to 1990, the ISEW per capita increased more slowly than GDP per capita, well-being lagged far behind output, and by the decade of 1980–1990, the ISEW per capita declined. Several studies in other countries have produced similar findings. Thus, a point is reached when the negative consequences of economic growth become uneconomic by causing more harm than good (Victor and Jackson, 2015).

Yet, critics of the LG perspective note that it depends on the notion of a fixed and finite biospheric carrying capacity, and scientific projections of overshoot have not proven correct. Critics, both popular and scholarly, never tire of pointing out that the environmental apocalypse never arrived on schedule. For instance, neo-Malthusian Paul Ehrlich predicted that most of mankind would be starving by 1975. More recently, the planetary boundaries perspective discussed in Chapters Two and Three has been labeled by some as another LG apocalyptic scenario. Remember the planetary boundaries perspective identifies a safe operating space for humanity within nine planetary systems. If a boundary is crossed (two-and-a-half have been—biodiversity, climate change, and the nitrogen cycle—but not phosphorous within the biogeochemical system), a tipping point could be reached risking irreversible, unpredictable, and catastrophic harm. It is the framework of the Anthropocene, illustrating how humanity is becoming the driving force of geological change. While it has become quite popular, scientists have debated the utility of the perspective. Notably, the ability of scientists to choose the right upper limits or parameters for each system has been questioned, and tipping points are very hard to predict (Zimmer, 2009). Moreover, science must be interpreted and is politicized. Some scientists worry that a false sense of security may be derived by seeing available space within a system (Phillips, 2014). This does not mean the planetary boundaries frame should be thrown out, but rather it is important to see how it is *limited*.

Critics also contend that the LG concern with global overshoot minimizes the importance of "elasticity of substitution" produced by technological innovation. For instance, the US based environmental NGO the Breakthrough Institute, that views nuclear energy and genetic modification as green alternatives to current throughput concerns, does not accept the LG thesis that economic growth must be decoupled from throughput (Phillips, 2014). They see human technology and ingenuity as trumping carrying capacity. Humans can alter the rate at which they consume throughput. As such, they offer what is called an ecological modernist view of sustainability (see, http://thebreakthrough.org).

ECOLOGICAL MODERNIZATION: PROSPERITY WHILE PROTECTING THE ENVIRONMENT

There is a radically different point of view, suggested by neoclassical economists, environmental economists, and some (mainly European) sociologists. They acknowledge that growth and modernity have produced environmental problems, but argue that further economic development could solve such problems rather than add to them.

Environmental quality is assumed to be a "luxury good," affordable and of interest mainly to affluent societies. When requisite affluent levels are reached, public concern, pressure from NGOs, and environmental state policies will make the mitigation of environmental problems cost-effective, and lead businesses to invest in environmental protection (e.g., "green technologies"). This hypothesized relationship, known as the *environmental Kuznets curve*, was named after economist Simon Kuznets (1955), who demonstrated a similar relationship between economic development and income inequality—that economic inequality grows in early phases of economic growth but shrinks in later phases as economies "mature." See Nordstrom and Vaughan (1999) for a summary of Kuznets's theory and research.

By the late 1980s, environmental sociologist Fred Buttel and colleagues noted that the focus of environmental debates was shifting from "limits to growth" to "global change" (1990), in other words, the "environmental dimensions of globalization processes" (Mol, 2003: 55). In 1987, the World Commission on Environment and Development advocated a global ethic and reforms directed at sustainable development. Indeed, *sustainable development* became the rhetorical unifying slogan of the times. Even having many critics, the language of sustainable development has entered contemporary discourses and retains currency across a remarkably broad swath of the political spectrum. This new emphasis was stimulated by accumulating evidence of a slowdown of environmental disruptions, and a decline in energy intensity in many of the most developed nations, such as Germany, the Netherlands, Japan, the United States, and Scandinavian nations. Some saw this as signaling the beginnings of the decoupling of material flows (throughput) from economic flows, and the transformation of modern institutions into being less destructive of the human subsistence base.

Called *ecological modernization* (EM), it was theorized first in Western Europe, particularly in Germany, the Netherlands, and the United Kingdom. It can be described as a less deterministic sociological rendition of the ideas of neoclassical economists, and is similar but not identical to other strands of sociological theory about the evolution of modern societies, such as post-materialism (Inglehart, 1990), reflexive modernization (Beck, 1995; Giddens, 1991), and the emergence of a "world civil society" (Frank et al., 2000). EM is more popularly known by a variety of names, including ecoefficiency, clean production, industrial ecology, natural capitalism, restorative technology, the natural step, design for the environment, and the next industrial revolution (Brown, 2001; Collins and Porras, 2002; Daily and Ellison, 2002; Daly and Cobb, 1989; Hawken et al., 2000; McDonough and Braungart, 2002; Prugh et al., 2000).

ECOLOGICAL MODERNIZATION PROCESSES

Let us be more specific. Some processes by which EM works include:

- *Biomimicry*, restructuring an industrial economy to resemble an ecosystem with recycling and feedback loops—and minimizing linear processes of production and consumption that connect extractive sources and waste sinks.

- *Cogeneration* or using the waste material of one industrial process as the "feedstock" of another (like using the heat generated by a factory to produce electricity for many uses). Industrial engineers are experimenting with "low emissions" industrial parks, whose tenants constitute an industrial ecosystem in which one company will feed upon the nontoxic and useful wastes of another.
- *Radically increased resource productivity*, which slows the depletion of natural resources and lowers pollution, toxicity, and—often—produces more jobs. Nearly all environmental and much social harm flows from wasteful use of natural and human resources. It means that for each unit of output, there will be progressively fewer environmental resources required. Consumer appliances, for instance, use far less material than they did in the 1970s, but it is worth noting that such "dematerialization" is often canceled by increased consumption or growth by investment in other infrastructures.
- *A service and flow economy* is emerging, where instead of being made and sold, goods are leased to consumers, serviced, and recycled (or remanufactured) by producers. A service and flow economy is being tried for industrial equipment, office copy machines, commercial carpets, and even automobiles. Corporations committed to EM (by any of its names) include big names, like Monsanto, 3M, DuPont, Duracell, and Johnson & Johnson. By practicing the three R's—reduce, reuse, recycle—they have reduced their environmental impacts, saved money, and received welcome publicity (Cunningham et al., 2005: 514).
- *Incentive shifting* like changes in taxes, markets, or government subsidies can counter many of the "perverse subsidies" that create ecological damage. Such incentive shifts do not increase taxes overall, but reduce some taxes (like income taxes) while increasing others (such as taxes on fossil fuel burning, the generation of garbage and toxic wastes, or the use of pesticides). Virtually every European Union nation is experimenting with such tax and subsidy shifts, with some real gains to show for it (Roodman, 2000: 138–139).

EM does not imply a diminution of human well-being, as many allege about proposed LG reforms. Rather, EM means "re-rationalizing the division of labor of modern industrialism" to be less ecologically destructive, and to internalize costs and impacts that are currently externalized (Mol and Sonnenfeld, 2000). Illustrations of EM come from diverse places, and are manifest at different levels. Some involve political policy change (as in the case of European incentive shifting), others involve subpolitical institutional (e.g., corporate) change, and other examples involve cultural and behavioral change through the operation of collective action and social movements (Mol, 2003).

ECOLOGICAL MODERNIZATION: EVIDENCE AND CRITICISMS

Most rigorous contemporary social science empirical research has supported the LG and ecological footprint notions discussed earlier. Yet research supportive of EM has emerged—several dozen studies, predominantly case studies on the energy and related economic sectors in industrialized nations, but also in Southeast Asia (Mol, 2003: 57). While important for an in-depth understanding of particular cases, critics argued that this is a weakness, since most EM research is not based on systematic measures of probability samples of nations, and that they demonstrate more about institutional change and symbols of hope rather than measurable environmental damage (Buttel, 2000a: 118; York et al., 2003b). But several studies partly address these problems. Fisher (2004) and Fisher and Freudenburg (2004) examined predictors of CO_2 emissions. They studied a sample (N = 30) of industrial (OECD) nations for whom such data were available. Like other researchers, they used population growth and GDP as causal variables that might predict production of carbon emissions, but applied a more finely grained set of control variables.

In Fisher and Freudenburg's research, the variables most predictive of CO_2 production included industrial waste in 1998, percentage change in energy consumption 1980–1997, and motor vehicle travel per capita 1997. All of these declined in recent years, and were obviously the kinds of energy efficiency variables specified by EM. Significantly, when they were introduced as control variables, GDP per capita—a major LG variable—"did not prove to have significant effects on CO_2 in *any* of the multivariate analyses" (emphasis in the original) (Fisher and Freudenburg, 2004: 177). This is a case of EM having an effect on ecological conditions (not just institutional change); and since the variables in question were related to state policy, the researchers understood this as an instance where the environmental state has *substantive* rather than merely *symbolic* consequences.

Subsequent research suggests possibilities for efficiencies of the sort that the EM perspective envisions by examining the notion of the "treadmill of production" (Freudenburg, 2005, 2006). It does not question that economic growth in the United States is broadly connected with environmental degradation, but asks whether such degradation is inherent in capitalist (even "late capitalist") modes of production for all firms proportionately across the American economy. If so, environmental damage would be broadly evident across most sectors and firms in the US economy. Freudenburg examined toxic wastes from the 2,039 firms in 1993 that reported handling toxic wastes on their Toxic Release Inventory (TRI), required by the government. He found that 60 percent of all industrial emissions can be traced to just two industrial sectors—chemicals and primary metals. Within that small sector, which accounted for about 4 percent of the GNP, just two firms (DuPont and Freeport-McMoran) accounted for 14 percent of all the toxic releases in the nation, and one facility (Freeport McMoran's IMC-Agrico of St. James, Louisiana) alone accounted for 4.55 percent of the nation's over 2.8 billion pounds of toxic emissions in 1993 (2005: 20–21). The treadmill of production may be intrinsic to capitalist firms, but that generalization cloaks the enormous differences among them and the *disproportionality* of their impacts on the environment. While certainly not definitive proof of the validity of EM, it suggests that much of the economy has a potential for greater efficiencies and lower environmental impact as envisioned by EM theorists.

You can also find support for both LG and EM in other sectors of contemporary economies, such as agriculture and food. Making a case for LG would emphasize the overuse of water and soil erosion; agricultural disruption of natural habitats that destroys biodiversity; monoculture production of highly "technified" crops with agrichemicals, nitrates, and organic endocrine disrupters that find their way into water tables and the human body; and the growing depletion of ocean fisheries. Most of these topics were discussed in Chapters Two and Five. But other observations could support EM. Efficiencies are apparent in water use, and have reduced per-acre water use in the United States. Surprisingly, the total amount of water used has remained virtually unchanged since the 1970s, but during the same period irrigated acreage increased by 20 percent (Perry, 2004: 2A). Soil erosion slowed in its biggest historical drop ever, protected by the Conservation Reserve Program (CRP) and its successors in the 1985 Farm Bill, which encouraged the conversion of fragile farmland into grassland or trees. While industrialized agriculture captures headlines, Chapter Five noted the spread of "agroecological" practices among America's farmers as well as the proliferation of natural foods, and outdoor "farmers' markets" where people buy fresh foods from local producers. Vegetarian menu items are a choice available nearly everywhere now, quite different from earlier decades. At retail stores, "natural" or organic foods are now the fastest-growing shelf space (even though still relatively small markets at high prices). Chapter Five also mentioned similar cases of growing agroecology in other nations, including some LDCs like Cuba, China, Korea, and Sri Lanka (Halweil, 2000; Harper, 2005).

UNDERSTANDING THE CONTROVERSY

Having described two different views of human–environmental futures with very different implications for sustainability, let us examine them in tandem. The weight of the best evidence so far suggests that LG does indeed capture the dominant trend in human–environment relations, which is moving in an unsustainable direction. Or, paraphrasing York and his colleagues (2003a: 281), total environmental impacts generally increase steadily with economic development, but not quite proportionately due to improvements in efficiency. Understandably, social scientists have always depended more on evidence about "measures of central tendency" than variance and outliers. Possibly, the most serious criticism of EM is that it has not adequately distinguished between *efficiency* and *total resource consumption*. This problem has been termed the *Jevons paradox*, after the nineteenth-century British engineer Jevons, who observed that increases in the efficiency of coal use did not lead to decreases in total coal consumption, because greater efficiency made coal more attractive to investors ([1865], cited in York et al., 2003a). Greater efficiency can produce the rebound effect. Thus, dematerialization due to greater efficiencies envisioned by EM is something of an illusion. Critics are right when they suggest that, so far, EM illustrates more about the possibilities of institutional and cultural change than about change in the human impact on the earth's biophysical resources.

That said, suppose that EM succeeds significantly in MDCs, the main source of its supportive evidence so far. Two problems must still be dealt with. First, MDCs may appear to have dematerialized, but given globalization and processes of ecological unequal exchange, these gains may at least be partly attributable to the off-shoring of dirty manufacturing and importing of natural resources and manufactured goods from other areas. Second, people in LDCs are still seeking to replicate the kind of modernization and consumption growth that produces environmental overshoot. In spite of some evidence of EM from LDCs, in such countries where modernization has been even modestly successful (e.g., China and India) newly affluent classes are rapaciously adopting Western-style consumerism. China's rising global economic and political influence will have significant ramifications for global environmental change and policies. China has a mixed environmental record. On one hand, it produces terrible environmental harms and destruction, but on the other, it is implementing positive environmental policies (Gareau, 2012). A situation may emerge where EM succeeds in places and at times in both MDCs and LDCs. EM theory is rife with possibilities for environmental reforms in the direction of greater sustainability (Dunlap and Marshall, 2006: 31).

So far, however, processes of modernization, growth, and globalization illustrating LG and its pessimistic implications are the "main show," while EM processes are a distinctly visible "sideshow." Analysts use a homely metaphor, familiar to almost everyone, to illustrate—the tortoise and the hare. The hare can run very fast, but does so sporadically, often wasting time and going nowhere, while the tortoise plods along slowly but at a steady pace. Of course, the race is won by the tortoise. As York et al. note, the central question is "whether the hare of institutional and technological transformation can outpace the tortoise of relentless growth" (2003a: 280).

Figure 6.9 Green urban farming, Hong Kong, China

This is not only the opinion of a handful of academic researchers. In the 1990s, a broad consensus among the organized scientific bodies of the world about the importance of attending to the issues of limits and sustainability emerged (Science Advisory Board, US Environmental Protection Agency, 1990: 17; Union of Concerned Scientists, 1992). More recently, in July 2013, current and former government ministers from France, Sweden, Greece, Spain, and Brazil, met in Paris, for a conference titled, "An Innovative Society for the Twenty-First Century," to discuss the possibility of governments abandoning their commitment to on going economic growth to pursue other goals such as improving human well-being, sustainability, and environmental health. Even though the conference did not resonate outside of Europe, it showed some world leaders are willing to consider an alternative development pathway (Victor and Jackson, 2015).

In the United States, continuous economic growth is viewed almost like a law of nature. The idea gained prominence through post-WWII Keynesian economic policies. John Maynard Keynes, a British economist, essentially argued that government investment in the economy can induce full employment. As such, Keynesian economics provided the rationale for income maintenance programs like Social Security, expanding public works employment, and investment in infrastructure. The basic premise involves putting money in people's pockets so they can buy consumer goods. Consumer demand will create new jobs and lower unemployment—staving off the repeated crises of capitalism—recessions and depressions (Leicht and Fitzgerald, 2014; Victor and Jackson, 2015). It also spurred what environmental sociologist Michael Bell calls the *treadmill of consumption* by which people consume more material goods without any real gains in human satisfaction or well-being (Bell, 2004: 49).

Consider that the average person in 1960 consumed a third of the average person in 2008. Since 1990, average real-per-person spending has increased 42 percent. There has been a 300 percent increase in inflation-adjusted per person spending for furniture alone, and 80 percent for apparel (Schor, 2011: 26). But how has consumption increased, when the real earnings of the American middle class have stagnated? The answer quite simply is the extension of consumer credit. Today, in the United States, credit and debt far outstrip the incomes of average people. The current generation of American middle-class workers is in greater debt, earning less money, and working longer hours at less stable jobs than the previous generation. The real average credit card debt per household has risen from a little over $4,000 in 1990 to $9,000 in 2003 (Leicht and Fitzgerald, 2014). Since 1986, tuition for higher education has risen 500 percent (Derber, 2015). College students graduating in 2011 averaged $26,600 in student loan debt (Leicht and Fitzgerald, 2014). Debt causes numerous social and individual troubles, including destroyed credit scores and bankruptcy, less or no wealth to pass on to children, physical and mental health problems, and suicide. The treadmill of consumption is intertwined with the treadmill of production, and both are running on debt.

According to Nathan Hagens (2015), a former hedge fund manager and professor of human ecology, governments are relying on debt to power our economy forward.

Remember, we need energy to do everything, and consume anything! While cash or money places a claim on energy and resources, *debt* is a claim on *future energy and resources*. Increasingly, the energy we produce is being used to get the energy we need. A statistic used to measure the biophysical limitations of energy is the *energy return on energy invested* (EROEI). Since the beginning of modern oil production, the EROEI has been declining. In the case of oil discovery, it has fallen from a ratio of 100:1 to less than 10:1. A declining EROEI means that the productivity of energy extraction is decreasing. For more than a decade, oil production costs have increased 17 percent a year, but inflation has only averaged 2 percent per year. By subsidizing oil depletion and using credit, companies have moved on from the easy-to-access fuels, to extreme fossil fuel extraction (mining subsalt reserves like the tar sands, deep-water drilling, and fracking). These new methods are more energy intensive and require capital expenditures that are greater than oil prices. This cannot last, as energy prices will rise, and some creditors will get less than they are owed. Hagens points to three problems that make credit and debt unsustainable.

First, the highest-energy gain fuels (easy access oil) are depleted when debt is initially issued so that energy is usually more expensive to the creditor in the future than the debtor in the present. Second, to avoid the social costs of rising energy prices—increasing poverty and falling demand—more and more credit must be issued. Third, the productivity of debt declines similar to the EROEI of energy production, more debt has to be added to get small increases in gross domestic product (GDP). Since 2008 the Group of Seven wealthiest nations (Canada, France, Germany, Italy, Japan, United Kingdom, and the United States) have added $1 trillion per year to nominal GDP but only because debt increased by $18 trillion. Debt productivity has gotten so low that more debt is continually added to essentially tread water—maintain consumption and keep GDP slowly growing. If we continue with extreme fossil fuel production, the entire economy will have to be devoted to energy production, which means few funds left over to spend on education, health care, and other societal needs. Hagens surmises that we need to transition to renewable energy and increase efficiencies, but it is equally important that consumer expectations are reckoned with and leveled.

PROMOTING MORE SUSTAINABLE CONSUMPTION

The LG perspective is not a doomsday scenario, pure and simple; it should be taken as a future we would wish to avoid by more positive possibilities. At this point, you may be wondering exactly why consuming "more" is always preferable to stopping growth of consumption. It is so deeply embedded in American culture that the question "How much is enough?" appears unnatural.

EM provides many possibilities for reducing human impact per unit of natural resources, but they need to mean more than the justification for continued consumption on a massive scale (even if done efficiently). Positive change would mean productive efficiencies coupled with real reductions in material consumption. It would involve reining in the treadmill of consumption. The idea of reducing consumption and living more gently on the earth is not new. In fact it embodies the teachings of the world's religious traditions that emerged in pre-industrial agrarian societies. See Box 6.1.

Ideas about not desiring wealth recently became a visible social and cultural movement that urged people to adopt lifestyles of *voluntary simplicity* (Elgin, 1982). Similar ideas were popularized in the widely read book, *Small Is Beautiful* by maverick English economist and philosopher E. F. Schumacher (1973). In the 1980s, millions of Americans and Europeans were undertaking voluntary simplicity (Durning, 1992: 137). It means simpler habits and appliances (e.g., cooking from scratch rather than eating frozen manufactured convenience or fast foods, clotheslines rather than drying machines, walking, using mass transit, and bicycling more and certainly driving less). Voluntary simplicity would require more forethought and attention to how life is grounded in the seasons and nature. Lowering consumption need not deprive people of goods and services which *they say* really matter, and it may free them to pursue some—conversation, family and community gatherings, theater, music, and spirituality (Durning, 1992: 140–141; Schor, 2011). However, simple living *is* less convenient by many of today's standards. This is especially true in the US where the work–life balance is tilted in favor of the workplace. This means people have little spare time to pursue simpler habits. Plus, people running on a debt-powered treadmill of consumption end up working more to service their debt. Voluntary simplicity, however, has little relevance for the poor—they already live in an "involuntary simplicity" of a more malevolent kind.

In fact, relatively few people were willing to *voluntarily* give up the pleasures of "life in the fast lane" for a simpler lifestyle. Such efforts are opposed by powerful and well-financed marketing and media promotions that seek, rather successfully, to increase

BOX 6.1

RELIGIOUS TEACHINGS ABOUT DESIRES, WEALTH, AND POVERTY

- ***Christian:*** "It is easier for a camel to go through the eye of a needle than for a rich man to enter the kingdom of God." (Matthew 19: 23–24)
- ***Jewish:*** "Give me neither poverty nor riches." (Proverbs: 30: 8)
- ***Islamic:*** "Poverty is my pride." (Muhammad)
- ***Hindu:*** "That person who lives completely free from desires, with longing … attains peace." (Bhagavad Gita, 11.71)
- ***Buddhist:*** "Whoever in the world overcomes his selfish cravings, his sorrows fall away from him, like drops of water from a lotus flower." (Dhammapada, 336)
- ***Confucian:*** "Excess and deficiency are equally at fault." (Confucius, XI. 15)

Source: Durning (1992: 144).

material consumption—or at least the desire for it. Many in the MDCs spend more time and energy figuring out how to increase consumption rather than practice material frugality and voluntary simplicity! Yet the idea is more than a passing fad—it is a social (or in this case, cultural) movement of some significance (Bell, 2004; Schor, 2011).

GROWTH, WELL-BEING, AND HAPPINESS

As you read this, you may be thinking, "Voluntary simplicity might help, if enough people adopted that lifestyle, but would I (or we) really be happy if I were more frugal and refrained from consuming all the things and having the conveniences I want?"

Is there, in fact, a positive relationship between continual economic growth, affluence, and well-being or happiness? A solid body of research shows a decoupling of economic growth from economic prosperity and human well-being (Dietz and Jorgenson, 2014; Frey and Stutzer, 2002; Jorgenson and Givens, 2015; Schor, 2011; Victors and Jackson, 2015; Weiss, 2015). First, wealthy countries do not have to sacrifice their prosperity or high quality of life to reduce their ecological footprint. Second, the most commonly used measure of human well-being—life expectancy—is not compromised by decreasing environmental stressors, such as carbon emissions. For instance, World Bank data show that life expectancy and other objective indicators of a population's health no longer increase once income growth passes a moderate $7,000 to $8,000 per year (in international dollars) per capita (Frey and Stutzer, 2002). Third, research shows diversity across nations in how they achieve well-being, some do it efficiently (low CO_2 emissions) while others achieve it inefficiently (high CO_2 emissions) (Dietz and Jorgenson, 2014).

The carbon intensity of well-being (CIWB) is a relatively new measure used to examine a pathway to sustainability by reducing carbon emissions per unit of well-being. The CIWB is the ratio between per capita carbon emissions and well-being (life expectancy) (Jorgenson and Givens, 2015). Jorgenson and Givens analyzed the effect of economic development (GDP per capita) on consumption-based CIWB for 25 highly developed countries and 44 developing countries from 1990 to 2008. A consumption-based estimate of CO_2 emissions is used because MDCs have a higher well-being and are net importers of CO_2. The opposite is generally true for LDCs. They found that the effect of economic development on consumption-based CIWB is nearly static over time and much larger each year for developed countries than developing countries. So, wealthy countries' overconsumption of carbon is not producing gains in well-being. For developing countries, an unsustainable relationship between economic development and consumption-based CIWB exists.

Think about how this line of research could help inform international diplomacy on climate change as well as public health policy. First, the barriers to adopting aggressive mitigation measures to reduce CO_2 emissions include concerns over compromising economic prosperity, and fair access to the carbon space (Dietz and Jorgenson, 2014; Jorgenson and Givens, 2015; refer to Chapter Three). Second, the CIWB can be utilized to explore the effect of other social drivers of change that could influence the relationship between economic development and CIWB, such as the role of inequality (Jorgenson, 2015). Third, the public health literature shows a negative relationship between income inequality and life expectancy (Jorgenson, 2015). This has significant implications for health policy because it indicates that expansion of health care coverage cannot resolve inequities in health outcomes alone, and other policies that address income inequality should also be pursued (also see, Snowden et al., 2015).

Finally, and possibly even more surprising, beyond a certain income level, there is little evidence of improved subjective assessments of well-being or "happiness" (Rees, 2002: 258). Between 1957 and 1993, US real per capita income doubled. In 1957, 35 percent of American respondents to a poll by the National Opinion Research Center said they were "very happy." With doubled affluence in 1993, only 32 percent said the same.

BOX 6.2

WHY ARE COSTA RICANS HAPPY?

A Happy Planet Index (HPI), created in 2008, multiplies years of life expectancy by life satisfaction (as measured by the Gallup Poll and World Values Survey) to obtain "Happy Life Years," which are then divided by pressure on ecosystems as measured by the ecological footprint (Garrigues, 2010). In total 143 countries were ranked. Costa Rica ranked number 1, and the United States ranked number 114.

Why was Costa Rica at the top? It enjoys a privileged position as a mid-income nation where people have sufficient spare time and abundant interpersonal relations. The country abolished its military in 1948, allowing it to spend more on health and education. There is little difference in life expectancy across income levels, unlike the United States, which has vast differences depending on income, location, race, and other factors. The Costa Rican government's promotion of health and peace extends to its relationship with the planet. In the 1970s, the country began to respond to deforestation by setting aside rainforests in national parks that prohibited some logging. Even so, by 1986 illegal logging, cattle ranching, and development had reduced the country's rainforest from 73 percent to 21 percent of the landscape. In 1996, Costa Rica introduced a Payment for Environmental Services Program (PES) for some industries such as oil importers and water bottlers to do business in other countries, while other businesses contribute via a voluntary carbon offset fee. Such programs have had mixed results, but in connection with a UN-sponsored tree planting program begun in 2007, the country is once again more than half covered with rainforests. According to the HPI, the average Costa Rican has an ecological footprint one-fourth that of the average person in the United States (Garrigues, 2010: 12–15).

Americans are richer, and no happier (Myers and Diener, 1995: 14). Other studies in the United States and elsewhere report the same thing (Schor, 2011).

What does seem to affect subjective well-being is *relative* income. Among MDCs, it is not the richest societies that have the best individual and population health or subjective happiness, but rather those within countries with the smaller income gaps between the rich and the poor (Wilkinson, 1996). Another important factor is a sense of control over decisions affecting daily life. Frey and Stutzer (2002) found local democratic institutions that involve people in politics have a greater affect on happiness than rising income. Ironically, *growing inequality* and *greater alienation* of people from decision processes affecting their lives are major trends connected with globalization (Rees, 2002: 259). More sustainable societies will have to reverse these trends.

MORE SUSTAINABLE SOCIETIES?

Greater sustainability is a vision of a desirable future, and it is important to consider what kinds of characteristics more sustainable human sociocultural systems have. What would such sociocultural systems be like? Seeking to avert large-scale social-environmental collapse is supremely important, but the choice of methods is probably as important for many humans as averting the collapse itself. They can be adopted broadly, democratically, and aimed at reducing inequality within and between nations, or by economic stagnation or even political tyranny. The Great Recession of 2007–2009 decreased environmental stressors and harms, but undesirable economic and social outcomes were widely experienced. Sustainability does not necessitate zero economic growth, but rather it should decrease throughput and land transformations that degrade the soil, and it must rebuild damaged ecosystems (Victor and Jacskon, 2015). Completely sustainable societies have rarely (ever?) existed since the Neolithic revolution, but their broad characteristics are relatively clear as hypothetical or "ideal" types. These would relate to their (1) biological base, (2) population, (3) energy, (4) economic efficiency, (5) social forms, (6) culture, (7) resilience, and (8) inclusion in a world order.

1. A more sustainable society would work to conserve and restore its biological base, including fertile soil, grasslands, fisheries, forests, wetlands, freshwater bodies, and water tables. Insofar as possible, a more sustainable society creates agriculture systems to mimic nature in its diversity and mineral recycling rather than degrading nature with monoculture cultivation and industrial agrochemicals.
2. A more sustainable society would reduce population growth and work to stabilize its size. Slowing growth and a more stable population size implies that people have access to contraception and family health care, control resources to alleviate extreme material insecurity, and reduce gender inequality.
3. A more sustainable society would phase out the use of fossil fuels, and as we have noted, this needs to happen quicker than once thought. It would shift to depend

Figure 6.10 Green roofs are living roofs that have numerous benefits, which include sequestering carbon, helping with storm water management, reducing the heat island effect, reducing energy needs, enhancing biodiversity, and beautifying a city, to name a few. This green roof can be seen along English Bay in Monica's favorite city, Vancouver, British Columbia. (Learn about green roofs at http://www.greenroofs.org)

more on energy from a diversity of renewable energy sources—as feasible by local conditions and by preservation of carbon sinks (Roodman, 1999; Renner, 2015).

4. A more sustainable society would work to become economically and environmentally efficient in all senses. It would greatly increase investments in efficient equipment and buildings, and maximize the recycling of materials and wastes. More fundamentally, it would reduce waste in processes of production, packaging, and distribution of goods and services. It would also reduce waste by decreasing the material component of goods and services (Frosch and Gallopoulos, 1990; Hawken et al., 2000).
5. A more sustainable society would have social forms compatible with these natural, technical, and economic characteristics. In doing so, a new business model would reduce the number of hours per job. Reducing work hours means more people can work, a more productive work force, and a work–life balance compatible with the goals of sustainability (Schor, 2011). Coordinated decentralization and flexible centralization would exist. This means developing local community entrepreneurialism and small-scale networks, but also connecting to larger organizations, and urban life. People would come to understand that small is not always beautiful and large is not always ugly (Lewis, 1994: 254). Sustainable societies would continue to have social restraints on behavior, but tolerance of diversity, social justice, and democratic politics would be valued as necessary to elicit the required responsiveness, cooperation, and coordination of people (Roodman, 1999: 182–185). A more sustainable society would have policies aimed at inhibiting both grinding poverty and redundant material wealth.

6. A more sustainable society would require a culture of beliefs, values, and social paradigms that define and legitimize these natural, economic, and social characteristics. Dominant social paradigms that underlie belief and action would change appropriately. Much of the energy now devoted to consuming goods and accumulating material possessions could be directed at forming richer human relationships, stronger human communities, and greater outlets for artistic and cultural expression.
7. A more sustainable society would enhance its adaptive capacity to be *resilient*, meaning the ability of systems to absorb change and still persist (Carmin et al., 2015; Holling, 1973). Resiliency requires (1) persistence, or the capacity to maintain structure and function when faced with shocks and change (e.g., for a forest to withstand a storm), (2) adaptability, or the collective capacity to learn and adapt to changing conditions to stay within a desired state (e.g., safeguarding water supplies in a dry climate), and (3) transformability, meaning the capacity to innovate and transform in periods of crisis when conditions make the existing system untenable (e.g., turning a financial crisis into opportunities to revitalize local economies) (Pearson, 2008).
8. In a world where societies are connected with each other and to a shared global environment, more sustainable societies would be required to cooperate in the negotiation of sustainability—in terms of their different circumstances. A more sustainable society would participate in multinational accords, treaties, and regulatory agencies, and would work to promote a *world of sustainable societies* rather than one of growing inequality and environmental destruction. In a finite world, it would work to balance the requirements for some sort of global regulatory system with desires of national autonomy (Roodman, 1999: 176).

As you can see, the characteristics of more sustainable societies have been described in stark (some would say utopian) terms. But real sustainability may require some approximations of them. Are today's societies anywhere close to being such more sustainable ones? *Obviously not.* Surely sustainability is relative, and may involve change in small, incremental stages. But to be effective over time, they would need to result in dramatic social transformations. Given the difficulties of such social transformations, is it reasonable to think that they have even a chance of happening? That depends on how we think about social change.

INTEGRATING PERSPECTIVES: AGENCY, STRUCTURE, AND TIME HORIZONS

Many social scientists and analysts of historical change have been critical of the macro-structural theories—inherited from the nineteenth century—like functionalism and conflict theories, which assumed that social change and the evolution of societies is law-like and predictable. Such perspectives, from which the actions of real people were strangely absent, could not in fact give a very good account of the particulars of actual historical change. As such, Charles Tilly suggested some general features of social change:

1. Society is a process and undergoes constant change.
2. Change is mostly endogenous (from within), taking the form of self-transformation.
3. The motor of change is the power of human agency as individuals and collectivities.
4. The direction, goals, and speed of change are contestable among multiple agents and become the arena of conflicts and struggles.
5. Action occurs in the context of encountered structures, which it shapes . . . [and results in] a "dual quality" for both structures and actors.
6. Human interchange of action and structure occurs in time, by means of alternating phases of human agency creativeness and structural determination. (Tilly, 1984; cited in Sztompka, 1993: 200)

This is helpful, but it is still important to sort out the relationship between the forces that drive change and change that actually happens. *First*, there are *actors* or *agents*, meaning individuals, perhaps as members of groups or social movements, who behave and have impulses to behave—intentionally or not—to promote change. Such actors or agents are active within the structures that limit, constrain, or facilitate their impulses and efforts. Smaller groups themselves may become agents for change within larger systems that constrain them. *Second*, there are *systems* or *structures*, composed of abstract "wholes" such as societies, social systems, communities, organizations, cultures, and social institutions. Such systems exhibit repeated patterns or dynamics in the way that they operate or function. For instance, General Motors, the Roman Catholic Church, and the US Congress, all large organizations, have repetitive and somewhat predictable patterns in the ways that they operate that differentiate them from other systems.

Agents and systems are the drivers of change, and carry potentials for change, but *actual change results from the interaction of agents and systems*. That is a reciprocal process: Agents work within systems, sometimes to transform them, and systems constrain or facilitate the efforts of actors. For instance, citizens may work to promote or prevent change, and in doing so, they encounter systems that define the limits of what is possible. You might think that the power is on the side of systems, but there are times and circumstances in which the passions, efforts, and ingenuity of actors succeed in dramatically transforming systems. After World War II, for instance, environmental activists and organizations produced a genuine transformation of the relationship between US society and its natural environment (e.g., soil, air, water, and species diversity). But by 2000, they discovered the necessity of revisiting such arrangements. The actual change outcomes that result from encounters between change agents and systems or established structures are sometimes called *praxis.* That term, which may be strange to you, comes from the Greek root word from which we get the words *practical* and *practice.* It is a dialectical synthesis of what is going on in society and what people are doing. Praxis is the confluence of operating structures and purposely acting agents. It is doubly conditioned, from above by the functioning of the wider society and from below by the conduct of individuals and their groups. But, it is not reducible to either. It is the "really real changing reality of the social world" (Sztompka, 1993: 217).

TIME HORIZONS

Large-scale change outcomes that would result in sustainability are strongly shaped by time horizons from which actors and systems operate. How far into the future they are willing to think and plan depends on their willingness to forgo present benefits for future ones. If actors and collections of people have short time horizons and an orientation toward individuals, they will find it rational to defer the costs of unsustainability (for example) to others and to future generations. If, on the other hand, they have long time horizons and a more social orientation, the most rational action may delay immediate gains by contributing to the collective good, in expectation that both they (or their children) and their communities will benefit in the long run. You can see how important this is: At present, corporations have time horizons from one business quarter to three years, and governments may plan four years in advance or maybe until the next election. Some individuals and groups may think in terms of 25 to 50 years, or their grandchildren's lives (Passarini, 1998: 64–65). Or there is the seventh generation principle embraced by many Indigenous peoples, which instructs that any human action taken in the present must consider its effect on descendants seven generations into the future. In sum, "Anticipations of the future become part of the present, thereby rebounding upon how the future actually develops" (Giddens, 1991: 177–178).

CONCLUSION: A TRANSFORMATION TO SUSTAINABILITY?

The whole point of this detour about social change is to consider the likelihood of a transformation to a more sustainable world. Social science perspectives have large areas of contingency ("it all depends") in knowing outcomes. Let us address the likelihood of moving toward sustainability by posing a series of rhetorical questions. Is a major transformation on this scale possible? *Quite simply, yes.* Is it probable? *Who knows? Educated guesses vary widely.* Can the purposive actions of humans based on current knowledge shape that process? *Yes.* Are the longer-term outcomes of that process concretely knowable or predictable? *No.* Outcomes of change may be mostly negative, mostly positive, or mixed, *but* (and this is important) we are not really trapped in a particular set of societal structures, institutional arrangements, structures of power and domination, consumption dynamics, and so forth, unless we *choose* to be.

There are, in fact, examples of such massive and purposive social transformations that have taken place rather quickly. In the nineteenth century, feudalism was abandoned in

Japan, and slavery was legally outlawed around the world (though slavery continues to exist in various places but not on the same scale). The twentieth century saw the retreat of imperialism and the creation of a United Europe. War provides obvious examples. Given the belief that national survival was at stake during World War II, the US population mobilized and transformed itself in remarkable ways. Equally impressive was the Marshall Plan for reconstructing Europe after the war, and starting in 1947 America spent nearly 3 percent of its GNP on this huge set of projects for about a decade (Ruckelshaus, 1990: 131–132). The Soviet system collapsed, largely through the action of agents internal to that huge system. Most remarkably, in 1994 the Union of South Africa had transformed itself *peacefully and democratically* from an outrageously brutal and authoritarian racial caste system to a multiparty and multiethnic society with a native African as the popularly elected prime minister. Along with the accelerated economic and technological integration in the world market, we have witnessed the emergence of a whole panoply of multilateral institutions, which attempt to deal with war and peace; international monetary instability (like the IMF, for all of its problems); as well as the growth of scholarly, scientific, cultural, and humanitarian networks on an unparalleled scale. We have witnessed the emergence of a global culture emphasizing democracy, universal human rights, and ecological concern.

While these transformations are unprecedented, they are tentative, and some are embryonic and emerging. None turned out exactly "as intended" and none brought a problem-free world into being. Such illustrations certainly don't of course prove that transformations to greater sustainability will happen. But before these illustrative transitions had occurred, many people, including experts, would have found them highly unlikely or impossible. They demonstrate that such large-scale transformations are possible and often unforeseen.

Not only are massive social transformations possible, but some societies have existed sustainably for thousands of years without collapse. Jared Diamond mentions Java, Tonga, and Tikopia (the latter two are contrary cases to the kind of collapse that happened on Easter Island), and (until 1945) Japan. Today both Germany and Japan have successful reforestation programs, and their forests are expanding rather than shrinking. The Alaskan salmon fishery and the Australian lobster fishery are being sustainably managed. The Dominican Republic, a poor country with an authoritarian history, nevertheless set aside a comprehensive system of protected areas encompassing most of the nation's habitats, making it a rarity in Latin America and the Caribbean (Diamond, 2003: 51; see also Diamond, 2004).

The last part of this book focuses on pathways to greater sustainability and the barriers that must be overcome. It examines more closely the drivers of change noted in this chapter. Chapter Seven is about social structures and organizations, specifically economic markets, politics, and public policy. Chapter Eight examines human agency toward the environment, the meaning of activism, ideology, and the various forms of environmentalism that have emerged.

PERSONAL CONNECTIONS

QUESTIONS FOR REVIEW

1. Why is "free trade" an important idea and basis for laws in contemporary globalization? How has it been strongly defended and criticized?
2. Large multinational organizations play an important role in globalization. Be able to describe the roles of the World Bank, the International Monetary Fund, and the World Trade Organization. What are some social and environmental reasons why their critics think they are in need of reform?
3. Why do low income and people of color bear a disproportionate share of the costs of environmental damage? What social justice issues are raised by this fact?
4. What is "green imperialism" and why do some charge that it is being practiced today? Do you agree? How do green imperialism and traditional imperialism differ?
5. What does it mean to say that environmental sustainability involves the "three E's"? What difference does it make for policy to improve sustainability? Which of these would you start with?
6. As formulas for studying environmental impact, what do IPAT, STIRPAT, and ecological footprinting mean? Using these, what factors has research found related to understanding the environmental impact of nations?
7. What is ecological modernization? What are some of its dimensions?
8. What is the relationship between the treadmill of consumption, debt, and environmental problems?
9. What has contemporary research concluded about the relationship between a growing economy, money, and happiness (or well-being)? What is the CIWB? Why are Costa Ricans so happy?
10. How are the operation of structures and human agency two connected aspects of social change? What would illustrate each?

QUESTIONS FOR REFLECTION

Chapter One raised questions about consumerism in the Personal Connections section as an attempt to help you concretize the very rarefied abstraction of the dominant social paradigm. Here are some questions to help you think about some personal implications of affluence and the consumerist culture that supports it.

1. Consumption in itself is not a problem. Consumption sustains life itself and provides the goods and services that make human life meaningful beyond elementary physical survival. *Consumerism* as a cultural complex is something quite different. It suggests that buying and consuming an ever-increasing supply of things and services will provide security as well as personal happiness and satisfaction. Affluence is an indicator of social power and status. And having the right things (the right makeup, deodorant, or fashionable clothes or autos) is

linked to personal and sexual attractiveness. None of the world religions teach that happiness and fulfillment can be achieved through material acquisition and consumption. In fact, most go to pains vehemently to deny this idea. How, then, did we come to buy the consumerist ethos? There are many forces that impel us to do so: our early socialization, wanting to be liked and accepted, our ability to have burning wants in addition to needs, and—oh yes—a multimillion dollar advertising industry that gets us to consume on a grand scale. You might think about how some of these factors have worked in your own life.

2. Here's a quote from Gandhi, leader of the Indian independence movement, and inspirer of much of the thinking embodied in the small-is-beautiful movement: "Civilization, in the real sense of the term, consists not in the multiplication, but in the deliberate and voluntary reduction, of wants." Do you agree with him? Why or why not?
3. Calculate your "ecological footprint" (http://www.footprintnetwork.org/en/index.php/GFN/page/calculators). How many worlds would it take to support the world's people if they all lived like you do? Even if there are large error factors built into such calculations (say, 50 percent), it is a real eye-opener!

WHAT YOU CAN DO

Here are some hints about living more sustainably ("greener") for college and university students.

1. Practice the three R's: Reduce, Reuse, and Recycle.
2. Printer and paper use: If possible, print on both sides of the page. Think twice about whether you need a hard copy of a web page or document—could you bookmark a page or save a file on your computer?
3. Limit your use of disposable products, including cups, plates, and paper napkins. The next time you grab a handful of napkins at your dining hall or in a restaurant, ask yourself whether you really need that many. One might be enough.
4. Use compact fluorescent light bulbs in your dorm room or apartment. They may cost more, but will last longer and save you money.
5. Walk, bike, and limit your car use.
6. Carry a refillable water bottle. No more bottled water.
7. Buy recycled products if you can. This includes paper for printing.
8. Use refillable binders instead of notebooks. Or, go electronic and take notes on your laptop.
9. Buy used clothing and furniture. It is a great way to save money, and good for the environment too.
10. Share your message—get others to "live greener" on campus.

Some of the United States' greenest campuses in 2009 were Arizona State University; Bates College in Lewiston, Maine; College of the Atlantic in Bar Harbor, Maine; Georgia Tech.; and Emory University, Georgia (adapted from Rockler-Gladen, 2009).

REAL GOODS

There are two "real goods" we want to mention here. Neither are products or things.

1. A healthy skepticism about "green goods." Producers and advertisers got the message about environmentally sophisticated consumers. Not everything that is labeled "green," or environmentally benign, natural, or organic, is. In the United States many products are labeled "ozone friendly, biodegradable, recyclable, compostable, lite, natural, local," or something similar. Sometimes these claims are real, and sometimes they are misleading, a fact recognized by consumers as well as environmental scientists. There has been pressure to label the contents of products and display warnings on labels, but reading the labels of products is usually a confusing experience for consumers who don't have the knowledge to evaluate them as truth claims. Such green deceptions generated counter pressures. In the 1990s, the US Pure Food and Drug Administration required that food producers use standardized labels to make them easier to understand, detailing the additives, caloric, fat, and mineral content of their products (over howls of protest from some industry groups) (Durning, 1993: 17–18). Currently, there is a great deal of controversy over GMO labeling (see http://www.justlabelit.org). A helpful website on figuring out eco or green labels is http://www.explainthatstuff.com/eco-labelling.html.
2. Look out for Public interest groups: Such groups monitor marketing campaigns and advocate advertising and media reforms. You can recognize these groups because they are not connected to a particular industry and usually not to a professional community. They are organizations of civic activation. By no means are all concerned with environmental or health matters, but rather some are animated by social justice, religious, family, or political reform issues. For instance, Action for Children's Television is a Boston-based group that won a victory in the late 1990s by getting the US Congress to limit commercials aimed at children. The Australian Consumers' Association attacked junk food ads, calling for a ban or restriction on ads selling unhealthy food to children. In Europe, public interest organizations have been doing the same thing, as has the American Academy of Pediatrics in America. These are optimistic signs, but their effects are often overwhelmed by large, powerful lobbies.

MORE RESOURCES

Bales, K. (2016). *Blood and earth: Modern slavery, ecocide, and the secret to saving the world*. New York, NY: Spiegal and Grau.

Bartly, T., Koos, S., Samel, H., Setrini, G., and Summers, N. (2015). *Looking behind the label: Global industries and the conscientious consumer* (Global Research Studies). Bloomington, IN: Indiana University Press.

Edwards, A. (2005). *The sustainability revolution: Portrait of a paradigm shift*. Gabriola Island, British Columbia: New Society Publishers.

Gould, K.A. and Lewis, T.L. (2017). *Green gentrification: Urban sustainability and the struggle for environmental justice*. New York, NY: Routledge.

Leonard, A. (2011). *The story of stuff: The impact of overconsumption on the planet, our communities, and our health—and how we can make it better*. New York, NY: Free Press.

Schor, J.B. (2011). *True wealth: How and why millions of Americans are creating a time-rich, ecologically light, small-scale, high-satisfaction economy*. New York, NY: Penguin Books.

Szasz, A. (2007). *Shopping our way to safety: How we changed from protecting the environment to protecting ourselves*. Minneapolis, MN: University of Minnesota Press.

Victor, P.A. (2008). *Managing without growth: Slower by design, not disaster (Advances in ecological economics)*. Cheltenham, UK: Edward Elgar Publishing.

Wackernagel, M. and Rees, W.E. (1996). *Our ecological footprint: Reducing the human impact on earth.* Philadelphia: New Society Publishers.

ELECTRONIC RESOURCES

http://www.clubofrome.org
The premier real deal limits to growth website.

http://www.ecomodernism.org
An interesting site if interested in the ecological modernist perspective, which includes an eco-modernist manifesto.

http://www.globalecolabelling.net
This website does a good job explaining eco-labeling standards and helps to avoid greenwash.

http://www.globalexchange.org
A great website filled with resources on learning about and becoming actively involved in promoting global sustainability.

http://www.footprintnetwork.org/en/index.php/GFN/page/calculators
On this site you can calculate your ecological footprint.

http://www.sristi.org
A nongovernmental organization about sustainable technologies, products, and entrepreneurial opportunities; many links.

http://storyofstuff.org
The companion website for the 20 minute video on the story of stuff. Lots of cool educational resources on this website.

https://www.sustainablecommunities.gov
The US EPA, Department of Housing and Urban Development, and Department of Transportation joined together to help create sustainable communities in the US.

www.tellusinstitute.org
The Stockholm Environment Institute's website. Material and reports about large-scale social and environmental change and sustainability.

http://www.wri.org/our-work/topics/sustainable-cities
World Resources Institute link on building sustainable cities.

CHAPTER 7
ECONOMIC MARKETS AND POLITICS: TRANSFORMING STRUCTURES

Leading global investors and governments have signaled that the era of the fossil fuel–powered economy—the engine of modern industrial development—must come to an end. It is no longer sustainable. The 2015 Paris Climate Agreement set the goal to keep the global average temperature rise to ***well below*** 2 degrees Celsius and 1.5 degrees Celsius as preferable (see Chapter Three). To stay within this carbon budget, at least 80 percent of known fossil fuel reserves must stay in the ground! This means that large shares of fossil fuel reserves will be stranded assets. *Stranded assets* is a financial term referring to the unexpected or early conversion of assets that produce profit into liabilities that result in profit loss. Stranded assets are often large investments and contain fixed or sunk costs that cannot be liquidated into cash. They include capital stock investments (an offshore oil platform or infrastructure development like building roads, or water or oil pipelines) and current asset inventories (agricultural land, mineral reserves, oil, or natural resource inputs), which help to determine the value of a corporation (Caldecott, 2015: 52–54).

Shutterstock.com

Figure 7.1 Abandoned or soon to be retired oil platforms in the North Sea are being used in the development of offshore wind farms. In the twenty-first-century economy, environmental risks and climate conditions play a key role in value destruction and value creation.

The fossil fuel industry holds large shares of potential stranded assets. If the below 2 °C goal is to be met, oil is projected to take in $28 trillion less in revenues over the next two decades. Indeed, oil is facing opposition around the globe for many reasons. The rapidly rising costs of accessing oil and growing geopolitical risks are key factors. In fact, oil companies have $215 billion of capital expenditures planned in countries that Goldman Sachs rates as "high" or "very high" in political risks because of organized resistance against them. Also, lower natural gas prices and technological advancements have made renewable energy production more economically competitive and socially desirable. Despite the low cost of natural gas, the industry has experienced asset stranding in the European Union (EU). During 2013, numerous recently built, high-efficiency combined-cycle gas-turbine power plants across the EU were prematurely closed, or mothballed—taken out of production but maintained for potential future use. The unexpected change for natural gas in the EU was caused by decreased electricity demand, improved renewable energy operations, lower demand of carbon permits in the EU, and cheap coal from the US (Caldecott, 2015). As you can see, economic, political, and social factors combine to create risks that can potentially strand environmental related assets.

Furthermore, the impact of stranded assets stretches beyond their owners and affects other forms of assets (or capitals) in local communities. For example, early retirement of a coal mine is a stranded economic asset. Once closed, the process of restoring the land and other natural capital assets (water and soil) must be paid for and managed, which, depending on conditions of closure, can drain state and local budgets. Local economies are weakened by loss of jobs and income (economic capital), and affected individuals will need new jobs, which may require investments in job training or education (human capital). Also, local social networks will be impacted (social capital), along with individual, family, and community identity and culture (cultural capital). To avoid destructive and destabilizing outcomes from stranding assets, each of these impacts must be dealt with (Caldecott, 2015). Later in the chapter, economic and political policies that can help plan for, and prevent, asset stranding are discussed.

This chapter focuses on the role economic and political decision making and policy play in perpetuating and remedying our contemporary environmental and climate change problems. By doing so, the potential to transform social structures is illustrated. In the next chapter human agency, environmentalism, and environmental movements are the focus. Structures and agency as discussed in Chapter Six are the essential components of the dialectic of social change. More concretely, this chapter will examine (1) economic markets, and environmental and ecological economics, (2) politics and policy, (3) the potential for structural change, and (4) the global political economy. Before we dive into the economics of environmental problems, let us suggest that meeting the 2 degrees C target will require employing a *new perspective and set of tools*. By a new perspective, we acknowledge the limitations of using economic markets to solve our contemporary environmental challenges. To be clear, we are not arguing to throw out well-tested economic and political policy. Rather, we suggest that knowledge of variation in social institutions, organizations, and community structures and conditions must be incorporated into economic and political decision making and policy. Sociologists, other social scientists, and civil society organizations are well-equipped to help in this endeavor. Furthermore, to achieve a sustainable future, environmental and climate justice must be a guiding principle. This will require investing in the well-being of the world's most marginalized people and harnessing their too often hidden and undervalued creative energy. Thankfully, there are examples of successful sustainable development!

Consider the case of *favelas*—festering city slums—in Curitiba, Brazil. As noted in several previous chapters, around the developing world, slums develop in areas unsuitable to human habitation plagued by social and environmental problems (Gratz, 2013). However, in 1973, when architect Jaime Lerner was appointed mayor of Curitiba, Brazil, then a sprawling city of 500,000, half full of *favelas*, he came up with a plan to address their many problems—it started with garbage. In the *favelas*, garbage was attracting rodents and disease and garbage collection trucks could not get in because of narrow or nonexisting streets. Lerner decided to pay people for their garbage by placing recycling bags around the *favelas* and by giving tokens to the city's transport system for the separated and therefore recyclable trash. The mayor also gave tokens that could be exchanged for food for organic waste, which was taken by farmers and made into fertilizer for their fields. It worked spectacularly. Kids scoured the *favelas* for trash and learned to spot the difference between low-density and high-density polyethylene bottles. The tokens gave poorer citizens the means to get out of the *favelas* and access jobs, while promoting cleanliness, frugality, and the reclaiming and recycling of waste. The plan was innovative but simple: The money gained from recycling combined with the money saved by not having to take trucks into the narrow streets paid for the tokens. It was a cyclical, waste-equals-food system implemented at the grassroots level (Hawken, 1993: 213–214).

Curitiba is now considered a world model in *sustainable urban development*. The city invested in economically cost-effective policies that preserve the natural environment for future generations while ensuring that all of its citizens contribute to, and receive the benefits of, its development. It is not a futuristic dream, and has grown into a vibrant Brazilian city of 3 million people with a prosperous corporate economy in Brazil and the world market. Bike paths run throughout most of the city, and cars are banned from about 50 blocks in the downtown area. The city uses less energy per person, has less air pollution, greenhouse gas emissions, and traffic congestion than most comparable cities. It recycles 70 percent of its paper and 60 percent of its glass, metal, and plastic, which is sorted by households for collection three times a week. Some old buses are used as roving classrooms to teach basic skills to unemployed people, while others operate as daycare centers that are free to low-income families. The poor receive free medical, dental, and child care. In Curitiba almost all households have electricity, drinking water, and trash collection. About 95 percent of its citizens can read and write, and 83 percent of adults have at least a high school education. Polls show that 99 percent of the city's inhabitants would not want to live anywhere else (Cunningham et al., 2005: 494; Gratz, *Global markets* are composed of formal and informal networks of producers, distributers, buyers, and sellers. Millions of waste pickers and recyclers around the globe labor in the *informal green economy* by salvaging recyclables from dumps and the streets (see, Global Alliance of Waste Pickers: http://globalrec.org). The informal economy, however, is not regulated, taxed, or included in estimates of national economic productivity, such as GDP. The recycler in this photo is transporting waste in Bangkok, Thailand.

1000 Words / Shutterstock.com

Figure 7.2

2013; Miller, 2005: 563). Though not typical of cities in LDCs, or most cities in the United States, Curitiba demonstrates that sustainability is possible. There are numerous US cities attempting to move toward sustainability; the most successful are probably Portland, Oregon, and Chattanooga, Tennessee (the case of Portland is relatively well known; regarding Chattanooga, see Cunningham et al., 2005: 478).

ECONOMIC MARKETS

Humans have obvious needs for an incredible variety of goods and services that are all provided by the earth's resources. *Economic markets* include the systems through which such goods and services are distributed that bring investors, producers, sellers, and buyers together. Think of a city farmers' market or traditional markets in villages around the world in ancient times or in contemporary LDCs. In such markets, people compare quickly and see what the competition is; you can taste a wedge of pear, smell a bunch of roses, or eat an olive. You can haggle about prices, compare the quality of goods in different stalls, and, if they are not to your liking, you can walk away. In the longer term, such markets have built-in protections against fraud and misrepresentation. In contemporary society, markets are often not concrete places like traditional markets, but rather abstractions to represent the interaction among the costs of production, the asking price, and the price consumers are willing to pay for goods and services. More simply put, real economic values (prices) are determined by the interplay of supply and demand. Markets are important because they can send realistic signals about the actual economic value of goods and services, the work that you do, and the prices that people are willing to pay for a particular product or service in specific circumstances. So there are specific markets for Fords, bushels of wheat, books about environmental issues, and the development of more environmentally benign products. All of these products have prices attached that must be paid (by someone), and they have amounts or levels of benefits that you can get for particular prices.

Because neoclassical economic theory views such markets primarily as structures to allocate values, it emphasizes that many human problems (social and environmental) can be understood as market problems and failures. As noted in earlier chapters, neoclassical economic theory is embedded in a *resource allocation paradigm* of the human world and its problems. The theory argues that producers and consumers respond to changing relative incomes, prices, and external constraints, so that—*if* the market signals are allowed to reach individuals *and* market prices include all the social costs and benefits of individual actions—responses to problems will be rapid and efficient (Beder, 2011; Stern et al., 1992: 136). It is important to note that the global recession that began in 2007 reduced damage to the environment because it minimized human economic activity that produces environmental impacts. It may have had positive environmental effects, but the human costs of a sudden and dramatic world recession had devastating human consequences, in terms of lost income, jobs, and human well-being.

Notably, the theory of the "perfect market" is a tidy abstraction that is useful as an approximation device and a policy tool. Its conditions however, are often *not* met in the real world. Economic growth and profits "unbalance" the market, and many human social and environmental problems result from *market failures* (Casten, 2009). While mainstream economists assume that the market system operates independent of environmental conditions and constraints, environmental and ecological economists have sought to correct for market failures by incorporating ecosystems and natural capital into economic modeling and decision making. Their conundrum is how to assign value to ecosystems and environmental change. In the next section, the relatively recent subfields of environmental and ecological economics will be briefly contrasted and we discuss the three primary forms of market failures both subfields see as problematic in resource allocation and accountability.

ENVIRONMENTAL AND ECOLOGICAL ECONOMICS: MARKET FAILURES

Environmental economists assume that if ecosystems and natural capital are assigned value and appropriately priced, they can be efficiently allocated (Beder, 2011; Dietz, 2015). Thus, they adopt mainstream economic principles to fix the market failures discussed below. Taking a utilitarian and instrumental view of environmental decision making, it is accepted without question that individual pursuit of self-interest within competitive markets produces the greatest social good. This is the basis of rational-choice theory, which is discussed further into the chapter. It also is the economic perspective that, as previous chapters have noted, has been the most widely utilized to guide environmental research and policy both internationally and nationally (Beder, 2011; Dietz, 2015; Dunlap and Brulle, 2015).

On the other hand, *ecological economists* contend that despite decades of economic and political policy using the market strategies promoted by neoclassical and environmental economists, environmental problems have worsened. Ecological economists call for an interdisciplinary research agenda and approach to policy that incorporates the perspectives of ecologists, ethicists, and social scientists, based on the premise that markets alone cannot solve our environmental problems. While environmental economists look at natural capital in terms of inputs and outputs within the economic system, ecological economists view the economic system as a component of ecosystems. They also are willing to consider the intrinsic nonhuman value of nature separate from human preferences, and the social consequences of the unequal distribution of environmental goods and bads. Accordingly, they have used measures such as ecological footprinting (see Chapter Six). They are most well-known for coining the concept, *ecosystem services*—which acknowledges limits to growth by recognizing human dependence on the natural environment that contains a "fixed stock of capital" (Beder, 2011: 147). The concept has been widely utilized to develop economic measures for planning and policy. Four types of *ecosystem services* have been identified: (1) provisioning—food, water, fiber, and fuel; (2) regulating—carbon sinks, flood mitigation, and waste treatment; (3) cultural—spiritual values, aesthetic pleasure, and recreation; and (4) support—soil formation and nutrient recycling (Beder, 2011: 147; Dietz, 2015). Nonetheless, Ecological economists, stress an overreliance on market solutions to environmental and climate problems is inadequate and even dangerous (Beder, 2011; Costanza et al., 2014).

Both environmental and ecological economists focus on how market failures create environmental problems or do not succeed in remedying them. One reason that markets don't always work is because all resources are not owned or used in the same manner. Such resource arenas fall into three categories: (1) there are *private-property resources*, which can be owned and used by an individual (or organization). Others can be excluded from using such resources, and since individuals (or organizations) can own them, they are normally more willing to use them frugally and to invest in their upkeep and maintenance. In short, we are more likely to use private property resources sustainably. Private-property resources not only include things like clothing and automobiles, but also privately owned farmland, business equipment, and financial investments. There are (2) *common-property resources*, to which people have virtually free and unrestricted access. They are not owned by individuals; therefore, few real economic costs exist for individuals (or organizations) overusing them, and few incentives exist to manage them or pay for their upkeep. Many resources illustrate common-property resources: air, rivers, groundwater, international waters, and all the chemical and biological resources that they contain. Somewhere in between private- and common-property resources are (3) *public-property resources.* These are jointly owned by all people of a country, state, or local community, and are managed by a government or public agency. National and state forests, wildlife refuges, beaches, coastal waters, parks, and rangelands are examples of public-property resources restricted from private ownership. Social institutions can also be understood as public-property resources, and in the United States they include such things as fire protection, public education, military security, highway systems, and prisons. Obviously people use (or participate in) all these public-property resources, but governments have the exclusive rights to regulate their use. Precisely how much and what needs are met through private-property and public-property resource pools change among societies in terms of different cultural, legal, and political traditions.

This distinction among kinds of resources is important for understanding the environmental consequences of economic processes because there are problems particular to common-property and public-property resource arenas. Air and rivers have been polluted, water tables drawn down, international fishing grounds depleted. Because they are controlled by the governments or international agencies and subject to pressures from powerful interest groups, rights of access to timber, grazing land, minerals, and energy resources are often "priced" far below what they would be if they were private-property resources. Individuals following their "rational" best interests often results in a social and collective disaster, and a powerful commons social dilemma. Zoologist Garrett Hardin popularized the notion of environmental commons problems as the *tragedy of the commons* (1968). Because social traditions and laws often allow free access, he observed that pastureland owned in common was often overgrazed, compared to private land. The same principle applies to polluting the atmosphere or overfishing the oceans. In short, commons problems produce market failures because of the lack of clearly defined private property rights that leaves no incentives to prevent environmental degradation. Some analysts understand the tragedy of the commons as so powerful and pervasive that it is like a "law" of the natural world. We find this to be misleading, and will return to this notion.

OTHER SOURCES OF MARKET FAILURE

Commons problems represent a generic source of market failure, but others also exist. *First*, the problem of *externalities* (mentioned in earlier chapters) means that someone must pay the "full costs of production and consumption," but they are not calculated into the existing market price. Individuals not involved in buying or selling a good or service may nevertheless be affected. Pollution affects people and other species generally as it flows downstream or drifts in the wind, not just the industries that produce it, or the consumers of products. As noted in Chapter Four, the full diplomatic, foreign aid, and military costs of keeping crude oil flowing "through the pipelines" are not calculated into the costs of each gallon of gasoline in the United States. The costs of decommissioning a nuclear power plant (which has about a 40-year life span or less) could be prorated into your electric rates but probably aren't. Externalities may be a substantial hidden "tax" on you or others in the future. *Second*, for understandable reasons, governments often impede or supersede the market by providing price regulations, subsidies, or by creating a *quasicommon* (public-property resource) from what *could* be privately owned. Examples include the oil depletion allowances and artificially cheap access given to public lands to ranchers and lumber industries. In western parts of the United States, water rights are defined in a way that precludes the emergence of realistic water markets. *Third, cost accounting problems* exist. Markets may not send real signals about complete values/costs because of the difficulty and costs of collecting information about the net value of something that considers its costs to all impacted producers, consumers, and nonconsumers. The accounting problem is particularly intense when we face a dilemma of consuming something now or saving for the future. Because of constant price inflation, neoclassical economists usually "discount" future values and argue that consuming now is of greater economic value (Gardner and Stern, 2002: 100; Roodman, 1999; Rubenstein, 1995).

MARKET INCENTIVES: ENVIRONMENTALLY PERVERSE OR NOT?

It is necessary to understand the powerful and pervasive ways that government interventions distort markets. They actively encourage public and private decisions that stimulate unsustainable resource use and environmental degradation. Evidence for this is overwhelming. Such interventions flow from the understandable efforts of powerful economic groups and firms to get government leaders to provide protection from the unalloyed discipline of the market and from the desire of politicians to keep people working and prices low. For instance, virtually the entire food cycle in North America, Western Europe, and Japan attracts huge subsidies, amounting to about 30 percent of farm income, as well as others for irrigation water, and agrochemicals (Halweil, 2003: 96). They encourage farmers to occupy marginal lands, clear forests, and wastefully use pesticides, fertilizers, and aquifer water. Such perverse subsidies now total about $850 billion or about 2.5 percent of the global economy and create a huge economic incentive for environmental destruction (Myers and Kent, 2001: 188).

Clearly, economic subsidies are not always environmentally "perverse." Governments can phase in subsidies and tax breaks for pollution prevention, sustainable agriculture, water use, energy conservation, and renewable energy. Some countries have begun reducing environmentally harmful subsidies. Japan, France, and Belgium have phased out coal subsidies. Germany cut its coal subsidies in half between 1989 and 2002, and plans to entirely phase them out by 2018. China cut its coal subsidies by about 73 percent and has imposed a tax on high-sulfur coal. New Zealand has eliminated virtually all of its agricultural subsidies (Miller and Spoolman, 2009: 621). The Obama administration used market incentives and other forms of government power to promote clean energy development, green jobs (e.g., producing, installing and managing wind turbines, retrofitting doors and windows in homes and offices), and low carbon transportation. Beginning with the American Recovery and Reinvestment Act (ARRA) of 2009, $70 billion was included in the form of tax credits and direct funding for clean energy and transportation. Obama has since used the US Department of Energy's Loans Programs Office to issue billions of dollars in loans to renewable energy projects (Biello, 2015). In sum, the argument that market incentives are always wrong is incorrect. Market incentives and government subsidies have in fact always been used as a means to create social structures we wish to live within, sustainable or unsustainable. So, how are markets reformed to produce a more sustainable society?

TRANSFORMING MARKETS AND CONSUMER BEHAVIOR: GREEN TAXES AND BUYING GREEN

Environmental economists suggest inverting the old system of taxes and subsidies to internalize the full costs of doing business and reassign them to the marketplace where they belong. Doing this would create an economy where business firms prosper by being responsible, both socially and environmentally. In other words, they prosper by competing to be more ecological not because it is the right thing to do, but because it aligns with profitability. A common proposal to do this is to shift present taxes on income and payroll to *green taxes.* Governments could gradually and incrementally (not suddenly) decrease taxes on income, savings, and investments ("goods") and increase them on energy and resource use, on polluting emissions to land, air, and water, and on products with a high environmental impact ("bads"). If taxes rise overnight (as they did during the oil boycotts of the 1970s), they cause inflation and economic and social chaos. But, phased in over a longer time (10 to 20 years), producers and consumers are given time to adapt, plan, and reinvent. It is also important that green taxes should *not* be used to increase total government revenues (they should be revenue-neutral). Their purpose should be to provide all participants in markets with accurate information about full costs and to undo the perverse distortions produced by the relentless pursuit of low prices. A tax on the carbon content of fuels would give consumers incentives to switch to fuels that produce less pollution and greenhouse gases, and give producers reason to invest in energy efficiency.

Today, it seems people do not like to pay taxes. Green taxes could be structured to give people and companies positive incentives to avoid them. The less you pollute or consume, the lower the tax, or may be no tax is paid at all. This could positively impact consumption patterns without adding to the overall tax burden on industry and society. For instance, some cities have banned plastic bags (San Francisco) while others have "taxed" them by charging the consumer for their use (Baltimore). However, manufacturers of plastic bags tend to oppose these measures. Maybe manufacturers need

TFoxFoto / Shutterstock.com

Figure 7.3 A man in Eugene, Oregon collects signatures to ban plastic bags. You can check out the following website for more information on states and other countries that tax or have other laws to prohibit the use of plastic bags (see, http://plasticbaglaws.org/legislation/state-laws/).

to be taxed a fee to help pay for their collection, disposal, and recycling? Nonetheless, green tax shifts can also be graduated so as not to overly burden low-income people (Hawken, 1993: 167–171; Miller and Spoolman, 2009: 622–623; Speth, 2008: 100–125).

A second idea about transforming markets and consumer behavior is *buying green.* Green consumerism has considerable potential, but only if consumers have adequate information, are willing to pay a bit more, and if it has strong government backing. Consumers could insist that the production of goods and services be done in a more environmentally friendly way by ensuring provisions for the recycling and reuse of consumer products. When the consumer is finished with a TV, fridge, or computer, the manufacturer should take it back and see that it is reused, recycled, or disposed of with less damage to the environment. In Europe and Japan, some "extended producer responsibility laws" require that products be returned to producers "cradle to cradle," which has the effect of encouraging producers to think about reuse of materials from the onset of production.

There is some evidence that American consumers are changing. By 2006, the proportion of people willing to pay more for environmentally benign goods had grown, as had the market for hybrid cars, compact fluorescent light bulbs, and organic foods. Despite these gains, "green" remained a small share of all markets and consumer

Courtesy: brandalism.org.uk

Figure 7.4 Called out for hypocrisy—corporate sponsorship of the 2015 Paris Climate Summit (COP21) by firms such as Renault, AirFrance, and electric utility companies—are these firms more invested in reducing their carbon footprint or attracting new consumers?

interests (Speth, 2008: 150–162). There are a number of limitations on the greening of consumption. *First*, greener consumption may be overwhelmed by the growth of consumerism. *Second*, a "rebound effect" may occur when savings—for instance, in efficiency and utility bills—get spent in ways that undermine them—like keeping one's house warmer or buying more appliances. *Third*, it suggests that individual consumer choices are the problem, when control of these choices is constrained and shaped by institutions and political forces, which can be changed only by collective citizen action rather than by individual consumer behavior. *Finally*, there is enormous potential for *greenwashing*, a tactic used by advertisers, public relation firms, and private and public business firms to mislead consumers that a company's practices or products produce environmental benefits.

With all of these problems, what *are* the long-term potentials for green products and consumerism? Possibly quite large—if government supports it powerfully with clear mandatory requirements uniformly and fairly applied to all. It could, however, be quite small if government stays on the sidelines and counts on major change from the voluntary consumer choices of individuals. There is, however, another, more fundamental area for action—*reducing consumption!* The bad news is that hyperconsumption is an aspiration, even an addiction, of people around the world, and reducing it would be difficult, but we are certainly not trapped (Speth, 2008: chap. 6, 153–160). The good news is ample research shows that market-based consumption is *not* tightly coupled with human welfare or life satisfaction, which was clearly illustrated in Chapter Six.

NEW MEASURES OF ECONOMIC AND SOCIAL PROGRESS

The economic health of nations is usually measured in terms of changes in the total value of all goods and services bought, a measure called the gross national product (GNP). Economists also use the GNP per capita, which is the GNP divided by the number of people in the population. Such statistical means can be misleading because of the vast inequality that exists among people. Sometimes they use a measure called the gross domestic product (GDP), which factors out the value of imported goods and services. These measures are relatively easy to record, and their *growth* is often taken as a measure of the social, as well as economic, well-being of a nation. But they are not adequate measures of human well-being. They treat all goods and services as being equal, regardless of externalities, or whether they are made by producing healthy food, treating sick people made ill by pollution, or cleaning up the damage from massive oil spills or nuclear power disasters. They are not, in fact, good measures of social well-being and do not differentiate between goods produced under safe and remunerative labor conditions and those produced under exploitive and hazardous ones. They tell you nothing about the actual distribution of the value of goods and services among individuals or groups within a nation.

To change this, ecological economists have proposed various modifications of GNP to better capture environmental and social factors. They are trying to figure out how to develop "strong sustainability" measures that, for example, account for biodiversity, for which no adequate framework exists. This has sparked controversy amongst ecological economists over the term *incommensurability*, which suggests that common units of measurement such as money cannot express all value (Beder, 2011: 147).

Finally, a US NGO, Redefining Progress, created a *genuine progress indicator* (GPI) that adds ignored sectors like unpaid child care and volunteer work and subtracts uncounted economic costs like traffic, pollution, and crime. In 2004, their calculations showed the GPI at $4.4 trillion, compared with a GDP of $10.8 trillion, implying that well over half of the economic activity in the United States was unsustainable and did not contribute to genuine progress (Talberth, 2008). Most widely used, the United Nations created a *human development index* (HDI), which combines economic and social indicators to estimate the average quality of life in a country. Measured on a scale from 0 to 1, the HDI aggregates (1) life expectancy at birth, (2) literacy rates, and (3) real GDP per person, based on data that is easily obtainable for most of the world's nations. UN analysts rank nations and give them standardized scores.

Also, the carbon-intensity of well-being discussed in Chapter Six is another measure that is being developed to help better gauge the relationship between human well-being and socioeconomic and environmental conditions (Jorgenson and Givens, 2015; Jorgenson, 2014). As a whole, the alternative indicators of economic, social, and environmental well-being are not beyond question and are still being developed. What they include for environmental and social costs is notoriously difficult to price.

RATIONAL-CHOICE AND HUMAN–ENVIRONMENT PROBLEMS

These economic arguments have a common theoretical thread that is an outgrowth of neoclassical economic theory. A wide variety of scholars from diverse disciplines such as behavioral psychology, economics, political science, sociology, and policy studies created a genuinely transdisciplinary perspective on human behavior, now called *rational-choice theory* (Coleman, 1990; Ritzer, 2010). In this view, humans are rational choice makers. Economic theory argues that they choose economic goods and services in terms of how much they cost and how badly they need them. But rational-choice theory argues that—far beyond economic purchases—people make reasoned *social choices*, based on experienced costs and benefits, about all manner of things. These include, for instance, decisions regarding sexual and romantic attractiveness of others, whether to maintain a social relationship or let it erode, and whether to see a therapist about your problems or deal with them yourself. Rational-choice theory argues that we choose things that have high benefits relative to their costs. When you say, "I don't really have a choice," what that means is that you think the costs are too high to make a choice. It is not that anyone believes that individuals go around like cost accountants, meticulously calculating exact numerical costs and benefits. The assertion is rather that in some more vague but real sense, humans adapt to life by trying to minimize costs and maximize benefits. Some costs and benefits may be given in nature, but others are shaped by culture and individual perceptions. They may be symbolic as well as material (people value social honor and spiritual rewards). Rational choices need not operate in the short term. Over time, we develop a sense of what are roughly fair exchanges of goods, favors, or obligations to each.

The human cause of environmental degradation is that we get the benefits of unsustainable consumption, but the costs are often invisible or work in such a delayed time frame that we don't take them into account. Furthermore, rational-choice theory argues that many of the change strategies of environmental movements are inadequate to produce significant behavior change. The way to avert ecological disaster is not to persuade people to give up their selfish habits for the common good (often for the benefit of generations yet unborn). Typically, appeals are made in terms of sacrifice, selflessness, and moral shame. A more effective strategy is to tap a durable human propensity for thinking mainly of short-term self-interest. Moral appeals to "be good" do not work very well in the absence of real incentives. We should think about "saving the commons" by privatizing it (so the argument goes). Real cooperation, this perspective argues, builds up trust from experience with small-scale quid pro quo exchanges, not from moral exhortation. External costs are somebody else's business, and we can go for "free rides" on commons resources. Or, so we think.

Most people are aware of environmental problems and agree abstractly with the idea of developing a sustainable society, but the problem is transforming our behavior and the way social systems operate. Rational-choice perspectives suggest that instead of urging us to be "good," we transform incentive systems in economic markets and social life to send concrete signals that make self-interest consistent with what is desirable so that people get real rewards for being good. That is the real logic underlying all of those proposals discussed. It is a powerful and compelling argument based on an undoubtedly variable dynamic of human behavior. It is also slippery and can be misleading, so let us explain.

MARKETS ALONE ARE NOT "*THE*" ANSWER

All of the preceding ideas about internalizing environmental costs, privatizing the commons, and creating quasimarkets from common property resources imply that our problems are a variety of market failures and the prescription is to get markets functioning optimally. Neoclassical economists and more conservative political thinkers are so enamored with market solutions that they believe the answer to most human and environmental problems is to unhook markets from any undue intervention and just let them work, while environmental economists suggest that markets can be redirected or programmed to guide humans in the direction of sustainability (Beder, 2011; DiLorenzo, 1993). Unlike purest neoclassical economists, both ecological and environmental economists (and sociologists) acknowledge the importance of markets, but they recognize that environmental and social problems are not simply the result of market failures. This means that even full functioning markets will not, by themselves, solve these problems.

There are at least four recognized limitations of markets. *First*, markets treat as equal worth (without value judgments) all dollar values, regardless of whether they are generated by clear-cutting a forest; producing toxic wastes or nuclear missiles; or by producing housing, food, or humanly enriching art. Whether a product was made by well-trained workers in a safe environment or by the underpaid labor of unhealthy workers or unhealthy children carries no weight and often misrepresents societal preferences by making the less appropriately produced item less expensive. Markets don't care about these things, *but people do*.

Second, goods that are valued by nonparticipants in formal markets are systematically underpriced. What is the dollar value of a living tree? Usually it is the price at which dead timber can be sold in a market. But what of its value to the person who relies on that tree for protecting his or her nearby land from being flooded? Or the person who values it because he or she just likes to look at its beauty, or enjoys its shade? The combined net worth of the tree for all these people may be well above its market price as lumber. But, barring some cooperative arrangement that incorporates the needs of all those who value the tree, cutting the tree and selling it on the market means that the market will have operated in a way that did not optimally represent its value to all those who valued it.

Third, markets gauge the real value of resources or products only in present actual exchanges. All other attempts to internalize prices or create quasimarkets from common property resources are *shadow prices*, which are speculative administered prices determined by an expert, planner, administrator, or bureaucrat. Take, for instance, the common practice of discounting future values—prices. Because of inflation and technological innovation, future values are discounted by some percentage for every year that a resource is conserved. This process conflicts with long-term sustainability and reduces the rights of future generations to near zero (Stern et al., 1992: 86).

A *fourth* limitation of markets has often been noted by those on the political left. Markets may create economic efficiency, narrowly defined, but as they operate over time without some sort of nonmarket restraints, they generate *vast* systems of social inequality that represent significant (but normally externalized) *social costs that affect human welfare and even markets themselves.* The evidence for this effect is overwhelming both within and between nations, as documented in Chapter Six. Some opposition to the creation of quasimarkets of tradable emission permits from common-pool resources is on exactly these grounds. Rich firms or nations would have the resources to pay surcharges or buy emission permits from poorer firms or nations (who would be under routine pressure to sell them cheaply). Either way, the rich could still afford to pollute, and real reduction would be accomplished on the backs of the poor. In sum, these problems with markets mean that for all their virtues, they do not price all things effectively and do not price many things that people care about.

Pure market strategies have a broader limitation. Some in free-market nations, especially Americans and neoclassical economists in particular, tend to view markets as somehow natural and real systems that arise spontaneously among all people regardless of their differences. Markets seem almost like a part of nature. In contrast, politics and culture are viewed as more obviously socially constructed, arbitrary, whimsical—and often irrational. The GNP is taken as real. The other measures of social and economic progress are seen as arbitrary. Furthermore, when the word *market* is appended to the technical term *economy*, we have the satisfying feeling that we are dealing with forces in the world that function properly without government interference. We think of vast global markets organized by banks and multinational corporations as simply projections of the elemental reality of village markets—even though the scale and connections among market participants are something vastly different and the feedback signals about economic and social value are much more nebulous, abstract, and easily manipulated.

In fact, markets are no more natural than politics and culture, whether traditional face-to-face or the world market economy. There never has been, nor will there ever be, a market that operates beyond the contexts and constraints of politics and culture. The traditional village market was consigned to a specific place in the town, and it was conducted on certain days—assigned by cultural tradition. Certainly in contemporary national and international markets, there is really no such thing as a completely free-functioning market, unconstrained by political regulation or culture. In the global marketplace, every nation expects its government to try to create favorable terms of trade for national firms and products. Even so, as Chapter Six noted, the World Trade Organization is working toward a relatively free global trade system. It is emerging, not because of the "natural operation of markets," but because of painful and laborious negotiations between politicians, bureaucrats, and corporate representatives. These efforts are fraught with compromises and opposition. Like politics and culture, markets are social constructions of reality.

Why keep hammering at this point? If you look again at the market strategies for dealing with environmental problems discussed earlier (green taxes, privatizing the commons, and creating quasi markets with tradable emission permits), they all require *political action* to reengineer markets that deliver different signals to producers and consumers. It is *not* a case of going from a regulated market to a free one, but of moving from today's environmentally perverse interventions to a new set of less damaging ones. That is *politically* a tough nut to crack!

Think about it: what politician in an energy-producing state is going to vote for higher taxes on energy? What senator from Wyoming is going to vote to end subsidies like cheap permits for ranchers to graze their animals on public lands (often destroying them)? The principle of rational-choice theory still holds: Politicians operate in different political resource markets (electoral votes and campaign contributions). As discussed in Chapter One, the complex division of labor and occupational specialization in industrial societies produce a *quasispeciation*, which means that different economic groups benefit and bear costs very differently, even in the same physical environment. Rational choice can be broadly as well as narrowly defined. The fact that for many goods, like TVs or electronic appliances, German consumers are obliged by law to pay a small tax to recycle them, and retailers and manufacturers are legally obliged to take them back for proper disposal, recycling, or remanufacture, says more about the influence of the Green political party and German culture than markets per se. Such costs save more in the costs of externalities than in the small costs they add to economic transactions. To support creating a green economy that makes doing good consistent with doing well sounds very good. Changing market incentives can change behavior. But changing market incentives means looking squarely in the face of politics.

POLITICS AND POLICY

Like markets, political institutions are also concerned with resource allocation. The classic definition of politics is the process of deciding who gets what, when, and how. Although rational-choice theory might understand politics as involving merely a different sort of market (with influence for sale), that is partly misleading. Politics involves the mobilization of power to allocate resources for an ostensible collective good and is justified by whether or not it produces public and collective benefits. Markets, on the other hand, are justified in terms of whether or not they produce private gain.

As recently as the late nineteenth century, the American state was a government of "courts and parties" in which conservative congresses blocked attempts to fashion a stronger role for federal intervention in private property prerogatives. But as unregulated modernization proceeded, many of its consequences produced aggrieved constituencies. These included farmers, workers, the elderly, and victims of bank and consumer fraud. The degradation of natural resources also became widely viewed as caused by unregulated private use and profit making. Reformers fought for protection from monopolistic railroads, banks, and farm machinery firms; middle-class reformers called "progressives" strived for regulation of banking, finance, food and drugs, and the protection of workers, children, and the elderly, and also for protection of natural resources (as in the conservation movement, discussed earlier). There can be little doubt that the mobilization of public and environmental movements and pressure groups (discussed in Chapter Eight) helped to create the "environmental regulatory state." Found in the United States and many other nations, this illustrates what Max Weber meant by extending rationality and the importance of "managers" in Western democracies (Humphrey et al., 2002: 275; see also Chapter One). Environmental regulation and management varies between and within nation states.

STRATEGIES FOR PUBLIC POLICY

Governments attempt to manage or change behavior by *public policy.* But that is a broad umbrella that encompasses an enormous diversity of agents and modalities that governments use. There are four broad policy options that governments can use to "fix" environmental problems.

First, and most often identified as a solution for problems, are *technological fixes.* They include, for instance, retrofitting the energy grid to use diverse renewable energy sources, more efficient auto engines with emission control devices that use less fuel and pollute less, insulating houses to cut fuel bills, genetic breeding of more productive seed hybrids, biotechnology, and so forth. The list of technological proposals to address problems seems endless. Public policy can stimulate the adoption of new technology in a variety of ways, such as public investment, subsidies, tax policies, and/or regulatory mandates.

Second, *behavioral fixes* use public policy to provide incentives to get us to behave differently. These are (supposedly) more difficult than technological fixes, which require no behavioral modifications. Examples of behavioral fixes include getting people to eat lower on the food chain (for ecological and health reasons); wear sweaters; turn down thermostats in the winter; install attic fans and use air conditioners less in the summer; and walk, bike, carpool, or use public transportation as alternatives to driving. Whereas technology requires investment, behavioral changes typically require incentives (or penalties). The rational-choice perspective has guided policy to create effective measures for reducing household energy consumption, which can be reviewed in Chapter Four.

Third are *cognitive fixes* that attempt to create awareness of problems in people's minds. The assumption is that if you change people's minds, they will change their behavior. Cognitive fixes often rely on public education and media campaigns. Cases in point are production cycle. *First*, the familiar downstream or "end-of-the-pipe" interventions work after consumption has taken place. Clean air standards, antipollution measures, and recycling are examples. Such end-of-the-economic-cycle strategies are how most environmental legislation is structured (Matoon, 1998; Renner, 1998). Such strategies are useful, but they do nothing to reduce unsustainable consumption. In people's minds, they may even constitute a rationale for consuming more! *Second*, midstream strategies reduce consumption and not only encourage frugality with trash and effluents, but also include the behavioral changes already noted and industries that use cogeneration processes. *Third*, policy interventions work upstream early in the production process itself, either to make production more environmentally benign or to reduce waste and materials in the production process. The standout example of this in the United States is the engineering of more energy-efficient products, ranging from dishwashers to automobiles.

History is part of the reason most policy attention has been given to downstream interventions that deal with pollution and toxic emissions. Environmental consciousness in the 1960s focused mainly on pollutants. Awareness of consumption and resource use issues came later, but there are reasons other than history. Midstream and upstream policies mean intervening in the economy in more fundamental ways than just cleaning up pollution. They mean altering production technologies, consumption patterns, or both. Real upstream policies shift the burden of change from consumers to producers. This is particularly difficult in a political system where producers have more power than consumers. Even though reducing pollution and waste by end-of-the-pipe controls or recycling is often costly, reducing it through resource efficiency is usually profitable. As you might guess, it was probably politically easier to focus on end-of-the-pipe policies. They provided the comforting illusion that we can go on consuming as we like, as long as we clean up the messes.

POLICY AND SOCIAL STRUCTURE

Political scientist Theodore Lowi worked to develop a framework depicting how public policy interacts with social structure in different ways, and he distinguished between *constituent* and *regulatory policies* (1964, 1972, 1979). Constituent policies provide benefits to particular constituents, clients, or publics, as illustrated by providing tax incentives for the lumber or oil industry. Environmental constituent policies would be those that provide subsidies for solar power for residents of the sunny Southwest or "gasohol" fuel that benefits primarily those who live in corn-growing regions. Even when they regulate, constituent policies are often—grudgingly—welcomed by particular constituent groups and industries as necessary to police their deviants. Examples include the Securities Exchange Commission, which regulates the stock market against securities fraud. In the Great Plains states, state legislatures considered enabling legislation to regulate ("meter") water use from the Ogallala aquifer in order to conserve water supplies. Constituent policies are politically easy and enthusiastically welcomed when they involve subsidies or tax concessions. If they involve regulation, they may be grudgingly accepted as a necessary collective security measure for an interest group or industry.

In contrast to constituent policies, true regulatory policies are another matter. *Regulatory policies* attempt to control behavior across a broad spectrum of constituent groups, industries, and economic processes. Related to environmental matters, early legislation from the 1960s that established broad air and water pollution standards are examples of such regulatory policies. Since 1872, national policies, including some broad regulatory ones, have been enacted to protect many environments and ecosystems as noted in Table 7.1.

Virtually all of the legislation shown in Table 7.1 had important results, protecting wilderness, forests, and sensitive habitats, and making progress in air and water pollution control and workplace health and safety. When enacted, most of these laws were very controversial among different interest groups. Notice how many environmental regulations were passed in the 1960s and 1970s, and that no major environmental law has been passed since the 1990s. Why do you think that is?

POLITICS AND THE LIMITS OF POLICY

The fragility of regulatory policy is that it tends to devolve into constituent policy through legislation and enforcement. *Constituent policy* often triggers conflict between *different* constituent groups, meaning that environmental policy often becomes mired in *politics*—the contentious processes of deciding who gets what, when, and how. Emphasizing that policy is embedded in politics underscores faulty technocratic assumptions that often dominate discussions of public policy: that we can simply devise rational, feasible, and cost-effective market interventions and incentive systems that get us to behave properly—and simply enact them.

Political institutions and cultures in different nations are not alike, and the policy process works differently in various nations. In the United States, the constitutional separation of powers provides corporations and nongovernmental organizations (NGOs) with greater opportunities to shape policy through lobbying, litigation, and the judicial system. Environmental policy is relatively centralized at the national level in Great Britain, Japan, and France, but is administered primarily by regional and local governments in Germany (Brickman et al., 1985). Noted earlier, some European nations have taken a substantial lead in improving human–environment connections. That is where notions of ecological modernization (EM) thrive and shape national policies (see Chapter Six). The reasons for the European lead have to do not only with culture, but also with political structure. For one thing, the American electoral system, with its two-party "winner take all" elections, makes it difficult for reform-oriented groups, factions, and movements to be represented in the executive policy-making process. In Germany, by contrast, parliamentary proportional representation of various electoral parties in the formation of governments provides greater access to the political system for parties and groups committed to social reform (Parkin, 1989). The Dutch and German "Greens" were never a dominant party, but have been important parliamentary coalition members of the ruling coalition since the 1990s with the leftist Social Democrats. But, there are other differences, such as political financing.

It is not news that for congressional and presidential candidates, winning elections in the United States is a very expensive process, and the parties and candidates who raise the most money are likely to win. Unless they are personally wealthy and willing to spend their own money (some are), candidates can get this money only from very wealthy individuals or corporations. Thus, the American electoral system has become increasingly driven by money from corporate political action committees, and so-called "soft money" from economic elites. This type of system produces a bias toward *shareholder control*, that is, control by corporations and economic elites (Longworth, 1998). By contrast, other democracies have strong biases for *stakeholder influence*, which gives more consideration to the interests of a large array of groups with a stake in the system, such as municipalities, labor unions, and civic, professional and regional groups. The German tradition of "codetermination" specifies that labor, local communities, and corporate interests are each represented on the board of directors of companies, in about equal proportions, to make decisions (Weinberg et al., 1998).

In spite of their differences, democracies are capable of delivering system-wide reforms. One can think of such system-wide reforms in American history: the Progressive Reforms of the 1900s that regulated banking, interstate commerce, food safety, and labor relations; the New Deal of the 1930s that established Social Security and a government more active in managing the economy (though it did not end the Great Depression); or the extension of Civil Rights and the War on Poverty of the 1960s. Probably the last great American reform was the passage of the National Environmental Protection Act of 1969, which established the Environmental Protection Agency (EPA) and gave administrative coherence to the plethora of environmental legislation of the 1960s and 1970s noted in Table 7.1.

Table 7.1 Major Environmental Laws of the United States, 1872–1992

1872	Mining Act
1935	Soil Conservation Act
1963	Clean Air Act (1965, 1970, 1977, 1990 Amendments)
1964	Wilderness Act
1965	Federal Water Pollution Control Act (Clean Water Act) (1972 Amendment)
1968	Wild and Scenic Rivers Act
1969	National Environmental Policy Act
1972	Federal Pesticides Control Act

	Marine Protection, Research, and Sanctuaries Act
	Marine Mammal Protection Act
	Coastal Zone Management Act
1973	Endangered Species Act (1982, 1985, 1988 Amendments)
1974	Safe Drinking Water Act (1984 and 1996 Amendments)
1975	Resource Conservation and Recovery Act (RCRA)
	Federal Land Policy Management Act
	National Forest Management Act
1976	Clean Water Act (CWA)
	Surface Mining Reclamation Act
	Toxic Substances Control Act (TOSCA)
	National Forest Management Act
1977	Soil and Water Conservation Act
1980	Comprehensive Environment Response, Compensation, and Liability Act (Superfund)
	Fish and Wildlife Conservation Act (Nongame Act)
1984	Hazardous and Solid Waste Amendments (RCRA Amendments)
1987	Water Quality Act (CWA Amendments)
1988	Ocean Dumping Acts of 1988
1990	Clean Air Act Amendments of 1990
1992	Environmental Justice Act
1992	Energy Policy Act

Sources: Adapted from Cunningham and Cunningham (2010: 32); Miller (2002: A7); Miller and Spoolman (2009: 641); Kraft (2001).

The establishment of the EPA signaled the American version of a similar change in many nations, which some have called the creation of an *environmental regulatory state* (Fisher and Freudenburg, 2004). Most nations, now, have environmental regulatory departments at the ministerial level. In America the EPA (and agencies in other nations) produced substantive improvements, or at least slowed environmental degradation for 40 years, but it did a distinct about-face in the recent decade. The American environmental regulatory state was created in an atmosphere of bipartisan cooperation

BOX 7.1

WEAKENING THE ENVIRONMENTAL REGULATORY STATE, 2000–2009?

After two terms of office, the George W. Bush administration compiled a record of a destructive campaign against America's environmental established safeguards. For example, the administration attempted to undermine the Clean Air Act by weakening the new source review program that pushed old polluting industries and power plants to clean up. It tried to narrow the scope of the Clean Water Act by stripping environmental protections from thousands of wetlands and streams. It moved to hobble the Endangered Species Act by eliminating habitat protective programs. While nearly every state warns about the threat of mercury poisoning from the consumption of locally caught fish, the administration promoted a scheme that would dramatically weaken mercury pollution control requirements in the existing clean air law. The administration turned a blind eye to calls from governments and scientists from around the world to limit global warming emissions, and now stands virtually alone in opposing even the most basic effort to move forward cooperatively. Since the Bush administration began, health warnings to avoid eating locally caught fish have doubled, and completed cleanup of toxic wastes at Superfund sites has fallen by 52 percent. Civil citations to polluters have dropped by 57 percent. A Knight-Ridder media analysis of the government's own data shows that Americans face a dirtier environment, while polluters largely get a free pass (Kennedy, 2006; Pope and Rauber, 2004). One environmental sociologist quipped that in the past half-decade, "Bush policies have done more to damage the environment than all other causes combined—including population growth and rampant consumerism" (Dunlap, 2006a).

(under the leadership of Richard Nixon, a moderate Republican president) from the 1970s to the 1980s that does not exist today. By the late 1980s, neoliberalism unleashed shareholder politics (in which the major shareholders are the corporate sponsors of conservative—and anti-environmental—politicians) to roll back many of the environmental protections enacted in the 1960s and 1970s. These actions were initiated under President Reagan and visible during the Clinton years, which conservative Congresses dominated, but became especially noticeable during the administrations of George W. Bush, who made only the barest pretense of having any interest in protecting the environment.

The administration could not actually dismantle the American "environmental regulatory state," because protecting the environment continued to have broad popular appeal. But they could subtly change the application of such regulations to be less stringent, which they did systematically.

There is ample data to suggest that these policies have had a significant negative effect on the American environment and people:

- After years of consistent decline, the most recent annual inventory of industrial toxic releases shows an increase of 5 percent in the release of toxic substances to the air, water, and land.
- The EPA reports a 36 percent increase in annual beach closings due to unsafe water quality since 2001.
- More than half of the total area of national forests has been degraded by logging, mining, and the 440,000 miles of publicly funded roads that make industrial resource extraction possible (Pope and Rauber, 2004: 121).
- While President Carter appointed a presidential commission to study the Three Mile Island nuclear mishap, the Bush administration never asked or commented about a similar nuclear "near miss" at the Besse-Davis reactor near Toledo, Ohio, in 2001 (Pope and Rauber, 2004: 104–105).
- In 2003, 76 percent of fish samples from US lakes were found to contain mercury levels unsafe for children three years old, and more than 600,000 newborns may have been exposed to levels of mercury exceeding EPA health standards while still in the womb (National Resources Defense Council, 2006).

These consequences are not only failures of the Bush administration, but in a larger context, the "dirty little secret" about public policy in the United States, known among policy scholars but not often publicly discussed. No national administration or political party in recent decades (probably since the 1970s) has been able to mobilize coalitions to support system-wide reforms like those of the past. Increasingly, American public policy is *retail policy*, that is, constituent policy that addresses the needs of particular organized client groups, rather than "wholesale" policy in the public interest (Mans, 1994). Retail policy may be a contributing factor to another problem the environmental regulatory state faces—public mistrust.

THE RECREANCY THEOREM—MISTRUST OF REGULATORY AGENCIES IN COMPLEX SOCIETIES

Sociologists have examined how citizens in technically advanced societies can become more dependent on their technologies rather than in control of them (Alario and Freudenburg, 2003; Barber, 1983). Entire armies of specialists are expected to be competent to judge and control the risks posed by advanced technologies. In public arenas, there are institutional actors (regulatory bodies) that must be perceived as both *competent* and reasonably *responsible to the interests of citizens* (termed "fiduciary responsibility"). Such regulatory agencies are charged with regulating and controlling (in the public interest), for instance, the safety of the US food system, risks in offshore oil drilling, the risks of methane pollution and environmental toxins, risks of economic collapse in the investment and lending practices of large banks and financial institutions. Now think about institutional actors like the Food and Drug Administration, the

Department of the Interior, the EPA, and the Federal Exchange Commission charged with assessing and regulating these risks. Freudenburg (1993) found that *recreancy*—the mistrust of competency and fiduciary responsibility of regulators—explained about three times as much public mistrust about the handling of nuclear wastes as did any sociodemographic variable (age, gender, income or education) or political attribute (party affiliation or political ideology). Similarly, researchers found that mistrust of a wide range of issues about agriculture and the safety of the US food system was shaped more by recreancy than any social or demographic characteristic. In addition, mistrust of competency was outweighed by mistrust of the fiduciary responsibility of regulators (Sapp et al., 2009).

We will revisit public mistrust of government agencies to manage environmental problems when discussing grassroots environmental activism in Chapter Eight. For now, however, we must consider that if limitations of purely market strategies for environmental policy bring us face to face with flawed regulation in contemporary politics, what can work? Is all lost?

TRANSFORMING ECONOMIC AND POLITICAL STRUCTURES

Some scholars have suggested that the consequences of the environmental state are more symbolic and ideological than real, not only recently, and not only in the United States (Bunker, 1996; Fisher and Freudenburg, 2004; Gonzalez, 2015; Schnaiberg and Gould, 1994: 53). In the United States, the widespread assumption is that environmental degradation, toxic emissions, and polluting industries are regrettable, but ultimately necessary for economic growth, jobs, and prosperity. Environmental protection may be desirable, but it is unrealistic. So, it's a trade-off—environmental protection or economic growth (jobs)—which do you choose? This pervasive narrative has broad acceptance by the general public, many scientists, politicians, and policy makers. In the next section, we show that it is a false assumption. The answer to the question above: Is all lost? We say, absolutely not!

THE ENVIRONMENTAL STATE AND REGULATORY POLICY: WHY ORGANIZATIONAL VARIATION MATTERS

In Chapter Six, we discussed research findings that showed a small number of economic firms produce the greatest share of the environmental harm, referred to as *disproportionality*. Significant improvements in environmental protection can be made "… if a small fraction of all economic actors were to reduce their emissions-per-job ratios simply to the 'average levels for their economic sector or for the economy as a whole'" (Freudenburg, 2006: 12, 19). For instance, the chemical and primary metals industry, which together produce 60 percent of the nation's toxic emissions as measured by their

Toxic Release Inventory (TRI), produce just 4.2 percent of the nation's economic output, and just 1.4 percent of the nation's jobs. A single enterprise (the Magnesium Corporation of America, in Rowley, Utah) has been responsible for over 95 percent of the measured toxic emissions from that industrial sector (Freudenburg, 2006). There is also good evidence that environmentally regulated sectors of the economy have done somewhat *better* than manufacturing firms in terms of international competitiveness policies (Freudenburg, 2006; Repetto, 1995). Furthermore, states and regions with more stringent environmental policies have stronger economies compared to those with weaker policies (Freudenburg, 1991a).

Why do some firms pollute so much more than others? Why does a policy work in one social setting, but not another? Two recent quantitative studies of large corporations analyzed the influence of organizational variation between parent companies on pollution rates. Parent companies represent the largest US corporations and their top managers hold considerable influence in economic decision making. One study examined US electrical energy parent companies (Prechel and Touch, 2014). The other analyzed parent companies listed in the Standard & Poor 500 Index (this is a rating system for investors of the largest companies with the most widely held stocks), representing several US economic sectors from 1994 to 2001 (Prechel and Zheng, 2012: 2). The Standard & Poor 500 companies have widespread influence on social and natural environments due to their control of large assets, which actually doubled during the study time period from $15.6 billion to $35 billion. The entire group represented 75 percent of US equities during that time (Prechel and Zheng, 2012: 2). How did these companies increase their economic wealth and power? Does it contribute to their capacity to cause environmental harm?

First, in the 1970s several forces converged that threatened to lower corporate profits, including the establishment of environmental regulations. In response, a coalition of large corporations lobbied Congress for tax provisions that would create an organizational structure to shield them from lawsuits for the harm they caused to the environment and/or social groups, and protect their assets from penalties. President Reagan signed the Tax Reform Act of 1986, which eliminated the New Deal tax on transfers of money from a subsidiary corporation to parent holding companies. This enabled US corporations to restructure to a multi-layer-subsidiary form. This organizational structure has a parent company at the top of the corporate hierarchy that essentially functions as the financial management company for two or more subsidiary companies underneath it. A *subsidiary* is a legally independent corporation in which the parent company owns more than 50 percent of their stock and can legally access its profits in the form of tax-free dividends. Companies can create multiple subsidiaries, and subsidiary layers, under one parent company. As such, some parent companies own only one subsidiary, and others own more than a hundred, organized into multiple subsidiary layers. Wrapping your head around the complexity of these organizations is a task most of us would rather avoid, but of course, that is the advantage of this organizational type—*they are hard to regulate*. It also creates an opportunity to increase profits by access to capital, avoiding fines and costly investments in pollution abatement. Other neoliberal policies, like financialization of markets, also incentivized consolidations and paying high dividends to shareholders rather than repaying debt. This has left some companies more capital dependent (in debt or leveraged), amplifying incentives to not invest in new technologies to reduce pollution (Prechel and Zheng, 2012; 4–6; Prechel and Touche, 2014).

Second, the political structures and economic conditions of states have become increasingly important in environmental protection in part because states have been granted more authority to monitor toxic emissions regulated by federal policies, such as the Clean Air Act and others. Some states have stronger pollution standards and enforcement structures that create strong disincentives for companies to pollute. Also, some states have more money to provide tax incentives to help companies comply with environmental regulations. Finally, state laws tend to reflect the values and norms of their population so companies headquartered in states that enforce green policies have an incentive to comply to avoid bad publicity and boycotts of their products (Prechel and Zheng, 2012; Prechel and Touche, 2014).

Both of these studies looked at how pollution rates are affected by variation in the organizational complexity of parent companies—number of facilities and subsidiary layers, and level of debt, and the green policies of states. They essentially had the same results. Not surprisingly, higher pollution rates were found for parent companies with more facilities and layers of subsidiaries. Second, companies with higher debt produced higher pollution rates. Third, states with stronger green policies *do deter* pollution. This finding is supported by other research. On the upside, it is encouraging that state policies matter. On the downside, it can create an incentive for corporations to move to states that tolerate higher levels of pollution (Prechel and Zheng, 2012; Prechel and Touche, 2014).

In sum, these studies suggest that (1) there is *disproportionality* in companies' contributions to pollution; and (2) regulatory policies can control the most damaging enterprises and regions without damaging the entire economy. The tendency to see polluting resource industries as providing benefits to "capitalism"—rather than to a relatively small number of capitalists—reflects sloppiness in interpreting relevant data. Time and time again, we find that where there are environmentally harmful impacts, whether it be toxic emissions from industrial facilities, failed levee systems, such as the case of Hurricane Katrina, or the 2010 BP Oil disaster in the Gulf of Mexico, the underlying problem is not one of environmental protection versus economic prosperity. Quite possibly, the real problem is how economic benefits are structured so that a few privileged actors get an unfair share of the goods at the expense of harming the environment and many people (Freudenburg, 2006; Freudenburg et al., 2009; Freudenburg and Gramling, 2012; Prechel and Zheng, 2012; Prechel and Touche, 2014). Environmental regulations are not spoilers of "good business climates" and, if anything, can improve them. However, decentralization of environmental regulatory authority to

a katz / Shutterstock.com

Figure 7.5 Environmental activists want genetically modified foods to be labeled so consumers can decide whether or not to buy them. Agribusiness firms such as Monsanto have opposed GMO labeling.

energy conservation ads telling people "Don't be fuelish," or recycling ads reminding us that "If you're not recycling, you are throwing it all away." The appeal of cognitive fixes is that they rely on voluntary change and are compatible with norms of personal freedom. Unfortunately, there is very little evidence that such strategies work in isolation from others. Even so, the importance of cognitive change as part of more comprehensive policy change strategies is often underrated.

Fourth are *legal fixes* that mandate change through laws and regulations rather than incentives, subsidies, or persuasion. Examples include federal speed limits on interstate highways and requirements to remove lead from gasoline, install antipollution devices, or recycle beverage containers or household or industrial wastes. Actually, the first two strategies (technological, behavioral) can be pursued by regulatory or nonregulatory means. Regulatory strategies can be very effective, but they are unpopular in a society that views government regulation negatively. A reality among policy scholars is that the most effective strategies for change produced by public policy combine all four approaches. In other words, change could be promoted by simultaneously providing better technical means, changing people's minds, providing material incentives, and using regulatory restrictions or targets.

POLICY AND THE ECONOMIC PRODUCTION CYCLE

Policy strategies can apply to different domains of social behavior (as the fixes just described), but policy can also be applied at three different stages of the economic

Rena Schild / Shutterstock.com

Figure 7.6 March in Washington DC on November 29, 2015, the eve of the beginning of the Paris Climate Summit

states and regions can lead to a "race to the bottom" by cash-strapped states lowering environmental regulations to create jobs and bring in corporate tax revenues. At the same time, companies that are the most leveraged may be pulled to those states. In regard to policy, there are three points to consider: (1) the trend toward decentralization of the environmental state ought to be revisited; (2) environmental policy ought to look at how shared organizational characteristics of companies and the political-policy environment in which they are embedded create opportunities and (dis)incentives to pollute; and consequently, (3) other policies, such as the 1986 Tax Reform Act, that have made it possible for companies to form complex structures that shield them from being held liable for the negative social and environmental externalities they produce, ought to be revisited (Prechel and Zheng, 2012; Prechel and Touche, 2014).

From the limits to growth perspective (Chapter Six) the capacity of economic actors to externalize costs is rapidly shrinking as planetary boundaries are exceeded, or even pushed to a tipping point. But regardless of one's viewpoint on limits to growth, global leaders are signaling to economic investors and companies that carbon emissions must be reduced. Time is up. Thus, we began this chapter with a discussion of an economic problem: stranded assets related to climate change risks. We now turn to stranded assets to further consider how to pave a sustainable path forward.

ENVIRONMENTAL RISKS AND STRANDED ASSETS

Other sets of environmental risks exist that jeopardize valued assets in addition to climate change. Some of them are illustrated in Table 7.2.

Table 7.2 Environmental Change That Could Produce Stranded Assets

Environmental Risk		**Examples of Potential Stranded Assets**
Climate change	→	Coastal zones prone to flooding and storm surges
Natural capital degradation and depletion	→	Forestry holdings
Biodiversity loss and decreasing species richness	→	Pharmaceuticals
Air, land, and water contamination	→	Agricultural land, tourist & recreational assets
Habitat loss	→	Holdings of species-sensitive real estate
Freshwater availability	→	Agricultural land; certain industrial operations

Source: Adapted from Caldecott (2015: 53).

The various sets of environmental risks are not isolated from one another and reverberate through social and natural systems. While natural capital assets—land, soil, air, water, species, biodiversity—have been undervalued and unaccounted for in business spread sheets, their contribution to asset stranding, directly and indirectly, is extensive and the impacts can ripple across markets and into other sectors of society. A 2013 study that examined the effect of natural capital loss on revenues in various economic sectors found agriculture to be the most impacted. For instance, global wheat prices doubled due to weather-induced supply shortages in Russia, Ukraine, and Canada. At the same time, the Chinese increased wheat imports due to their drought. Consequently, major wheat importing countries like Egypt, where the typical household spends 38 percent of its income on food, were heavily impacted by the rise in food costs. These examples are only the tip of the iceberg, and economic, political, and social costs are mounting (Caldecott, 2015).

Several policy recommendations have been made to avoid environmental related stranded assets. Perhaps the most obvious is to *stop investing* in polluting and resource-intensive activities, and *retire* existing ones. An economic policy tool for retiring existing assets is *reverse auctions* in which bids represent the price an owner is willing to accept to shut down an unsustainable asset. It has been successfully implemented in overfished areas by buying fishing fleets, and in areas undergoing water stress by buying back pumping licenses. Research conducted at the Stranded Assets Programme at the University of Oxford's Smith School of Enterprise and the Environment has conservatively estimated the cost of compensating the premature closing of the least efficient coal-fired power plants in the US by 2025 to be $47 billion, and $106 billion in India. The cost in the US is lower because plants are older so owners are more likely to accept less for early retirement. Also, if premature closures are to be successfully carried out, it will be essential to enact measures that meet the natural, economic, human, and social capital needs of negatively impacted individuals and communities. The lost generation capacity also must be replaced by cleaner technologies at an acceptable replacement rate. Where do the funds come from? A couple of examples are special levies on electricity bills, and foreign assistance to a developing country (Caldecott, 2015: 61–63).

Another means to avoid asset stranding is to not *lock-in*—firms should not invest in technologies and infrastructure that can become quickly outdated or unacceptable by societal standards. To successfully create a pathway to decarbonize our economy, transparent use of market tools that can predict winners and losers in the process is needed. Financial institutions that internalize the costs of environmental-related risks and the level of exposure will encourage better risk management and hedging. A means of doing this is to assign higher risk premiums to environmental related risks, which could also encourage greater investment in cleaner and more sustainable economic sectors. A recent analysis of relevant research revealed that 80 percent of studies show that good sustainability practices positively influenced the stock-performance of companies. Firms that better manage their own current and future risks, and are aware of those borne by their clients, are significantly more competitive over time (Caldecott, 2015: 61–63).

To successfully institute premature closings and new technologies, transition pathways need to account for and invest in the entirety of ecosystem and social system assets: natural, economic, human, social and cultural systems, that are risk exposed and sources of value creation. If not, premature closings will overwhelm social systems and the implementation of new technologies will be spotty at best, and fall short of reaching full potential or having a large-scale cumulative impact on the trajectory of current environmental and climate change trends. Next, we will discuss a policy tool or resource management "regime" (the legal term) that has the longest tradition in human societies for preserving natural capital.

COMMUNITY MANAGEMENT OF COMMONS RESOURCES

Sustainable community management of commons resources (CRM) has been practiced for many centuries. Yet, it has only recently been "rediscovered" by social scientists, and this suggests that Hardin's "tragedy of the commons" notion—the assumption that people and groups will *always* overuse common pool resources—is not a "law of nature." A classic example is Torbel, Switzerland, where it was decided that the fragile alpine meadowlands should belong to the community rather than to private owners. Since the fourteenth century, they have communally managed a system where no one was permitted to graze more animals in the summer than they could feed in the winter. Cows were sent to alpine meadows all at once and counted, and trees for harvest were marked once a year by a community forester (Netting, 1981). This system of CRM has stood the test of time.

Consider another case from the United States. Unlike many fishing grounds in the North Atlantic, lobster fisheries along the central coast of Maine have been sustainably maintained for many decades, and their efforts have paid off! In 2013, the Maine lobster industry received the prestigious Marine Seafood Certification seal as an ecologically sustainable and well-managed fishery. The lobster industry expects the certification to produce positive economic returns by opening up new markets and securing existing ones (see www.msc.org). The Maine lobster fishery, which is older than the founding of the Americas, uses small boats that drop lobster traps (or "pots") into identifiable shoreline harbors, moving to deeper water in the winter to do lobstering. CRM is possible because the state limits the number, size, and sex of lobsters that can be harvested and requires lobster fishers to get a license number to prominently display on the line connected to each particular pot. Most of the credit goes to the lobster fishers themselves. In order to maintain their livelihood, communities of lobster fishers developed strong unwritten rules governing assigned territories that were defended against outsiders (Acheson, 1981; Gardner and Stern, 2002: 127–128). Are these cases unusual exceptions to the tragedy of the commons? *The simple answer is no.*

Political scientist Elinor Ostrom and her colleagues are well-known for their research that documented many successful cases of CRM (Ostrom, 1990; see also Baland and Platteau, 1996; Costanza et al., 2014). In fact, the CRM model has

Photo courtesy Barbara Hayford.

Figure 7.7 Community-based conservation in Mongolia: The Mongolian Aquatic Insect Survey (MAIS) team sampling a stream. See, http://clade.ansp.org/entomology/mongolia/mais_home.html been adopted in a variety of local settings and also used to assist private property owners with conservation management. A note on terminology, CRM has been loosely interchanged with numerous other terms such as community-based resource management (CBRM), community-based conservation, participatory conservation management, participatory action research, participatory governance, or civic environmentalism (also noted in Chapter Two) (Bell and Ashwood, 2016; Bullard and Wright, 2012; Stedman et al., 2009; Wilmsen et al., 2012). The underlying assumption with each is that communities are empowered to solve their own environmental problems. It also has become a policy option often preferred by governments to manage a wide range of environmental issues, such as forest conservation, biodiversity loss, land management, watershed management, and wetland restoration. For instance, in the US community watershed organizations have proliferated to manage local water issues, such as nonpoint water pollution, and depletion rates (Stedman et al., 2009). As a bottom up approach to sustainable resource management, it is designed to incorporate local knowledge and seek solutions that connect local, national, and international interests. It produces greater long-term success in local ecosystem management. Research also shows that CRM/CBRM can create more sustainable communities by building local capacity through the development of human capital (acquisition of new skills and knowledge); economic capital (creation of new local jobs); and social capital (forming new networks and social bonds between community members and external individuals and organizations). An important outcome is more sustainable and resilient communities that can better address other potential problems and opportunities, such as a natural disaster or economic change. CRM/CBRM participants routinely report an overall improvement in quality of life (Stedman et al., 2009; see case studies in Wilmsen et al., 2012). Table 7.3 summarizes the conditions that are conducive to sustainable CRM/CBRM.

The great service of Ostrom and her colleagues was not to disprove Hardin's "tragedy of the commons," but to contest its universality and to offer a powerful set of counterexamples of conservationist social institutions. The problem of the commons is really a problem of *open access*, but where a common resource is limited to a particular group of users, it may suffer no such degradation (Rose, 2001: 234). Ostrom also found that the success of CRM depends on factors beyond local communities, particularly the support of local, regional, and national governments who can assist, or inhibit, their efforts. Furthermore, CRM may be contrary to powerful social trends in the twenty-first century. World markets and the world-system often disrupt local CRM. Global markets ensure that people with cash incomes can almost always escape the pain of local shortages and simply buy from elsewhere. As such, globalization has been weakening two of the major conditions in Table 7.3 for effective CRM: (1) local resource dependence and (2) the presence of dense, stable community networks. Even places like Torbel, Switzerland, have seen significant socioeconomic change in the last 30 years. The institutions and cultural practices of communal management still exist, but are now challenged to remain relevant. The region has undergone emigration with young people seeking new opportunities in the urban economy. The homogeneity of stakeholders

Table 7.3 Conditions Conducive to Successful Community Resource Management

I.	Resource is controllable locally
	A. Definable boundaries (land more than water, water more than air)
	B. Resources stay within boundaries (plants more than animals, lake fish more than ocean fish)
	C. Local CRM rules can be enforced (higher-level governments recognize local control and help enforce rules)
	D. Changes in resource can be adequately monitored
II.	Local resource dependence
	A. Perceptible threat of resource depletion
	B. Difficulty in finding substitutes for local resources
	C. Difficulty or expense attached to leaving area
III.	Presence of community
	A. Stable, usually small population
	B. Thick network of social interaction and relationships
	C. Shared norms ("social capital"), especially norms for upholding agreements
	D. Resource users have enough local knowledge of the resource to devise fair and effective rules (*A* facilitates *B,* and both facilitate *C.* All make it easy to share information and resolve conflicts informally)
IV.	Appropriate rules and procedures
	A. Participatory selection and modification of rules
	B. The group controls monitoring, enforcement, and personnel
	C. Rules emphasize exclusion of *outsiders* and the restraint of *insiders*
	D. Congruence of rules and resources
	E. Rules have built-in incentives for compliance
	F. Graduated, easy-to-administer penalties

Sources: Adapted from Ostrom, 1990; Gardner and Stern, 1996: 130.

no longer exists and people are not totally dependent on their local resources for their livelihood. The diversity of stakeholder interests makes monitoring and enforcing local resource management norms more difficult. The ability of local, regional, and national institutions to adapt to broader changes is critical to the success of CRM/CBRM in Torbel and beyond (Wehkamp et al., 2013).

Moreover, defining the boundaries of a community can be problematic. Is it reasonable to define a local community in terms of the boundaries of a watershed, meadowlands, or a forest area? How community is defined may be open to manipulation by powerful interests that run contrary to the environmental problem, and can result in unequal power relations in a community. The most successful CRM/CBRM cases are developed to be inclusive of the diversity of community members and stakeholders. Furthermore, issues that produce high levels of community conflict and uncertainty, such as threats from toxic pollutants where local people bear responsibility for the potential harm; extra-local assistance may be needed to address the problem. (Bullard and Wright, 2012; Novek, 2003; Stedman et al., 2009). To summarize, the *advantages* of CRM/CBRM are:

1. Builds on long-standing social traditions.
2. Can internalize externalities.
3. Can be effective over very long periods.
4. Can encourage people to move beyond egoism or selfishness.
5. Has low enforcement costs.
6. Can build sustainable and resilient communities.
7. Improves quality of life.

But CRM/CBRM *is limited* because

1. Works best with a limited range of resource types.
2. Not well-suited for high conflict issues.
3. Social trends often destroy the basis for its successful practice.
4. Seeks equitable community representation and outcomes.
5. Remains adaptable to changing conditions (Gardner and Stern, 2002: 149–150; Stedman et al., 2009).

The limitations cannot be ignored. They mean that many world environmental problems are not amenable to CRM/CBRM, at least alone. Even with these limitations, CRM/CBRM has great promise for dealing with certain environmental problems as part of a mix of strategies. Thus, market tools, such as tradable environmental allowances, offer ways to address environmental problems.

TRADABLE ENVIRONMENTAL ALLOWANCES

The market strategies most preferred by industry and government are broadly referred to as *tradable environmental allowances* (TEAs). Seen as the major alternative to the imposition of green taxes, TEAs require that the government establish a maximum allowable level of exploitation (for forestry or fishing) or for the production of wastes and pollutants, and auction off permits to producers. The work of ecological and environmental economists has helped develop a pricing system that allows industry or landowners to receive payments for ecosystem services (PES), and to set up markets for ecosystem services (MES) (Beder, 2011). PES have been instituted in global climate change policy to preserve forests as carbon sinks, such as the UN-REDD+ program (Reducing Emissions from Deforestation and forest Degradation, discussed in Chapter Three). An MES essentially allows producers to buy permits or credits to pollute or destroy ecosystems. Notable examples are emissions trading schemes (e.g., carbon cap-and-trade, discussed in Chapter Three) and reverse auctions. Another example is wetlands mitigation banks that allow producers to buy credits to compensate for destroyed wetlands (learn more at www.nrcs.usda.gov).

The government does not establish prices for such permits; rather, in the auction process, some permits would accrue value while others, of less importance to producers, would decline in value. Enterprises with permits can use them in current production, bank them for future expansion, or sell them to other firms, as their value accrues. TEAs are intended to effectively "ration" access to common pool resources. Applied to emissions control, a permit to produce a certain level of emissions carries an economic incentive to figure out ways to maximize units of production per unit of emission. Applied to exploitation of fisheries, as the estimated "maximum sustainable yield" for orange roughly declines and fewer permits are available, they are "bid up." Fishing of that particular species would halt or slow, as fishers are likely to turn to other, more plentiful, commercially viable catches. Once a quantity limit is specified, the government has no responsibility for finding the right price in a tradable permit system; the market defines the price. With a tax system, the government must find the appropriate tax rate—no small task.

Perhaps the most ambitious and successful application of a TEA was the US scheme for reducing sulfur emissions by half from 1990 to 2000. Permits were assigned to approximately 263 of the more sulfur dioxide-intensive electrical plants operated by 61 electric utilities. These were mostly coal-fired power plants east of the Mississippi River. The result was that sulfur emissions were cut in half between 1990 and 1995, well ahead of schedule (Schmalensee et al., 1998). Interestingly, the cost of doing this was one-tenth of the costs projected by electric industry, because the market-based strategy motivated companies to reduce emissions in more efficient ways (Miller, 2002: 411). During this time, however, many energy corporations along with other companies were consolidating into the multilayered corporation, creating new opportunities to externalize the costs of pollution (Prechel and Touche, 2014). Nonetheless, environmental economists argue that when it is desirable to keep environmental destruction at or below a certain level, TEAs are often more effective than green taxes, which have less certain effects.

There are two overarching problems with TEAs. First, they ensure that economic growth continues unabated by targeting an acceptable level of pollution at the lowest cost to industry. Thus, TEAs are less effective: (1) When substantial reductions in pollution are required at higher costs because the range of options is limited for finding a cheap solution and to trade excess emissions permits; (2) by favoring cheaper downstream solutions (e.g., retrofitting an old power plant is less expensive in the short term than transitioning to new clean-energy technologies); and (3) by allowing industry to pay for pollution, innovation is stifled (Beder, 2011).

The second overarching problem is TEAs may provide guidance to economic actors, but they do not account for variability in the social settings, organizations, and institutions through which they must be implemented and enforced. In this way TEAs present the following problems: (1) if enforcement is weak or ineffective, permit holders have an incentive to cheat. Also, loopholes make them ineffective. For instance, the multilayered subsidiary parent company does not have to cheat to make minimal reductions. That is, it is legal for independent subsidiaries that are owned by the same parent company to trade emissions with one another (Prechel and Zheng, 2012). (2) They do not account well for ecosystem variability. For instance, wetlands provide different services dependent on the surrounding ecosystem and social system (Beder, 2011). (3) In many developing countries, PES for carbon sinks has led to the growth of plantation forests that has jeopardized the livelihoods and culture of local indigenous peoples and produced negative ecosystem impacts (Beder, 2011; Ciplet et al., 2015).

Overall, the cumulative effect of TEAs has been negligible given the worsening of global environmental and climate change problems. If the purpose is to stimulate a long-term trend, then graduated taxes for industry over time may be more effective. While taxes are unpopular, think about who has the most to gain by keeping the current approach to environmental protections in place. Clearly, the capacity of industry to continue to externalize pollutions costs and financial service companies that administer TEA schemes are benefitting. Meanwhile, the costs of pollution are largely covered by the taxes paid by the working and middle classes (Prechel, 2015).

COMPARING TRADABLE ENVIRONMENTAL ALLOWANCES AND COMMUNITY RESOURCE MANAGEMENT

Legal scholar Carol Rose (2002) has compared the two strategies for environmental protection. Table 7.4 summarizes the differences between CRM and TEA regimes as if they were pure (or "ideal") types, though Rose cautions that reality is more complex.

CRM and TEA systems are like mirror images, and you can see why TEA systems have been the dominant idea for modern property rights systems, particularly in a global arena. Yet CRM regimes have some positive features, especially at those points where TEA systems tend to be least effective, particularly in coping with locally dense, complex natural systems like forests or wetlands (Salzman and Ruhl, 2000). In our estimation, the enormity of our current environmental and climate challenges suggests that all options must be considered.

Table 7.4 Comparison of Community Resource Management (CRM) and Tradable Environmental Allowance (TEA) Regimes

	CRMs	**TEAs**
Scale	Smaller (unless "nested" or coordinated)	Larger
Resource complexity	Complex, interactive	Simple, single focus
Practices encouraged	Adaptation, long-term stability, risk sharing	Security of investment, innovation
Social structure	Close-knit	Loose, stranger relations
Adaptation to shifts in the natural environment	More adaptive	Less adaptive
Adaptation to shifts in human demand	Less adaptive	More adaptive
Typical resource application	Pollution (putting in …)	Extraction (taking out …)
Relation to commerce	Vulnerable to commerce	Accommodates commerce

Source: Adapted from Rose (2001: 250).

THE GLOBAL POLITICAL ECONOMY AND THE ENVIRONMENT

Let us end with a brief discussion of the global forces that influence our way forward on environmental and climate change-related economic, social, and political policies.

INTERNATIONAL ORGANIZATIONS, TREATIES, AND REGIMES FOR ENVIRONMENTAL PROTECTION

The emergence of the world market and world-system of nations was connected with multilateral political and economic organizations, many conferences, and treaties. Chapter Six discussed the formation of the World Bank, the International Monetary Fund, and the World Trade Organization. Large international gatherings of governments, corporations, and a multitude of NGOs were convened by the United Nations in Stockholm, Sweden, in 1972; in Rio de Janeiro, Brazil, in 1992; Johannesburg, South Africa, in 2002; and most recently, for the Conference of Parties (COP 21) to the United Nations Framework Convention on Climate Change (UNFCCC) in Paris, France, in 2015. The more recent global gatherings were attended not only by UN member states, but also by representatives from interested human rights, labor, environmental NGOs, and social movement organizations that together form

BOX 7.2

UNITED NATIONS AND PRIVATE MULTINATIONAL ORGANIZATIONS

The United Nations Environment Programme (UNEP), the Food and Agriculture Organization (FAO), the World Health Organization (WHO), the United Nations Development Programme (UNDP), and the United Nations Conference on Trade and Development (UNCTAD) are agencies of the United Nations. UNCTAD represents the economic and trade interests of LDCs. The UNEP is a small and underfunded agency compared to older, more well-established ones like the WHO. While UN agencies have international legitimacy compared to many private organizations, they often have overlapping concerns and jurisdictions, or ones only partly concerned with environmental issues. A Commission on Sustainable Development (CSD) was founded to monitor progress (or lack thereof) of the programs initiated at the Stockholm, Rio, and Johannesburg meetings.

The Global Environmental Facility (GEF) is a private organization, funded by donors, which makes grants to LDCs for projects about environmental protection and promoting sustainable livelihoods. The International Union for Conservation of Nature (IUCN) is a global alliance of biologists, conservationists, and environmentalists primarily concerned with the preservation of biodiversity. It has actively sponsored the development of nature reserves around the world. The Climate Action Network (CAN) is a transnational advocacy network of more than 100 NGOs that seek to influence global policy to limit human-induced impacts to ecologically sustainable levels (see: http://www.climatenetwork.org).

transnational advocacy networks (TANs). See Box 7.2 for some of the more important UN agencies and the few private and nonprofit ones dealing with global development and environmental and climate issues (not an exhaustive list!).

There are now 500 or so international environmental agreements (or "conventions") in effect. About 150 are global treaties, while others are agreements among a more limited set of parties (nations) (Cunningham et al., 2005: 24). Some important ones are shown in Table 7.5.

Scholars have debated the significance of such treaties and organizations. Some scholars believe they are a part of an emerging "world society" (Frank, 1999). The concept of a world society is based on two intriguing observations: (1) in spite of strikingly diverse cultural origins, global cultural similarities are increasingly impressive (about, for example, the importance of human rights and environmental protection); and (2) there exists a level of similarity of structural and organizational forms among governments and NGOs around the world that is far too great to be accidental or explainable in terms of some kind of "functional necessity" (Buttel, 2000c: 117; Shorette, 2012). Frank et al. see global forces at work when national parks appear in Nepal, when a chapter of the

Table 7.5 Some Important International Treaties

Convention Concerning the Protection of the World Cultural and Natural Heritage 1971 (1975)
Convention on Wetlands of International Importance, Especially as Waterfowl Habitat 1971 (1975)
Convention on International Trade in Endangered Species of Wild Flora and Fauna 1973 (1987)
Convention on the Conservation of Migratory Species of Wild Animals 1979 (1983)
Basel Convention on the Transboundary Movements of Hazardous Wastes and Their Disposal 1989 (1992)
Vienna Convention for the Protection of the Ozone Layer and Montreal Protocol on Substances that Deplete the Ozone Layer 1985 (1992)
U.N. Framework Convention on Climate Change 1992 (1994)
Convention on Biological Diversity 1992 (1993)
U.N. Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa 1994 (1996)
U.N. Convention on the Law of the Sea 1982 (1994)
U.N. Paris Climate Agreement (2016)*

Source: Adapted from Cunningham and Cunningham (2010: 533); *Monica's addition.

International Council for Bird Preservation opens in a poor nation such as Gambia, when Mexico joins the International Whaling Commission, when environmental impact assessments begin in Kuwait, and when Romania founds an Environmental Ministry (Frank et al., 2000: 111). Furthermore, the studies found that global institutionalization of environmental protection spreads when:

- There are greater and "denser" ties between a nation state and the world society, in terms of national chapters of all kinds of governments and NGOs.
- The nation states have many "receptor sites," meaning domestic scientific and ecology organizations, capable of receiving and interpreting global blueprints for environmental protection.

They concluded that large-scale (regional and global) structural processes and forces promote the spread of institutions and treaties for environmental protection, and that "domestic factors" like national opinion and social movements promoting mobilization are mechanisms of change rather than causes of change (Frank et al., 2000: 111).

In a pointed response, the late environmental sociologist, Fredrick Buttel, argued that Frank et al. prematurely dismiss the importance of state-level organizations and social movements for environmental protection. He further suggests that Frank et al. overemphasize the extent of cultural agreement and consistency in the "world society" and underemphasize the extent of tensions and conflict over environmental protection in a vastly unequal and conflict-prone world. Finally, Buttel notes that in many cases there is little evidence that the global spread of organizational forms and treaties has had positive impacts on environmental quality (2000c). Among many critics, James Gustave Speth, a highly respected environmental lawyer, university professor, founder of the World Resources Institute, and former administrator of the UN Development Programme, agrees:

> The current international effort to help the environment simply isn't working.… The climate convention is not protecting the climate, the biodiversity convention is not protecting biodiversity, the desertification convention is not preventing desertification, and … the law of the sea is not protecting fisheries. [Protection of the world's forests has not even] reached the point of a convention.… Global environment problems have gone from bad to worse. The problem is not weak enforcement or weak compliance; it is weak treaties.
>
> (2004, cited in Miller, 2005: 623–624)

In response to such critics, Frank et al. respond that some studies show evidence that changes in national and global policies *do* improve environmental quality (see, Dietz and Kalof, 1992; Roberts, 1996; and more recently, Shorette, 2012). Furthermore, "populations of various endangered species (elephants, wolves, and tigers)" are strong and resurgent. CFC emissions, the culprits behind ozone depletion, have declined precipitously. Polluted rivers and bays throughout the industrial world have improved dramatically. Clearly some regulations, national and international, are working. But the "holes in the system" are legendary. Are policies *effective enough* in restoring or maintaining environmental quality? Certainly not. Are policies *effective at all?* The answer is most likely yes. "Even a pockmarked system is better than no system at all" (Frank et al., 2000: 123).

Finally, consider the proliferation of transnational advocacy networks (TANS). TANs are composed of groups from different countries that share beliefs, values, and a common understanding and discourse of concerns about global problems (Ciplet, 2014). In regard to climate change policy, three groups that have been marginalized in negotiations, women, indigenous peoples, and waste pickers, have formed TANs to gain recognition in the UNFCCC climate regimes. They have sought rights in regime policies and procedures to address their disparate vulnerability to present and future impacts, as well as their unique capacities to adopt adaptation and mitigation measures. And they have lobbied for representation in the decision making and enforcement processes within the UNFCCC organizational bodies.

For example, the Global Alliance of Waste Pickers and Allies (GAWA) organized to address how the UNFCCC climate change policy undermines the livelihoods of waste pickers and recyclers in the informal economy around the world. They teamed up with other groups such as Women in Informal Employment: Globalizing and Organizing

Figure 7.8 Indigenous Peruvians in Paris try to influence the COP 21 Climate Summit

(WIEGO) and the Global Alliance for Incinerator Alternatives (GAIA). They have sought rights for waste pickers by targeting the Clean Development Mechanism (CDM) (see Chapter Three). The CDM oversees methodology for determining which "clean energy" projects receive funding. The GAWA has argued that waste pickers are the *green* choice because they use the most sustainable practices for waste management. They argue that CDM has been biased toward supporting large-scale private recycling firms that produce negative environmental and social externalities. Large private recyclers rely on capital and carbon-intensive technologies, such as incineration. This bias towards private organizations threatens the livelihoods of some of the world's poorest people. The waste pickers successfully garnered media attention. The World Bank and Clinton Initiative also recognized GAWA. They have successfully gotten key language included in the CDM methodology that states, credits (funds) should not be given to "counterproductive waste projects" (Ciplet, 2014: 90). However, the next step is to see this language enforced. Perhaps most important, waste pickers, along with women and indigenous peoples, contend that their unique perspectives and built-in capacities—human capital—should not be wasted, but rather harnessed to contribute to sustainable solutions. Jamie Lerner in Curibita, Brazil, chose not to waste the human capital of the people who lived in the *favelas*, and it turned out to be a wise choice.

CONCLUSION

Moving toward sustainability is unthinkable without utilizing the power of market incentives and public policy, though doing so will challenge our collective wisdom and will. However, the business as usual economic and political policies have not prevented environmental problems from worsening, and thus, new strategies and tools will need to be utilized. True sustainability goes hand-in-hand with environmental and climate justice. The stakes are too high to continue down the same path. Finally, *resilience* was discussed as an important part of sustainability in Chapter Six and in Chapter Three regarding climate change adaptation. Paradoxically, markets and political policies that use rigid control mechanisms to preserve social-environmental systems can only erode resilience and promote collapse. In contrast, resilience-building management can sustain such systems in the face of surprise, unpredictability, and complexity. It is open and flexible to learning, focusing on slowly changing things that enhance memory, diversity, and the capacity to innovate. It conserves and nurtures diverse elements necessary to adapt to novel, unexpected, and changing circumstances, and increases the range of surprises with which systems can cope (Flint, 2010: 48: Pearson, 2008). Economic and political policies that enhance resiliency, which include investments in improving the social well-being of communities should be part of a new tool set for addressing environmental problems.

In surveying the structural dimensions of change in this chapter, you have been introduced to the heart of several academic and policy controversies. But something was missing from this discussion, namely, the impact of ideas and the power of individuals joining forces to advocate for change, apply pressure on government, or change markets by selective buying, or economic boycotts. The next chapter turns to the role of agency within the various forms of "environmentalism."

PERSONAL CONNECTIONS

QUESTIONS FOR REVIEW

1. Economists believe that markets deliver realistic signals about values, costs, and scarcities, and that many problems (including environmental ones) are market failures. How so? What are some different ways that market failures can generate environmental problems?
2. What are "externalities," and what is an example of one that affects a human and environmental problem?
3. How could a "carbon tax" address environmental problems like pollution and global warming? Why are they so difficult for politicians to enact?
4. What is "green consumption," and how, if widely accepted, could it produce jobs and address environmental issues? What are some things that could limit or enhance the ability of green consumption to make a difference?
5. What are "upstream," "midstream," and "downstream" (or "end-of-the-pipe") interventions to improve the environment? Provide a real-world illustration of each type.
6. Why did America produce so many *major* environmental reforms in the 1960s and 1970s, but none since the 1990s? (Hint: Think about the re-alignments in American politics since the 1960s and 1970s.)

7. Most contemporary nations, even poor ones, are also "environmental regulatory states," to one degree or another. What does this mean? What are some illustrations of the successes and failures of environmental regulatory states? What is the "recreancy theorem"?
8. Zoologist Garrett Hardin believed that an environmental "tragedy of the commons" was a universal condition, but Elinor Ostrom's research about community resource management found conditions under which it was *not* universal. What were some of these conditions, and how does modernization make management of community resources more difficult?
9. Freudenburg found the relationship between the degree of government regulation of the environment and regional prosperity to be counterintuitive. How so?
10. What factors did Frank and his colleagues identify as increasing the likelihood that nations would accept international treaties and institutions that protect the environment?

QUESTIONS FOR REFLECTION

The rational-choice perspective suggests that you make choices to maximize benefits and minimize costs. Here are some questions to help explore this in terms of some of the ordinary choices that people make:

1. Earlier we argued that there were some benefits in living close to work. What are some of its costs? What are some costs and benefits of living in the suburbs and driving or commuting miles to work? Include in your considerations not only the monetary costs of transportation or the environmental impacts, but also things like the social quality of life in various neighborhoods. Are there places close to where people work that they would not like to live in and would bear large costs to avoid? As you can see, deciding what is a net rational choice is not so simple.
2. Many have noted that convenience meals are very expensive per unit price, wrapped in layers of packaging that took an enormous amount of material and energy to produce, and perhaps laced with fat, sugar, salt, chemicals, preservatives, and dyes that make their nutritional and health value questionable. Even knowing this, are there times when the benefits of eating them outweigh the benefits of healthier food? Consider costs and benefits broadly: money, costs imposed by job routines, family roles, time constraints, and market availability. Alternately, consider the costs and benefits of cooking the way most nutritionists and environmentalists advocate: buying unprocessed food in larger quantities and cooking as much from scratch as possible. To quote Kermit the Frog, "It's not easy being green!"Think of your own examples. There are many things you could do to be more environmentally frugal. Why do they seem difficult? It is easy to talk glibly about changing lifestyles, but this is often difficult for us to do, even when we want to. What are some of the reasons why?
3. You can see the complexities of the rational-choice perspective in action. Some argue that regulatory strategies are indeed necessary for environmental protection, occupational and safety standards, health, social justice, and many

other concerns. The National Environmental Policy Act, which created the EPA, revolutionized the American way of thinking about regulatory policy. How has your life been impacted, negatively or positively, by environmental or occupational regulation? Talk to some other people for their perspectives: city officials, university administrators, homemakers, your relatives, or small business owners. You will find that hardly anyone likes such regulations. But how do opinions differ about whether they are necessary or not? What do you think shapes divergent opinions?

WHAT YOU CAN DO

Environmental careers? As environmental problems proliferate, there will be jobs for people with environmental expertise in government, private nonprofit organizations, and companies. There will be opportunities for people with scientific and engineering backgrounds, but also for people with environmental interests combined with backgrounds in other fields, such as business, policy studies, law, the social sciences, ethics, and journalism. An incredible variety of careers that involve environmental and ecological issues exist. Here are just a few:

- Scientific fields: Environmental health and toxicology, environmental geology, ecology, chemistry, climatology, biology, air and water quality control, solid waste management, energy analysis, energy conservation, renewable energy technologies, agronomy, urban and rural land-use planning, atmospheric science.
- Resource and land management careers: Sustainable forestry and range management, parks and recreation, fishery and wildlife conservation management, conservation biology.
- Engineering and architecture: Environmental engineering, solid and hazardous waste management, environmental design and architecture, product and appliance engineering.
- Humanities, social sciences, and other fields: Environmental law, law enforcement, policy, consulting, social science and communications, risk analysis, risk management, demography (population dynamics), environmental economics, psychology or sociology, environmental communications and journalism, environmental marketing, environmental policy, international diplomacy, public relations, activism, lobbying, and environmental writing and journalism.

For help, go to

www.ecojobs.com/index.php
A newsletter listing 500 jobs every two weeks in various environmental fields.

www.EcoEmploy.com
Direct links to jobs in the United States and Canada; job listings, help with résumés.

MORE RESOURCES

Brown, L. (2009). *PLAN B 4.0: Mobilizing to save civilization.* New York: W. W. Norton & Company.

Haley, H., Martinez-Alier, J., Temper, L., Walter, M., and G. J. F. (Eds.). (2013). *Ecological economics from the ground up*. New York: Routledge.

Hawken, P., Lovins, A., and Lovins, H. (1999). *Natural capitalism: Creating the next industrial revolution.* New York: Little Brown.

Kraft, M. E. (2014). *Environmental policy and politics* (6th ed.). New York: Routledge.

Ostrom, E., Dietz, T., Dolsak, N., Stern, P., Stonich, S., and Weber, E. (Eds.). (2002). *The drama of the commons.* Washington, DC: National Academy Press.

Speth, J. G. (Ed.). (2013) *Worlds apart: Globalization and the environment* (2nd ed.). Washington, DC: Island Press.

Stavins, R. (Ed.). (2012). *Economics of the environment: Selected readings* (6th ed.). New York: W. W. Norton & Company.

Wilmsen, C. Elmendorf, W., Fisher, L., Ross, J., Sarathy, and Wells, G. (Eds.). (2012). *Partnerships for empowerment: Participatory research for community-based natural resource management*. New York: Routledge.

ELECTRONIC RESOURCES

www.unep.org/unep/products/eeu/eeupub.htm
This is the website for the US EPA National Center for Environmental Economics (NCEE). It is a source for technical expertise and provides analyses of economic and health impacts of environmental regulations and policies.

http://www.isecoeco.org
This is the website for the International Society of Ecological Economics.

http://ec.europa.eu/environment/enveco
This is the website for the European Commission on Environment. It includes information on European environmental and economic policy and legislation.

http://www.brookings.edu/research/topics/energy-and-environment
This is the Brookings Institute website, a nonprofit public policy organization based in Washington, D.C. They conduct research and develop policy to address energy and environmental issues at the national and global level.

https://www.msc.org
The Marine Stewardship Council is an international nonprofit organization devoted to addressing the problem of unsustainable fishing. It provides a wealth of information on sustainable fisheries and how to find sustainable seafood for consumers.

http://globalrec.org
This is the Global Alliance of Waste Pickers site. It provides information on the social, economic, and environmental benefits of waste picking.

http://wiego.org
This site represents a broad coalition of individuals and institutions that address women's roles and needs in the informal economy, including waste picking.

http://www.pbs.org/wgbh/frontline/film/business-of-disaster
This Frontline and NPR investigation illustrates environmental and climate injustice by uncovering how some businesses are profiting from disasters such as Superstorm Sandy while many people remain displaced from their homes and communities.

CHAPTER 8
ENVIRONMENTALISM: IDEOLOGY AND COLLECTIVE ACTION

We are going to begin this chapter with a story of environmental injustice. Lois Gibbs was president of the local neighborhood association of Love Canal, a working-class suburb of Niagara Falls, New York, and she was mad as hell. In the 1970s, she and her neighbors complained to local officials about strange, smelly chemicals leaking into their basements, gardens, and storm sewers. Local officials listened, but ignored their complaints. Children playing on school grounds and around the old canal got strange chemical burns. The Hooker Plastic and Chemicals Company used the old canal for which the subdivision was named, long deserted by barge traffic, as a dumping ground for toxic chemical wastes. Between 1942 and 1953, the company dumped more than 20,000 metric tons of wastes into the canal, mostly in steel drums. In 1953, the company covered the dump site with clay and topsoil and sold it to the Niagara Falls school board for $1 in a sales agreement that specified that the company would have no future liability for injury or property damage caused by the dump's contents. Eventually an

txking/Shutterstock.com

Figure 8.1 A boy from Boise, Idaho, has a message about fracking…fracking has been met with resistance in local communities and by environmentalists across the globe. This is one reason why the future of fracking is uncertain.

elementary school and housing project with 949 homes were built in the 10-square-block Love Canal area.

Informal health surveys conducted by alarmed residents, and led by Lois Gibbs, revealed an unusually high incidence of birth defects, miscarriages, assorted cancers and nerve, respiratory, and kidney disorders among residents. Again, complaints to local officials had little effect. But continued pressure from local residents led New York State officials to conduct more systematic health and environmental surveys, which confirmed the suspicions of the residents (miscarriages were four times higher than normal). They found that the air, water, and soil of the area, as well as the basements of houses, were badly contaminated with toxic and carcinogenic chemicals. In 1978, the state closed the school and relocated more than 200 families living closest to the dump. After outraged protests from the remaining residents and investigations by the Environmental Protection Agency (EPA), President Jimmy Carter declared Love Canal a federal disaster area and relocated all families who wanted to move. About 45 families remained, unwilling or unable to sell their houses to New York State and move. In 1985, former residents received payments from an out-of-court settlement from Occidental Chemical Corporation (which had bought Hooker in 1968), from the city of Niagara Falls, and from the school board. Payments ranged from $2,000 to $400,000 for claims of injuries ranging from persistent rashes and migraine headaches to severe mental retardation. By 1988, a US District Court ruled that Occidental Chemical must pay cleanup costs and relocation costs, which had reached $250 million, but the company appealed that ruling.

Ironically, the dumpsite was covered with a clay cap and surrounded by a drain system that pumped leaking wastes into a treatment plant. By 1990, the EPA renamed the area Black Creek Village and proposed a sale of the 236 remaining dilapidated houses at 20 percent below market value. Several environmental organizations, however, filed a federal complaint against the EPA for failing to conduct a health risk survey before moving people back into the Love Canal area. By that time, Lois Gibbs had founded the Citizens' Clearinghouse for Hazardous Wastes (now the Center for Health, Environment, and Justice), an organization that has helped more than 7,000 grassroots environmental organizations. Concerning the effort to relocate people in the old Love Canal subdivision, she said, "It would be criminal.… It isn't a matter of if the dump will leak again, but when" (cited in Miller, 2005: 532).

This classic case illustrates two things about protecting the environment. First, environmental change is the outcome of interactions between collectively organized individuals (agents of change) and the social structures they encounter. This was referred to in Chapter Six as praxis. Second, it illustrates grassroots mobilization of local community members: In a setting with longstanding problems, a committed organizer and activist arrives on the scene unburdened with blueprints for change and mobilizes the latent talents of community members. From the beginning the community members control the process, but they eventually encounter an expanding web of bureaucrats, experts, and politicians in existing organizations (structures).

This chapter is about how collective action transforms human–environment relationships. It is, in other words, about *environmentalism*. After discussing this briefly, the chapter will focus on four broad topics: (1) the varieties of American environmentalism, both historical and contemporary, (2) anti-environmentalism, (3) global environmentalism, and (4) patterns and predictors of environmental concern, ending with the issue of how we determine the success of environmentalism.

Environmentalism is both ideology and action. Ideology denotes a set of beliefs about desirable human activities and perceived sets of problems. But ideologies are not only abstract beliefs and "models about how the world works." They are beliefs that are used, often quite deliberately, to justify change. Environmentalists have produced a social, economic, and philosophical literature of remarkable breadth, depth, and variety that significantly shapes the political values and agendas—if not the actual operation—of most nations today.

Environmentalism is also purposive action intended to change the way people relate to the environment. In other words, collective action results in environmental social movements. When thinking about social movements and activists, many Americans will imagine the abolitionists, suffragists, the civil rights movement, environmental movements, or more recently, the Occupy Wall Street movement. These are examples of *progressive movements* because their goals for change entail expanding community boundaries by granting more groups full access to rights and opportunities, ensuring justice, and improving conditions for existing community members. Aldo Leopold, a conservationist, argued to extend our vision of community to include the land, writing in 1949: "The land ethic simply enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land" (1949: 239). His writings and especially the essays included in the *Sand County Almanac* influenced the ideology of the modern environmental movement.

On the other hand, *regressive social movements*, also referred to as conservative or countermovements, emerge to reverse the achievements of progressive movements or to block further expansions of rights or protections. One example is the climate change denial movement, which we will discuss in this chapter. Another example is white supremacist movement organizations, such as the Ku Klux Klan (KKK) that first organized after the Civil War. Today, the KKK's goal to reverse racial progress is unpopular, so they use covert strategies and less publicly visible spaces such as the Internet (much like Astroturf campaigns, also discussed later in the chapter) to spread their message (Adams and Roscigno, 2005; Schmitz, 2016). Countermovements to civil rights influence the environmental conditions and protections enjoyed by local communities. For instance, the continuing practice of restrictive housing options for people of color in America leads to inequities in the distribution of environmental disamenities (toxic facilities and environmental hazards) or amenities (green space, clean water and air) (Bullard and Wright, 2012; Taylor, 2014).

Social movements are the product of civil society. Civil society is the social space that exists outside of the market and government. It includes our interactions within numerous formal and informal organizations and settings, such as churches, watershed protection organizations, and even public gatherings. Economic and government actors and organizations are driven to meet specific goals that are often complementary to one another. Participation in civil society is voluntary and social action is not constrained in the same ways as in economic and government institutions (Caniglia et al., 2015). Social movements challenge vested interests—those that have a stake in defending the status quo. In doing so, they must define their grievances, identify goals for change and develop strategies and tactics to achieve their goals. Importantly, social movements develop strategies and actions for change from outside of the mainstream political process. Activists do take actions like write letters to senators, testify at public hearings, and initiate voter campaigns, but their repertoire for actions includes some forms of protest and dissent. Moreover, the organizations, groups, and individuals targeted for change will resist and develop strategies and tactics to try to neutralize their challengers (Gamson, 1990). In many ways, social movement activism becomes like a game of chess between the challenging group (social movement activists) and the antagonist (organizations and individuals targeted for change).

Sociological scholarship on social movements is extensive (for useful summaries, see Harper and Leicht, 2011; McAdam and Snow, 2010). Highlighted briefly here are three frameworks for studying social movements. First is *resource mobilization*, which looks at how social movements organize financial support, and participants' time, talents, and social networks. This lens identifies the organizing bases for groups, such as college campuses, churches, labor unions, or other social movement organizations with complementary interests. These organizational bases provide the infrastructure to share knowledge, develop strategies and tactics, and organize mass protests, all of which are necessary to force a response by those with vested interests. Resource mobilization can take a top-down approach, meaning those with economic and political power can organize social movements, such as the climate denial countermovement (Caniglia, et al., 2015; Dunlap and McCright, 2015). Additionally, when movements achieve success, they can become co-opted or bureaucratized, such as the large environmental movement organizations known as the Group of 10 (i.e., Environmental Defense Fund and Nature Conservancy, see Table 8.1) that take a top-down approach.

The second perspective, *frame analysis*, addresses how social movements get the attention of the larger society. Social movements must recruit participants and get others to believe in their cause. Collective action frames must inform the public of the problem and connect with commonly held values and beliefs. There are three types of frames: *diagnostic*—what is the problem, who is responsible and how it is unacceptable; *prognostic*—what needs to happen to make the problem better and what would be the ideal solutions; and *motivational*—why collective action to bring about change is required and sacrifices of time and energy are worth it. Social movement frames also must *align* with one another, and resonate with people outside the movement (Brulle and Benford, 2012; Snow and Benford, 1988).

The third perspective is the *political opportunity structure model*. It starts with the premise that challenges to elite vested interests are often shut down and controlled. When using this lens, scholars and activists learn the importance of being able to read social structures and conditions to know when openings and closures for change are likely to occur. Opportunity structures can be tightened or weakened by external events like a massive oil spill, or internal pressures, such as division amongst elites. This perspective has been used to look at how a social movement is maintained over time. It also is used to examine how marginalized groups from below, rise to successfully challenge elite interests to create systemic and cultural change. A key ingredient is *cognitive liberation*, meaning that people must believe that through collective action they can make social change happen (Caniglia et al., 2015; McAdam, 1999).

AMERICAN ENVIRONMENTALISM

You might think that American environmentalism is relatively new, but it is the product of over 100 years of collective action and movement organizations. This involved not only historically specific organizations, but also different ways of framing environmental problems and various discourses about them, both among environmental movement activists and in the broader arenas of public discourse (the media and political process). Sociologist Robert Brulle (2000) identified eight unique environmental discourses that shaped different waves of environmentalism throughout US history. They are briefly summarized below in approximate chronological order of their emergence along with associated environmental movement organizations.

1. ***Preservation (1830s):*** Nature is important to support both the physical and spiritual life of humans. The continued existence of wilderness and wildlife undisturbed by human action is necessary (Wilderness Society, Sierra Club).
2. ***Conservation (1860s):*** Natural resources should be scientifically managed from a utilitarian perspective to provide for the greatest good for people over the longest period of time (Society of American Foresters).
3. ***Wildlife management (1890s):*** The scientific management of ecosystems can ensure stable populations of wildlife, viewed as a crop from which excess populations can be harvested, particularly in recreation and sport (Ducks Unlimited).
4. ***Reform environmentalism (1870s, but really flourished in the 1960s):*** Human health is linked to ecosystem conditions like water quality and air pollution. To maintain a healthy human society, ecologically responsible actions are required, which can be developed and implemented through the natural sciences (Environmental Defense Fund).
5. ***Environmental justice (1970s):*** Ecological problems exist because of the structure of society and its imperatives, and the benefits of environmental exploitation accrue

to the wealthy while the poor and people of color bear most of the costs. The resolution of environmental problems requires fundamental social change (Center for Health, Environment and Justice, Environmental Justice Resource Center).

6. ***Deep ecology (1980s):*** The richness and diversity of life has intrinsic values, so human life is privileged only to the extent of satisfying basic needs. Maintenance of biodiversity requires decreasing the human impact (Earth First!).
7. ***Ecofeminism (1980s):*** Ecosystem abuse is rooted in androcentric ideas and institutions. Relations of complementarity rather than domination are required to resolve conflicts between culture/nature, human/nonhuman, and male/female relationships (World Women in Development and Environment).
8. ***Ecospiritualism (1990s):*** Nature is God's creation, and humans have a moral obligation to keep and tend the creation, including biodiversity and unpolluted ecosystems (National Council of Churches, as well as most denominational bodies).

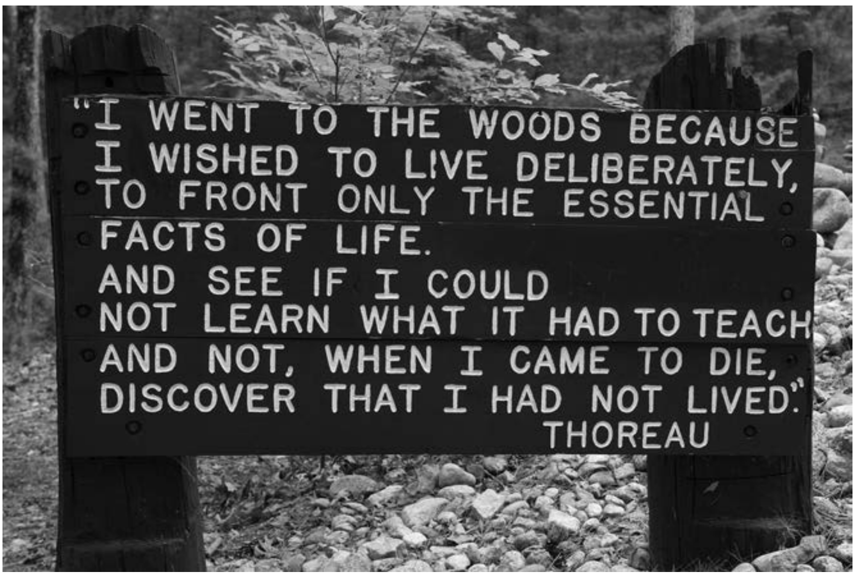
Importantly, Brulle noted another human–environment ideological frame, virtually unchallenged in its domination of American environmental discourse from 1620 until the middle of the nineteenth century, referred to as *manifest destiny.* In effect, it is an ideological belief system that views nature as composed of infinitely abundant resources to be used at the will of humans. Manifest destiny was a rationale for the European conquest of the North American continent, and it has continued to serve as the argument and discourse for several waves of countermovements to environmentalism (McCright and Dunlap, 2000; Dunlap and McCright, 2015; Meyer and Staggenborg, 1996: 1632). We return to anti-environmentalism later in the chapter.

The earliest stage of American environmentalism emphasized the conservation and preservation of natural resources and areas, while the 1950s and 1960s focused on air and water quality, pollution, and human health issues. While these concerns continue, more recently environmentalism has developed a more ecological focus on global issues, such as loss of biodiversity and climate change (Mertig et al., 2002).

EARLY AMERICAN ENVIRONMENTAL MOVEMENTS, 1870–1950

Preservation and conservation were the first manifestations of American environmentalism, foreshadowing many contemporary environmental concerns. The swift destruction of America's forests and wilderness in the late nineteenth century by the lumber industry was the greatest public concern. Devastating environmental catastrophes turned public opinion against the cutting of large contiguous stands of trees. Cutting left pollution from residual bark, branches, and other waste. Worse, it surrounded small hamlets throughout the country with a virtual tinderbox. Approximately 1,500 persons died and 1,300,000 acres of land were burned in a Wisconsin fire in 1871. Related community disasters, such as the famous Johnstown, Pennsylvania flood, were attributed to clear-cutting, because clear-cut soil does not hold water (Humphrey and Buttel, 1982: 114). Such wanton environmental destruction of America's forests and rangeland produced a broad-based effort to curb the abuses of private ownership and to institute "scientific management" of the nation's environmental resources. There were many individual leaders in this movement (called Progressives or Reformers, as were many leaders for political change in that era). Three are particularly remembered for their influence: President Theodore Roosevelt, John Muir, and Gifford Pinchot. They mobilized public support for conservation and created organizations such as the Sierra Club (founded in 1892 by Muir), the Audubon Society (1905), and many outdoor recreation clubs, such as the Boone and Crockett Club (founded by Theodore Roosevelt).

Conservationism was given intellectual and ideological shape by the writings of three persons. The first was *George Perkins Marsh* (1801–1882), whose work *Man and Nature: Physical Geography as Modified by Human Action* identified the negative impact of human economic activity on forests and rangeland. It documented the connections between the cutting of forests and soil erosion and between the draining of marshes and lakes. It also highlighted the cascading effects of species loss in ecosystems and the relationship between human activity and climate change. Marsh's eerily prescient ecological view is all the more remarkable because it was published in 1874, *before* the automobile, the significant use of oil, and the mechanized clearing of forests or modern mining that were to come (Paehlke, 1989: 15). *John Muir* (1838–1914) reacted angrily to the anthropocentrism of those who saw humans as above nature. Nature and



Jay Yuan/Shutterstock.com

Figure 8.2 Henry David Thoreau (1817–1862) from Concord, Massachusetts, was a naturalist, poet, essayist, and abolitionist, to name a few of his interests. He perhaps is most well known for his writings on wilderness, living life with principle and civil disobedience, and of course, living by Walden Pond. His writings have inspired many environmentalists (you can learn more about Thoreau at, https://www.walden.org).

wilderness were a spiritual experience, and he saw people, at their best, as part of that spiritual whole. Both politically and intellectually, Muir campaigned tirelessly for the preservation of wilderness areas from human intrusion. For him, the notion that the world was made especially for the uses of man was an enormous conceit (Nash, 1967: 131). *Aldo Leopold* (1886–1948) agreed, but his intellectual achievement was a blending of ecology and ethics. He saw the land itself as a living organism. People, he noted, are the only species that can threaten nature as a whole. If we do so, we will, of course, destroy ourselves. Leopold also pointed out that while most humans imagine that they are sustained by the economy and industry, these are in turn sustained, as all living things, by the land. We are therefore but one part of an interactive global ecosystem, and we injure the land at our own peril (Nash, 1967: 182). In short, the intellectual and ideological basis of contemporary environmentalism was well underway in the latter half of the nineteenth century.

The appeal of *conservationism*, as it was termed, was strongest among the upper and upper-middle classes, who were most concerned about outdoor recreation, the shrinkage of the public domain, and the destruction of forests. Conservationists sought to use the legal and political power of the state to protect forest lands from exploitation, resulting in, for example, the Yellowstone Act (1982), the Adirondack Forest Preserve (1885), and legislation to preserve Yosemite (1890) and Mount Rainier Parks (1890, 1899). Such efforts came to be effectively organized by national movement organizations such as the Audubon Society and particularly by Muir and the Sierra Club (Humphrey and Buttel, 1982: 113–114).

Government officials, however, constantly struggled to balance two different public interests. Organizations such as the Sierra Club and the Audubon Society urged for the *preservation of wilderness*, with a minimum of human use for scientific, aesthetic, and "nonconsumptive" recreational use. Others, such as hunters and fishers as well as large ranching, mining, and timber commercial interests, argued for the *utilitarian use of natural resources* subject to "scientific management." The second interest was spearheaded by Gifford Pinchot, a private forestry manager in North Carolina. The US Department of Agriculture formed a Forestry Division, helped Congress to pass the Forest Reserve Act in 1891, and hired Pinchot to study the possibilities of the scientific management of forests. He was appointed chief of the Division of Forestry, and his combination of technical and political skills enabled him to form a close relationship with President Theodore Roosevelt, whose domestic policy advocated the "wise use" of natural resources. Pinchot proved politically far more astute than Muir. In short, *the utilitarians won a decisive political victory over the preservationists.* Such policies enabled commercial interests to use public lands, subject to government regulation. They protected natural resources, but also reinforced and rationalized the exploitation of public lands by lumber companies and ranchers (Hays, 1959).

After World War I, the United States was confronted with massive environmental calamities such as flooding and soil erosion in the Great Plains "Dust Bowl," as well as by the Great Depression. A second wave of conservationism developed during the Franklin Roosevelt administration emphasized both protecting and developing natural resources. New Deal programs, such as the Civilian Conservation Corps and the Tennessee Valley Authority, worked to protect natural resources and stimulate economic recovery. In the 1950s, more emphasis was placed on preservation of natural beauty and wilderness for public enjoyment. This "wilderness movement," spearheaded by older organizations such as the Sierra Club, developed highly publicized campaigns to save the Grand Canyon and Dinosaur National Monument (Dunlap and Mertig, 1992: 2).

AMERICAN ENVIRONMENTALISM SINCE THE 1950s

By the 1950s, conservationism was an established social force in American life. The 1970s transformed it into a different and greatly expanded environmental movement. This movement, often called *reform environmentalism*, was a complex system of ideas (Brulle, 2000). It was not simply an amplification of conservationism; the newer environmental discourse viewed problems as (1) being more complex in origin, often stemming from new technologies; (2) having delayed, complex, and difficult-to-detect effects; and (3) having consequences for human health and well-being as well as for natural systems. Because they encompassed both pollution and loss of recreational and aesthetic resources, environmental problems were increasingly viewed as threats to the total quality of life (Dunlap and Mertig, 1992: 2–3).

Like earlier movements, the new American environmentalism had important intellectual and ideological foundations. The first was *Silent Spring* (1962) by marine biologist Rachel Carson—an angry and uncompromising analysis of the toxic effects of modern pesticides on every form of wildlife. Carson focused on the politics of science and the exclusion of the public from knowing what risks they were being exposed to by the development and use of synthetic chemicals. *Silent Spring* made bestseller lists and sold more than a million copies—rare for a serious nonfiction book. Indicative of its impact, the American pesticide industry mounted a $250,000 campaign to prove Carson a "hysterical fool." Carson's work enhanced public awareness of the ecological impact of pesticides, and that awareness helped pass the Pesticide Control Act of 1972 (Sale, 1993: 4). Carson's work put the issue of pollution on the environmental agenda.

In 1968, zoologist Garrett Hardin rediscovered Malthusian ideas in his famous essay, *The Tragedy of the Commons* (discussed in Chapter Seven). Zoologist Paul Ehrlich's (1968) extremely popular neo-Malthusian book, *The Population Bomb*, forced the issue of overpopulation into public consciousness in an apocalyptic way, claiming that "the battle to feed all humanity is over." Biologist Barry Commoner (1971), the most political and intellectually sophisticated "framer" of environmental concerns, disagreed with Ehrlich by arguing that the greatest threat to the environment was not population growth per se, but modern technology and the power of corporations that promote overconsumption.

Furthermore, the media widely publicized environmental disasters, raising public awareness of problems. In New York City, 80 people died from smog during an air inversion in the summer of 1966. An offshore oil rig near Santa Barbara poured undetermined millions of gallons of oil along the California coastline in January and February of 1969, killing wildlife and soaking beaches with black, oily goo. The industrially polluted Cuyahoga River near Cleveland burst into flames, and in the summer of 1969 nearby Lake Erie was declared a dying sinkhole as a result of sewage and chemical pollutants. As the 1960s wore on, media attention continued, reaching a crescendo by 1970 with a wave of front-page articles and cover stories in *Time*, *Fortune*, *Newsweek*, *Life*, *The New York Times*, and the *Washington Post*. "Ecology" became a word known—if incompletely understood—by the average citizen. Public outcry about such environmental abuses was widespread. Many people were no longer willing to accept pollution and environmental disruption as business as usual and demanded government protections from environmental harms (Sale, 1993: 19–25).

The event that symbolized this effervescence of environmental consciousness and activism was *Earth Day 1970*. The idea began with Senator Gaylord Nelson, who proposed a nationwide environmental teach-in on college campuses, following the model of the 1960s antiwar teach-ins. He received a federal grant and support from government agencies (e.g., the Interior Department) to organize the event, in spite of opposition from the Nixon administration. The popular response was overwhelming. *The New York Times* estimated that 20 million people participated. It displayed a surprising depth of feeling about environmentalism (Sale, 1993: 34–35), and the immense political momentum of the environmental movement continued to build. In 1972, the Apollo 17 crew took a series of photographs of the earth from 22,000 miles away. One of these is on page 228, and it has become an icon of the environmental movement. Using the metaphor "spaceship earth," it came to represent a fragile earth with finite limits and a delicate natural balance—to which the fate of humanity is collectively linked (Brulle, 2000: 187). Earth Day continues as an annual ritual of American environmentalism.

Older national conservation organizations were invigorated by this upsurge of consciousness as they attempted to incorporate it. The National Audubon Society, for instance, enthusiastically supported anti-pesticide campaigns, while the National Wildlife Federation began to use lawsuits as a key strategy to achieve environmental protections (Sale, 1993: 19–20). By 1967, new organizations emerged representing a new wave of environmental movement organizations, such as the Environmental Defense Fund (EDF). They marked the beginning of an environmental discourse and movement "frame" based on Rachel Carson's book. Using scientific research and legal action to protect the environment and human health, EDF action methods served as an exemplar for many newer organizations. Over time, the environmental movement spawned thousands of organizations, and many of the relatively large organizations have budgets in excess of $100,000 (Brulle, 2000). Many are led by well-compensated executives, employ scores of professional legal, scientific, and administrative staff, and have the capacity to promote multiple goals using diverse techniques at different levels of political action (local, national, and international). In this sense, we do indeed have an "environmental establishment" (Bosso, 2005: 7).

REFORM ENVIRONMENTALISM AND THE ENVIRONMENTAL LOBBY

A national network of transformed environmental movement organizations came to dominate the movement's presence in Washington. Known as the "Group of 10," their interests and strategies differed: Some engaged in pro-environment lobbying; some developed the expertise and scientific capability for educational programs and advocacy research; some specialized in litigation to shape the development and enforcement of environmental policy; some purchased land to set aside for wilderness preserves. This core coalition met periodically to discuss common strategies and problems, and worked with other organizations. See Table 8.1.

Collectively, national environmental organizations grew significantly after the 1960s, but it came in waves interspersed by periods of slow growth or stalled altogether. The first growth was in the years just prior to Earth Day in 1970. It slowed during the 1970s but, ironically, as the conservative Reagan administration attacked environmentalism, it stimulated a second wave of growth in the 1980s. Visible ecological problems such as toxic wastes, beach contamination, the Exxon *Valdez* oil spill, and global warming stimulated a third surge in membership in the early 1990s. The environmental movement grew again (and perhaps declined) during the Clinton/Gore administrations that were, at least, rhetorically "green." In 2000, national environmental organizations began another period of intense membership mobilization and lobbying with the election of a generally unsympathetic president and a conservative Congress (see Chapter Seven, and Box 7.1.) This is an interesting and curious dynamic: in democratic societies official hostility can sometimes stimulate the mobilization of oppositional movements. What is beyond question is that by the 1990s, national environmental movement organizations claimed millions of members, or at least "checkbook supporters" (Brulle, 2000: 105; Mitchell et al., 1992: 2–3).

REFORM ENVIRONMENTALISM, PUBLIC OPINION, AND LEGISLATION

The national environmental movement organizations—termed *reform environmentalism*—channeled and amplified environmental awareness and concerns among broad segments of the population, particularly about the hazards connected with life in industrial society (Brulle, 2000). For instance, national public opinion poll data between 1965 and 1970 demonstrated a growing willingness to define air and water quality as significant problems. Increasingly, these were seen as deserving government attention, serious in respondents' communities, and as government spending areas they would *least* like to see cut. People were increasingly willing to pay modest taxes to address pollution problems. By the 1970s, large majorities expressed pro-environmental opinions, which had become a *consensual issue*. Public opinion polls, however, did not report how important or *salient* environmental concerns were. Even though the majority of the public had accepted environmentalists' definition of environmental issues as problems and had

Table 8.1 Selected National Environmental Organizations, 2003

Organization	Year Founded	Members**	Revenue ($ millions)
*Sierra Club**	1892	736,000	83.7
*National Audubon Society**	1905	550,000	78.6
*National Parks and Conservation Association**	1919	375,000	20.9
*Izaak Walton League**	1922	45,000	4.3
*The Wilderness Society**	1935	225,000	18.8
*National Wildlife Federation**	1936	650,000	102.1
Ducks Unlimited		656,000	125.1
Defenders of Wildlife		463,000	21.8
Nature Conservancy		972,000	972.4
World Wildlife Fund—U.S.		1,200,000	93.3
*Environmental Defense Fund**	1967	350,000	43.8
*Friends of the Earth**	1969	35,000	3.8
*Natural Resources Defense Council**	1970	450,000	46.4
League of Conservation Voters		60,000	7
Greenpeace USA		250,000	25.9
American Rivers		30,000	5.5
Sea Shepherd Conservation Society		35,000	1
Earth Island Institute		20,000	4.9
Environmental Working Group		—	1.8
*Environmental Policy Institute**	1972	Not a membership organization	
Total		7,799,400	$2,135

*Group of 10

**Includes members or supporters, where possible to estimate.

Sources: Adapted from Bosso (2005: 7); Mertig et al. (2002: 463).

become sympathetic to environmental protection, only a minority saw them as among the nation's *most* important problems, compared to issues like crime or unemployment (Dunlap, 1992: 92–96; Smith, 1985).

In the 1970s, when Republicans as well as Democrats attempted to govern from the political center, newly elected Republican President Nixon announced that he was an environmentalist and supported legislation to protect the environment. The EPA required an *Environmental Impact Statement* (EIS), which also required a Social Impact Assessment to be done for every federal agency project and had the power to approve or veto projects. Environmental legislation usually included so-called hammer clauses intended to produce strict compliance through mandatory deadlines, explicit and detailed procedural prescriptions, provisions for citizen participation, and citizen legal standing to sue agencies. In fact, almost every major piece of environmental legislation has been challenged in court by industry, environmentalists, or community groups—sometimes simultaneously. But the National Environmental Policy Act (NEPA) and the EPA helped to create a new era of administrative law, characterized by the expanding participation of environmental and nontraditional groups in administrative decision making (Miller, 1992: 680–681; Rosenbaum, 1989: 214–219). This influence spread to other agencies concerned with environmental issues, such as the Department of Energy, the Bureau of Land Management, and the Nuclear Regulatory Commission. This period of expanding environmental protection, however, did not last. Although the "environmental regulatory state" was not dismantled no significant environmental legislation has been passed through Congress since 1990.

THE LIMITS OF REFORM

Reform environmentalism became the dominant ideological frame for American environmentalism, with the possibility of examining every conceivable environmental or ecological issue. Early reform environmentalism focused mainly on pollution and health-related concerns, while later expanding concerns to global ecological problems, such as the proliferation of chemicals that disrupt the endocrine system of humans and wildlife, potentially causing developmental, neurological, immune system and reproductive problems, biodiversity loss, and global warming. Yet, reform environmentalism for a variety of reasons did not deal well with the "new" issues of the 1990s.

A primary problem for reform environmentalism was the almost exclusive reliance on the research of natural and physical scientists. With the exception of Barry Commoner, most natural scientists did not examine the social and political causes of ecological degradation. While they had great competence in specific areas of expertise, the social driving forces of environmental degradation were left unexamined (see Chapters One, Three, Six, and Seven). This created a second problem, the absence of a political vision of how to create a more sustainable society. Lacking such a vision, it was politically naive and perhaps irrelevant (Taylor, 1992: 136). Environmental reform came in the form of piecemeal efforts, continually mired in technical and legal debates and carried out within a cloistered community of lawyers and scientists (Brulle, 2000: 192).

A third problem reform environmentalism encountered was a limited capacity for political mobilization. By practicing piecemeal science-based reforms, movement organizations came to have an oligarchic style because scientists play such a prominent role. Politicians and the public became only minor players—to heed the advice of scientists. The Sierra Club and the Audubon Society were notable exceptions to this oligarchic top-down management style, because they also maintained effective grassroots

Greenpeace is an international environmental organization that began in 1971. It also has national chapters, such as Greenpeace, USA. Greenpeace, USA has been grouped with the big reform environmental organizations. Greenpeace however can also be seen as a bridge organization between the group of 10, grassroots, and radical environmental social movements. Greenpeace is known for their flamboyant and daredevil, but nonviolent, direct action tactics like sailing into atomic test sites or between whales and whaling ships. Their direct action tactics have come at a high cost over the years. For instance, the French government apologized for the killing of a Greenpeace member from two explosions that ripped through their ship, the *Rainbow Warrior*, while in harbor in New Zealand in 1985. At the time Greenpeace had been involved in a campaign to halt atomic testing by the French in the South Pacific (see, http://www.greenpeace.org/international/en/about/history/the-bombing-of-the-rainbow-war). Greenpeace maintained efforts to stop nuclear testing, and continued to wage campaigns to halt nuclear power and climate change, in addition to many others. The photo here shows people gathered in support of 30 Greenpeace activists charged in 2013 by the Russian government for piracy at an oil platform in the Arctic.

Vlad Karavaev/Shutterstock.com

Figure 8.3

local and regional chapters. Without effective grassroots support, such movement organizations became distant from the constituencies they claimed to represent (Brulle, 2000: 192–193). As reform environmentalism grew from amateur enterprises to ones run by scientists and lawyers, its political clout was accompanied by conservatizing pressures to play by the "rules of the game" in the world of Washington, DC politics. As early as the 1980s, critics argued they had been co-opted and tensions simmered between the group of ten and other environmental movement organizations (Mitchell et al., 1992: 24).

ENVIRONMENTAL JUSTICE AND GRASSROOTS MOVEMENTS

Reform environmental organizations in Washington, DC took the soft political road of negotiation, compromising with industry and government actors about the amount of pollution or environmental disruption that was acceptable. In response, many people living in environmentally degraded and polluted communities have taken the hard political road of confrontation (Bell, 2013; Bullard, 2000; Bullard and Wright, 2012; Sale, 1993). Grassroots mobilization expanded dramatically in the 1970s and 1980s. Local environmental activism is often stimulated by clear and present community health hazards. However, grassroots movements take different forms with some being described as *Not-in-my-backyard (NIMBYs)*—oppositional groups who rise to fight the placement of a locally unwanted land use (LULU), but their environmental concern ends once their goal is achieved. Second, some are considered *radical environmental groups* driven by an ecological consciousness that significantly challenges the status quo. Third, *local environmental groups*, often in rural areas, have grown in number and typically focus on community conservation issues, such as a watershed protection organization (Kempton et al., 2001; Savage et al., 2005). Finally, *environmental justice movements* contest the distributional equity of the benefits and costs of living in advanced industrialized societies (Bell, 2013; Bullard and Wright, 2009, 2012; Bullard, 1990; Taylor, 2014). Environmental justice activists contend that socially marginalized and less powerful communities that are disproportionately home to people of color, immigrants, and low-income residents are more likely to bear the greatest environmental burdens while receiving the fewest environmental amenities and protections (Bell, 2013; Bullard and Wright, 2009, 2012; Taylor, 2014). As such, the environmental justice frame is focused on distributive justice, community empowerment, and democratic accountability. It argues that human societies and the natural environment are inextricably linked, and that the health of one depends on the health of the other (Taylor, 1993: 57).

There are four phases to grassroots environmental organizing that parallel, but are also distinctive from, the big 10 environmental organizations (Cable and Cable, 1994). First, grassroots environmental organizations form in response to an *energizing event*, such as the discovery of a cluster of cancer cases that can be linked to a local hazardous facility; an incompetent disaster preparedness plan and response; or a flash flood caused by mountaintop removal for coal mining. Second, to address the problem, individuals realize that they must *collectively mobilize* resources. Unlike the national organizations, grassroots movements depend almost entirely on volunteers. Experienced community activists may become involved, but it is a distinguishing characteristic of grassroots environmental movements that new leaders arise often with no previous organizing experience. Women tend to be overrepresented in both the membership and the leadership of grassroots environmental organizations. Sociologist Shannon Elizabeth Bell relates that she titled her book *Our Roots Run Deep as Ironweed* (2013) to illustrate the determination of Appalachian women to defend their family and community's health and safety, homes, land, and culture from coal-industry-related harm. Appalachian women as environmental justice activists and leaders defy local gender ideologies, transforming a motherhood identity into a "protector identity" (Bell, 2013: 9).

In the early stages of collective mobilization, a tremendous amount of time and energy is devoted to education. But, the third stage of *sustained resistance* requires maintaining the movement over time, often a very long time, even decades. Vested interests, such as corporations, have the resources for a long battle (Bell, 2013; Bullard and Wright, 2012; Cable and Benson, 1993; Cable and Cable, 1994). The final stage is *politicization* which results in a transformed political consciousness. Often activists are demanding changes in business practices and for government bureaucrats to enforce environmental regulations or institute new ones. This draws activists into interaction with public health officials, lawyers, scientists, and government actors. The state is not a neutral player in the process, and is typically more responsive to corporate rather than community interests. Thus, activists challenge the democratic responsiveness, credibility, and effectiveness of officials—from city hall to the EPA. Grassroots environmental activists learn that both government and science can be used against them, often deflecting and trivializing their claims. The outcome is typically significant skepticism and mistrust of both science and authority. Grassroots activists learn quickly that environmental problems are not purely, or even primarily, technical problems. As such, grassroots activists often graduate to broader concerns. What started out as an attempt to clean up Love Canal wound up being a national toxic waste campaign, and many groups that began by blocking the construction of garbage incinerators became advocates for recycling, and waste reduction measures. The grassroots activist is more likely to become a NIABY ("Not in *anybody's* back yard!") than a NIMBY (Bell, 2013; Bullard and Wright, 2012; Cable and Benson, 1993; Cable and Cable, 1994; Freudenberg and Steinsapir, 1992).[1] In the end, most grassroots environmental activists report gaining a strong sense of purpose and meaning from their participation (Bell, 2013; Bullard and Wright, 2012; Cable and Cable, 1994).

At the same time, some people of color may experience these stages somewhat differently than white grassroots activists. People of color often have had experience in social movement participation, such as African Americans in the civil rights movement or Native Americans in the American Indian Movement. Moreover, people of color are already likely to believe that the government does not look out for their best interests (Bullard, 2000; Bullard and Wright, 2012; Taylor, 2014). Environmental justice movement organizations contend they cannot wait for the government or courts to provide them environmental protections.

Environmental justice activists use a diverse set of tactics and strategies to achieve redress for their concerns. Some use *direct action tactics*, such as picketing the homes of key opposition figures or holding sit-ins that block construction of new facilities. At Love Canal, Lois Gibbs and other residents held two EPA officials hostage for several hours; two days later, President Jimmy Carter declared Love Canal a disaster area (Gibbs, 1982).

Another organizing strategy of the environmental justice movement is the use of *action-oriented research*, which brings together people with different knowledge bases and organizational ties to address environmental justice issues—university faculty and students, professionals, and grassroots and community organizers. It is similar to community-based resource management, but can also be distinctive by using the research to achieve social change. The United Church of Christ Commission (UCC) for Racial Justice sponsored the pioneering study on the social predictors of living in a community with a commercial hazardous waste facility that helped to launch the environmental justice movement into the national arena (see Chapter Six). Sociologist Robert Bullard, a founding scholar of environmental justice and leader in the environmental justice movement, formed the Environmental Justice Center (EJRC) at Clark Atlanta University in 1994. The EJRC helped to update the UCC for Racial Justice 1987 study, which found people of color were more likely to be concentrated in communities that host hazardous waste facilities. Environmental justice activists use research to uncover disparities in the existence of and potential for environmental harm, and to achieve practical solutions.

Some start their own programs to show government organizations how to do their jobs. In the harrowing aftermath of Hurricane Katrina, sociologist and founder of the Deep South Center for Environmental Justice (DSCEJ), Beverly Wright, worked with union organizations such as the United Steelworkers, community organizations, and universities to start the *Safe Way Back Home* program. *Safe Way Back Home* trained volunteers to show government officials how to implement a cleanup program of hazardous materials. They were fed up with watching residents try to return home with no information about the risks of environmental contamination or protective gear. Over and over again representatives of the EPA, the Louisiana Department of Environmental Quality, and the Agency for Toxic Substances and Disease Registry (ATSDR) showed incredible ineptitude in performing their jobs. They denied risks of harm, did not respond to citizen needs, or were painfully slow in responding to acknowledged risks, ranging from elevated unsafe levels of lead, arsenic, and PCBs in the soil to formaldehyde in the FEMA trailers that housed families homeless after Hurricanes Katrina and Rita. In 2008 a congressional report acknowledged that the ATSDR allowed "…families to live in trailers with elevated levels of formaldehyde… for at least one year longer than necessary" (as quoted in Bullard and Wright, 2012: 102).

Environmental justice scholars and activists argue that systemic and institutional changes are necessary to begin remedying the pattern of environmental injustice. A first step was taken when environmental justice leaders got President Clinton to sign Executive Order

12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." The order intended to address environmental injustice within *existing* federal laws and regulations, such as under NEPA, which not only is supposed to ensure that *all* Americans enjoy environmental health and safety protections, but also an aesthetically pleasing and cultural environment (Bullard and Wright, 2012: 21–22). Also, by 2009, all 50 states and the District of Columbia had some type of environmental justice law, policy, or executive order on the books. According to Bullard and Wright, existing environmental protections and laws would stand a greater chance of being enforced if the operational structure of the EPA were changed so the regions could not operate as essentially autonomous subagencies (as discussed in Chapter Seven) (Bullard and Wright, 2012: 102–103). The cooperative relationships that perpetuate institutional discrimination need to be dismantled. Working-class people and people of color find themselves in sacrifice zones because of a historical legacy—company coal-mining towns, slavery and Jim Crow segregation, or a history of stolen lands—that interacts with contemporary social conditions (see Bell, 2013; Bullard and Wright, 2012; Taylor, 2014). Environmental injustice is often ignored and justified by the larger society through cultural belief systems that blame individuals for systemic causes of inequality. As such, disaster preparedness plans should develop culturally responsive intervention measures, including having people of color representatives on the community response teams. The mistrust many people of color have of whites decreases the likelihood of receiving adequate information about preparedness measures and seeking assistance (Bullard and Wright, 2012).

OTHER VOICES: DEEP ECOLOGY, ECOFEMINISM, AND TOTAL LIBERATION

As environmentalism developed, it became substantially more diverse, with a broader array of issues, organizations, and strategies. Just as the blending of the earlier frames of conservationism and environmentalism led to greater breadth, by the 1980s other frames and discourses were taking shape. The 1980s saw the rise of radical environmentalism, including movements that seek significant transformation of the existing social and cultural systems. They do not accept that reforms to the current social, economic, or political order will address the root causes of environmental problems (Caniglia et al., 2015; Pellow and Brehm, 2015). Radical environmentalism grew out of frustration with reform environmentalism, especially the willingness of the Group of 10 environmental organizations to compromise with industry and government. These groups adopt direct action tactics aimed at disrupting the current system in order to remake it. We will discuss three prominent forms of radical environmentalism, deep ecology and ecofeminism, and the newly emerging total liberation.

DEEP ECOLOGY

Originally formulated by Norwegian philosopher Arne Naess in the 1970s, *deep ecology* was brought to the United States by philosopher George Sessions and sociologist Bill Devall (1992). In contrast to what they view as the "shallow environmentalism" of most of the environmental movement, deep ecology thinkers are *biocentric* or *ecocentric* rather than anthropocentric. Deep ecology emphasizes that (1) the richness and diversity of all life on earth has an intrinsic value, which is threatened by human activities; (2) human life is privileged only to the extent of satisfying vital needs; (3) maintaining biodiversity requires a decrease in human impacts on the natural environment and substantial increases in wilderness areas; and therefore (4) economic, technological, and cultural changes are necessary (Devall and Sessions, 1985). Deep ecology also emphasizes the *self-realization* of humans as belonging to nature, referring to the process whereby one strives for organic wholeness in nature. Those influenced by deep ecology were also determined to reclaim their spiritual identity with nature, some in terms of Buddhist traditions, and some in terms of reviving indigenous "tribal rituals" (Devall, 1992: 56; Sale, 1993: 63).

Although diverse lifestyles and social policies are potentially compatible with deep ecology thinking, its literature emphasizes decentralized and small-scale human communities, self-sufficiency, participatory democracy, and lifestyles that minimize material consumption and maximize the richness of nature. Deep ecological thinking was very much influenced by the limits scenario of the future, discussed in Chapter Six, and the new ecological paradigm from Chapter One. Deep ecologists embrace the positive possibilities that voluntary simplicity lifestyles have to offer. They support the protection of ancient forests and other wild ecosystems, the restoration of biodiversity, and many advocate vegetarianism. Most promote nonviolent direct action strategies for change. They support green consumerism that would minimize the environmental impacts of consumer goods, and green politics, meaning the formation of political movements and parties to advocate for ecological principles. Most fundamentally for deep ecologists, the path to ecological freedom requires cultivation of an ecological consciousness that permits humans to see through the erroneous and dangerous illusions of Western cultures that justify human dominance over the nonhuman environment (Devall and Sessions, 1985). As complicated and abstract as these ideas are, they gained a diverse following, primarily among intellectuals and activists in the United States as well as in Canada, Australia, and northern Europe.

DEEP ECOLOGY ORGANIZATIONS AND ACTION

Earth First! (EF!), the most widely known deep ecology organization, was founded by Dave Foreman and other people disillusioned by their experience in national environmental organizations. EF! is known for its use of direct action tactics including civil disobedience combined with absolute nonviolence against humans and other living things, and strategic violence against "things" such as bulldozers, power lines, and whaling ships (Miller, 1992: 689). Although not committed to any specific political tactics, speaking in many voices, and disavowing bureaucracy, centralized decision making, sexism, and hierarchy, EF! was a vortex of radical environmental action during the 1980s (Devall, 1992: 57). The founders of EF! were inspired by Edward Abbey's novel *The Monkey Wrench Gang* (1975) and advocated militant tactics in defense of nature, eventually including guerrilla theater, media stunts, and civil disobedience.

Unofficially, they practiced ecotage (also called monkey wrenching): sabotaging bulldozers and road-building equipment on public lands, pulling up survey stakes, cutting down billboards, and, famously, "spiking" trees at random to prevent their being cut and milled. The advocacy of such tactics alarmed many, but investigations found EF! not guilty of the most damaging accusations (Sale, 1993: 66).[2]

Never large in comparison with national reform organizations, EF! and other radical groups try to avoid professionalization and bureaucratization. Overcoming major fractures, EF! grew from a small group in 1980 to having an estimated following of more than 10,000 from all over the nation and the world, and an annual budget of over $200,000 by the end of its first decade (Lee, 1995). Advocating such militant tactics made EF! controversial and elicited considerable opposition. They were described variously as anarchists, ecowarriors, social deviants, ecoterrorists, and visionaries. The group's founder, Dave Foreman, said that "from one side have come efforts to mellow us out and sanitize our voices; from another efforts to make us radical in a traditional leftist sense, and there are on-going efforts by the powers that be to wipe us out entirely." The FBI spent three years and $2 million infiltrating EF!, and in 1989 a trumped-up federal suit charged Foreman with conspiracy for helping to finance the destruction of an electric power tower near Phoenix, Arizona. In 1990, two EF! activists, Judi Bari and Darryl Cherney, were car bombed in California and then falsely arrested for it (Bevington, 1998; Devall, 1992: 57; Miller, 1992: 689–690; Sale, 1993: 57). This occurred shortly before Redwood Summer when EF! engaged in direct action tactics to halt cutting of old-growth redwood. This action initiated tree sitting campaigns in northern California and Oregon that lasted 20 years until a deal was finally brokered with a new lumber company in 2008 that agreed to stop clear-cutting and help restore the forests.

EF! was not the only manifestation of the deep ecology frame. *First*, it inspired *bioregionalism*, a movement that advocates changing political boundaries of human communities to boundaries defined by ecosystems. Existing political boundaries are defined by many historical accidents of human settlement and control. A *bioregion* is a geographical area defined by ecological commonalities, including soil characteristics, watersheds, climate, and native plants and animals. This perspective would reframe human existence as a part of a natural ecosystem. Many problems could be understood in an ecological focus, such as dealing with water shortages among communities that are located within the same watershed. *Second*, deep ecology inspired the formation of the academic discipline of *conservation biology*, understood as the unification of evolutionary biology and ecology with a commitment to preserve biodiversity. This field emerged in 1986 at a national conference in Washington, DC sponsored by the National Academy of Science and the Smithsonian Institute, attended by 14,000 people. At this conference, a group of eminent biologists redefined and publicized the problem of endangered species, coining the term *biodiversity* (see Chapter Two). They did this to spur political action, based on the belief that "humans and other species with which we share the earth are imperiled by an unparalleled ecological crisis" (Takacs, 1996: 9). Conservation biologists formed alliances with financiers to create the Foundation for Deep Ecology in 1989, which funds activities in support of rainforest preservation, grassroots activism, and indigenous third world people's efforts to protect their natural environment. Deep ecologists, however, have been criticized for lacking compassion for other humans and ignoring the relationship between social inequalities and environmental problems. Ecofeminists attempt to correct for this oversight.

ECOFEMINISM

The ecofeminist discourse is a blend of feminist and ecological thought that emphasizes conceptual connections between the patriarchal domination of women by men and the domination of nature. It sets the problems of women and the ecological crisis in a common framework (Gaard, 1993; Merchant, 1981). Both are seen as products of a patriarchal society in which *domination* has emerged as a pervasive cultural theme and social paradigm. The Western worldview, with its abstract science and the impulse to control "nature" that deep ecologists hold responsible for the ecological crisis, is in fact a historical product of patriarchal societies. The domination of both nature and women is not caused by human nature but by specific institutional arrangements developed and controlled by men.

Was this not always so? Not according to ecofeminist scholars. They sought evidence for this view by retrieving the "full" historical record from our commonly understood history (in patriarchal societies, not surprisingly, a history largely written and interpreted by men). Ecofeminist scholars found evidence that European Neolithic societies were largely peaceful, and minimally stratified, harmonious, goddess worshipping and valued the life-generating powers of the universe until the invasion of patriarchal, militaristic, Indo-European pastoralists in the fourth millennium B.C.E. From this turning point in Western civilization, the direction of human cultural evolution literally turned around. The invaders of Neolithic communities worshipped the "lethal power of the blade." In other words, they emphasized the power to take rather than give life as the ultimate power to establish and enforce domination (Eisler, 1988; Gimbutas, 1977). "Domination" is thus a pervasive mindset that is applied to other men and women, and to nature. It is not human nature but a worldview with a history.

By providing a plausible—but still arguable—history, ecofeminist scholarship provides an evolutionary depth lacking in deep ecology. But even if you don't accept this historical argument, a more indisputable set of facts support ecofeminist views. First is the connection between women, colonialism, development, and environmental disruption. Historically and to this day, women have been displaced from food production (see Chapter Two). Currently, in the global South the introduction of intensive agricultural, deemed economic development replaces ecologically sustainable subsistence agriculture with cash crop monocultures that often appropriate and destroy the natural resource base for subsistence. Women's role as the primary producers of food, water, and fuel is jeopardized, and consequently, women are more likely than men to be impoverished. In short, men have been the prime beneficiaries of development, from the colonial era to the contemporary world market system (Gaard, 1993; Mies and Shiva, 2014; Shiva, 2016). Second, Chapter Five noted the consensus among demographers that improving the status of women is critical to slowing world population growth. Third, decades of survey research show women to be more concerned than men about health threats posed by environmental and technological problems (Dunlap, 2000b; Shwom et al., 2015). Ecofeminists contend that patriarchal societies have undervalued women's role as nurturers and protectors of their family's health and well-being, calling for the elevation and inclusion of a feminine perspective in environmental decision making.

Finally, ecofeminism has a considerable following, particularly in university circles and women's studies programs. Moreover, the voice of women is increasingly heard at international environmental gatherings (such as the 1994 Cairo Conference about population; the subsequent 1995 Beijing World Conference on Women; and the United Nations Framework Convention on Climate Change summits). As with deep ecology, ecofeminists are not all of one voice, reflecting schisms in the larger feminist movement. Nonetheless, ecofeminism is an important discourse and critique of both deep ecology and reform environmentalism.

TOTAL LIBERATON

According to sociologists David Pellow and Hollie Nyseth Brehm (2015) US radical environmentalism is undergoing a *frame transformation*. A frame transformation occurs when old understandings of a problem are changing and/or new understandings are being produced (2015: 187). To explore frame transformation within the radical environmental and animal rights movements in the United States, Pellow and Brehm conducted a qualitative research study, which included 88 semi-structured activist interviews, field research, and content analyses of public documents and websites of radical groups. Groups included in their study are EF!, the Animal Liberation Front, the Earth Liberation Front, Sea Shepherd Conservation Society, Stop Huntingdon Animal Cruelty, and People for the Ethical Treatment of Animals. They call the new frame *total liberation*, which seeks to transform the social and cultural systems that concurrently harm people, ecosystems, and animals. They argue this has been a response to both micro-level interactions within the radical environmental movement, resulting in frustration with the pull of the reformist approach, and the acceleration of macro-level socio-ecological crises, such as current and impending climate change impacts. This frame transformation has emerged from an adherence to, and then critique of, existing *master frames* (similar to a paradigm) that have shaped the contemporary radical environmental movement, including the following: the new ecological paradigm (NEP), deep ecology, ecofeminism, and the environmental justice paradigm.

First, while the NEP challenged the dominant social paradigm by emphasizing the need to create a healthy balance between human social systems and ecosystems, the NEP is silent on the role of capitalism in perpetuating environmental destruction and social harms in pursuit of profit. This omission creates an alliance with the mainstream environmental movement, which maintains too close and friendly ties with industry. It is then difficult to regulate or transform polluting organizations, such as carbon-intensive

Hadrian/Shutterstock.com

Figure 8.4 The Sea Shepherd Conservation Society is an international environmental movement organization. These youth are protesting in Strasbourg, France, against the slaughter of pilot whales and the arrest of fellow members.

energy regimes, or factory farms. Moreover, the NEP's tactical repertoire is constrained by the institutionalized agenda of incremental change. Consequently, the role of elite privilege in maintaining oppressive social and environmental conditions remains unchallenged. A prime example is the unwillingness of mainstream environmental organizations to demand that wealthy countries drastically cut their carbon emissions and provide their promised financial support to LDCs for climate change adaptation and mitigation.

While the second master frame, deep ecology, promotes biocentric equality and overcoming narrow egoistic (and anthropomorphic) understandings of self-interest, its discourse is limited by its almost exclusive focus on the defense of wilderness. Environmental movement organizations influenced by it are largely uninterested in reforming oppressive social conditions. Indeed, deep ecology often vacillates between overt hostility toward the human community and vague appeals to extend that community to the broader natural world (Brulle, 2000: 206). Both the NEP and deep ecology reproduce Western cultural bias by identifying population growth reduction as key to resolving environmental problems. Critics acknowledge that growing populations in the global South compound their problems, but the forces behind high fertility rates, notably, global neocolonial economic and political policy, gender inequality, poverty, and other forms of marginality, are the greater problem. By ignoring these oppressive conditions, the role of privilege is reinforced—especially male, Western, and white privilege—which includes receiving the majority of environmental benefits and protections (Pellow and Brehm, 2015).

On the other hand, ecofeminism does offer a framework to analyze the interconnections between multiple forms of domination and oppression, including that of nonhuman species and ecosystems. However, ecofeminism is not always well articulated or cohesive in its diagnosis or prognosis for change, and sometimes romanticizes indigenous peoples and cultures. The environmental justice paradigm does offer a coherent theoretical and practical analysis of the relationship between social inequalities and environmental problems, but driven to resolve practical community concerns, it is seen as being pulled in a reformist direction that is decidedly anthropocentric (Pellow and Brehm, 2015).

Total liberation is the outgrowth of these master frames, and it appears to have four distinct features. First, it rejects oppression and demands justice for humans and nonhumans alike. It emphasizes the need to address the interconnected root causes of the exploitation and degradation of people, ecosystems, and animals. Second, it adheres to anarchism, which supports a system of governance that is nonhierarchical and nonauthoritarian. Anarchism rejects the nation state largely because of the monopoly it has on the legitimate use of force, which disproportionately dominates vulnerable populations. This view has likely been strengthened by state repression of radical group activists (FBI infiltrations and incarcerations). The third feature is anti-capitalism because the profit motive leads to the exploitation of people, animals, and ecosystems. Fourth, direct action is the radical movements' signature strategy, which may include property destruction. In sum, Pellow and Brehm note that only a few of the activists in their study used the phrase total liberation, but 68 percent of their respondents incorporated each of these four components into their view of radical environmentalism. They see total liberation as a frame transformation underway.

OTHER VOICES: ECOTHEOLOGY AND VOLUNTARY SIMPLICITY

The beginnings of *ecotheology* are found in Lynn White's landmark essay (1967) in which he argued that the Western biblical tradition—on which both Judaism and Christianity are based—was the root of the modern environmental crisis. Man was viewed as the master of, and apart from, the rest of God's creation. According to White, "more science and more technology are not going to get us out of the present ecologic crisis until we find a new religion, or re-think our old one" (White, 1967: 1206). Although an arguable view (as discussed in Chapter One), it did create a problem for Western theologians and religious thinkers. Thus they have sought to develop a spiritual vision of the environment combined with the imperative for humans to preserve God's creation.

Several versions of this perspective developed within Christianity in the US and to some extent globally. First, African-American churches link a spiritual view of the environment with environmental justice. The black church has long been an organizational base for African Americans in their struggles for civil rights and environmental justice. Caring for the environment is tied to the creation of loving and just human communities so that no community is more or less worthy of environmental protection (Brulle, 2000; Bullard and Wright, 2012). Another perspective, known as *Christian stewardship*, focuses on an evangelical interpretation based on a biblical mandate to care for God's creation. Founded on conservative Christian theology, it creates a moral imperative to preserve God's creation. It sees God as a transcendent being, and human nature as fallen, sinful, and in need of redemption. According to an early statement, "Christians, who should understand the creation principle, have a reason for respecting nature, and when they do, it results in benefits to man. Let us be clear: It is not just a pragmatic attitude; there is a basis for it. We treat it with respect because God made it" (Schaeffer, 1970: 76, cited in Brulle, 2000: 232). A third view, usually called *creation spirituality*, sees the need to go beyond the Christian tradition to develop alternative notions of creation and a synthesis of religion and science. One of its founders, Matthew Fox, accepted all religions as revelations of the sacred in different contexts. This position got Fox excommunicated from the Catholic Church. Finally, popular poet, environmental activist, and farmer, Wendell Berry, advocated a "new story" for humanity by uniting Genesis with scientific knowledge, for humans to serve as stewards of the land (Berry, 1981).

In the mid-1980s, ecotheology emerged within religious communities that had traditionally not been involved in environmental issues. In 1989, Pope John Paul II wrote an essay entitled *The Ecological Crisis: A Common Responsibility.* He urged Catholics to reduce resource consumption and warned farmers to use ethical caution when embracing biotechnology. By 1993, virtually all major religious bodies had issued a proclamation on environmental degradation, and a *National Religious Partnership* was formed that united the major Protestant, Catholic, Jewish, and evangelical communities into one organization focused on developing and implementing religious approaches to combating environmental degradation (Brulle, 2000: 234; Mastny, 2001).

While ecotheology is an emerging discourse, some argue that the world's religions have tremendous potential to motivate action on our most pressing ecological crises, notably climate change. There are four reasons for looking at religion as a force of environmental change. First, a great deal of research shows that religion shapes individual and group members' perceptions and behaviors toward the natural environment. Second, most people on the planet (about 84 percent) identify with one of the major world religions. Third, established religious institutions have command of vast stores of economic, social, and cultural capital, which strategically position them to facilitate environmental consciousness raising and collective mobilizations. Fourth, because religions build social capital through individuals, groups, and organizations working toward a collective goal of mutual benefit (does not mean of equal benefit), they form caring connections to others. These social ties can create trust and norms of reciprocity, a sense of solidarity, and an appreciation of shared vulnerabilities and interest in the well-being of others. For instance, religious groups are often the first to offer aid after a disaster. But, can this capacity for care be harnessed to address ecological problems beyond disaster response (Caniglia et al., 2015: 256–258)?

Research shows that together mainline Protestant and Catholic organizations have the capability to influence public opinion on climate change and policy. Mainline Protestant

Denominations generally accept the science of climate change and see it as a real and serious threat. Many Protestant churches have pursued local, domestic, and global projects that seek to build adaptive capacity and mitigate climate change. They also have been represented at the UNFCCC climate summits advocating for more aggressive climate action. The Catholic Church has largely defined climate change as a moral issue that must be reckoned with. The most recent Popes, John Paul II, Benedict XVI, and Francis, have each advocated for climate justice. While both denominations express care, compassion, and commitment for environmental problems, their ability to translate that into concrete actions has been weak. On the other hand, conservative Protestant denominations that hold quite a bit of political influence are somewhat of a mixed group, with an active segment of adamant conservative climate change deniers. However, evangelicals have increasingly adopted the belief that Christians should embrace "stewardship" and take "creation care." These two terms have become more accepted even amongst evangelicals that are climate change deniers. Some also point to a younger generation of evangelicals that are passionately pro-environmental and hope that this minority can grow more influential, especially in the face of worsening climate change impacts (Caniglia et al., 2015: 258–259).

VOLUNTARY SIMPLICITY AGAIN?

As noted in Chapter Six, philosopher Duane Elgin coined the term *voluntary simplicity* (VS) in the 1970s to promote a movement away from materialism, excessive consumerism, and unsustainable consumption. The early VS movement was linked to New Age spirituality, the themes of the 1960s counterculture, and moving "back to nature." Its rhetoric was primarily moralistic, presenting idyllic images of romantic asceticism and living in nature or rebuking consumers for overindulgence. It had a limited appeal and was overwhelmed by the more powerful forces promoting consumerism, living on credit, shopping at malls, and buying SUVs. But the idea of voluntarily simplifying lifestyles was more than just a passing fad. It returned in the 1990s, along with a movement to promote it. Most Americans think that they consume more than they need, produce too much waste, and focus too much on consuming. A wide variety of groups sprang up dedicated to plain living, frugality, "downshifting," and living lightly on the earth. Numerous publications from newsletters to journals and magazines exist for those interested in voluntary simplicity. People interested in voluntary simplicity make contact through a wide variety of local discussion groups ("simplicity circles"), publications, and websites. Simplicity circles, which started in Seattle, now exist in many states. You can easily find them.[3] VS organizations, like the Center for a New American Dream (CNAD) in Tacoma Park, Maryland, seek to change North American attitudes about overconsumption in a "throwaway" culture (Bell, 2004: 29–30; CNAD, www.newdream.org). There are a number of such organizations in Europe as well (Humphrey et al., 2002).

If the new VS movement is to have greater appeal and impact, it needs to be promoted differently than was the earlier movement. High mass consumption is more complex than promoters of simple lifestyles often think. Consumption is related to the creation and

Figure 8.5 In the Netherlands, using bicycles as a primary means of transport is not voluntary simplicity. It is part of the taken-for-granted way of life in Amsterdam.

transmission of meaning in modern societies, as it defines identity, status, and privilege more clearly than production in increasingly large and uncontrollable global systems. It is not just a psychological blight or "sick culture" (Cohen, 1995). Most important, voluntary simplicity would have broader appeal if seen as a means of improving the quality of life in a society where many experience life as overly complex and hectic and in which "life in the fast lane" provides little satisfaction or leisure. The movement for voluntary simplicity must also contend with the social and political realities of contemporary society. Especially important is the political mobilization of environmental countermovements. Chapter Three briefly introduced the political opportunity structure model to help explain how the climate change denial countermovement was able to take advantage of an opening in the political structure of the US government in the 1990s. Importantly, the vested interests of fossil fuel industries and conservative organizations were able to effectively mobilize resources to create the denial frame. We will now turn to look at a brief history of anti-environmentalism in the US, the organizing strategies and tactics and the effect of these countermovements on environmentalism.

ANTI-ENVIRONMENTALISM: MANIFEST DESTINY AND CONTEMPORARY COUNTERMOVEMENTS

The oldest and most pervasive human–environment discourse derives from the Western worldview of America and industrial societies. Termed *manifest destiny*, this discourse provides a moral and economic rationale for exploiting the natural environment. Manifest destiny and the human exemptionalist paradigm (HEP) to which it is connected assumes that nature (1) has no intrinsic value, (2) is unproductive and valueless without human labor transforming it into commodities upon which human welfare depends, and (3) has abundant natural resources for humans—who have rights to use it to meet their needs. Manifest destiny provided a rationale for the development of the modern North American continent by European colonialism (Brulle, 2000: 116). Manifest destiny, the HEP, and the dominant social paradigm combine to create a stalwart faith in the ability of modern economic and political institutions and culture to use science and technology to overcome all barriers to economic growth. Today this perspective is most consistent with core American conservative and Republican beliefs in individual rights, private property, and free capitalist enterprise with minimal government intervention (laissez-faire). Liberals and Democrats, however, are more likely to accept that some government intervention (regulations) is needed to ensure public welfare and agree that some human needs and natural system resources are better managed by the public sector (Dunlap and McCright, 2015).

The ideology of manifest destiny provided the frame for several waves of countermovements opposing the goals of environmentalism. The most significant early development of manifest destiny countermovements erupted when President Grover Cleveland created 23 new national forests (bringing the total to 39 million acres) in 1897. Protests happened in the West, including a mass rally that attracted 30,000 people in Deadwood, South Dakota. A Montana senator accused the president of "contemptuous disregard" for people's interest, and a Washington state senator asked: "Why should we be everlastingly and eternally harassed and annoyed and bedeviled by these scientific gentlemen from Harvard College?" (Robbins, cited in Brulle, 2000: 120). Another series of Western protests over federal land policy happened between 1925 and 1934. Known as the Stansfield Rebellion, it focused on opposition to the imposition of grazing fees in the national forests. The Taylor Grazing Act as amended in 1939 resolved the issue in a series of compromises between the interests of ranchers and conservationists.

By the 1970s, laws governing land use had shifted in favor of environmentalism, including movements with wilderness protection and endangered species acts that permanently locked up parts of national forests and placed limits on land use, even by private property owners. Ranchers, miners, lumber corporations, and the business community bore the most obvious and direct costs of environmental protection. The previous chapter discussed *internalizing* environmental costs that are presently unaccounted for. Economic interest groups made major efforts to return control of federal lands to local enterprises. The Sagebrush Rebellion was a reincarnation of earlier land use issues. Several movement organizations emerged, such as the Center for the Defense of Free Enterprise, to prevent environmental restrictions from being imposed on the free market system, and the Mountain States Legal Foundation (MSLF), a business-supported anti-environmental law firm (both of these organizations are still active today). The first president and chief legal officer of the MSLF, James G. Watt, also a key player in the Sagebrush Rebellion, was appointed director of the EPA under President Reagan (Brulle, 2000: 124–126). Watt's appointment to the EPA was an energizing event for many environmentalists leading them to join radical environmental organizations like EF!.

When it was obvious that reform and radical environmentalism was not a passing fad, many corporations went on the offensive. Companies heavily invested in public campaigns to depict themselves as good environmental corporate citizens, while environmentalists were depicted as unrepresentative nuts who needlessly threatened economic prosperity, jobs, and human well-being. Corporate-sponsored attacks on environmentalists have taken a variety of forms: political lobbying, public relations campaigns, and advertising.[4] Increasingly, corporations have used litigation tactics against anyone who publicly opposes their use of the environment (Clyke, 1993: 87–88; Sale, 1993: 102). Such suits, called *strategic lawsuits against public participation* (SLAPPs), seek to silence activists or divert their attention away from the issues. SLAPPs charge environmental groups and grassroots activists with defamation of character, interference with contracts or business, or conspiracy. Most of these suits are unsuccessful and eventually dropped, but in the meantime they create many problems for activists (for instance, financial troubles and fears of retribution for exercising constitutionally guaranteed free speech). Corporate America has found SLAPPs an effective strategy for neutralizing opponents (Dold, 1992).

Where legal methods did not suffice, environmentalists were harassed by extralegal methods—intimidation, offices trashed, cars smashed, homes entered, death threats. In the most egregious and well-documented case, a congressional committee discovered in 1991 that the corporate managers of the Trans-Alaska Pipeline paid hundreds of thousands of dollars for a nationwide hunt to find and silence critics of the Alaska oil industry—complete with eavesdropping, theft, surveillance, and sting operations—and harassed its own employees to cover up leaks about its environmental and safety errors. Corporate actions are sometimes supported by government agencies (Dowie, 1995; Helvarg, 1994; Sale, 1993: 102–103). In 2002, the city of Oakland, California, and the FBI agreed to pay $4 million to the EF! activists who were blamed for the car bomb explosion that nearly killed them. Even though the couple reported receiving death threats from timber industry supporters, local and federal authorities never investigated anyone other than them (Zamora and Lee, 2002). In 2012, an environmental justice activist gave congressional testimony of the impacts of coal mining on Central Appalachian communities and showed a picture (she had gained parental consent to use) of a young girl bathing in rust-colored water polluted with toxins from a neighboring coal mine. After testifying, she was taken by capitol police for questioning because a Republican Representative from Colorado with close ties to coal reported her as being in possession of child pornography (Bell, 2013).

Today, many scholars use reflexive modernization theory to understand the influence of new forms of anti-environmentalism on environmental public opinion and policy (McCright et al., 2016; Mix and Waldo, 2015). The *reflexive modernization theory* thesis contends that the current institutions of advanced capitalism are plagued by a legitimacy crisis because they cannot resolve enduring social, environmental, and technological problems. Modern industrial capitalism produced unprecedented growth and prosperity from the post-WWII era to the early 1970s. However, our world has undergone rapid and significant economic, political, social, and environmental upheavals since the latter part of the twentieth century (Dunlap and McCright, 2015). National economies have been transformed through the intensification of global economic ties made in large part possible by technological advancements, such as the microchip. Globalization and technological advancements have resulted in global free trade deals linked to the loss of homegrown jobs, and displacement of union labor in extractive industries and manufacturing. Wages have been stagnant for decades and social safety nets cut. The transnational corporation leads the global economy. The power of nation states to oversee their own economies has dwindled. The ability to achieve the cultural ideal of the breadwinner-homemaker model of the American middle-class family has been out of reach for the vast majority for decades. We live in a society in which much of our public or civic engagement is pre-arranged and corporate sponsored. Industry-driven public participation reflects a society in which civic ties are increasingly indirect, and mediated by communication technologies like e-mail, texting, and social network websites (Walker, 2010). As we have discussed throughout the text, environmental problems encountered today are larger in scale and present us with an enduring sense of uncertainty and insecurity whether it be climate change or hazardous toxins. The cumulative effects of these changes are disillusionment, frustration, fear, and anger amongst significant segments of the population.

Reflexive modernization theorists argue that scientists and social movements are the critical social forces that can unearth what lies behind the frustration and anger. A heightened reflexivity of critical self-evaluation and confrontation with the unintended and unexpected consequences of advanced capitalism that science and social movements expose is needed to resolve the current crises. But, it lays bare the conflict between long-held cultural beliefs about the way things ought to be and the reality of changed conditions. This can be discomfiting. When the world around a person is changing beyond their control, deep-seated cultural beliefs can function like a security blanket. When some segments of society feel their core belief systems and/or material interests are being threatened, they mobilize to manufacture anti-reflexivity. This necessitates employing strategies to defend the current system from introspection and obfuscate negative impacts to protect the status quo, even if it is causing harm to those who embrace it.

The climate change countermovement that emerged in the 1990s is an anti-reflexive response to the social, economic, and environmental realities of climate change. As discussed in Chapter Three, it was coordinated by individual fossil fuel and affiliated industries, along with conservative foundations and think tanks and a few contrarian scientists, to delegitimize the reality of global warming, create scientific skepticism around the issue, and to oppose the ratification of the Kyoto accords (Lutzenhiser, 2001; McCright and Dunlap, 2000, 2003; Dunlap and McCright, 2015). The production of climate change denial ranges from not accepting the reality of climate change to accepting that it is real, but rejecting that it is anthropogenic and/or denying negative consequences. By environmentalists and scientists pushing climate change into the public and political arenas, they have possibly presented the greatest challenge to industrial capitalism, which has been driven by cheap fossil fuels. In response, the climate change countermovement has played upon contemporary American insecurities to prompt anti-reflexivity among a persistent segment of the population (Dunlap and McCright, 2015; McCright et al., 2016). This countermovement has helped to politicize science and strengthen the political divide over environmentalism.

In response to the denial countermovement, environmental activists, climate scientists, environmental/science journals and policy makers have been encouraged to develop positive framing strategies that go beyond, or even downplay, the scientific facts of climate change (McCright et al., 2016). An effective frame resonates with a broad swath of the population. Also, different frames can be used to target different segments of the population. Research bears out four promising positive frames that can appeal to large segments of the American public to take climate action: economic opportunities such as saving money; Christian stewardship of God's creation; national security; and public health. McCright et al. (2016) conducted a national survey of Americans to test the effectiveness of each of the positive frames listed above on anthropogenic climate change views. Their study is the first to directly test the anti-reflexivity thesis by examining the influence of the climate change denial counter-frame on general beliefs about climate change. They used four composite indicators to measure general views on climate change: beliefs about the reality of climate change; beliefs about climate science; awareness of climate change consequences; and support for GHG emission reductions. According to the anti-reflexivity thesis, self-identified conservatives are expected to be more receptive to the climate change denial message than moderates and liberals.

They found that the economic opportunity frame and national security frame influence Americans' beliefs about the positive impact of policies to reduce the nation's GHG emissions. The Christian stewardship and public health frames, however, did not affect beliefs about the positive impacts of climate change policy. They concluded that the positive frames had inconsistent effects and limited potential for shifting Americans' views on climate change. On the other hand, they found that exposure to the denial counter-frame significantly decreased respondents' beliefs in general climate change views. The anti-reflexivity thesis was confirmed. Conservatives and Republicans were more likely to report weaker beliefs in all measures of anthropogenic climate change and exposure to the denial counter-frame had a greater influence on conservatives than moderates and liberals (McCright et al., 2016: 92–93).

The climate change countermovement has successfully manufactured denial using some of the same strategies, as another stream of anti-environmentalism in the US commonly termed the *Wise Use Movement* (WUM). The WUM is supported by conservative/right-wing politicians and media spokespersons (e.g., Rush Limbaugh, George Will, and Ron

davidkrug/Shutterstock.com

Figure 8.6 This man is standing outside of a Portland, Oregon, federal courthouse protesting the court case against individuals who had participated in the armed occupation of the Malheur National Wildlife Refuge for 41 days during January and February of 2016 that ended with one man killed by police and several arrests. The standoff began over grazing rights on federal land. The leaders of the standoff have been described as adopting the ideology of the Wise Use Movement (see http://www.nytimes.com/2016/01/10/opinion/sunday/the-ideological-roots-of-the-oregon-standoff.html.)

Arnold with the Center for the Defense of Free Enterprise) and sees itself as waging war on environmentalists, who want, they claim, to destroy free enterprise, private property rights, and jobs by misguided efforts to increase government regulations. The WUM's primary constituencies are those who blame industry cutbacks on excessive environmental regulations and feel threatened by environmental reforms: loggers, miners, ranchers, farmers, hunters, industrialists, motorized recreationists, property owners, and factory workers (Helvarg, 1994). Although organized by a relatively small group, their influence is greater because of its connections to conservative foundations (e.g., the Heritage Foundation and the Cato Institute) and legal and lobbying organizations.

A strategy used by both the WUM and the climate change countermovement is to create Astroturf campaigns. *Astroturf campaigns*, also referred to as false grassroots, faux grassroots, and synthetic grassroots, are sophisticated public relations campaigns that seek to shape public opinion and policy to favor the hidden interests of private business or elite political entities. They can be conceptualized as including two key components: (1) elite corporate or political sponsorship; and (2) false claims of having support from a coalition of constituent groups. A common strategy used by Astroturf campaigns is issue advocacy advertising. It includes two key tactics. The first is to establish the endorsement of a front group (Mix and Waldo, 2015: 126). Take a look at some of these misleading names:

- National Wetlands Coalition (oil drillers and real estate developers)
- The US Council on Energy Awareness (the nuclear power industry)
- Friends of Eagle Mountain (a mining company that wants to create landfills in open pit mines)
- Wilderness Impact Research Foundation (logging and ranching interest groups in Nevada)
- American Environmental Foundation (a Florida property owners' group)
- Global Climate Coalition (corporations opposed to regulations to control global warming)

From their names, you would think that these *were* environmental organizations! The use of deceptive names to gain public acceptance has also been referred to as *greenscamming*. Imagine the public relations problems of a group calling itself something like the "Coalition to Trash the Environment for Profit" (Gottleib, cited in Brulle, 2000: 127).

The second strategy used by Astroturf campaigns is to fabricate grassroots support to influence target audiences with limited and manipulated information. Techniques sometimes called "guerrilla marketing" are used to invent independent third party support. The naming of front groups and "marketing" ploys are carefully crafted to attach to the values of receivers of the information so they will not question or be motivated to check their validity (Mix and Waldo, 2015). For instance, Mix and Waldo investigated an Astroturf campaign in Oklahoma by the Chesapeake Energy Corporation, a major supplier of natural gas and developer of "unconventional natural gas fields" for fracking. They formed the front group, Know Your Power (KYP), to manipulate public opinion to scrap plans to build a new coal-fired plant (Mix and Waldo, 2015: 126). They sought public support of natural gas to create a state legislative environment that would not only favor natural gas over coal, but limit regulations placed on the industry. Tapping into the public's concern over coal's contribution to climate change and health problems, KYP framed natural gas as clean energy while downplaying concerns about the risks associated with it. They also faked a statewide coalition of individuals (e.g., doctors and students) and private and public organizations aligned to promote clean energy. Their research showed that the coalition was no more than a statement on their website, and no proof of actual networks or alliances could be found.

In sum, Astroturf campaigns present several concerns. First, Astroturfing undermines democracy. When these campaigns are exposed, it creates cynicism and distrust of grassroots organizations and oftentimes the political process to influence public policy. Second, it enables corporations and elite political actors to consolidate their power and strengthen their business interests. Third, because they often weaken real grassroots organizations and other opponents, the options available to the larger society on how to best meet societal needs like supplying energy are severely restricted. Fourth, we need all corporations to authentically and democratically work with local communities if companies who want to pursue an agenda for positive social and environmental outcomes are to succeed (Mix and Waldo, 2015).

GLOBAL ENVIRONMENTALISM

As in the United States, environmentalism grew in virtually every MDC nation during the 1960s and 1970s, but particularly in Western Europe. Environmentalism visibly emerged in Eastern Europe and the Soviet Union as those governments began to unravel in the 1980s. As in the United States, heightened public awareness everywhere led to collective action and pressure on public officials. A multitude of environmental and other public and private organizations became internationally linked as nongovernmental organizations (INGOs in the parlance of diplomats and international agencies), several environmental movement organizations created international offices, such as Greenpeace and the Audubon Society, and transnational advocacy networks (TANs) have expanded (Ciplet, 2014; Lewis, 2016; Shorette, 2012; Widener, 2009, 2011).

Global environmentalism was stimulated by increasing cooperation among the world's scientific communities to study things at biospheric and planetary levels, including the International Geophysical Year (1957–1958), the International Biological Programme (1963–1974), the Scientific Committee on Problems of the Environment (SCOPE), and of course, the Intergovernmental Panel on Climate Change (IPCC). Agencies noted earlier helped, including the World Meteorological Organization (WMO) and the UN Food and Agriculture Organization (FAO), and particularly NGOs like the International Union for Conservation of Nature and Natural Resources (IUCN). At both national and international levels, there was scientific progress in atmospherics, soil science, oceanography, environmental toxicology, and ecology. Although organized by MDCs, scientists from LDCs emerged as leaders in the diffusion of environmental awareness in their nations, and in 1971 SCOPE convened a meeting of LDC scientists in Australia to consider environmental issues from their perspective (Caldwell, 1992: 65).

Another stimulus for the globalization of environmental consciousness was the emergence of problems that transcend national boundaries. These included concerns about climate change; pollution of the air and water; nuclear radiation; transborder shipment of hazardous materials; the global reduction of biodiversity (especially tropical deforestation); the spread of contagious disease; and dilemmas about use of outer space, the seas, and the Antarctic region. International environmental awareness was also amplified by media-covered disasters (Caldwell, 1992: 67). Examples include, the disastrous escape of toxic gases at a Union Carbide plant in Bhopal, India, in which an MDC corporation killed people in third world communities; the diffusion of radioactivity from the atomic nuclear reactor disaster at Chernobyl in the USSR in 1986; and more recently, after a tsunami hit Japan on March 12, 2011, the world watched a triple meltdown at the Fukushima Daiichi Nuclear Plant. Not to forget several disastrous ocean oil spills, notably the 2010 BP oil spill in the Gulf of Mexico.

Environmentalism is not limited to the affluent MDCs or stimulated only by global problems. The Environmental Resource Justice Center has developed strong international ties with human rights organizations and NGOs in the developing world, including Nigeria, South Africa, and Brazil (Bullard and Wright, 2012). As in the United States, grassroots environmental justice movements have proliferated in developing countries. In Kenya, East Africa, in 1974, a woman, Wangari Maathai, attended an international UN meeting where she met and developed connections with women active in environmental and social justice NGOs. Returning to Kenya, she started a reforestation "Green Belt" movement, primarily among Kenyan women, for small farmers to plant trees. The goals of the *Green Belt movement* were not only to stop soil erosion, but to educate people about the interrelations of the environment with other issues, such as food production and health. They also intended to improve the income and sense of efficacy of women. Remarkably, the Green Belt movement slowly thrived in a hostile and authoritarian political climate by using consensus and nonconfrontational strategies (vs. conflict strategies) and by developing support among international organizations. By 1992, 10 million trees had been planted that survived (a 70 percent to 80 percent survival rate), and as many as 80,000 women were involved in work at nursery sites. At the local level, the Green Belt movement increased farm income and also helped to transform Kenyan communities by empowering them to help themselves. At the societal level, environmental degradation gained widespread recognition as an important issue. Environmental leaders from other African nations attended workshops conducted by the Kenyan Green Belt movement; and in 1992, after the UN Environment Summit in Rio de Janeiro, a Pan-African Green Belt Movement was launched (Michaelson, 1994). Wangari Maathai became a powerful symbol of the international struggle for environmental justice. She won the Nobel Peace Prize in 2004 for her contribution to "sustainability, democracy and peace" (see, www.greenbeltmovement.org).

On another continent, the people of the Amazon rainforests have been struggling to defend their homes and heritage for decades, using a variety of strategies, including direct action tactics. In the late 1970s, a union of 30,000 Brazilian rubber tappers in the rainforest decided to draw the line.[5] Their tactics were simple and direct: Where the chainsaws were working, men, women, and children would peacefully occupy the forest, putting their bodies in the path of destruction. These actions were met with violent reprisals that continue today. In 1988, opponents gunned down Chico Mendez, the national leader of the rubber tappers—later to become a powerful symbolic martyr of rainforest protection for environmentalists around the world. At a high price, the tappers made modest gains: They helped reshape World Bank development policy, and international environmental organizations have called on the Brazilian government to set off large "extractive reserves" where tappers could continue their traditional livelihood.

BOX 8.1

TREE HUGGERS?

The most acclaimed LDC grassroots movement grew in the hills of Uttar Pradesh, India, in 1993, when a timber company headed for the woods above an impoverished village, and local men, women, and children rushed ahead of them to *chipko* (literally "hug" or "cling to") the trees, daring the loggers to let the axes fall on their backs. Maybe you've heard the word "tree hugger" as American slang for environmentalist. That's where the term came from (Bell, 1998: 190). The Chipko movement has gone beyond resource protection to ecological management. The women who first guarded trees from loggers now plant trees, build soil-retention walls, and prepare village forestry plans. Similarly, communities of traditional fishers in Brazil, the Philippines, and the Indian states of Goa and Kerala organized to battle commercial trollers and industrial polluters who deplete their fisheries.

International environmental movements are increasingly focused on the urgent need to address climate change. Ciplet et al. (2015) have studied the international climate change movement within the sphere of the UNFCCC for some time. They find a similar pattern of organizing and action to the US Group of 10 environmental movement organizations, a pull towards reform environmentalism. This is partly due to the structure of the UNFCCC meetings, which allows NGOs very little access to the formal negotiations (see Chapter Seven discussion of TANs and waste pickers). The Climate Action Network is the largest TAN representing civil society at the meetings. But, Ciplet et al. suggest it has taken the position of compromise by accepting market solutions that have not significantly slowed the pace of global warming or provided the incentive to keep fossil fuels in the ground. They also have not effectively advocated for the interests of the global South. The global South is in a double bind by desperately needing environmental protections, especially climate action, but also economic development (discussed in Chapter Three). Ciplet et al. conclude that civil society still offers the greatest hope for avoiding runaway climate change and transitioning to a post-fossil fuel future.

Consider the case of Ecuador: Ecuador has struggled to pursue a post-fossil fuel pathway to sustainable development. It is a country rich in biodiversity, largely contained in its share of the Amazon, and in oil reserves. This country is a prime example of how civil society organizing can transform existing structures, such as government constitutions and industrial practices, to keep oil in the ground. Through grassroots mobilizations of indigenous peoples and workers demanding environmental and social justice, Ecuador has possibly come closer than any other country to achieving sustainability in the global South (Lewis, 2016). In 2008, the Ecuadorian people ratified the rewriting of their constitution to include the Rights of Nature (see, www.therightsofnature.org/

ecuador-rights). It extends citizenship rights and gives legal standing to ecosystems! This monumental action is intended to preserve the great stores of biodiversity in Ecuador's Amazon forests, and to protect the indigenous people who dwell within them. Environmental grassroots organizations in Ecuador have used a multitude of strategies to protect their forests and resist the persistent pressure to pump and pipe oil, including promoting oil tourism (Widener, 2009, 2011). For example, Widener (2009) showed how Ecuadorian grassroots environmental organizations resisted the proposal of a seven-member multinational oil corporation to build an oil pipeline. They framed the proposed pipeline as an environmental disaster and then promoted tourism to underscore what is at stake. Oil pipelines break, and the risk of polluting the beautiful and biodiverse Amazon forests, its unique species, and waterways is grave. Tourism was promoted as an alternative form of economic development.

Ecuador is also a prime example of the potential of international environmentalism. Most of Ecuador's environmental movement organizations have connections with international environmental organizations, such as the World Wildlife Fund for Nature, and other environmental TANs (Lewis, 2016; Widener, 2009, 2011). This has given Ecuadorian environmental movements the advantage of mobilizing resources and gaining media coverage to create awareness of threats to the Amazon forests. While environmentalists have won major battles in Ecuador, plans are currently in place to pursue oil development (Lewis, 2016). Nonetheless, international environmental movement organizations and TANs are still fighting. Ecuadorian environmental activists have used their natural capital as leverage. That is, preservation of Amazon rainforests and their biodiversity not only benefits Ecuadorians, it is vital to the well-being of all humanity. Ecuador's radical move to give legal standing to ecosystems and their battle to

Figure 8.7 Ecotourism in Puerto Ayora, Galapagos, Ecuador

Mark52/Shutterstock.com

Figure 8.8 Ecotourism in Puerto Ayora, Galapagos, Ecuador

pursue a new path to development is not only inspirational, it is a vital test case for the future of sustainability (Lewis, 2016).

In recent decades, a truly global world culture of concern about environmental harm has emerged, stimulated by a combination of more global scientific knowledge, the impacts of international environmental degradation, the globalization of poverty, the growth of international environmental activism in both MDCs and LDCs, and a series of UN conferences and treaties to manage global environmental threats. Furthermore, Shorette's (2012) research finds that a country's level of integration into the world culture that promotes environmentalism decreases their use of harmful products, such as chemical fertilizers and pesticides. This is good news. We turn now to public environmental opinion.

ENVIRONMENTAL CONCERN: POPULAR SUPPORT AND CHANGE

Sociologists and other social scientists around the world have been investigating environmental concerns for many decades. Keep in mind that environmental concern is a concept that includes several dimensions: beliefs, attitudes, cognition, and individual pro-environmental behavior and collective action, such as participation in social movements (Dunlap and Jones, 2002). Different studies may measure one or more of these dimensions as well as focus on a specific environmental problem, such as climate change or toxic wastes. Environmental public opinion examines environmental concern within a specific geographic location. Survey research is the primary method used to collect data on mass public opinion (Shwom et al., 2015). Let us begin with a brief discussion of global environmental concern.

GLOBAL ENVIRONMENTAL CONCERN

Some have argued that people in poor countries are less likely to be environmentally concerned than citizens of affluent countries because they hold materialist values that focus on the need for economic and physical security. Postmaterialist values, on the other hand, focus more on individual self-expression, freedom, and quality of life and arise after basic needs are met. Postmaterialist values are then said to spawn environmentalism (Inglehart, 1990). To some this means that environmentalism is for the elite. The first analysis of global environmental concern and also a test of Inglehart's postmaterialist values thesis was done using the Gallup Organization's Health of the Planet (HOP) Survey. It compared the public's views of environmental issues and concerns among representative samples in 24 economically and geographically diverse nations. The HOP survey found significant levels of environmental concern among people in all nations, including wealthy ones (like the United States and Denmark) and impoverished ones (like Nigeria and India). But concerns were not identical around the world. People in poor nations were more likely to rate the environment as a serious problem than their counterparts in rich nations. However, they rated it less serious relative to other national problems, such as poverty and malnutrition (Gallup et al., 1993). Subsequent studies have also contradicted the idea that environmental concern is a luxury reserved for affluent people and nations, although national economic conditions do influence levels of concern (Dunlap and Mertig, 1995; Dunlap and York, 2008; Franzen and Vogel, 2013; Mertig and Dunlap, 2001).

In the last few decades, several cross-national studies exploring climate change public opinion have produced mixed results. A 2007 and 2008 Gallup survey of representative national samples in more than 150 countries included the question: "How much do you know about global warming or climate change?" Globally, approximately 39 percent reported they were unaware of either term, however, nearly all of the respondents in developed countries had at least heard of climate change. But, an estimated 75 percent of Egyptians, 71 percent of Bangladeshis, 65 percent of South Africans, 65 percent of Indians, and 63 percent of Indonesians reported having not heard of climate change. While publics in the Middle East/North Africa, Asia, and Sub-Saharan Africa are the least likely to have heard of climate change, many within these regions are the most vulnerable to climate change impacts. However, environmental knowledge and attitudes do not automatically equate to changes in individual behavior or taking actions aimed at large-scale structural changes (Shwom et al., 2015).

In fact, research shows that in both developed and developing countries, the willingness to pay money to fight climate change is lower than expressed concern for it. One reason is that climate change may be seen as more of a distant threat than other environmental problems, such as the need for clean water and air. Education also increases awareness of climate change and support for climate action. At the same time, it may be true that many rural people in developing countries do not know of the term climate change, but they do report observing changing weather patterns and altering farming strategies in response. And here is a final paradox: Among the least concerned of wealthy nations are four countries that are amongst the group of largest emitters of GHG—the United States, Great Britain, Russia, and China. While the Chinese are amongst the least concerned, they also are among the most supportive of climate change policies, but for India, the reverse is true. Making sense of these findings and using them to inform policy will clearly require further investigation (Shwom et al., 2015: 270–274).

AMERICAN ENVIRONMENTAL CONCERN

As discussed in Chapter One, environmental sociology emerged in the late 1970s as a subfield seeking to understand the interrelationships between human social systems and natural systems. To overcome the human exemptionalist perspective, which characterized mainstream sociology at the time, the new ecological paradigm (NEP) was proposed to analyze human–environment relationships (Catton and Dunlap, 1980). Early research in environmental sociology began to map environmental concern and its social bases in America. Using Gallop survey data, Dunlap and Van Liere (1978) found empirical evidence for a shift in American environmental beliefs and attitudes from the dominant social paradigm toward the NEP. Over time, they refined their measurement of the NEP scale and have identified key predictors of adherence. Subsequently, many other researchers have tested it using national and subnational samples in the US and in other countries, finding support of the NEP (e.g., Caron, 1989; Cooper et al., 2004; Dunlap et al., 2000; Edgell and Nowell, 1989; Pierce et al., 1999). For some time now, nearly everyone claims to be pro-environmental, an obvious motive behind Astroturf campaigns. However, we know that environmental public opinion is much more complex than supporting a simple slogan.

Today, environmental public opinion may be more fluid due to increasing political polarization of environmental problems, as well as more responsive to disruptive social and environmental conditions. For instance, a 2007 Gallup poll found that when Americans were asked if they gave a higher priority to protecting the environment or energy production, 58 percent responded in favor of environmental protection and 34 percent favored energy production. By 2010, it switched, 43 percent favored giving a higher priority to protecting the environment, while those favoring a higher priority for producing energy had increased to 50 percent. But between March and May of 2010, the BP oil spill in the Gulf of Mexico sharply altered Americans' views. By May, a majority again favored environmental protection (55 percent) over energy production (39 percent). This shift, however, was found among self-described Democrats and Independents, but negligible for Republicans (Jones, 2010). This illustrates the effect environmental events, like oil spills, can have on human attitudes and culture.

Further, April 22, 2010, marked the 40th anniversary of Earth Day and poll data found from 2000–2010 a slight increase in the percentage of Americans reporting to be active participants in the environmental movement. The most striking finding was the 10-point drop (71 percent to 61 percent) in the overall percentage of Americans reporting a positive view of the environmental movement, and a 10-point increase (28 percent to 38 percent) in those that claimed to be neutral or unsympathetic toward the movement. Thus, the majority of Americans still hold a positive view of the environmental movement, but there is less agreement than at the beginning of the twenty-first century. On both issues (participation and beliefs about its impact), those more supportive of the environmental movement were younger (aged 18–32), held college degrees, were Democrats, and self-described liberals. Women also were more likely to personally identify with the environmental movement (Dunlap, 2010).

Furthermore, a number of national surveys have charted trends in American climate change public opinion and analyzed the predictors of individual views. Leading organizations in these efforts include Gallup, which began periodically collecting data in the 1980s and 1990s and then annually in 2001; the Pew Charitable Trust; and the General Social Science Survey in 2006 and 2010. Several other organizations have gathered national, state, and local data on climate change public opinion. This body of research reveals several key patterns drawn from six dimensions of public opinion on climate change: awareness of climate change; knowledge about climate change; belief in the reality of climate change and the scientific consensus; perceived nearness of climate change impacts; relative concern about climate change compared to other pressing issues; and support for climate change policies (Shwom et al., 2015: 275).

The good news is the vast majority of Americans are aware of climate change, as 96 percent report having heard about it. This is a big jump from 1988 when 58 percent reported being aware of climate change (in 1986 only 39 percent were aware). However, awareness does not mean that more people are knowledgeable about why it is occurring and the consequences of it. For instance, many people confound fluctuations in short-term weather patterns with long-term climate change trends. Beliefs about the reality of climate change have fluctuated over time with a downturn from 2008–2010 and a more recent upswing from 2010–2013. Additionally, recent data indicates that about two-thirds of Americans believe climate change is happening, but *only about half* believe it is human-induced. And compared to other wealthy countries, America continues to be home to a notable portion of the population that denies climate change. In regard to the salience of climate change, when asking Americans whether or not climate change poses a threat to their way of life, approximately one-third report a high level of concern. However, the Pew Research Center has been tracking relative concern for climate change since 2007, and it has consistently ranked as the lowest to second lowest in a list of 20 issues. Similar to findings in other countries, Americans worry less about climate change than other environmental problems, such as air and water pollution, and toxic waste contamination. Nonetheless, when it comes to implementing a range of climate change policies, about 50 percent of Americans are supportive. The type of policy actions that are most supported target individual behaviors like tax credits for energy-efficient purchases, and subsidies for renewable energy development. Regulations of specific industries are less supported and the least supported are gasoline taxes or a carbon tax (Shwom et al., 2015).

As we have indicated, there is variance in the individual predictors of environmental concern. After decades of research, political orientation, including political ideology (very conservative to very liberal), and political identity or partisanship (Democrat, Independent or Republican), is clearly the most consistent and powerful predictor. Generally, Republicans and conservatives are less environmentally concerned than Democrats and liberals. The relationship between political orientation and climate change public opinion is strong and has strengthened over time. It appears conservative countermovements have successfully politicized environmental issues. According to party sorting theory, ideological and political party activists drive elite polarization, and in turn elites give cues to their publics on how to think about and react to an issue (Shwom et al., 2015).

Gender also is a consistent predictor of environmental concern, but the dimension that is being measured matters (Davidson and Freudenburg, 1996; Kahan et al., 2007). The most recent data indicates women are slightly more concerned than men regarding climate change and are more likely to report beliefs that agree with the scientific consensus (Shwom et al., 2015). Gender socialization theory suggests that differences in environmental concern stem from cultural gender role expectations. Core values women are socialized to adopt such as attachment, empathy, and care align with concern for environmental problems. On the other hand, men are socialized to adopt values of detachment, control, and mastery, which align more with beliefs associated with the dominant social paradigm. Some researchers have identified the conservative "white-male effect" because conservative white men have been found to be the least concerned about technological and environmental risks compared to nonwhite men, and nonwhite and white women (Kahan et al., 2007), and more likely to deny the reality and consequences of climate change than the general public (McCright and Dunlap, 2011).

Higher educational attainment is often found to increase environmental concern, but it is less consistently predictive. For instance, the effect of a higher education on climate change views differs between Republicans and Democrats. An explanation is people can select information that supports their cognitive biases (Shwom et al., 2015; Zhou, 2015). Research indicates younger cohorts are more likely to adopt pro-environmental views. However, similar to education, age is often moderated by other variables and produces unpredictable findings given the sample population and the measure of environmental concern. The most inconsistent predictors of environmental concern are income, race and ethnicity, religiosity, and place of residence (rural or urban) (Shwom et al., 2015). Early studies in environmental sociology produced some evidence that urban residents are more environmentally concerned than rural. One explanation of this difference was the extractive commodity thesis, which assumed rural people held more utilitarian environmental views. Over time, the rural–urban divide in environmental concern has not held up. Once again it appears that political orientation moderates the effects of place of residence (Blankenau et al., 2008).

ENVIRONMENTALISM: HOW SUCCESSFUL IS IT?

At various points throughout this text we have looked at debates over the effectiveness of environmental policy, and in doing so, pointed to the role of civil society and environmentalism more broadly. In 2004, journalist Michael Schellenberger and Ted Nordhaus heralded the "Death of Environmentalism." They argued that the bureaucratization of the environmental movement had left it out of touch with the people it ought to represent and politically irrelevant. They also started the Breakthrough Energy Institute, which takes an ecological modernist approach to environmental problem solving (see Chapter Six). Nonetheless, there is ample evidence that environmentalism and its ability to change ideologies, behaviors, and policies that direct the globe onto a path of sustainability is limited After decades of establishing numerous environmental global treaties and instituting the environmental regulatory state in many nations, the cumulative effects of environmental degradation have worsened. Planetary boundaries are being crossed. The reality of runaway climate change is becoming less and less a dystopian fantasy with every day we stay on the business as usual course. In 2010, 40 years after Earth Day, it appeared America's embrace of environmentalism had declined. Scientists have been harassed by government actors and climate denial is well entrenched. Communities across the nation and globe live in sacrifice zones. From this perspective, environmentalism has at best brought about a managed scarcity synthesis (see Chapter One), by producing piecemeal reforms to address the most immediately destructive problems, while falling short of reversing large-scale environmental and climate problems.

On the side, the strengths and successes of environmentalism must not be overshadowed. Conservation reserves and national parks exist across the globe. We have international treaties and organizations to address global environmental problems. The environmental regulatory state has been instituted in many countries. We have dramatically transitioned away from harmful production practices like using CFCs. People across the globe have organized at multiple levels to defend themselves and other human beings and living things from environmental degradation and harm. Ecuador has granted constitutional rights to nature. We have a wealth of knowledge about how natural systems and social systems work and interact with one another. Some of this knowledge is stored in the diverse repositories of culture. Other knowledge is acquired through scientific research and the practical application of science. The well-organized and funded environmental countermovements have not been able to squash environmentalism and must rely on Austroturfing and greenscamming.

To summarize, we have sketched the varieties of contemporary environmental movements in broad strokes. Having different ideological frames and discourses with different organizational structures, action strategies, and diverse clienteles, they can all claim successes. Such fractious movements need a *metanarrative*, or master frame, which could enable them to work in complementary fashion, rather than in contradictory ways that blunt the effectiveness of the larger movement. An environmental metanarrative could provide a common discourse, enabling people to unite around actions creating just, democratic, and sustainable societies. It would not destroy existing discourses, but rather would incorporate them, creating a larger capacity for collective action. If you think that is impossible, consider a more limited version of a metanarrative that did just that, about biodiversity, discussed earlier as a fairly recent invention of conservation biologists. It incorporated separate preexisting environmental discourses about deforestation, overfishing, habitat destruction, the introduction of exotic species, and endangered species. It did not destroy other discourses; it expanded the concerns of various groups to see their common purpose and created the potential for greater collective action (Brulle, 2000: 200–201). Could a climate justice frame offer another organizing metanarrative? As a metanarrative it could link together environmental concerns related to biodiversity loss, water scarcity, energy production, population growth (to name a few), and social and economic concerns related to jobs, health, migration flows, community life, and culture. It also could link together social change needed at the local, national, and international level. After all, climate change is a global phenomenon, which will require international cooperation to adequately address, but when a hurricane hits or drought lasts for years, it affects the everyday life of local people who are likely to turn to their country for assistance. Of course, whether or not a government is willing or able to assist is an issue of justice.

PERSONAL CONNECTIONS

QUESTIONS FOR REVIEW

1. How do social movements, progressive and regressive, shape social change? How are the actions taken by civil society groups such as social movements distinct from government and industry groups and actors? Give examples of how environmental social movements have sought to create change?
2. What are some important environmental discourses in the history of the United States that define differently issues about human–environment relations and have given rise to different groups and organizations?
3. The earliest environmental discourse has been termed “manifest destiny,” and it played an important role in the development of North America by Europeans. How so? What forms do “manifest destiny” and anti-environmentalism take today? What are some of their strategies? What key concerns do they present?
4. How did the rise of an urban industrial society in the United States, particularly from the 1950s onward, transform movements to protect the environment? What has emerged as the ritual celebration of the environment in American culture?
5. What environmental issues did the Group of 10 large environmental organizations focus on? What are some of the successes of the group of 10? Downfalls?

6. What are the variations of grassroots environmentalism? How have environmental justice organizations challenged reform environmentalism? What are the different types of radical environmentalism? How do they challenge other forms of environmentalism?
7. Why are the goals of environmental movements (even moderate ones) controversial, and why do they engender strong (often organized) opposition?
8. What are some of the natural and social causes of the emergence of *global* environmental consciousness and movements? What are some of the successes of global environmentalism?
9. What is environmental concern? How does environmental concern vary globally and within the US? What are the key predictors of environmental concern?
10. In the last 100 years, how has environmentalism succeeded and failed?

QUESTIONS FOR REFLECTION

1. How do your acquaintances view environmental activists or organizations? Ask a variety of people from different social backgrounds (friends, several professors, clergy, businesspeople, relatives). Do people differentiate between "reasonable" and "radical" environmentalism? Do people see environmentalism as a threat? If so, to what?
2. It has been argued that environmentalists ought to use positive frames that emphasize the side benefits of addressing environmental problems rather than issuing warnings of harm and disaster. What motivates you to be more or less environmentally concerned? Can you identify positive side benefits of addressing environmental problems? Think about energy, transportation, consumption, food issues, water, maintaining biodiversity, global warming, etc. that have been suggested in several places.
3. In what sense do you think environmentalism has succeeded or failed?

WHAT YOU CAN DO

While this book has examined broad, abstract issues, we hope you recognize that there has been another theme: that individuals matter. Significant social change often comes from the bottom up, not from the top down. Individuals can matter in several ways. You can change your own lifestyle to be more environmentally benign (which is good in itself but may also demonstrate to others the possibility of positive change). Many of the "what you can do" suggestions that have offered so far are about these kinds of possibilities. If the idea of voluntary simplicity intrigues you and you want to find out more about how people are doing it or make contact with others, try these websites: www.simplicitycircles.com; www.newdream.org; www.adbusters.org. Changing yourself is important, but we also think it's important that you join with others to act or raise consciousness about human and environmental issues.

MORE RESOURCES

Bell, S.E. (2013). *Our roots run deep as ironweed: Appalachian women and the fight for environmental justice*. Champaign, IL: University of Illinois Press.

Boggs, G.L. and Kurashige, S. (2012). *The next American revolution: Sustainable activism for the twenty-first century.* Berkeley, CA: Unversity of California Press.

Brulle, R. J. (2000). *Agency, democracy, and nature: The U.S. environmental movement from a critical theory perspective.* Cambridge, MA: MIT Press.

Dobson, A. (2000). *Green political thought*. London, UK: Routledge.

Dryzek, J., Downes, D., Hunold, C., and Schlosberg, D. (2003). *Green states and social movements: Environmentalism in the United States, United Kingdom, Germany, and Norway.* New York: Oxford University Press.

Helvarg, D. (1994). *War against the greens: The "Wise Use" movement, the New Right, and antienvironmental violence.* San Francisco, CA: Sierra Books.

Kline, B. (2000). *First along the river: A brief history of the U.S. environmental movement* (2nd ed.). San Francisco, CA: Arcada Books.

Lewis, T. L. (2016). *Ecuador's environmental revolutions: Ecoimperialists, ecodependents, and ecoresisters*. Cambridge, MA: MIT Press.

Littig, B. (2001). *Feminist perspectives on environment and society.* New York, London, UK: Prentice Hall.

Mies, M. and Shiva, V. (2014). *Ecofeminism* (2nd ed.). New York, NY: Zed Books, Ltd.

Pellow, D. N. (2014). *Total liberation: The power and promise of animal rights and the radical earth movement*. Minneapolis, MN: University of Minnesota Press.

Taylor, D. E. (2014). *Toxic communities: Environmental racism, industrial pollution and residential mobility*. New York: NYU Press.

Taylor, D.E. (2016). *The rise of the American conservation movement: Power, privilege, and environmental protection*. Durham, NC: Duke University Press.

ELECTRONIC RESOURCES

http://www.greenbeltmovement.org/wangari-maathai/wangari-maathai-institute
Established in honor of Dr. Wangari Maathai, to share knowledge of sustainable use of resources and development.

www.WVPhotovoice.org
Shannon Elizabeth Bell (2013) shares this web link in her book *Our roots run deep as ironweed*. It is the work of 40 women from five different Southern West Virginia communities who share photo images and tell their story of environmental concern in their region.

NOTES

1. Freudenberg and Steinsapir list seven kinds of outcomes: (1) blocking the construction of waste disposal facilities, forcing the cleanup of toxic dumps, banning aerial spraying of pesticides, and so forth; (2) altering corporate practices, particularly through product liability suits; (3) applying increased popular economic and political pressure for the prevention of environmental hazards; (4) winning legislative victories about rights for citizen participation in environmental decision making; (5) increasing community mobilization; (6) linking environmental problems with problems of social justice; and (7) promoting broader public environmental consciousness (1992: 33–35).
2. The only known injury from tree spiking was to a millworker at a Louisiana Pacific mill in California in 1987, when a bandsaw struck an embedded spike. The company blamed it on EF! and the media broadcasted the allegation with great fanfare. EF! was never charged or even investigated, however, and no evidence ever connected it to the spiking. Furthermore, the tree was not in an old-growth area that activists had been defending, nor was it even standing when it was spiked, not a monkey wrench tactic (Sales, 1993: 66).
3. In a few minutes on my computer Charlie located 22 in California, 7 in Minnesota, 4 in New York, and 4 in Missouri. The website address for the voluntary simplicity network is www.simplicitycircles.com.
4. Consider a March 1998 article entitled "Environmental Effects of Increased Atmospheric Carbon Dioxide," in a format closely resembling a reprint of the *Proceedings of the National Academy of Sciences* (which it was not). The article concluded that predictions of global warming are in error and that increased CO_2 levels greatly benefit plants and animals. In fact, this article was in a non-referred publication funded by the George C. Marshall Institute, an anti-environmental think tank (Brulle, 2000: 128).
5. Rubber tappers make their living in the Amazon basin by harvesting latex from rubber trees spread throughout the region. They also gather Brazil nuts, fruits, and fibers in the forest and cultivate small plots near their homes. A 1988 study showed that sustainable harvesting of such nonwood products *over 50 years* would generate twice as much revenue per hectare as timber production and three times as much as cattle ranching (Miller, 1992: 261).

GLOSSARY

Absolute water scarcity [Ch 2, p. 50] When annual supplies of water fall below 500 cubic meters per person.

Action-oriented research [Ch 8, p. 335] Organizing strategy of the environmental justice movement that brings together people with different knowledge bases and organization ties.

Active solar heating system [Ch 4, p. 169] A solar space heating system that uses panels mounted on rooftops that pipes warm water to water tanks or living space.

Adaptation [Ch 3, p. 123] Modifying human activities, communities, and subsistence practices to adapt to the climate change that has taken or will take place.

Adaptive capacity [Ch 3, p. 105] Refers to the ability to accommodate and cope with climate change threats and stressors.

Additionality [Ch 3, p. 122] Premise stating that emissions reductions would not have happened without the added income from selling those reductions.

Agroecology [Ch 5, p. 217] Growing a variety of crops and livestock in a manner that mimics a natural ecosystem.

Ambition gap [Ch 3, p. 124] The gap that exists between emission reduction goals and current action.

Anthropogenic [Ch 1, p. 36] Environmental changes caused by humans

Anti-environmentalism [Ch 8, p. 345] Ideologies and movements that oppose environmental movements.

Anti-global warming movement [Ch 3, p. 123] The organizations and foundations that lobby against measures to address climate change. Some, like the Heartland Institute, have extensive publishing operations, and are funded by some industries (particularly energy and refining industries).

Astroturf campaigns [Ch 8, p. 350] Sophisticated public relations campaigns that seek to shape public opinion and policy to favor the hidden interests of private business or elite political entities.

Attitude-behavior consistency model [Ch 4, p. 155] A social psychological framework for studying energy conservation that focuses on the efficacy of proconservation attitudes and behaviors.

Austerity [Ch 3, p. 108] Reducing government social spending to offset budget deficits.

Behavioral fixes [Ch 7, p. 289] Using public policy to provide incentives to get people to behave differently in ways that can address environmental problems.

Bioaccumulation [Ch 2, p. 81] The accumulation of synthetic agrochemicals in living tissues through various levels of food chains.

Biodiversity [Ch 2, p. 61] The degree of genetic and species diversity in an ecosystem. For example, a rainforest is more diverse than a corn field.

Biofuels [Ch 4, p. 166] Fuels such as ethanol produced from the fermentation of plant materials like corn, grasses, algae, or sugarcane.

Biome [Ch 1, p. 3] A broad, regional ecosystem, with distinctive climate, soil conditions, and living things, for example, desert, temperate forest, or Arctic biomes.

Biomimicry [Ch 6, p. 252] The idea of constructing an economy with many feedback loops like natural systems, rather than just extracting resources and generating wastes.

Biopiracy [Ch 2, p. 68] The corporate practice of prospecting for useful products in tropical countries, often without compensating them.

Bioprospecting [Ch 2, p. 72] The practice, often practiced by pharmaceutical firms, of looking for pharmacologically active compounds produced by rainforest species.

Bioregion [Ch 8, p. 338] A geographical area defined by ecological commonalities, including soil characteristics, watersheds, climate, and native plants and animals.

Bioregionalism [Ch 8, p. 338] A movement that advocates changing political boundaries of human communities to boundaries defined by ecosystems.

Biosphere [Ch 1, p. 3] The entire "layers of life" on the planet, from deep in the oceans to high in the stratosphere.

Buying green [Ch 7, p. 282] Consumerism that considers the environmental impacts of buying and selling goods with the goal of reducing harmful effects on the environment and ensuring provisions for the recycling and reuse of consumer products.

Carrying capacity [Ch 1, p. 6] The capacity of an environment to support life.

Chlorofluorocarbons (CFCs) [Ch 3, p. 117] Chlorinated carbon compounds, used in refrigeration and air-conditioning units. When they "leaked" (as they all did), they rose to the stratosphere where they destroyed ozone molecules that absorbed ultraviolet solar radiation.

Christian stewardship [Ch 8, p. 343] Perspective that creates a moral imperative to preserve God's creation and makes minor adjustments in Christian theology to accommodate environmental concerns.

Circle of toxins [Ch 2, p. 82] Toxic agrochemicals banned in industrial nations are "re-imported" with food from the less developed nations, where their use is still widespread.

Classical economic theory [Ch 1, p. 21] Founded by Adam Smith in the 1700s, and based on the idea that the interplay of supply and demand in economic markets meant that they are naturally and benignly self-regulating without human intervention.

Climate [Ch 3, p. 93] The average weather conditions experienced on the earth over a long time. Unlike the weather, climate changes are usually not accessible to unaided human senses.

Climate reductionism [Ch 3, p. 102] Occurs when climate and natural system forces are assumed to be the primary drivers of climate change, while the social catalysts are treated as an outcome of natural forces.

Club of Rome [Ch 6, p. 246] The name of an organization of computer modelers whose simulations about the earth's future were published in the 1970s as "the Limits of Growth." Updates of this report are used today.

Coevolution [Ch 1, p. 7] The complementary evolution of closely associated species, such as the interlocking adaptation of flowering plants and their pollinating insects. Humans are thought to have similarly co-evolved with the earth's climate.

Cogeneration (see ***combined heat and power systems*****) [Ch 4, p. 173]**

Cognitive fixes [Ch 7, p. 289] Attempt to create awareness of environmental problems in people's minds under the assumption that if you change people's minds, they will change their behavior.

Cognitive liberation [Ch 8, p. 323] People must believe that through collective action they can make social change happen.

Collective mobilization [Ch 8, p. 334] The organization of movement members to pursue the goals of the cause.

Combined heat and power systems (cogeneration) [Ch 4, p. 173] Using the heat produced by an economic process to power another, widely used for its efficiencies in some parts of the world (e.g., Scandinavia and Eastern Europe).

Common-property resource [Ch 7, p. 279] Resources like air and oceans that cannot be individually owned or preserved. Common resources are commonly abused and degraded (see **community management of commons resources**).

Community [Ch 1, p. 3] A system of organisms or people that interact in a particular region or place.

Community management of commons resources (CRM) [Ch 7, p. 302] The conditions, studied by Elinor Ostrum, under which community resources are sustainably managed, including (1) local resource dependency, (2) stable community ties, and (3) effective rules governing resource use.

Community of interests approach [Ch 2, p. 55] Focuses on the mutual benefits of sharing water sovereignty, thereby pursuing a more equitable distribution of water for people and ecosystems.

Conflict theory [Ch 1, p. 29] A major sociological perspective with its history in the ideas of Karl Marx (though greatly modified) emphasizing the role of conflict in the structure of society and social change.

Conservation biology [Ch 8, p. 338] A subdiscipline of biology focusing on the study of the maintenance of biodiversity (see ***deep ecology***).

Conservation corridor [Ch 2, p. 71] Pathways for species to migrate through and disperse when undergoing short-term stress, such as a drought, or a long-term crisis, such as climate change.

Conservation environmental movement [Ch 8, p. 324] A historic American environmental movement, organized around the conservation and "scientific management" of nature, associated with Gifford Pinchot and the foundation of the national forests, grassland, and parks of the federal Interior Department.

Conservationism [Ch 8, p. 326] Environmental movement founded by Aldo Leopold that viewed the land as a living organism, part of an interactive global ecosystem with humans.

Conservatories [Ch 2, p. 72] Institutions like zoos, botanical gardens, nurseries, and gene banks established to protect and preserve "wild" species of plants and animals (see ***gene bank***).

Constituent policy [Ch 7, p. 291] A policy that gives benefits or tax incentives to particular constituent groups, regions, or communities.

Countermovement [Ch 3, p. 114; Ch 8, p. 321] A social movement that develops in opposition to another movement and/or the changes it produced.

Coupled-Human-Natural Systems (CHANS) [Ch 3, p. 103] Examines the reciprocal interactions and their feedback loops between natural and human systems.

Creation spirituality [Ch 8, p. 343] Environmentalist framework that seeks a new synthesis of religion and science.

Cultural eutrophication [Ch 2, p. 83] A process caused by the increased pollution of bodies of water from inorganic chemical fertilizers that leads to the death of water plants and oxygen-consuming fish and aquatic animals.

Culture [Ch 1, p. 10] The total way of life of a group of people, including their customs, habits, symbols, and material things.

Debt for nature swap [Ch 2, p. 72] Programs where nations act as custodians of their natural resources in exchange for debt relief from lenders.

Deep ecology [Ch 8, p. 324] An ecocentric (vs. anthropocentric) environmental movement emphasizing the maintenance of biodiversity and wilderness, and that the rights of humans include only meeting basic needs. Scientists influenced by deep ecology founded conservation biology (see ***conservation biology***).

Dematerialization [Ch 2, p. 77] The extent to which an economy can maximize its results while minimizing material resources.

Demographic transition [Ch 5, p. 186] Related to social development, a complex and lengthy process whereby human populations change from ones with high birth and death rates to ones with low birth and death rates. Between these points, there is a period of rapid population growth.

Demography [Ch 5, p. 199] The study of the size, change, and characteristics of human populations.

Devolution [Ch 1, p. 16] The process of reversal of the evolution of human societies, usually meaning the collapse of large complex structures into simpler ones (see ***evolution***).

Dialectic See ***societal-environmental dialectic***.

Direct action tactics [Ch 8, p. 335] Strategies used by environmental justice organizations to demand change by key actors. Examples include picketing and sit-ins.

Discounting the future [Ch 7, p. 287] Reducing future profits by anticipating inflation and technological improvements.

Discourse [Ch 8, p. 323] A narrative that tells the story of something.

Disproportionality [Ch 7, p. 297] When, after controlling for differences between firms, a small number produce much more than their "share" of pollutants or toxic wastes.

Distribution problem [Ch 4, p. 139] Related to energy, the problem of getting energy from where it is produced to the people and communities that need to use it. Related to food, a similar problem (maldistribution) is a cause of hunger, malnourishment, and famine.

Division of labor [Ch 1, p. 15] An older term meaning *specialization*.

E-waste [Ch 2, p. 73] All the by-products that make TVs, cell phones, computers, and other electronic devices work.

Ecofeminism [Ch 8, p. 324] An environmental movement based on assumptions and archeological evidence that human domination of the environment is related to male domination of females.

Ecological economics [Ch 1, p. 24] The subdiscipline of economics that focuses on how the environment and ecosystems relate to economic processes.

Ecological footprint [Ch 6, p. 248] A method of calculating the human impact on the earth, which can be done for individuals, households, communities, regions, and nations.

Ecological modernization [Ch 6, p. 252; Ch 7, p. 292] A perspective maintaining that economic and social progress without disastrous growth can occur within capitalistic markets by incorporating enough consumption and environmentally benign technology.

Ecological niche [Ch 1, p. 4] The role of an organism in the community for species that live in an ecosystem.

Economic markets [Ch 7, p. 276] Include the systems through which goods and services from the earth's resources are distributed that bring investors, producers, sellers, and buyers together.

Economic nationalism [Ch 6, p. 230] Using means like armies, trade rules, taxes, and subsidies to benefit a nation's economic products over those of other nations (see ***mercantilism***).

Economic-rationality model [Ch 4, p. 155] A strategy of reducing energy consumption by making it more expensive.

Ecosocial system [Ch 2, p. 85] An environment that has been shaped so much by human–environment relations.

Ecospiritualism [Ch 8, p. 324] Environmental movements that view the environment as permeated by spiritual realities (similar but not identical to ***ecotheology***).

Ecosystem services [Ch 7, p. 278] Recognizes limits to growth by acknowledging human dependence on the natural environment that contains a "fixed stock of capital." It includes four types of services—provisioning (food, water, fiber, and fuel); regulating—carbons sinks, waste treatment, and flood mitigation; cultural—spiritual, aesthetic, and recreation; and support—soil formation and nutrient cycling.

Ecotheology [Ch 8, p. 342] Environmental movements that use religious literature and mobilize religious people and organizations on behalf of the environment (related to ***ecospiritualism***).

Efficiency [Ch 4, p. 172] The ratio between energy input and productive output for consumption, with such possibilities for improvement that it is now viewed as an overlooked source of more energy.

Energetics [Ch 4, p. 138] Related to energy.

Energy regime [Ch 4, p. 176] A system of producing energy from particular fuels and their infrastructure (e.g., the coal or gasoline energy regimes).

Entropy [Ch 1, p. 4; Ch 4, p. 149] Combustion or metabolism degrades high-quality organized forms of energy to low-quality less organized forms, such as heat (a law of thermodynamics).

Environment [Ch 1, p. 1] The total surroundings of living things, with many dimensions (e.g., physical, geo-chemical, biological, sociocultural).

Environmental justice movement [Ch 8, p. 333] A movement that grows from the experience of the unequal distribution of environmental costs and benefits by different groups and social classes.

Environmental Kuznets curve [Ch 6, p. 252] The hypothesis that at the highest levels of technological development, human impact on the environment declines somewhat, which is an environmental adaptation of the ideas of economist Simon Kuznets.

Environmental movement [Ch 1, p. 36] A social movement aimed at addressing environmental problems (see ***environmentalism***, ***social movement***).

Environmental possibilism [Ch 1, p. 16] The idea that certain kinds of material, social, and cultural factors are *likely* to produce other things, which is an alternative to a deterministic view.

Environmental regulatory state [Ch 7, p. 294] States that attempt to regulate the variety of ways humans use the environment, which includes most contemporary states.

Environmentalism [Ch 8, p. 321] Ideology and collective action concerning various aspects of the environment.

Evolution [Ch 1, p. 7] Change by the survival of organisms or groups that are best adapted for particular environments, sometimes associated with the emergence of greater complexity (see ***devolution***).

Exchange [Ch 1, p. 4] A way of speaking of cycles of nutrients or minerals, such as the carbon cycle. May mean economic exchange (see ***reciprocal exchange, exchanges of redistribution,*** and ***market exchanges***).

Exchanges of redistribution [Ch 1, p. 15] Economic exchanges that shift goods and services to different social levels (see ***exchange***).

Externalities of scale [Ch 2, p. 84] A point at which the social and environmental costs exceed that of a less concentrated operation, and consequently are unsustainable.

Extreme fossil fuels [Ch. 4, p. 139] Exploiting unconventional fossil fuel sources, such as hydraulic fracturing (fracking) to extract natural gas (shale gas, tight gas, coal bed methane, and methane hydrates), deep water drilling, and extraction of tar sands. Unconventional sources pose many known and unknown environmental and social risks and are capital intensive.

Favelas [Ch 7, p. 275] Festering city slums that develop in areas unsuitable to human habitation plagued by social and environmental problems.

Food pyramid (or food chain) [Ch 1, p. 4] The way that organisms feed on others in an ecosystem depicting the flow of energy and minerals within an ecosystem.

Fossil fuels [Ch 4, p. 138] Fuel formed by the sedimentation and decay of organic material over long periods of time (e.g., coal, natural gas, and oil).

Frame analysis [Ch 8, p. 322] Addresses how social movements get the attention of the larger society.

Frame transformation [Ch 8, p. 340] Occurs when old understandings of a problem are changing and/or new understandings are being produced.

Framing [Ch 4, p. 157] The symbols and discourses that surround and give meaning to a social issue.

Functionalism [Ch. 1, p. 32; Ch. 3, p. 103; Ch. 6, pp. 231–233 and p. 264] A sociological perspective (functionalist theory) that emphasizes how subsystems operate to integrate and support the persistence of society; change is shaped by structural processes and social interactions required for the survival of the society. (see ***social institutions*** and ***functions of the environment***).

Functions of the environment [Ch 1, p. 34] The environment "functions" for society by providing a supply depot, a waste repository, and living space.

Gene bank [Ch 2, p. 72] A conservatory that preserves the genes and DNA of wild and historic species (see ***conservatories***).

Generational equity [Ch. 6, p. 244] Equity within (intra) and between (inter) generations by ensuring that humanwell-being is not achieved by borrowing from future generations or at the expense of current generations.

Genuine Progress Indicator (GPI) [Ch 7, p. 284] A measure of social progress that, in addition to the gross domestic product, adds the value of unpriced social benefits (like volunteerism and housekeeping) and subtracts unpriced costs (like pollution and crime).

Geoengineering [Ch 3, p. 130] Ideas thought to be effective but unproven about addressing climate change by changing the nature of the planet, like putting minerals in the oceans to maintain the circulation of ocean thermal currents, and seeding the stratosphere with reflective objects.

Geopolitical problem [Ch 4, p. 140] A problem having to do with world politics and conflict, and trade among nations.

Global environmentalism [Ch 8, p. 352] World consciousness and action about environmental issues; an element of contemporary global culture stimulated, for instance, by trans-boundary problems (like drought, pollution, and global warming), the internationalization of the mass media, science, and activism.

Globalization [Ch 6, p. 228] The pervasive trends toward the integration of distinct national cultures, economies, politics, and problems into a worldwide—but highly volatile—world order. This has both positive and negative causes and consequences.

Grassroots [Ch 8, p. 333] The extent to which an organization, community initiative, or movement has broad-based support from non-elites.

Green Belt movement [Ch 8, p. 353] A successful reforestation movement started by Kenyan women in the 1990s.

Green imperialism [Ch 6, p. 243] When the advice of wealthy nations to less developed nations ("preserve the rainforest; avoid unsustainable growth") is perceived as a form of imperialism justified by environmental issues.

Green taxes [Ch 7, p. 281] Incrementally decreasing taxes on income, savings, and investments ("goods") and increasing them on energy and resource use, on polluting emissions to land, air, and water, and on products with a high environmental impact ("bads").

Greenhouse effect [Ch 3, p. 97] The warming of the atmosphere due to the accumulation of greenhouse gases.

Greenhouse gases [Ch 3, p. 97] Gases that warm the atmosphere in a way that is similar to how gardeners grow plants in glass greenhouses.

Greenscamming [Ch 8, p. 351] The use of deceptive names to gain public acceptance.

Greenwashing [Ch 7, p. 283] Marketing and advertising products as "green" on questionable grounds to promote sales.

Herbicide and pesticide treadmill Technological [Ch 2, p. 81] Cycle of increased pollution stemming from the agrochemical industry and the growing usage of chemicals that have toxic effects on living things.

Heuristic [Ch 6, p. 248] Using an easily understood metaphor to explain an abstract and complex reality (e.g., "greenhouse gases" to understand climate change, or a "dustbowl" to describe prolonged drought).

Human Development Index (HDI) [Ch 7, p. 284] A measure of development, created by the United Nations, that combines data for nations about life expectancy, literacy, and real GDP per person.

Human Exemptionalism Paradigm (HEP) [Ch 1 p. 27] A paradigm for human–environment relations suggesting that human technological inventiveness makes them exempt from most environmental restrictions and limits (see ***New Ecological Paradigm***).

Human–environment relations [Ch 2, p. 38] The relationships between people and their biophysical environments.

Hydrological cycle [Ch 2, p. 48] Solar-driven circulation of water from the ocean to the atmosphere, from the atmosphere to the land, and back to the ocean.

I = PAT [Ch 6, p. 247] A way of calculating human environmental impact, in which impact equals population size multiplied by the level of consumptive affluence, times the level of technology.

Ideology [Ch 1, p. 14] A system of ideas that explains a situation and justifies action (e.g., free markets, individualism, nationalism, environmentalism).

Incentive shifting [Ch 6, p. 253] Changing economic incentives so that production and consumption have minimal environmental impacts. This can be accomplished, for instance, through taxing things like wasteful use of resources and pollution.

Incommensurability [Ch 7, p. 284] Suggests that common units of measurement such as money cannot express all value.

Inelastic economic demand [Ch 4, p. 155] When the price of goods or services goes up, demand is not much affected (the opposite of elastic demand, which is sensitive to changes in price).

Infrastructure [Ch 4, p. 160] The system of mechanisms for delivering a product. For fossil fuels, all the wells, mines, refineries, trucks, tankers, and pumping facilities, pipelines, transmission lines, etc.

Inorganic chemical fertilizers [Ch 2, p. 82] Boost crop yields, but leave large concentrations of nitrates and phosphates that wash into streams, rivers, lakes, and groundwater.

International Monetary Fund (IMF) [Ch 6, p. 231] A fund created by donor nations to stabilize international currencies through rapid inflation and recessions.

Inverted quarantine [Ch 2, p. 57] How individuals attempt to protect themselves from perceived environmental risks through their consumer choices.

Issue attention cycle [Ch 4, p. 175] Cycles in media attention (or inattention) to issues. In 2010, for instance, the media was flooded with stories about the Gulf oil spill, but there were few stories about species extinction.

Keep it in the Ground [Ch 3, p. 125] Slogan accompanying efforts to achieve a net-zero carbon future.

Kyoto Protocol [Ch 3, p. 121] An international accord, signed at the ancient Japanese city of Kyoto, for nations to address climate change by reducing greenhouse gas emissions. The accord was revisited (inconclusively, without reaching quantitative national targets) at Copenhagen in 2009. The United States is not a signatory to the accord.

Land ice [Ch 3, p. 101] Ice that has accumulated over thousands of years from snowfall and is stored up ocean water on land.

Land grabbing [Ch 2, p. 47] Buying or leasing land by foreign investment firms for large-scale agriculture, biofuel production, and government use.

Legal fixes [Ch 7, p. 290] Mandate change through environmental laws and regulations rather than incentives, subsidies, or persuasion.

Less developed country (LDC) [Ch 3, p. 136; Ch 4, p. 234] A country that is poor, typically agrarian, and relatively less developed in economic and technological terms. Collectively, LDCs were referred to as the "third world," but now sometimes as the "global South," since most are in the Southern Hemisphere. Contrast with wealthier industrial nations, the MDCs.

Limits to growth (LG) [Ch 6, p. 246] The notion that there are limits to continual population, consumption, and economic growth in a finite world of resources.

Local environmental groups [Ch 8, p. 333] Often exist in rural areas and typically focus on community conservation issues, such as a watershed protection organization.

Love Canal [Ch 8, p. 319] A famous community in upstate New York, where a housing development was built on top of a toxic waste dump, which resulted in an epidemic of disease, cancers, and deaths. Activists (especially Lois Gibbs) went on to create a national toxic wastes campaign.

Malnourishment (see ***distribution problem***)

Manifest destiny [Ch 8, p. 324] An ideological belief system that views nature as composed of infinitely abundant resources to be used at the will of humans.

Market exchange [Ch 1, p. 15] Exchanges for money that accumulate wealth, rather than for use, in which social relationships may become embedded in economic ones (see ***exchange***).

Market failures [Ch 7, p. 277] Imbalances in the economic market system leading to human social and environmental problems.

Master frame [Ch 8, p. 340] Dominant paradigm that shapes current understandings and beliefs surrounding social issues.

Materials Flow Analysis (MFA) [Ch 6, p. 250] A methodology developed by Ayers and Kneese that estimates the environmental impact of economic growth by separating the "material throughput" from nonmaterial aspects of economic production.

Megaproblem [Ch 3, p. 94] A problem that is on such a vast scale that it is difficult to observe by ordinary human senses, as in the case of climate change or the "population explosion."

Mercantilism [Ch 6, p. 230] In European history, when kings tried to protect their nations' products by royal decrees and military force (see ***economic nationalism***).

Metanarrative [Ch 8, p. 361] A "grand narrative" that can integrate more particular narratives and frames. An environmental metanarrative would, for instance, address issues about biodiversity, climate change, resource exhaustion, and justice.

Mitigation [Ch 3, p. 113] Curtailing greenhouse gas emission to curb further global warming.

Monoculture [Ch 1, p. 8] An area where primarily one kind of organism grows, for instance, a corn field, or an urban lawn of bluegrass.

Montreal Protocol [Ch 3, p. 115] Successful global environmental treaty in which the world recognized the significant environmental threat and gave up profitable and useful products to avoid significant human and ecological damage.

More developed country (MDC) [Ch 1, p. 20] A wealthy industrial nation, more developed in economic and technological terms. Historically known as "first world nations." MDCs are mainly in the Northern Hemisphere.

Multinational corporation (Ch 7, p. 287) A corporation that has investors, production facilities, and offices in several nations (see ***transnational corporation***).

Natural capital [Ch 2, p. 45] Viewing "nature" as capital, compared with economic or social capital.

Natural selection [Ch 1, p. 7] The mechanisms by which "nature" selects the most well-adapted species for survival, assumed to be a major process in organic evolution.

Neoclassical economic theory [Ch 1, p. 23] Contemporary economic theory, which, in contrast to classical theory, assumes the need for some regulation of "free" markets for the public good.

Neoliberalism [Ch 6, p. 230] The perspective, primarily shared by Western economists, bankers, and finance ministers, that world economic growth will come about if world trade is unfettered by government labor policies, tariffs, or environmental restrictions.

New Ecological Paradigm (NEP) [Ch 1, p. 27; Ch 8, p. 340] The view that humans, like all other species, are subject to environmental limits in a finite world. Contrast this view with the "human exemptionalism paradigm," which views humans as so culturally and technologically creative that most limits can be transcended.

NIMBY [Ch 8, p. 333] A slogan of grassroots movements, referring to opposition to toxic and nuclear waste dumps being built near their communities: "Not in my back yard."

Oil peak [Ch 4, p. 139] The observation of geologist M. King Hubbert that oil production follows a "bell shaped curve" increasing rapidly, peaking, and then declining to exhaustion. Production peaked in the United States in the 1970s, and the world peak will occur in this century.

Outbreak crash [Ch 6, p. 246] A process familiar to population biologists; when a population grows beyond its environmental "carrying capacity," it experiences a rapid decline. Human communities have experienced sudden collapses for similar reasons, as was the fate of the Easter Islanders, the Western Roman Empire, and Mesopotamian civilizations.

Paradigm [Ch 1, p. 27] A mental image of "the way the world works," a term coined by philosopher Thomas Kuhn to describe the Newtonian ("quantum mechanics") view of the universe. Paradigms may be held unwittingly, and they may be elements of popular culture or scholarly/scientific ones.

Passive solar heating system [Ch 4, p. 169] A solar space heating system that uses walls or windows to collect solar radiation.

Persistent organic pollutants (POPs) [Ch 2, p. 81] Synthetic agrochemicals that accumulate in living tissues through various levels of food chains.

Perverse subsidy [Ch 7, p. 253] A subsidy that makes an economic commodity artificially cheap, and leads to its overuse. For example, water in the Western United States is highly subsidized. When water is overused in a dry region, subsidies to farmers encourages them to "over farm" and farm on marginal lands.

Photovoltaic electricity (PVE) [Ch 4, p. 170] When semiconductor cells absorb sunlight and produce an electric current.

Planetary boundary [Ch 2, p. 62] The safe operating space for humanity in regard to nine earth systems that are connected to the planet's biophysical subsystems and processes.

Policy [Ch 7, p. 289] A set of rules or procedures to address an important problem or concern. Policy may be public (governmental) or private.

Politicization [Ch 8, p. 334] The final stage of collective mobilization, which results in a transformed political consciousness regarding an issue.

Preservation of wilderness [Ch 8, p. 326] One side of the conservationism debate that called for a minimum of human use for scientific, aesthetic, and "nonconsumptive" recreational use.

Primary forests [Ch 2, p. 63] Forests that show no signs of human impact.

Primary treatment [Ch 2, p. 78] Water filtration that removes the suspended pollution.

Private-property resource [Ch 7, p. 278] A resource that can be privately owned, and may be more likely to be sustainably used.

Progressive movements [Ch 8, p. 321] Goals for change entail expanding community boundaries by granting more groups full access to rights and opportunities, ensuring justice, and improving conditions for existing community members.

Public-property resource [Ch 7, p. 279] A resource that could be privately owned, but is often owned by governments having exclusive rights to control their use (e.g., national parks, public education, prisons).

Quasispeciation [Ch 7, p. 288] From an economic market perspective, different economic groups benefit and bear costs very differently, even in the same physical environment.

Radical environmental groups [Ch 8, p. 333] Groups driven by an ecological consciousness that significantly challenges the status quo.

Rational-choice theory [Ch 7, p. 285] A recent perspective that can integrate substantial bodies of theory in economics, biology, and psychology, that humans (both individually and collectively) are rational choice makers, who seek to minimize costs and maximize rewards or benefits.

Rationality [Ch 1, p. 34] As used by Max Weber, "rationality" means an efficient linkage between means and ends, that is, minimizing inputs (of cost, resources, or labor) and maximizing output.

Rebound effect [Ch 7, p. 255] When efficiency (for instance, in the operation of home appliances) saves money that gets spent in other ways, perhaps increasing consumption.

Reciprocal exchange [Ch 1, p. 15] Mutual benefit exchanges, as in symbiosis.

Recreancy [Ch 7, p. 297] The idea that as people become more dependent on "experts," they become suspect for their lack of competence, or lack of commitment to the public good.

Recycling [Ch 2, p. 76] Processing used materials and waste for repurposing into usable goods.

Reform environmentalism [Ch 8, p. 327] Channeled and amplified environmental awareness and concerns among broad segments of the population, particularly about the hazards connected with life in industrial society.

Regressive social movements [Ch 8, p. 321] A complex system of ideas developed to expand the environmental movement and account for both pollution and loss of recreational and aesthetic resources.

Regulatory policy [Ch 7, p. 291] Policy that attempts to control behavior over a broad spectrum of economic processes, institutions, and communities.

Renewable energy source [Ch 4, p. 164] Energy from sources that are hypothetically renewable, like solar, wind energy, or energy driven by tidal motion, unlike fossil fuels.

Resilience [Ch 7, p. 314] The ability of a social-ecological system to absorb change and persist. Resilient systems have a greater capacity to learn, undergo transformation, and stay within a desired state.

Resource allocation paradigm [Ch 7, p. 277] The notion of neoclassical economists that markets allocate resources efficiently, by the interplay of supply and demand.

Resource mobilization [Ch 8, p. 322] How social movements organize financial support, and participants' time, talents, and social networks.

Resource partitioning [Ch 1, p. 4] Mechanisms that make it possible for different species to share the same resource base without much conflict or competition, for example, in lakes and seas, bottom feeders versus top feeders, or day versus nocturnal feeders. In human communities, the segmentation of labor markets does much the same.

Retail policy [Ch 7, p. 296] Constituent policy that addresses the need of particular organized client groups, rather than "wholesale" policy in the public interest.

Retrofit [Ch 4, p. 169] Making a building more energy efficient, for instance, by installing more insulation or more efficient appliances.

Reuse [Ch 2, p. 77] Encouraging the usage of products that can be used over and over again to extend resource supplies and reduce energy use and pollution.

Salinization [Ch 2, p. 81] When soil becomes too salty by over-irrigation, water evaporates, leaving mineral salts behind in the soil. A major cause of the decline of soil fertility.

Sea ice [Ch 3, p. 101] Accumulates in ocean salt water during the winter months, and in Antarctica it melts during the summer, having no measurable impact on sea level.

Secondary treatment [Ch 2, p. 78] Water filtration that uses settling basins where aerobic bacteria degrade organic pollutants.

Service and flow economy [Ch 6, p. 253] Instead of being based on ownership, an economy where many goods and services can be leased or rented. In Paris, there are stations where you can rent a car or bicycle by the hour, and in some places you can rent the services of a nurse or an attorney for a short time. Such a system multiplies re-use and recycling of resources.

Shadow prices [Ch 7, p. 286] Speculative administered market prices determined by an expert, planner, administrator, or bureaucrat.

Shareholder control [Ch 7, p. 293] Control by corporations and economic elites.

Sink [Ch 2, p. 138] A waste repository—landfill, dump. Pollution makes environmental sinks out of air or bodies of water.

Sink problem [Ch 4, p. 99] Related to energy, the "sink problem" is about the combustion by-products of fuels, as in smoke, smog, or greenhouse emissions.

Smog [Ch 2, p. 80] A hazy, dirty brown, toxic witch's brew of more than 100 exotic chemicals that hangs in a bubble over most cities in certain weather conditions.

Social construction [Ch 1, p. 35] The perspective that realities are not only external, but constructed by people who define, discuss, and experience them.

Social impact assessment [Ch 8, p. 331] A method of assessing the community impacts of major new projects like mines, power plants, and hydroelectric dams.

Social institution [Ch 1, p. 12] Long established parts of society that address important concerns (e.g., families, politics, the economy, health care).

Social movement [Ch 8, p. 321] Ideology and collective action about promoting or preventing change.

Social stratification [Ch 1, p. 29] Layers of social inequality arranged in layers. The basic "building blocks" of society, such as status-roles, groups, organizations, and social classes.

Societal-environmental dialectic [Ch 1, p. 30] A three-part process of change in human–environmental relations consisting of a direction (or thesis), its opposite (or an antithesis), and a fusion (or synthesis) (see ***treadmill of growth***).

Source [Ch 2, p. 45] Natural bodies from which resources are drawn.

Self-realization [Ch 8, p. 337] A component of deep ecology whereby humans accept that they belong to nature; involves the process of one striving for organic wholeness in nature.

Source problem [Ch 4, p. 138] As related to energy, having to do with the adequacy of supplies.

Status-role [Ch 1, p. 12] The most elementary units of social structure. Statuses are structures, and roles are expectations and/or behaviors (see ***social structure***).

STIRPAT [Ch 6, p. 248] The stochastic regression of impacts on population, affluence, and technology: A method of studying environmental impacts using data from a large sample of nations over time, rather than summary numbers in an "accounting" equation.

Stochastic [Ch 6, p. 248] Probabilistic, rather than deterministic.

Stock-taking [Ch 3, p. 127] Mechanism to determine if voluntary emissions reductions are being met.

Stranded assets [Ch 7, p. 273] Financial term referring to the unexpected or early conversion of assets that produce profit into liabilities that result in profit loss.

Strategic lawsuits against public participation (SLAPPs) [Ch 8, p. 347] Legal tactics used by corporations against environmental activist groups who publicly oppose their use of the environment.

Supply side energy policies vs. demand side [Ch 4, p. 140] Policies to address energy problems by increasing the supply of fuels.

Sustainability [Ch 6, p. 229] When a process can be carried on indefinitely without collapse.

Sustained resistance [Ch 8, p. 334] Maintaining a movement over time.

Symbiosis [Ch 1, p. 7] When two or more species live in a closely associated way that may or may not be mutually beneficial.

Symbolic interactionism [Ch 1, p. 35] A social psychological perspective emphasizing that behavior and self-concepts are critically influenced by language and symbols.

System [Ch 1, p. 3] A network of interconnected parts, so that a change in one element of a system has implications for other parts of the system.

Technological fixes [Ch 7, p. 289] One way the government can address environmental problems that includes a focus on technology, such as retrofitting the energy grid to use diverse renewable energy sources.

The Three E's [Ch 6, p. 244] Understanding sustainability as involving ecology, economics, and (social) equity. Any of the three can be a starting place for policy to address environmental sustainability, but which one you start with can makea big difference.

Third World nations See ***less developed country*** (LDC).

Throwaway economies [Ch 2, p. 77] An economic system that encourages the mass usage and discarding of products at an increasing rate.

Total liberation [Ch 8, p. 340] A new frame of environmentalism that seeks to transform the social and cultural systems that concurrently harm people, ecosystems, and animals.

Tradable Environmental Allowances (TEAs) [Ch 7, p. 306] A system of giving producers permits for limits on their impact on common property resources (e.g., industrial emissions or fish catch from an ocean fishing ground). Producers who exceed their permits buy permits from more efficient producers in a special auction. Known as a "cap and trade" system, it provides incentives for using fewer resources and promoting efficiency (see ***common property resources***).

Traditional ecological knowledge (TEK) [Ch 2, p. 71] Knowledge held by indigenous people concerning the relationship of living things with one another and their environment.

Tragedy of the commons [Ch 7, p. 279] Garrett Hardin's observation that common property (or common pool) resources are often exploited beyond sustainable levels.

Transboundary waters [Ch 2, p. 52] Lakes, rivers, inland water, and aquifers that are shared by two or more nations.

Transnational corporation (TNC) [Ch 8, p. 348] A corporation that produces goods and services in more than one country, to reduce production costs, or avoid taxes, or both (see ***multinational corporations***).

Treadmill of production [Ch 1, p. 29] The observation that in market economies continual growth is universally desirable (to avoid unemployment and recessions), but—ironically—continual growth undermines the environmental resources that make growth possible.

Tree huggers [Ch 8, p. 354] A label applied to environmentalists, deriving from rural Indians who surrounded forest trees, attempting to prevent logging companies from cutting them.

TRI (Toxic Release Inventory) [Ch 7, p. 254] Under the provisions of the National Environmental Protection Act (NEPA), in the United States industrial firms are obliged to publish an annual estimate of the volume of toxins that they produce and release into the e nvironment.

Utilitarian use of natural resources [Ch 8, p. 326] Another side of the conservationism movement led by hunters and fishers that called for the "scientific management" of ecological goods.

Virtual water [Ch 2, p. 50] Water that is embodied in the products a population consumes and trades.

Volatile Organic Compounds (VOCs) [Ch 2, p. 80] A harmful collection of more than 100 organic compounds remaining from the incomplete combustion of hydrocarbons from transportation and industry. Urban "smog."

Voluntary simplicity [Ch 6, p. 259] A recurring but minor theme (and movement) in contemporary societies advocating less consumption, simpler lifestyles, and less environmentally damaging technologies.

Water scarce [Ch 2, p. 50] When annual supplies of water fall below 1,000 cubic meters per person in an area.

Water stressed [Ch 2, p. 50] When annual supplies of water fall below 1,700 cubic meters per person in an area.

Wind farm [Ch 4, p. 169] A large array of wind turbines in a particular place linked to an energy grid.

Wind turbine [Ch 4, p. 169] The contemporary version of windmills that are complex and highly engineered machines with many moving parts, metal alloys and gears.

World Bank [Ch 6, p. 230] The international agency that provides loans and assistance for development to poor nations.

World market economy [Ch 1, p. 18] The emerging system of international trade, labor relations, and currency exchange that is the key to understanding globalization.

World Trade Organization (WTO) [Ch 6, p. 232] The organization created by nations and large banks to promote, establish policy for, and monitor world trade.

World-system [Ch 6, p. 233] Wallerstein's theory about the integration of economies, politics, and culture into a connected hierarchy of nations, which began to replace older colonialism in the twentieth century. When not hyphenated, world system is a synonym for globalization.

Worldview [Ch 1, p. 13] The total understanding of the world and universe that people have, which includes all dimensions of their knowledge, beliefs, and experience.

REFERENCES

Abbey, E. (1975, 2014). *The monkey wrench gang*. New York, NY: Harper Perennial.

Acheson, J. (1981). The lobster fiefs, revisited: Economic and ecological effects of territoriality in the Maine lobster industry. In B. McCay and J. Acheson (Eds.), *The question of the commons* (pp. 37–65). Tucson, AZ: University of Arizona Press.

Adams, J., and Roscigno, V.J. (2005). White supremacists, oppositional culture and the worldwide web. *Social Forces*, *84* (2), 759–778.

Adeola, F. (2004). Boon or bane? The environmental and health impacts of persistent organic pollutants (POPs). *Human Ecology Review*, *11* (1), 27–35.

Agricultural Health Study. (2015). 2015 study up-date. Available at https://aghealth.nih.gov/news/2015.html. Accessed on April 1, 2016.

Alario, M. and Freudenburg, W.R. (2003). The paradoxes of modernity: Scientific advances, environmental problems, and risks to the social fabric. *Sociological Forum*, *17 (2)*: 193–214.

Aldern, C. (March 30, 2016). This chart shows the United States' mind-blowing clean energy potential. www.Grist.org. Available at http://grist.org/climate-energy/this-chart-shows-the-united-states-mind-blowing-clean-energy-potential. Accessed on April 5, 2016.

Aleklett, K. (2006). Oil: A bumpy road ahead. *Worldwatch*, *19* (1), 10–11.

Alexander, J. (1985). *Neofunctionalism*. Beverly Hills, CA: Sage.

Alexander, S., Schneider, S., and Largerquist, K. (1997). The interaction of climate and life. In G. Daily (Ed.), *Nature's services: Societal dependence on natural ecosystems* (pp. 71–92). Washington, DC: Island Press.

Allison, S. (November 17, 2015). Farmers bear brunt of South Africa's severe drought: all we can do is pray. *The Guardian*. Available at: http://www.theguardian.com/global-development/2015/nov/17/farmers-bear-brunt-of-south-africas-severe-drought-all-we-can-do-is-pray. Accessed on April 2, 2016.

Altieri, M. (1995). *Agroecology: The science of sustainable agriculture*. Boulder, CO: Westview Press.

Altieri, M. (1998). Ecological impacts of industrial agriculture and the possibility for a truly sustainable farming. *Monthly Review*, *50* (3), 60–71.

Amano, A. (1990). Energy prices and CO2 emissions in the 1990s. *Journal of Policy Modeling*, *12*, 495–510.

Amlario, M., and Freudenburg, W. (2003). The paradoxes of modernity: Scientific advances, environmental problems, and risks to the social fabric. *Sociological Forum*, *18*, 193–214.

Anderson, T., and Grewell, J. (1999). Property rights solutions for the global commons: Bottom up or top down? *Duke Environmental Law and Policy Forum*, *10*, 73–101.

Appadurai, A. (1996). *Modernity at large: Cultural dimensions of globalization*. Minneapolis, MN: University of Minnesota Press.

Armillas, P. (1971). Gardens on swamps. *Science*, *174*, 653–661.

Assadourian, E. (2005). Toxic chemicals. In Prugh, T. (Ed.), *State of the world, 2005: Redefining global security* (pp. 78–79). New York: W. W. Norton.

Austin, K. (2010). The "Hamburger Connection" as ecologically unequal exchange: A cross-national investigation of beef exports and deforestation in less developed countries. *Rural Sociology*, *75* (2), 270–299.

Auth, K. (2015). The oceans: Resilience at risk. In Gardner, G., Prugh, T. and Renner, M. (Project Directors). *State of the world 2015: Confronting hidden threats to sustainability* (pp. 79–90). Washington, D.C.: Island Press.

Ayalew, M. Chenoweth, J., Malcolm, R., Mulugetta, Y., Okotto, L.G., and Pedley, S. (2014). Small independent water providers: Their position in the regulatory framework for the supply of water in Kenya and Ethiopia. *Journal of Environmental Law*, *26*, 105–128. Available at https://www.researchgate.net/publication/270786477_Small_Independent_Water_Providers_Their_Position_in_the_Regulatory_Framework_for_the_Supply_of_Water_in_Kenya_and_Ethiopia. Accessed on April 1, 2016.

Ayres, J., and Kneese, A. (1968). *Environmental pollution*. Washington DC: Federal Programs for the Development of Human Resources.

Ayres, R. (2001). The energy we overlook. *Worldwatch*, *14* (6), 30–39.

Balaam, D., and Veseth, M. (1996). *Introduction to international political economy*. Upper Saddle River, NJ: Prentice Hall.

Baland, J., and Platteau, J. (1996). *Halting degradation of natural resources: Is there a role for rural communities?* Oxford, UK: Clarendon Press.

Bales, K. (2016). *Blood and earth: Modern slavery, ecocide, and the secret to saving the world*. New York, NY: Spiegal and Grau.

Banerjee, B. (December 20, 2010). The great wall of India. *Slate*. Available at http://www.slate.com/articles/health_and_science/green_room/2010/12/the_great_wall_of_india.html. Accessed on June 22, 2016.

Barash, D. (1979). *Sociobiology: The whisperings within*. New York: HarperCollins.

Barber, B. (1983). *The logic and limits of trust*. Rutgers, NJ: Rutgers University.

Baskin, L., Himes, K., and Colburn, T. (2001). Hypospadias and endocrine disruption: Is there a connection? *Environmental Health Perspectives, 109* (11), 1175–1183.

Beck, E.L. (2011). Organic agriculture sustained through economic crisis. *Vital signs: global trends that shape our future.* Available at *vitalsigns.worldwatch.org/vs-trend/organic-agriculture-sustained-through-economic-crisis*. Accessed on June 20, 2016.

Beck, U. (1995). *Ecological politics in an age of risk*. New York: Polity Press.

Beck, U. (1996). World risk society as cosmopolitan society? Ecological questions in a framework of manufactured uncertainties. *Theory, Culture, and Society*, *13*, 4.

Beder, S. (1998). *Global spin: The corporate assault on environmentalism*. White River Junction, VT: Chelsea Green.

Beder, S. (2011). Environmental economics and ecological economics: The contribution of interdisciplinarity to understanding influence and effectiveness. *Environmental Conservation*, *38* (2), 140–150.

Bell, M. (1998). *An invitation to environmental sociology*. Thousand Oaks, CA: Pine Forge Press.

Bell, M. (2004). *An invitation to environmental sociology* (2nd ed.). Thousand Oaks, CA: Pine Forge Press.

Bell, M. and Ashwood, L.L. (2016). *An invitation to environmental sociology* (5th ed.). Thousand Oaks, CA: Pine Forge Press.

Bell, S.E. (2013). *Our roots run deep as ironweed: Appalachian women and the fight for environmental justice*. Champaign, IL: University of Illinois Press.

Bell, S. E., and York, R. (2010). Community economic identity: The coal industry and ideology construction in West Virginia. *Rural Sociology*, *75* (1): 111–143.

Bender, W., and Smith, M. (1997). Population, food, and nutrition. *Population Bulletin*, *51* (4), 2–43.

Benton, T. (1989). Marxism and natural limits: An ecological critique and reconstruction. *New Left Review*, *178*, 51–86.

Berger, P., and Luckmann, T. (1976). *The social construction of reality*. New York, NY: Doubleday.

Berkes, F. (2012). *Sacred ecology*. (3rd ed.). New York, NY: Routledge.

Berman, E. R., and Johnson, R. K. (2015). The unintended consequences of changes in beverage options and the removal of bottle water on a university campus. *American Journal of Public Health*, *105* (7): 1404–1408.

Berry, W. (1981). *The gift of good land: Further essays cultural and agricultural*. New York, NY: North Point Press.

Bevington, D. (1998). Earth First! in Northern California: An interview with

Judi Bari. In Daniel Farber (Ed.), *The struggle for ecological democracy: Environmental justice movements in the United States* (pp. 248–271). New York, NY: Guilford Press.

Biello, D. (September 8, 2015). The Great Recession enabled bold steps to seed a clean-energy revolution. *The Scientific American*. Available at http://www.scientificamerican.com/article/obama-has-done-more-for-clean-energy-than-you-think. Accessed on June 5, 2016.

Birdsall, N. (1980). Population and poverty in the developing nations. *Population Bulletin*, *35*, 1–48.

Black, J. et al. (1985). Personal and contextual influences on household energy adaptations. *Journal of Applied Psychology*, *70*, 3–21.

Blankenau, J., Snowden, M., and Langan, M. (2008). Understanding environmentalism in a red agricultural state: The impact of political party identification and place of residence. *Sociological Spectrum*, 28, 55–80.

Bleviss, D. L., and Walzer, P. (1990). Energy for motor vehicles. *Scientific American*, *263* (3), 103–109.

Bliss, L. (October 1, 2015). Before California's drought, a century of disparity. *The Atlantic: CityLab*. Available at: http://www.citylab.com/weather/2015/10/before-californias-drought-a-century-of-disparity/407743. Accessed on March 25, 2016.

Block, B. (2010). Covering climate change. *Worldwatch*, *23* (2), 20–25.

Bomey, N. (July 14, 2016). BP's Deepwater Horizon costs total $62B. USA Today. http://www.usatoday.com/story/money/2016/07/14/bp-deepwater-horizon-costs/87087056/ Accessed December 10, 2016.

Bookchin, M. (1982). *The ecology of freedom: The emergence and dissolution of hierarchy*. Palo Alto, CA: Cheshire Books.

Boserup, E. (1981). *Population and technological change: A study of long-term trends*. Chicago: University of Chicago Press.

Bosso, C. (2005). *Environment, Inc.* Lawrence, KS: University of Kansas Press.

Brickman, R., Jasanoff, S., and Ilgen, T. (1985). *Controlling chemicals: The politics of regulation in Europe and the United States*. Ithaca, NY: Cornell University Press.

Brown, L. (1988). *The changing world food prospect: The nineties and beyond*. Worldwatch Institute Paper No. 85. Worldwatch Institute.

Brown, L. (1991). The new world order. In L. Starke (Ed.), *State of the world 1991* (pp. 3–20). New York: W. W. Norton.

Brown, L. (1994). Who will feed China? *Worldwatch*, *7* (5), 10–22.

Brown, L. (1999). Feeding nine billion. In L. Starke (Ed.), *State of the world, 1999* (pp.116–132). New York: W. W. Norton.

Brown, L. (2001). *Eco-economy: Building and economy for the earth*. New York: W. W. Norton.

Brown, L. (2004). *Outgrowing the earth: The food scarcity challenge in an age of falling water tables and rising temperatures*. New York: W. W. Norton.

Brown, L. (2008). *Plan B 3.0: Mobilizing to save civilization*. New York: W. W. Norton.

Brown, L. (2009). *Plan B 4.0: Mobilizing to save civilization*. New York: Earth Policy Institute.

Brown, L. (2012). *Full planet, empty plates: Geopolitics of food scarcity*. New York: W. W. Norton.

Brown, L., and Flavin, C. (1999). A New economy for a new century. In L. Brown, C. Flavin, and H. French (Eds.), *State of the world 1999*. New York: W. W. Norton.

Brulle, R. J. (2000). *Agency, democracy and nature: U.S. environmental movements from the perspective of critical theory*. Cambridge, MA: MIT Press.

Brulle, R. J. (2014). Institutionalizing delay: Foundation funding and the creation of U.S. climate change counter-movement organizations. *Climatic Change*, *122* (4), 681–694.

Brulle, R.J., and Benford, R. (2012). From game protection to wildlife management: Frame shifts, organizational development, and field practices. *Rural Sociology*, *77*, 1: 62–88.

Brulle, R. J. and Dunlap, R. E. (2015). Sociology and global climate change: Introduction. In Dunlap, R. E. and Brulle, R. J. (Eds.). *Climate change and society: Sociological perspectives*. Report of the American Sociological Association's task force on sociology and global climate change (pp. 1–31). New York, NY: Oxford University Press.

Brulle, R. J., and Jenkins, C. (2006). Spinning our way to sustainability? *Organization and Environment*, *19* (1), 82–87.

Bruno, M. (2010). Disaster contingency plans are "fantasy documents" when it comes to oil spills. http://grist.org. Accessed May 11, 2010.

Bullard, R. D. (1990). *Dumping in Dixie: Race, class, and environmental quality*. Boulder, CO: Westview.

Bullard, R. D. (Ed.) (1993). *Confronting environmental racism: Voices from the crossroads*. Boston: South End Press.

Bullard, R.D., and Johnson, G. (2000). Environmental justice: Grassroots activism and its impact on public policy decision making. *Journal of Social Issues*, *56*, 555–578.

Bullard, R.D. and Wright, B. (Eds.) (2009). *Race, place and environmental justice after Hurricane Katrina: Struggles to reclaim, rebuild, and revitalize New Orleans and the gulf coast*. Boulder, CO: Westview Press.

Bullard, R.D. and Wright, B. (2012). *The wrong complexion for protection: How the government response to disaster endangers African American communities*. New York, NY: NYU Press.

Bunker, S. (1996). Raw materials and the global economy: Distortions in industrial ecology. *Society and Natural Resources*, *9*, 419–429.

Burns, T. R., and Dietz, T. (1992). Cultural evolution: Social rule systems, selection and human agency. *International Sociology*, *7* (3), 259–283.

Buttel, F. (1986). Sociology and the environment: The winding road toward human ecology. *International Social Science Journal*, *109*, 337–356.

Buttel, F. (2000a). Ending hunger in developing countries. *Contemporary Sociology*, *29* (1), 13–27.

Buttel, F. (2000b). *The adoption and diffusion of GM crop varieties: The "gene revolution" in global perspective*. PATS Paper Series, Program on Agricultural Technology Studies, College of Agricultural Life Sciences, Paper no. 6, March. Madison, WI: University of Wisconsin–Madison.

Buttel, F. (2000c). World society, the nation-state, and environmental protection: Comment on Frank, Hironaka, and Schofer. *American Sociological Review*, *65* (February), 117–121.

Buttel, F. (2002). Ecological modernization as a social theory. *Geoforum*, *31*, 57–76.

Buttel, F., Hawkins, A., and Power, A. (1990). From limits to growth to global change: Constraints and contradictions in the evolution of environmental science and ideology. *Global Environmental Change*, *1190* (December), 57–66, cited on p. 53 in A. Mol (2003). *Globalization and environmental reform: The ecological modernization of the global economy*. Cambridge, MA: MIT Press.

Cable, S., and Benson, M. (1993). Acting locally: Environmental injustice and the emergence of grassroots environmental organizations. *Social Problems*, *40* (4), 464–477.

Cable, S. and Cable, C. (1994). *Environmental problems/grassroots solutions: The politics of grassroots environmental conflict*. London, UK: Worth Publishers.

Caiazza, A., and Barrett, A. (2003). *Engaging women in environmental activism: Recommendations for Rachel's Network*. Washington, DC: Institute for Women's Policy Research.

Caldecott, B. (2015). Avoiding stranded assets. In Gardner, G., Prugh, T. and Renner, M. (Project Directors). *State of the world 2015: Confronting hidden threats to sustainability* (pp. 51–63). Washington, DC: Island Press.

Caldwell, L. (1992). Globalizing environmentalism: Threshold of a new phase in international relations. In R. E. Dunlap and A. G. Mertig (Eds.), *American environmentalism: The U.S. environmental movement, 1970–1990* (pp. 63–76). New York: Taylor & Francis.

Camp, S. L. (1993, Spring). Population: The critical decade. *Foreign Policy*, *90*, 126–144.

Caniglia, B.S., Brulle, R. J., and Szasz, A. (2015). Civil society, social movements, and climate change. In Dunlap, R. E. and Brulle, R. J. (Eds.). *Climate change and society: Sociological perspectives*. Report of the American Sociological Association's task force on sociology and global climate change (pp. 235–268). New York, NY: Oxford University Press.

Cao, J., Yeh, E.T., Holden, N. M., Qin, Y., and Ren, Z. (2013). The roles of overgrazing, climate change and policy as drivers of degradation of China's grasslands. *Nomadic Peoples*, 17 (2), 82–101.

Carmin, J., Tierney, K., Chu, E., Hunter, L. M., Roberts, J. T., and Shi, L. (2015). In Adaptation to climate change. Dunlap, R. E. and Brulle, R. J. (Eds.). *Climate change and society: Sociological perspectives*. Report of the American Sociological Association's task force on sociology and global climate change (pp. 164–198). New York, NY: Oxford University Press.

Caron, J. (1989, Spring). Environmental perspective of blacks: Acceptance of the new environmental paradigm. *Journal of Environmental Education*, *20*, 21–26.

Carrington, D. (January 7, 2015). Leave fossil fuels buried to prevent climate change, study urges. *The Guardian*. Available at: http://www.theguardian.com/environment/2015/jan/07/much-worlds-fossil-fuel-reserve-must-stay-buried-prevent-climate-change-study-says. Accessed on April 14, 2016.

Carrington, D. (January 5, 2016). December 2015 was the wettest month ever recorded in UK. *The Guardian*. Available at: http://www.theguardian.com/environment/2016/jan/05/december-2015-was-wettest-month-ever-recorded-in-uk. Accessed on February 23, 2016.

Carrus, K. (2006). Birds remain threatened. In L. Starke (Ed.), *Vital signs 2006–2007: Trends that are shaping our future* (pp. 96–97). New York: W. W. Norton.

Carson, R. (1962). *Silent spring*. Boston: Houghton Mifflin.

Carver, T. N. (1924). *The economy of human energy*. New York: Macmillan.

Castells, M. (2000). *The rise of the network society*. Oxford, UK: Blackwell.

Casten, S. (2009). The perfect market fallacy. *The recycled energy blog*. Accessed March 30, 2011.

Catton, W. (1993/1994). Let's not replace one set of unwisdoms with another. *Human Ecology Review*, *1* (1), 33–38.

Catton, W. (1997). Redundancy anxiety. *Human Ecology Review*, *3* (2), 175–178.

Catton, W., and Dunlap, R. E. (1978). Environmental sociology: A new paradigm? *The American Sociologist*, *13*, 41–49.

Catton, W. R., and Dunlap, R. E. (1986). Competing functions of the environment: Living space, supply depot, and waste repository. Paper presented at the 1986 meeting of the Rural Sociological Society, Salt Lake City, UT.

Charman, K. (2006). Brave nuclear world. *Worldwatch 19* (4), 12–18.

Chase-Dunn, C. (1989). *Global formation: Structures of the world economy*. Oxford, UK: Blackwell.

Chiu, A. (2009). One twelfth of global electricity comes from combined heat and power systems. In L. Starke (Ed.), *Vital signs 2009: Trends that are shaping our future* (pp. 50–52). New York: W. W. Norton.

Cinnatell, P. (1999). It's all about power: The political economy and ecology of redefining the Brazilian Amazon basin. *Sociological Quarterly*, *40* (2), 293–315.

Ciplet, D. (2014). Contesting climate injustice: Transnational advocacy network struggles for rights in UN climate politics. *Global Environmental Politics*, *14* (4), 75–96.

Ciplet, D., Roberts, J.T., and Khan, M. R. (2015). *Power in a warming world: The new global politics of climate change and the remaking of environmental inequality*. Cambridge, MA: MIT Press.

Clapp, J. (2002). The distancing of waste: Overconsumption in a global economy. In Princen, T., Maniates, M., and Conca, K. (Eds.), *Confronting consumption* (pp. 155–176). Cambridge, MA: MIT Press.

Clark, M. (1991). Rethinking ecological and economic education: A gestalt shift. In R. Costanza (Ed.), *Ecological economics: The science and management of sustainability* (pp. 400–414). New York: Columbia University Press.

Clark, N. (2014). Geo-politics and the disaster of Anthropocene. *The Sociological Review*, *62* (S1), 19–37.

Clark, W. (1990). *Managing planet earth*. In *Managing plane earth: Readings from Scientific American* (pp. 1–12). New York: W.H. Freeman.

Clyke, F. (1993). *The environment*. New York: HarperCollins.

Cochran, P., Huntington, O.H., Pungowiyi, C., Tom, S., Chapin III, F.S., Huntington, H.P., Maynard, N.G., and Trainor, S.F. (2014). Indigenous frameworks for observing and responding to climate change in Alaska. In Maldonado, J.K., Colombi, B., and Pandya, R. (Eds). *Climate and indigenous peoples in the United States* (pp. 1-8). Berlin: Springer.

Cohen, J. E. (1995). *How many people can the earth support?* New York: W. W. Norton.

Coleman, J. S. (1990). *Foundations of social theory*. Cambridge, MA: Harvard University Press.

Collins, J., and Porras, J. (2002). *Built to last: Successful habits of visionary companies*. New York: Harper Business.

Collins, R. (1975). *Conflict sociology: Toward an explanatory science*. New York: Academic Press.

Commoner, B. (1971). The *closing circle*. New York: Knopf.

Commoner, B. (1992). *Making peace with the planet*. New York: The New Press.

Condorcet, M. De (1979). *Sketch for a historical picture of the progress of the human mind* (J. Barraclough, Trans.). London: Weidenfeld and Nicolson. (Original work published in 1795.)

Cook, E. (1971). The flow of energy in an industrial society. *Scientific American*, *224* (3), 134–147.

Cooper, P., Poe, G., and Bateman, I. (2004). The structure of motivation for contingent values: A case study of lake water quality improvement. *Ecological Economics*, 50: 69–82.

Costanza, R., Cumberland, J., Daly, H., Goodland, R., and Norgaard, R. (1995). *An introduction to ecological economics*. Boca Raton, FL: St. Lucie Press.

Cottrell, F. (1955). *Energy and society*. New York: McGraw-Hill.

Cozzetto, K., Chief, K., Dittmer, K., Brubaker, M., Gough, R., Souza, K., Ettawageshik, F., Wotkyns, S., Opitz-Stapleton, S., Duren, S., and Chavan, P. (2014). Climate change impacts on the water resources of American Indians and Alaska Natives in the U.S. In Maldonado, J.K., Colombi, B., and Pandya, R. (Eds). *Climate and indigenous peoples in the United States* (pp. 61–76). Berlin: Springer.

Craig, J. R., Vaughan, D. J., and Skinner, B. J. (1988). *Resources of the earth*. Englewood Cliffs, NJ: Prentice Hall.

Crosson, P., and Rosenberg, N. (1990). Strategies for agriculture. In *Managing planet earth: Readings from* Scientific American. New York: W. H. Freeman.

Cunningham, W., and Cunningham, M. (2010). *Environmental science: A global concern* (11th ed.). Boston: McGraw Hill Higher Education.

Cunningham, W., Cunningham, M., and Saigo, B. (2005). *Environmental science: A global concern* (8th ed.). Boston: McGraw Hill Higher Education.

Dahrendorf, R. (1959). *Class and class conflict in industrial society*. Stanford, CA: Stanford University Press.

Daily, G., and Ellison, K. (2002). *The new economy of nature*. Washington, DC: Island Press.

Daily, G., Matson, P., and Vitousek, P. (1997). Ecosystem services supplied by soil. In G. Daily (Ed.), *Nature's services: Societal dependence on natural ecosystems* (pp. 113–150). Washington, DC: Island Press.

Daly, H., and Cobb, J. (1989). *For the common good: Redirecting the economy towards community, the environment, and a sustainable future*. Boston: Beacon Press.

Daly, H., and Townsend, K. (Eds.). (1993). *Valuing the earth: Economics, ecology, and ethics*. Cambridge, MA: MIT Press.

Davidson, D. J. and Freudenburg, W.R. (1996). Gender and Environmental risk concerns: A review and analysis of available research. *Environment and Behavior* 28(3): 302–339.

Davidson, O. G. (August 1, 2013). The great burning: How wildfires are threatening the west. *Rolling Stone*. Available at http://www.rollingstone.com/politics/news/the-great-burning-how-wildfires-are-threatening-the-west-2013080. Accessed on October 2, 2016.

Davis, M. (2007). *Planet of slums*. New York: Verso Press.

De Blij, H. J. (1993). *Human geography: Culture, society, and space* (4th ed.). New York: John Wiley and Sons.

De Jong, G. (2000). Expectations, gender, and norms in migration decision-making. *Population Studies*, *54*, 307–319.

Derber, C. (2015). *The wilding of America: Money, mayhem, and the new American dream*. New York: Worth Publishers.

DeRose, L., Messer, E., and Millman, S. (1998). Who's hungry? And how do we know? *Food shortage, poverty, and deprivation*. New York: United Nations University Press.

Devall, B. (1992). Deep ecology and radical environmentalism. In R. E. Dunlap and A. G. Mertig (Eds.), *American environmentalism: The U.S. environmental movement, 1970–1990* (pp. 51–62). Philadelphia: Francis Taylor.

Devall, B., and Sessions, G. (1985). *Deep ecology*. Salt Lake City, UT: Peregrine Smith.

Devereaux, S., and Edwards, J. (2004). Climate change and food security. *IDS Bulletin*, *35* (3), 22–30.

Diamond, J. (2002). Lessons from lost worlds. *Time*, *160* (9), August 26, A54–A55.

Diamond, J. (2003). The last Americans. *Harper's Magazine*. June, 34–51.

Diamond, J. (2004), *Collapse: How societies choose to fail or succeed*. New York: Viking Press.

Dickinson, T. (January 22, 2016). WTF is happening in the Flint Water Crisis, explained. *Rolling Stone*. Available at: http://www.rollingstone.com/politics/news/wtf-is-happening-in-the-flint-water-crisis-explained-20160122 Accessed on June 9, 2016.

Dietz, T. (1996/1997). The human ecology of population and environment: From utopia to topia. *Human Ecology Review*, *3* (3), 168–171.

Dietz, T. (2015). Environmental values. In Brosch, T. and Sander, D. (Eds.), *Oxford handbook of values* (pp. 329–349). Oxford: Oxford University Press.

Dietz, T. and Jorgenson, A. K. (2014). Towards a new view of sustainable development: Human well-being and environmental stress. *Environmental Research Letters*, *9* (3), 3pp. Available at http://ioscience.iop.org/article/10.1088/1748-9326/9/3/031001. Accessed on May 10, 2016.

Dietz, T., and Kalof, L. (1992). Environmentalism among nation-states. *Social Indicators Research*, *26*, 353–366.

Dietz. T., and Rosa, E. (1994). Rethinking the environmental impacts of population, affluence, and technology. *Human Ecology Review*, *1*, 277–300.

Dietz, T., and Vine, E. L. (1982). Energy impacts of a municipal conservation program. *Energy*, *7*, 755–758.

Dietz, T., Burns, T., and Buttel, F. (1990). Evolutionary thinking in sociology: An examination of current thinking. *Sociological Forum*, *5*, 155–185.

Dietz, T., Stern, P., and Rycroft. R. (1989). Definitions of conflict and the legitimatization of resources: The case of environmental risk. *Sociological Forum*, *4*, 47–50.

Dillman, D., Rosa, E., and Dillman, J. (1983). Lifestyle and home energy conservation in the United States: The poor accept lifestyle cutbacks while the wealthy invest in conservation. *Journal of Economic Psychology*, *3*, 299–315.

Dilorenzo, T. J. (1993, September/ October). The mirage of sustainable development. *The Futurist*, *27* (5), 14–19.

Dold, C. (1992, July/August). Slapp back! *Buzzworm*, *4* (4), 34–41.

Dorow, S. and O'Shaughnessy, S. (2013). Fort McMurray, Wood Buffalo, and the oil/tar sands: Revisiting the sociology of "community." *Canadian Journal of Sociology*, *38* (2), 121–140.

Dowie, M. (1995). *Losing ground: American environmentalism at the close of the twentieth century*. Cambridge, MA: MIT Press.

Downs, A. (1972). Up and down with ecology—the "issue-attention cycle." *Public Interest*, 28, 38–50.

Dunlap, R. E. (1992). From environmental to ecological problems. In C. Calhoun and G. Ritzer (Eds.), *PRIMIS: Social Problems*. New York: McGraw Hill.

Dunlap, R. E. (2000a). Paradigms, theories, and environmental sociology. In R.E. Dunlap, F. Buttell, and A. Gijswijt (Eds.), *Sociological theory and the environment* (pp. 329–350). New York: Rowman and Littlefield.

Dunlap, R. E. (April 18, 2000b). Americans have positive image of the environmental movement. *Gallup Poll Monthly*, *415,* Available at http://www.gallup.com/poll/2989/americans-positive-image-environmental-movement.aspx Accessed on October 21, 2016..

Dunlap, R. E. (2006a). Personal comment.

Dunlap, R. E. (2006b). Where's the data? An examination of the death of environmentalism's ambiguous empirical foundations. *Organization and Environment*, *19* (1), 1–15.

Dunlap, R. E. (2010). At 40, environmental movement endures, with less consensus. http://www.gallop.com/poll/127487/environmental-movementendures-less-consensus.aspx. Accessed June 1, 2010.

Dunlap, R. E. and Brulle, R. J. (Eds.) (2015a). *Climate change and society:*

Sociological perspectives. Report of the American Sociological Association's task force on sociology and global climate change. New York, NY: Oxford University Press.

Dunlap, R. E. and Brulle, R. J. (2015b). Challenging climate change: The denial countermovement. In Dunlap, R. E. and Brulle, R. J. (Eds.), *Climate change and society: Sociological perspectives*. Report of the American Sociological Association's task force on sociology and global climate change (pp.412-436). New York, NY: Oxford University Press.

Dunlap, R. E., and Catton, W. (1983). What environmental sociologists have in common. *Sociological Inquiry*, *33*, 113–135.

Dunlap, R. E., and Catton, R. (2002). Which function(s) of the environment do we study? A comparison of environmental and natural resource sociology. *Society and Natural Resource Ins*, *15*, 239–249.

Dunlap, R.E., and Jones, R.E. (2002). *Environmental concern: Conceptualization and measurement issues*. In R.E. Dunlap and W. Michelson (Eds.), *The handbook of environmental sociology* (pp. 482–524). Westport, CT: Greenwood Press.

Dunlap, R. E., and Marshall, B. (2006). Environmental sociology. In D. Bryant and D. Peck (Eds.), *The handbook of 21st century sociology* (pp.329–340). Thousand Oaks, CA: Sage.

Dunlap, R.E., and McCright, A. M. (2015). Challenging climate change: The denial countermovement. In Dunlap, R. E. and Brulle, R. J. (Eds.). *Climate change and society: Sociological perspectives*. Report of the American Sociological Association's task force on sociology and global climate change (pp. 300–332). New York, NY: Oxford University Press.

Dunlap, R. E., and Mertig, A. G. (1992). The evolution of the U.S. environmental movement from 1970 to 1990: An overview. In R. Dunlap and A. Mertig (Eds.), *American environmentalism: The U.S. environmental movement, 1970–1990* (pp. 1–10). Philadelphia: Francis Taylor.

Dunlap, R. E., and Mertig, A. G. (1995). Global concern for the environment: Is affluence a prerequisite? *Journal of Social Issues*, *51*, 121–137.

Dunlap, R. E., and Scarce, R. (1991). The polls—poll trends: Environmental problems and protection. *Public Opinion Quarterly*, *55*, 651–672.

Dunlap, R. E., and Van Liere, K. (1978, Summer). The new environmental paradigm: A proposed measuring instrument and preliminary results. *Journal of Environmental Education*, *9*, 10–19.

Dunlap, R. E., and Van Liere, K. (1984). Commitment to the dominant social paradigm and concerns for environmental Q: An empirical examination. *Social Science Quarterly*, *65*, 1013–1028.

Dunlap, R.E., and York, R. (2008). The globalization of environmental concern and the limits of the postmaterialist values explanation: Evidence from four multinational surveys. *Sociological Quarterly*, *49* (3), 529–563.

Dunlap, R. E., Van Liere, K., Mertig, A., and Jones, R. (2000). Measuring endorsement of the new ecological paradigm: A revised NEP scale. *Journal of Social Issues*, *56* (3), 425–442.

Dunn, S. (1999). Automobile production drops. In L. Starke (Ed.), *Vital signs 1999: The environmental signs that are shaping our future* (82–84). New York: W. W. Norton.

Durkheim, E. (1964). *The division of labor in society*. (G. Simpson, Trans.) New York: Macmillan. (Original work published in 1893.)

Durning, A. (1989). *Poverty and the environment: Reversing the downward spiral*. Worldwatch paper no. 92. Washington, DC: Worldwatch Institute.

Durning, A. (1992). *How much is enough? The consumer society and the future of the earth*. New York: W. W. Norton.

Durning, A. (1993). Can't live without it: Advertising and the creation of needs. *Worldwatch*, *6* (3), 10–18.

Durning, A. (1994, March/April). The seven sustainable wonders of the world. *Utne Reader*, *62*, 96–99.

Eckerele, K. (2006). Plant diversity endangered. In Starke, L. (Ed.), *Vital signs 2006–2007: Trends that are shaping our future* (pp. 98–99). New York: W. W. Norton.

Eckholm, E. (1976). *Losing ground: Environmental stress and world food prospects*. New York: W. W. Norton.

Edgell, M., and Nowell, D. (1989). The new environmental paradigm scale: Wildlife and environmental beliefs in British Columbia. *Society and Natural Resources*, *2*, 285–296.

Edwards, B. and Driscoll, A. R. (2009). From farms to factories: The environmental consequences of swine industrialization in North Carolina. In Gould, K. A. and Lewis, T. L. (Eds.), *Twenty lessons in environmental sociology* (pp. 153–175). New York: Oxford Press.

Edwards, B. and Ladd, A.E. (2000). Environmental justice, swine production and farm loss in North Carolina. *Sociological Spectrum*, *20* (3), 286–314.

Ehrhardt-Martinez, K., Rudel, T. K., Norgaard, K.M., and Broadbent, J. (2015). Mitigating climate change. In Dunlap, R. E. and Brulle, R. J. (Eds.), *Climate change and society: Sociological perspectives*. Report of the American Sociological Association's task force on sociology and global climate change (pp. 199–234). New York, NY: Oxford University Press.

Ehrhardt-Martinez, K., and Schor, J.B., with Abrahamse, W., Alkon, A. H., Axsen, J., Brown, K., Shwom, R.L., Southerton, D., and Wilhite. (2015). Consumption and climate change (Eds.), Consumption and climate change. In *Climate change and society: Sociological perspectives*. Report of the American Sociological Association's task force on sociology and global climate change (pp. 93–126). New York, NY: Oxford University Press.

Ehrlich, P. (1968). *The population bomb*. New York: Ballantine Books.

Ehrlich, P., and Ehrlich, A. (1992). *The population explosion*. New York: Doubleday.

Ehrlich, P., and Holdren, J. (1974). Impact of population growth. *Science*, *171*, 1212–1217.

Ehrlich, P., and Holdren, J. (1988). *The Cassandra conference: Resources and the human predicament*. College Station, TX: Texas A & M Press.

Eisler, R. (1988). *The chalice and the blade*. New York: Harper and Row.

Eitzen, S., and Baca Zinn, M. (1992). *Social problems* (5th ed.). Boston: Allyn and Bacon.

Elgin, D. (1982). *Voluntary simplicity: Toward a way of life that is outwardly simple, inwardly rich*. New York: Morrow.

Fallows, J. (2010). Dirty coal, clean future. *The Atlantic*, 306 (*4*, December), 64–78.

Farhar, B. (1994). Trends: Public opinion about energy. *Public Opinion Quarterly*, *58*, 603–632.

Fickett, A., Gellings, C., and Lovins, A. (1990). Efficient use of electricity. *Scientific American*, *263* (3), 64–75.

Field, J. (1993). *The challenge of famine*. West Hartford, CT: Kumarian Press.

Fischer, C. (1976). The *urban experience*. New York: Harcourt Brace Jovanovich.

Fischer-Kowalski, M. (1998). Society's metabolism: The intellectual history of flow analysis. *Journal of Human Ecology*, *2* (*1*), 61–78.

Fischer-Kowalski, M., and Amann, C. (2001). Beyond IPAT and Kuznets curves: Globalization as a vital factor in analysing the environmental impact of socio-economic metabolism. *Population and Environment*, *23* (1), 7–47.

Fischoff, B. (1990). Psychology and public policy: Tool or toolmaking? *American Psychologist*, *45*, 647–663.

Fischoff, B., Slovic, P., and Lichtenstein, S. (1980). Lay foibles and expert fables in judgments about risk. *American Statistician*, *36*, 240–255.

Fisher, J. (1993). *The road from Rio: Sustainable development and the nongovernmental movement in the Third World*. Westport, CT: Praeger.

Fisher, D. (2004). *National governance and the global climate change regime*. New York: Rowman and Littlefield.

Fisher, D., and Freudenburg, W. (2004). Postindustrialization and environmental quality: An empirical analysis of the environmental state. *Social Forces*, *83* (1), 157–188.

Fisher, D.R., Waggle, J. and Jasny, L. (2015). Not a snow ball's chance for science. *Contexts 14* (4), 44–49.

Fitzpatrick, M. (July, 2014). What are the range of possibilities for sea level rise projections? *Union of Concerned Scientists*. Available at: http://www.ucsusa.org/publications/ask/2014/sea-level-rise.html#.VucH3pwrLIU Accessed on March 14, 2016.

Flavin, C. (1986). Moving beyond oil. In L. Starke (Ed.), *State of the world, 1986*. New York: W. W. Norton.

Flavin, C. (1997). Storm damages set record. In L. Starke (Ed.), *Vital signs 1997: The environmental trends that are shaping our future* (pp. 70–71). New York: W. W. Norton.

Flavin, C. (1998). Last tango in Buenos Aires. *Worldwatch*, *11* (6), 10–18.

Flavin, C. (1999). Wind power blows to new records. In L. Starke (Ed.), *Vital signs 1999: The environmental trends that are shaping our future* (pp. 52–53). New York: W. W. Norton.

Flavin, C. (2001a). Wind energy growth continues. In L. Starke (Ed.), *Vital signs 2001: The trends that are shaping our future* (pp. 44–45). New York: W. W. Norton.

Flavin, C. (2001b). Rich planet, poor planet. In L. Starke (Ed.), *State of the world, 2001* (pp. 3–20). New York: W. W. Norton.

Flavin, C. (2005). Fossil fuel surges. In Starke L. (Ed.), *Vital signs 2005: The trends that are shaping our future* (pp. 30–31). New York: W. W. Norton.

Flavin, C. (2006). Nuclear revival? Don't bet on it. *Worldwatch*, *19* (4), 19.

Flavin, C., and Dunn, S. (1999). Reinventing the energy system. In L. Stark (Ed.), *State of the world, 1999*. New York: W. W. Norton.

Flavin, C., and Young, J. E. (1993). Shaping the next industrial revolution. In L. Starke (Ed.), *State of the world, 1993*. New York: W. W. Norton.

Flint, R. (2010). Seeking resiliency in the development of sustainable communities. *Human Ecology Review*, *17* (1), 44–57.

FAO. (2015). World hunger falls to under 800 million, eradication is next goal. *Food and Agriculture Organization of the United Nations*. Available at: http://www.fao.org/news/story/en/item/288229/icode. Accessed on June 23, 2016.

FAO. (2016). AQUASTAT Website. *Food and Agriculture Organization of the United Nations*. Available at: http://www.fao.org/nr/water/aquastat/water_use/index.stm. Accessed on June 28, 2016.

Fortune Magazine. (2008). *The Fortune global 500*. Cited in Giddens, A., Dunier, M., Applebaum, R., and Carr, D., *Introduction to sociology* (7th ed., pp. 439–440). New York: W. W. Norton.

Foster, J. B. (1999). Marx's theory of metabolic rift: Classical foundations for environmental sociology. *American Journal of Sociology*, *105* (2), 366–405.

Foster, J. B. (2013). Marx and the rift in the universal metabolism of nature. *Monthly Review*, *65* (7). Available at http://monthlyreview.org/2013/12/01/marx-rift-universal-metabolism-nature/. Accessed on January 10, 2016.

Fothergill, A., and Peek, L. (2015). *Children of Katrina*. Austin, TX: University of Texas Press.

Fountain, H. (March 2, 2015). Researchers link Syrian conflict to a drought made worse by climate change. *The New York Times*. Available at http://www.nytimes.com/2015/03/03/science/earth/study-links-syria-conflict-to-drought-caused-by-climate-change.html?_r=0. Accessed on February 26, 2016.

Francisco, R. (November 27, 2013). Philippines' typhoon rebuilding may cost more, last longer than Aceh. *Reuters*. Available at: http://www.reuters.com/article/us-philippines-typhoon-rebuilding-idUSBRE9AQ0LE20131127. Accessed on March 30, 2016.

Frank, A. (1967). *Capitalism and underdevelopment in Latin America: Historical studies of Chile and Brazil*. New York: Monthly Review Press.

Frank, D. (1999). The social bases of environmental treaty ratification, 1900–1990. *Sociological Inquiry*, *69*, 523–550.

Frank, D., Hironka, A., and Schofer, E. (2000). The nation-state and the natural environment over the twentieth century. *American Sociological Review*, *65*, 96–116.

Franzen, A. and Vogel, D. (2013). Time preferences and environmental concern. *International Journal of Sociology*, 43 (4): 39–62.

Freudenberg, N. (1984). *Not in our backyards! Community action for health and the environment*. New York: Monthly Review Press.

Freudenberg, N., and Steinsapir, C. (1992). Not in our backyards: The grassroots environmental movement. In R. E. Dunlap and A. G. Mertig (Eds.), *American environmentalism: The U.S. environmental movement, 1970–1990* (pp. 27–37). Philadelphia: Francis Taylor.

Freudenburg, W. R. (1984). Boomtown's youth: The differential impacts of rapid community growth on adolescents and adults. *American Sociological Review*, *40*, 697–705.

Freudenburg, W. R. (1991a). Rural–urban differences in environmental concern: A close look. *Sociological Inquiry*, *61* (2), 167–198.

Freudenburg, W. R. (1991b). A "good business climate" as bad economic news? *Science and Natural Resources*, *3*, 313–331.

Freudenburg, W. R. (1992). Addictive economies: Extractive industries and vulnerable localities in a changing world economy. *Rural Sociology*, *57* (3), 305–332.

Freudenburg, W. R. (1993). Risk and recreancy: Weber, the division of labor, and the rationality of risk perceptions. *Social Forces*, *71*, 909–932.

Freudenburg, W. R. (2005). Privileged access, privileged accounts: Toward a socially structured theory of resources and discourses. *Social Forces*, *84* (1), 89–114.

Freudenburg, W. R. (2006). Environmental degradation, disproportionality, and the double diversion: Reaching out, reaching ahead, and reaching beyond. *Rural Sociology*, *71* (1), 3–32.

Freudenburg, W. R., and Davidson, D. (1996). Gender and environmental risk concerns: A review and analysis of available research. *Environment and Behavior*, *28* (3), 332–339.

Freudenburg, W. R., and Frickel, S. (1994). *Digging deeper: Mining-dependent regions in historical perspective*. Paper presented at the 1994 meeting of the Midwest Sociological Society, St. Louis, MO.

Freudenburg, W. R., and Frickel, S. (1995). Beyond the nature/society divide: Learning to think about a mountain. *Sociological Forum*, *10*, 361–392.

Freudenburg, W. R., and Gramling, R. (1994). Natural resources and rural poverty: A closer look. *Society and Natural Resources*, *7*, 5–22.

Freudenburg, W.R. and Gramling, R. (2012). *Blowout in the Gulf: The BP oil spill disaster and the future of energy in America*. Cambridge, MA: MIT Press

Freudenburg, W.R., Gramling, R., Laska, S., and Erikson, K.T. (2009). Disproportionality and disaster: Hurricane Katrina and the Mississippi river-gulf outlet. *Social Science Quarterly*, *90* (3), 497–515.

Frey, B., and Stutzer, A. (2002). *Happiness and economics*. Princeton, NJ: Princeton University Press.

Friedeburg von, C. (April 21, 2015). Effects and sustainability of the U.S. shale gas boom. *Vital signs: Global trends that shape our future*. Available at http://vitalsigns.worldwatch.org/vs-trend/effects-and-sustainability-us-shale-gas-boom. Accessed on June 25, 2016.

Fritz, A. (March 15, 2015). Boston clinches snowiest season on record amid winter of superlatives. *The Washington Post*. Available at https://www.washingtonpost.com/news/capital-weather-gang/wp/2015/03/15/boston-clinches-snowiest-season-on-record-amid-winter-of-superlatives. Accessed on Febuary 26, 2016.

Frosch, R., and Gallopoulos, N. (1990). Strategies for manufacturing. *Managing planet earth: Readings from* Scientific American (pp. 97–108). New York: W. H. Freeman.

Fulkerson, W., Judkins, R., and Sanghvi, M. (1990). Energy from fossil fuels. *Scientific American*, *263* (3), 128–135.

Gaard, G. (Ed). (1993). *Ecofeminism: Women, animals, nature*. Philadelphia: Temple University Press.

Gaffney, O. (February 26, 2016). Bees in decline: IPBES releases global pollinators assessment. Future Earth: Research for global sustainability. Available at: www.futureearth.org/blog/2016-feb-26/ bees-in-decline-ipbes-releases-global-pollinators-assessment. Accessed on April 30, 2016.

Gallup, G., Dunlap, R. E., and Gallup, A. (1993). *Health of the planet*. Princeton, NJ: Gallup International Institute.

Gamlin, J. B. (2011). "My eyes are red from looking and looking": Mexican working children's perspectives of how tobacco labour affects their bodies. *Vulnerable Children & Youth Studies*, *6* (4), 339–345.

Gamson, W. (1990). *The strategy of social protest* (2nd ed.). Belmont, CA: Wadsworth Publishing Company.

Gardiner, R. (2001). Foreign direct investment: A lead driver for sustainable development? *Towards Earth Summit 2002* (p. 3). London: UNED Forum–UK Committee.

Gardner, G. (1998). Organic waste reuse surging. In L. Starke (Ed.), *Vital signs 1998: Environmental trends that are shaping our future* (pp. 105–116). New York: W. W. Norton.

Gardner, G. (2012). Municipal solid waste growing. *Vital signs: Global trends that are shaping our future*. Available at: http://vitalsigns.worldwatch.org/vs-trend/food-trade-and-self-sufficiency. Accessed on April 22, 2016.

Gardner, G. (2015). Mounting losses of agricultural resources. In Gardner, G., Prugh, T., and Renner, M. (Project Directors). *State of the world 2015: Confronting hidden threats to sustainability* (pp. 65–78). Washington, DC: Island Press.

Gardner, G., and Sampat, P. (1999). Forging a sustainable materials economy. In L. Starke (Ed.), *State of the world, 1999* (pp. 41–59). New York: W. W. Norton.

Gardner, G., and Stern, P. (1996). *Environmental problems and human behavior*. Needham Heights, MA: Allyn and Bacon.

Gardner, G., and Stern, P. (2002). *Environmental problems and human behavior* (2nd ed.). Boston: Pearson Custom Publishing.

Gareau, B. J. (2012). Theorizing environmental governance of the world-system: Global political economy theory and some applications to stratospheric ozone politics. *Journal of World Systems Research*, *18* (2): 187–210.

Gareau, B. J. (2013). *From precaution to profit: Contemporary challenges to environmental protection in the Montreal Protocol* (Yale Agrarian Studies Series). New Haven, CT: Yale University Press.

Garrigues, L. (2010). Why is Costa Rica smiling. *Yes!* Winter: 12–15. 1. Available at http://www.yesmagazine.org/issues/climate-action/why-is-costa-rica-smiling Accessed on October 21, 2016

Ge, M., Freidrich, J., and Damassa, T. (2014). 6 graphs explain the world's top 10 emitters. World Resources Institute. Available at http://www.wri.org/blog/2014/11/6-graphs-explain-world%E2%80%99s-top-10-emitters. Accessed on June 12, 2016.

Geddes, P. (1979). *Civics as applied to sociology*. Leicester, England:

Leicester University Press. (Original work published in 1890.)

Geewax, M. (November 30, 2015). Bill Gates and other billionaires pledge to take on climate change. *National Public Radio*. Available at http://www.npr.org/sections/thetwo-way/2015/11/30/457900449/bill-gates-and-other-billionaires-pledge-to-take-on-climate-change. Accessed on February 21, 2016.

Gelbard, A., Haub, C., and Kent, M. (1999). World population beyond six billion. *Population Bulletin*, *3* (54), 1.

Gelbspan, R. (1997). *The heat is on*. Reading, PA: Addison-Wesley.

Gibbons, J., Blair, P., and Gwin, H. (1990). Strategies for energy use. In *Managing planet earth: Readings from* Scientific American (pp. 85–96). New York: W. H. Freeman.

Gibbs, L. (1982). *Love Canal: My story*. Albany, NY: State University of New York Press.

Giddens, A. (1991). *Modernity and self-identity: Social and society in the later modern age*. Stanford, CA: Stanford University Press.

Giddens, A. (1995) *Beyond left and right: The future of radical politics*. Stanford, CA: Stanford University Press.

Gilbert, D. (2014). *The American class structure in an age of growing inequality* (9th ed). Los Angeles, CA: Pine Forge Press.

Gillis, J. (January 20, 2016). 2015 was the hottest year in the historical record, scientists say. *The New York Times*. Available at http://www.nytimes.com/2016/01/21/science/earth/2015-hottest-year-global-warming.html. Accessed on February 17, 2016.

Gillis, J. and Krauss, C. (November 5, 2015). *Exxon Mobil investigated for possible climate change lies by New York Attorney General*. Available at http://www.nytimes.com/2015/11/06/science/exxon-mobil-under-investigation-in-new-york-over-climate-statements.html?_r=0. Accessed on April 3, 2016.

Gimbutas, M. (1977, Winter). The first wave of Eurasian steppe pastoralists into Copper Age Europe. *Journal of Indo-European Studies*, *5*, 281.

Giordano, L. (2015). Alaska's 2015 fire season consumes 5.1 million acres of forest. Climate Change. Available at http://climatechange.medill.northwestern.edu/2015/12/02/fires-in-alaska. Accessed on March 10, 2016.

Gleick, P. (2009). Water use is lower than it was 30 years ago. Interviewed by Renee Montaigne on *The Morning Edition, National Public Radio*. November 18, 2009.

Goldenberg, S. (April 25, 2016). Paris climate deal: Countries with about half of global emissions to join this year. *The Guardian*. Available at http://www.theguardian.com/environment/2016/apr/25/paris-climate-agreement-environment-climate-change-un. Accessed on June 9, 2016.

Goldfrank, W., Goodman, D., and Szasz, A. (Eds.) (1999). *The global environment and the world system*. Westport, CT: Greenwood Press.

Goldstein, D. (2004). Cited in Roberts, P., *The end of oil: On the edge of a perilous new world* (p. 225). Boston, MA: Houghton Mifflin.

Gonzalez, G. A. (2015). Is Obama's 2014 greenhouse gas reduction plan symbolic? The creation of the US EPA and a reliance on the states. *Capitalism, Nature, Socialism*, 26 (2): 92–104.

Gonzalez, M. (May 22, 2014). Smart grid investment grows with widespread smart meter installation. *Vital signs: Global trends that shape our future*. Available at http://vitalsigns.worldwatch.org/vs-trend/smart-grid-investment-grows-widespread-smart-meter-installations. Accessed on June 28, 2016.

Gonzalez, M. and Lucky, M. (October 24, 2013). Fossil fuels dominate primary energy consumption. *Vital signs: Global trends that are shaping our future*. Available at http://www.worldwatch.org/fossil-fuels-dominate-primary-energy-consumption-1. Accessed on October 10, 2016.

Goodland, R., and Anhang, J. (2009). Livestock and climate change. *Worldwatch*, *22* (6, November/December), 10–19.

Goodland, R., Daly, H., and Kellenberg, J. (1993, June 27–July 1). *Burden sharing in transition to environmental sustainability*. Paper presented at the Seventh General Assembly of the World Future Society, Washington, DC.

Goodstein, D. (2004). *Out of gas: The end of the age of oil*. New York: W. W. Norton.

Gould, K. (1991). The sweet smell of money: Economic dependency and local environmental political mobilization. *Society and Natural Resources*, *4*, 133–150.

Gould, K. (1998, Spring). Nature tourism, environment, and place in a global economy. *Environment, Technology, and Society*, *89*, 3–5.

Gould, L., Gardner, G., Deluca, D., Tiemann, A., and Doob, L. (1988). *Perceptions of technological risks and benefits*. New York: Russell Sage Foundation.

Gourmelon, G. (January 28, 2015). Global plastic production rises, recycling lags. *Vital signs: Global trends that are shaping our future*. Available at: http://vitalsigns.worldwatch.org/vs-trend/food-trade-and-self-sufficiency. Accessed on April 22, 2016.

Grant, D., Trautner, M.N., Downey, L., and Thiebaud, L. (2010). Bringing the polluters back in: Environmental inequality and the organization of chemical production. *American Sociological Review*, *75*, 4, 479–504.

Gratz, R. B. (October 21, 2013). A favela transformed. *The Huffington Post*. Available at http://www.huffingtonpost.com/roberta-brandes-gratz/a-favela-transformed_b_3777182.html. Accessed on October 16, 2016.

Greenfield, N. (2015). 10 threats from the Canadian tar sands industry. *Natural Resources Defense Council*. Available at https://www.nrdc.org/stories/10-threats-canadian-tar-sands-industry. Accessed on March 19, 2016.

Gurwitt, S. and Roberts, T. (December 18, 2015). The Paris climate talks according to U.S. print media: Plenty of heat, but not so much light. Brookings. Available at: http://www.brookings.edu/blogs/planetpolicy/posts/2015/12/18-cop21-paris-climate-talks-us-print-media-roberts. Accessed on January 20, 2016.

Hagens, N. J. (2015). Energy, credit, and the end of growth. In Gardner, G., Prugh, T., and Renner, M. (Project Directors). *State of the world 2015: Confronting hidden threats to sustainability* (pp. 21–35). Washington, DC: Island Press.

Haimson, L. (2002a, March 8). This just in … *Grist Magazine*, *www.gristmagazine.com*.

Haimson, L. (2002b, January 24). This just in… *Grist Magazine*, *www.gristmagazine.com*.

Halweil, B. (1999). The emperor's new clothes. *Worldwatch*, *12* (6), 21–29.

Halweil, B. (2000). Where have all the farmers gone? *Worldwatch*, *13* (5), 13–28.

Halweil, B. (2003). High farm subsidies persist. In Starke, L. (Ed.), *Vital signs: Trends that are shaping our future* (pp. 96–97). New York: W. W. Norton.

Halweil, B. (2006a). Can organic farming feed us all? *Worldwatch*, *19* (3), 16–20.

Halweil, B. (2006b). Grain harvest flat. In L. Starke (Ed.), *Vital signs: The trends that are shaping our future* (pp. 22–23). New York: W. W. Norton.

Hamlin, J., Hummel, H., and Canpa, R. (2007). *Review of renewable energy in global scenarios*. Prepared for the IEA. San Francisco: Center for Resource Solutions, 1.

Hannigan, J. (1995). *Environmental sociology: A social constructionist perspective*. New York: Routledge.

Hardin, G. (1968). The tragedy of the commons. *Science*, *162*, 1243–1248.

Hardin, G. (1993). Second thoughts on the tragedy of the commons. In H. E. Daly and K. N. Townsend (Eds.), *Valuing the earth: Economics, ecology, and ethics*. Cambridge (pp. 145–154). MA: MIT Press.

Harlan, S. L., Pellow, D. N., and Roberts, J.T. with Bell, S. E., Holt, W.G., and Nagel, J. (2015). Climate justice and inequality. In Dunlap, R. E. and Brulle, R. J. (Eds.) *Climate change and society: Sociological perspectives*. Report of the American Sociological Association's task force on sociology and global climate change (pp. 127–163). New York, NY: Oxford University Press.

Harper, C. (1998). *Exploring social change* (3rd ed.). Englewood Cliffs, NJ: Prentice Hall.

Harper, C. (2005). Limits to growth and ecological modernization: The case of food and agriculture. Presented to the Annual Meeting of the Midwest Sociological Society, March, Kansas City, MO.

Harper, C. (2007). *Food, society, and environment* (2nd ed.). Victoria, BC, Canada: Trafford.

Harper, C., and Leicht, K. (2002). *Exploring social change* (4th ed.). Upper Saddle River, NJ: Prentice Hall.

Harper, C., and Leicht, K. (2011). *Exploring social change* (6th ed.). Upper Saddle River, NJ: Prentice Hall.

Harris, M. (1971). *Culture, man, and nature*. New York: Thomas Crowell.

Harris, M. (1979). *Cultural materialism*. New York: Vintage.

Harrison, P. (1993). *The third revolution: Population, environment, and a sustainable world*. London: Penguin.

Harvey, D. (2005). *A brief history of neoliberalism*. Oxford, UK: Oxford University Press.

Hawken, P. (1993). *The ecology of commerce: A declaration of sustainability*. New York: HarperCollins.

Hawken, P., Lovins, A., and Lovins, H. (2000). *Natural capitalism: Creating the next Industrial Revolution*. Boston: Back Bay Books.

Hayes, D. (1990, April). Earth Day 1990: The threshold of the green decade. *World Policy Journal*, *7*(2), 389–404.

Hays, S. (1959). *Conservation and the gospel of efficiency*. New York: Atheneum.

Heberlein, T., and Warriner, G. (1983). The influence of price and attitudes on shifting residential electricity consumption from on to off peak periods. *Journal of Economic Psychology*, *4*, 107–131.

Heilbroner, R. (1974). *An inquiry into the human prospect*. New York: W. W. Norton.

Heilbroner, R. (1985). *The making of economic society* (7th ed.). Englewood Cliffs, NJ: Prentice Hall.

Helvarg, D. (1994). *War against the greens: The "wise use" movement, the new right, and anti-environmental violence*. San Francisco, CA: Sierra Books.

Henderson, G., Igusky, K., Waskow, D., Ballesteros, A., and Joffe, P. (September 29, 2015). US-China climate change announcement signals new phase for global action. World Resources Institute. Available at http://www.wri.org/blog/2015/09/us-china-climate-change-announcement-signals-new-phase-global-action. Accessed on June 12, 2016.

Hendry, P. (1988). Food and population: Beyond five billion. *Population Bulletin*, *43*, 2.

Hertzgaard, M. (July 31, 2006). Green grows grassroots, *The Nation*, Available at https://www.thenation.com/article/green-grows-grassroots/. Accessed on October 21, 2016.

Hirsch, R. (1987). Impending United States energy crisis. *Science*, *235*, 1471.

Holdren, J. (1990). Energy in transition. *Scientific American*, *263* (3), 156–164.

Hollesen, J., Mattiesen, H., Moller, B. A., and Elberling, B. (2015). Permafrost thawing in organic Arctic soils accelerated by ground heat production. *Nature Climate Change*, *5*, 574–578.

Holling, C. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*, *4*, 1–23.

Homer-Dixon, T. (1996). Environmental scarcity, mass violence, and the limits of ingenuity. *Current History*, *95* (604), 359–365.

Homer-Dixon, T. (2006). *The upside of down: Catastrophe, creativity, and the renewal of civilization*. Washington, DC: Island Press.

Howard, E. E. (January 14, 2016). Linking India's rivers: Critics rally to protest illegal and unnecessary plans. *The Guardian*. Available at http://www.theguardian.com/global-development-professionals-network/2016/jan/14/linking-indias-rivers-critics-rally-to-protest-illegal-and-unnecessary-plans. Accessed on April 25, 2016.

Howell, F. M., Porter, J.R., and Wynveen, B. J. (2013). "Unpacking" the domestic ecological footprint of the United States. *Sociological Spectrum*, *33* (3), 197–218.

Hulme, M. (2011). Reducing the future to climate: A story of climate determinism and reductionism. *OSIRIS*, 26: 245–266.

Humphrey, C., and Buttel, F. (1982). *Environment, energy, and society*. Belmont, CA: Wadsworth.

Humphrey, C., Lewis, T., and Buttel, F. (2002). *Environment, energy, and society: A new synthesis*. Belmont, CA: Wadsworth.

Hunt, S., and Stair, P. (2006–2007). Biofuels hit gusher. In L. Starke (Ed.), *Vital signs 2006–2007: Trends that are shaping our future* (pp. 40–41). New York: W. W. Norton.

Hutchinson, E. (1967). *The population debate*. Boston: Houghton Mifflin.

Hutchinson, G. (1965). *The ecological theater and the evolutionary play*. New Haven, CT: Yale University Press.

Inglehart, R. (1990). *Culture shift in advanced industrial society*. Princeton, NJ: Princeton University Press.

Intergovernmental Panel on Climate Change (IPCC) (2001). *Climate change 2001: Impacts, adaptation and vulnerability* (McCarthy, J., Canziani, O., Leary, N., Dokken, D., and White, K., Eds.). Cambridge, UK: Cambridge University Press.

Intergovernmental Panel on Climate Change (IPCC) (2007). Summary for policy makers. *Climate change 2007: Mitigation of climate change*. Cambridge, UK: Cambridge University Press, p. 13.

Intergovernmental Panel on Climate Change (IPCC) (2014). *Climate Change 2014 Synthesis Report*. Contribution of Working Groups 1, II, and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. [Core Writing Team, Pachauri, R.K., and Meyer, L.A. (Eds).]. IPCC, Geneva, Switzerland, 152pp.

International Displacement Monitoring Centre. (2016). *Global Report on Internal Displacement 2016*. Available at http://www.internal-displacement.org/global-report2016. Accessed on June 27, 2016.

International Energy Agency (IEA) (1987). *Energy conservation in the IEA countries*. Paris: OECD.

International Energy Agency (IEA) (2007). *World energy outlook 2007*. Paris: IEA.

International Energy Agency (IEA) (2008). *Energy technology perspectives 2008: Scenarios and strategies 2008*. Paris: IEA.

International Energy Agency (IEA) (2015). Low prices give no cause for complacency on energy security, IEA says. Available at http://www.iea.org/newsroomandevents/pressreleases/2015/november/low-prices-should-give-no-cause-for-complacency-on-energy-security-iea-says.html. Accessed on June 25, 2016.

Jacobson, M., and Delucchi, M. (2009). A path to sustainable energy by 2030. *Scientific American*, *301* (5), 58–65.

Jaffe, D. and Newman, S. (2013). A more perfect commodity: Bottled water, global accumulation, and local contestation. *Rural Sociology*, *78* (1), 1–28.

Jahan, F. and Quddusi, K.S.M.K.A (2013). Climate change and Bangladesh: Geographical and socio-economic impacts, *Dhaulagiri Journal of Sociology and Anthropology*, *7*, 113–132.

Jensen, O.P., Gilroy, D.J., Hogan, Z., Allen, B.C., Hrabik, T.R., Weidel, B.C., Chandra, S., and Vander Zanden, M.J. (2009). Evaluating recreational fisheries for an endangered species: A case study of taimen, Hucho taimen, in Mongolia. *Canadian Journal of Fisheries and Aquatic Sciences*, *66* (10), 1707–1718.

Jones, J. (May 27, 2010). Oil spill alters views on environmental protection. Available at http://www.gallup.com/poll/137882/oil-spill-alters-views-environmentalprotection.aspx. Accessed on October 21, 2016.

Jorgenson, A. K. (2003). Consumption and environmental degradation: A cross-national analysis of the ecological footprint. *Social Problems*, *50*, 374–394.

Jorgenson, A.K. (2005). Unpacking international power and the ecological footprints of nations: A quantitative cross-national study. *Sociological Perspectives*, *48* (3): 383–402.

Jorgenson, A.K. (2014). Economic development and the carbon intensity of human well-being. *Nature Climate Change*, *4*: 186–189.

Jorgenson, A.K. (2015). Five points on sociology, PEWS and climate change. *The Journal of World-Systems Research*, *21* (2): 269–275.

Jorgenson, A.K. and Clark, B. (2016). The temporal stability and developmental differences in the environmental impacts of militarism: The treadmill of destruction and consumption-based carbon emissions. *Sustainability Science*, *11* (3): 504–514. DOI:10.1007/s11625-015-0309-5.

Jorgenson, A.K., and Givens, J. (2015). The changing effect of economic development on the consumption-based carbon intensity of well-being, 1990–2008. *PLoS ONE*, 10(5): 1–14. Available at http://journals.plos.org/plosone/article/asset?id=10.1371/journal.pone.0123920.PDF. Accessed on April 10, 2016.

Joskow, P. (2002, March). United States energy policy during the 1990s. *Current History*, *101* (653), 105–124.

Kahan, D.M., Braman, D., Gastil, J., Slovic, P., and Mertz, C.K. (2007). Culture and identity-protective cognition: Explaining the white-male effect in risk perception. *Journal of Empirical Legal Studies*, *4*(3): 465–505.

Kahn, B. (March 16, 2014). New Greenland ice melt fuels sea level rise concerns. Climate Central. Available at http://www.climatecentral.org/news/new-greenland-ice-melt-fuels-sea-level-rise-concerns-17187. Accessed on October 3, 2016.

Kemp, W. B. (1971). The flow of energy in a hunting society. *Scientific American*, *224*, 104–105.

Kempton, W., Hollard, D.C., Bunting-Howarth, K., Hannan, E., and Payne, C. (2001). Local environmental groups: A systemic enumeration in two geographical areas. *Rural Sociology*, *66*, 557–578.

Kennedy, R. (2005). *Crimes against nature: How George W. Bush & his corporate pals are plundering the country & hijacking our democracy*. New York: Harper Perennial.

Kent, M. (1984). *World population: Fundamentals of growth*. Washington, DC: Population Reference Bureau.

Keyfitz, N. (1990). The growing human population. *Managing planet earth: Readings from* Scientific American (pp. 61–72). New York: W. W. Freeman.

Kingsley, G. (1992). U.S. energy conservation policy: Themes and trends. *Policy Studies Journal*, *20* (1), 114–123.

Klare, M. (2002, March). Global petro-politics: The foreign policy implications of the Bush administration's energy plan. *Current History*, *101* (653), 99–104.

Klein, N. (2014). *This changes everything: Capitalism vs the climate*. New York, NY: Simon and Schuster, Inc.

Klinenberg, E. (2015). *Heat wave: A social autopsy of disaster in Chicago* (2nd ed.). Chicago, IL: University of Chicago Press.

Konold, M., and Wu, X. (July 15, 2014). Wind power growth still surging where strongly supported. *Vital signs: Global trends that shape our future*. Available at http://vitalsigns.worldwatch.org/vs-trend/wind-power-growth-still-surging-where-strongly-supported. Accessed on June 27, 2016.

Kormondy, E., and Brown, D. (1998). *Fundamentals of human ecology*. Upper Saddle River, NJ: Prentice Hall.

Kotok, D. (1993, December 6). Arab oil embargo changed habits. *The Omaha World-Herald*, pp. 1–2.

Kraft, M. (2001). *Environmental policy and politics* (2nd ed.). New York: Longman.

Krause, F., Bach, W., and Koomey, J. (1992). *Energy policy in the greenhouse*. New York: John Wiley and Sons.

Kuhn, T. (1970). *The structure of scientific revolutions*. Chicago: University of Chicago Press.

Kumar, S. (March 19, 2013). The looming threat of water scarcity. *Vital signs: Global trends that shape our future*. Available at: http://vitalsigns.worldwatch.org/vs-trend/looming-threat-water-scarcity. Accessed on April 21, 2016.

Kunzig, R. (October 15, 2015). Germany could be a model for how we'll get power in the future. *National Geographic*. Available at http://ngm.nationalgeographic.com/2015/11/climate-change/germany-renewable-energy-revolution-text. Accessed on October 11, 2016.

Kuznets, S. (1955). Economic growth and inequality. *American Economic Review*, *45*, 1–28.

Ladd, A. E. (2011). Feedlots of the sea: Movement frames and activist claims in the protest over salmon farming in the Pacific Northwest. *Humanity & Society*, *35*, 343–375.

Lander, M. and Wu, X. (July 29, 2014). Solar power installations jump to a new annual total. *Vital signs: Global trends that shape our future*. Available at http://vitalsigns.worldwatch.org/vs-trend/solar-power-installations-jump-new-annual-total. Accessed on October 12, 2016.

Lane, R. (2000). *The loss of happiness in market democracies*. New Haven, CT: Yale University Press.

Lappé, F., and Collins, J. (2015). *World hunger: 10 myths*. New York: Grove Press.

Lappé, F., Collins, J., and Rosset, P. (1998). *World hunger: Twelve myths*. New York: Grove Press.

Lee, M. (1995). *Earth first! Environmental apocalypse*. Syracuse, NY: Syracuse University Press.

Lee, R. (1969). !Kung bushmen subsistence: An input–output analysis. In A. Vayda (Ed.), *Environment and cultural behavior* (pp. 47–78). Garden City, NJ: Natural History Press.

Leicht, K. T., and Fitzgerald, S. T. (2014). *Middle class meltdown in America:*

Causes, consequences, and remedies (2nd ed.). New York, NY: Routledge.

Lelieveld, J., Evans, J.S., Fnais, M., Giannadaki, D., and Pozzer, A. (September 17, 2015). The contribution of outdoor air pollution sources to premature mortality on a global scale. *Nature*, *525*: 367–371.

Lemonick, M. D. (January 7, 2013). Why bark beetles are chewing through U.S. forests. *Climate Central*. Available at: http://www.climatecentral.org/news/why-bark-beetles-are-chewing-their-way-through-americas-forests-15429. Accessed on April 26, 2016.

Lenski, G., and Nolan, P. (1999). *Human societies: An introduction to macrosociology*. New York: McGraw-Hill.

Leon-Guerrero, A. (2009). *Social problems: Community, policy, and social action* (2nd ed.). Thousand Oaks, CA: Pine Forge Press.

Leopold, A. (1949). *A Sand County almanac*. New York, NY: Ballantine Books.

Lewis, M. (1994). Environmental history challenges the myth of a primordial Eden. *The Chronicle of Higher Education*, *40* (35), A56.

Lewis, T. L. (2016). *Ecuador's environmental revolutions: Ecoimperialists, ecodependents, and ecoresisters*. Cambridge, MA: MIT Press.

Li, L. (2007). Bottled water consumption jumps. In L. Starke (Ed.), *Vital signs 2007–2008: The trends that are shaping our future* (pp. 102–103). New York, W. W. Norton.

Li, Z. (May, July, August, 2006). Capturing the sun: The future of China's solar power. *Worldwatch*, *18* (4), 10–11.

Liu, Y. (2006). Groundwater overdraft problem persists. In L. Starke (Ed.), *Vital signs 2006–2007: Trends that are shaping our future* (pp. 104–105). New York: W. W. Norton.

Living Planet Report. (2014). The global footprint network. Available at http://www.footprintnetwork.org/en/index.php/GFN/page/living_planet_report2/. Accessed on June 14, 2016.

Longworth, R. (1998). *Global squeeze: The coming crisis for first-world nations*. Skokie, IL: NTC/Contemporary Books.

Lotka, A. (1922). Contribution to the energetics of evolution. *Proceedings of the National Academy of Sciences*, *8*, 147–151.

Lotka, A. (1924). *Elements of physical biology*. New York: Williams and Wilkins. [Republished in 1956 as *Elements of mathematical biology*. New York: Dover.]

Lotka, A. (1945). The law of evolution as a maximal principle. *Human Biology*, *14*, 167–194.

Lovins, A. (1977). *Soft energy paths*. Cambridge, MA: Ballinger.

Lovins, A. (1993). Letter to the editor. *Atlantic Monthly*, *272*, 6.

Lovins, A. (1998). Energy efficiency to the rescue. In T. Miller (Ed.), *Living in the environment* (10th ed., p. 378). Belmont, CA: Wadsworth.

Lowi, T., Jr. (1964). American business, public policy, case-studies, and political theory. *World Politics*, *16*, 677–715.

Lowi, T., Jr. (1972). Four systems of policy, politics, and choice. *Public Administration Review*, *32*, 298–310.

Lowi, T., Jr. (1979). *The end of liberalism* (2nd ed.). New York: W. W. Norton.

Lucky, M. (November 17, 2011). Global nuclear generation capacity falls. *Vital signs: Global trends that shape our future*. Available at http://vitalsigns.worldwatch.org/vs-trend/global-nuclear-generation-capacity-falls. Accessed on June 27, 2016.

Lutzenhiser, L. (1993). Social and behavioral aspects of energy use. *Annual Review of Energy and the Environment*, *18*, 247–289.

Lutzenhiser, L. (2001). The contours of U.S. climate non-policy. *Society and Natural Resources*, 14, 511–523.

Lutzenhiser, L., and Hackett, B. (1993). Social stratification and environmental degradation: Understanding household CO2 production. *Social Problems*, *40* (1), 50–73.

Lutzenhiser, L., Harris, C., and Olsen, M. (2002). Energy, society, and environment. In Dunlap, R.E. and Michelson, W. (Eds.), *Handbook of environmental sociology* (pp. 222–271). Westport, CT: Greenwood Press.

Lynn, K., Daigle, J., Hoffman, J., Lake, F., Michelle, N., Ranco, D., Viles, C., Voggesser, G., and Williams, P. (2014). The impacts of climate change on tribal traditional foods. In Maldonado, J.K., Colombi, B., and Pandya, R. (Eds). *Climate and Indigenous Peoples in the United States* (pp. 1–8). Berlin: Springer.

Machalaba, C. C., Loh, E. H., Daszak, P., and Karesh, W. B. (2015). Emerging diseases from animals. In Gardner, G., Prugh, T., and Renner, M. (Project Directors). *State of the world 2015: Confronting hidden threats to sustainability* (pp. 105–116). Washington, DC: Island Press.

Mack, R., and Bradford, C. P. (1979). *Transforming America* (2nd ed.). New York: Random House.

Maldonado, J. K., Shearer, C., Bronen, R., Peterson, Kr., and Lazrus, H. (2014). The impact of climate change on tribal communities in the US: Displacement, relocation, and human rights. In Maldonado, J.K., Colombi, B., and Pandya, R. (Eds). *Climate and indigenous peoples in the United States* (pp. 1–8). Berlin: Springer.

Mans, T. (1994). Personal communication.

Marsh, G. (1874). *The earth as modified by human action*. New York: Scribner and Armstrong.

Martin, M. (2009). Income gap between Whites and Blacks continues to grow. *Tell Me More*. National Public Radio, March 23.

Martin, R. (2010). The new nuke. *Wired*, January 4: 114–119.

Maryanski, A. (1998). Evolutionary sociology. In L. Freese (Ed.), *Advances in human ecology*, vol. 7 (pp. 1–56). Greenwich, CT: JAI Press.

Mason, J., and Ennis, D. (2009). G 20 agrees on phase out of fossil fuel subsidies. *Reuters, U.S. Edition*. September 25.

Mastney, L. (2006). Coral reef losses increasing. In L. Starke (Ed.), *Vital signs 2006–2007: Trends that are shaping our future* (pp. 94–95). New York: W. W. Norton.

Mastny, L. (2001). Religious environmentalism rises. In L. Starke (Ed.), *Vital signs 2001: The trends that are shaping our future* (pp. 146–147). New York: W. W. Norton.

Mathiesen, K. (October 9, 2014). Why is Antarctic sea ice at record levels despite global warming? *The Guardian*. Available at: http://www.theguardian.com/environment/2014/oct/09/why-is-antarctic-sea-ice-at-record-levels-despite-global-warming. Accessed on March 14, 2016.

Matoon, A. (1998). Paper recycling climbs higher. In L. Starke (Ed.), *Vital signs 1998: The environmental trends that are shaping our future* (pp. 144–145). New York: W. W. Norton.

Mazur, A. (1991). *Global social problems*. Englewood Cliffs, NJ: Prentice Hall.

Mazur, A., and Rosa, E. A. (1974). Energy and lifestyle: Cross-national comparison of energy consumption and quality of life indicators. *Science*, *186*, 607–610.

McAdam, D. (1999). Political process and the development of black insurgency, 1930–1970 (2nd ed.). Chicago, IL: University of Chicago Press.

McAdam, D., and Snow, D. (2010). *Readings on social movments: Origins, dynamics, outcomes*. Los Angeles: Oxford University Press.

MCallister, L., Magee, A., and Hale, B. (2014). Women, e-waste, and technological solutions to climate change. *Health and Human Rights: An International Journal*, *16* (1), 166–178.

McCloskey, M. (1972). Wilderness movement at the crossroads. *Pacific Historical Review*, *41*, 346–364.

McCright, A., and Dunlap, R. E. (2000). Challenging global warming as a social problem: An analysis of the conservative movement's counter-claims. *Social Problems*, *47* (4), 499–522.

McCright, A., and Dunlap, R. E. (2003). Defeating Kyoto: The conservative movement's impact on U.S. climate change policy. *Social Problems*, *50* (3), 348–373.

McCright, A. and Dunlap, R. E. (2011). The politicization of climate change and polarization in the American public's views of global warming, 2001–2010. *The Sociological Quarterly*, *52*, 155–194.

McCright, A., Charters, M., Dentzmen, K., and Dietz, T. (2016). Examining the effects of climate change frames in the face of climate change denial counter-frame. *Topics in Cognitive Science*, *8*: 76–97.

McCutcheon, P. (March 28, 2016). Great Barrier Reef coral bleaching at 95 per cent in northern section, aerial survey reveals. *ABC News*. Available at: http://www.abc.net.au/news/2016-03-28/great-barrier-reef-coral-bleaching-95-per-cent-north-section/7279338 Accessed on April 12, 2016.

McDonough, W., and Braungart, M. (2002). *Cradle to cradle: Remaking the way we make things*. New York: North Point Press.

McKeown, A. (2009). Genetically modified crops only a fraction of primary global crop production. In L. Starke (Ed.), *Vital signs 2009: Trends that are shaping our future* (pp. 18–19). New York: W. W. Norton.

McKibben, B. (March 23, 2016). Global warming's terrifying new chemistry. *The Nation*. Available at https://www.thenation.com/article/global-warming-terrifying-new-chemistry. Accessed on June 25, 2016.

McNamara, R. (1992, November/December). The population explosion. *The Futurist*, 9–13.

McPhearson, P. (December 1, 2015). Dhaka: the city where climate refuges are already a reality. *The Guardian*. Available at https://www.theguardian.com/cities/2015/dec/01/dhaka-city-climate-refugees-reality. Accessed on June 16, 2016.

McSweeney, R. (September 3, 2015). Earth entering a new era of rapid temperature change study warns. *Carbon Brief*. Available at: http://www.carbonbrief.org/earth-entering-new-era-of-rapid-temperature-change-study-warns. Accessed on March 1, 2016.

Mead, G. (1934). *Mind, self, and society: From the standpoint of a social behaviorist*. Chicago: University of Chicago Press.

Meadows, D. H., Meadows, D. L., and Randers, J. (1992). *Beyond the limits: Confronting global collapse and envisioning a sustainable future*. Post Mills, VT: Chelsea Green.

Meadows, D., Randers, J., and Meadows, D. (2004). *Limits of growth: The 30-year update*. White River, VT: Chelsea Green.

Meadows, D. H., Meadows, D. L., Randers, J., and Behrens, W. (1972). *The limits of growth: A report for the Club of Rome's project on the predicament of mankind*. New York: New American Library.

Mekonnen, M.M., and Hoekstra, A. Y. (December 2013). Water footprint benchmarks for crop production. Value of water research report series No. 64. UNESCO-IHE Institute for Water Education. Available at, http://waterfootprint.org/media/downloads/Report64-WaterFootprintBenchmarks-

CropProduction_1.pdf. October 21, 2016.

Merchant, C. (1981). *The death of nature: Women, ecology, and the scientific revolution*. San Francisco, CA: Harper and Row.

Merrick, T. (1986). World population in transition. *Population Bulletin*, *41*, 2.

Mertig, A., and Dunlap, R. E. (2001). Environmentalism, new social movements, and the new class: A cross national investigation, *Rural Sociology*, *66* (1), 115–136.

Mertig, A., Dunlap, R. E., and Morrison, D. (2002). The environmental movement in the United States. In R. E. Dunlap and W. Michelson (Eds.), *Handbook of environmental sociology* (pp. 448–481). Westport, CT: Greenwood Press.

Meyer, D., and Staggenborg, S. (1996). Movements, countermovements, and the structure of political opportunity. *American Journal of Sociology*, *101*, 6.

Meyer, R. (December 16, 2015). A reader's guide to the Paris Agreement. *The Atlantic*.

Michaelson, M. (1994). Wangari Maathai and Kenya's green belt movement: Exploring the evolution and potentialities of consensus movement mobilization. *Social Problems*, *41* (4), 540–561.

Mies, M. (1986). *Patriarchy and accumulation on a world scale*. London: Zed Books.

Mies, M. and Shiva, V. (2014). *Ecofeminism* (2nd ed.). New York, NY: Zed Books, Ltd.

Miller, G. T., Jr. (1992). *Living in the environment* (7th ed.). Belmont, CA: Wadsworth.

Miller, G. T. (1998). *Living in the environment* (10th ed.). Belmont, CA: Wadsworth.

Miller, G. T., Jr. (2002). *Living in the environment* (12th ed.). Belmont, CA: Wadsworth.

Miller, G. T., Jr. (2005). *Living in the environment* (14th ed.). Belmont, CA: Wadsworth.

Miller, G. T., and Spoolman, S. (2009). *Living in the environment* (16th ed.). Belmont, CA: Brooks/Cole.

Minter, A. (January 13, 2016). The burning truth behind an e-waste dump in Africa. *The Age of Humans Living in the Anthropocene*. Available at http://www.smithsonianmag.com/science-nature/burning-truth-behind-e-waste-dump-africa-180957597/?no-ist. Accessed on October 2, 2016.

Mitchell, R., Mertig, A., and Dunlap, R. E. (1992). Twenty years of environmental mobilization: Trends among national environmental organizations. In R. E. Dunlap and A. G. Mertig (Eds.), *American environmentalism: The U.S. environmental movement, 1970–1990* (pp. 11–26). Philadelphia: Francis Taylor.

Mix, T., and Waldo, K. G. (2015). Know(ing) your power: Risk society, Astroturf campaigns, and the battle over the Red Rock coal-fired plant. *Sociological Quarterly*, *56* (1), 125–151.

Mol, A. (2003). *Globalization and environmental reform: The ecological modernization of the global economy*. Cambridge, MA: MIT Press.

Mol, A., and Sonnenfeld, D. (Eds.) (2000). *Ecological modernization around the world: Perspectives and critical debates*. Ilford, UK: Frank Cass.

Monfort, J. (2009). Despite obstacles, biofuels continue surge. *Vital signs 2009* (pp. 35–37). Washington DC: Worldwatch Institute.

Montgomery, D. (2010). Dirt: The erosion of civilizations. *Worldwatch Magazine*. January–February, p. 32.

Moore, D. (August, 20, 2013). Vancouver near top of list of cities threatened by rising sea levels. *The Globe and Mail*. Available at: http://www.theglobeandmail.com/news/british-columbia/flooding-due-to-rising-seas-could-cost-1-trillion-by-2050-study-says/article13889544. Accessed on February 26, 2016.

Motavalli, J. (January/February, 2006). The outlook on oil. *E Magazine*, *17* (1), 27–37.

Mulrow, J. (April 22, 2010). The world will completely miss 2010 biodiversity target. *Vital signs: Global trends that shape our future*. Available at http://vitalsigns.worldwatch.org/vs-trend/world-will-completely-miss-2010-biodiversity-target. Accessed on April 26, 2016.

Mungai, N.w. (2014). Critical Essay Review: Sustaining native biodiversity through conservation and nature friendly farming. *Rural Society*, *23* (2), 198–206.

Musolino, E. (February 12, 2013). Hydropower and geothermal growth slows. *Vital signs: Global trends that are shaping our future*. Available at http://vitalsigns.worldwatch.org/vs-trend/hydropower-and-geothermal-growth-slows. Accessed on October 11, 2016.

Myers, D., and Diener. (1995). Who is happy? *Psychological Science*, *6* (1), 10–19.

Myers, N. (1997). The world's forests and their ecosystem services. In G. Daily (Ed.), *Nature's services: Societal dependence on natural ecosystems* (pp. 215–236). Washington, DC: Island Press.

Myers, N., and Kent, J. (2001). *Perverse subsidies: How tax dollars can undercut the environment and the economy*. Washington, DC: Island Press.

Nagel, J. (2016). *Gender and climate change: Impacts, science and policy*. New York: Routledge.

NASA. (January 20, 2016). NASA, NOAA Analyses reveal record-shattering global warm temperatures in 2015. Available at http://www.nasa.gov/press-release/nasa-noaa-analyses-reveal-record-shattering-global-warm-temperatures-in-2015. Accessed February 18, 2016.

NASA Global Climate Change. (n.d.) Scientific consensus: Earth's climate is warming. Available at http://climate.nasa.gov/scientific-consensus. Accessed on June 13, 2016.

Nash, R. (1967). *Wilderness and the American mine*. New Haven, CT: Yale University Press.

National Center for Statistics. (1984). Blood levels for persons 6 months to 74 years of age: United States, 1976–1980. *Vital Statistics*, no. 79. Hyattsville, MD: National Center for Health Statistics.

National Geographic. (2016). Ocean acidification. *National Geographic*. http://ocean.nationalgeographic.com/ocean/explore/pristine-seas/critical-issues-ocean-acidification. Accessed on October 14, 2016.

National Public Radio News. (2006). *The Morning Edition*, April 18.

National Public Radio News. (2010). Renee Montagne, Spill with cost BP at least 1 year of profits. *The Morning Edition*, June 1.

National Research Council. (1986). *Population growth and economic development: Policy questions*. Committee on Population, Working Group on Population and Development. Washington, DC: National Academy Press.

Natural Resources Defense Council. (2006). Cited in *The Page that Counts, YES!* Winter 2010.16.

Nelson, T. (1996). Urban agriculture. *Worldwatch*, *9* (22), 110–17.

Netting, R. (1981). *Balancing on an Alp: Ecological change and continuity in a Swiss mountain community*. Cambridge, UK: Cambridge University Press.

Neumayer, E. and Plumper, T. (2007). The gendered nature of natural disasters: The impacts of catastrophic events on the gender gap in life expectancy, 1981–2002. *Annals of the Association of American Geographers*, *97*(3): 551–566.

New York Times. (2009). If we grow it, can we feed the hungry? In *The Omaha World Herald*, October 26, p. 4A.

Newell, P. (2000). *Climate for change*. Cambridge, UK: Cambridge University Press.

Nierenberg, D. and Burney, S.A. (July 30, 2012). Investing in women farmers. *Vital signs: Global trends that shape our future*. Available at: http://vitalsigns.worldwatch.org/vs-trend/investing-women-farmers. Accessed on April 22, 2016.

Nordstrom, H., and Vaughn, S. (1999). *Trade and environment*. Geneva, Switzerland: World Trade Organization.

Norgaard, K.M. (2006). "*People want to protect themselves* a little bit”: Emotions, denial, and social movement nonparticipation. *Sociological Inquiry*, *76* (3): 372–396.

Norgaard, K.M. (2011). *Living in denial: Climate change, emotions and everyday life*. Cambridge, MA: MIT Press.

Normander, B. (2011). World's forests continue to shrink. *Vital signs: Global trends that shape our future*. Available at: http://vitalsigns.worldwatch.org/vs-trend/worlds-forests-continue-shrink. Accessed on April 25, 2016.

Norse, D. (1992). A new strategy for feeding a crowded planet. *Environment*, *43* (5), 6–39.

Novek, J. (2003). Intensive hog farming in Manitoba: Transnational treadmills and local conflicts. *Canadian Review of Sociology & Anthropology*, *40* (1): 3–26.

Nunez, C. (2014). How green are those solar panels, really? *National Geographic*. Available at http://news.nationalgeographic.com/news/energy/2014/11/141111-solar-panel-manufacturing-sustainability-ranking. Accessed on July 1, 2016.

O'Connor, J. (1994). Is sustainable capitalism possible? In M. O'Connor (Ed.), *Political economy and the politics of ecology* (pp. 152–175). New York: The Guilford Press.

Odum, E. P. (1971). *Fundamentals of ecology* (3rd ed.). Philadelphia: W. B. Saunders.

OECD (Organization for Economic Development and Cooperation) (1999). *Implementing domestic tradeable permits for environmental protection*. Paris: OECD.

Oelschlaeger, M. (1994). *Caring for creation: An ecumenical approach to the environmental crisis*. New Haven, CT: Yale University Press.

Olsen, M. (1968). *The process of social organization*. New York: Holt, Rinehart, & Winston.

Olsen, M., and Cluett, C. (1979). *Evaluation of Seattle city light neighborhood conservation program*. Seattle, WA: Battelle Human Affairs Research Center.

O' Meara, M. (2002). CFC use declining. In L. Starke (Ed), *The state of the world, 1999* (pp. 128–129). New York: W.W. Norton.

Ostrom, E. (1990). *Governing the commons: Evolution of institutions for collective action*. Cambridge, UK: Cambridge University Press.

Ostwald, W. (1909). *Energetische grundlagen der kulturwissenshaften*. Leipzig, Germany: Vorvort.

Paehlke, R. (1989). *Environmentalism and the future of progressive politics*. New Haven, CT: Yale University Press.

Parag, Y. and Roberts, J. T. (2009). A battle against the bottles: Building, claiming and regaining tap-water trustworthiness. *Society and Natural Resources*, *22*, 625–636.

Parkin, S. (1989). *Green parties: An international guide*. London, UK: Heretic Books.

Parrick, D. W. (1969). An approach to the bioenergetics of rural West Bengal. In A. Vayda (Ed.), *Environment and cultural behavior* (pp. 29–46). Garden City, NJ: Natural History Press.

Parsons, T. (1951). *The social system*. Glencoe, IL: Free Press.

Passarini, E. (1998). Sustainability and sociology. *The American Sociologist*, *29* (3), 59–70.

Pearce, F. (1997). Thirty meals that suck the well. *The New Scientist, 153* (2667), 7

Pearce, F. (2015). On the river Nile, a move to avert a conflict over water. Available at: E360.yale.edu/feature/on_the_river_a_move_to_avert_a_conflict_over_water/2855. Accessed on April 10, 2016.

Pearson, L. (2008). Applying resilience thinking for sustainable development. *ECOS.* Available at http://ecosmagazine.com/?act=view_file&file_id=EC142p16.pdf. Accessed on October 21, 2016..

Pellow, D. (1994). Environmental justice and popular epidemiology: Grassroots empowerment or symbolic politics. Presented at the annual meeting of the Midwest Sociological Society, St. Louis, MO.

Pellow, D. (2000). Environmental inequality formation. *American Behavioral Scientist*, *43* (4), 581–601.

Pellow, D. N. and Brehm, H. N. (2015). From the new ecological paradigm to total liberation: The emergence of a social movement frame. *The Sociological Quarterly*, *56* (1): 185–212.

Pelto, P. (1973). *The snowmobile revolution: Technological and social change in the Arctic (p. 192)*. Menlo Park, CA: Cummings.

Pelto, P., and Muller-Willie, L. (1972). Snowmobiles: Technological revolution in the Arctic. In H. Bernard and P. Pelto (Eds.), *Technology and cultural change (pp. 208–241)*. New York: Macmillan.

Pendleton, L., Donato, D.C., Murray, B.C., Crooks, S., Jenkins, W. A., Sifleet, S., Craft, C., Fourqurean, J.W., Kauffman, B. J., Marba, N., Megonigal, P., Pidgeon, E., Herr, D., Gordon, D., and Baldera, A. (2012). Estimating global "blue carbon" emissions from conversion and degradation and vegetated coastal ecosystems. *PLOS one*. http://dx.doi.org/10.1371/journal.pone.0043542. Accessed on October 21, 2016.

Perrow, C. and S. Pulver. (2015). Organizations and markets. In Dunlap, R. E. and Brulle, R. J. (Eds.) *Climate change and society: Sociological perspectives*. Report of the American Sociological Association's task force on sociology and global climate change. New York, NY: Oxford University Press.

Perry, T. (2004). Water conservation is working, report says. *Los Angeles Times*, March 11; also in *The Omaha World Herald*, March 11, 2A.

Phillips, L. (2014). Planetary boundaries: Can there be limits to human growth? *Road to Paris*. Available at http://roadtoparis.info/2014/09/15/planetary-boundaries-limits-human-growth. Accessed on October 20, 2016.

Phys.org. n.a. (July 28, 2014). Available at http://phys.org/news/2014-07-vapor-global-amplifier.html. Accessed on June 13, 2014.

Pierce, J., Dalton, R., and Zaitsev, A. (1999). Public perceptions of environmental conditions. In R. J. Dalton, P. Garb, N. Lovrich, J. D. Pierce, and J. M. Witely (Eds.), *Critical masses: Citizens, nuclear weapons production, and environmental destruction in the United States and Russia* (pp. 97–129). Cambridge, MA: MIT Press.

Pilgeram, R. (2011). The only thing that isn't sustainable…is the farmer: Social sustainability and the politics of class among Pacific Northwest farmers engaged in sustainable farming. *Rural Sociology*, *76* (3): 375–393.

Pimentel, D. (1997). Cited in Pearce, F., Thirty meals that suck the well dry. *The New Scientist*, *153* (2667), 7.

Pimentel, D., Berger, B., Filiberto, D., Newton, M., Wolfe, B., Karatinakis, E., Clark, S., Poon, E., Abbert, vE., and Handogopal, S. (2004). Water resources: Agricultural and environmental issues. *Bioscience*, *54* (10), 909–919.

Plait, P. (September 3, 2015). 5 trillion tons of sea ice lost since 2002. *Slate*. Available at: http://www.slate.com/blogs/bad_astronomy/2015/09/03/ice_loss_greenland_and_antarctica_lost_5_trillion_tons_since_1992.html. Accessed on March 18, 2016.

Plait, P. (February 17, 2016). January 2016: Shattering the global warming monthly record. *Slate*. Available at www.slate.com/blogs/bad_astronomy/2016/02/17/january_2016_was_the_hottest_january_on_record.html. Accessed on February 24, 2016.

Podobnik, B. (1999, August). Towards a sustainable energy regime: Technological forecasting and social change. Presented at the 1998 meeting of The American Sociological Association, San Francisco, CA.

Ponsot, E. (January 18, 2016). California natural gas leak just one of thousands across country. *PBS Newshour*. Available at http://www.pbs.org/newshour/updates/california-natural-gas-leak-just-one-of-thousands-across-country. Accessed on June 25, 2016.

Ponting, C. (1991). *A green history of the world*. London: Sinclair Stevenson.

Ponting, C. (2007). *A green history of the world*. (2nd ed.). London: Penguin Books

Pope, C., and Rauber, P. (2004). *Strategic ignorance: The Bush administration is recklessly destroying a century* *of environmental progress*. San Francisco, CA: Sierra Club Books.

Population Reference Bureau. (2009). *World population: More than just numbers*. Washington, DC: Population Reference Bureau.

Population Reference Bureau. (2010). World Population Data Sheet, July 28, 2010.

Postel, S. (1992). *The last oasis: Facing water scarcity*. New York: W. W. Norton.

Postel, S. (2010). Will there be enough: How to change our habits and make water last. *YES! 54* (Summer), 18–23.

Potter, G. (2012). Urbanizing the developing world. *Vital signs: Global trends that shape our future*. Available at http://vitalsigns.worldwatch.org/vs-trend/urbanizing-developing-world. Accessed on June 21, 2016.

Prechel, H. (2015). Organizational political economy and environmental pollution. *Sociology Compass*, *9* (9), 828–840.

Prechel, H. and Touche, G. (2014). The effects of organizational characteristics and state environmental policies on sulfur-dioxide pollution in US electrical energy corporations. *Social Science Quarterly*, *95* (1), 76–96.

Prechel, H. and Zheng, L. (2012). Corporate characteristics, political embeddedness and environmental pollution by large U.S. corporations. *Social Forces*, *90* (3), 947–970.

Prugh, T. (2006). Peak oil forum. *Worldwatch*, *19* (1), 9.

Prugh, T. (March 31, 2014). Biofuel production declines. *Vital signs: Global trends that shape our future*. Available at http://vitalsigns.worldwatch.org/vs-trend/biofuel-production-declines. Accessed on June 25, 2016.

Prugh, T. (2015). Childhood's end. In Gardner, G., Prugh, T., and Renner, M. (Project Directors). *State of the world 2015: Confronting hidden threats to sustainability* (pp. 129–140). Washington, DC: Island Press.

Prugh, T., Costanza, R., and Daly, H. (2000). *The local politics of global sustainability*. Washington, DC: Island Press.

Rana, Rashedul (March 28, 2015). Climate refugees flooding into Dhaka. *Pathway to Paris*. Available at http://www.pathwaytoparis.org/dhaka-refugees. Accessed on June 16, 2016.

Rappaport, R. A. (1968). *Pigs for the ancestors: Ritual in the ecology of a New Guinea people*. New Haven, CT: Yale University Press.

Ravenstein, E. (1889). The laws of migration, I and II. *Journal of the Royal Statistical Society*, *52*, 241–305.

Redclift, M. (1987). *Sustainable development: Exploring the contradictions*. London: Methuen.

Reddy, A., and Goldemberg, J. (1990). Energy for the developing world. *Scientific American*, *263* (3), 110–119.

Rees, W. (2002). Global sustainability: Conflict or convergence? *Bulletin of Science, Technology & Society*, *22* (4), 249–268.

Renner, M. (1998). Pollution control markets expand. In L. Starke (Ed.), *Vital signs 1998: The environmental trends that are shaping our future* (pp. 144–145). New York: W. W. Norton.

Renner, M. (2002). Breaking the link between resources and repression. In L. Starke (Ed.), *State of the world, 2002* (pp. 149–173). New York: W. W. Norton.

Renner, M. (2007–2008). Number of violent conflicts steady. In L. Starke, (Ed.), *Vital signs 2007–2008: Trends that are shaping our future* (pp. 76–77). New York: W. W. Norton.

Renner, M. (June 25, 2013). Number of displaced people rises. *Vital signs: Global trends that shape our future*. Available at http://vitalsigns.worldwatch.org/sites/default/files/vital_signs_trend_displaced_populations_final_pdf.pdf. Accessed on October 7, 2016.

Renner, M. (August 22, 2014a). Peak meat production strains land and water resources. *Vital signs: Global trends that shape our future*. Available at: http://vitalsigns.worldwatch.org/vs-trend/peak-meat-production-strains-land-and-water-resources. Accessed on April 22, 2016.

Renner, M. (September 30, 2014b). Wind solar generation capacity catching nuclear power. *Vital signs: Global trends that shape our future*. Available at http://vitalsigns.worldwatch.org/vs-trend/wind-solar-generation-capacity-catching-nuclear-power. Accessed on June 27, 2016.

Renner, M. (2015). The seeds of modern threats. In Gardner, G., Prugh, T., and Renner, M. (Project Directors). *State of the world 2015: Confronting hidden threats to sustainability* (pp. 3–20). Washington, D.C.: Island Press.

Repetto, R. (1987). Population, resources, environment: An uncertain future. *Population Bulletin*, *42*, 2.

Repetto, R. (1995). *Jobs, competitivenesss, and environmental regulation: What are the real issues?* Washington, DC: World Resources Institute.

Resch, R. (2009). Cited in Getting political, *Photon* (December), 18–23.

Revkin, A. (2006). Climate expert says NASA tried to silence him. *The New York Times*. http://www.nytimes. com/2006/o1/29/science/earth/29climate.htm? Accessed on January 29, 2006.

Ritzer, G. (1975). *Sociology: A multiple paradigm science*. Boston: Allyn & Bacon.

Ritzer, G. (2010). *Contemporary social theory and its classical roots* (3rd ed.). New York: McGraw Hill.

Roberts, J. T. (1996). Predicting participation in environmental treaties: A world-system analysis. *Sociological Inquiry*, *66*, 38–57.

Roberts, J., and Grimes, P. (2002). World-system theory and the environment: Toward a new synthesis. In R. Dunlap, F. Buttel, P. Dickens, and A. Gijswijt (Eds.), *Sociological theory and the environment: Toward a new synthesis: Classical foundations, contemporary insights*. New York: Rowman and Littlefield.

Roberts, P. (2004). *The end of oil: On the edge of a perilous new world*. New York: Houghton Mifflin.

Roberts, T. and Weikmans, R. (December 22, 2015). The unfinished agenda of the Paris climate talks: Finance to the global South. *Brookings*. Available at https://www.brookings.edu/blog/planetpolicy/2015/12/22/the-unfinished-agenda-of-the-paris-climate-talks-finance-to-the-global-south. Accessed on October 2, 2016.

Rockler-Gladen, N. (2009). America's Greenest Campuses, 2008–2009, Suite 101.com. Accessed March 20, 2011.

Rockstrom, J., Steffen, W., Noone, K., Persson, A., Chapin, F. S., Lambin, E. F., Lenton, T., Scheffer, M., Folke, C., Schellnhuber, H. J., Nykvist, B., Wit de, C. D., Hughes, T., Leeuw van der, S., Rodhe, H., Sverker, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., and Foley, J.A., (2009). A safe operating space for humanity. *Nature*, *461* (24): 472–475. Available at: http://www.nature.com/articles/461472a.epdf?referrer_access_token=ITLPpVlGU3T0hJP8aED_ldRgN0jAjWel9jnR3ZoTv0P37Gs3zKRDU9gfE3JMDFVz7xzwh0QiMMAsPzdkipEmgINJpfmFK314LZrZYAGDDCaj060w3ffTNkZ59XzUjgXcGKF3ZH2-sKor2pQ4-lKpFiiHaR5LE5oXo6vlMVl7Cvv8v_izXBABsySh6Ji7B7X_&tracking_referrer=www.nature.com. Accessed on April 23, 2016.

Rogers, R. (1994). *Nature and the crisis of modernity*. Montreal, Canada: Black Rose Books.

Roodman, D. (1999). Building a sustainable society. In L. Starke (Ed.), *State of the world, 1999* (pp. 169–188). New York: W.W. Norton.

Roodman, D. (2000). Environmental tax shifts multiplying. In L. Starke (Ed.), *Vital signs 2000: The environmental trends that are shaping our future* (pp. 138–139). New York: W. W. Norton.

Rosa, E. (1998). Risk and environmental sociology. *Environment, Technology, and Society*, *88* (8).

Rosa, E., and Dietz, T. (2004). Reflections on the STIRPAT Research Program. *Environment, Technology, and Society*, Spring, 1–2.

Rosa, E., Keating, K., and Staples, C. (1981). Energy, economic growth and quality of life: A cross-national trend analysis. *Proceedings of The International Congress of Applied*

Systems Research and Cybernetics. New York: Pergamon.

Rosa, E., Machlis, G., and Keating, K. (1988). Energy and society. *Annual Review of Sociology*, *14*, 149–172.

Rose, C. (2001). Common property, regulatory property, and environmental protection: Comparing community-based management to tradable environmental allowances. In Dietz, T., Dolsak, N., Ostrom, E., and Stern P. (Eds.). *The drama of the commons* (pp. 123–258). Washington, DC: National Academy Press.

Rosenbaum, W. (1989). The bureaucracy and environmental policy. In J.P. Lester (Ed.), *Environmental politics and policy: Theories and evidence* (pp. 213–237). Durham, NC: Duke University Press.

Ross, M., and Williams, R. (1981). *Our energy: Regaining control*. New York: McGraw-Hill.

Rosset, P. (1997). Alternative agriculture and crisis in Cuba. *Technology and Society*, *12* (2), 19–25.

Rubenstein, D. (1995, Winter/Spring). Environmental accounting for the sustainable corporation: Strategies and techniques. *Human Ecology Review*, *2* (1), 1–21.

Ruckelshaus, W. (1990). Toward a sustainable world. In *Managing planet earth: Readings from* Scientific American (pp. 125–136). New York: W. H. Freeman.

Runyan, C., and Norderhaug, M. (2002). The path to the Johannesburg summit. *Worldwatch*, *15*, 3.

Sachs, A. (1995). Population growth steady. In L. Starke (Ed.), *Vital signs 1995: The trends that are shaping our future* (pp. 94–95). New York: W. W. Norton.

Sale, K. (1993). *The green revolution: The American environmental movement, 1962–1992*. New York: Hill and Wang.

Salzman, J., and Ruhl J. B. (2000). Currencies and the commodification of environmental law. *Stanford Law Review*, *53*, 607–694.

Sanderson, S. (1995). *Macrosociology: An introduction to human societies* (3rd ed.). New York: HarperCollins.

Sapp, S., Arnot, C., Fallon, J., Fleck, T., Soorholts, D., Sutton-Vermeulen, M., and Wilson, J. (2009). Consumer trust in the U.S. food system: An examination of the recreancy theorem. *Rural Sociology*, *74* (4), 525–545.

Savage, A. Isham, J., and Klyza, C.M. (2005). The greening of social capital: An examination of land-based groups in two Vermont counties. *Rural Sociology*, *70*, 113–131.

Sawin, J. (2005). Global wind growth continues. In L. Starke (Ed.), *Vital signs 2005: Trends that are shaping our future* (pp. 34–35). New York: W. W. Norton.

Sawin, J. (2009). Another sunny year for solar power, *Vital signs 2009* (pp.

38–40). Washington, DC: Worldwatch Institute.

Scarce, R. (1990). *Eco-warriors: Understanding the radical environmental movement*. Chicago: Noble Press.

Scheinberg, A. (2003). The proof of the pudding: Urban recycling in North America as a process of ecological modernization. *Environmental Politics*, *12* (4), 49–75.

Schellenberger, M., and Nordhaus, T. (2004). The death of environmentalism. *http://Grist.org*.

Schipper, L., and Lichtenberg, A. J. (1976). Efficient energy use and well-being: The Swedish example. *Science*, *194*, 1001–1013.

Schmalensee, R., Joskow, P., Ellerman, A., Montero, J., and Bailey, E. (1998). An interim evaluation of sulfur dioxide emissions trading. *Journal of Economic Perspectives*, *12* (3), 53–68.

Schmitz, R.M. (2016). Intersections of hate: Exploring the intersecting dimensions of race, religion, gender, and family in Ku Klux Klan websites. *Sociological Focus*, *49* (3), 200–214.

Schnaiberg, A. (1980). *The environment: From surplus to scarcity*. New York: Oxford University Press.

Schnaiberg, A., and Gould, K. (1994). *Environment and society: The enduring conflict*. New York: St. Martin's Press.

Schneider, S. H. (1990a). The changing climate. In *Managing planet earth: Readings from* Scientific American (pp. 26–36). New York: W. H. Freeman.

Schneider, S. (1990b) Cooling it. *World Monitor*, Spring, 30–38.

Schneider, S., and Londer, R. (1984). *The coevolution of climate and life*. San Francisco: Sierra Club Books.

Schor, J. (1992). *The overworked American: The unexpected decline of leisure*. New York: Basic Books.

Schor, J.B. (2011). *True wealth: How and why millions of Americans are creating a time-rich, ecologically light, small-scale, high-satisfaction economy*. New York, NY: Penguin Books.

Schumacher, E. F. (1973). *Small is beautiful: Economics as if people mattered*. New York: HarperCollins.

Schutz, A. (1967). *The phenomenology of the social world*. Evanston, IL: Northwestern University Press. (Original work published 1932.)

Sen, A. (1981). *Poverty and famines*. New York: Oxford University Press.

Sen, A. (1993). The economics of life and death. *Scientific American*, *208* (5), 40–47.

Shaiko, R. (1999). *Voices and echoes for the environment: Public interest representation in the 1990s and beyond*. New York: Columbia University Press.

Shamim, C. (2008). Alternative views of environmental security in a less developed country: The case of Bangladesh. *Journal of Third World Studies*, 25(1): 253-272.

Sheppard, K. (2009). Everything you always wanted to know about the Waxman-Markey energy/climate bill—in bullet points. *Grist*, June 30.

Shiva, V. (1988). *Staying alive*. London: Zed Books.

Shiva, V. (Ed). (2016). *Seed sovereignty, food security: Women in the vanguard of the fight against GMOs and corporate agriculture*. Berkeley, CA: North Atlantic Books.

Shorette, K. (2012). Outcomes of global environmentalism: Longitudinal and cross-national trends in chemical fertilizer and pesticide use. *Social Forces*, *91* (1), 299–325.

Shwom, R.L., McCright, A. M., and Brechin, S.R. with Dunlap, R.E., Marquart-Pyatt, S.T., and Hamilton, L.C. (2015). In Dunlap, R. E. and Brulle, R. J. (Eds.), *Climate change and society: Sociological perspectives*. Report of the American Sociological Association's task force on sociology and global climate change (pp. 269–299). New York, NY: Oxford University Press.

Silver, C., and Defries, R. (1990). *One earth, one future: Our changing global environment*. Washington, DC: National Academy of Sciences, National Academy Press.

Simon, J. (1990). Population growth is not bad for humanity. *National Forum: The Phi Kappa Phi Journal*, *70*, 1.

Simon, J. (1996). *Ultimate resources 2*. Princeton, NJ: Princeton University Press.

Simon, J. (1998). There is no crisis of unsustainability. In T. Miller (Ed.), *Living in the environment* (10th ed.) (pp. 26–27). Belmont, CA: Wadsworth.

Simon, J., and Wildavsky, A. (1993, May 13). Facts, not species, are periled. *The New York Times*.

Sinha, A. (2015, December 14). Paris climate talks: Differentiation of developed and developing stays, India happy. *The Indian Express*. http://indianexpress.com/article/india/india-news-india/paris-climate-talks-differentiation-of-developed-and-developing-stays-india-happy.

Slezak, M. (April 10, 2016). Mass coral bleaching now affecting half of Australia's Great Barrier Reef. *The Guardian*. Available at http://www.theguardian.com/environment/2016/apr/11/mass-coral-bleaching-now-affecting-half-of-australias-great-barrier-reef. Accessed on April, 15, 2016.

Smeeding. T. (2000). Change in income equality in the OECD countries. In A. Giddens, M. Dunier, R. Applebaum, and D. Carr (Eds.), *Introduction to sociology*. New York: W. W. Norton.

Smith, R. (May–June 2009). The blue baby syndromes. *American Scientist*. Available at http://www.americanscientist.org/issues/pub/2009/3/the-blue-baby-syndromes/1. Accessed on October 2, 2016.

Smith, S. J., Edmonds, J., Hartin, C. A., Mundra, A., and Calvinear, K. (2015). Near-term acceleration in the rate of temperature change. *Nature Climate Change*, *5*, 333–336**.**

Smith, T. (1985). The polls: American's most important problems: Part I. National and international. *Public Opinion Quarterly*, *46*, 38–61.

Snipp, C. M. (2012). The first Americans: American Indians. In Higginbotham, E. and Anderseon, M.L. (Eds.), *Race and ethnicity in society: The changing landscape* (3rd ed.) (pp. 166–173). Belmont, CA: Wadsworth.

Snow, D., and Benford, R. (1988). Ideology, frame resonance, and participant mobilization. In B. Klandfermans, H. Kriesi, and S. Tarrow (Eds.), *Structure to action: Comparing social movement research across cultures*. Greenwich, CT: JAI Press.

Snowden, M., Blankenau, J. and Nitze, J. (2015). Health care affordability and access in Nebraska after the Great Recession. *Great Plains Research*, *24* (1): 23–35.

Soble, J. (March 10, 2016), Fukushima keeps fighting radioactive tide 5 years after disaster. *The New York Times*. Available at http://www.nytimes.com/2016/03/11/world/asia/japan-fukushima-nuclear-disaster.html?_r=0. Accessed on June 27, 2016.

Socolow, R. (1978). *Saving energy in the home: Princeton's experiments at Twin Rivers*. Cambridge, MA: Ballinger.

Soddy, F. (1926). *Wealth, virtual wealth, and debt: The solution to the economic paradox*. London: Oxford University Press.

Southwick, C. (1996). *Global ecology in human perspective*. New York: Oxford University Press.

Spears, J., and Ayensu, E. (1985). Resources, development, and the new century: Forestry. In R. Repetto (Ed.), *The global possible: Resources, development, and the new century* (pp. 299–335). New Haven, CT: Yale University Press.

Spencer, H. (1896). *The principles of sociology*. New York: Appleton.

Speth, J. (2004). *Red sky at morning: America and the crisis of the global environment*. New Haven, CT: Yale Nota Bene. Yale University Press.

Speth, J. (2008). *Bridge at the end of the world: Capitalism, the environment, and crossing the bridge from crisis to sustainability*. New Haven, CT: Yale University Press.

Stanislaw, J., and Yergin, D. (1993). Oil: Reopening the door. *Foreign Affairs*, *72* (4), 81–93.

Stark, R. (1994). *Sociology*. Belmont, CA: Wadsworth.

Stedman, R., Lee, B., Brasier, K., Weigle, J.L., and Higdon, F. (2009). Cleaning up water? Or building rural community? Community watershed organizations in Pennsylvania. *Rural Sociology*, *74* (2), 178–200.

Stephan, E. (1970). The concept of community in human ecology. *Pacific Sociological Review*, *13*, 218–228.

Stern, N. (2006). What is the economics of climate change? *World Economics*, *7* (2, April–June), 1–10.

Stern, N. (2007). *The economics of climate change: The Stern review*. Cambridge UK: Cambridge University Press.

Stern, P. (1992). Psychological dimensions of global environmental change. *Annual Review of Psychology*, *43*, 269–302.

Stern, P., and Aronson, E. (1984). *Energy use: The human dimension*. New York: W. H. Freeman.

Stern, P., and Oskamp, S. (1987, March 28). Managing scarce environmental resources. In D. Stokals and I. Altman (Eds.), *Handbook of environmental psychology*, vol. 2. New York: Wiley.

Stern, P., Aronson, E., Darley, D., Hill, E., Hirst, E., Kempton, W., and Wilbanks, T. (1986). The effectiveness of incentives for residential energy-conservation. *Evaluation Review*, *10*, 147–176.

Stern, P., Young, O., and Druckman, D. (Eds.) (1992). *Global environmental change: Understanding the human dimensions*. Washington, DC: National Academy Press.

Stevens, M. (September 29, 2015). Water, 2015, California: The no-good, very bad year, – now, 'pray for rain.' *Los Angeles Times*. Available at: http://www.latimes.com/local/lanow/la-me-ln-water-year-20150929-story.html. Accessed on January 23, 2016.

Stolnitz, G. (1964). The demographic transition from high to low birth rates and death rates. In R. Freedman (Ed.), *Population: The vital revolution*. Garden City, NJ: Anchor Books.

Strayer, D.L. (2006). Challenges for freshwater invertebrate conservation. *Journal of the North American Benthological Society*, *25* (2), 271–287.

Stretesky, P.B., Long, M.A., Lynch, M. J. (2013). Does environmental enforcement slow the treadmill of production? The relationship between large monetary penalties, ecological disorganization and toxic releases within offending corporations. *Journal of Crime & Justice*, *36* (2), 233–247.

Sutter, J.D. (April 24, 2015). Climate: 7 questions on 2 degrees. *CNN*. Available at http://www.cnn.com/2015/04/24/opinions/sutter-questions-two-degrees-climate. Accessed on March 30, 2016.

Switzer, J. (1994). *Environmental politics: Domestic and global dimensions*. New York: St. Martin's Press.

Szasz, A. (2007). *Shopping our way to safety: How we changed from protecting the environment to protecting ourselves*. Minneapolis, MN: University of Minnesota Press.

Szasz, A., and Meuser M. (1997). Environmental inequalities: Literature review and proposals for new directions in research and theory. *Current Sociology*, *45*, 99–120.

Sztompka, P. (1993). *The sociology of social change*. Cambridge, MA: Blackwell Publishers.

Tainter, J. (1988). *The collapse of complex societies*. Cambridge, UK: Cambridge University Press.

Takacs, D. (1996). *The idea of biodiversity: Philosophies of paradise*. Baltimore, MD: Johns Hopkins University Press.

Talberth, J. (2008). A new bottom line for progress. *State of the world 2008: Innovations for a sustainable economy* (pp. 18–31). New York: W. W. Norton.

Tanner, K. (January 16, 2016). All Flint's children must be treated as exposed to lead. *The Detroit Free Press*. Available at http://www.freep.com/story/opinion/contributors/raw-data/2016/01/16/map-8657-flints-youngest-children-exposed-lead/78818888. Accessed on June 9, 2016.

Taraska, G. (December 15, 2015). The Paris climate agreement. The Center for American Progress. Available at www.americanprogress.org/issues/green/report/2015/12/15/127360/the-paris-climate-agreement. Accessed on April 15, 2016.

Taylor, B. (1992). *Our limits transgressed: Environmental political thought in America*. Lawrence, KS: University of Kansas Press.

Taylor, D. E. (1993). Environmentalism and the politics of inclusion. In R. Bullard (Ed.), *Confronting environmental racism: Voices from the grassroots*. Boston: South End Press.

Taylor, D. E. (2000). The rise of the environmental justice paradigm. *American Behavioral Scientist*, *43* (4), 508–580. Available at http://Tellus.org.

Taylor, D.E. (2014). *Toxic communities: Environmental racism, industrial pollution, and residential mobility*. New York, NY: NYU Press.

Thomas, W. I. (1923). *The unadjusted girl*. Boston: Little Brown.

Thompson, A. (December 21, 2012). *What is a carbon sink?* Available at www.livescience.com/32354-what-is-a-carbon-sink.html. Accessed on June 13, 2016.

Tietenberg, T. (2002). The tradable permits approach to protecting the commons: What have we learned? In Dietz et al. (Eds.), *The drama of the commons* (pp. 197–232). Washington, DC: National Academy Press.

Tilly, C. (1984). *Big structures, large processes, huge comparisons*. New York: Russell Sage Foundation.

Tuxill, J. (1997). Death in the family tree. *Worldwatch*, *10* (5), 13–21.

Tuxill, J. (1998). Vertebrates signal biodiversity losses. In L. Starke (Ed.), *Vital signs 1998: The environmental trends that are shaping our future* (pp. 128–129). New York: W. W. Norton.

Tuxill, J. (1999). Appreciating the benefits of plant biodiversity. In L. Starke. (Ed.), *State of the world, 1999* (pp. 96–114). New York: W. W. Norton.

Ungar, S. (1992). The rise and (relative) decline of global warming as a social problem. *The Sociological Quarterly*, *33* (4), 483–502.

Ungar, S. (1998). Bringing the issue back in: Comparing the marketability of the ozone hole and global warming. *Social Problems*, *48* (4), 510–527.

Union of Concerned Scientists. (1992). *Warning to humanity*. Washington, DC: Union of Concerned Scientists.

Union of Concerned Scientists. n.d. Shale and other unconventional sources of natural gas. Available at: http://www.ucsusa.org/clean_energy/our-energy-choices/coal-and-other-fossil-fuels/shale-gas-unconventional-sources-natural-gas.html#.V_wxpugrLIU. Accessed on October 10, 2016.

United Nations High Commissioner for Refugees. 2016. Global trends: Forced displacement in 2015. Available at http://www.unhcr.org/576408cd7.pdf. Accessed on October 7, 2016.

United Nations Population Division. (2015). World population prospects: The 2015 revision. Department of Economic and Social Affairs, United Nations Population Division. Available at https://esa.un.org/unpd/wpp/Publications/Files/Key_Findings_WPP_2015.pdf. Accessed on June 20, 2016.

United Nations Water. (2014). Transboundary water. Available at http://www.unwater.org/topics/transboundary-waters/en. Accessed on June 7, 2016.

United Nations. (1998a). *Human development report*. United Nations Development Programme. New York: Oxford University Press.

United Nations. (1998b). *World urbanization prospects: The 1996 revisions*. New York: United Nations.

United Nations. (2000). *World population prospects: The 1998 revisions*. United Nations Population Division. New York: United Nations.

United Nations Development Programme. (2005). In A. Giddens, M. Duneier, R. Applebaum, and D.Carr, *Introduction to sociology* (7th ed., p. 213). New York: W. W. Norton.

United Nations Development Programme. (2015). Millennium Goals Development Report, 2015. Available at http//www.undp.org/content/undp/en/home/librarypage/mdg/the-millennium-development-goals-report-2015. Accessed on June 15, 2016.

United Nations Population Division. (2006). *World urbanization prospects 2005*. New York: United Nations Press.

U.S. Department of Agriculture. (1993, February). *World grain situation and outlook*. Washington, DC: Government Printing Office.

U.S. Department of Agriculture (2015). USDA Agriculture Research Services. Available at http://www.ars.usda.gov/is/br/ccd. Accessed on April 10, 2016.

U.S. Department of Energy. (1989). *Energy conservation trends: Understanding the factors that affect conservation gains in the U.S. economy*. Washington, DC: Doe/Pe-0092.

U.S. Energy Information Administration. (May 11, 2016). International Energy Outlook 2016. Chapter 5. Electricity. Available at https://www.eia.gov/forecasts/ieo/electricity.cfm. Accessed on October 11, 2016.

U.S. Environmental Protection Agency. (1990). *Superfund: Environmental progress*. Washington, DC: EPA Office of Emergency and Remedial Response.

U.S. Environmental Protection Agency. (2015). *Causes of climate change*. Available at https://www3.epa.gov/climatechange/science/causes.html.

U.S. Environmental Protection Agency. (2016). Distributed Generation. U.S. EPA: Energy and environment. Available at https://www.epa.gov/energy/distributed-generation. Accessed on June 28, 2016.

Vaidyanathan, G. (July 24, 2014). How to determine the scientific consensus on global warming: An academic feud swirls around how best or even whether to express the scientific consensus around climate change. *Scientific American*. Available at: http://www.scientificamerican.com/article/how-to-determine-the-scientific-consensus-on-global-warming. Accessed on April 20, 2016.

Van Den Berghe, P. (1977–1978). Bridging the paradigms. *Society*, *15*, 42–49.

Van Liere, K., and Dunlap, R. E., (1980). The social bases of environmental concern: A review of hypotheses, explanations, and empirical evidence. *Public Opinion Quarterly*, *44*, 43–59.

Victor, P.A., and Jackson, T. (2015). The trouble with growth. In Gardner, G., Prugh, T. and Renner, M. (Project Directors). *State of the world 2015: Confronting hidden threats to sustainability* (pp. 37–49). Washington, DC: Island Press

Vidal, J. (June 7, 2014). As forests are cleared and species vanish, there's one other loss: a world of languages. *The Guardian*. Available at https://www.theguardian.com/environment/2014/jun/08/why-we-are-losing-a-world-of-languages. Accessed on October 2, 2016.

Vidal, J., Allegra, S. and Goldenberg, S. (December 18, 2009). Low targets, goals dropped: Copenhagen ends in failure. *The Guardian*. Available at: http://www.theguardian.com/environment/2009/dec/18/copenhagen-deal. Accessed on February 1, 2016.

Wackernagel, M., and Rees, W. (1996). *Our ecological footprint: Reducing human impact on the earth*. Gabriola

Island, BC, Canada: New Society Publishers.

Wackernagel, M., Onisto, L., and Bello, P. (1999). National natural capital accounting with the ecological footprint concept. *Ecological Economics*, *29* (3), 375–390.

Wackernagel, M., Linares, D., Sanchez, M., Falfan, I., and Loh, J. (2000). *Ecological footprints and ecological capacities of 152 nations: The 1996 update*. San Francisco, CA: Redefining Progress.

Wackernagel, M., Schulz, N., Deumling, D., Linares, A., Jenkins, M., Kapos, V., Monfreda, C., Joh, J., Myers, N., Norgaard, R., and Randers, J. (July 9, 2002). Tracking the ecological overshoot of the human economy. *Proceedings of the National Academy of Sciences of the United States of America*, *99* (14), 9266–9271.

Walker, E. (2010). Industry-driven activism. *Contexts*, *9* (2), 44–49. The American Sociological Association.

Wallerstein, I. (1980). *The modern world system*, *Vol. 2*. New York: Academic P ress.

Walsh, N.P. (2004, October 22). Russian vote saves Kyoto protocol. *The Guardian*. http://www.theguardian.com/world/2004/oct/23 /society.russia.

Walton, J. (1993). *Sociology and critical inquiry: The work, tradition, and purpose* (3rd ed.). Belmont, CA: Wadsworth.

Wappes, J. (August 18, 2015). Report finds $1.2 billion in Iowa avian flu damage. Center for Infectious Disease Research and Policy at the University of Minnesota. Available at: http://www.cidrap.umn.edu/news-perspective/2015/08/report-finds-12-billion-iowa-avian-flu-damage. Accessed on June 8, 2016.

Weber, M. [1922] 1958. *Economy and Society*. Selections reprinted in *From Max Weber*, ed. H. Gerth and C. W. Mills. New York: Oxford University Press.

Weeks, J. R. (1994). *Population: An introduction to concepts and issues* (5th ed.). Belmont, CA: Wadsworth.

Weeks, J. R. (2005). *Population: An introduction to concepts and issues* (9th ed.). Belmont, CA: Wadsworth.

Weeks, J. (2008). *Population: An introduction to concepts and issues* (10th ed.). Belmont, CA: Thompson Wadsworth.

Wehkamp, J., Devlin, S. and Williams, C. (2013). NEF working paper: Ownership models for sustainable natural resource governance. New Economics Foundation, www.neweconomics.org. Available at: http://b.3cdn.net/nefoundation/b1f9b344e9c1f11db4_zam6bpe51.pdf. Accessed on May, 301, 2015.

Weinberg, A., Pellow, D., and Schniberg, A. (1998). Ecological modernization in the internal periphery of the USA: Accounting for recycling's promises and performance. Presented to the American Sociological Association, August, San Francisco, CA.

Weinberg, A., Pellow, D., and Schniberg, A. (2000). *Urban recycling and the search for sustainable community development*. Princeton, NJ: Princeton University Press.

Weiss, K.R. (December 7, 2015). Global greenhouse-gas emissions set to fall in 2015 China's reduced appetite for coal drives a surprising departure from a long-term trend. *Nature*. Available at: http://www.nature.com/news/global-greenhouse-gas-emissions-set-to-fall-in-2015-1.18965. Accessed April 5, 2016.

Wernick, A. (December 4, 2016). The world's nations vow to move forward with the Paris Agreement, with or without Donald Trump. *PRI*. Available at http://www.pri.org/stories/2016-12-04/worlds-nations-vow-move-forward-paris-agreement-or-without-us-president-elect. Accessed December 10, 2016.

Westman, C. N. (2013). Cautionary tales: Making and breaking community in the oil sands region. *Canadian Journal of Sociology*, *38* (2), 211–231.

White, G. (1980). Environment. *Science*, *209* (4), 183–189.

White, L. (1949). Energy and the evolution of culture. In L. White, Jr. (Ed.), *The evolution of culture* (pp. 363–393). New York: Farrar, Straus, and Giroux.

White, L., Jr. (1967). The historical roots of our ecological crisis. *Science*, *155*, 1203–1207.

Widener, P. (2009). Oil tourism: Disasters and destinations in Ecuador and the Philippines. *Sociological Inquiry*, 79 (3): 266–288.

Widener, P. (2011). *Oil injustice: Resisting and conceding a pipeline in Ecuador*. Rowman & Littlefield Publishing.

Wildcat, D. R. (2014). Introduction: Climate change and indigenous peoples of the USA. In Maldonado, J.K., Colombi, B., and Pandya, R. (Eds). *Climate and indigenous peoples in the United States* (pp. 1–8). Berlin: Springer.

Wilkinson, R. (1996). *Unhealthy societies: The afflictions of inequality*. London: Routledge.

Williams, T. and Hardison, P. (2014). Culture, law, risk, and governance: contexts of traditional knowledge in climate adaptation. In Maldonado, J.K., Colombi, B., and Pandya, R. (Eds). *Climate and indigenous peoples in the United States* (pp. 23–36). Berlin: Springer.

Wilmsen, C., Elmendorf, W., Fisher, L., Ross, J., Sarathy, B., and Wells, G. (Eds). (2012). *Partnerships for empowerment: Participatory research for community-based natural resource management*. New York: Routledge.

Wilson, A. (1992). *The culture of nature: North American landscape* *from Disney to the* Exxon Valdez. Cambridge, MA: Blackwell.

Wilson, E. O. (1975). *Sociobiology: The new synthesis*. Cambridge, MA: Belknap Press of Harvard University.

Wilson, E. O. (1990). Threats to biodiversity. In *Managing planet earth: Readings from* Scientific American (pp. 49–59). New York: W. H. Freeman.

World Bank. (June 19, 2013). Warming climate to hit Bangladesh hard with sea level rise, more floods and cyclones, World Bank report says. Available at http://www.worldbank.org/en/news/press-release/2013/06/19/warming-climate-to-hit-bangladesh-hard-with-sea-level-rise-more-floods-and-cyclones-world-bank-report-says. Accessed on June 22, 2016.

World Commission on Environment and Development. (1987). *Our common future*. Oxford: Oxford University Press.

World Health Organization. (2016). Water sanitation health. Available at http://www.who.int/water_sanitation_health/emergencies/qa/emergencies_qa5/en. Accessed on June 1, 2016.

World Nuclear Association. (June 2016). Nuclear power in the USA. Available at http://www.world-nuclear.org/information-library/country-profiles/countries-t-z/usa-nuclear-power.aspx. Accessed on June, 27, 2016.

Yan, H. (March 3, 2016). Flint water crisis timeline: How years of problems led to lead poisoning. *CNN*. Available at http://www.cnn.com/2016/01/20/health/flint-water-crisis-timeline. Accessed on June 9, 2016.

Yardley, W. (March 2, 2016). Oklahoma takes on fracking-related earthquakes—but too late, critics say. *Los Angeles Times*. Available at http://www.latimes.com/nation/la-na-sej-oklahoma-quakes-fracking-20160302-story.html.

Yearly, S. (1996). *Sociology, environmentalism, globalization*. London: Sage.

Yeomans, M. (2004). *Oil: A concise guide to the most important product on earth*. New York: New Press.

York, R., Rosa, E., and Dietz, T. (2003a). Footprints on the earth: The environmental consequences of modernity. *American Sociological Review*, *68* (*2*): 279–300.

York, R., Rosa, E., and Dietz, T., (2003b). STIRPAT, IPAT, and IMPACT: Analytical tools for unpacking the driving forces of environmental impacts. *Environmental Economics*, *46*, 351–365.

York, R., Rosa, E. A., and Dietz, T. (2009). A tale of contrasting trends: Three measures of the ecological footprint in China, India, Japan, and the United States, 1961–2003. *Journal of World-Systems Research*, 15(2), 134–146.

Young, G. (1994). Community with three faces: The paradox of community in postmodern life with illustrations from the United States and Japan. *Human Ecology Review*, *1* (1), 137–146.

Zamora, J.H. and Lee, H. K. (2002). Earth First activists win case/FBI, cops must pay $4.4 million for actions after car bombing. *San Francisco Gate*. Available at http://www.sfgate.com/news/article/Earth-First-activists-win-case-FBI-cops-must-2829885.php. Accessed on October 21, 2016.

Zeitoun, M. (2013). Global environmental justice and international transboundary waters: An initial exploration. *The Geographical Journal*, *179* (2): 141–149.

Zhou, M. (2015). Public environmental skepticism: A cross-national and multilevel analysis. *International Sociology*, *30* (1), 61–85.

Zimmer, C. (2009). Provocative new study warns of crossing planetary boundaries. Environment 360. Available at http://e360.yale.edu/feature/provocative_new_study_warns_of_crossing_planetary_boundaries/2192. Accessed on June 10, 2016.

INDEX

Page numbers in bold refer to tables. Page numbers in italics refer to figures.