Preface

Climate change has become an undeniable force reshaping not only our physical environment but the very fabric of our social worlds. Rising temperatures, extreme weather events, ecological degradation, and widening inequalities expose the complex interconnections between human societies and natural systems. *Environment and Society* examines these interconnections through a sociological lens, asking how we arrived here, who bears the costs, and how we might collectively chart a more just and sustainable future.

At its core, sustainability asks us to balance the needs of the current generation with those of future generations and to do so in a way that respects ecological limits and promotes social well-being. But, sustainability is a contentious issue: Who decides what must change, and who benefits or loses as societies transition toward cleaner energy and more resilient communities? This book explores these questions by synthesizing key insights from environmental sociology and sustainability studies. It highlights the roles of governments, grassroots movements, and everyday citizens in advancing sustainability, at the same time they confront the complexities of climate change.

By framing the climate crisis through a sociological perspective, *Environment and Society* invites students, scholars, and engaged citizens to see that climate action is not only about new technologies or policies but about transforming the ways we live together on a shared and finite planet. It is about reimagining our communities and taking responsibility for one another and the generations yet to come.

Book Overview

This book is divided into four sections. The first section focuses on defining key concepts, processes, and historical environmental developments.

- Chapter 1 situates the issues of sustainability and climate change in the discipline of sociology, in particular the subfield of environmental sociology. It explains the causes and consequences of climate change, defining the key concepts of mitigation, adaptation, and resilience. Chapter 1 also introduces the concept of sustainability, including the various ways it has been defined, and identifies the United Nations Sustainable Development Goals (SDGs).
- Chapter 2 offers a brief environmental history of how the relationship between humans and nature has changed over time from hunter-gatherer to agrarian to

industrial societies. Various environmental ethics are also explored, including those of preservationists, conservationists, ecologists, eco-feminists, and Indigenous knowledge.

Section 2 investigates the key variables of the IPAT model, or the environmental impacts of population, affluence, and technology. Unlike most applications of the IPAT model, this book considers how each of these variables interacts not just with each other but with climate change and sustainability, too.

- Chapter 3 focuses on the relationship between population and the environment, including Malthusian theory and its critique, characteristics of evolving demographic transitions, and implications of current population trends. The impact of immigration, migration, and urbanization in the context of sustainability and climate change is also examined.
- Even after societies have achieved lower population rates, their impact on the environment can be excessive if they do not curb overconsumption, the carbon emissions it creates, and the waste it produces, issues examined in Chapter 4. Chapter 4 critiques the ecological and carbon footprints of households, including three unsustainable consumption trends: e-waste, fast fashion, and plastic waste. It provides ways we can become more sustainable consumers and debates whether affluence is a problem or solution to environmental harm and climate change.
- What role might green technology and renewable energy play in our decarbonization efforts? Chapter 5 describes how both can help mitigate climate change, evaluating the effectiveness of different types of renewable energy sources. The risk of technological change is also analyzed, so we attempt to account for and avoid costly and irreversible mistakes.

The third section of the book is centered on governance and justice, exploring the power dynamics of climate change policy-making and the unequal distribution of environmental harms.

- Many environmental problems, especially climate change, are global in scope and demand cooperation between nation-states to solve. Chapter 6 describes and critiques the policies of the two most significant international climate treaties: the Kyoto Protocol and the Paris Agreement. Environmental and climate politics within nation-states can be contentious, like in the United States, where political polarization divides the population. Some cities have sidestepped what they argue are ineffective global and national policies by enacting their own initiatives to build sustainable communities and mitigate climate change, proving that global problems are not beyond local actions.
- Chapter 7 focuses on the role of civil society in propelling social change, exploring mobilization strategies, tactics, and framing of nongovernmental organizations and climate movement activists. The emergence of climate justice, the divestment

movement, and the role of Indigenous communities and youth are emphasized. Environmental risks and the effects of climate change are not experienced equally across the population and disproportionately affect low-income communities and people of color.

- Chapter 8 provides a history of the environmental justice movement, highlighting key events, actors, and issues. Different theories of justice are also presented, including distributive justice, procedural justice, recognitional justice, and intergenerational justice. You will also learn about energy justice and the need to accomplish a just transition as we pursue decarbonization strategies.

The last section of this book offers a deep dive into the relationship between climate change and four UN Sustainable Development Goals: Hunger, Human Health and Well-being, Clean Water and Sanitation, and Climate Action.

- Chapter 9 centers on how to end hunger, UN SDG 2, and achieve good health and well-being, UN SDG 3. In this chapter, you will discover how climate change is affecting global efforts to end malaria and cholera and will likely increase heat-related illnesses and deaths, and pose mental health challenges, especially among youth. You will also investigate global hunger and food insecurity and how different agricultural practices might provide solutions to these problems. The factors leading to malnutrition, its effects, and possible remedies are examined as well. UN SDG 6, Clean Water and Sanitation, is also studied in the context of how water stress impacts food security and access to safe drinking water.
- The stakes are high—but not yet insurmountable—in the fight to slow climate change and meet the targets of the UN Sustainable Development Goals by 2030. Chapter 10 describes the progress made so far on global sustainability efforts and outlines strategies to make your own college campus sustainable and climate resilient, such as Meatless Mondays, rainwater harvesting, and a swap closet. These strategies are critical ways you can help your campus achieve multiple targets of UN Sustainable Development Goal 13, Climate Action.

Application of Sustainable Development Goals

The following chapters will provide case studies of each UN Sustainable Development goal, making connections between sustainability practices and climate resilience in countries and cities around the world. The following table offers an overview of each goal and case study.

Chapter	Goal
Chapter 1 Climate Change and Sustainability	Goal 1 No Poverty: Green Jobs
Chapter 2 Nature, Society, and Ethics	Goal 14 Life Below Water: Coral Reef Restoration Goal 15 Life on Land: Saving Megaforests
Chapter 3 Population	Goal 4 Quality Education: Secondary Schooling for Girls Goal 11 Sustainable Cities and Communities: Smart Cities
Chapter 4 Consumption and Affluence	Goal 8 Decent Work and Economic Growth: Work Time Reduction Goal 12 Responsible Production and Consumption Patterns: Sustainable Housing
Chapter 5 Technology and Energy	Goal 7 Affordable and Clean Energy: Clean Cookingstoves Goal 9 Industry, Innovation and Infrastructure: A Sustainable Industrial Revolution
Chapter 6 Governance: Global Institutions, Nation-States, and Cities	Goal 16 Peace, Justice, and Strong Institutions: Climate Change and Conflict in the Middle East
Chapter 7 Nonstate Actors: Civil Society and the Climate Movement	Goal 17 Partnerships for the Goals: Churches and Laudato Si’
Chapter 8 Environmental and Climate Justice	Goal 5 Gender Equality: Women as Climate Activists Goal 10 Reduced Inequalities: Cobalt Mining in the Congo
Chapter 9 Good Health, Food Security, and Well-Being	Goal 2: Zero Hunger Goal 3: Good Health & Well-Being Goal 6 Clean Water and Sanitation: Water Stress
Chapter 10 Becoming Sustainable, Building Resilience	Goal 13: Climate Activism

Chapter 1

Climate Change and Sustainability

Sustainability in the Age of Climate Change

FG Trade Latin / E+ / Getty Images

Learning Objectives:

1.1 Situate the study of climate change and sustainability in the field of sociology.

1.2 Understand the causes and consequences of climate change.

1.3 Describe climate mitigation, adaptation, and resilience.

1.4 Conceptualize sustainability, and identify the United Nations Sustainable Development Goals.

Studying the relationship between the environment and society is quite tricky as it demands a multidisciplinary examination that can offend specialists and deter generalists. Indeed, simply suggesting such a relationship exists is contentious as it implies that humans are separate from nature rather than part of it. Some believe that this separation grants humans the permission to control, manipulate, and exploit the natural environment. Others propose that this relational understanding of the environment and society positions humans as stewards of nature, responsible for its preservation and conservation. For better or worse, human agency matters and is critical to realize a sustainable future. However, it would be remiss to ignore nature's agency. Nature is not simply a passive social construct, and it is, at least at this point in time, a necessity for human survival. While this book emphasizes the consequences of human actions on the environment and climate from a social scientific perspective, the power of nature is not taken for granted. There is no denying that we are living in the **Anthropocene**, the geological time period characterized by the ascendency of human activity on the climate and environment. But, nature has not ended—yet.

More specifically, this book aims to examine the challenges posed by climate change and highlight how societies around the world are working to build a future where everyone regardless of their gender, race, ethnicity, religion, age, or sexual preference can achieve sustainability with lower (and eventually zero) carbon emissions. In the following chapters, you will explore the United Nations 17 Sustainable Development Goals (SDGs) and learn how they are being implemented to mitigate and adapt to climate change in a variety of communities, cities, and countries. By reading this book you will acquire both an ecological and sociological imagination. An **ecological imagination** involves developing the ability to discern the relationship between human action and its ramification on the natural environment (Norgaard, 2018). How does driving a car to school or work daily affect our natural environment? You might consider how and where the petroleum to drive your car was extracted, the carbon emissions that are released into the atmosphere when you drive your car, and the natural habitat that was destroyed to build the roads you drive on and the lot where you park your car. The **sociological imagination** challenges us to understand how social structures constrain and enable our actions, including those that destroy the environment and contribute to climate change but also those that can help create sustainable societies Using the sociological imagination to reflect on why you drive a car to school or work requires scrutinizing the social forces that constrain your ability to walk, bike, or ride public transportation: Perhaps your town lacks sidewalks or bike lanes, making these options unsafe, and public transportation does not exist. Alternatively, perhaps you live in city that is pedestrian-friendly and enables you to travel more sustainably with access to safe and reliable busses and subways. This chapter offers introductory explanations of climate change and sustainability to provide a foundation to begin cultivating your ecological and sociological imaginations.

Toward a Sociology of Climate Change and Sustainability

Sociological examinations of climate change and sustainability are relatively new, but they can learn from and expand on theories and research from the established subfield of environmental sociology. Some of the most important lessons from environmental sociologists are understanding that humans are inextricably connected to their natural ecosystems, recognizing environmental inequalities, evaluating environmental risk, and perceiving how economic growth negatively impacts the environment.

Lessons From Environmental Sociology

Environmental sociology emerged in the 1970s during a time of durable government and public support for environmental regulations and concern about how human activities, especially how mass production and consumption were threatening—if not destroying—our ecosystems (Dunlap & Catton, 1979; Pellow & Brehm, 2013). In 1970, over 20 million Americans celebrated the first Earth Day to raise awareness about air and water pollution, toxic industrial waste, the unregulated application of pesticides, biodiversity loss, the destruction of natural habitat, and other environmental harms A few months later, the Environmental Protection Agency (EPA) was created to protect the environment and human health, ensuring that we have clean air, water, and land (Environmental Protection Agency, 2025). The EPA monitors and enforces environmental laws passed by Congress, like the Clean Air Act passed in 1970 to reduce air pollution and the Clean Water Act passed in 1972 to prevent hazardous discharge from entering our waterways. Other federal agencies also work to keep our bodies healthy and preserve our natural environment. The Food and Drug Administration regulates chemicals, food, drugs, cosmetics, and other consumer products to reduce our exposure to toxins. The United States Department of Agriculture also works to ensure food safety in addition to establishing nutritional standards, supporting farmers with financial assistance, and overseeing food security programs, like the Supplemental Nutritional Assistance Program, to reduce hunger. The U.S. Fish and Wildlife Service specializes in efforts to conserve natural habitats, like the Arctic National Wildlife Refuge in Alaska, and protect endangered species, like loggerhead sea turtles and the California condor.

Efforts to understand our relationship with nature and protect the environment have a robust history informed by the reflections and observations of biologists, naturalists, poets, farmers, hunters, and philosophers (to name a few), which helped to establish the preservation and conservation movements of the late 19th and early 20th century (see Chapter 2). Many of their ideas, like Aldo Leopold's land ethic, John Muir's belief in the intrinsic value of wild places, and Henry David Thoreau's lifestyle of simplicity, continue to inspire people to respect nature and their relationship with nonhuman species. They also contribute to what Pellow and Brehm (2013, p. 229) argue is one of the two "defining features" of environmental sociology: the "inseparability of human and nonhuman natures." Understanding that humans and the societies they develop are connected with and often dependent upon the natural environment and other species was a consideration of classical sociological theorists, like Karl Marx, but was not sufficiently recognized (much less researched) by most sociologists until more recently (Foster, 1999; Pellow & Brehm, 2013; see Chapter 2).

In contrast, inequality, the other defining feature of environmental sociology identified by Pellow and Brehm (2013), is one of the central issues studied by sociologists and enables them to provide critical disciplinary insight into how power affects our relationships with nature, social institutions, and each other. The environmental justice movement that formed in the early 1980s to fight environmental racism and the inequitable distribution of environmental hazards has been the focus of research and advocacy for many sociologists, especially the work of Robert Bullard and his landmark book, *Dumping in Dixie: Race, Class, and Environmental Quality* (1990; see Chapter 8). Black, indigenous, and other people of color, women, the impoverished, the young, and the elderly are among the vulnerable populations that are most likely to suffer from disproportionate exposure to air pollution, water pollution, and toxic chemicals in their communities, workplaces, schools, and homes.

Pellow and Brehm (2013) also identify the significance of sociological theories and research on risk and disasters in the field of environmental sociology. Technological innovations that are intended to help society often pose risk to humans and nature, even unintentional destruction (see Chapter 5). Charles Perrow (1984) describes how such risks are normalized in modern societies due to the increasing complexity of technologies in his classical work, *Normal Accidents: Living With High-Risk Technologies*. Importantly, sociologists emphasize that natural disasters, like hurricanes and floods, often coincide with man-made disasters and can amplify economic and social inequalities. Kai Erikson's (1978) study of the deadly 1972 Buffalo Creek flood caused by the collapse of a coal slurry impoundment dam portrays the social disintegration and collective trauma suffered by residents in a desperately poor region of Appalachia. Over 100 people were killed, over 1,000 people were injured, and thousands were left homeless after waste water burst through the dam due to heavy rain. Though survivors sued for disaster relief damage, the mining company only paid $13.5 million in compensation. Likewise, Eric Klinenberg (2002) discovered that the most socially isolated people, especially the elderly and those residing in poor neighborhoods, suffered higher fatality rates during the 1995 heatwave that killed over 700 people in Chicago. Kathleen Tierney (2014) explains in her book, *The Social Roots of Risk: Producing Disasters, Promoting Resilience*, that all risks and disasters are essentially sociological because they are caused by social institutions and organization, but she reminds us that human resilience to minimize risk and prevent or reduce the severity of disasters is also produced by society.

Lastly, environmental sociologists have emphasized how the imperative of economic growth has caused and perpetuated environmental degradation. Corporate profit-seeking fuels the **treadmill of production**, which demands continuous increases in production, insatiable consumerism, and technological dominance over humans and nature (Buttel, 2004; Gould et al., 2008). Government policies that favor economic expansion support the treadmill of production at the expense of human health, community well-being, workers, and environmental protections. Environmental sociologists theorize that the treadmill of production is inherently contradictory: Natural resources that are exploited for current production will eventually be less efficient to extract and eventually be depleted. The waste generated by the treadmill of production is also inefficient. It is costly to clean up, and hazardous materials that are dumped in landfills can contaminate soil and water, threatening the health of humans and other species. Workers who are cast off the treadmill by new technologies also become a form of waste and expendable if they cannot find new jobs.

Bringing in Climate Change and Sustainability

While sociology has "hardly ignored the environment," it could more effectively "make sense of the social causes and consequences of climate change" (Klinenberg et al., 2020, p. 650). Compared to environmental sociology, which is firmly established in the discipline, the sociology of climate change is in its infancy—though it has great potential (Falzon et al., 2021). The first comprehensive work on climate change by sociologists was an edited volume, *Climate Change and Society: Sociological Perspectives* (Brulle & Dunlap, 2015), that compiled research from leading environmental scholars affiliated with the American Sociological Association's Task Force on Sociology and Global Climate Change (Klinenberg et al., 2020). Their message is clear: climate change is "an inherently sociological concern" (Brulle & Dunlap, 2015, p. 24). Given the breadth of the discipline, sociology is advantageously positioned to "contribute a deeper understanding of the human dimensions of climate change and its social, institutional, and cultural dynamics" (Brulle & Dunlap, 2015, p.2). However, most sociological research on climate change continues to be conducted and published in "transdisciplinary spaces beyond the boundaries of the discipline" (Koehrsen et al., 2020, p. 739). While this is not surprising given the interdisciplinary concerns of climate change, bringing climate change into mainstream sociological journals and other publication outlets would raise awareness of the contributions the discipline has to offer.

A sociology of climate change certainly can build on the lessons learned from environmental sociology outlined in the previous section. First, climate is an essential "prerequisite for human existence" (Padovan & Sannella, 2023). Human survival is inseparable from a climate that is either too hot or too cold, which depends on an optimal greenhouse gas effect to make the Earth habitable. The fact that human activity is the primary driver of the speed at which the earth's climate is changing demands that we interrogate and mitigate our dependence on fossil fuels (Dietz et al., 2020). It should also impel us to adopt a more reflexive understanding of our relationship with the climate and how it is affecting our built and natural environments and other species. In sum, how society responds to the impending climate crisis will determine the natural system of the climate, including the greenhouse gas effect, which in turn will shape the fate of all living beings in the biosphere.

Second, climate change is "poised to alter and exacerbate existing inequalities" (Falzon et al., 2021, p. 196) and expose power differentials across "multiple lines of stratification," especially race, class, and gender (Dietz et al., 2020, p.135). Countries, communities, and households with the most wealth, power, and technological expertise—often the very actors most responsible for generating greenhouse gas emissions that cause climate change—are best positioned to mitigate and adapt to climate change. Poorer people, people of color, and people residing in the Global South are already suffering the consequences of climate-induced extreme weather events and sea-level rise. Marginalized communities within nations, especially women and indigenous people, are also disproportionately impacted by climate change (Falzon et al., 2021). Their voices remain the least likely to be recognized in international climate policy. Thus, climate change is undeniably a matter of justice (see Chapter 8).

Clearly, climate change poses uncertainty and risk and has already caused disasters around the world. But, the third lesson of environmental sociology also teaches us that we can use our human ingenuity and social institutions to become more resilient. Creating ways to mitigate and adapt to climate change—or building climate resilience—will require not only new technologies but also new policies, new organizations, and new ways to collaborate. Beck (2015) explains how the global risk of climate change could engender what he calls **emancipatory catastrophism**, as the anticipation of this global catastrophe can produce an anthropological shock that ultimately acts as a social catharsis, resulting in new norms, laws, technologies, and international cooperation This "metamorphosis of the world" will change the way we conceptualize inequality, privileging a cosmopolitan perspective over national self-interest and bringing "communities of risk" into the decision-making process (Beck, 2015, p. 76; see Chapter 5).

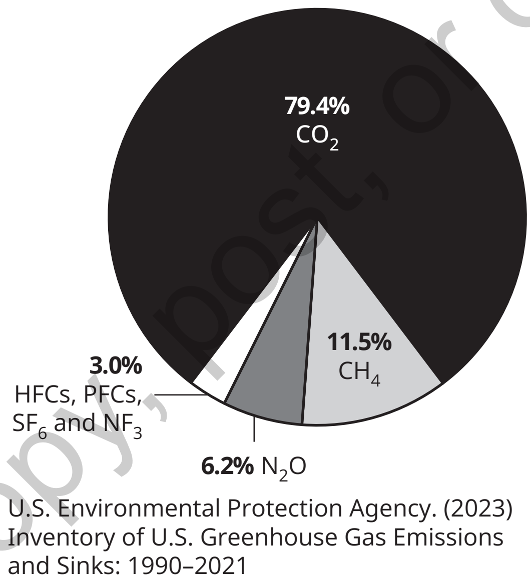
The good news is that sociology is making progress on studying climate change. However, sociologists remain "slow to address directly the questions raised by the issue of sustainability" (Passerini, 1998). In particular, sociologists studying climate change[1] could make stronger connections to **sustainability**, or how we can develop to meet the social, environmental, and economic needs of the present generation "without compromising the ability of future generations to meet their own needs" (Brundtland Commission, 1987). Given the fact that *social* is one of the pillars of sustainability, it is curious that sustainability is not more central to the discipline. Sustainability is hardly mentioned in *Climate Change and Society: Sociological Perspectives* (Brulle & Dunlap, 2015)—though, to be fair, it was published the same year that the United Nations initiated Agenda 30, which articulated 17 Sustainable Development Goals (SDG) to accomplish by the year 2030 (see Figure 1.7). Agenda 2030 makes it clear that "action on climate change will drive sustainable development" at the same time investing in sustainable development will help reduce greenhouse gas emissions and help communities adapt to climate change, or foster climate resilience (Sustainable Development Agenda, n.d.).

Each chapter of this book will highlight specific ways this is happening by examining how each SDG can be achieved through different climate mitigation and adaptation techniques (see Table in preface). This chapter examines the first SDG goal, No Poverty, and how green jobs can help build climate resilience (see Box). But before we investigate sustainable ways to solve—or least slow down—climate change, it is important that you know that basics of the anthropocentric causes of climate change as well as its ecological and social effects.

Climate Change 101

The Earth's temperature is regulated by greenhouse gases that trap heat in its atmosphere, absorbing solar energy that is not reflected back to space. This so-called **greenhouse gas effect** warms the Earth and makes it comfortably habitable for humans and other species. Problems arise, however, when an excess of these gases are present in the atmosphere. This results in more heat being trapped and subsequently warmer temperatures that threaten the survival of many species, potentially even humans. This is the situation we are currently experiencing. While the three most significant greenhouse gases—carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)— naturally exist and fluctuate, human activity has magnified the concentration of them in our atmosphere.

Figure 1.1 ▪ U.S. Greenhouse Gas Emissions



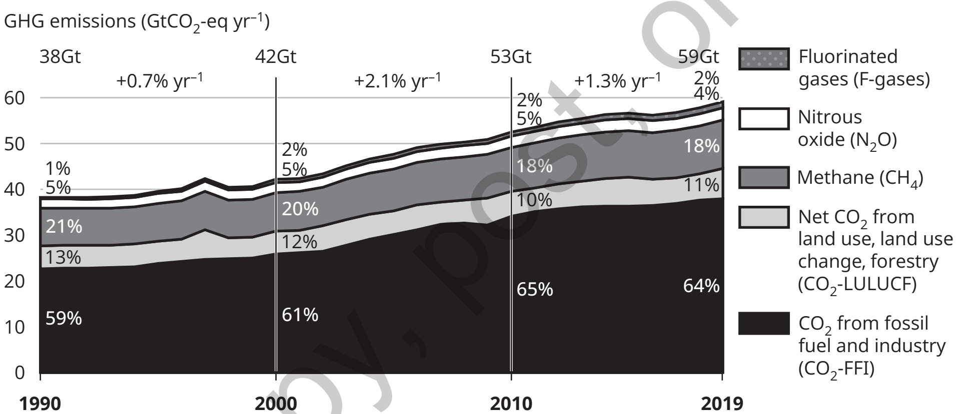
Environmental Protection Agency. (2025, January 16). Overview of Greenhouse Gases. https://www.epa.gov/ghgemissions/overview-greenhouse-gases

CO_2 is the most common greenhouse gas (see Figure 1.1), which enters the atmosphere primarily through the burning of fossil fuels, especially coal and oil, and deforestation. CO_2 accounts for almost 80% of greenhouse gas emissions in the United States, and its main sources include transportation (35%), electricity (31%), and industry (16%). CH_4 emissions are mainly a result of agricultural practices, particularly raising livestock, but are also created by fossil fuel production. CH_4 accounts for 11.5% of all U.S. greenhouse gas emissions. N_2O emissions are also largely caused by agriculture and account for 6.2% of greenhouse gas emissions in the United

States. While fluorinated gases only make up 3% of greenhouse gases in the United States, they are quite powerful and classified by the EPA as having high global warming potential. These gases are all made by humans and originate from industrial processes. Hydrofluorocarbons, used as a coolant in refrigeration and air conditioners, are the most common type of fluorinated gas and a growing source of emissions when they leak. According to the EPA, the United States emitted 6,343 million metric tons of carbon dioxide equivalent in 2022 (Environmental Protection Agency, 2025).

Global greenhouse gas emissions follow a similar trend to those in the United States, though CH_4 emissions are noticeably higher due to agriculture in Asia (see Figure 1.2). This is concerning because methane is more potent than carbon dioxide, trapping more heat in the atmosphere. However, it is short-lived compared to CO_2 so does not remain in the atmosphere for as long. CH_4 stays in the atmosphere on average for only a decade, while CO_2 concentrates in the atmosphere for thousands of years (Environmental Protection Agency, 2025).

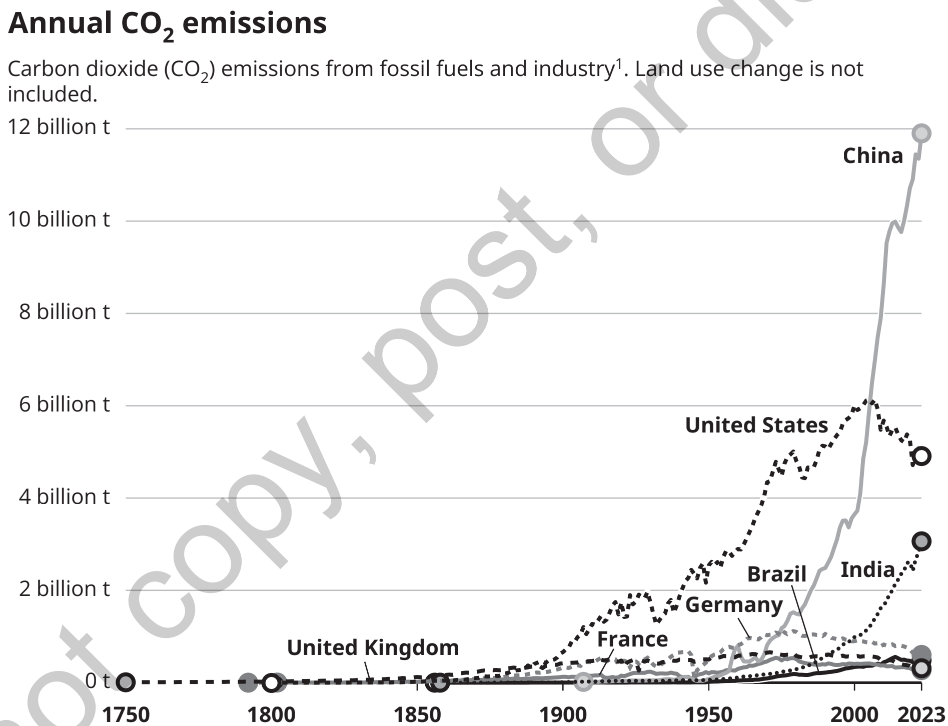
Figure 1.2 ▪ Global Greenhouse Gas Emissions



Based on IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.001. https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_SPM.pdf

Global greenhouse gas emissions reached an all-time high of 58 gigatons (Gt) in 2022 (United Nations Environment Programme, 2023). More specifically, carbon emission from energy combustion and industrial processes grew 0.9% in 2022, reaching a record high of 36.8 Gt (International Energy Agency, 2023). The countries with the highest carbon emissions are China (11.47 billion tons), the United States (5.01 billion tons), and India (2.71 billion tons) (see Figure 1.3). However, focusing on current emissions masks cumulative emissions of which the United States is responsible for 25%, the European Union for 22%, China for 13%, and India only 3% (Tollefson, 2019). Furthermore, emphasizing total emissions rather than per capita emissions more clearly illuminates the inequality of climate change. Saudi Arabia leads the world in tons of CO2 emissions per capita at 18.1 with the United States ranking second at 16.6 tons per capita and Canada ranking third at 15.3 tons per capita. In contrast China emits 7 tons of CO2 per capita and India only 2 tons (Tollefson, 2019). In general, poorer nations are suffering from the effects of climate change to which they have contributed very little and should arguably be compensated by wealthier countries—especially those that have developed their economies via fossil fuel extraction and consumption (see Chapter 8). One key goal of the 2015 Paris Climate Agreement is to provide financial and technical support to help developing countries build climate resilience—and uphold the $100 billion pledge wealthy countries made at the 2009 CO15 meeting in Copenhagen to achieve this.

Figure 1.3 ▪ Annual CO2 emission by select countries, 1750-2021



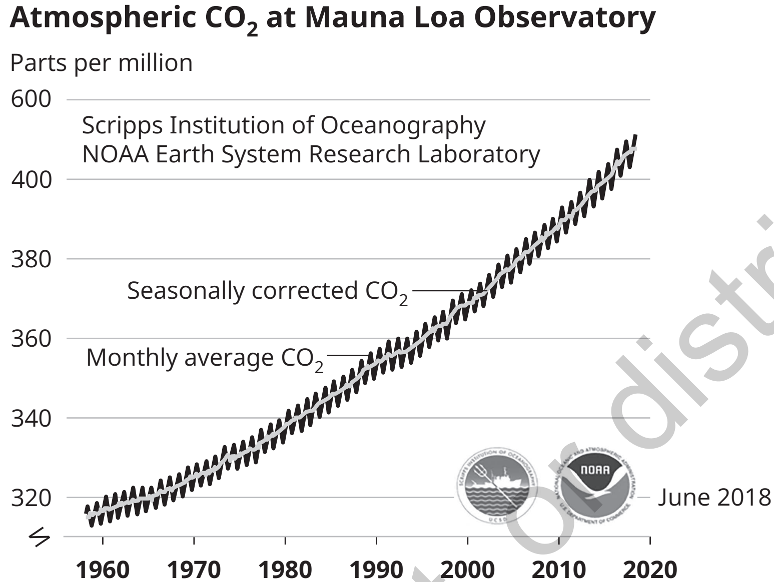
Our World in Data. ("Data Page: Annual CO_2 emissions", part of the following publication: Hannah Ritchie, Pablo Rosado, and Max Roser (2023). "CO_2 and Greenhouse Gas Emissions". Data adapted from Global Carbon Project. Retrieved from https://archive.ourworldindata.org/20250716-155402/grapher/annual-co2-emissions-per-country.html [online resource] (archived on July 16, 2025). https://ourworldindata.org/grapher/annual-co2-emissions-per-country CC BY 4.0 https://creativecommons.org/licenses/by/4.0/

Anthropogenic climate change is straightforward: The emission of greenhouse gases, especially CO_2, predominantly from burning fossil fuels, has caused temperatures to increase on Earth. Therefore, the most tangible way to reduce greenhouse gas emissions is for humans to reduce or eliminate their dependence on fossil fuels. Of course, this is easier to state than to accomplish since economic development has relied on burning fossil fuels. Though data from ice-cores show that CO_2 began to rise over 7,000 years ago when early farmers destroyed forests to clear land to grow crops (Maslin, 2021; Ruddiman, 2005), it was not until the Industrial Revolution in the mid-to-late 18th century that CO_2 and other greenhouse gases started to increase exponentially in the atmosphere as a consequence of burning coal. Recent research has found that global warming started in the Arctic and tropical oceans in the 1830s, developed in Europe, North American, and Asia in the 1850s, and advanced to Australia and South America in the early 1900s (McGregor et al., 2016). Data from the Mauna Loa observatory in Hawaii confirm that CO_2 has steadily increased in the Earth's atmosphere since 1958 from 316 parts per million by volume (ppmv) to over 420 ppmv in 2021—the highest level that has ever been recorded (Maslin, 2021, p. 6) (see Figure 1.4). Interestingly, on average, the growth of global GNP per capita correlates with this increase in CO_2, suggesting that what might be good for the economy is not necessarily good for the environment (Groningen Growth and Development Centre, 2020). But, this trend is changing as the United States and the European Union are now reducing their carbon emissions at the same time their economies are growing. Further, decoupling of economic growth and increasing emission is likely to expand as businesses and investors find ways to profit from reducing greenhouse gas emissions (Jaffe, 2021; see Chapter 4).

Fossil fuels are efficient and relatively inexpensive sources of energy but quite costly from an environmental standpoint. Increasing temperatures have resulted in global sea-level rise due to melting ice sheets; extreme weather events like floods, droughts, and heat waves; and the loss of biodiversity. Climate scientists warn that these occurrences will intensify if the Earth continues to warm. Research from the Intergovernmental Panel on Climate Change (IPCC**, 2019**) sixth assessment report published in 2022 predicts we will experience warmer temperatures globally and more extreme climate-induced weather events, stressing the importance of limiting global temperature rise to 1.5 degrees Celsius (about 2.7 degrees Fahrenheit). Likewise, the 2015 Paris Agreement on Climate Change recommends limiting the increase in global temperature ideally to no more than 1.5 degrees Celsius above pre-industrial levels if we hope to prevent further, irreversible damage to the environment. This target was reaffirmed at the 26th United Nations Climate Change Conference (COP26) in 2021 with countries being asked to implement strategies, such as phasing out coal and investing in renewable energy sources, which can help them achieve net zero greenhouse gas emissions by 2050. Chapter 6 provides a comprehensive examination of global governance and law as well as U.S. environmental regulations and policies.

In addition to burning fossil fuels, other human activity, particularly clearing forests and land for agriculture and urban development, contributes to greenhouse gas emissions. Trees, grasses, plants, and soil act as **carbon sinks** that store CO_2, and when they are destroyed or degraded to grow crops, raise livestock, or build cities, more CO_2 is released into the atmosphere. Recently, scientists discovered that the Amazon rainforest is now emitting more carbon dioxide (over a billion tons per year) than it absorbs due to farmers burning sections of it for beef and soy production (Carrington, 2021). Methane emissions also increase when land is transformed

Figure 1.4 ▪ Historical Levels of Atmospheric CO_2



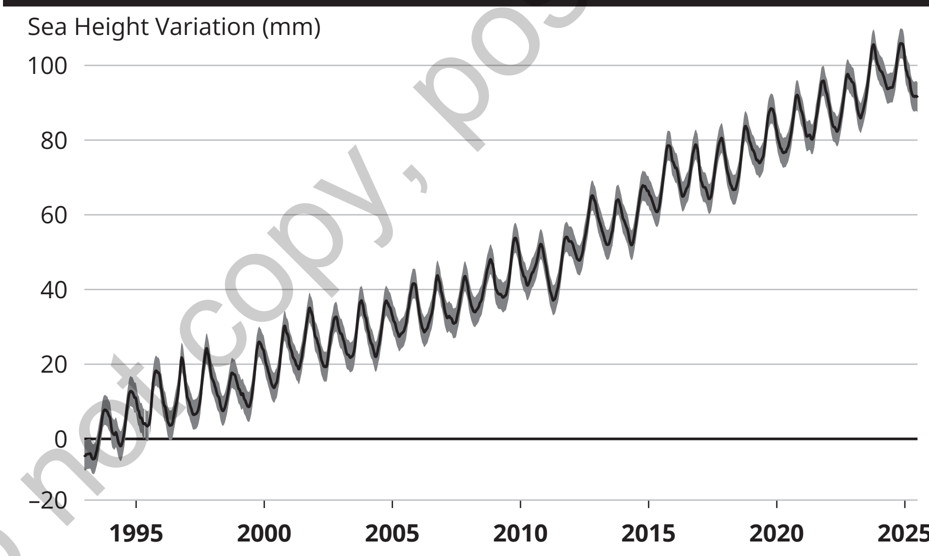
National Oceanic and Atmospheric Association (2018, June 7). "Carbon dioxide levels breach another threshold at Mauna Loa." https://www.noaa.gov/news/carbon-dioxide-levels-breach-another-threshold-at-mauna-loa

for rice cultivation, which necessitates flooding fields. This water blocks oxygen from the soil, resulting in bacteria that emit CH_4. Manure and digestive gas from livestock raised for human consumption, especially ruminants like cattle and lamb, also produce methane, accounting for approximately 32% percent of global anthropogenic CH_4 emissions. The increase of methane will become even more problematic if the world's population increases its consumption of animal protein (Ritchie, 2024).

Oceans are another important carbon sink that absorb about 25% of all global carbon emissions (Maslin, 2021; Shutler & Watson, 2020). Oceans are becoming warmer from absorbing so much carbon, and this warmth has been extending to lower depths over time. Average global sea surface temperatures have increased 0.14 degrees Fahrenheit per decade since 1901 (National Oceanic and Atmospheric Administration, 2021). Oceans are also becoming more acidic, which harms ocean life and has contributed to the bleaching of coral reefs (see Chapter 2). Two major concerns are how warmer oceans affect global weather patterns and elevate sea levels. Severe tropical cyclones or storms, which cause flooding and wind damage, have increased and are predicted to continue to do so in the future due to warmer oceans (Chung et al., 2021). These incidents are amplified in coastal regions and cities, such as Houston, Texas that witnessed record flooding in August 2017 from Hurricane Harvey.

As oceans warm, they expand in volume and cause the global sea level to rise. Data from the IPCC indicate that the global sea level increased over 24 centimeters (9.4 inches) between 1901 and 2018 (Maslin, 2021). The rate of change between 1993 to the present has been quite rapid at 3.4 millimeters per year (see Figure 1.5). Warmer oceans accounted for 39% of this increase, but the melting of the Greenland and Antarctic ice sheets have accelerated this growth in recent decades. Between 2007 and 2016, mass loss of the Antarctic ice sheet tripled, and mass loss from Greenland doubled compared to the previous decade (IPCC, 2019; Maslin, 2021). Melting glaciers, warming (and disappearing) permafrost, and decreasing spring snow cover in the Northern hemisphere are other significant changes that contribute to global sea level rise. New research reveals that glaciers across the Himalayas are melting quickly, receding at a rate "ten times faster in the past forty years than during the previous seven centuries" (Subbaraman, 2021). Thawing permafrost in Siberia and Alaska is creating unstable land that distresses if not destroys homes and infrastructure and releases a significant amount of greenhouse gases, especially methane, into the atmosphere. The global rising sea level is quite troublesome for tiny island nations, like Tuvalu, which may completely disappear. At COP26, the foreign minister of Tuvalu stressed that his people were being confronted with the likelihood of climate mobility, or being forced from their homes and, in this case, the entire island, due to the catastrophic effects of climate change. He also stated that government officials were investigating legal options to retain ownership of its maritime zones and " recognition as a state under international law" if the nation becomes entirely submerged (Booth & Adam, 2021). Clearly, climate change is not being experienced equally, which you will learn more about in Chapter 8.

Figure 1.5 ▪ Increase in Global Sea Level



NASA (2025, April). "Sea Level." https://climate.nasa.gov/vital-signs/sea-level/

Extreme flooding events from more intensive rainfall are expected to escalate in the future (Brunner et al., 2021). The catastrophic flooding in July 2021 in parts of Germany and Belgium when 8 inches of rain fell in less than 24 hours destroyed homes and caused more than 200 deaths. Climate scientists predict that in parts of Western Europe these events might be up to 19% more intense as a result of a 1.2 degrees Celsius (2.16 degrees Fahrenheit) increase in global temperature since pre-industrial times (Reuters, 2021). In the summer of 2021, the Henan and Hubei provinces in China also experienced torrential rainfall, resulting in devastating flooding that destroyed homes, businesses, bridges, and roads. Over 300 people died in the Henan province after one 1 of rainfall fell in 3 days (Victor, 2021).

Many people around the world have also perished from heatwaves and droughts as a consequence of anthropogenic climate change. The summer of 2021 witnessed record-breaking heatwaves in the Pacific Northwest of the United States and Canada, where hundreds of people died from the high temperatures—often due to a lack of air conditioning in their homes and the inability to access cooling centers. Portland, Oregon reached an all-time high of 116 degrees Fahrenheit in June and experienced another heatwave in early August. The heat was so intense that roads buckled, and power lines melted, including the cables for Portland's Streetcar service. In July 2022, the United Kingdom issued its first red extreme heat warning in history, reaching its highest temperature ever recorded at 104.5 degrees Fahrenheit. The extreme heat fueled wildfires in southwest France, Spain, and Portugal, where over 1,000 deaths were attributed to heat-related causes. The summer of 2024 was the hottest on record. According to data from the National Aeronautics and Space Administration (Younger, 2024), August 2024 set a new monthly temperature record—it was 2.34 degrees Fahrenheit warmer than average. The year 2024 also marked the first year since records have been kept that the Earth's average temperature was higher than 1.5 degrees Fahrenheit above preindustrial times (Gramling & Rosen, 2024).

Even if the global temperature increases only 1.5 degrees Celsius, the impact of climate change will become more complex. Disasters caused by extreme weather events are predicted to compound or happen simultaneously, with their effects cascading across different sectors of the natural environment and human society. The IPCC Sixth Assessment Report provides the following example:

> Unavoidable sea level rise will bring cascading and compounding impacts resulting in losses of coastal ecosystems and ecosystem services, groundwater salinisation, flooding and damages to coastal infrastructure that cascade into risks to livelihoods, settlements, health, well-being, food and water security, and cultural values in the near to long-term (Intergovernmental Panel on Climate Change, 2022, p.21)

Communities need to prepare for the cascading and compounding effects of climate change by becoming as climate resilient as possible.

Climate Resilience: Mitigation and Adaptation

Given our current state of knowledge about climate change and experiences dealing with its effects so far, it is critical that we discover ways to develop **climate resilience** so we can prepare for, respond to, and cope with the potentially life-altering effects of climate change (Center for Climate and Energy Solutions, n.d.). Two key processes to build climate resilience are mitigation and adaptation. **Mitigation** involves efforts to reduce or prevent the emissions of greenhouse gasses that cause climate change, like replacing fossil fuels with renewable energy sources. **Adaptation** refers to how we can reduce vulnerabilities and manage the risks associated with climate change, such as building infrastructure to withstand strong wind or flooding. Some activities both mitigate climate change and help communities adapt to it. Urban forests, for example, function as carbon sinks that mitigate emissions and also provide shade so city dwellers can adapt to heatwaves. While technology plays a large role in mitigation and adaptation efforts, biological or natural options also matter—and may be less expensive, like restoring wetlands to control flooding and planting more trees to absorb carbon.

Climate resilience can be pursued by individuals, communities, businesses, all levels of government, and global institutions. Systemic change is best realized through climate resilience plans at the global institutional level, especially for mitigation. International climate treaties that hold countries accountable for specific emission reduction targets ideally can limit global temperature rise at the macrolevel. But, lifestyle changes by individuals can also make a difference in mitigating emissions by reducing our carbon footprints (see Chapter 4). Driving less (or not at all) clearly reduces carbon emissions and improves air quality. Walking and cycling can help not only to mitigate climate change but also become adaptation strategies if power outages render subways or electric trams inoperable. Solar reflectance pavement, increased greenery, cooling shelters with green roofs, and water stations can help walkers and bikers adapt to rising temperatures. In colder weather, enclosed pathways between buildings can provide safe and comfortable walking opportunities, like the Minneapolis skyway system. One low-tech social adaptation to heat-related fatalities that individuals can perform is checking on one's neighbors, especially elderly ones who are isolated. Research on the 2003 heatwave in France that killed around 15,000 people found that individuals who participated in no social activities were six times as likely to die. Residents of the Edison-Eastlake community in Phoenix—one of the hottest cities in the United States—hope to avoid such a tragedy by training qualified heat responders to help neighbors at risk of heat-related trauma (Kaplan, 2020).

Considering the localized impacts of climate change, adaptation strategies vary considerably, which is why it is important that individuals and other stakeholders participate in their communities to build climate resilience. The U.S. Climate Resilience Toolkit, managed by National Oceanic and Atmospheric Administration's (NOAA) Climate Program Office, recommends the following steps:

1. Explore hazards
2. Assess vulnerability and risk
3. Investigate options
4. Prioritize and plan
5. Take action

NOAA's toolkit website (https://toolkit.climate.gov/case-studies) provides over 100 case studies on climate resilience projects from communities around the country. For example, the city of San Angelo, Texas collaborated with Adaptation International and a NOAA project team to sponsor workshops for various stakeholders in the community on weather-related challenges. Heavy rainfall was the key concern, but attendees learned that projected increases in extreme heat were likely to cause more intense droughts. The desire to use excess rainwater during drought situations and monitor areas in the city that needed water encouraged the adoption of two adaptation strategies: launching rainwater harvesting systems in two parks and installing an evapotranspiration weather station adjacent to recreational fields for efficient irrigation.

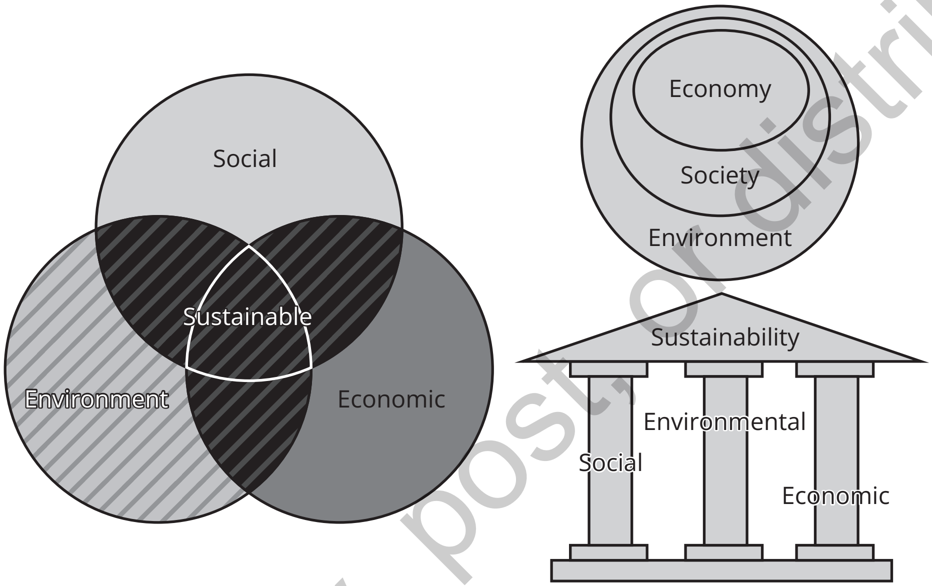
While climate change is a challenge to everyone, those without the financial and technical resources to adapt to or mitigate its potentially life-threatening effects are especially vulnerable. It is also important to recognize that the risk of climate change is not distributed equally. Poor people, especially those in the Global South, suffer disproportionately from climate-related weather events and disasters caused by warmer temperatures. Wealthier countries, which produce the most CO_2 emissions per capita, developed their economies and many would argue their global power via fossil fuels. Yet, poorer nations are suffering the costs of climate change to which they have contributed very little. As a consequence, they are victims of climate injustice and many argue they should be compensated by developed countries (see Chapter8). As noted previously, one key goal of the 2015 Paris Agreement is to provide financial and technical support to help developing countries build climate resilience and uphold the $100 billion pledge wealthy countries made at the 2009 CO15 meeting in Copenhagen to achieve this (see Chapter 6). However, vulnerable populations have not been waiting idly for this support to materialize. Many have no choice but to proactively find ways to adapt to the most urgent effects of climate change in their local environments with or without the help of those most responsible. For example, Vietnam is adapting to coastal erosion in the Mekong Delta by restoring mangrove forests to buffer flooding and experimenting with aquaculture in floodplains. The country has also strategized resettlement plans for citizens who will be displaced by climate-related disasters. In Bangladesh, communities are adapting to flooding and sea-level rise by investing in mangrove reforestation, developing rice that is tolerant to saltwater, and building elevated houses. Other countries are taking similar adaptation measures, but some, including almost half of the countries in Latin America, lack national adaption policies (Cisneros et al., 2024).

Ideally, climate mitigation and adaptation strategies in all countries—rich and poor—can be planned and implemented through the lens of sustainability. Understanding climate action through a sustainability framework ensures that we not only address the immediate challenges of climate change but also propel long-term environmental, economic, and social transformation. Grounding mitigation and adaptation in sustainability will allow international organizations, national governments, cities, and local communities to develop policies and practices that build resilience, reduce inequality, and promote systems that are equitable and enduring across generations.

Sustainability 101

Sustainability is fundamental to fighting climate change and achieving climate resilience. As mentioned previously, sustainability consists of three pillars or concentric circles: the social, the environmental, and the economic (see Figure 1.6).

Figure 1.6 ▪ Pillar and Concentric Circles of Sustainability



Purvis, B., Mao, Y., & Robinson, D. (2019). Three pillars of sustainability: In search of conceptual origins. *Sustainability Science, 14*, 681-695. CC BY 4.0 http://creativecommons.org/licenses/by/4.0/

The pillar conceptualization of sustainability was developed by the World Commission on Environment and Development in its legendary 1987 Brundtland Report that instituted the concept of sustainable development, which is development that meets the needs of the current generation without undermining the efforts of future generations from achieving their needs (The Brundtland Commission, 1987). The pillar approach aims to balance the protection of the environment with economic growth and social inclusion or equality (see bottom right corner of Figure 1.6). Newer models have been developed over the years that capture the relationship between the three pillars in a more sophisticated manner. Sustainability is conceptualized as the intersection between society, the environment, and the economy in the overlapping concentric circles located on the left side of Figure 1.6. This model recognizes that not all social and economic development is sustainable. It also conveys that environmental initiatives may not be sustainable from a social or economic perspective, like protecting land for an endangered species when it could be used to grow crops for those who suffer from hunger or be developed for tourism to boost a local economy. Environmental sustainability is emphasized in the third model (upper right corner of Figure 1.6), implying that if we do not have a healthy environment, then society and the economy will suffer. This is perhaps most obvious in the case of climate change—the economy or society will cease to exist if global temperatures exceed our mitigation and adaptation efforts. Clearly, society and the economy depend on the environment to exist, while the environment can exist independently of either. This model also demonstrates that the economy exists *within* society, which is important when studying equity, equality, and justice.

Figure 1.7 ▪ United Nation Sustainable Development Goals

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United Nations. Sustainable Development Goals. https://www.un.org/sustainabledevelopment/news/communications-material/

The Brundtland Report became the foundation of Agenda 21, a sustainable development action plan that was adopted by over 175 countries at the 1992 UN Earth Summit in Rio de Janeiro. Many of the Rio Declaration principles of Agenda 21, including poverty eradication, intergenerational equity, inclusive decision-making and participation, and gender equality set the precedent for future UN action plans to achieve global sustainable development including the 2015 Millennium Development Goals and the 2030 Agenda for Sustainable Development. The first principle of the Rio Declaration—that humans should be the center of concern for sustainable development and that they are entitled to live healthy and productive lives in harmony with nature—is significant as it signaled a shift away from development models of the 1960s and 1970s. Policies that informed these traditional development models privileged economic growth via rapid industrialization, productivity, and technology sometimes at the expense of the well-being of humans they were attempting to help and frequently at the expense of the natural environment. They favored a top-down administrative approach, controlled by international agencies, like the World Bank, and determined by Western interests. In contrast, Agenda 21 action plans sought the involvement of governments and local communities to prioritize their needs and capabilities to implement sustainable development projects. This aim toward inclusivity is also noteworthy in terms of informing and accomplishing future sustainable development goals.

Agenda 21 was succeeded by the **Millennium Development Goals** (MDGs) adopted in 2000 by over 185 countries with the aim to achieve the following 8 goals by the year 2015:

1. Eradicate extreme poverty and hunger
2. Establish universal primary education
3. Promote gender equality and empowerment of women
4. Reduce child mortality
5. Improve maternal health
6. Combat HIV/AIDs, malaria and other diseases
7. Ensure environmental sustainability
8. Develop a global partnership for development

The MDGs continued the trend away from the traditional development model's focus on economic growth per se to securing basic human rights. Poverty reduction was the key priority of the MDGs with most other goals oriented toward health and social inclusion. While some applauded that environmental sustainability was an objective of one goal, others felt this was a slight that failed to prioritize ecological concerns, especially climate change (Koehler, 2015). Notably, several of the MDGs were met before the program ended in 2015. While extreme poverty and hunger were not fully eradicated, fewer people suffered from extreme poverty and hunger in 2015 than in the 1990s. In the 1990s, almost half of the population in the Global South lived on less than \$1.25 per day compared to 14% in 2015. In the early 1990s, 23.3% experienced extreme hunger, but only 12.9% did by 2016.Educational progress was also realized. In developing countries, 91% of children were enrolled in primary school in 2015 compared to only 83% in 2000, including more girls. More women were also employed outside of agriculture in 2015 than in 1990 and gained political ground as members of parliamentary governments in 90 countries. Remarkably, the mortality rate for children under 5 years old declined by more than half—from 90 deaths per 1,000 live births in 1990 to 43 deaths per 1,000 live births in 2015. New HIV infections dropped by 40% between 2000 and 2013, and over 6.2 million malaria deaths were averted between 2000 and 2015. The major success in regard to environmental sustainability was an international effort to phase out substances that harm the ozone layer, which is expected to recover almost entirely by 2050. Global partnerships also improved with increased development assistance funding (United Nations, 2015).

After the MDGs were retired in 2015, a new sustainable development plan, Agenda 2030, was adopted by all 193-member countries of the United Nations. Agenda 2030 contains a comprehensive set of 17 **Sustainable Development Goals** (SDGs; See Figure 1.7).

Unlike past sustainable action plans, the SDGs apply to all countries, which "moves the discourse away from the patronizing North-South dichotomy" (Koehler, 2015, p. 475). Broader in scope, the SDGs also make more intentional connections between goals compared to the MDGs and conform to the Brundtland Report's conceptualization of sustainable development better. The UN's SDG Action Platform provides thousands of examples of how such connections are being realized by stakeholders around the world that are implementing initiatives to achieve the SDGs by 2030. The environment and climate change play a much larger role in the SGDs than they did with MDGs, including not just several of the goals themselves (like Goals 13, 14, and 15) but also as components of the 169 targets that comprise the SDGs. For example, target 11.7 of Goal 11 (Sustainable Cities and Communities) promotes universal access to green space, target 6.3 of Goal 6 (Clean Water and Sanitation) aims to improve water quality by reducing pollution, minimizing the release of hazardous chemicals, and safely reusing treated wastewater.

Agenda 2030 prioritizes ending poverty, which is the first SDG (see Box 1). Some argue that ranking human development ostensibly via economic growth to raise living standards is a form of **weak sustainability**. Food, shelter, transportation, telecommunication, and energy infrastructure for the sake of improving human well-being may come at the expense of forests, rivers, and wildlife. In contrast, **strong sustainability** gives precedence to the natural environment, which supporters argue should be protected irrespective of the financial costs to society (de Soysa, 2022). Proponents of weak sustainability believe that human or manufactured capital are viable substitutes for natural capital, or the goods and services produced by ecosystems. In fact, they view all forms of capital as substitutable. Those advocating for strong sustainability disagree, contending that no substitutes exist for natural capital—so once depleted, it is gone and therefore unavailable for future generations (Pelenc et al., 2015). Admittedly, they have a point insofar as the extinction of a species or depleting all nonrenewable resources are irreversible. However, improving human well-being and saving the environment need not be a zero-sum game. The resilience of humans to mitigate and adapt to our planet's most imperative challenge—climate change—offers hope that human capital will not simply replace natural capital but also preserve and protect it.

Sustainability in Focus:

UN SDG 1 No Poverty: Green Jobs

One target of SDG 1 is to ensure equal rights to economic resources and access to basic services, including new technology. The creation of green jobs is a one way to achieve this target and build climate resilience. If policies to promote a green economy are implemented, the International Organization of Labor (IOL) expects over 24 million new jobs will be created around the world by 2030 (International Organization of Labor, 2018a). Many of these jobs will be green ones with sufficient income to lift people out of poverty and raise their standard of living. Green jobs include those that

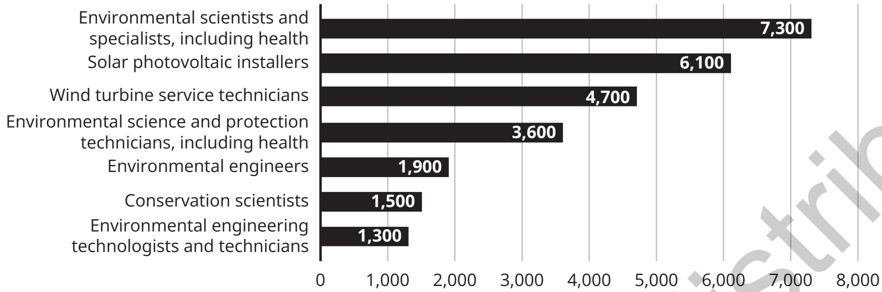
- build and maintain renewable energy systems, like wind turbine technicians and solar panel installers;
- construct and design sustainable buildings and housing, such as environmental engineers, sustainable architects, and Leadership in Energy and Environmental Design (LEED) consultants;
- protect the environment, like land and water conservationists;
- manage waste via recycling and biological reprocessing; or
- specialize in environmental health.

The creation of new green jobs will help mitigate greenhouse gas emissions and provide skills for workers to adapt to a more climate resilient economy. For example, the 2013-2017 Green Jobs Programme in Zambia empowered women in the rural Copperbelt Province with skills to build green homes and to assemble and install solar panels, which secured electricity to many households, especially those that could not afford kerosene or more expensive alternatives. It also helped urban, mostly young male construction workers upgrade their skills in green building technologies with the aim of protecting their health and safety, creating sustainable and affordable housing, and preserving the environment. Entrepreneurs and small-scale contractors were also involved in greening their building construction businesses to stimulate employment opportunities and move toward more sustainable development practices. By 2015, Zambia added 2,660 full-time new green jobs and improved the occupational safety and health of 2,018 jobs (International Organization of Labor, n.d., 2018b).

Green jobs with above-average median wages are also building climate resilience in the United States. They are also a key component of creating a just transition (see Chapter 8) for workers who lose their jobs in the fossil fuel industry. The Bureau of Labor projects employment growth in selected green occupations over the next decade (see Figure 1.8). Not only do these jobs provide a higher than average income, they do not require education beyond a bachelor's degree—and some only require a high school diploma or associate's degree, making them potential routes to economic opportunities and social mobility (Muro et al., 2019). Currently, most green jobs are held by older, white men but integrating environmental sustainability into school curricula and initiating better training programs that include pre-apprenticeships and neighborhood outreach are strategies to recruit the younger generation in addition to women and people of color (Muro et al., 2019).

Figure 1.8 ▪ Projected Employment Growth in Selected Green Jobs

New Jobs, Projected 2020–30 (numeric change)



Occupation	Median annual wage, 2021[1]	Employment, 2020	Employment, projected 2030	Typical entry-level education
Environmental engineers	$96,820	52,300	54,300	Bachelor's degree
Environmental scientists and specialists, including health	76,530	87,100	94,400	Bachelor's degree
Conservation scientists	63,750	25,300	26,800	Bachelor's degree
Wind turbine service technicians[2]	56,260	6,900	11,700	Postsecondary nondegree award
Environmental engineering technologists and technicians	48,390	17,300	18,600	Associate's degree
Solar photovoltaic installers[3]	47,670	11,800	17,900	High school diploma or equivalent
Environmental science and protection technicians, including health	47,370	34,200	37,800	Associate's degree

Note: None of these occupations typically requires work experience in a related occupation for entry.
[1]Wage data exclude self-employed workers.
[2]This occupation typically requires long-term on-the-job training to attain competency.
[3]This occupation typically requires moderate-term on-the–job training to attain competency.

"Green growth: Employment projections in environmentally focused occupations," Career Outlook, U.S. Bureau of Labor Statistics, April 2022. https://www.bls.gov/careeroutlook/2022/data-on-display/green-growth.htm

Conclusion

Climate change is often portrayed as an existential crisis that at best divides people and at worst will cause the demise of all species, including humans, regardless of any actions we may try to take. Critics of sustainability complain that it is unrealistic both practically and fiscally—and does not do enough to protect the environment or reduce future carbon emissions. Understandably, these views lead to fear, anxiety, and resignation, which can discourage people from exploring innovative ways to manage both issues. It can also dishearten the younger generations from developing their ecological and sociological imaginations—imaginations the future needs to share knowledge, create new technologies, and transform institutions so societies can become sustainable and climate resilient. This book hopes to inspire its key audience of undergraduates at universities and colleges in the United States and ideally other countries to achieve such change.

Key Terms

Adaptation
Anthropocene
Carbon sinks
Climate resilience
Ecological imagination
Emancipatory catastrophism
Greenhouse gas effect
Millennium Development Goals
Mitigation
Sociological imagination
Strong sustainability
Sustainability
Sustainable Development Goals
Treadmill of production
Weak sustainability

Discussion Questions

1. Use your ecological imagination and sociological imagination to explain what you ate for lunch today.
2. What are the four lessons you learned about environmental sociology in this chapter?
3. What are the main causes of Anthropogenic climate change? Explain three effects of climate change.
4. Explain how mitigation and adaptation can make our society more climate resilient.
5. Work in a small group to draft a climate adaptation plan for your university or local community using the NOAA steps to resilience.
6. Compare and contrast different conceptualizations of sustainability. Which one do you favor? Why?
7. Select three UN SDGs that interest you the most. Go to the UN SDG website (https://sdgs.un.org/goals), and investigate each one, clicking on the tabs labeled "'overview," "targets and indicators," and "progress and info."
8. Explain how green jobs can help build climate resilience.

9. How does the treadmill of production help explain the contradictions between economic growth and environmental sustainability? What alternatives might break this cycle?

10. What are some challenges on relying on natural carbon sinks like forests and oceans to mitigate carbon emissions? Should they be prioritized over technological mitigation solutions? Why, or why not?

Notes

1 Two recent articles on climate change and sociology published in the *Annual Review of Sociology* (Dietz et al., 2020; Klinenberg et al., 2020) also fail to address sustainability.

Chapter 2

Nature, Society, and Environmental Ethics

Sirachai Arunrugstichai / Stringer / Getty Images

Learning Objectives

2.1 Understand how the relationship between nature and humans has changed over time from hunter-gatherer to agrarian to industrial societies.

2.2 Describe the environmental ethics of preservationists, conservationists, and ecologists

2.3 Explain how eco-feminism and Indigenous knowledge challenge the domination of humans over nature.

Although human activity has touched if not outright exploited nature in the past, today we have entered the epoch of the Anthropocene, where our impact is fundamentally altering nature due to the irreversible effects of climate change (McKibben, 2019; McNeill & Engelke, 2016;). Before the Anthropocene, most climate change occurred due to natural, not human-made reasons. Environmental harm caused by human activity was more localized, not global, which author and activist Bill McKibben (2006) suggests made restoration of the natural environment more feasible both practically and mindfully. Hunter-gatherer societies had to contend directly with nature and other humans for survival, but as agricultural innovations developed, humans became more capable of controlling their natural environments by domesticating plants and animals. Industrial societies amplified this control on a larger scale, extracting the fossil fuels needed for their economic growth at the expense of nature. Whether out of ignorant disregard or intentional exploitation this harm to nature provoked—and continues to motivate—philosophers, novelists, ecologists, activists, and others who care about the environment to become advocates for nature, seeking to encourage ethics and practices that protect and conserve it. This chapter will explain the environmental ethics of several prominent advocates and how they have influenced different understandings of our relationship with nature. But first, a brief history of this relationship will be offered to situate the development of these ethics.

A Brief History of Society and Nature

Human development from hunter-gatherers to farmers to factory workers, service personnel, and technological entrepreneurs, has demanded changes in food and energy sources, lifestyles, and values (Morris, 2015). Agriculture became possible after hunter-gatherers started to establish permanent settlements, allowing humans to grow food surpluses that they could store and eventually trade, turning nature into a commodity that could be bought, sold, and taxed (Scott, 2017). Increasing food supplies was necessary to feed growing rural populations and eventually those who left rural communities (either voluntarily or by force) to reside in cities. Urbanites found themselves not only progressively separated from nature but dependent upon fossil fuels for industry, travel, housing, and an abundance of consumer goods. The trajectory from hunter-gatherer to agrarian to industrial societies is briefly summarized in this section.

Hunter-Gatherer Societies

Before the Anthropocene, human dependence on nature rather than control of it was the norm. Nature dictated the diet, population size, and lifestyles of our hunting-gathering ancestors, who lived "in small groups within the confines of local ecosystems" (Gowdy, 2020, p. 1). These ecosystems varied from the frigid tundra of the Arctic to the tropical rainforests of the Amazon to the arid Sahara Desert in Africa. Most hunter-gatherers were nomadic, owned only as many possessions as they could practically carry, and foraged for the majority of their calories. Sharing was normative, inequality was weak, and hierarchy was distrusted (Morris, 2015). While evidence suggests that new forms of hunting with fire in North and South America may have led to the mass extinction of some large mammals around 12,500 years ago, most hunter-gatherers, particularly those in Africa and Eurasia, co-evolved with the animals they hunted (Ruddiman, 2005). Local knowledge of their ecosystems was critical for survival, including seasonal migration patterns of animals and fish and the edibility of plants, fungi, nuts, berries, and insects (Sahlins, 1972). The biological diversity of wild plants and animals enabled hunter-gatherers to consume more nutrients and enjoy better health and taller stature than the carbohydrate-laden diets of the agrarian societies that followed (Mummert et al., 2011).

Approximately 90% of human existence has been in hunting and gathering communities, leading one to surmise that they inadvertently practiced what we now call sustainability, meeting their immediate needs without compromising the needs of future generations (Gowdy, 2011). Hunter-gatherers derived their energy from solar power that was converted by plants into biomass through photosynthesis. They ate these plants for food, which provided them calories to hunt and forage, and they burned biomass, like wood, to cook food, warm their bodies, and heat their shelters. The largest hunter-gatherer societies were around 100 people, but most consisted of bands or extended families of 25 people or less (Service, 1971)—though group size and biological relationships likely varied depending on mobility (Bird et al., 2019). Researchers have estimated that the total global population of hunters-gatherers was approximately 10 million over 10,000 years ago (Burger & Fristoe, 2018). Many were densely concentrated in the "ecological sweet spots" of Eastern North America, Western Europe, and Southeast Asia where they had reliable access to abundant resources and experienced low disease burdens (Burger & Fristoe, 2018, p.1138). But, even in these more populated regions hunters and gatherers lived by necessity within the **carrying capacity** of their natural environments. Indeed, current research suggests that the group size of hunter-gatherers was shaped by their land use over time, such as how their actions changed the biodiversity of their ecosystems (Bird et al., 2019). The population size of hunter-gathering societies was also kept in check due to high rates of violence. Periodic food shortages coupled with violent deaths resulted in average life expectancy at birth of between 25 to 35 years old (Morris, 2015).

Agrarian Society

This sustainable relationship with nature started to shift with the Holocene epoch around 12,000 years ago, when warmer, stable temperatures led to an increasing reliance on wild grains and eventually made agriculture feasible. Wheat, rice, barley, maize, and legumes soon came to dominate food production and became dietary staples for people around the world. As farming expanded, those hunter-gatherers that remained were "pushed into marginal habitats"—or unproductive land from the perspective of farmers—where a few continue to survive (Ehrlich et al., 1995, p.144; Scott, 2017). In contrast to foraging edible plants and hunting wild game, agriculture entails the domestication of plants and animals, which necessitates the manipulation of nature to serve the interests of humans.

Domestication entails human intervention in the reproduction of other species that serve the interest of our survival—these species would not exist or continue to reproduce without human involvement (Morris, 2015). Coincidentally, farming also demands the domestication of humans, who must relinquish their nomadic life of foraging and reside on permanent settlements (Scott, 2017). As geographer Neil Roberts (2014, p. 200) explains, agriculture "strengthened the mutual dependence between people (as farmers) and a limited range of (domestic) plants and animals."

Ranging from the subtle to the exploitative, humans started to take control of nature in agrarian societies, producing "the first serious environmental degradation from human actions" (Ruddiman, 2005, p. 73). Early agriculturists removed existing vegetation with simple techniques like tree-felling and burning to clear land for crop cultivation. Over time, farmers developed new technologies to help them better tame nature and increasingly left a damaging mark on it. According to Lynn White (1962), the inception of heavy plowing in the 7th century CE was the first agricultural innovation to directly exploit nature. The invention of the moldboard plow pulled by oxen or horses allowed for a more efficient way to till the soil compared to human labor, but it caused erosion when the wind blew or water washed away exposed topsoil. Though the moldboard plow was a simple technological innovation, it allowed farmers to plant crops in heavy soil, like clay, which helped to create a food surplus, increasing caloric energy capture and subsequent population growth. The population density of agrarian societies was 100 times higher than hunting and gathering ones (Burger & Fristoe, 2018). The moldboard plow also helped to initiate an agricultural revolution in Northern and Western Europe.

Before the Industrial Revolution could occur, an **agricultural revolution** was necessary to produce a large enough food surplus that could facilitate the transfer of labor from the land to industry (Ogilvie, 2000). In the case of Great Britain and parts of Western Europe, agricultural innovations and land reform during the 18th century CE increased farming productivity via new crop varieties and rotations, which reduced the demand for labor in rural areas. Many peasants moved from farming communities (sometimes by coercion because of land enclosure) to cities, where they became wage laborers in newly established factories. Farmers who remained were tasked with supplying the growing population of cities with food. Improvements in road and water transportation helped lower the cost of trade for these farmers and enabled them to reach urban consumers, who could purchase their surplus crops. In turn, farmers could spend their profits on nonnecessities, like extra clothing, toys, and furnishings, which supported the livelihoods of merchants and shopkeepers and gave rise to a nascent market economy (Ogilvie, 2000). Ogilvie (2000, p. 107) reminds us that none of this would have been possible without the breakdown of seigneurial privileges of nobles and priests and entitlements afforded to urban guilds, which opened up the opportunity for people to break "out of the productivity trap that had stifled economic growth for millennia."

Karl Marx described the bifurcation of the rural land from urban populations during Europe's transition from agriculture to industry as an "irreparable rift in the interdependent process of social metabolism" that degrades soil fertility by preventing the "constituent elements consumed by man" from returning to it (Angus, 2016, p. 118). This **metabolic rift** that separates humans from nature only expanded as farmers cleared more land, substituting natural biodiversity for measurable, predictable yields of a single crop that could be traded as commodities for profit (Scott, 1999). As early as the 1830s "soil exhaustion" from industrialized agriculture became a growing concern in Europe and the United States as demand exceeded the limited supply of natural fertilizer (Bellamy, 1999, p. 375). Over time cows, horses, and other animals started to disappear from farms with the introduction of synthetic fertilizers and machinery powered by fossil fuels, rendering their manure and muscle obsolete. Today, most domesticated cows, pigs, and chickens are confined on massive concentrated animal feeding operations that are more comparable to factories than any natural habitat. Their waste is stored in giant lagoons, and when it is returned to the soil, it is in the form of liquid that is sprayed onto fields or pumped into subsurface drainage systems. The runoff from the overapplication of this liquid manure ends up in streams, rivers, and lakes. In the case of Lake Erie, it contributes to algae blooms that contaminate the water and kill fish. Thus, one can reasonably argue that today the metabolic rift not only applies to humans but also to livestock as their excrement fails to be sustainably recycled back to soil and undermines the metabolic cycle of freshwater ecosystems.

Industrial Societies

While domestication was the necessary condition of agrarian societies, fossil fuel is the primary determinant of industrial ones (Morris, 2015). In the late 1700s, coal began "shattering the energy constraints on farming society" (Morris, 2015, p. 98). Burning wood to produce fire was the main source of energy in previous societies, but it was quite inefficient. Deforestation was also a problem as increasing quantities of wood were needed to heat homes, cook food, and forge metals. No machine existed yet that could turn fire into motion, so transportation required "muscle, water, or wind," which "placed a tight limit on the material work a society could accomplish" (Freese, 2003, p. 43). In Britain, coal was the solution to all of these problems. This so-called "king" of the Industrial Revolution was cheap, abundant, and could generate the power to fuel a steam engine. Steam engines were first used in England in the 17th century CE to pump water out of its coal mines, allowing access to deeper deposits (Morris, 2015). This coal was used to fuel steam engines used for transportation and manufacturing. While the first steam engines required an excessive amount of coal to heat, they became much more efficient after James Watts invented a new design in 1776 (Morris, 2015). Steam locomotives could now transport coal, manufactured goods, and crops long distances—more quickly and at lower cost—on newly constructed railways. Steam powered machines like the cotton gin boosted productivity, replacing handcraft workers with wage laborers who worked in factories. Steamships delivered imported food to help feed the growing British population and exported textiles and surplus coal to other parts of the world. Coal was also important because it could be heated high enough to produce coke, which could convert iron ore into iron in a blast furnace. This iron was then used to make the parts needed for locomotives, machines, rails, and bridges.

The United States also took advantage of its plentiful coal to fuel industrialization, but it took a bit longer to gain popularity because of the abundant wood supply from the nation's forests—even trains burned wood for fuel with workers chopping down trees by rail tracks when more wood was needed. Like Britain, the United States possesses massive deposits of bituminous or soft coal—the most in the world—but it also contains a pocket of anthracite coal in Northeast Pennsylvania that is hard, contains little sulfur, and is cleaner and more efficient to burn. Today, the top producing coal state is Wyoming, where bituminous coal is mined mostly in massive open pits. The coal that remains in the Appalachian Mountains, especially in West Virginia and Kentucky, is more likely to be blasted out of mountaintops and hauled via giant machines—a technique commonly referred to as mountaintop removal—than excavated underground by human labor. Given the energy required to extract coal, it can be easy to forget that coal is derived from decayed plants.

Likewise, the prehistoric marine organisms that constitute petroleum rarely capture our imagination as we pump the refined product into our cars. Unlike Europe, the United States was not only blessed with an abundance of coal but also petroleum. Oil fueled industrialization in the United States in the late 1800s when John D. Rockefeller established Standard Oil in 1870. His monopoly control of this fossil fuel made him one of the wealthiest men in the United States and established Cleveland, Ohio, where Standard Oil was headquartered, as the richest city in the country during this time. Henry Ford's invention of the Model T with a gasoline-powered engine and the future of automobile transportation would have looked much different without cheap and widely available gas from Standard Oil. Indeed, the first cars were electric. Though the Supreme Court ruled Standard Oil was a trust that had to be legally broken up into independent companies in 1911, our dependence on oil as a key source of fuel for transportation was already entrenched. From cars to airplanes, the internal combustion engine propelled by petroleum has offered the privilege of mobility at the cost of air pollution, carbon emissions, and even dependency on imports from authoritarian regimes, like Saudi Arabia. While we are slowly weaning ourselves from oil as we switch to natural gas, which produces far fewer carbon emissions, and renewable resources that emit no greenhouse gas emissions, petroleum continues to be the primary energy source in the United States (see Chapter 5).

Until the mid-20th century, most energy consumption occurred in Europe and the United States and "is the single most important reason behind [their] political and economic dominance" (McNeill & Engelke, 2016, p.10). Coal, oil, and natural gas provide over 80% of the world's energy today, increasing significantly since 1945, or the beginning of what is called the **Great Acceleration** (McNeill &Engelke, 2016, p.2). This acceleration shows no signs of slowing. The use of fossil fuel has almost doubled since 1980, shifting from predominantly coal to oil and natural gas (see Chapter 5). The reliance on fossil fuels for energy is significant because humans continue to control nature as in agrarian societies but now control the climate as well (Ruddiman, 2005). Though deforestation to clear land to grow crops caused an increase in CO_2 in agrarian societies, fossil fuels became the primary source of CO_2 emissions in the late 1800s (Ruddiman, 2005). As discussed in Chapter 1, the burning of fossil fuels emits greenhouse gases that accumulate in the Earth's atmosphere and cause the climate to change. Many suggest that this has elicited a new geological epoch called the Anthropocene, when human action "has become the most important factor governing crucial biogeochemical cycles" (McNeill & Engelke, 2016, p.4). Bill McKibben (2019, p.16) fears that humans have "emerged as a destructive geological force" that threaten not only the natural world but their essential humanness. He argues carbon dioxide and other greenhouse gases that we have produced are "*substantially alter[ing] the earth's atmosphere*" and potentially "ending nature" (McKibben, 2019, p.41). Since the beginning of the Great Acceleration, human activity has pushed atmospheric CO_2 concentrations to levels "not seen in the past 870,000 years" (McNeill & Engelke, 2016, p. 208).

According to ecologist Mark Urban (2015), rising temperature attributed to climate change is responsible for the acceleration of the extinction and endangerment of a variety of species around the world. Unless greenhouse gas emissions are reduced, 7.9% of all species are predicted to become extinct (Urban, 2015). Coupled with habitat destruction, climate change is creating the conditions for the **sixth extinction**, the only period of mass extinction caused by human activity. Elizabeth Kolbert (2014) describes the "unnatural history" of this sixth extinction and how even the loss of a few species has the potential to disrupt entire ecosystems, like rainforests. Extinction risk is greatest in South America, Australia, and New Zealand because of their unique habitats and endemic species (Urban, 2015). Species that can migrate to try to survive or are inadvertently transported by humans who travel the globe threaten native species that may be vulnerable to diseases these so-called invasive species carry or lose the "evolutionary arms race" because they are inept at competing for resources (Urban, 2015, p.571).

Ian Angus (2016) argues that the Anthropocene is based on fossil capitalism, or burning fossil fuels for profit and economic growth. Others agree, such as social justice activist Naomi Klein and environmental sociologists John Bellamy Foster, Brett Clark, and Richard York. In her influential book, *This Changes Everything*, Klein argues that

> Our economic system and our planetary system are now at war. Or, more accurately, our economy is at war with many forms of life on earth, including human life. What the climate needs to avoid collapse is a contraction in humanity's use of resources; what our economic model needs to avoid collapse is unfettered expansion. (2014, p. 21)

She doubts that capitalism can provide solutions to cut carbon emissions and proposes we need to transform our economy to prevent global collapse. Foster et al. (2010, p.7) also believe that capitalist accumulation is the main cause of environmental problems and has created an **ecological rift**, or opened up "a deep chasm . . . in the metabolic relation between human beings and nature—a metabolism that is the basis of life itself." Like Marx, all of these authors are critical of the economic growth imperative that drives capitalism and argue it is contradictory to the laws of nature. Some would argue it is also contradictory to human nature, alienating us from what Marx called our species being or our inner drive to engage in diverse forms of activity in a free, creative manner. Capitalism forces us to specialize our labor, which most of us need to sell for wages to survive. This divorces us from knowing how to perform multiple tasks and the satisfaction of owning or controlling our labor. Supporters of the degrowth movement believe that the only way to stop climate change, protect the environment, increase human well-being, and ultimately repair the ecological rift is to halt economic expansion (see Chapter 4).

Though climate change is most frequently invoked to describe the Anthropocene, the invention of synthetic chemicals—most derived from petroleum—has also fundamentally altered nature (Smil, 2022). Pesticides, like dichlorodiphenyltrichloroethane (DDT), perfluorooctanoic acids (PFOA), such as C-8 used in Teflon skillets and Gore-Tex clothing, Bisphenol A (BPA) that coats beverage containers, and phthalates in our personal care products have been proven to not only cause harm to humans but our environment as well. In reference to pesticides, biologist—and arguably the founder of the modern environmental movement—Rachel Carson famously questioned in her book *Silent Spring*,

> How could intelligent beings seek to control a few unwanted species by a method that contaminated the entire environment and brought the threat of disease and death even to their own kind? (1962)

While some human-made chemicals, like DDT, have been banned, and dangerous products that contain PFOA and perfluorooctane sulfonate (PFOS) have been phased out, they nonetheless have bioaccumulated in our bodies and the environment, persisting across generations. The majority of synthetic chemicals (approximately 40,000) are unregulated in the United States, and few consumers are aware of their exposure to them or that some are endocrine disruptors that mimic or alter hormones or their association with rare cancers (MacKendrick, 2018; Steingraber, 2010). Workers in facilities that produce these chemicals and residents who live in neighborhoods where these facilities are located are especially susceptible. Mid-valley Ohio residents living near a Dupont plant that manufactured Teflon were exposed to C-8 in contaminated drinking water, causing many to develop serious health problems. Over 3,500 of these residents sued Dupont, and the company eventually settled the lawsuit for $670 million in 2017 (Rinehard, 2017).

Synthetic chemicals also threaten other species that are exposed to them. The herbicide glyphosate found in the popular Round Up brand kills milkweed, which threatens the survival of monarch butterflies that rely on milkweed as their sole source of food (Endangered Species Coalition, 2019). Likewise, the decline of bees has been attributed to insecticides, in particular neonicotinoids or "neonics" that are used to coat soybean and corn seeds and are applied on residential lawns to prevent grubs. Brazil, for example, witnessed the death of about 500 million bees between December 2018 and February 2019 due to contact with pesticides that contained fipronil and neonics (BBC, 2019). Banning neonics, like the European Union did in 2020, and dramatically reducing the use of pesticides in general is a critical step to prevent the extinction of approximately 40% of the world's insects in the coming decades (EPA, 2021). Taking such measures will require humans to understand how we depend on the services of other species, like bees, who act as free pollinators for approximately 30% of the food we eat (Khalifa et al., 2021). It will also challenge us to respect the intrinsic value of species that do not immediately (and may never) provide instrumental value for humans in addition to developing robust ethics to protect entire ecosystems

Environmental Ethics: Preservation, Conservation, and Ecology

Clearing forests for agriculture and burning fossil fuels for energy turned nature into a resource with **instrumental value** to humans, or convincing us that we should dominate and exploit it for the sake of the general public or our own self-interest. The human domination of nature rests upon three key assumptions:

1. That humans are different from and superior to all other species
2. That nature is passive and can be acted upon without resistance or consequence for humans
3. That human mastery over nature through science and technology represents societal progress

Some who subscribe to this view defend it as the will of God, citing the first book of Genesis in which God gives humans "dominion over the fish of the sea, over the birds of the air, and over the cattle, over all the earth and over every creeping thing that creeps on the earth." Others like Francis Bacon, known as the father of empiricism, defend interrogating and altering nature as a source of human knowledge that can engender technological innovations (Merchant, 1983). While Bacon did not necessarily view nature as docile—indeed, sometimes it was too wild, so had to be tamed—his mechanized understanding of it rendered it "passive and inert" (Merchant, 1983, p. 170).

Personal, corporate, and political gain are other motivations for controlling and exploiting nature. Taking advantage of shared resources for these reasons can lead to the **tragedy of the commons**, or depleting common resources through the unregulated pursuit of self-interest (Hardin, 1968). For example, if every sheep herder has free access to common pastureland, then it is likely they will allow as many of their own sheep as possible to overgraze because they incur no immediate costs. Over time, this results in the unintended consequence of the loss of the pasture. Similar logic can be applied to the profit motive of corporations in contemporary capitalist society. If air and water are free resources, then it may incentivize them to pollute. Why pay to dispose of industrial waste, when one can freely dump it in a river? This is what companies located along the Cuyahoga River did in Cleveland, OH for years until there was so much waste in the river that it caught on fire numerous times in the 1960s—and eventually caught the attention of the nation and the world, inciting the passage of the 1972 Clean Water Act.

Governments have also viewed nature as a source of revenue that they can manipulate through scientific management. James Scott (1999) describes how state German forestry in the late 18th century standardized nature, making it legible via quantification and eliminating its biodiversity to increase yield and profits. Privileging the Norway Spruce, the Prussian state literally failed to see the forest for the trees and dismissed the soil the trees grew in, the vegetation that sprouted under them, and the birds and squirrels that nested in their branches and hollows as nuisances or waste because they served no utility to humans. While this resulted in high rates of productivity in the short-term, by the third rotation, yields declined. Nutrients in the soil diminished due to disappearance of the biomass of the forest floor, which also made the simplified habitat more inviting to new pests that favored the Norway Spruce. According to James Scott (1999, 15), "[t]he German forest became the model for imposing on disorderly nature the neatly arranged constructs of science." Unfortunately, this vision of nature remains, particularly how we continue to slight the importance of soil and insects. Plant pathologist Jo Handelsman (2021) warns of the "silent crisis" of soil loss due to intensive tillage that is starting to reduce wheat yields in Ukraine and corn and soybean yields in the state of Iowa. Likewise, Oliver Milman (2022) cautions that the current decline of insect populations due to climate change and pesticides should be taken more seriously—even if some of these bugs have little or no obvious instrumental value for humans.

Sustainability in Focus:

Coastal Reef Rejuvenation: UN SDG 14 Life Below Water

Oceans help mitigate climate change by absorbing carbon emissions—approximately 25% per year—and support a large diversity of marine life in what is the world's largest ecosystem (United Nations, n.d.). However, they are warming and becoming more acidic at an alarming rate as temperatures continue to rise, which is threatening one of their key habitats: coral reefs. Coral reefs provide shelter for fish, maintain fisheries that supply food and jobs for coastal residents, and offer recreational opportunities for tourists, which can assist communities with economic development. They also protect coastal communities from flooding caused by storms, so can help them adapt to climate change. Unfortunately, researchers at the Carnegie Institute predict coral reefs will dissolve if carbon emissions are not curbed to less than 560 parts per million (Silverman et al., 2009). Rising carbon dioxide levels cause seawater to become more acidic, which harms the ability of coral reefs to develop and support their exoskeletons. More acidic water inhibits coral reefs from producing the calcium carbonate they need to grow. Warmer water temperatures are also stressing the zooxanthellae on coral reefs that they need to survive. Once this algae-like substance leaves, coral reefs bleach and may ultimately turn black and die if they succumb to starvation or disease (National Oceanic and Atmospheric Administration, 2025).

Underwater coral farming, raising coral in nurseries and transplanting them in oceans, and even reattaching broken coral pieces with cement or epoxy putty are a few ways that scientists are working to restore coral reefs. Restoring coral reefs before they die off is imperative not only for the intrinsic value of coral reefs themselves but also the instrumental value they serve for other species. Coral reef rejuvenation is a natural way to prevent flooding and beach erosion—and is less expensive and more durable than building concrete breakwaters or seawalls. A healthy coral reef structure can absorb 97% of a wave's energy before it hits shore and help cities develop coastal resilience in a sustainable way (National Oceanic and Atmospheric Administration, 2024). Cancun, Mexico launched a program in 2019 to restore and maintain the Meso-American reef that is funded by an innovative coral reef insurance program. Tourism taxes fund what is called the Coastal Zone Management Trust that purchases insurance for the reef. When an emergency event occurs, the trust pays for reef restoration work, which in turn benefits the tourism industry that can continue providing tourism products and services that are taxed to fund the trust (The Nature Conservancy, n.d.).

Early preservationists and conservationists anticipated the short-sightedness of dominating nature for personal gain or a revenue stream. They contended that humans should be stewards of nature to avert destroying it entirely. **Preservationists** support the idea that nature should be protected because it has **intrinsic value**, or worth as an end-in-itself. John Muir was a notable advocate of this position, helping to establish Yosemite National Park, the Grand Canyon, and other national parks in the United States to preserve wilderness for the sake of all species—even humans. Muir believed nature was a source of beauty and inspiration, a transcendental place where humans could reflect and spend their leisure time in the absence of modern distractions. In his words "everybody needs beauty as well as bread, places to play in and pray in, where nature may heal and give strength to body and soul" (Muir, 1912). Muir cofounded the Sierra Club in 1892, which continues his mission "to explore, enjoy, and protect the wild places of the earth" (Sierra Club, n.d.) Muir's work persuaded President Theodore Roosevelt to establish the U.S. Forest Service in 1905, which dedicated millions of acres of public land for wildlife refuges and forest conservation programs. Though Muir may have preferred the preservation-model of the national parks for the national forests, he commended the federal administration and protection of both.

Compared to preservationists, **conservationists** propose a more instrumental approach to nature, viewing it as a means-to-an-end (such as trees for timber); however, they support the need to regulate the impact humans have on their natural environments to achieve a sustainable future for all species. Roosevelt and Gifford Pinochet, the first head of the U.S. Forest Service (USFS), understood the forests as a resource with instrumental value for humans. Individuals can enjoy a wide variety of recreational activities, like hiking, camping, hunting, and snowmobiling in them for free or minimal fees. The USFS is authorized to sell timber and lease land for grazing livestock but must afford a percentage of its revenues to fund schools and roads in the mostly rural counties where its forests are located (United States Forest Service, n.d.). Pinochet's vision of conservation is similar to what is now referred to as sustainability, or meeting the needs of the current generation without compromising the needs of future generations. He believed that "conservation means the wise use of the earth and its resources for the lasting good of men" (Chan, 2022) and did not consider the inherent conflict between financial gain and environmental sustainability. Contemporaries, Pinochet and Muir were on friendly terms until Pinochet supported the construction of the Hetch Hetchy Dam in Yosemite as a means to provide water to the city of San Francisco (Clayton, 2019). Muir (1912) considered the dam sacrilegious to what he considered the "temple" of Yosemite, calling its defenders "temple destroyers" and "devotees of commercialism" who "seem to have a perfect contempt for Nature" (Clayton, 2019).

Preservationists and conservationists favor a stewardship model of nature that posits humans should take care of nature rather than exploit it. While this model is certainly less harmful to nature than pure domination, critics argue that it also assumes humans essentially are different from other species and situates nature as passive. This can lead to unintended consequences that are just as devastating as categorical domination, such as protecting one species at the victimization—or even extinction—of another. For example, the successful recovery of the great white shark population is threatening the conservation efforts of protecting sea otters. Furthermore, stewardship of nature often entails controlling it via scientific management and technology for the purpose of humans over other species. To return to the example of German forestry, James Scott (1999) explains that when the state shifted its vision from domination to stewardship it continued to privilege productivity over biodiversity, or instrumental value over intrinsic value. Rather than restoring the natural ecosystem of the forests, boxes were constructed for birds to nest as a substitute for tree hollows, and ant colonies were artificially raised and embedded in the forests by local children (Scott, 1999). Positioning humans within nature rather than outside caretakers or managers offers a more inclusive relationship with other species and even entire ecosystems. Critical of conservationism, Aldo Leopold offers a more holistic and ecological understanding of our relationship with nature, which situates us within rather than outside ecosystems. His renowned land ethic proposes that "the boundaries of the community" be enlarged "to include soils, waters, plants, and animals, or collectively: the land" (Leopold, 1968, p.204). Like preservationists, he respected nature for its intrinsic value and urged farmers, conservationists, and others to

> quit thinking about decent land-use as solely an economic problem. Examine each question in terms of what is ethically and esthetically right, as well as what is economically expedient. A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise. (Leopold, 1968, p. 224-225)

Leopold challenged humans to be more than mere spectators of nature and become integral participants in a moral community that includes nature (Goralnik & Nelson, 2011). Instead of conquering nature Leopold proposed that we develop an ecological conscience to recognize that we are **biotic citizens**, members of a single community with nature and therefore obliged to treat other species and the land itself with moral consideration.

Leopold's environmental thought has influenced **biocentrism**, or the belief that individual species have moral standing and **ecocentrism**, which is the belief that entire ecosystems deserve moral standing (Attfield, 2019). From a biocentric perspective, the bald eagle has inherent worth as an individual species and should be respected. Those that believe in ecocentrism, like **deep ecologists,** contend that not only other species but entire ecosystems have inherent worth and even the legal right to exist, just like humans. They question if any human interference with nature can be sustainable because it fails to change the dominant perspective that we exist outside of nature and is therefore too anthropocentric. Deep ecologist Arne Naess promoted biospheric egalitarianism, or "the equal entitlement of all species to live their own way of life" (Attfield, 2019, p.7). Simply stated, this entails pursuing ecological justice between species (Kopnina, 2014). Followers of the Rights of Nature movement have acted on such ethical considerations by pursuing policy that grants legal rights to rivers, lakes, forests, and even wild rice. Ecuador modified its constitution in 2008 to recognize the legal standing of "Pachamama," or Mother Earth to "maintain and regenerate its cycles, structure, function and evolutionary processes" (Surma, 2021). In 2017, New Zealand officially established legal personhood of the Whanganui River, a protection that the Māori tribe had been struggling to attain since the British colonized the island in 1840. Residents of Toledo, Ohio gained similar legal rights for Lake Erie and its watershed. After toxic algae blooms poisoned the municipal water supply in the summer of 2014, voters passed the 2019 Lake Erie Bill of Rights, which allows residents to sue on behalf of the lake. Though a federal judge struck down the law as unconstitutional, supporters continue to fight to protect the lake from agricultural runoff and other sources of pollution.

Inclusivity: Eco-Feminism and Indigenous Knowledge

Eco-feminists equate the domination of nature with the oppression of women, arguing that patriarchy seeks to objectify and control both (Warren, 1997). Women are often referred to as animals, like foxes or bitches, and in practice treated like objects with no agency. Likewise, nature is feminized, most famously idolized as Mother Earth, yet available to be raped by men for resources and profit. Science, on the other hand, is often masculinized, and its practitioners praised for analyzing "hard facts" and possessing "penetrating minds" (Merchant, 1983, p.171). Eco-feminists blame men—not women—for exploiting nature and regarding only its instrumental value. They also criticize deep ecologists for ignoring patriarchy and structural inequality more generally. Women, particularly poor women of color, are disproportionately exposed to and suffer from environmental harms, disasters, and climate change, which deep ecologists fail to prioritize. Some eco-feminists embrace the interconnections between women and nature and believe only women can cure the male havoc on Mother Earth through nurturing it back to health. Others wish to overcome the female/nature and male/science dichotomies because of the gender stereotypes they perpetuate (Tong & Botts, 2018).

Indigenous people have also been devalued by being associated with nature. Settler colonizers and imperialists viewed them as uncivilized savages that could either be noble and pure or brutal and violent, like nature itself. The noble savage was perceived as an innocent, ignorant child in need of protection by their civilized conquerors, while the brutal savage needed to be forcibly tamed or exterminated. Such stereotypes have been used by those with power to justify denying Indigenous people basic rights, such as removing them from their homes and relocating them to reservations, classifying them as wards of the state, and compulsorily assimilating Indigenous children in government boarding schools. Until recently, **Indigenous knowledge**, which understands humans and nature as interdependent, rather than separate entities, was dismissed by Western science as irrational if it was even recognized at all. Instead of a resource, nature is a relative that must be cared for and sustained via the practice of reciprocity (Mazzocchi, 2020). Animals, plants, fungi, insects, and soil provide subsistence and sustenance, but humans are obliged to be their caretakers. Indigenous knowledge is "place-based" formed by millennia of "direct experience interacting with biophysical and ecological processes, landscapes, ecosystems, and species" and "transmitted across generations" (Jessen et al., 2021, p. 93-94). These insights and experiences position Indigenous people to become leaders and active participants in conservation and management programs around the world.

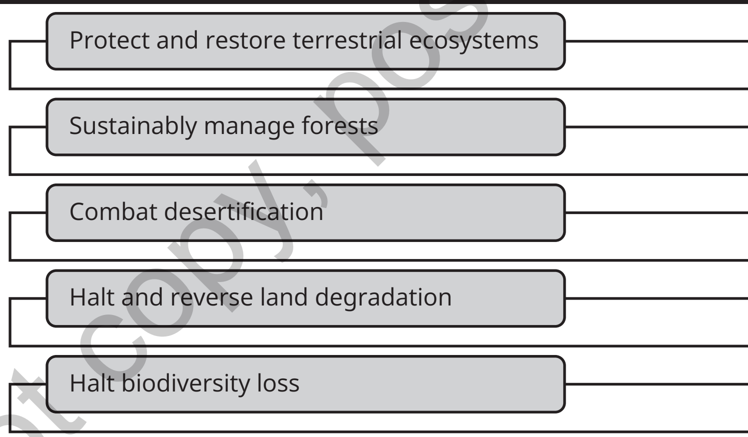
Indigenous knowledge can also help Western societies "redefine the notion of sustainability" (Mazzocchi, 2020, p. 77) to make it more inclusive of nature and other species. The Sámi concept of sufficiency captures this well:

> You only take what is necessary from nature, never a surplus. It is the exact opposite of the modern idea of sustainability, which is based on the maximum surplus that can be taken without destroying nature's capacity to sustain the resource. (Rawlence, 2022, p. 74)

Sustainability in Focus:

UN SDG 15 Life on Land: Saving Megaforests

Figure 2.1 ▪ Sub-Goals for UN SDG 15



The Life on Land Sustainable Development Goal (SDG) encompasses a wide range of issues that are altering different habitats, ecosystems, and the species that depend on them for their survival, including humans. Terrestrial ecosystems comprise forests, deserts, mountains, and grasslands—all of which are being threatened if not already altered by climate change. Preserving forests is especially important as a mitigation strategy given that they capture and sequester carbon in their soil and trees. Saving the world's five megaforests (New Guinea, the Congo, the Amazon, the Taiga, and the

North American boreal forest) is an inexpensive and easy way to stabilize global warming. According to Reid and Lovejoy,

> keeping carbon in tropical forests costs a fifth as much as reducing emissions from energy and industry in the United States and Europe. And it's more affordable by a factor of at least seven than regrowing forests once they've been felled. (2022, p.4)

The unbroken cores or intact forest landscapes of megaforests are especially important to protect (Reid & Lovejoy, 2022). They store carbon, cool the air, and can even moderate if not prevent forest fires. Once these intact landscapes are fragmented to construct roads or build farms, their edges dry out, making trees vulnerable to wind damage and potential wildfires. Fewer trees results in thicker undergrowth, less biomass (so less carbon storage), and a less desirable habitat for birds and other wildlife. Thus, saving megaforests can also help halt biodiversity loss. From the grizzly bears of the boreal forests to the monkeys of the tropical forests, these ecosystems harbor the most diverse array of species on our planet. Reid and Lovejoy (2022) note that they are also home to a diversity of people. The Amazon, for example, has over 350 languages, while the island of New Guinea has over 1,000. Indigenous people sustain their lifestyles in these megaforests, sharing their traditions and knowledge with the next generation. Some, like First Nations in Canada, have organized through the Indigenous Leadership Initiative to become guardians of forests and other natural habitat in their traditional lands. The guardians of the Łutsël K'"é Dene First Nations in the Northwest Territories monitor caribou and comanage Thaidene Nëné Indigenous Protected Area, which is on the northern edge of the boreal forest and just over 5,400 square miles in size (Indigenous Guardians, n.d.; Reid & Lovejoy, 2022).

The Sámi, who are Indigenous to the Northern region of Scandinavia and the Kola Peninsula in Russia, also offer lessons on how to adapt to climate change given their direct observations and experiences with warmer temperatures in the Arctic environment for the past several decades. Changes in vegetation, precipitation, ice conditions, and length of seasons have been affecting their traditional reindeer husbandry practices, compelling them to adopt **adaptive management** strategies (Raygorodetsky, 2017). Such strategies are helping them to maintain their traditional lifestyle at the same time they cope with what are likely permanent changes to their natural environment. Snowmobiles are now being used to keep reindeer herds together instead of skis, which also better enables them to spread their herds over more land. The Sámi are adapting to the lack of available land for traditional rotational grazing by utilizing pastures a second time in the same winter (snow permitting) and to unpredictable weather patterns by using lichen heaths as a source of food earlier in the winter and increasing supplemental feed (Linkowski et al., 2020). Reminding us that no culture is static, the younger generation of Sámi reindeer herders are "develop[ing] new and innovative strategies to handle increasing uncertainty" that they can teach the next generation (Linkowski et al., 2020, p. 487).

Conclusion

There is promise as we transition from industrial to postindustrial societies that our environmental ethics and practices will develop, too—if not return to the understanding our hunter-gatherer ancestors and Indigenous contemporaries had about a more sustainable relationship between nature and society. The relative economic security experienced by many in the global North is inspiring some to value postmaterialism, which prioritizes one's quality of life over acquisition of frivolous material possessions (Inglehart, 1990; see Chapter 4). Breathing clean air, drinking safe water, eating food grown without pesticides, using personal care products that do not contain parabens or phthalates, having access to well-maintained sidewalks and clearly delineated bike lanes, and birdwatching in local parks are a few ways postmaterialists feel that they can improve their quality of life while promoting sustainability.

Undoubtedly, affluence has been the culprit for overconsumption and its associated problems of waste, debt, resource extraction, habitat destruction, and carbon emissions. However, affluence may afford us the knowledge to cultivate an awareness and care for the environment and the technological innovations to protect it for future generations. More affluent societies also generally have lower fertility rates and decreasing population growth over time, which can ease human stress on the Earth's carrying capacity if consumption is kept in check and green technologies continue to be created. The relational environmental impacts (I) of population (P), affluence (A), and technology (T) are referred to as the IPAT model. The following three chapters will cover each of these variables, exploring how they contribute to climate change and unsustainable practices but may also offer solutions to these problems as well

Key Terms

Adaptive management
Agricultural revolution
Biocentrism
Biotic citizen
Carrying capacity
Conservationists
Deep ecologists
Domestication
Ecocentrism
Ecological rift
Eco-feminism
Great Acceleration
Indigenous knowledge
Instrumental value
Intrinsic value
Metabolic rift
Preservationists
Sixth extinction
Tragedy of the commons

Discussion Questions

1. Describe how hunter-gatherers depended upon nature for their survival. How did domestication change this relationship with nature in agrarian societies?
2. How did the agricultural revolution support the rise of the industrial revolution?
3. Why was Marx critical of how industrial society separates humans from nature?

4. Explain the role fossil fuels played in the origins of the industrial revolution and the Great Acceleration, including the creation of synthetic chemicals.

5. What are the three assumptions of the human domination of nature? How does eco-feminism and indigenous knowledge challenge these assumptions?

6. Compare the intrinsic value of nature with the instrumental value of nature. Walk around your campus or neighborhood, taking photos to illustrate these different values.

7. What is the tragedy of the commons? Use this concept to explain the sixth extinction.

8. Image Leopold is having a conversation with a conservationist. What do you think they would be most likely to disagree about?

9. Do you support the Rights for Nature movement? Why or why not?

10. Explain how the Samí concept of sufficiency informs their adaptive management practices.