1

Introduction

The 2018 Nobel laureate for economics William Nordhaus (2013: 19) illustrates how deceptive are the consequences of fossil-fuelled social practices that cause climate change. If he drives 100 miles in his car, ‘I consume 5 gallons of gasoline. This will produce about 100 pounds of $\text{CO}_2$, which will come out of the tailpipe and go into the atmosphere. I cannot see or hear it or smell it, and I generally do not even think about it. If I am like most people, I will probably assume that my trip will have no effect on the world’s climate, and so I will ignore the consequences’.\(^1\) If the trip by Nordhaus were unique, the consequences would be negligible. However, it is typical of much more numerous sets of social practices. An easy way to remember the consequences of fossil-fuelled social practices is as follows. If you drive the average 3500-pound midsize car a distance in miles equal to your weight in pounds, you are emitting your weight of carbon dioxide into the atmosphere on that one trip: a 200-pound person driving 200 miles emits 200 pounds of carbon dioxide. Hence, think about the weight of $\text{CO}_2$ emitted by millions of people commuting to and from work in cars, usually one person per car, in urban sprawled metropolitan areas. This has to be understood in its global context. The average car will be driven about 10,000 miles yearly,
so it will emit about 10,000 pounds of CO₂ annually. There are about one billion cars in the world. Therefore, by simple arithmetic the global fleet of cars is emitting about 10 trillion pounds of CO₂ every year.

In addition, imagine the weight of CO₂ being pumped into the atmosphere by the combustion of jet fuel lifting and powering a heavy plane, multiplied by the distance travelled per plane every year and the number of planes. Moreover, there are ships of all sorts and fossil-fuelled industries, including those that combust fossil fuels to extract, transport, and refine fossil fuels. Cement is the essential constituent used worldwide in concrete buildings, roads, bridges, dams, pipes, etc. Its manufacture by combusting fossil fuels emits a weight of carbon dioxide into the atmosphere almost equal to the weight of cement in these heavy structures. All this carbon pollution of the atmosphere continues year after year. The scale of carbon being taken from safe storage in the ground and emitted into the atmosphere is enormous. Carbon dioxide, which the US Supreme Court in 2007 ruled a pollutant in terms of the Clean Air Act, remains in the atmosphere for on average one hundred years and piles up, then descends to acidify the oceans. Our planet and its atmosphere used as a carbon waste dump are huge so it takes time to pollute them, but that implies it will take much time for them to be restored to their beneficial state, if that proves possible.

Fossil fuels have been and remain the energy source that has powered modern society since industrialization. Even ecological saints with the best intentions can not avoid using fossil fuels, either directly by gassing up their vehicles or indirectly by flying in a plane, using air conditioners and social media. Every individual, every company, and every country is a carbon polluter and has contributed to global warming. But this fact should neither legitimate carbon pollution in terms of a we-are-all-sinners ideology nor lead to fatalism. The significant variables are the amount of emissions and whether action is being taken to decrease them or increase them. This varies enormously. There are colossal polluters—huge even relative to their industry (Freudenburg 2006)—and groups that promote fossil fuels and therefore emissions. Nevertheless, there are also small polluters, and groups that try to reduce emissions. A small number of gigantic corporate carbon polluters have major consequences for global warming and climate change, but so does a massive number
of much smaller individual polluters, and the latter’s pollution loading varies greatly according to their social class and specific practices. Hence, the fossil-fuelled practices of both huge oligopolistic companies and those of ordinary people and institutions need to be examined.

Many readers might be tempted to assume that Nordhaus is mistaken because five American gallons of gasoline only weigh about 31 pounds. Where do the remaining 69 pounds of CO₂ come from? But Nordhaus is right. His example demonstrates how insidious fossil-fuelled social practices are, and how important it is for the population, decision-makers, and social scientists to ground their understanding of global warming on natural science’s comprehension of biophysical dynamics. This is one of the reasons why Chapter 2 gives a brief outline of the natural science understanding of fossil-fuelled climate change, including an explanation of the Nordhaus example and the cement illustration. Pielke (2010: 46–50) claims there is an ‘iron law of climate change’ that describes the population’s refusal to support a price on carbon pollution anywhere near what is needed to prevent fossil-fuel combustion causing greenhouse-gas emissions and global warming. This book argues that the refusal is at least in part contingent on lack of a practical understanding of how ordinary fossil-fuelled practices are contributing to the problem. Scientists communicate in the language of gigatonnes, but non-scientists think in pounds or kilograms. Hence, an everyday grasp of the fossil-fuelled climate crisis is being lost by lack of translation of the abstract theoretical knowledge of science into commonplace units. Safran Foer (2019a: 13; 2019b: R14) states that ‘most of us would find it difficult to explain how our individual and collective behavior is boosting hurricane winds by almost thirty miles per hour or contributing to a polar vortex that [sometimes] makes Chicago colder than Antarctica’. This book strives to promote as much as possible a practical comprehension of the fossil-fuelled climate crisis.

Is It a Crisis?

The term ‘global warming’ was suitable when Wallace Broecker of Columbia University introduced it in 1975, and ‘climate change’ was fitting when the National Academy of Sciences announced it in 1979.
But subsequent massive emissions have made the carbon accumulation in the atmosphere and the greenhouse effect much worse (IPCC 2018; US Global Change Research Programme 2018; UNEP 2018). Because of those emissions, the global surface temperature has increased 1 degree Celsius since the pre-industrial period and already hurricanes, deluges, droughts, wildfires, etc., are more intense. Most nations agreed in the Paris Accord of 2015 to limit the increase to 2 degrees. The 2018 emissions gap report documented, however, that few countries are on track to achieving the goal, that most of the highest emitting countries are not meeting their near-term targets much less the more ambitious ones to start later, and that the present global trajectory is leading to an increase of 3 degrees (UNEP 2018). This would result in foreseeable dire consequences and likely some unforeseeable ones. There is strong backlash against the Paris Accord: the USA withdrew; a carbon tax in France resulted in riots in 2018; the Canadian government is promoting the extraction of high-emissions bitumen by purchasing a pipeline, and conservative parties oppose a price on carbon pollution; Australia is combusting and exporting coal; etc. In 2011, Victor (2011) published a book entitled *Global Warming Gridlock*. Nine years later in 2020, the gridlock persists. The Global Carbon Project (2018) documented that emissions, far from decreasing, have increased 2% in 2018 to a new record high.

Government policies to control greenhouse-gas emissions are often not implemented, or are overturned by the next government in the name of stimulating economic growth. This lurching to-and-fro contrasts with the unidirectional accumulation of carbon in the atmosphere and the growing hazard of global warming. In the USA, the Republican Administrations of George W. Bush and Donald Trump rolled back the climate change mitigation initiatives of the Democratic Administrations of Clinton/Gore and Obama/Biden. The 1997 Kyoto Protocol was signed by 192 countries, but did not require any restriction on emissions by big carbon polluters like China, India, Brazil, and South Africa. Therefore, the highest carbon polluter at the time the USA refused to ratify it, and the big per capita carbon polluter Canada reneged on its ratification when a conservative government took power.
One significant reason why anthropogenic global warming is so challenging consists of the speed of greenhouse-gases accumulating in the atmosphere compared to the slowness of the transition to clean, renewable energy. Implementing new energy sources requires, in addition to innovative technologies, new infrastructures and social learning. Rhodes (2018: O1) documented that ‘across the past 400 years, as the world has transitioned from wood to coal, to oil, to natural gas and nuclear power, the average transition time from zero to 50-percent market penetration has been about 100 years’. Imagine all the carbon that human activities will have placed in the atmosphere if it takes a century for non-carbon, renewable energy to achieve half of the global energy market. Worse yet, the other half will still be fossil fuels emitting carbon. These fossil-fuelled practices would likely result in the elimination of the Arctic ice cover which has reflected much of the sun’s radiation back out into space and the thawing of permafrost letting loose the potent greenhouse gas methane hitherto trapped underground. Both are currently melting because of the fossil-fuelled warming that has already occurred. This could well lead to runaway global warming by nature’s autonomous dynamics by the time clean renewable energy constitutes one-half of the global energy supply. Little wonder Rhodes (2018: O4) concluded that ‘energy transitions take more time than a world faced with global warming may have’. The disjuncture between socioeconomic causal temporalities and socially acceptable mitigating temporalities renders management of the fossil-fuelled climate crisis extremely difficult for a global population increasing in number and energy consumption per person.

Because fossil-fuelled climate change creeps up slowly in most of the world, it is a threat more for the future than for the present. If fossil-fuelled climate change were to suddenly cause a rise of one metre in the level of oceans thereby immediately affecting polluters by flooding many of the world’s cities, few would deny or be apathetic about it. But the ocean level rise is predicted by science to creep upward slowly and take a century or more to reach that height. Immediacy of consequences is not the physical property of the fossil-fuelled greenhouse effect. Hence, it can be pushed to the back of mind as near-term economic pursuits worsen the problem. Most of the world’s population and countries perceive it
as distant, leading to a tendency to discount it and shove aside costly and/or inconvenient changes in social practices. Nevertheless, in the Arctic, temperatures are increasing at twice the rate as in the rest of the world, causing near-term harm. At the Arctic Council whose members include the USA, Russia, Sweden, Norway, Denmark, Finland, Canada, Iceland, and the Inuit Circumpolar Council, the Swedish Foreign Affairs Minister stated that a ‘climate crisis in the Arctic is not a future scenario, it is happening as we speak’ (Dickson 2019: A7). The Inuit representative added that ‘Inuit are feeling the effects of climate change every day, … our people are witnessing the adverse impacts of climate change. What about us and our reality?’

Globalization has tightly coupled not only societies and industries but also social dynamics with worldwide biophysical dynamics. In small scale, complex, tightly coupled systems manipulating nature’s dynamics, such as nuclear reactors, the accumulation of minor inadvertent errors has led to disasters (Perrow 1984). There is no reason or evidence to conclude disasters could not occur on a global scale, namely because of a failure of foresight resulting in the incubation of dangerous fossil-fuelled climate change in a tightly coupled complex world.

Neither of the benign labels ‘global warming’ (which sounds nice for cold countries) nor ‘climate change’ (which implies it could change for the better) does justice to the gravity of the problem. When a Canadian province fought a national carbon tax in its supreme court, that court approved the tax and concluded that climate change constitutes an emergency. Branding the problem as ‘global warming’ and ‘climate change’ has failed to incite mitigation. After almost a half-century of accelerating atmospheric carbon buildup since those terms were introduced, it is now appropriate to redefine the problem as a ‘fossil-fuelled climate crisis’. The Oxford dictionary defines ‘crisis’ as a time of intense difficulty or danger, when important decisions must be made, and a turning point when an important change takes place leading to recovery or demise. All this is applicable to the situation in which societies now find themselves because of their ongoing combustion of fossil fuels. Admittedly, it is not a disaster everywhere right now, but it is a crisis in the sense that if preventive measures are not taken promptly then far worse consequences will unfold in slow-onset fashion. Thus, it is a creeping
crisis similar to that caused in New Orleans prior to its disaster by shortsighted economic development in flood-prone and hurricane-prone areas in a below sea level city surrounded by the Gulf of Mexico, the Mississippi River, and Lake Pontchartrain. The disaster there was scientifically predicted in advance, only the timing was unknown, but canal construction and wetlands destruction continued thereby exacerbating vulnerability (Freudenburg et al. 2009), and disaster occurred in 2005 when Hurricane Katrina struck. Global warming does not feel like a crisis to many people, but neither did the threat of a pandemic predicted by epidemiologists, so the lack of foresight, discounting danger, and failure to mitigate promptly when COVID-19 surfaced resulted in huge costs in lives and economic losses. In both pandemics and fossil-fuelled climate change, science is needed to explain the danger and causal linkages, and to make informed decisions determining whether demise or a turning point leading to recovery will occur.

The threat is one of the piling up an enormous environmental debt to be paid by future generations including our grandchildren. The environmental debt will belatedly be paid in disasters or costs of disaster preparedness, adaptation, and resilience. This generation, especially high emitters, insists on externalizing the costs of fossil fuels to the environmental commons. There is an increasing ‘normalization of the environmental crisis …. [characterized by] the curious simultaneity of an unprecedented recognition of the urgency of radical ecological policy change … and an equally unprecedented unwillingness and inability to perform such change’ (Blühdorn 2011: 36). The crisis consists of a refusal to stop the environmental debt from accumulating, what Beck (1995: 48–49) refers to as ‘the death reflex of normality’, and the evidence indicates that it currently applies to fossil-fuelled normality. Thus, an increasing number of scholars who have studied fossil-fuelled climate change are referring to it as a crisis (Speth 2009, 2012; Flannery 2009, 2015; Nordhaus 2013; Suzuki and Hanington 2017). It is a material crisis of the beneficial biospheric habitat for humanity, but it is also a crisis of culture and imagination, of faith in the market, in production science and technological innovation, and on the other hand faith in impact science and socioeconomic innovation. ‘I would call it a crisis of belief’ (Safran Foer 2019b: R14).
Fossil Fuels

Fossil fuels have been central to modern societies and their development. They power automobiles, trucks, planes, boats of all sorts, heating and air conditioning, factories, social media servers, and much more. The military is a fossil-fuel glutton and thereby a mammoth greenhouse gas-polluter. The US Department of Defense is the world’s single largest institutional petroleum consumer and the single biggest consumer of energy in the USA. As a result, its CO₂ emissions surpassed those of many industrialized countries, for example in 2017, 59 million tonnes for the American military compared to 48 million tonnes for all of Sweden and 34 million tonnes for all of Switzerland (McCarthy 2019). Mechanized food production for a large and still growing population depends on fossil fuels, which have liberated vast proportions of the population from toiling in the fields like their great-grandparents. Oil ‘packs a huge amount of energy by volume and weight: three large spoonfuls of crude oil contain about the same amount of energy as eight hours of human manual labour, and when we fill our car with gas, we’re pouring into the tank the energy equivalent of about two years of human manual labour. Oil is also versatile, convenient, and still relatively cheap. No other substance or fuel comes close to matching its properties’ (Homer-Dixon 2006: 82–83). Low-carbon renewable energy forms a tiny proportion of the world’s energy compared to fossil fuels, which currently provide 81% and has only decreased marginally (World Bank 2015), leaving emissions greatly exceeding carbon withdrawals thereby worsening global warming. In some social practices the fossil fuel combustion is visible, but in many others it is not. Social media, cloud data storage, and smartphones depend on servers which consume enormous amounts of electricity for functioning and cooling, most of it supplied by combusting fossil fuels. ‘With so much of the world now dependent upon cloud computing, social media, online streaming, and the like we have all become cheap electricity addicts’ (Carolan 2014: 151). Users are unaware of the massive upstream carbon emissions involved in social media. Even cryptocurrencies like bitcoin, which appear to be created from nothing are constructed by combusting fossil fuels to produce electricity needed by computers for their complex
computations. Most of the activities and conveniences people need, enjoy, or desire are powered by fossil fuels. They are the inanimate sources of energy that drive modern societies. Desrochers and Szurmak (2018) describe how important fossil fuels have been, but their tribute ignores how threatening this transfer of carbon from safe storage underground to a long-lasting danger in the sky has become. The multiplicity of fossil-fuelled social practices means that there are many dimensions to global warming. That will require many solutions, but the overall danger has been well documented by science. Mitigating fossil-fuelled climate change is much more difficult than solving urban water and air pollution and the like. This book’s focus is on the role of fossil fuels in the climate crisis because they are so central to modern societies and such a big part of the problem.

The problem is particularly difficult to deal with because fossil-fuelled global warming is cumulative and largely invisible to the senses. The increase of greenhouse gases in the atmosphere can’t be seen with the naked eye, nor can a global temperature increase be felt, unlike a local increase. In fact, a 2 °C increase seems insignificant. The climate seems normal because it is often confused with weather whose fluctuations have been experienced previously. Natural science is needed to know that the carbon content and temperature of the global atmosphere are increasing significantly, dangerously, and rapidly. In this sense, fossil-fuelled climate change is similar to the depletion of the ozone layer by CFCs, which could not be seen and was only made visible by science. This comparison shows that problems can be solved if there is political will by decision-makers and the population. But anthropogenic climate change is much more difficult to remedy because it involves an enormous number of social practices based on fossil-fuel energy that has propelled society’s development. Unlike CFCs, there are no easy cost-effective substitutes for flexible, energy-laden fossil fuels used in so many sectors. Alternatives for fossil fuels require replacing not only those fuels but also much of the present physical and social infrastructure that has enabled their use. Moreover, the most severe consequences of global warming foreseen by science are distant in space and time; hence carbon polluters are not dissuaded from polluting by experiencing immediate harm. The threat of fossil-fuelled climate change is actualized in an insidious, creeping
fashion, which reduces the conditions for creating strong social movements to combat it. The metaphor of a frog in water slowly brought to a boil is apt.

This book deals with only fossil-fuelled climate change, but climate change is a particularly important cause of environmental degradation affecting all the others. Fossil fuels power deforestation, overfishing, mining, agriculture, urbanization, plastic pollution of oceans, etc. (IPBES 2019). It is essentially a socioeconomic problem in its causes, consequences, and hopefully solutions. Societies have become dependent on machines that use greenhouse-gas emitting fossil fuels as their source of primary energy. This creates structured, locked-in, path-dependent (Nye 1998) predispositions, habitus, and perceived entitlements to emit carbon into the atmosphere. Dependence on fossil fuels is fostered by powerful fossil fuel oligopolies, related vested interests, consumer predispositions and habits, identities, values, reluctance to change, etc. Removal of that dependence requires not only technological innovations of low-carbon alternative energy sources, but also improved political and media institutions, environmental education, enhanced future orientation, and foresight. Companies justify their exploitation of fossil fuels by claiming they are satisfying demand by consumers. They are, however, also stimulating demand, not only by advertising but also by increasing supply thereby lowering price and increasing consumption, innovating new fossil-fuelled products, etc. The need to bring emissions into balance with carbon withdrawals from the atmosphere implies that most of the fossil fuels will have to be left safely in the ground unless inexpensive carbon capture and storage or geoengineering solutions are implemented. Thus, fossil fuel industries, their workers, and especially countries whose economies depend on extraction and export of fossil fuels feel threatened by the conclusions of science.

Berners-Lee and Clark (2013: 2) argue that societies have been unable to change the emissions trajectory, the problem is urgent, technological solutions are a long way off, the choice is between taking unimaginable risks and leaving fossil fuels in the ground, so it is ‘critical that we get a proper understanding of the core barriers that are holding us back’. Boström, Davidson, and Lockie (2018: abstract) conclude
that it is crucial that ‘individual and collective actors, lay persons and experts, develop the reflexive capability to promote change, and counteract structural and cultural forces that prevent change’. That is the goal of this book, which seeks to move the investigation forward on the solid foundation of natural science conclusions.

The Autonomous Dynamics of Nature

The environment for humanity consists of complex systems of biophysical dynamics. Far from being constant or passive, they are actants that act and react, not intentionally but autonomously nevertheless. I (Murphy 2002) argued that modern societies are internalizing autonomous dynamics of nature as never before. The autonomous dynamics of nature are significant actants, whether they act independent of human social practices or are unleashed inadvertently by them. Nuclear reactors, satellites, planes, and the like consist of recombinations of nature’s dynamics in the context of nature’s broader dynamics. The autonomy of the actions of nature’s dynamics becomes evident when reactors meltdown as in Chernobyl or are struck by tsunamis as in Fukushima, when satellites and electrical grids are disrupted by sun storms, when earthquakes and extreme weather devastate cities (Zebrowski 1997; Murphy 2009). As Adam (1995, 1998, 2000) argued, social constructions are superimposed upon the biophysical constructions of nature. Long-term sustainability or unsustainability is determined by whether material social constructions are or are not in harmony with the constructions of the natural world. The latter have sustained human societies and enabled their development during the Holocene. The issue is whether fossil-fuelled practices of humans will degrade nature’s services in the long run. The focus of this social science analysis is on the interaction (i) of fossil-fuelled social practices at all levels with the dynamics of nature, (ii) of social constructions with nature’s constructions, and (iii) of the actions of human actors having intended and unintended consequences with the actions of nature as an autonomous actant.
Environmental Social Closure

There is a serious weakness in conceptions of environmental impacts in the Anthropocene. They typically depict an undifferentiated humanity as the cause, and a homogeneous humanity suffering the effects. Hence, they fail to capture the socioeconomic dynamics that are the drivers of human impacts. This book attempts to correct those deficiencies by introducing the Weberian theoretical framework of social closure (Murphy 1988) to the environmental social sciences, and showing how it helps elucidate the socioeconomic drivers of environmental problems, victimization from them, and the resulting reaction. Closure refers to processes of monopolization of resources thereby closing off opportunities to others. The book analyses environmental social closure involving the appropriation of biophysical resources, including carbon sinks, by the present generation disproportionately benefiting some of its members, resulting in the risk of excluding latecomers from such benefits, as well as other species. Latecomers consist of poor individuals, poor societies, and future generations. The global biophysical environment such as the atmosphere constitutes a commons shared by everyone, including future generations, and is a medium that carries social relations of monopolization and exclusion across space and between generations over time. Priority given to near-term economic benefits to the exclusion of long-term costs, which are discounted, results in social closure becoming embedded in culture, practices, and physical infrastructures. Reaction against such environmental closure is led by environmental movements, impact scientists, and social democratic governments. Reaction also consists of nature as an actant whose biophysical dynamics strike back against their manipulation by humans, for example fossil-fuel combustion produces global warming thereby unleashing more intense wildfires and hurricanes.

Is the fossil-fuelled climate crisis the result of the interests, values, and actions (or inaction) of decision-makers and the powerful in society, or of actions by the overall population steered by their interests and values? Some people and companies disproportionately appropriate not only benefits but also influence and decision-making, hence make a particularly heavy impact on the environment and on climate change.
Leadership is crucial in determining whether there will be successful mitigation or a failure of foresight. Nevertheless, the remainder of the population are not passive followers or cultural dopes (Lynch 2016). They too have interests, values, and impacts, especially because of their large numbers, and are active agents in their relations with nature. Hence, it is important to take into account not only the concentration of decision-making, influence, and benefits but also social practices at all levels of society. Rowe et al. (2016: 234–235) apply Gramsci’s insight ‘that elite power is maintained not only through coercion, but also through the everyday actions of people that confer consent upon hierarchical social orders, ... the carboniferous capitalism of today, while reinforced by a daunting nexus of corporate and state power, is reproduced daily by the everyday consent of popular publics. This consent manifests itself in consumer decisions, the driving of cars, voting patterns, hands-off approaches to pension and mutual fund investments, and political quiescence’. Redclift (2010: 132) counsels ‘analysing how current behavior is tied into patterns and cycles of carbon dependence’ and advocates taking the long view of society. The concentration of benefits and decision-making regarding fossil fuels and the disproportionality of carbon pollution practices are important, but so are the huge number of small polluters who need or enjoy fossil-fuelled polluting practices. It would be an oversimplification to reduce the problem to the practices of big polluters or to demand for fossil fuels by the enormous number of smaller polluters. Hence, this book will include both dimensions in terms of (a) the social closure theoretical framework and (b) the social practices paradigm. These overlap in the monopolizing practices of the powerful.

Social Practices

The anthropogenic effect on the environment is usually represented as the consequence of human activities. Social scientists (Shove 2012a, b; Shove et al. 2012; Shove and Spurling 2013) have replaced ‘activities’ with the concept of ‘social practices’ and use it to study climate change.
They argue that practices involve the integration of three elements—materials, meanings, and competences—into performances. Thus, the practice of intercontinental tourism consists of the integration of a plane combusting jet fuel, competent pilots and employees, and meanings that motivate flying. Important also are marketing practices of aviation companies, operation of airports as shopping centres, etc. Following Latour’s (2000: 113) argument that artefacts ‘are in large part the stuff out of which socialness is made’, Shove et al. (2012: 9) emphasize ‘the constitutive role of things and materials in everyday life. … [and] that practices are constituted through the actions of material entities as well as people’. Social practices impact the environment because materiality is an indispensable ingredient out of which socialness is made.

The focus on social practices that degrade the environment and result in global warming, compared to other practices that are more benign, as well as their constitutive elements is important. But two improvements are needed. First, although there had been a cultural turn in some social theory that resulted in evacuating materiality leaving a significant gap, this was not true of most of the environmental social sciences like environmental sociology. Researchers (see Catton and Dunlap 1980; Freudenburg and Gramling 1993; Freudenburg, Frickel, and Gramling 1995; Gramling and Freudenburg 1996; Dunlap and Catton 1994; Benton 1994, 2001; Murphy 1994, 1997, 2002; Dickens 2004; Dunlap 2010; Foster, Clark, and York 2010) explicitly and continually analysed interactions between the material and the sociocultural. Second, authors like Latour and Shove et al. who include materiality typically reduce it to artefacts, things, etc., and have only an abstract, unexplicated sense of how they act. They are shy about incorporating the most important elements of materiality, namely nature’s dynamics and properties, its services and threats, into social theory. This must be explicitly integrated into a theory of social practices.

The Inuit Nobel Peace Prize nominee Sheila Watt-Cloutier (2019: O11) gives an example of social practices in their physical context, which is shifting because of global warming. ‘As a young child growing up in Kuujjuaq, Que., I travelled only by dogsled for the first 10 years of my life. I was often snuggled into warm blankets and fur as my family set out on hunting and fishing trips. The vast Arctic sky surrounded us and the
ice was strong beneath our feet – the foundation that carried us across the frozen land. … But, in my generation, the Arctic sea ice and snow, upon which we Inuit have depended for millennia, is now diminishing’. This resulted from fossil-fuelled practices of people far away because there was no carbon pollution in traditional Inuit transportation practices. But in Watt-Cloutier’s generation, the transportation practices of the Inuit themselves have changed to non-traditional, fossil-fuelled ones: snowmobiles, all-terrain vehicles, motorboats, planes, etc.

Social practices can be portrayed as purely cultural only by abstracting them out of their material context. Social media interaction appears to be only cultural, but it and data storage clouds depend on servers consuming massive amounts of electricity, much of it coming from fossil fuels. Nevertheless, social practices vary enormously in their interaction with broader dynamics of nature. Travelling in an automobile propelled by fossil fuels emitting CO$_2$ contributes to global warming whereas propelling oneself on a bicycle does not. Differences in social practices matter.

It is informative to juxtapose the travelling practices of the rich and powerful with those of a young climate activist. Sir Elton John flew Prince Harry and his wife from England to Nice on his private jet. Each way combusted 1868 litres of fuel, which emitted 4.7 tonnes of carbon dioxide into the atmosphere, for a round-trip total of 9.4 tonnes (Reality Check Team 2019). Specialists state this should be multiplied by 1.9 to reflect emissions at high altitudes. Sir Elton claimed he paid a certified company for carbon offsets, but did not say how much, and it is difficult, expensive, and dubious to offset almost 10 tonnes of emissions. He used security to justify this private jet flight, but strict security reasons do not apply to Sir Elton himself when he flies around in his private jet. Prince Harry doesn’t show much restraint either, since he and Meghan flew in a private jet earlier to vacation in Ibiza, with round-trip emissions calculated to be 10.4 tonnes. This case is not presented to single out the celebrity musician nor the prince for hypocrisy, as global warming deniers do. For every private jet flight of the prince, there are thousands of such flights by the rich who discount jet-fuelled danger. The fossil-fuelled practices of the rich and the powerful winging about in private jets disproportionately cause global warming compared to flyers
packed like sardines in economy class of commercial airlines, and more so compared to those who rarely fly.

The distinctive contribution of the teenage climate activist Greta Thunberg is that her social practices speak louder than words. When she travels in Europe, she does so in electrically powered trains, which underscores the global warming consequences of combusting gasoline or diesel to power vehicles and jet fuel for short-haul flights. When invited to a summit on global warming in New York, she accepted to cross the Atlantic in a solar-powered racing yacht built for speed rather than comfort, but was warned that the journey would take two weeks and the ride would be choppy. Nobody expects people, including Thunberg in the future, to cross oceans like that, but she called attention to fossil-fuelled practices like flying causing global warming. Thunberg accused world leaders of mouthing ‘empty words’, and called for action to cut carbon pollution and prevent climate change. These two cases demonstrate the significant consequences of flying for global warming, the differential environmental impact of the powerful who monopolize private jets compared to ordinary folk, the difficulty of finding low-carbon alternatives for travelling long distances, but nevertheless the need for action and not just words.

Shove et al. (2012: 162) succinctly make three important arguments: ‘people are somehow captured by the arrangements they sustain and to which they devote finite amounts of time, attention and resources. … there are no reliable means of steering or governing transitions in practice: systemic forms of policy intervention only have effect when taken up in (and through) practice’. First, in North America, people are captured by low gasoline prices into buying gas-guzzling SUVs, crossovers, pickup trucks, and fossil-fuelled adult toys such as motorboats, four wheelers, snowmobiles, etc. Then they develop a sense of entitlement such that they resist carbon taxes. Second, if these authors are right, then whether a transition sufficient to mitigate anthropogenic climate change will be achieved must remain an open question because there are no reliable means of governing it in practice. The third point correctly concludes that policy discourse is vacuous unless implemented into changed practices, implying that the key variable is not so much policy construction as implementation.
If one extracts or/and combusts fossil fuels to make money with no thought of global warming, or with the intention of causing it (which is rare), the result is the same: global warming. The converse is also true, with Giddens (2009) giving an example. In the nineteen-seventies, Germany, France, and other European countries increased the tax on petrol (gasoline), hence its price. The motivation was to enhance each country’s energy security and independence from unreliable Middle Eastern sources of oil after the formation of OPEC. Nevertheless, it decreased the use of petrol and provided monies to build efficient public transportation systems. This policy indirectly contributed to mitigating climate change. What is significant are social practices and their effects, regardless of intentions. The analytical focus should be on social practices because they are consequential for climate change.

Emissions-reducing technological improvements have great difficulty keeping up with the treadmill of social practices that increase emissions. There was a 40% increase in the carbon footprint of tourism between 2009 and 2013, much of it from aviation (IPBES 2019). According to the International Civil Aviation Organization (ICAO 2018), there was a passenger-kilometer increase of 7.1% in 2015 and 6.3% in 2016. Hence, the International Air Transport Association (IATA) will have extreme difficulty achieving its 50% net emissions reduction goal by 2050 even if flights remain at present levels, and moreso if there is a global increase in flying, which is likely. The fossil-fuelled global auto fleet is expected to increase by 80% by 2035, especially in Asia (Reguly 2018: 19). The very belief that fossil-fueled engines are becoming more efficient leads decision-makers and the population to use more of them, thereby undermining the goal of emissions reduction (York 2012; York and McGee 2016). Use of social media and data clouds has exploded, requiring energy-glutton data servers that are insidious because there are no visible exhaust pipes as in vehicles nor do they leave contrails visible in the sky like planes. As developing countries rise out of poverty, their populations engage in the same social practices that inhabitants of wealthy countries have long enjoyed: drive cars, eat more meat, see the world, use air conditioning and data servers, etc. Even if greenhouse-gas emissions per person remain constant, population growth, expected to climb from
7.7 to over 9 billion, would result in more emissions. The treadmill of carbon polluting practices is accelerating.

The Struggle Between Value Spheres

A century ago, Max Weber (1946: 147–148) argued that ‘the various value spheres of the world stand in irreconcilable conflict with each other … here too, different gods struggle with one another, now and for all times to come’. There are many conflicting value spheres, which are relevant to the fossil-fuelled climate change threat: economy versus environment; near term versus long-term; free market versus government intervention; temporalities of climate change and temporalities of politics (Lockie and Wong 2018); faith in technological innovation to master nature versus hope that humans can master their own social practices. It is an open question whether those conflicting value spheres can be reconciled. The pair of warring gods consisting of near-term economic prosperity worshiped in modern societies versus long-term environmental sustainability is more complex than economy versus environment. Stern (2009) documents that future costs of fossil fuel global warming will far outweigh current economic benefits of fossil fuels. Similarly, the Fourth National Climate Assessment documented that climate change is engendering substantial net damage to the US economy during this century and will cause further damage (US Global Change Research Program 2018). The costly 2018 wildfires in California, in Australia in 2020, and the 2017 hurricanes striking wealthy Houston and poor Puerto Rico are foretastes of what is coming. Fossil-fuelled social practices by the present generation are accumulating expensive environmental debts to be paid by future generations. Near-term priorities are excluding concern for long-term needs, so the tension is between discounting future danger and foresight. Solutions require having the foresight to act to prevent adverse consequences predicted by science. This involves shifting to clean, renewable energy and cultural shifts to more inclusive, cosmopolitan, future orientations.

Political and business decision-makers claim the economy and the environment are being reconciled, especially by themselves, and many
ordinary people act and vote as if they have been reconciled. It is necessary to examine material social practices to determine whether such discourse constitutes reconciliation or greenwashing. The pursuit of profit and affluence through market dynamics have resulted in priority given to current economic growth at any environmental cost. Is mitigating emissions compatible with present economic growth, and how could this be done? Can economic growth be based on clean renewable energy, or must fossil-fuel consumption be reduced, and will that entail major sacrifices?

Near-term economic goals can be reconciled with long-term sustainability, but it is a difficult, enduring task that involves bringing social practices into harmony with dynamics of nature. The most sustainably prosperous societies (Switzerland, Sweden, South Korea, Germany, and Japan) do not have a drop of oil and typically develop their human capital to add value to a minimum of raw materials, produce a diverse range of goods, and develop their intellectual property and service sectors. Economies based on exporting crude oil (Saudi Arabia, Russia, Venezuela, and Nigeria) suffer boom-and-bust cycles of the market. To reduce their contribution to global warming, they become dependent on innovating technological solutions, which must be technically effective, cost-effective, and scalable, and are nowhere to be found. Therefore clean energy movements seeking to displace carbon polluting fossil fuels threaten them. Countries exporting crude fossil fuels typically become leaders of the laggards concerning global warming.

A Foreseeable Threat with Unforeseeable Specific Harms

The overall trajectory of fossil-fuelled global warming is foreseeable by science if present trends continue. Hyper-carbon societies and a hyper-carbon world are emerging, thereby brownfielding the atmosphere and the oceans. Claims of unforeseeability of the overall trajectory are a refuge for those who do not want to foresee and discount danger. However, the specific long-term impacts, locations, timing, etc., are difficult to foresee and in many cases unforeseeable. For example, global warming
is causing Greenland’s and Antarctica’s glaciers to melt into the oceans, which may cause temporary cooling in some regions. The diversity and unforeseeability of harms of global warming has correctly led to the more general concept of climate change. The principal unknown is whether fossil-fuelled global warming will tip the planet into a new irreversible state less beneficial as a habitat for humanity. This book investigates how societies are responding to their foreseeable creation of brownfields in the sky having unforeseeable damages (Lockie and Wong 2017), that is, to their present incubation of the possible unsustainability of their beneficial habitat.

Biophysical uncertainties pale in comparison to uncertainties about the socioeconomic response. ‘Today, the largest uncertainty in projecting future climate conditions is the level of greenhouse gas-emissions going forward. Future global greenhouse gas-emissions levels and resulting impacts depend on economic, political, and demographic factors that can be difficult to predict with confidence far into the future’ (US Global Change Research Program 2018: Chapter 1 Overview). Mitigating anthropogenic climate change will be expensive and likely require changes of fossil-fuelled practices. It requires a better balance between near-term economic goals and minimizing long-term harm to the human-supporting environment and human health, but achieving that balance is socially problematic. It could spark serious tensions, likely by exacerbating pre-existing social divisions. Environmental problems could be mitigated if there is sufficient understanding and willingness to improve social practices causing those problems. But such willingness is in short supply, which could lead to a ‘failure of foresight’ and the ‘incubation’ of a slow-onset global calamity that researchers (Turner and Pidgeon 1978) have long documented in small scale ‘man-made disasters’. If danger is discounted for slow-onset threats to gain near-term economic benefits, then serious harms may not be experienced until it is too late to avoid tipping environments and perhaps the whole planet into a new less beneficial state. This is what Giddens (2009) labelled as his paradox.

For many global environmental problems—fossil-fuelled climate change, degradation of oceans, biodiversity loss, etc.—there are enormous time lags and/or spatial distances between causal social practices
and consequences, and issues of scale whereby any one cause can be dismissed as minor. Land, water, and the atmosphere on our planet are huge, so it takes enormous accumulation of pollution and much time to degrade them globally. But precisely because they are huge, it would take much time, effort, and expense to rectify anthropogenic global environmental problems. Natural disasters and anthropogenic disasters are merging empirically. Fossil fuels are combusted and forests are cut down, resulting in global warming. This makes extreme weather (wildfires, droughts, hurricanes and floods, etc.), which has always occurred, more intense and frequent, and will eventually result in the rise of ocean levels. Despite the empirical merging, it is important to distinguish those causes, and especially to avoid depicting anthropogenic unleashing of nature’s forces as natural occurrences. The distinction is necessary for scholarly rigour and appropriate preparedness and prevention. Disasters can be viewed as ‘focusing events’ (Birkland 1998) and prompts to preventive or/and preparatory action leading to greater sustainability, but they are often dismissed and written off as Acts of God or Mother Nature to avoid annoying conclusions of human responsibility (Zebrowski 1997).

The Need to Draw on the Natural Science of Fossil-Fuelled Climate Change

Admittedly, some risks are only sociocultural scares with improbable or negligible impact. It is important to avoid conflating all claims of hazards, such as unfounded apocalyptic climate predictions centuries ago with contemporary scientifically documented fossil-fuelled global warming. If conflated, then the distinction between high-impact probable hazards as opposed to imaginary or improbable threats is blurred, and the sense of urgency is diluted for real threats being caused now. This also incites the response that there are so many difficult threats we might as well discount danger and enjoy what we are doing because it won’t last. A judicious assessment of threats is necessary to prioritize them, and identify and implement means to mitigate them promptly. How can probable high-impact threats be distinguished from all the
alarmist claims continually being socially constructed, such as vaccinations causing autism? The best available evidence and understanding must be used, and this comes principally from natural science for a global, invisible, slow-onset biophysical threat like fossil-fuelled climate change. Hence, this social science analysis of the human-made climate crisis builds upon the conclusions of natural science (see Clark 2011; Wong and Lockie 2018). Because scientific consensus is based on confirmed theory, rigorous methodology, empirical evidence, and peer-reviewed analysis, it is the most reliable in a world filled with a cacophony of voices about threats.

Appearances to the eye are often deceiving. The Earth seems flat and the Sun appears to go around the Earth from east to west. These common sense presumptions were believed for most of the existence of humanity until science provided evidence that the Earth is round and rotates around the Sun. Science faced stiff opposition when it confronted cherished beliefs with its evidence-based theory, but eventually prevailed. Hopefully, that will also be the outcome for the fossil-fuelled climate crisis. Avoidance of misleading conclusions and deceptive wishful thinking requires a natural science understanding of the issues to build valid social science analyses.

It is important to avoid conflating ‘solutionism’ with practical solutions and improved practices. ‘Solutionism’ consists of changing discourse without changing practices and improving policies without implementing them, which goes with worsening of problems. It most misleadingly involves putative solutions that fail to address problems effectively. Hence, the best available understanding, concepts, evidence, and conclusions of natural science must be used to learn whether the problem is being lessened or worsened, and to carry out a nuanced social science analysis of why this is so. A clear understanding of the depth of the challenges is needed to lay the foundation to mitigate the threat. Earth scientists have documented that fossil-fuelled climate change unleashes self-reinforcing feedbacks of the Earth system resulting in the likelihood of crossing thresholds to much higher global average temperatures and sea levels than at any time in the Holocene. ‘If the threshold is crossed, the resulting trajectory would likely cause serious
disruptions to ecosystems, society, and economies. Collective human action is required to steer the Earth System away from a potential threshold and stabilize it in a habitable interglacial-like state. Such action entails stewardship of the entire Earth System – biosphere, climate, and societies – and could include decarbonization of the global economy, enhancement of biosphere carbon sinks, behavioural changes, technological innovations, new governance arrangements, and transformed social values’ (Steffen et al. 2018: abstract). They conclude that addressing these issues ‘requires a deep integration of knowledge from biogeophysical Earth System science with that from the social sciences and humanities on the development and functioning of human societies’ (Steffen et al. 2018: 8252).

Humanity has enjoyed amazing progress in health, education, and affluence since the development of science. Many challenges have been successfully met. The single best overall indicator is arguably the rise in life expectancy. Population increased from one billion around 1860 to over 7.6 billion in 2017 and appears to be going up to 11.8 billion by 2100, yet the proportion of people living in extreme poverty is decreasing and affluence is increasing. Water and air quality in European cities is better today than at the time of the industrial revolution. Natural disasters in countries like China and Japan killed people in greatest numbers after population increase but before science developed. Now applied science coupled with foresight has made infrastructures more robust and societies more resilient resulting in fewer fatalities (Zebrowski 1997; Murphy 2010). Depletion of the ozone layer by the innovation of CFCs was made visible by impact scientists, international negotiations led to the Montreal Protocol which restricted their use, and harm was diminished. In the 1970 and 1980s in Europe and North America, acid rain resulting from sulphur dioxide and nitrogen oxides produced by the combustion of fossil fuels was a major problem. Subsequent regulations and cap-and-trade systems successfully abated the problem. Environmental problems can be dealt with if they are understood, if there is willingness to pay the cost of prevention and adaptation, and if social practices and/or technologies are changed to meet the challenges. Those are three big ‘if’s for dealing with the fossil-fuelled climate crisis.
The Structure of the Book

After this introductory chapter, the book consists of two sections, each with five chapters. Part I analyses the fossil-fuelled climate crisis. Although other human actions contribute to global warming and climate change, the focus is on fossil fuels because they are the most significant single cause. They are also the most challenging since they are the energy source of most of what people have needed and enjoyed since the industrial revolution. Fossil-fuelled climate change is a physical problem, nevertheless it has socioeconomic causes and consequences. Part I doesn’t shy away from explaining the depth of the problem. That is not intended to lead to despair and foster fatalism, but rather to provide a firm basis for solutions. Part II assesses solutions that have been proposed, of which there are many. It examines both their possibilities and weaknesses with eyes wide open in order to distinguish between hope and wishful thinking, and provide a solid foundation for mitigating the problem.

Chapter 2 presents a brief summary of current natural science understanding of the fossil-fuelled climate crisis. It underscores the crucial concept of net change in atmospheric carbon (if emissions exceed carbon withdrawals, then global warming is worsening) and the concept of a global carbon budget. The chapter assesses the scientific validity of the oft-used concept of greenhouse-gas emissions per GDP (intensity) as an indicator of improvement. It examines science’s roadmap for limiting global warming to 2 °C and the possibilities and weaknesses of assuming improvements in technical efficiency will solve the problem. The chapter probes a paradox. Scientific knowledge of global warming has been available, increasing, and disseminated for a quarter-century, yet emissions continue to rise, as if the findings of impact science have had little effect. However, to legitimate the accelerating treadmill of fossil-fuelled social practices, faith in science to innovate just-in-time technological solutions abound. The chapter also assesses the concept of the Anthropocene for social science.

Chapter 3 uses the concept of social closure for the social science analysis of the climate crisis. It first examines whether recent market dynamics have resulted in greater concentration of economic power.
Then it analyses environmental social closure involving the appropriation of biophysical resources, particularly the atmosphere as a carbon dump, by the present generation, disproportionately by some companies and groups. It investigates whether emissions from fossil-fuelled practices degrading the environment are closing off resources and opportunities to latecomers, namely future generations and poor countries. Moreover it examines whether monopolization of resources by high consuming humans are excluding other species from needed resources and habitats, resulting in human-induced extinctions. It probes the purposeful reaction to environmental closure by impact scientists, environmental movements, and political actors. The chapter also studies nature’s reaction as an actant biting back with autonomous dynamics: extreme weather, wildfires, sea level rise, etc. It examines environmental regulations as processes of demonopolization, and inquires whether deregulation involves practices of monopolization.

Chapter 4 probes how fossil fuel use by one group can close off resources and opportunities for other groups even on the opposite side of the planet or living centuries later. How can the environmental commons, namely the atmosphere, oceans, and land, act as a medium that carries social relations of monopolization and exclusion over space and time? To answer, it draws on the theory of externalities. Unlike wind and solar energy, fossil fuels have environmental costs, namely costs of wildfires, floods, biodiversity loss, etc., because of global warming. These are not included in their price. Their unpaid cost accumulates into an environmental debt, which will be paid belatedly by others. The chapter investigates the resistance of carbon polluters, big and small, to pay the full cost of fossil fuels upon use through carbon taxes, regulations, etc. It also examines whether supply or demand generates fossil-fuel use and emissions, and the effectiveness of additionality, offsetting, and incrementalism.

Chapter 5 presents a social science documentation of the road actually being travelled concerning society’s response to the scientific findings of global warming, which is compared with the roadmap deemed necessary by science. It examines whether society is (i) heading towards transition out of fossil fuels, which requires leaving them stored safely in the ground if a safe technological solution is not implemented, or
(ii) is bedeviled by a Cassandra-like syndrome discounting scientific warnings and stuck in a path-dependent fossil-fuelled old normal characterized by failure of foresight. It investigates the accelerating treadmill of carbon polluting practices, market innovation as part of the problem, apathy, excuses, lucrative discounting of danger, top-down discounting and bottom-up discounting, backsliding, the culture of every man for himself, and free-ridership. It exposes dark sides of adaptation and resilience building. Thus it probes the depth of the fossil-fuelled climate crisis.

Chapter 6 documents a pattern that emerges and the phases or steps occurring as science reveals that near-term economic benefits from the exploitation of a dangerous resource are bringing long-term harm. It examines the extraction and combustion of one type of fossil fuel, and hypothesizes that the pattern is true for all fossil fuels. The fossil fuel investigated is oil from Canada's bituminous sands, often known as tar sands, which contain the world’s third largest oil reserves. This analysis shows how challenging it is for states to transition away from fossil fuels, especially those that base their economies on fossil-fuel extraction. The chapter takes for comparison the steps travelled by that same country concerning its world-leading reserves of the valuable but dangerous resource of asbestos. The harm it caused and failure to find ways to make it safe prompted the innovation of technological alternatives. The massive asbestos reserves are being left safely underground, but only after a century-long struggle and enormous harm in many countries. Will the same outcome occur for bitumen and all fossil fuels, or will the steps be longer and more arduous, the consequences more severe, and the end-stage different because of the greater importance of fossil fuels to the modern economy?

Chapter 7 is the first chapter of Part II assessing possible solutions. It begins with an analysis of risk, its assessment, the actualization of risk into disaster, and uncertainty. Scientific assessments of risk cannot be communicated to non-scientists by simply presenting complex computer models. Therefore, the chapter next investigates staging strategies for the danger of climate change and its suitability for staging. Beck’s staging framework is then turned right-side-up by analyzing the more significant staging of safety and of discounting danger. The chapter examines
the uncertainty of whether there will be foresight under threats of fossil-fueled climate change.

Chapter 8 examines whether safe social practices are coming, and elucidates grounds for hope. It evaluates the theory of the preeminent social scientist of risk Ulrich Beck that anticipation of global catastrophe will result in a cosmopolitan inclusive worldview, emancipation from dangerous social practices, and a safe new normal. Empirically, it investigates social change after Hurricane Katrina catastrophe devastated New Orleans, which Beck used to support his theory, and the BP Deepwater Horizon blowout which gushed oil pollution for two months. The chapter then descends from Beck’s high level of abstraction. It examines practical cases where foresight prevailed and the economy reconciled with the environment.

Chapter 9 investigates whether faith in mastering nature through future technological climate fixes (i) has collapsed when confronted with global environmental problems like anthropogenic climate change, or (ii) has taken a new form. It examines whether reluctance to modify fossil-fuelled practices incites reliance on future technological innovation conceptualized here as ‘faith 2.0 in the mastery of nature’. The reformed faith believes in future technological innovations that will control nature’s forces and impacts and create just-in-time mitigation, increased efficiencies, adaptation, robustness, and resiliency when the problem becomes sufficiently serious. The chapter investigates ways that belief in nature’s mastery has legitimated present fossil-fuelled practices. It clearly distinguishes between (1) hoping for technological remedies, and (2) relying on such solutions because society refuses to change its fossil-fuelled practices.

Chapter 10 assesses technological climate fixes. It distinguishes two broad types. One would mitigate global warming while enabling fossil-fuel use to continue. Proposals assessed include carbon capture and storage (CCS), direct air capture (DAC) storing the carbon underground, innovations in cement, cultivating seaweed to draw down atmospheric carbon, and a geoengineered sunscreen in space. The other would leave fossil fuels safely underground with solar, wind, hydro, tidal, geothermal energy, and direct air capture of carbon producing energy. Although informed by technical knowledge, the objective of this social
science assessment is to investigate their socioeconomic implementation and consequences. Thus, the chapter assesses the solution of economists of paying the full cost of fossil fuels upon use instead of belatedly, and exposes deficiencies in the iron law of climate change.

Chapter 11 gives suggestions to enhance foresight, many of which are derived from the analysis in the previous chapters. These include communicating climate science in words and illustrations understandable to non-scientists, making the danger concrete, focusing on social practices and timeliness, valuing nature’s services, combatting fallacies that carbon taxes are job killers, and promoting inclusion and equality of opportunity particularly for future generations. The chapter also assesses proposed solutions of divestment, lawsuits, reducing consumption practices especially of fossil fuels, moral suasion impelling action, and restraining population growth by educating girls. It evaluates proposals to transcend capitalism, examines governance and in particular social democracy. The book ends by examining three possible outcomes of the fossil-fuelled climate crisis with different energy futures and relates the outcome to the central issue of whether foresight or discounting danger will prevail.

Notes

1. American President Trump called the COVID-19 virus an ‘invisible enemy’. Greenhouse gases like carbon dioxide are also invisible enemies, but they are much worse. Carbon dioxide remains in the atmosphere for a century and accumulates with intensifying effect. Imagine if the virus were to accumulate for a century with increasingly disastrous consequences. The virus appeared as I was at the end of writing this book, so I will leave to others to explore the interesting parallels between this global pandemic and global warming.
2. There are other greenhouse gases in addition to long-lasting carbon dioxide (CO₂) and potent methane (CH₄) but these two are the main ones. When ‘carbon’ is used in the book, it refers to greenhouse gases.
3. The more general term ‘anthropogenic climate change’ would in addition deal with other greenhouse gases like HCFCs and other sources such as those from ruminants like cattle and sheep, as well as land use changes like
Introduction

Deforestation and certain agricultural practices (see IPCC 2019). Nevertheless, the combustion of fossil fuels is by far the biggest contributor of human activities to global warming. It is also the most socially problematic to deal with because of the centrality of fossil fuels to modern economies.

4. Nevertheless, the terms ‘global warming’ and ‘climate change’ will also be used in this book because they are the terms currently most often used.

References

Adam, Barbara. 1995. *Timewatch: The Social Analysis of Time*. Cambridge, UK: Polity Press.

Adam, Barbara. 1998. *Timescapes of Modernity: The Environment and Invisible Hazards*. London: Routledge.

Adam, Barbara. 2000. The Media Timescapes of BSE News. In *Environmental Risks and the Media*, ed. S. Allan, B. Adam, and C. Carter, 117–129. London: Routledge.

Beck, U. 1995. *Ecological Politics in an Age of Risk*. Cambridge: Polity Press.

Benton, T. 1994. Biology and Social Theory in the Environmental Debate. In *Social Theory and the Global Environment*, ed. M. Redclift and T. Benton, 28–50. London: Routledge.

Benton, Ted. 2001. Why Are Sociologists Naturephobes? In *After Postmodernism*, ed. J. Lopes and G. Potter. London: Athlone.

Berkers-Lee, M., and D. Clark. 2013. *The Burning Question*. London: Profile.

Birkland, T.A. 1998. Focusing Events, Mobilization, and Agenda Setting. *Journal of Public Policy* 18 (1): 53–74.

Blühdorn, I. 2011. The Politics Of Unsustainability: COP15, Post-ecologism, and the Ecological Paradox. *Organization & Environment* 24 (1): 34–53.

Boström, Magnus, Debra J. Davidson, and Stewart Lockie. 2018. Conclusions: A Proposal for a Brave New World of Conceptual Reflexivity. In *Environment and Society: Concepts and Challenges*, ed. Magnus Boström and Debra J. Davidson, 351–374. Cham, Switzerland: Palgrave Macmillan.

Carolan, Michael. 2014. *Cheaponomics: The High Cost of Low Prices*. Abingdon, UK: Earthscan.

Catton, W., and R. Dunlap. 1980. A New Ecological Paradigm for Post-exuberant Sociology. *American Behavioral Scientist* 24: 15–47. https://doi.org/10.1177/000276428112400103.
Clark, N. 2011. *Inhuman Nature*. London: Sage.

Desrochers, Pierre, and Joanna Szurmak. 2018. *Population Bombed: Exploding the Link Between Population and Climate Change*. Toronto: The Global Warming Policy Foundation.

Dickens, P. 2004. *Society & Nature*. Cambridge, UK: Polity Press.

Dickson, Janice. 2019. Chrystia Freeland Says It’s a “Disappointment” Arctic Council Could Not Issue Joint Communiqué. *Globe and Mail*, 7 May: A7.

Dunlap, R. 2010. The Maturation and Diversification of Environmental Sociology. In *The International Handbook of Environmental Sociology*, 2nd ed, ed. M. Redclift and G. Woodgate, 15–32. London: Edgar Elgar.

Dunlap, R., and W. Catton. 1994. Struggling with Human Exemptionalism. *The American Sociologist* 25 (1): 5–30.

Flannery, Tim. 2009. *Now or Never*. Toronto: HarperCollins.

Flannery, Tim. 2015. *Atmosphere of Hope: Searching for Solutions to the Climate Crisis*. New York: Atlantic Monthly Press.

Foster, John Bellamy, Brett Clark, and Richard York. 2010. *The Ecological Rift: Capitalism’s War on the Earth*. New York: Monthly Review Press.

Freudenburg, W. 2006. Environmental Degradation, Disproportionality, and the Double Diversion. *Rural Sociology* 71 (1): 3–32.

Freudenburg, William R., and Robert Gramling. 1993. Socioenvironmental Factors and Development Policy. *Sociological Forum* 8 (3): 341–364.

Freudenburg, William R., Scott Frickel, and Robert Gramling. 1995. Beyond the Nature/Society Divide. *Sociological Forum* 10 (3): 361–392.

Freudenburg, William, Robert Gramling, Shirley Laska, and Kai Erikson. 2009. *Catastrophe in the Making*. Washington: Island Press.

Giddens, Anthony. 2009. *The Politics of Climate Change*. Cambridge: Polity Press.

Global Carbon Project. 2018. *Global Carbon Budget Summary Highlights*. http://www.globalcarbonproject.org/carbonbudget/18/highlights.htm. Accessed 6 December 2018.

Gramling, Robert, and William R. Freudenburg. 1996. Crude, Coppertone, and the Coast. *Society and Natural Resources* 9: 483–506.

Homer-Dixon, Thomas. 2006. *The Upside of Down*. Toronto: Random House.

ICAO. 2018. Traffic Growth and Airline Profitability Were Highlights of Air Transport in 2016. *Uniting Aviation: A United Nations Specialized Agency*. https://www.icao.int/Newsroom/Pages/traffic-growth-and-airline-profitability-were-highlights-of-air-transport-in-2016.aspx. Accessed 29 January 2018.
IIPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services). 2019. *Global Assessment Report on Biodiversity and Ecosystem Services*. Bonn: IPBES. https://ipbes.net/sites/default/files/2020-02/ipbes_global_assessment_report_summary_for_policymakers_en.pdf. Accessed 10 April 2020.

IPCC. 2018. Intergovernmental Panel on Climate Change. *Global Warming of 1.5 °C*. http://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf. Accessed 8 October 2018.

IPCC. 2019. *The Ocean and Cryosphere in a Changing Planet*. https://report.ipcc.ch/srocc/pdf/SROCC_SPM_Approved.pdf. Accessed 25 September 2019.

Latour, Bruno. 2000. *When Things Strike Back*. *British Journal of Sociology* 51: 107–123.

Lockie, Stewart, and Catherine Wong. 2017. Risk, Sustainability and Time: Sociological Perspectives. In *Social Science and Sustainability*, ed. Heinz Schandl and Iain Walker, 187–198. Melbourne: CSIRO Publishing.

Lockie, Stewart, and Catherine Wong. 2018. Conflicting Temporalities of Social and Environmental Change. In *Environment and Society: Concepts and Challenges*, ed. Magnus Boström and Debra J. Davidson, 327–350. London: Palgrave Macmillan.

Lynch, Michael. 2016. *Cultural Dopes*. https://doi.org/10.1002/9781405165518.wbeos0712. Accessed 31 January 2020.

McCarthy, Niall. 2019. Report: The U.S. Military Emits More CO₂ Than Many Industrial Nations. *Forbes*, 13 June. https://www.forbes.com/sites/niallmccarthy/2019/06/13/report-the-u-s-military-emits-more-co2-than-many-industrialized-nations-infographic/#52f5901f4372. Accessed 10 April 2020.

Murphy, Raymond. 1988. *Social Closure: The Theory of Monopolisation and Exclusion*. Oxford: Oxford University Press.

Murphy, Raymond. 1994. *Rationality and Nature*. Boulder: Westview.

Murphy, R. 1997. *Sociology and Nature: Social Action in Context*. Boulder: Westview.

Murphy, Raymond. 2002. The Internalisation of Autonomous Nature into Society. *The Sociological Review* 50: 313–333.

Murphy, Raymond. 2009. *Leadership in Disaster: Learning for a Future with Global Climate Change*. Montreal: McGill-Queens University Press.

Murphy, Raymond. 2010. Environmental Hazards and Human Disasters. In *The International Handbook of Environmental Sociology*, 2nd ed, ed. Michael Redclift and Graham Woodgate, 276–291. Cheltenham, UK: Edward Elgar.
Nordhaus, William. 2013. *The Climate Casino: Risk, Uncertainty, and Economics for a Warming World*. New Haven: Yale University Press.

Nye, D. 1998. *Consuming Power*. Cambridge, MA: MIT Press.

Perrow, C. 1984. *Normal Accidents*. New York: Basic Books.

Pielke, Roger Jr. 2010. *The Climate Fix*. New York: Basic Books.

Reality Check Team. 2019. Prince Harry and Private Jets: What’s the Carbon Footprint? *BBC News*, 20 August. https://www.bbc.com/news/uk-49408915. Accessed 21 August 2019.

Redclift, Michael. 2010. The Transition Out of Carbon Dependence: The Crises of Environment and Markets. In *The International Handbook of Environmental Sociology*, 2nd ed, ed. Michael Redclift and Graham Woodgate, 121–135. Cheltenham UK: Edward Elgar.

Reguly, Eric. 2018. Bet Big on Big Oil. *Report on Business*, February: 19.

Rhodes, Richard. 2018. How Will the World Overcome Its Largest-Ever Energy Crisis? Slowly. *The Globe and Mail*, 16 June: O1, O4.

Rowe, James, Jessica Dempsey, and Peter Gibbs. 2016. The Power of Fossil Fuel Divestment (and Its Secret). In *A World to Win: Contemporary Social Movements and Counter-Hegemony*, ed. William R. Carroll and Kanchan Sarker, 233–249. Winnipeg: ARP Books.

Safran Foer, Jonathan. 2019a. *We are the Weather: Saving the Planet Begins at Breakfast*. New York: Farrar, Straus, and Giroux.

Safran Foer, Jonathan. 2019b. ‘A Crisis of Belief’. *The Globe and Mail*, 28 September: R14.

Shove, E. 2012a. Putting Practice into Policy: Reconfiguring Questions of Consumption and Climate Change. *Contemporary Social Science* 9: 1–15.

Shove, E. 2012b. Energy Transitions in Practice: The Case of Global Indoor Climate Change. In *Governing the Energy Transition: Reality, Illusion or Necessity?*, ed. G. Verbong and D. Loorbach. London: Routledge.

Shove, E., and N. Spurling (eds.). 2013. *Sustainable Practices: Social theory and Climate Change*, 208. Routledge: London.

Shove, E., M. Pantzar, and M. Watson. 2012. *The Dynamics of Social Practice: Everyday Life and How It Changes*, 240. London: Sage.

Speth, James Gustave. 2009. *The Bridge at the Edge of the World: Capitalism, the Environment, and Crossing from Crisis to Sustainability*. New Haven: Yale University Press.

Speth, James Gustave. 2012. *America the Possible: Manifest for a New Economy*. New Haven: Yale University Press.
Steffen, Will, Johan Rockström, Katherine Richardson, Timothy Lenton, Carl Folke, Diana Liverman, Colin Summerhayes, Anthony Barnosky, Sarah Cornell, Michel Crucifix, Jonathan Donges, Ingo Fetzer, Steven Lade, Marten Scheffer, Ricarda Winkelmann, and Hans Joachim Schellnhuber. 2018. Trajectories of the Earth System in the Anthropocene. *PNAS Proceedings of the National Academy of Sciences of the United States of America* 115 (33): 8252–8259. https://doi.org/10.1073/pnas.1810141115.

Stern, Nicholas. 2009. *A Blueprint for a Safer Planet*. London: Random House.

Suzuki, David, and Ian Hanington. 2017. *Just Cool It: The Climate Crisis and What We Can Do*. Vancouver and Berkeley: Greystone Books.

Turner, B., and N. Pidgeon. 1978. *Man-Made Disasters*. London: Wykeham.

UNEP (United Nations Environmental Programme). 2018. *Emissions Gap Report 2018 Executive Summary*. Nairobi: UNEP. https://wedocs.unep.org/bitstream/handle/20.500.11822/26879/EGR2018_ESEN.pdf?sequence=10. Accessed 28 November 2018.

U.S. Global Change Research Program. 2018. *Fourth National Climate Assessment Vol. II: Impacts, Risks, and Adaptation in the United States*. Washington. https://nca2018.globalchange.gov/. Accessed 26 November 2018.

Victor, David. 2011. *Global Warming Gridlock: Creating More Effective Strategies for Protecting the Planet*. Cambridge: Cambridge University Press.

Watt-Cloutier, Shiela. 2019. If We Protect the Arctic, We Save the Planet. *Globe and Mail*, 5 October: O11.

Weber, Max. 1946 (1958). *From Max Weber: Essays in Sociology*. H.H. Gerth and C. Wright Mills (eds.). New York: Oxford University Press.

Wong, C., and S. Lockie. 2018. Sociology, Risk and the Environment: A Material-Semiotic Approach. *Journal of Risk Research* 21 (9): 1077–1092.

World Bank. 2015. Fossil Fuel Energy Consumption (% of Total). World Bank. https://data.worldbank.org/indicator/eg.use.comm.fo.zs. Accessed 1 April 2019.

York, R. 2012. Do Alternative Energy Sources Displace Fossil Fuels? *Nature Climate Change* 2 (6): 441–443.

York, R., and J.A. McGee. 2016. Understanding the Jevons Paradox. *Environmental Sociology* 2 (1): 77–87. https://doi.org/10.1080/23251042.2015.1106060.

Zebrowski Jr., Ernest. 1997. *Perils of a Restless Planet: Scientific Perspectives on Natural Disasters*. Cambridge: Cambridge University Press.