James Gustave Speth

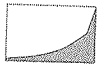
The Bridge at the Edge of the World

Capitalism, the Environment, and Crossing from Crisis to Sustainability

YALE UNIVERSITY PRESS

NEW HAVEN AND LONDON

I Looking into the Abyss



If you take an honest look at today's destructive environmental trends, it is impossible not to conclude that they profoundly threaten human prospects and life as we know it on the planet. That is the abyss ahead. Robert Jay Lifton has said, "If one does not look into the abyss, one is being wishful by simply not confronting the truth. . . . On the other hand, it is imperative that one not get stuck in the abyss."[1] Confronting the truth about environmental conditions and trends is the first step.

I remember looking into another abyss, when I was a sophomore at Yale in 1961, one closer to Lifton's main subjects. It was the prospect of thermonuclear war. My guide was a wonderful professor, Brad Westerfield, who taught Yale's principal course on the Cold War at the time. He took it upon himself to inform us that we had to take seriously the possibility of nuclear war with the Soviet Union. I tried to absorb that, but it was in some way unimaginable. And then one day in 1962, there was President Kennedy on television informing us of the Cuban missile crisis. And at that moment it became all too easy to imagine nuclear war.

I feel now a little like Westerfield must have felt at that moment. I have been sounding off, Dr. Doom-like, about the risks of climate change and other large-scale environmental threats since 1980, when I was in President Carter's White House and we released the *Global 2000 Report*.[2] And, now, sad to say, *Global 2000*'s forecasts are coming true. Those forecasts were issued as warnings, but like many others, they went largely unheeded.

It was not always this bleak. Both in the final days of the Carter administration and in the years that immediately followed, many of us undertook to do the policy analysis that could be the springboard to tackling global-scale environmental challenges. The hopefulness of that era is reflected, for example, in Robert Repetto's volume *The Global Possible* (1985). In my foreword to Repetto's book, I wrote: "This book gives grounds for informed optimism about how the world's governments, businesses and citizens can make headway against an array of difficult environmental challenges. . . . [The book's recommendations] have taken an important step in proposing initiatives for public and private action, thus allaying the restive pessimism that stands between the world we have and the world we want."[3] Now one can see, more than two decades later, that the road to sustainability was the road not taken. The disturbing trends set out in *Global 2000* continued, and we find ourselves where we are today.

The World We Live In

To assess environmental performance to date, it is useful to distinguish two sets of environmental challenges. A set of predominantly local and regional concerns drove the first Earth Day in 1970. The insults then were acute and obvious: air pollution; water pollution; strip mining; clearcutting; dam building and river channelization; nuclear power; loss of wetlands, farmland, and natural areas; massive highway building programs; urban sprawl; destructive mining and grazing practices; toxic dumps and pesticides; and so on. On a portion of these first-generation Earth Day issues, the United States has made progress. Some see the part of the glass that is filled. Others, including our leading environmental groups, point to the continuation of these problems, the still unmet promises of the far-reaching legislation of the 1970s, and the emergence of serious new threats. Environmental deterioration in the United States remains surprisingly severe (see Chapter 3).

A different agenda emerged a decade later in the *Global 2000 Report* of 1980 and elsewhere. The issues on this newer agenda are more global, more insidious, and more threatening (see table 1).

On these "global change" issues, as they are sometimes called, progress has been dismal. As I noted in *Red Sky at Morning*, my generation is a generation of great talkers, overly fond of conferences. We have analyzed, debated, discussed, and negotiated these global issues almost endlessly. But on action, we have fallen far short.

As a result—with the notable exception of international efforts to protect the stratospheric ozone layer and the partial exception of progress on acid rain—the threatening global trends highlighted a quarter century ago continue to this day and have become more serious and more intractable. It is now an understatement to say we are running out of time. For such crucial issues as climate change, deforestation, and loss of biodiversity, we ran out of time quite a while ago. Appropriate action is long overdue.

Let us review where we stand with the eight major global-scale challenges where progress has been seriously lacking.[4] The presentation of conditions and trends in these eight areas does not always make for easy reading, but understanding what's happening to the planet is the backdrop to concern and action.

Climate Disruption

Of all the issues, global warming is the most threatening. The possibilities here are so disturbing that some—like Sir David King, the chief

Global Environmental Threats

Trend	Overuse of renewable resources	Pollution		
Effects of trend	Biotic impoverishment and resource scarcity	Toxification and threats to public health	Atmospheric change	Chemical imbalances in ecosystems
Issues	Marine losses Desertification Deforestation Freshwater system decline Biodiversity loss	Persistent toxic chemicals	Ozone depletion Climate change	Acid rain Nitrogen excess

Source: From James Gustave Speth and Peter M. Haas, *Global Environmental Governance* (2006), 19

scientist in the British government—believe that climate change is the most severe problem the world faces, bar none.[5]

Scientists know that the "greenhouse effect" is a reality: without the naturally occurring heat-trapping gases in the earth's atmosphere, the planet would be about 30°C cooler on average—an ice ball rather than a life-support system. The problem arises because human activities have now sharply increased the presence of greenhouse gases in the atmosphere. These gases prevent the escape of earth's infrared radiation into space. In general, the more gases that accumulate, the more heat the atmosphere traps.

The atmospheric concentration of carbon dioxide, the principal greenhouse gas contributed by human actions, has increased by more than a third over the preindustrial level due mainly to the use of fossil fuels (coal, oil, natural gas) and to large-scale deforestation. Carbon dioxide in the atmosphere is now at its highest level in at least 650,000 years. The concentration of methane, another greenhouse gas, is about 150 percent above preindustrial levels. Methane accumulates from the use of fossil fuels, cattle raising, rice growing, and landfill emissions. Atmospheric concentrations of still another gas, nitrous oxide, are also up due to fertilizer use, cattle feedlots, and the chemical industry, and it is also an infrared trapping gas. A number of specialty chemicals in the halocarbon family, including the chlorofluorocarbons (CFCs) of ozone-depletion notoriety, are also potent greenhouse gases.

The major international scientific effort to understand climate change and what can be done about it is the Intergovernmental Panel on Climate Change (IPCC). The fourth of its periodic reports, released in 2007, underscores the reality that human activities are already changing the planet in major ways:

- "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level."

- "Eleven of the last twelve years (1995–2006) rank among the 12 warmest years in the instrumental record of global surface temperature (since 1850)."
- "Most of the observed increase in global average temperatures since the mid-twentieth century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. Discernible human influences now extend to other aspects of climate, including ocean warming, continental-average temperatures, temperature extremes and wind patterns."
- "Mountain glaciers and snow cover have declined on average in both hemispheres. Widespread decreases in glaciers and ice caps have contributed to sea level rise. New data . . . now show that losses from the ice sheets of Greenland and Antarctica have very likely contributed to sea level rise over 1993 to 2003."
- "More intense and longer droughts have been observed over wider areas since the 1970s, particularly in the tropics and subtropics. Increased drying linked with higher temperatures and decreased precipitation has contributed to changes in drought."
- "The frequency of heavy precipitation events has increased over most land areas, consistent with warming and observed increases of atmospheric water vapor."[6]

The IPCC's Fourth Assessment also identifies the likely *future* impacts of climate change in a variety of contexts—the larger the buildup of greenhouse gases, the more severe these impacts will become. Here are some of the IPCC's projections:[7]

The availability of fresh water will shift. Some areas will get much wetter, others much dryer. Both drought and flooding will likely increase. Water stored in glaciers and snowpack will decline, reducing water supplies to more than a billion people.

The health of ecosystems will be damaged by an unprecedented combination of climate change and other drivers of global change such as land use change, pollution, and overexploitation of resources. About 20 to 30 percent of the plant and animal species studied so far will be at increased risk of extinction. As the oceans take up more carbon dioxide from the atmosphere, shellfish and corals will be harmed. The oceans absorb a large portion of all carbon dioxide emitted, and as the resulting carbonic acid increases in the seawater, the extra acidity hurts the ability of marine organisms to form shells. The impacts could eventually be devastating. On top of that, ocean warming will lead to more frequent coral bleaching and mortality.

Coastal and low-lying areas are expected to be hard-hit. Rising sea levels will increase coastal erosion, flooding, and wetland loss. The IPCC report concludes that "many millions more people are projected to be flooded every year due to sea-level rise by the 2080s. Those densely-populated and low-lying areas where adaptive capacity is relatively low, and which already face other challenges such as tropical storms or local coastal subsidence, are especially at risk. The numbers affected will be largest in the mega-deltas of Asia and Africa while small islands are especially vulnerable."[8] The IPCC ominously notes that "the last time the polar regions were significantly warmer than present for an extended period (about 125,000 years ago), reductions in polar ice volume led to 4 to 6 meters of sea level rise."[9]

Human health will also suffer in various ways. As the IPCC concludes: "Projected climate change-related exposures are likely to affect the health status of millions of people, particularly those with low adaptive capacity, through:

- increases in malnutrition and consequent disorders, with implications for child growth and development;
- increased deaths, disease and injury due to heat waves, floods, storms, fires and droughts;
- the increased burden of diarrheal disease;
- the increased frequency of cardio-respiratory diseases due to higher concentrations of ground level ozone related to climate change; and,
- the altered spatial distribution of some infectious disease vectors."[10]

Other reports besides that of the IPCC have drawn special attention to particular risks. The *Arctic* is warming at nearly twice the rate as the rest of the globe. Projections see the Arctic icecap continuing to diminish and eventually disappearing altogether in the summer, perhaps as early as 2020.[11] Governments of the circumpolar north have begun positioning themselves strategically to claim sovereign control over new shipping lanes opened up by the disappearing ice. In an ironic twist, they all seek also to exploit the region's large fossil fuel resources. The loss of ice on Greenland more than doubled in the last decade of the twentieth century and may have doubled again by 2005.[12]

On *human health*, the World Health Organization estimated in 2004 the loss of 150,000 lives each year due to climate change. Its most recent report projects that loss of life caused by climate change could double by 2030 due largely to diarrhea-related disease, malaria, and malnutrition. Most of the casualties would fall in the developing world.[13]

A major area of ongoing climate change impact is in the North American West, where *tens of millions of acres of forest* are being devastated by bark beetles and other infestations. The pests—which have attacked pine, fir, and spruce trees in the western United States, British Columbia, and Alaska—are normally contained by severe winters. The milder winters in the region have increased their reproduction, abundance, and geographic range.[14]

Natural areas in the United States could be hit hard. Assuming business as usual in greenhouse gas emissions throughout this century, the maple-beech-birch forests in New England could simply disappear, while much of the Southeast could become a vast grassland savanna, too hot and dry to support trees.[15] Meanwhile, other studies project that human-caused climate change is likely to lead to extreme drought throughout the Southwest, starting soon.[16] The Great Lakes also appear to be undergoing disruptive changes due to climate change. Not only are the lakes warming, but water levels are declining and fish disease is increasing.[17]

A major concern is *sea level rise*, and the greatest fear is a catastrophic rise caused by movement into the oceans of landed ice on Greenland and Antarctica. Disturbing and unpredicted movements of ice have occurred in both places. Ten thousand years ago, when the continental ice sheets melted, sea levels rose more than twenty yards in five hundred years. While the IPCC is projecting somewhat less than a three-foot sea level rise in this century, some scientists believe that a continuation of greenhouse gas emission growth could lead to yards of sea level rise per century.[18]

Even with "modest" sea level rise, we could see the displacement of large numbers of people from small island nations and the low-lying delta areas of Egypt, Bangladesh, Louisiana, and elsewhere. Today, as Alaskan permafrost melts, Inuit villages are being moved inland. Beaches, coastal marshes, and near-coast development in the United States and elsewhere could also be severely affected. Related to this, evidence is accumulating that ocean warming and increased evaporation are contributing to stronger hurricanes.[19]

Sea level rise is only one of the consequences of climate change that could contribute to the *forced migrations of large numbers of people.* Depletion of water in regions supplied by glacial melt, changes in monsoon patterns, and spreading drought could combine to cause many refugees from climate change. One study has estimated that as many as 850 million people could be displaced in these ways later in this century.[20] Prospects such as these are a reminder that climate change is not only an environmental and economic issue. It is also a profoundly moral and human issue with major implications for social justice and international peace and security.[21]

Although many people assume that the impacts of climate change will unfold gradually, as the earth's temperature slowly rises, the buildup of greenhouse gases may in fact lead to abrupt and sudden, not gradual, changes. A National Academy of Sciences report in 2002 concluded that global climate change could have rapid impacts: "Recent scientific evidence shows that major and widespread climate changes have occurred with startling speed. . . . [G]reenhouse warming and

other human alterations of the earth system may increase the possibility of large, abrupt, and unwelcome regional or global climatic events."[22]

The possibility of abrupt climate change is linked to what may be the most problematic possibility of all—"positive" feedback effects where the initial warming has effects that generate more warming. Several of these feedbacks are possible. First, the land's ability to store carbon could weaken. Soils and forests can dry out or burn and release carbon; less plant growth can occur, thus reducing nature's ability to remove carbon from the air. Second, carbon sinks in the oceans could also be reduced due to ocean warming and other factors. Third, the potent greenhouse gas methane could be released from peat bogs, wetlands, and thawing permafrost, and even from the methane hydrates in the oceans, as the planet warms and changes. Finally, the earth's albedo, the reflectivity of the earth's surface, is slated to be reduced as large areas now covered by ice and snow diminish or are covered by meltwater. All these effects would tend to make warming self-reinforcing, possibly leading to a greatly amplified greenhouse effect.

The real possibility of these amplifying feedbacks has alarmed some of our top scientists. James Hansen, the courageous NASA climate scientist, is becoming increasingly outspoken as his investigations lead him to more and more disturbing conclusions. He offered the following assessment in 2007: "Our home planet is now dangerously near a 'tipping point.' Human-made greenhouse gases are near a level such that important climate changes may proceed mostly under the climate system's own momentum. Impacts would include extermination of a large fraction of species on the planet, shifting of climatic zones due to an intensified hydrologic cycle with effects on freshwater availability and human health, and repeated worldwide coastal tragedies associated with storms and a continuously rising sea level. . . .

"Civilization developed during the Holocene, a period of relatively tranquil climate now almost 12,000 years in duration. The planet has been warm enough to keep ice sheets off North America and Europe, but cool enough for ice sheets on Greenland and Antarctica to be stable. Now, with rapid warming of 0.6°C in the past 30 years, global temperature is at its warmest level in the Holocene.

"This warming has brought us to the precipice of a great 'tipping point.' If we go over the edge, it will be a transition to 'a different planet,' an environment far outside the range that has been experienced by humanity. There will be no return within the lifetime of any generation that can be imagined, and the trip will exterminate a large fraction of species on the planet.

"The crystallizing scientific story reveals an imminent planetary emergency. We are at a planetary tipping point. We must move onto a new energy direction within a decade to have a good chance to avoid setting in motion unstoppable climate change with irreversible effects.

"We live in a democracy and policies represent our collective will. We cannot blame others. If we allow the planet to pass tipping points . . . it will be hard to explain our role to our children. We cannot claim . . . that 'we did not know.'"[23]

In short, there is little doubt that the process of human-induced global warming has begun in earnest, that the consequences are already serious, and that they could be devastating if the buildup of greenhouse gases is not halted.[24] Yet the process of halting their buildup has hardly started. Global carbon dioxide emissions climbed by 22 percent between 1980 and 2000. Since 2000, the growth rate of emissions has tripled over the average for 1990–1999.[25] The International Energy Agency projects that if societies continue on a business-as-usual path between 2004 and 2030, the result will be a rise in carbon dioxide emissions of 55 percent globally. Even in its most optimistic scenario, where environmental actions are taken, global emissions climb by 31 percent.[26] Congress is finally waking up, but it is terribly late.

To date, industrial nations have contributed far more to the buildup of greenhouse gases than developing countries. The developed countries with 20 percent of the world's people have contributed more

than 75 percent of the cumulative carbon dioxide emissions and are responsible for about 60 percent of today's emissions. The United States emits roughly the same amount of greenhouse gases as 2.6 billion people living in 150 developing nations. The rich countries have reaped huge economic benefits in the process. That said, developing country emissions of greenhouse gases are increasing rapidly, especially in China and India. The developing world was the source of the majority of carbon dioxide emissions growth in 2004. It is doubtful that the developing nations will act to curb their emissions unless the industrial nations help provide powerful incentives, technology, and other assistance, as well as a good example.

At the same time, the developing world is more vulnerable to climate change. Its people are more directly dependent on the natural resource base, more exposed to extreme weather events, and less capable economically and technologically to make needed adaptations. The disruption of water supplies or agriculture, the loss of glacial meltwater in spring and summer, as well as rising sea levels, declining ecosystem services, and other impacts, could easily contribute to social tensions, violent conflicts, humanitarian emergencies, and the creation of ecological refugees. If these north-south differences are not addressed with care, they will emerge as an increasing source of international tension.

Governments must now address the urgent need for a major, concerted international response, one that is effective but also both equitable and economically efficient. Many climate scientists such as NASA's Hansen believe that a global average temperature increase of 2°C or more over the preindustrial level would run risks too great to accept.[27] The European Union has set a goal of holding warming to no more than +2°C. Yet current estimates are that we have already committed to 1.5°C warming (or even more if we clean up traditional pollution), due to past emissions.[28] Given that societies seem unlikely to halt the rise of greenhouse gas concentration at today's levels, these estimates suggest that the warming could easily continue until it enters dangerous territory. The news, in short, underscores the case for urgency.

The Stern Review, *The Economics of Climate Change*, concluded that the risks of climate change could be substantially reduced if greenhouse gas levels in the atmosphere can be stabilized between 450 and 550ppm carbon dioxide equivalent (CO_2e).[29] (CO_2e measures the presence of all greenhouse gases in the atmosphere.) Today's level, Stern reported, is 430ppm carbon dioxide equivalent, and it is rising at more than 2ppm each year. Many scientists would favor the lower portion of the Stern range, and that is why they believe we have only a short period to see greenhouse gas emissions globally peak and then begin to decline.

In sum, it is likely that societies are already too late to head off very serious climate change impacts. The worst impacts can still be averted, but action must be taken with swiftness and determination or a ruined planet is the likely outcome, based on the best science we have. Yet right now, we are on a path to more than double the preindustrial level of greenhouse gases in the atmosphere and reap a calamitous 4–5°C warming of the planet.

What types of cuts in emissions are needed to cap the buildup at tolerable levels? The Stern Review's conclusion is that "stabilization . . . requires that annual emissions be brought down to more than 80% below current levels. . . . Even if the rich world takes on responsibility for absolute cuts in emissions of 60–80% by 2050, developing countries must take significant action too."[30] Chinese greenhouse emissions recently passed those of the United States, making China the leader in this dubious achievement.

It is notable that this goal—an 80 percent cut in greenhouse gas emissions by 2050—is the target that California and New Jersey have set. Many analyses have identified measures, particularly changes in the U.S. energy system, needed to reach a goal of this extraordinary magnitude. In a nutshell, the United States could reduce its emissions by 80 percent by 2050 through a combination of steps: (1) energy efficiency gains, both in electricity generation and use and in transportation,

including more fuel-efficient vehicles; (2) renewable energy development, especially wind and solar energy; (3) other energy efficiency gains including improvements in residential and commercial buildings; (4) shifting to low-carbon fuels; (5) geologic disposal (sequestration) of carbon dioxide; (6) reducing emissions of greenhouse gases other than carbon dioxide; and (7) enhanced forest and soil management practices. Eventually, if some of the more serious fears come to pass, it may become necessary to explore ways to remove carbon dioxide directly from the atmosphere. There are several means of doing this involving enhanced vegetative growth, human engineering, or both together, but some of these entail their own significant risks.[31]

Losing the Forests

About half of the world's temperate and tropical forests have already been lost, mostly to clear land for agriculture. Deforestation contributes to species loss, climate change, loss of economic value, landslides, flooding, and soil depletion. Forest loss has been particularly serious in the tropics, home to about two-thirds of our planet's plant and animal species. In recent decades, the rate of deforestation in the tropics has been about an acre each second, a pattern that continued unabated between 2000 and 2005.[32] Meanwhile, the industry-oriented International Tropical Timber Organization reported that only 3 percent of tropical forests were being sustainably managed even though two-thirds have been designated as under some type of management regime.[33]

The causes of deforestation in the developing world are many, including cutting for tropical timber, fuelwood use, expansion of export-oriented plantations and agriculture, and other pressures such as mineral development. The tropical forests are also the victims of chronic corruption, cronyism, and illegal logging.

Deforestation is widespread, but it is especially prevalent in Brazil, Indonesia, and the Congo River basin. Indonesia has lost about 40 percent of its forest in the past fifty years. About nine thousand square miles of rain forest are cleared there each year, and at current rates of loss, almost all lowland forests on Sumatra and Borneo will be gone in a matter of years, not decades.[34] Indonesia's deforestation, forest fires, and peat land degradation have made it the world's number three greenhouse gas emitter, after the United States and China.[35] Similarly, it is estimated that two-thirds of the Congo basin forests could disappear in fifty years if logging and mining continue at current rates.[36] Forest loss in the Amazon, the highest in the world, may have been severely underestimated according to new results indicating that as much of the Amazon has been lost to selective logging as to clear-cut type deforestation typically measured.[37] Altogether, between 2000 and 2005, the world lost forest acreage the size of Germany.[38]

Losing the Land

Desertification involves more than spreading deserts. It includes all the processes that degrade productive land, eventually turning it into wasteland. Soil erosion, salinization, devegetation, and soil compaction can all be involved. The process is most prevalent in arid and semiarid areas, which cover about 40 percent of the planet's land surface. These lands account for about a fifth of the world's food production. About a fourth of the developing world's people—some 1.3 billion in all—live on these dry and other fragile lands.

The United Nations estimates that an area larger than Canada or China suffers from some degree of desertification and that each year fifty million acres become too degraded for crop production or are lost to urban sprawl. That's an area the size of Nebraska.[39] Africa is particularly affected by desertification, but so are large areas in Asia and the Western Hemisphere, including the southwestern United States and northern Mexico. Among the many consequences of desertification are large losses in food production, greater vulnerability to drought and famine, loss of biodiversity, the creation of ecological refugees, and social unrest.

Desertification is typically caused by overcultivation, overgrazing, and poor irrigation practices. But behind these immediate pressures are deeper factors such as population growth, poverty and lack of alternative livelihoods, and concentrated patterns of land ownership in the developing regions.

Losing Freshwater

It has been said that there are alternative sources of energy, but there are no alternatives to water. There are several dimensions to what has correctly been called the world water crisis.[40]

First, there is the crisis of natural watercourses and their attendant wetlands. No natural areas have been as degraded by human activities as freshwater systems. Natural water courses and the vibrant life associated with them have been extensively affected by dams, dikes, diversions, stream channelization, wetland filling and other modifications, and, of course, pollution. Sixty percent of the world's major river basins have been severely or moderately fragmented by dams or other construction. Since 1950 the number of large dams has increased from 5,700 worldwide to more than 41,000. Much of this activity is done to secure access to the water, but power production, flood control, navigation, and land reclamation have also been important factors. As freshwater is diverted from natural sources, ecosystems dependent on that water suffer, including aquatic systems, wetlands, and forests. About half the world's wetlands have been lost, and more than a fifth of known freshwater species have already been driven to extinction.[41]

The second crisis is the crisis of freshwater supply. Human demand for water climbed sixfold in the twentieth century, and the trend continues today. Humanity now withdraws slightly over half of accessible freshwater, and water withdrawals could climb to 70 percent by 2025.[42] Meeting the world's demands for freshwater is proving problematic. About 40 percent of the world's people already live in countries that are classified as "water stressed," meaning that already 20 to 40 percent of the available freshwater is being used by human societies. Projections indicate that the percentage of people living in water-stressed countries could rise to 65 percent by 2025.[43]

A large portion of freshwater withdrawals, about 70 percent, goes to agriculture. Since 1960, acreage under irrigation has more than doubled. A special problem is occurring in India, China, and elsewhere in Asia where tens of millions of tubewells are depleting "fossil" groundwaters. The *New Scientist* reports that "hundreds of millions of Indians may see their land turned to desert."[44] Overall, according to a study by top water specialists from around the world, world demand for water could double by 2050.[45] "At the worst," the *New York Times* reported, "a deepening water crisis would fuel violent conflicts, dry up rivers and increase groundwater pollution. . . . It would also force the rural poor to clear ever-more grasslands and forests to grow food and leave many more people hungry."[46]

Last, there is the crisis of pollution. Pollutants of all types are discharged into the world's waters in enormous quantities, reducing the capacities of bodies of water to support life in the water and to support human communities. Contamination denies a large portion of the world's population access to clean water supplies. About a billion people, a fifth of the world's population, lack clean drinking water; 40 percent lack sanitary services. The World Health Organization calculates that each year about 1.6 million children die from diseases caused by unsafe drinking water and lack of water for sanitation and hygiene.[47]

Water supply issues will become increasingly prevalent in the United States. Freshwater withdrawals per capita from surface and groundwaters in the United States are twice that of the OECD (Organisation for Economic Co-operation and Development) as a whole. The Environmental Protection Agency estimates that if current American water use remains constant at a hundred gallons per person per day, thirty-six states will face water shortages by 2013. As a result, humanity's "first need" will soon be privatized. Investors are moving into a water-

related market that is estimated to be worth at least $150 billion in the United States by 2010. "Water is a growth driver for as long and as far as the eye can see," a Goldman Sachs water analyst told the *New York Times* in 2006.[48]

Losing Marine Fisheries

The negative impact that human societies are having on the health of marine fisheries and on the world's oceans and estuaries generally is difficult to exaggerate. In 1960, 5 percent of marine fisheries were fished to capacity or overfished. Today that number is 75 percent. The global catch of fish has gone down steadily since 1988 (taking the highly volatile Peruvian anchoveta catch, the chief supply of fishmeal, out of the calculation).[49] In 2003, scientists reported that populations of large predator fish—including such popularly consumed varieties as swordfish, marlin, and tuna—are down 90 percent over original stocks; only 10 percent remain.[50] And in 2006, fisheries scientists projected that essentially all ocean commercial fisheries would collapse by 2050 if current patterns persist. This projection is controversial, but it at least suggests the magnitude of the problem.[51]

The core problem here is overfishing. It is driven by powerful fishing-industry interests and the deep subsidies they have secured from governments. But the marine environment is also being affected by destruction of mangroves and coastal wetlands, by pollution and silt from runoff, and other factors. About 80 percent of marine pollution originates on the land, and the marine environment is increasingly polluted by sewage, agricultural waste, and other discharges.[52] Particularly hard-hit have been the coral reefs. About 20 percent of coral reefs worldwide have been lost, and a further 20 percent are severely threatened.[53]

Like forest loss, overfishing is exacerbated by illegal harvesting and wasteful and destructive practices (large portions of many catches are unwanted by-catch that are thrown back, typically dead or dying, and deep-sea trawling is destroying underwater habitats) compounded by weak or nonexistent regulation. In the United States, of sixty-seven depleted fish stocks identified in the mid-1990s for special care, sixty-four remain scarce today, and probably half are still being overfished.[54] Aquaculture (fish farming) is soaring, but much of it depends critically on wild-caught fish made into fishmeal.[55]

Toxic Pollutants

There are many serious environmental threats to human health, including numerous persistent organic pollutants, or POPs. Certain pesticides and other POPs can cause cancer and birth defects as well as interfere with hormonal and immune system functioning. Child health experts at Mount Sinai School of Medicine in New York report that today virtually every person on earth can be shown to harbor detectible levels of dozens of POPs and other toxic substances.[56] Samples of Canadians were tested for the presence of eighty-eight harmful chemicals; on average forty-four were found in each person. Blood and urine samples from a Toronto mother were found to contain thirty-eight reproductive and respiratory toxins, nineteen chemicals that disrupt hormones, and twenty-seven carcinogens. A First Nation volunteer living remotely on Hudson Bay had fifty-one of the eighty-eight chemicals.[57] Researchers do not know the long-term health effects of living with this chemical cocktail, but it is known that chemicals like phthalates, bisphenol A, polybrominated diphenyl ethers, formaldehyde, carbofuran, atrazine, polycyclic aromatic hydrocarbons, and many others are dangerous in experimental studies, particularly in prenatal and neonatal contexts.[58]

One important subcategory of these chemicals is the endocrine disrupting substances (EDSs)—the so-called gender benders. Many can disrupt natural hormone functioning in humans, leading to feminization, low sperm count, and hermaphroditism. Although they acknowledge that large uncertainties remain in our knowledge of these EDSs, the Mount Sinai researchers believe that "enough evidence has

accumulated to justify moving aggressively to limit environmental dispersion of endocrine disruptors."[59]

Inorganic chemicals, notably heavy metals like mercury, can also cause serious problems. Mercury is a potent neurotoxin; much of it comes from coal-fired power plants. Beyond mercury, a wide range of toxic substances continues to pose environmental threats, including hazardous and radioactive wastes and other heavy metals, lead and arsenic among them. Some three hundred to five hundred million tons of hazardous waste were generated annually in the 1990s; the United States was the largest producer by far.[60]

Losing Biodiversity

Biological diversity, or biodiversity, has three dimensions: the genetic variety within a given species; the millions of individual species of plants, animals, and microorganisms; and the diversity of different types of ecosystems such as alpine tundra, southern hardwood bottomlands, or tropical rain forests. An alarming global homogenization and simplification of biodiversity is occurring at all three levels. Massachusetts Institute of Technology professor Stephen Meyer has offered this particularly bleak assessment: "Over the next 100 years or so as many as half of the earth's species, representing a quarter of the planet's genetic stock, will functionally if not completely disappear. The land and the oceans will continue to teem with life, but it will be a peculiarly homogenized assemblage of organisms unnaturally selected for their compatibility with one fundamental force: us. Nothing—not national or international laws, global bioreserves, local sustainability schemes, or even 'wildlands' fantasies—can change the current course. The broad path for biological evolution is now set for the next several million years. And in this sense the extinction crisis—the race to save the composition, structure, and organization of biodiversity as it exists today—is over, and we have lost."[61]

Unfortunately, certain trends point in the direction Meyer has outlined. A major United Nations survey of available information reached these conclusions: "Trends of some 3,000 wild populations of species show a consistent decline in average species abundance of about 40% between 1970 and 2000; inland water species declined by 50%, while marine and terrestrial species both declined by around 30%. Studies of amphibians globally, African mammals, birds in agricultural lands, British butterflies, Caribbean and Indo-Pacific corals, and commonly harvested fish species show declines in the majority of species assessed.

"More species are becoming threatened with extinction. The status of bird species show a continuing deterioration across all biomes over the last two decades, and preliminary findings for other major groups, such as amphibians and mammals, indicate that the situation is likely worse than for birds. Between 12% and 52% of species within well-studied higher taxa are threatened with extinction."[62]

Habitat loss through land conversion and other human activities is now the principal source of the problem. Scientists estimate that the past loss of about half the tropical forests, home to a majority of the planet's species, may have cost us 15 percent of species in these forests.[63] Destruction of aquatic and wetland habitats has also contributed to serious biodiversity declines. Nonnative invasive species have emerged as a huge threat to biodiversity, second only to habitat loss. About 40 percent of the species listed in the United States as endangered or threatened are on the list because of threats from invasives. But overharvesting of particular plant and animal species is also a major cause of biodiversity loss, whether we look at codfish, mahogany, or tropical birds. Toxic chemicals, extra ultraviolet radiation from ozone layer depletion, and acidification from acid rain can also contribute to ecosystem impoverishment. Climate change is not yet a major source of biodiversity loss, but many scientists believe it could rival habitat loss as the key culprit before long.[64]

The cumulative effect of all the factors is that species loss today is estimated to be about a thousand times the natural or normal rate

that species go extinct.[65] Many scientists believe we are on the brink of the sixth great wave of species loss on earth, the only one caused by humans. The World Conservation Union, which keeps the books on species, estimates that two of every five recognized species on the planet risk extinction, including one in eight birds, one in four mammals, and one in three amphibians.[66] Almost 95 percent of the leatherback turtles in the Pacific have disappeared in the past twenty years;[67] at least nine and perhaps 122 amphibian species have gone extinct since 1980;[68] tigers are on the verge of extinction in the wild;[69] populations of nearly half the world's waterbird species are in decline, and populations of twenty common American meadow birds like the bobwhite and the meadowlark have lost more than half their populations in forty years.[70]

Overfertilizing with Nitrogen

Earth's atmosphere is mostly nitrogen, but it is not biologically active. Bacteria such as those associated with legumes "fix" nitrogen, changing it to a biologically active form, which plants can use. But we humans have started fixing nitrogen also. Today, the man-made nitrogen comes primarily from two sources: about 75 percent from fertilizers and 25 percent from fossil fuel combustion. At present humans are fixing as much nitrogen as nature does. Once fixed, nitrogen remains active for a long time, cascading through the biosphere.

Nitrogen in waterways leads to overfertilization and, when heavy, to algal blooms and eutrophication—aquatic life simply dies from lack of oxygen. There are now more than two hundred dead zones in the oceans, mostly due to excess fertilization, some of them huge, like the one at the mouth of the Mississippi. Not all of the effects of extra nitrogen are negative: the extra nitrogen is contributing to forest growth and carbon sequestration.[71]

Implications

These eight global-scale environmental problems, as well as acid deposition and ozone layer depletion, do not exist in isolation—they are constantly interacting with one another, typically worsening the situation. The loss of forests, for example, contributes to biodiversity loss, climate change, and desertification. Climate change, acid rain, ozone depletion, and water reductions can in turn adversely affect world forests. Changing climate will affect everything. Among other things, it is likely to worsen desertification, lead to both additional flooding and increased droughts, reduce freshwater supplies, adversely affect biodiversity and forests, and further degrade aquatic ecosystems.

What is one to make of all this? A number of prominent scientists have taken a hand at describing what all these trends mean. In 1998, ecologist Jane Lubchenco, in her address as president of the American Association for the Advancement of Science, drew the following conclusions: "The conclusions . . . are inescapable: during the last few decades, humans have emerged as a new force of nature. We are modifying physical, chemical, and biological systems in new ways, at faster rates, and over larger spatial scales than ever recorded on earth. Humans have unwittingly embarked upon a grand experiment with our planet. The outcome of this experiment is unknown, but has profound implications for all of life on Earth."[72]

In 1994, fifteen hundred of the world's top scientists, including a majority of living Nobel Prize–winners, issued a plea for more attention to environmental problems: "The earth is finite," they stated. "Its ability to absorb wastes and destructive effluents is finite. Its ability to provide food and energy is finite. Its ability to provide for growing numbers of people is finite. Moreover, we are fast approaching many of the earth's limits. Current economic practices that damage the environment, in both developed and underdeveloped nations, cannot be continued with the risk that vital global systems will be damaged beyond repair."[73]

The Millennium Ecosystem Assessment was a massive four-year effort involving 1,360 scientists and other experts worldwide to assess conditions and trends regarding the world's ecosystems. At the conclusion of this unprecedented effort in 2005, the board governing the assessment issued the following statement: "Nearly two thirds of the services provided by nature to humankind are found to be in decline worldwide. In effect, the benefits reaped from our engineering of the planet have been achieved by running down natural capital assets.

"In many cases, it is literally a matter of living on borrowed time. By using up supplies of fresh groundwater faster than they can be recharged, for example, we are depleting assets at the expense of our children. . . .

"Unless we acknowledge the debt and prevent it from growing, we place in jeopardy the dreams of citizens everywhere to rid the world of hunger, extreme poverty, and avoidable disease—as well as increasing the risk of sudden changes to the planet's life-support systems from which even the wealthiest may not be shielded.

"We also move into a world in which the variety of life becomes ever-more limited. The simpler, more uniform landscapes created by human activity have put thousands of species under threat of extinction, affecting both the resilience of natural service and less tangible spiritual or cultural values."[74]

In 2007, the *Bulletin of the Atomic Scientists* moved its Doomsday Clock closer to midnight, citing environmental threats.[75] The Doomsday Clock reminds us that today's alarming environmental trends have consequences far beyond the environment. They can also contribute to conflicts over human access to water, food, land, and energy; ecological refugees and humanitarian emergencies; failed states; and armed movements spurred by declining circumstances. They are profound affronts to fundamental fairness and justice in the world and discriminate against both those too poor and powerless to hold their own against these tides and voiceless future generations. And they bring large economic costs. The Stern Review estimated that the total cost of a business-as-usual approach to climate change could be "around a 20% reduction in current per capita consumption, now and forever." And that's just from climate change.[76]

An interesting and important question is whether measures can be devised to "sum up" the various human impacts on the planet's environment. The most sustained efforts in this regard have been made by the Global Footprint Network, which has developed the Ecological Footprint for each nation. It seeks to measure a country's demand on the biosphere in terms of the area of biologically productive land and sea required to provide the resources consumed in each country and absorb the wastes generated. The footprint of a country includes all the cropland, grazing land, forest, and fishing grounds required to produce the food, fiber, and timber it consumes, to absorb the wastes emitted in generating the energy it uses, and to provide space for its infrastructure. Since the late 1980s, the Global Ecological Footprint has exceeded the earth's biocapacity, as of 2003 by about 25 percent—a measure of the degree we are not living off nature's interest but instead are drawing down its capital. "For how long will this be possible?" they ask. "A moderate business-as-usual scenario, based on United Nations projections showing slow, steady growth of economies and populations, suggests that by mid-century, humanity's demand on nature will be twice the biosphere's productive capacity. At this level of ecological deficit, exhaustion of ecological assets and large-scale ecosystem collapse become increasingly likely."[77]

The Ecological Footprint analysis also provides one way to estimate the responsibility of each region for these enormous pressures on the planet's environment. The billion people in the high-income countries, about 15 percent of the world's people, are responsible for about 45 percent of the Global Ecological Footprint, and the United States is responsible for almost half of that total.[78]

Another way to measure responsibility for ecological pressures on the planet is to examine international resource consumption patterns. An analysis prepared for the *1998 Human Development Report* found

that the 20 percent of the world's people in the highest-income countries account for 86 percent of total private consumption expenditures, 45 percent of meat and fish consumption, 58 percent of energy consumption, 84 percent of paper consumption, and 87 percent of the world's vehicle fleet.[79] This list could be extended.

How Do We Respond?

The challenges are daunting; the reality they reflect is frightening. How do people respond? It is possible to assume any number of attitudes. Here are some I've encountered:

Resignation. All is lost.
Divine providence. It's in God's hands.
Denial. What problem?
Paralysis. It's too overwhelming.
Muddling through. It's going to be all right, somehow.
Deflection. It's not my problem.
Solutionist. Answers can and must be found.

Most of us are solutionists; certainly this book is. We have not denied the problems nor assumed they will be solved merely because we've solved other problems. We are not resigned to their great force, nor are we paralyzed by them. Nor have we left them to God or somebody else.

Solutionists can take refuge from time to time in one last predisposition, the existentialist one. "The struggle itself toward the heights is enough to fill a man's heart. One must imagine Sisyphus happy," Albert Camus says in *The Myth of Sisyphus.* Here, it is the struggle itself that matters and provides meaning. As the angels said as they carried Faust to heaven, "Whoever strives with all his power, we are allowed to save."

Solutionist thinking may be the most hopeful, but there are many varieties of solutionist thinking. Not all solutions are the same, nor are all equally promising. Paul Raskin and his coauthors in *Great Transition* and others have sketched a range of alternative scenarios of the future.[80] These scenarios each reflect different solutions; they embody different worldviews; they seek to bracket the possible ways of dealing with these challenges, with options ranging from breakdown to true solutions.

1. *Fortress World.* This is a solution but a highly unattractive one. It evolves as a result of social breakdown and disintegration as the well-to-do escape to protected enclaves and wall out the global underclass. Varieties of Fortress World are the backdrop to countless science fiction stories, but unfortunately, one can see signs of Fortress World today in gated communities, armed civilians, private security protection and mercenary armies, the size of prison populations, the emergence of large gaps between the rich minority and the poor majority, and countless natural and other amenities that only the rich can afford. A related possibility is the slow growth of authoritarianism; if conditions deteriorate and the public is increasingly fearful, draconian measures could seem more and more acceptable.

2. *Market World.* This solution is Promethean and cornucopian. Market cornucopians have faith in free markets and competition to resolve problems. They tend to see nature as boundless and thus unlikely to exercise significant constraints over human action. They are optimistic about the economy's ability to innovate and develop ever-more efficient and cleaner technologies, thus keeping environmental problems under control. In their view, economic growth is wholly positive. It facilitates technological innovation and solutions to natural resource scarcity.

3. *Policy Reform World.* Reformists or institutionalists believe in policy fixes. They emphasize that skillful policy guidance relying on close connections among governments, scientists, nongovernmental organizations (NGOs), and indigenous communities is capable of recognizing emerging scarcities and threats and devising responses. Strong and effective institutions, laws, and policies at the national and

international levels can make this possible. Economic growth can be consistent with environmental preservation, but only if appropriately guided by regulations, market corrections, and other measures.

4. *New Sustainability World.* This just-emerging worldview seeks to protect and reclaim natural and human communities and, to that end, envisions major changes in values, lifestyles, and human behavior. It involves a deep change in social values—away from ever-increasing material consumption and toward close community and personal relationships, social solidarity, and a strong connection to nature. It sees this new consciousness as essential to resolving today's environmental and social dilemmas. The natural environment is seen as having a "carrying capacity" that must limit the scale of resource consumption and pollution. It recognizes that ecosystems and the services they provide are being lost due to harvesting above regeneration rates or pollution beyond assimilative capacities. Growth is not viewed as a high priority. Market forces are seen as useful but as only one of many tools at society's disposal.

5. *Social Greens World.* Social greens argue that the true questions have to do with power within society and with inequitable resource access and distribution. They look at the social and political contexts in which resource decisions are taken and focus on redistributive policies—including power redistribution—to address environmental questions. Many favor a thoroughgoing decentralization and strong protection of local economies and communities. They question both the political impartiality of expertise and the ability of governments as commonly constituted to guide sensible behavior.

In recent decades, Market World advocates have very much controlled the actual levers of power and decision-making. As necessary, they have made concessions to the reformers, and today's laws and institutions are the result. This pattern continues to be the dominant one in national and international environmental affairs.[81] As I discuss in Chapter 3, today's environmentalism operates largely in Policy Reform World, and it has offered an abundance of reform proposals addressing

global-scale as well as national and local environmental challenges. But the system for selecting and implementing proposals for action both limits their effectiveness and puts off-limits more far-reaching ideas for change.

Since this pattern is not yielding the desired results, something new clearly is needed. The solutions of the New Sustainability World and the Social Greens World point positively beyond today's situation to the new vision and new worldview that are needed. Cultural historian Thomas Berry has written that "history is governed by those overarching moments that give shape and meaning to life by relating the human venture to the larger destinies of the universe. Creating such a movement might be called the Great Work of a people." He goes on to describe the Great Work of Greek civilization and others in Europe and Asia. "The Great Work now," he writes, "is to carry out the transition from a period of human devastation of the Earth to a period when humans would be present to the planet in a mutually beneficial manner. . . . Perhaps the most valuable heritage we can provide for future generations is some sense of the Great Work that is before them of moving the human project from its devastating exploitation to a benign presence."[82]

We must now begin this work in earnest.