

## Selected Papers of Beijing Forum 2009

## Environmental Crises in World History

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The Greek physician Hippocrates used the term *crisis* to refer to a perilous turning point – the moment when an individual's physical condition either improves and begins to recover or degenerates and leads to death. The term transfers awkwardly to the analysis of large-scale historical developments, which are far more complex than individual health – and which reflect the cumulative effects of numerous incremental changes rather than sharp or clear turning points. Hippocrates' medical crises lasted a few hours or a few days, but historians have spoken of crises lasting for periods of a few years or for longer terms of a century or more. They have offered dramatically different explanations of the nature and causes of historical crises. Those who recognize a "general crisis of the seventeenth century," for example, have attributed it variously to political, economic, financial, social, cultural, and demographic causes that overlapped and influenced one another in myriad ways. To the extent that the term *crisis* might be useful for historical analysis, it will need to draw attention to specific conditions that pose serious threats to the stability or even the survival of society.

While recognizing that many different kinds of problems can threaten the stability or survival of society, this presentation will focus on environmental crises arising from imbalances between human demands and the ability of the natural environment to satisfy those demands. It will distinguish three broad and very different categories of environmental crisis and will discuss their implications for human society. The three categories are: 1) those caused by purely natural conditions, 2) those caused or aggravated by human activity, and 3) those arising from increasing human demand for sources of energy to power infrastructures that have become increasingly energy-dependent over time. This is admittedly a highly biased approach in that it considers environmental crises from the perspective of only one species. It may nevertheless have some value, however, if it is able to yield a framework that facilitates analysis of relationships between human beings and the natural environment over the long term, and if it is also able to create a deep historical context for the understanding of contemporary environmental issues.

## 1. Environmental Crises of Purely Natural Origin

Changing environmental conditions have influenced the evolution of human and other species since the appearance of life on earth. Indeed, until the Upper Paleolithic era, environmental crises arose almost entirely from natural conditions. A growing consensus among archeologists recognizes that global climatic and environmental changes over geological time created the conditions under which biological evolution took place. Dinosaurs ruled the earth for some two hundred million years, for example, but disappeared rather suddenly, perhaps because of a purely natural global environmental catastrophe caused by collision of the earth with an asteroid. About thirty million years ago, the earth entered a long-term cooling phase that devastated the extensive forest cover that had nourished the dinosaurs. A cooler and drier global climate favored the development of savannas, prairies, and grasslands, which in turn favored the increase of large herbivorous mammals like horses, cattle, and antelopes, as well as their predators. The bounty of the grasslands was so great that it lured some primates from their original homes in the forest to the savannas. Except for this larger environmental context, arising purely from natural causes, it is possible that hominids and human species might never have evolved.<sup>i</sup>

Once human species had appeared on the face of the earth, purely natural conditions continued to influence their fates far more than human species themselves influenced environmental change. Like other animals, human beings – including *Homo habilis*, *Homo ergaster*, *Homo erectus*, *Homo neandertalensis*, and *Homo sapiens* among other human species – adapted to conditions through learning or evolution or both. Thanks to superior brainpower, ability to communicate complex messages accurately, and capacity to accumulate knowledge, *Homo sapiens* proved to be a particularly effective competitor for the earth's resources.

Yet even *Homo sapiens* was liable to unpleasant environmental surprises. Many of these surprises produced environmental crises that threatened social stability or even human survival. Most of them probably posed threats on a regional rather than global basis, as when volcanic eruptions, earthquakes, tsunamis, droughts, floods, or massive storms afflicted local populations. A much larger and far more serious crisis took place about seventy thousand years ago, when human species flirted with extinction. Geneticists have detected indications in the human genome of a population bottleneck at that time resulting from a precipitous decline in human numbers. Genetic analysis suggests that the population of *Homo sapiens* declined to about ten thousand individuals, or even as low in some estimates as one thousand breeding pairs. In either case, assuming the basic accuracy of the genetic models, the human species stood on the brink of extinction.

Stanley H. Ambrose has advanced the hypothesis that this abrupt population decline resulted from eruption of the supervolcano Toba on the island of Sumatra about seventy thousand years ago.<sup>ii</sup> Toba was the second-largest known volcano of the past 450 million years. Its eruption caused a volcanic winter lasting six years, followed by a long period of the coldest temperatures of the Late Pleistocene epoch (from about 1.8 million to twelve thousand years ago). Summer temperatures in Europe and northern China instantly dropped about 12 degrees Centigrade, with devastating effects for ecosystems and their inhabitants, including humans. Indeed, only two human species survived the Toba event: Neandertals, who had evolved to survive cold environments in Europe and western Asia during the ice ages, and *Homo sapiens*. Cold temperatures endured globally for the next thousand years. Under these conditions, the best places for human survival were tropical refuges, principally in Africa, which to judge from the high incidence of genetic diversity there was the home for all ancestors of humans living today.

It is obviously impossible to arrive at certainty about the details of causes and effects in such a remote era. Yet it is clear from more recent experience that purely natural conditions have brought environmental changes and created local and regional environmental crises, even if not in such a dramatic way as the Toba event. William S. Atwell has argued persuasively for volcanic activity as a cause of short-term but sometimes nevertheless sharp climate change in historical times, and the well known case of the Little Ice Age demonstrates the potential of purely natural processes to produce environmental effects with significant consequences for human societies.<sup>iii</sup> Eruptions of volcanoes like Thera (1628 B.C.E.), Tambora (1815), and Krakatoa (1883) clearly threatened the stability and survival of neighboring societies, but none of them posed a threat on a continental or global basis. Humans have been able to make adjustments and survive the effects of volcanically generated climate change and the effects of the Little Ice Age, but adjustments brought their own stresses, particularly for outposts of society occupying agriculturally marginal lands.<sup>iv</sup> In any case, while emphasis in contemporary discussions of environmental crises falls heavily and quite correctly on anthropogenic effects on the natural environment, it is worth remembering that human activity takes place in a much larger context of natural processes, some of which stand well beyond human control or influence. Indeed, the earth remains vulnerable to a large number of purely natural processes such as collisions with extraterrestrial objects, volcanic activity, global warming, rising ocean levels, hurricanes and typhoons, and others as well.<sup>v</sup>

## 2. Environmental Crises Caused or Aggravated by Human Activity

Since the emergence of large-scale hunting, and especially after the invention of agriculture, environmental crises have increasingly reflected the influence of human behavior and human policies. During the course of the Holocene epoch (the period from about twelve thousand years ago to the present), anthropogenic effects on the natural environment have influenced ever-larger parts of the earth and have posed threats to social stability in regional contexts. Since widespread use of fossil fuels in the industrial era, anthropogenic effects have extended their reach to literally global proportions. Indeed, some earth scientists suggest that since about the eighteenth century, the earth has entered a new geological epoch – the Anthropocene – in which human activities play major roles in environmental change and hence in the creation of environmental crises as well.<sup>vi</sup> Purely natural processes have by no means disappeared. Indeed, it is likely that purely natural processes created a set of conditions favoring the expansion of human prominence in the biosphere by warming the earth to the point that agriculture was a viable option in many world regions. Once they became established as a dominant species throughout the world, though, human beings soon began to register their own influence back on the natural environment.

Human activity had environmental influence before the invention of agriculture. After they developed effective hunting techniques, human beings placed pressure on some animal species. It has been quite clear for some time now that human arrivals in Australia and the Americas coincided with the rapid decline of megafauna in those regions. It is less clear what role humans played in megafaunal extinctions. Paul S. Martin and Tim Flannery have argued passionately that overhunting by humans was the principal reason for the extinctions.<sup>vii</sup> For the moment, the scholarly consensus clusters around the less dramatic view that climatic change probably accounted for most of the difficulties megafauna faced. Human overhunting may well have aggravated a difficult situation further, but it was not likely the only or even the main cause of extinctions. Even this attenuated interpretation recognizes, however, that human beings were fully capable of aggravating natural processes in remote times. Meanwhile, there is general agreement that human predation was responsible in later centuries for large-scale extinctions of avifauna in Pacific islands.<sup>viii</sup>

Yet the environmental effects of hunting were minimal compared to the influence of agriculture, including herding as well as cultivation, and especially industrialization. Indeed, the environmental effects of agriculture and industry have been so numerous that it is difficult even to catalogue them, and much more so to understand the many ways various effects have overlapped and reinforced one another. There are obviously many differences between agriculture and industry as forms of economic organization, and the two forms have had different effects on the natural environment. From an environmental viewpoint, though, mechanical industry reinforced and amplified long-standing effects of cultivation, even as it also introduced new effects of its own. In keeping with the purposes of this presentation, emphasis here will fall on effects that contributed to environmental crises rather than distinctions between agricultural and industrial production.

Continuing the focus on land animals for the moment, agriculture and herding brought several very different prospects for the animal kingdom. For some animals, the eras of agriculture and mechanical industry brought domestication and much larger populations, although the animals paid for this advantage by undergoing genetic changes and serving human interests. In other cases, agriculture and industry facilitated the dispersal of animal species beyond the range of their original homelands. For the past five hundred years – during the late centuries of agrarian empires and the era of industrialization – human methods and technologies of hunting have been so powerful as to drive some animal species to the point of extinction when concentrated demand has created markets for their products: examples are elephants, tigers, and even Atlantic cod fish. Finally, agriculture and industry have also brought habitat destruction and chemical pollution that have pushed numerous animal species toward extinction even when there has been little or no commercial demand for their products. All of these fates clearly reflected anthropogenic environmental effects rather than purely natural processes.

Have domestication, dispersal, and extinction caused environmental crises? Extinctions certainly have the potential to bring dramatic ecological changes, although they have historically presented humans with few environmental crises. What John F. Richards has called “the world hunt” brought extinction or severe population decline to deer, beavers, and other fur-bearing animals. The world hunt dramatically changed local environments, but its effects on humans involved changes in fashion more than threats to social stability and survival.<sup>ix</sup> In most cases, humans have been able to adapt to extinctions by turning their attention to different animals: after the disappearance of megafauna, for example, early human inhabitants of Australia and the Americas simply hunted smaller animals. Extinctions may have caused subsistence problems for some island populations, but even in most of those cases, aquatic resources were available for exploitation.

Domestication and dispersal have provided humans with exploitable animal resources and hence served as a foundation for human communities. As a result, it may seem that domestication and dispersal would have few if any implications for environmental crisis. Yet while increasing supplies of food, labor, and other resources available to humans, concentrations of domesticated animals have also made it possible for crowd diseases to flourish among animal populations. Some of these diseases have posed threats to herds that were essential to subsistence, while others have been able to make the leap from animal to human hosts. The most important disease of this latter group is smallpox, which has taken an enormous toll in human lives. Although it usually became endemic in large societies, and thereafter carried away a steady stream of victims without threatening the stability of whole societies, smallpox has always been a ferocious killer when it struck populations with no prior exposure to the disease. It almost certainly devastated small groups of foraging peoples when it reached them from early complex societies like those of Mesopotamia in ancient times.<sup>x</sup> It sparked the largest single demographic catastrophe in world history when it raged through the native populations of the Americas and later Australia and the Pacific islands as well. Influenza, measles, and other maladies that originally arose from animal populations accompanied smallpox and amplified its effects. Indirectly, then, through their maintenance of flocks and herds of domesticated animals, humans unwittingly created the conditions for environmental crises of local, regional, and continental proportions.

Apart from the influences they worked by way of herd diseases, the effects of agriculture and industry contributed to numerous local and regional environmental crises, but the crises never reached continental or global proportions before recent times. Agriculture sustained human societies by cushioning against environmental fluctuations, while mechanical industry developed and harnessed technologies that made human life more agreeable in countless ways. Yet agriculture and industry also harbored profound implications for the natural environment. Both agriculture and industry sparked numerous environmental crises on local and regional scales, and by the twentieth century, it had become clear that both were capable of generating environmental crises on a transregional and global basis.

From its earliest days, agriculture had profound environmental consequences. It increased human control over plants and animals, and it brought about both morphological and genetic changes in domesticated species. It favored the spread of plant and animal species that humans found useful. Agriculture also brought about environmental degradation. It increased the populations of humans and their favored species while placing pressure on predatory animals and others for which humans found little or no practical use. Cultivation of crops necessarily involved deforestation and the removal of ground cover, which in turn facilitated erosion of soils, leading in extreme cases to desertification. In some cases, artificial irrigation of crops compounded this problem by bringing underground salts to the surface and retarding or preventing the growth of salt-sensitive crops. In various forms, anthropogenic environmental degradation brought about political and social crises in multiple regions. From ancient Mesopotamia to Mediterranean Europe to the American southwest, archaeologists have documented oscillating patterns of development followed by decline.<sup>xi</sup> In one case after another, agriculture flourished and supported large populations – and sometimes formal states as well – until degraded lands returned diminishing agricultural yields. With declining food resources, populations abandoned cities, and states dwindled or even disappeared. Remaining populations clustered in small villages practicing subsistence agriculture for at least a few generations until the land was able to recover some of its productive potential.

Over time, cultivators in most world regions found and employed reasonably sustainable practices that supported sizable populations without exposing them to the threat of periodic crashes. The occasional appearance of new food crops – particularly the large-scale transfers following the Islamic green revolution and the Columbian exchange – made it possible to produce more calories and support larger populations.<sup>xii</sup> Droughts, famines, and pests all had potential to compromise harvests, but as sharp as they were for afflicted lands and peoples, the resulting crises mostly struck in limited areas.

The industrialization of agriculture enabled environmental crises to pose threats to social stability and survival on a much larger basis than before while also introducing new sets of problems. The industrialization of agriculture brought immediate benefits in the form of dramatically increased yields. Heavy machinery, fertilizers, hybrid crops, and new methods of irrigation all contributed to increased agricultural production and productivity. During the twentieth century, however, and especially after World War II, industrialized agriculture brought many problems along with it, including chemical pollution from heavy reliance on fertilizers and pesticides, erosion from cultivation of marginal lands, depletion of water resources, and exposure of crops to pests and diseases because of monoculture, quite apart from more general environmental destruction due to deforestation, dam construction, draining of wetlands, and expansion of cultivation to marginal lands.

It goes without saying that quite apart from agriculture, the industrialization of production more generally has also brought its own share of environmental problems. An extensive list of problems flows from industrialization: concentration of people in densely populated urban centers, depletion of resources, increasing demand for scarce fuels, creation of extremely dangerous toxins (including nuclear toxins), and the chemical pollution of soil, water, and air, to name only the most obvious.<sup>xiii</sup>



Human actions have aggravated natural conditions and amplified environmental problems since the Upper Paleolithic era, but enhanced state power of the industrial era has afforded opportunities for human intervention to magnify difficulties that arose naturally because of drought or famine. The most catastrophic and most deadly famines of world history occurred when deliberate policies prevented the production and especially the distribution of foods in famine-struck lands. Examples include: the “late Victorian holocausts” of the period 1876 to 1902, when British imperial policies aggravated El Niño famines and contributed to the deaths of as many as sixty million people, mostly in India and China but also other lands as well, by preventing the distribution of relief supplies on the basis of free-trade ideology; the Great Hunger of 1932 to 1933 in the Soviet Union, whose victims may have approached fifteen million when Soviet authorities confiscated crops and sold them abroad, thus creating an artificial famine; and the Great Leap Forward of 1958 to 1963 and the Three Hard Years of 1959 to 1962, when neglect of agriculture and confiscation of crops contributed to the deaths of more than thirty million people in China.<sup>xiv</sup> These three are only a few examples of many cases in which human actions caused environmental crises or aggravated natural conditions that generated environmental crises. They are special cases, however, and they merit the special attention of historians, in that they represented deliberate efforts to deploy environmental resources as weapons by inducing environmental crises for political purposes, or they at least involved the willful turning of a blind eye toward suffering that was largely preventable in the interests of political programs or in the name of ideological purity.

### 3. Energy Crises

Two points are already clear: first, ~~environmental crises have threatened~~ humans (and other species) for as long as there has been life on the earth, and second, because of their high intelligence and abilities to communicate and innovate, human beings have found their own ways to amplify natural effects or even to create new environmental threats in the course of pursuing their individual and collective interests. Meanwhile, also following from their intelligence, humans have discovered increasingly ingenious ways to exploit energy resources for their own benefit.<sup>xv</sup> Their remarkable record of success in extracting energy from natural resources is the foundation of a special category of environmental crisis having to do with the sources of energy.

Over the past twelve thousand years or so, human beings have turned ever-larger portions of the energy available in the world to their own uses. This is a remarkable and even stunning development. Before the turn to agriculture, human beings consumed little more energy than was necessary for subsistence – about two thousand calories per capita per day. After they learned to control fire, they captured more energy for their own uses than other animals but only marginally so, consuming about five thousand calories per day in food and other energy uses combined. With the adoption of agriculture, ~~human energy use~~ more than doubled to about twelve thousand calories per capita per day, including food consumption for both humans and animal stocks as well as energy used for heat, construction, agriculture, commerce, production, and crafts. By the time of advanced agricultural societies around 1000 C.E., consumption more than doubled again to about 26,000 calories per day. The advent of industrial production and early exploitation of fossil fuels almost trebled per capita energy consumption to 77,000 calories per day by 1850. Today the rate of human energy consumption is almost a quarter-million calories per capita per day.<sup>xvi</sup> The distribution of this consumption is highly unequal – individuals in some world regions consume many more while those in other regions consume many less than a quarter-million calories per day – but with a population surpassing six billion, it is obvious that human beings have managed to capture an astonishing portion of the world’s available energy and turn it to their own uses.

Considering the world's history from the viewpoint of energy production and consumption, Edmund Burke, III recognizes "two major energy regimes in human history: the age of solar energy (a renewable resource) from 10,000 B.C.E. to 1800 C.E., and the age of fossil fuels (a nonrenewable resource) from 1800 C.E. to the present."<sup>xvii</sup> Energy sources deriving from solar energy were not necessarily renewable on the schedule that human consumers preferred. Time and again before the age of fossil fuels, humans ran up against limits of fuel resources. John F. Richards has documented fuel shortages throughout the world during the early modern era. Surging populations and increasing demand for industrial products that required heat (such as salt and beer) placed enormous pressure on biomass fuels. The results were rising prices and rationing, as well as a search for new sources of fuel.<sup>xviii</sup> Meanwhile, Kenneth Pomeranz has shown that by about 1750, both Europe and east Asian lands were experiencing shortages of fuel resources that sharply limited their ability to serve the material needs of increasing populations.<sup>xix</sup>

First in Europe, and later in other lands as well, human beings escaped this energy crunch by turning to fossil fuels. In early days these fuels were so abundant and held so much potential energy that humans made profligate use of the newly discovered resources. During the past two centuries, they have devised so many uses for relatively inexpensive energy, and they have built such energy-consuming and energy-dependent infrastructures that they have begun to test the limits of fossil fuel resources while also bringing new problems of pollution and global warming into clear focus. There is no danger that exploitable fuels are on the point of imminent exhaustion. Reserves of natural gas and coal are enormous, and even reserves of petroleum are substantial and increasing.

There are several dangers, however, that arise from the widespread use of fossil fuels, and they have the potential to trigger environmental crises beyond the local to transregional and even global scales. The menaces of pollution and global warming are clear enough, and they certainly pose threats to the stability of human societies and even to the survival of many low islands and coastal regions. Moreover, human beings have built such dense populations and outfitted them with such energy-dependent infrastructures that a major decline or interruption in flows of energy sources would have strong potential to create severe difficulties in the provision of food, water, and essential services, such as electricity and sanitation, that modern societies depend upon. Although efforts have been underway for some time to develop alternative sources of clean and reliable energy, it will in the nature of things take time to develop alternatives at attractive prices and then to retrofit infrastructures so that they can make use of the alternatives. In the meantime, an energy-based environmental crisis would in all likelihood lead to serious collateral damage by weakening economic systems throughout the world.

Between the eruption of the supervolcano Toba and the twentieth century, most environmental crises were local or regional in nature. For seventy thousand years or more, no matter what their cause, and regardless of the extent to which human efforts aggravated difficulties, environmental crises mostly threatened the stability or survival of societies in limited regions. The main exceptions were the hemispheric and continental crises unleashed by pandemic diseases like bubonic plague in the fourteenth century and smallpox in the sixteenth century. These pandemics were huge catastrophes that disrupted human societies for decades if not centuries, so I certainly do not wish to minimize their significance. For the past half-century, however, environmental problems have emerged that pose threats on a scale that dwarfs even those caused by pandemic plague and smallpox, and they suggest that environmental crises of transregional and global reach may pose the greatest general threats to the stability and survival of human society since the eruption of Toba. Powerful technologies of the industrial era have produced massive global pollution, and the accumulated effects from two centuries' of fossil fuel use threaten to cause global warming on a scale that would dramatically change the conditions of life on planet earth. Meanwhile, because of its reliance upon energy-dependent infrastructures, modern human society may well find it difficult, in the absence of clean, effective, and reasonably inexpensive alternatives to fossil fuels, to reproduce itself over the long term.

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