What Should We Remember? A Global Poll Among Environmental Historians

Compiled and introduced by Frank Uekötter

"If you could suggest one event for entry into the collective environmental memory of the world, what would it be?" In the spring of 2013, scholars from around the world found themselves confronted with this pointed question, and many of them – 22 in all – sent a reply. The original idea was that, in a volume dedicated to the merger of memory studies and environmental history, such a poll would broaden our perspective beyond the individual articles. The result is a colorful mix. It includes animals and bombs, dust and climate, organic and mineral resources, the old conservation movement and the new post-1970 environmental movement. From a geographical per-

spective, events spanned the entire globe. It is a selection that proved highly revealing concerning both our historical imagination and the discipline of environmental history. These introductory remarks seek to highlight some of the findings.

Respondents were given as much room as possible so as not to prejudge their choice. They were invited to take a liberal view of "event" in this project, including individuals, books, studies, or anything else that would be specific enough to qualify as an event. Scholars were also free to suggest well-known events or events that, in their judgment, *should* be well known. Of course, there were no chronological or geographic limitations, and scholars were expressly invited to suggest events from their region of study and events that they have discussed in a monograph.

The one requirement was that scholars needed to offer a brief explanation for their choice. A rigid space limit forced them to get to the point without lengthy deliberations about possible counter-arguments and alternative choices. We discouraged footnotes and bibliographies, as scholars were obviously offering a subjective opinion. Since no entry is superior to another, it would probably have been best to put entries on a world map, but because the written text asks for a sequence – one of the more subtle limitations of memory studies in the humanities, and one of the most ignored –, time appeared as the least intrusive organizing principle. The reverse chronological order serves as a reminder that the rationale of memory studies differs from that of history.

It would be an understatement to say that the temporal span of responses is wide. The events discussed in the poll move beyond the confines of human history, on both ends. The earliest event is the asteroid that killed the dinosaurs 65 million years ago; at the other end, we are moving into the future, as Greg Bankoff speculates about a future mega-earthquake in the Tokyo Bay area.[1] Big history has clearly left an imprint on the collective imagination of environmental historians, as three responses lie beyond the common chronological limitations of historical scholarship: the Yucatán

[1] In a tribute to the fictional nature of this event, we have put it at the very end – outside the historical chronology, but within our realm of collective imagination.

asteroid, the crossing of Wallace's Line by prehistoric humans some 50,000-60,000 years ago, and the Neolithic agricultural revolution.

That some scholars went so far back in time is no less remarkable than what follows: a yawning chronological gap. Scholars proposed exactly one event between the end of the Neolithic Age and the nineteenth century – the dust veil event of 536 CE. This probably reflects scholarship: it is no secret that the Middle Ages, antiquity, and all other pre-modern eras have been a backwater of environmental history, with most scholars devoting their attention to the nineteenth and twentieth centuries. But maybe this provides us with a more fundamental insight into our collective imagination: citizens of the modern age are having a hard time connecting intellectually to pre-modern events. They probably give us a shiver when we recognize how ephemeral great civilizations can be, but lessons rarely go deeper, at least when it comes to the environment. Those who have seen the dawn of modernity as a fundamental watershed of environmental history will find support in this poll.

Looking closer at the chronological distribution, two clusters emerge: the late nineteenth century and the years after 1970. The present author was not completely surprised, as he has identified a similar distribution in his previous reflections on turning points of environmental history. That endeavor suggested that the crisis years of Europe from 1914 to 1945 represented "something of a hiatus" for turning points in environmental history, and it is interesting to see that only one of the following events, Andreas Stihl's invention of the chainsaw in 1929, falls into the interwar years.[2] The nuclear bombs on Hiroshima and Nagasaki could technically fall into this time span, too, but Martin Melosi's rationale for the event is mostly looking forward into the postwar years where people encountered, in a phrase coined by Allan Winkler, "life under a cloud".[3]

[2] F. Uekoetter, "Thinking Big: The Broad Outlines of a Burgeoning Field", in *The Turning Points of Environmental History*, F. Uekoetter (ed.), University of Pittsburgh Press, Pittsburgh 2010, pp. 1-12, 9.

[3] A.M. Winkler, *Life Under a Cloud: American Anxiety about the Atom*, University of Illinois Press, Urbana 1999.

Reflecting on the first cluster in the late nineteenth century (which by historical convention ends in 1914), we can find a certain emphasis on environmental management. This is most evident in the US Bureau of Reclamation that was responsible for irrigation and hydroelectric power and ended up shaping economic and urban development all over the American West. However, environmental management is also an issue in the Big Blowup (which influenced fire management), phylloxera (which changed the wine industry), mass destruction mining (which revolutionized the extraction of minerals), and the invention of nitrogen fixing techniques.

In contrast, management is much more muted for the postwar years. The one event where it is front and center – the rhino relocation project – is also the earliest. In the rest, it is a more tacit theme, fittingly illustrated in the Chico Mendes reserve in Acre, as the human being is far better known than the legal concept of extractive reserves. None of the post-1969 events had consequences that even remotely qualify as solutions. The Santa Barbara oil spill has recurred in locations from Alaska to the Gulf of Mexico; the Stockholm Summit was a catalyst for awareness and policies in some countries, but not the birthplace of a global environmental policy regime; Chernobyl did not end nuclear power; and in spite of Chico Mendes' heroic activism, the rainforest is still under threat. There is a message in this for environmental management in the twenty-first century.

As discussed in the introduction to this special issue, the intellection tradition of *lieux de mémoire* grew out of an eminently nationalist tradition of historiography. That makes it all the more gratifying to note that the scholars' choices turned out to be eminently transnational. Events either ignored national boundaries altogether – as in pollution traveling from China to Japan –, or they had effects far beyond the confines of nation-states. Earth Day was born as a US celebration and is a global event nowadays, and the Bureau of Reclamation shaped water development beyond the American continent through the power of its expertise. As memory studies move increasingly towards transnational perspectives, there is ground to hope that environmental perspectives will gain more attention.

Looking at the issues that captured the scholars' attention, one top-

ic stands out: natural and man-made disasters. In this poll, the earth is an eminently unsafe place: we see an asteroid hitting the planet, volcanic eruption curbing global sunlight, a global pandemic, and a huge forest fire. Two nuclear bombs, one oil rig, and one atomic power plant explode, and the one individual who was designated as memorable gets killed. And we have not even witnessed the Tokyo earthquake yet. All in all, these events mirror the extent to which our environmental imagination has been shaped by catastrophes.

We can also see the link between the current environmental discourse and our historical imagination in the prevalence of climate issues. Two scholars nominated anthropogenic climate change: Susan Flader did so directly, and Richard Tucker focused on the world's first oil well as a site that mirrored the fateful shift in our energy base. We can also see the climate issue behind the dust veil event of 536 CE, the Yucatán meteor, and the pollution that Japan receives from China. It is unlikely that climate issues would have received so much attention in a poll before the 1980s.

Organic resources are another prevalent theme. In this collection, the modern era starts with the plowing up of grasslands all over the world, the ecological downside of the advancing frontier in the nineteenth century. The chainsaw, synthetic nitrogen, and industrial-scale irrigation (courtesy of the US Bureau of Reclamation) were all technologies that boosted the transformative capacities of humans about their environment; phylloxera and the crossing of Wallace's Line highlight the biological unification of the world. Organic resources become less visible after 1945, however – though it is worth recalling that Chico Mendes was a rubber tapper before he became a global environmental icon.

The prominence of organic resources is particularly remarkable given that glaring gap in this list, the Industrial Revolution. No one nominated the steam engine, the factory system, or Karl Marx – an omission that will surely come as a shock to scholars in the post-1968 tradition. It almost looks as if respondents were engaging in a collective effort at tiptoeing around the Industrial Revolution by focusing on energy. They highlighted oil (with two entries), hydroelectric energy, and nuclear power in both its destructive and its

civil-turned-destructive incarnation, along with anthropogenic climate change as the cumulative result of the shift towards fossil energies. Of course, the hesitation may mirror the fact that economic history has cast doubts on the concept of the Industrial Revolution over recent decades; but then, the colossal transformative powers of industrial capitalism are painfully clear all over the world in the twenty-first century. At the risk of offending our kind respondents, there is probably a warning sign here for our discipline. An environmental history that focuses on energy rather than industrialism is dangerously close to mistaking symptoms for causes.

However, what impressed the present author the most was the overwhelming negativity of our environmental imagination. No scholar suggested a natural treasure for this list: in the following, national parks are mentioned just once – as the site of a chainsaw demonstration. We have Earth Day, the Stockholm Summit and the saving of the rhinoceros, but other than that, there are few events that environmentalists can recall with a sense of pride. Even when the event was not an imminent catastrophe, events usually had disastrous outcomes, and it is gratifying to note that scholars make no bones about this negativity. Decades of deconstruction have not eaten away our ability to be moral critics. But then, what does the overwhelming presence of negative events in the following list mean?

There are probably two interpretations, with choice being one of worldviews rather than evidence. The turnout may reflect the extent to which environmental historians, and environmentalism more generally, has become infatuated with dystopian thinking.

Or it may just say who we humans are.

Memories of Pollution from the "Outside", 2013

Osamu Hattori, Doshisha University, Kyoto, Japan

In the spring of 2013, the Japanese media produced dramatic reports on the high volume of dust coming from China. Air pollution in large Chinese cities was already well-known from the 2008 Beijing Olympics. However, it is now being more frequently report-

ed because in spring the dust is carried westward from the Chinese mainland. Many Japanese people are worried about pollution from China because they have a collective memory: agricultural products and groceries from China have often contained dangerous preservatives and chemical additives. Japanese people tend to view China as a developing country – a fact that, for the Japanese, explains why China's government and citizens have less environmental awareness and are less health-conscious.

Through history, the Japanese have often feared being polluted from the "outside". Epidemics such as cholera, typhus, and bird flu can also be understood as a cause of environmental pollution. Similar thought processes can be seen all over the world. If we analyze the historical discourse on the danger of pollution from the outside, we discover the cultural ethnocentric mindset of the nation in question. That's a form of cultural environmental history. If we can organize an international comparative research project or exhibition, we will deepen our understanding of each other.

Assassination of Chico Mendes, 1988

José Augusto Padua, Federal University of Rio de Janeiro, Brazil

The event I would like to suggest could be considered, at first glance, a local one: the murder of the union leader and environmentalist Chico Mendes in December 1988. The killing happened in the state of Acre, a poor and remote part of the Amazon region, close to the frontier between Brazil and Bolivia.

My choice is based on two main reasons. The first one is personal. We became friends in 1986, when I took part in a group that supported what was called "forest peoples". The historical background was the growth of the Brazilian economy since the 1970s and the strong push to open new frontiers for timber production, ranching, and farming in regions previously covered by tropical forests and other native ecosystems. This push generated conflicts with local communities who started to resist and to defend the ecosystems from which they took their livelihood. I was very impressed by Mendes'

willingness to risk his own personal security for the sake of what he considered a greater value: the continued existence of his people and the forest where they lived. His commitment and intelligence made this simple man a very special human being in my mind. His killing by local landlords was a personal shock and exposed to me in a very concrete way all the injustices and violence that were taking place in the Amazon region.

My choice also has a global dimension. The killing of Chico Mendes became a symbol of what was later called the "environmentalism of the poor". In Brazil, as well as in many other parts of the planet, communities of rubber tappers, plant and nut gatherers, small fishermen, and other poor people were leading social and environmental resistance to the invasion of their spaces, which were seen by developers as frontiers of exploitation of natural resources. An important aspect is that these movements were able not only to resist but also to make innovative proposals for conservation. Such was the case of the "Extractive Reserves" that were proposed by the National Council of Rubber Tappers (created in 1985) as a new kind of protected area that would combine protection of ecosystems and protection of the livelihood and cultural practices of the traditional communities living in the area. The first extractive reserve was created in 1990: the "Chico Mendes" reserve in Acre. Brazil now has 87 reserves of this kind, with a total area of around 14.3 million hectares. From a broader perspective, the national and international scandal produced by Chico Mendes' assassination was one of the turning points in the political attempt to halt the destruction of the Amazon forest, an attempt that has been producing very concrete results in the last decade (deforestation was reduced by more than 70 percent since 2004).

For me, besides the personal loss of a friend, Chico's assassination demonstrated that environmental problems could not be isolated from a complex network of social and ecological interactions and from broad historical patterns of land occupation. My later career as an environmental historian was marked by this perception.

Chernobyl, 1986

John R. McNeill, Georgetown University, USA

On the grounds that I can't remember anything before I was born, I will choose Chernobyl in April 1986. I choose it because it remains memorable for me as the first major nuclear catastrophe not kept secret; because its scale and scope were great enough to make it a significant event at the time; because its clumsy handling by Soviet authorities contributed (although we can't say how much) to the demise of the USSR, a major political event; and because its memory still affects debates over nuclear power a generation later.

Stockholm Conference, 1972

Bao Maohong, Peking University, China

I think the event should be the UN Conference on the Human Environment in Stockholm in 1972. The conference changed environmental consciousness around the world and encouraged environmental movements. China in particular acknowledged its environmental issues and developed environmental policies after that conference.

Earth Day, 1970

Adam Rome, University of Delaware, USA

The first Earth Day was a transformative event in the United States, and it subsequently became the inspiration for important days of environmental protest, education, and celebration around the world. Though Earth Day 1970 is well known, the basic facts still are amazing. In September 1969, Wisconsin Senator Gaylord Nelson vowed to organize a nationwide environmental teach-in in spring 1970, and his call to action inspired thousands of events across the country. Roughly 1,500 colleges and 10,000 schools held teach-ins. Earth Day activities also took place in hundreds of churches and

temples, in city parks, and in front of corporate and government buildings. Millions of Americans took part.

But the sheer scale of Earth Day 1970 is only part of the story. The inaugural event had a freshness and intensity that are difficult to imagine today. Because Earth Day 1970 was unprecedented, the organizers had to plan everything from scratch, and the effort often was life-changing. Tens of thousands of people spoke on Earth Day, many of whom had never spoken publicly about environmental issues before. The discussions at Earth Day teach-ins sometimes were soul-searching: Many participants truly were struggling to get to the roots of "the environmental crisis". Thousands of Earth Day organizers, speakers, and participants decided to devote their lives to the environmental cause. Earth Day also built a lasting eco-infrastructure – national and state lobbying organizations, environmental-studies programs, environmental beats at newspapers, eco sections in bookstores, and community ecology centers. Earth Day helped to give birth to the first green generation.

The Santa Barbara Oil Spill, 1969

Jeffrey K. Stine, Smithsonian Institution, Washington, DC, USA

In most parts of the world, television's ability to shape and intensify public awareness found few rivals during the latter part of the twentieth century. The world's collective memory was likewise influenced by this pervasive medium. If ever an environmental calamity was ready made for television coverage, it was the oil-well blowout in Southern California's ecologically vibrant Santa Barbara Channel.

The blowout occurred six miles offshore on 28 January 1969. Workers on Union Oil's Platform Alpha had just completed the drilling of a 3,500-foot-deep well when the build-up of extreme pressure shattered the well's inadequately reinforced casings, releasing a torrent of oil and natural gas that spewed freely for 11 days. Capping the wellhead stopped the undersea gusher but failed to stanch the flow completely. Pressurized gas and oil ripped five seams through the ocean floor, allowing smaller amounts of oil to escape for several more weeks.

Ultimately, the three-million-gallon spill coated 800 square miles of ocean and blackened over 35 miles of the state's scenic coastline.

The spill's visual nature – and its proximity to Los Angeles's well-staffed television stations – worked like catnip on the news media. Within days, heart-wrenching images of oil-soaked birds and marine mammals and beaches despoiled with thick crude oil were being broadcast into living rooms across the country and beyond. Newscasters pitched the oil-well blowout as a story of trouble in paradise. Indeed, Santa Barbara's mediterranean climate, the stunning beauty of its mountain-framed beaches, its Spanish-inspired architecture, and its cultured and relaxed social atmosphere had made it a world-renowned resort location. The idyllic coastal community had seemed immune from the environmental problems plaguing so much of the industrialized world. The oil spill broke this illusion of invincibility; if such a disaster could happen there, it could happen anywhere.

Improvised citizen protests – many of them intended to attract the voyeuristic eyes of television cameras – amplified the impact of the blowout on public opinion. The Santa Barbara oil spill soon became a visual metaphor for the global environmental crisis, dramatizing for the world the substantial risks of offshore oil development. Within the United States, the spill helped bring environmentalism into the political mainstream, where it became a major public policy concern. The organization of Earth Day the following year and the enactment of a flurry of environmental legislation during the next three years further contributed to a sensitized sociopolitical climate and fueled expanded environmental news coverage.

Television producers continued to use still and moving images of the Santa Barbara oil spill to provide historical background and comparative perspective for subsequent environmental disasters, such as 1989's 11-million-gallon *Exxon Valdez* oil spill in Prince William Sound and 2010's 210-million-gallon *Deepwater Horizon* oil spill in the Gulf of Mexico. Television's oft-repeated references to – and oft-rebroadcasted images of – the 1969 oil-well blowout reinforced its sordid position within the world's collective environmental memory.

"Operation Rhino", Kwazulu-Natal, South Africa, 1961

Jane Carruthers, University of South Africa, South Africa

In 1961, in what is now the South African province of Kwa-Zulu-Natal, white rhinoceroses were first successfully tranquilized, thus enabling their translocation throughout the subcontinent and indeed around the world. This timely intervention rescued this remarkable species from the brink of extinction to become the world's most common rhinoceros. Behind that abundance is an event that warrants entry into the collective environmental memory of the world. The current, well-publicized large-scale rhinoceros poaching in South Africa is thus doubly tragic because of the remarkable story of the recovery of this species from near-extinction.

Because it was not aggressive, inhabited open country, and was easy to shoot, the white (square-lipped) rhinoceros was a favored quarry of African and colonial hunters. Its hide was sought after for whips and its horn was exported to the Middle East for dagger handles and to the Far East for medicine. Once market and sport hunters had taken their toll, settler-farmers in the Zululand area lobbied the government to exterminate all wild animals in order to control the tsetse fly, vector of a fatal cattle disease. By the early twentieth century, the once abundant and widely distributed rhinoceros was one of the rarest large mammals in Africa. A few – around 25 – managed to survive at the junction of the Black and White Umfolozi Rivers in Zululand.

This was the site of the Umfolozi Game Reserve where, with strict protection in the 1940s and 1950s and a growing national conservation ethic, rhinoceros numbers grew while remaining extinct elsewhere. In the late 1950s and early 1960s a remarkable partnership developed between London-trained veterinary physiologist Dr. A.M. "Toni" Harthoorn and dedicated South African game rangers including Ian Player, John Clark, and Maqubu Nthombela. In East Africa in the late 1950s, Harthoorn had begun to experiment on African mammals with sedative drugs. At around the same time, Player and his fellow rangers, who were familiar with rhinoceros biology and behavior, began to appreciate that there were sufficient animals

in the reserve to consider relocating some of them elsewhere. But how to do so was the challenge: it had not been done before.

Harthoorn's work seemed promising, and the veterinarian arrived in Natal in December 1960. The history of attempts to concoct the correct drug cocktail to tranquillize such a large animal without damage or unnecessary trauma, as related by Player in *The White Rhino Saga* (1972) and by Harthoorn in *The Flying Syringe* (1970), is fascinating. Equally interesting is the role of the game rangers, especially Nthombela, the Head Game Guard and Player's mentor. Using their knowledge of the veld and experience of animal behavior, this team eventually devised the most suitable holding pens and transportation and other technical equipment, some of which is still standard procedure.

"Operation Rhino" was important in enabling rhinoceroses to repopulate their original range, but it also meant that other large mammals could be safely relocated. The technology developed in KwaZulu-Natal not only saved the rhino but also revolutionized wildlife conservation; it led to the creation of many game reserves in southern Africa and thus spawned the sustainable eco-tourism industry.

Bombing of Hiroshima and Nagasaki, 1945

Martin V. Melosi, University of Houston, USA

The event I would choose is the bombing of Hiroshima and Nagasaki in August 1945 (they are separate events, but certainly linked).

I find this choice, unfortunately, to be a very simple one. The explosion of the first atomic bombs in wartime (Trinity was of course the first experimental bomb to be exploded) had massive significance. From an environmental perspective, the immediate impacts were the nature of the human and urban destruction – not only the scale, but also the long-term impact of radiation. Atomic bombs helped to redefine total war, changing the course of World War II in particular and future warfare in general. Because of the long-term lingering effects of radiation, the atomic bomb and its successors introduced a new source of large-scale human and environmental

impacts, from genetic mutations to almost perpetual transformation of the physical landscape where the bombs were utilized. The risks associated with atomic bombs made it like no other weapon devised by humans, a type of warfare that threatened future generations as well as their habitats. The introduction of intense radiation into warfare has to be considered one of the most important environmental events in human history. The further development of nuclear weapons even threatened the very existence of the human race itself. Nuclear warfare became the ultimate apocalypse, an Armageddon.

The Chainsaw Begins to Chew Through the World's Forests, 1929

J. Donald Hughes, University of Denver, USA

Andreas Stihl's development of the gasoline-powered chainsaw in 1929 heralded a period of greatly accelerated worldwide deforestation that continues to the present day. He foresaw its major purpose from the first and named it the "tree-felling machine". With improvements, it would increase the efficiency of forest removal by more than an order of magnitude. With a six-horsepower, two-stroke internal combustion engine, the new model weighed 46 kg (101 lb) and still required two operators but was fully portable in the woods.

Stihl's company, founded in Stuttgart, Germany, in 1927, began to mass-produce these saws; it exhibited them at the Leipzig Trade Fair, sold them widely in Europe, and exported them to North America and the Soviet Union. Loggers resisted the chainsaw because they thought it would deprive them of jobs (a reasonable fear). Between 1950 and 1990, the output of Austrian loggers increased tenfold and the numbers of employees declined by 80 percent.

The Nazis made Stihl's the standard German chainsaw, but the export business disappeared with the war. American and British bombs destroyed the Stuttgart plant.

Meanwhile, chainsaw design and manufacture accelerated in America because of the demands of the war. Joseph Buford Cox of Portland, Oregon, developed a "chipper chain" model light enough

to be carried by one person in 1947. Its chain had improved teeth, a design Cox adapted from his observation of a timber-beetle larva the size of a forefinger, which easily chewed its way through wood grain with alternating sweeps of its curved jaws. The design he invented is still widely used.

Stihl developed similar models. In 1950, his company was producing machines light enough to be operated by one man. I saw such a chainsaw in a firefighting demonstration in Yosemite National Park in 1952. By that time the 11 kg (25 lb) models were in use. Philip Thöny says the use of chainsaws helped transform lumberjacks from day laborers to skilled machine operators.

Before the chainsaw, loggers used hand-drawn crosscut saws, with handles at both ends so that two men could work together. Bronze saws of similar design dating from 2750 BCE have been found in Mesopotamia. Ancient Minoan saws from around 1500 BCE have set teeth, with longer teeth curving outward in alternate directions. These were used to prepare wooden columns for palaces and temples.

Iron replaced bronze in Europe from the Greek Archaic Period onward. Leonardo da Vinci sketched saw teeth that would work in both directions: pulling and pushing. For felling trees, however, the saw did not replace the axe to a significant extent in Europe until the mid-eighteenth century, when Empress Maria Theresa of the Holy Roman Empire commanded its use. We still used hand-drawn saws in 1950 when I worked in Willamette National Forest, Oregon. It could take two hours to fell a tree that a chainsaw could take down in little more than two minutes.

Chainsaws have almost entirely replaced simple man-powered saws in forestry. Now in use around the world, legally or illegally, chainsaws are accelerating the deforestation of the Earth's landmasses. Large wood products companies adopt them as customary tools. As Michael Williams points out, "Now the individual settler/logger with a bit of cash or credit to purchase a saw and truck could wreak high-tech havoc". Not only that, but timber thieves could do their dirty work much more rapidly, although they sometimes avoided chainsaws, fearing that the loud noise would reveal their location. Now almost no forest in the world is too remote for exploitation.

Invention of Nitrogen-Fixing Techniques, 1913

Hugh S. Gorman, Michigan Technological University, USA

One of the most significant changes in human interactions with the rest of nature occurred when societies freed themselves from their dependence on nitrogen-fixing bacteria. The event most representative of this change was the introduction in 1913 of an efficient, industrial-scale process for transforming inert atmospheric nitrogen into ammonia – that is, for fixing nitrogen. Developed by Fritz Haber and Carl Bosch for the German company BASF, this industrial process not only freed societies from an ecological constraint but also placed human activity at the center of a fundamental biogeochemical cycle.

For most of human history, societies had to live within an important ecological limit. Protein is about 16 percent nitrogen, and farmers in all agricultural societies relied on nitrogen-fixing bacteria to replace whatever nitrogen the annual harvest removed from the soil. Over the long term, the quantity of food that a society could produce depended on how fast bacteria could replace that nitrogen. The recycling of nitrogen-rich human wastes helped, but that recycling tended to be minimal. The net result was a limit on the amount of food available for urban growth.

By the end of the nineteenth century, scientists recognized two important things: first, that bacteria were the only organisms capable of fixing nitrogen, and second, that industrial society's demand for nitrogen had outstripped the capacity of bacteria to place more into circulation. European leaders spoke of an impending nitrogen crisis. At the time, the cities of western Europe were importing large quantities of nitrogenous material – mainly in the form of food, fiber, and Chilean nitrate – from distant places. These imports not only allowed the nations of western Europe to feed a larger urban population than otherwise would have been possible; they also provided nitrogen compounds for the manufacture of explosives and other chemicals. However, this strategy of tapping into the nitrogen supplies of other regions could not keep up with demand. Cities, and the demand for nitrogen, continued to grow. Furthermore, Eu-

ropean leaders realized that, in a war, the flow of nitrogen-rich imports could be interrupted.

The introduction of the Haber-Bosch process put an end to the nitrogen crisis of the late nineteenth and early twentieth centuries. Today, through the production of ammonia using the Haber-Bosch process and the unintentional fixing of nitrogen through combustion processes, societies fix nitrogen on the same scale as the world's bacteria, resulting in (from a human perspective) too much nitrogen entering circulation rather than too little. Concerns in which the accumulation of these compounds plays a role include increased levels of nitrate in ground water, the formation of hypoxic dead zones at the mouths of rivers, photochemical smog, acid rain, the formation of fine particles in urban areas, and increased emissions of the greenhouse gas nitrous oxide. In addition, the availability of inexpensive nitrogen fertilizers has heightened the challenge of securing other agricultural resources, most notably water and phosphorus compounds. Given the potential coupling of biogeochemical cycles, scientists are now studying how changes in the cycling of nitrogen might be affecting the cycling of carbon. The forms of governance that societies have put into place to address such concerns are now an integral part of the nitrogen cycle.

The Big Blowup, 1910

Stephen J. Pyne, Arizona State University, USA

The Big Blowup of 20-21 August 1910 climaxed with the "Great Fires" of 1910 that, on a large scale and in a savage fashion, swept the northern Rocky Mountains of the United States. They were the first great wildland fires fought by the fledgling US Forest Service. Some 78 firefighters died in six separate incidents, the service went deeply into debt, and the experience traumatized a founding generation – three future agency chiefs were personally on the firelines. The fires occurred amid a national debate about how the country should manage fires on its reserved forests, and helped skew that discourse into suppression, or more broadly, fire exclusion. The US is still re-

covering from the shock. Through professional forestry, articles in scientific journals, and sheer force of example, it disseminated the lessons of the Big Blowup around the world.

Such were the practical consequences. But the fires have symbolic heft as well. State-sponsored conservation on reserved lands, notably parks and forests, was one of the lasting legacies of European colonization. These lands continue to hold considerable ecological value and have been the focus of much modern environmental legislation. More generally, good management of fires is among the most immediate and universal policies that can be implemented, the one thing that overseers must get right yet are still struggling to achieve. The management of fire is humanity's unique ecological signature, the expression of a species monopoly, the one thing we do that no other creature can. The Big Blowup can thus stand for all the other choices humanity has made regarding its control of combustion, including the Big Burn of fossil fuels that is informing the Anthropocene.

The United States Bureau of Reclamation, 1902

William D. Rowley, University of Nevada, Reno, USA

Over the course of the twentieth century, the United States Bureau of Reclamation drastically changed water and land environments and, at the same time, produced hydroelectricity for the industrialization and urbanization of the American West. In 1902, Congress passed the Reclamation Act, directed at irrigating crop lands in arid portions of the American West. First named the US Reclamation Service, the organization established through this act changed its name to the Bureau of Reclamation in 1923. During its first two decades, the organization built irrigation or reclamation farm projects in arid states of the American West with the purpose of settling small farmers on the land. Damming streams and rivers for water storage provided both water and hydroelectric power to the projects. Soon, larger dams and larger hydroelectric facilities with multiple turbines and dynamos produced electricity on a scale that supplied vast power networks over great distances in the West.

The Reclamation Service won world-wide attention for its expertise in building major dam structures whose reservoirs altered rivers and fisheries, irrigated arid land, and created supplies of hydroelectric power for farms as well as for urban-industrial cities.

Although efforts at settling people on arid land had been largely unsuccessful up to the 1920s, the Bureau of Reclamation stood on the threshold of a new era. The Great Depression of the 1930s led to the economic recovery programs of President Franklin D. Roosevelt's New Deal. An immense dam on the lower Colorado River received congressional approval as early as 1928, and with the New Deal came a flow of funding to the Bureau of Reclamation to begin an era of large dam building that far overshadowed its earlier efforts. The new dams included the Hoover Dam on the lower Colorado River, the Grand Coulee Dam on the Columbia, and the Shasta Dam in northern California, completed in the 1940s. These large dams and others provided hydroelectricity and water to growing western cities, and power for the United States during the war years. Power from the Grand Coulee Dam was used to produce plutonium for the development of the first atomic bomb, subsequently used in the Pacific war against Japan. After the Second World War, in an effort to support "world rehabilitation", the Bureau of Reclamation contributed to dam building in war-torn lands. The Bureau of Reclamation was the first to draw up initial plans for the damming of the Yangtze River in China even before the end of the war. In the underdeveloped world of postcolonial nations, the United States and its Bureau of Reclamation engineers competed with the Soviet Union during the Cold War to build river-basin economic development projects similar to those planned and implemented in the United States.

In conclusion, not only did the Bureau of Reclamation alter the river and land environments of the American West during the twentieth century; its expertise also became one of the United States' chief exports, with the US helping other countries pursue similar strategies in the post-WWII era.

The Invention of Mass Destruction Mining, 1899

Timothy James LeCain, Montana State University, USA

On the eve of a modern new century, 18 September 1899, the Americans Daniel Jackling and Robert Gemmell first proposed that humans annihilate an entire mountain to extract copper. The two engineers argued that the low-grade ore in a mountain near Salt Lake City, Utah, could be profitably removed by using coal-powered steam shovels operating in an immense open pit. At the time, many other mining engineers and executives dismissed the plan as laughable. For centuries miners had extracted copper ore through careful underground mining, taking only the best ore and leaving the waste. But Jackling and Gemmell proposed instead to dig up everything – a whole mountain of rock – and then grind it into dust to extract the one or two percent of copper. This was not mining. Rather, it was a process of mass destruction, a revolutionary idea that was closely related to the system of mass production that Henry Ford pioneered at roughly the same time. As with Ford's assembly line, the key to mass destruction was speed. Jackling and Gemmell had to dig in an open pit because it allowed them to use powerful coal-fired steam shovels to rapidly extract the lean ore. In essence, the two men realized they could draw on the power of millions of years of sunshine stored in coal to move mountains.

It would be almost a decade before Jackling finally convinced the Guggenheims to invest the millions needed to make the 1899 plan a reality. In 1908, eight steam shovels set to work stripping the overburden of grass, trees, and soil to expose the hard rock beneath. For the first few decades, workers spoke of going to work on "the Hill". Less than a quarter of a century later, however, much of the hill was gone and had been replaced by a rapidly growing hole in the ground that everyone now called "the Pit". For the first time in history, humans had done what earlier generations had thought only gods could do. When Jackling died in 1956, his Bingham Canyon Pit was the largest human-made excavation on the planet. Today it is more than half a mile deep, two-and-a-half miles wide, and is still growing.

Mass destruction mining stuffs huge portions of the natural

world into crushers, concentrators, and smelters that winnow out tiny amounts of copper. The rest of the mountain of rock is released as immense amounts of often toxic pollutants like sulfur, arsenic, cadmium, and lead, creating some of the most devastated environments in the world. Yet, because the system is so efficient, the technology has become the principal means by which humans around the globe extract vital industrial minerals. Experts estimate that by 1990 world open-pit mining operations moved twenty billion tons of rock each year, making it a more powerful topographical force than natural erosion. Jackling and Gemmell's 1899 idea helped give the world abundant supplies of copper and other metals, but only at a severe cost to the environment. If global demand for metals continues to grow, the pressure to expand the use of their mass destruction technology will likely grow with it.

Anthropogenic Climate Change, c. 1880

Susan Flader, University of Missouri, USA

If I had to suggest just one event for entry into the collective environmental memory of the world it would be anthropogenic climate change, together with its implications and related political and cultural responses. Like all memories, it differs greatly among individuals and cultures. Some display grave concern and suggest an array of often-contradictory remedies while others deny its existence or abjure any responsibility for dealing with it. It challenges our understanding of history, our vision for the future, and our sense of possibilities and limitations in shaping that future.

The Beginning of the Global Career of Phylloxera, 1864

Andreas Dix, Bamberg University, Germany

The phylloxera (*Viteus vitifolii, Phylloxera vastatrix*) is a pest of commercial grapevines originally native to eastern North America. In

its adult stage, it is an insect measuring around one millimeter with a whitish or yellowish color. It has a complicated life cycle, with at least 19 stages below and above ground. As the roots and leaves of the vine are infested by the phylloxera, the vine stock finally dies. Phylloxera was discovered by the American entomologist Asa Fitch in 1856.

Wine growing has been affected since the beginning of time by a large number of diseases and pests. New pests caused significant damage; the worst crisis was experienced by European winegrowers from the 1850s with the appearance of mildew. Mildew arrived on ornamental vines imported from America and subsequently appeared in many European countries. Finally it was discovered that a few American vines were resistant to mildew.

This discovery led to a rapid increase in the importation of American vines. But these vines carried phylloxera. The first indications of phylloxera infestations in Europe were observed in southern France in 1864. Only 20 years later, all wine-growing regions of France were infested with phylloxera. Nor was the crisis restricted to France: The importation of infected American vines caused devastation in nearly all other wine-growing countries of the world. Phylloxera was observed in Portugal in 1871, in Austria in 1872, in Switzerland and Germany in 1874, in Spain in 1877, in Italy in 1879, in South Africa in 1886, in Peru in 1888, in New Zealand in 1890, and in Lebanon in 1910. In the USA, California was affected around 1873.

Many attempts were made to find measures that would protect vines against phylloxera, including the application of sterile sand or the flooding of vineyards by water. Another method involved treating the vines with chemicals like petroleum or carbon disulfide (CS_2). But just a few remaining insects are sufficient to establish a new and fast-growing colony of phylloxera. All of the proposed treatments thus proved useless.

Another method of pest control involved intensive monitoring of the vineyards, control of the vine trade, and restriction of exchange of information. Regulations were proposed by an international phylloxera convention in 1878 and were finally established in 1881. At the beginning of the 1880s a growing number of experts argued that the best solution was the grafting of vines to American rootstocks,

which are resistant to phylloxera. As a consequence, many of the vineyards all over the world had to be replanted with grafted vines. Other areas, especially on marginal locations and at the northern frontier of viticulture in Europe, were abandoned and subsequently became orchards or woodland.

Because the reorganization required a lot of capital, a socioeconomic concentration occurred. Many wine growers have had to look for a new workplace. Particularly in France, this process caused social tensions between the larger and smaller wine-growing estates. As a result, phylloxera can be seen as one of the earliest global pests, with enormous economic and social consequences in all the wine-growing countries of that time.

Drilling of the World's First Oil Well, 1859

Richard Tucker, University of Michigan, USA

For years I confidently assumed that Hispaniola was the place and 1492 was the year when the world changed more fundamentally than any other time or place. What else could compare with the almost tectonic collision of the Eurasian and American gene pools? Not even 1348, when the bubonic plague conquered Europe with unimaginable force. In 1492 the character of the biosphere began to change and deteriorate inexorably, as different ecosystems began to interact. From then on, species diversity and something approaching stability was threatened; that was the moment when globalization truly began. Tracing back from Columbus's landing for any other event of equal importance, I sometimes considered one alternative: the day the first metal weapon was used, making all other human aggression possible, including Europe's conquests.

Yet perhaps none of that is fundamental, after all. More recent and more truly global, though less a matter of purposeful human action, is climate change. The demonic capacity of humanity broke out in the summer of 1945 in New Mexico, when the first nuclear weapon exploded. During the Cold War we lived with the imminent possibility of nuclear winter, the ultimate climate disaster. But nuclear annihila-

tion hasn't happened yet, and there's reason to think that it won't happen. Climate deterioration is happening, and it is truly global.

How can we mark that change? If we could establish the first day and place when humans deliberately harnessed the energy of coal for their purposes, we could mark that each year. Instead, there's a strong case for the day in 1859 when the first oil well was drilled, in western Pennsylvania. By now, whether it's the marshes of the Gulf Coast of Mexico, the delta of the Niger River, the Aramco sands of Arabia, the Baku fields in Azerbaijan, coastal Sumatra, or the tar sands of northern Alberta, sensitive regions have been severely damaged by our industrial and military appetites. In consuming these reserves we tap millions of years back into Big History; even more important, we project forward into the immediate future. In my more apocalyptic moments I admit that we are disrupting not only a specific ecosystem, but Gaia as a whole.

Changes in my course syllabi reflect that shift of perspective. The twins, energy history and climate history, are taking charge of our agenda as environmental historians. Their presence in our midst, and in the world our students are inheriting, urges us to re-vision the implications of our work. Our efforts may become an important tool for mitigating the worst future. And it all "began" in an obscure corner of Appalachia a century and a half ago.

Plowing up the World's Grasslands, c. 1850

David Moon, University of York, UK

One of the great transformations in global environmental history has been the plowing up of the world's grasslands to grow grain. The process began at the western end of the Eurasian steppes, in present-day southern Russia and Ukraine, in the second half of the eighteenth century. In the nineteenth and twentieth centuries, the great plow-up spread to vast areas of the prairies and Great Plains of North America, the pampas of South America, the veldt of southern Africa, lands in Australasia, northern India, and north Africa, and the plains of Hungary and Romania. Grasslands in Kazakhstan and southern Siberia, towards the eastern end of the Eurasian steppes, were also

broken by the plow. States with settled, agricultural populations in more humid regions conquered the grasslands. They encouraged arable farmers to move to the grasslands to create new agricultural lands. From the mid-nineteenth century, the movement of people and transport of the grain they grew were aided by the construction of railroads, cargo ships, ports, and grain elevators. Facilitated by domestic and international markets, the grain was consumed by the globe's burgeoning urban population. Farmers and agricultural scientists, meanwhile, wrestled with the problem of how to grow grain in the fertile soils that had formed on the grasslands in conditions of relatively low and unreliable rainfall.

The conversion of large parts of the world's grasslands to arable fields was achieved at the expense of the indigenous populations and their ways of life, which were based on herding or hunting livestock. Crucially, living off livestock that grazed on the grasslands supported far smaller populations than replacing the wild grasses with cereals. Condemned to settle or leave, the pastoral nomads of the steppes, the Plains Indians, and native peoples elsewhere lost their land, mobile lifestyles, and cultures. The Indian Wars of the late nineteenth century and wars on the Eurasian steppes, over many centuries, between states based on farming and pastoralism, opened the way to the plow.

The plowing up of the grasslands was achieved at the expense of the environment. In some grassland regions, the endless seas of grass were natural. In others, such as the prairies and parts of the steppes, the indigenous population had promoted the growth of grass at the expense of other plants, including trees, through regimes of burning and grazing livestock. Everywhere, the plowing of the deep, fertile soil that had formed over many centuries under the grass disrupted the grassland ecosystems. Some grassland ecologists have gone so far as to term plowing "ecological genocide".

The plowing of the fertile soil to grow grain, moreover, was followed by ecological disasters. Around the globe, grasslands are prone to periodic droughts. The flat landscapes of the plains are swept by strong winds. In times of drought, the high winds whipped up dried-out topsoil into dust storms, destroying the crops and ruining the farmers. The Dust Bowl on the southern plains of the USA in the 1930s and

the similar phenomenon on the Eurasian steppes, in particular Kazakhstan, in the wake of Nikita Khrushchev's "virgin lands campaign" of the 1950s and early 1960s, are the best known examples.

Scientists, environmental historians, and the governments and farming populations of the afflicted regions debate the causes of such disasters: some blame natural fluctuations of the climate while others blame ill-advised plowing up of grasslands with levels of moisture that are marginal for grain cultivation. We are left with a bifurcated understanding of the plowing up of the grasslands: a foolhardy venture into marginal environments that was bound to lead to disaster, or a development of highly productive, even sustainable, agriculture (interrupted by periodic shortfalls) that has put vast amounts of food made from grain into the homes of the globe's ever-growing population.

The Dust Veil Event, 536 CE

Jan Oosthoek, Brisbane, Australia

In recent years, questions of human-environmental interaction, and particularly the cultural impact of natural disasters, have become more prominent in humanities research. It has become clear that natural disasters do not necessarily result in the collapse of societies but act as catalysts for social, political, and economic transformation. One such event with a truly global influence was the dust veil of 536 CE. This event resulted in the transformation of societies around the globe including China, the Mediterranean, Scandinavia, and the American Southwest. It signaled the dawn of the Middle Ages in Eurasia. Because of its scale and importance, this event should be part of humanity's collective environmental memory.

Between 536 and 551, tree-ring growth was very low throughout Eurasia and many other parts of the world. Contemporary writers in southern Europe described what modern climate scientists call a "dust veil event" that sharply reduced the amount of solar radiation reaching the earth's surface. Although scientists have sought to explain the dust veil in terms of a comet hitting the earth, it has recently become clear that we are dealing with one or more huge

volcanic eruptions in the tropics. These eruptions put enough dust into the atmosphere to affect the earth's climate for years.

The resulting depressed temperatures and disrupted weather patterns reduced biological productivity, including that of food crops, resulting in famine and social disruption around the globe during the sixth century. In a contemporary report, Michael the Syrian wrote that "the sun became dark and its darkness lasted for one and a half years . . ." John of Ephesus and Procopius of Caesarea described the same events. In Britain, the period 535-555 saw the worst weather of the sixth century. In Mesopotamia there were heavy snowfalls, and in Arabia there was flooding followed by famine. In China, there was drought and famine, and yellow dust rained down like snow. It has also been suggested that the occurrence of the Justinian Plague, a pandemic that affected the Byzantine Empire in the years 541-542, is linked to the climatic events five years earlier.

In Sweden, archaeological evidence indicates that 75 percent of villages were abandoned in the mid-sixth century. Scandinavian narratives also seem to refer to the events of 536 CE. The epic *Edda* includes a reference to "Fimbulwinter" (the "mighty" winter) and describes terrible cold and snow in years without a summer. It has been suggested that the sharp agrarian decline and demographic disaster in Scandinavia may have been the catalyst for the social, religious, and political change that led to the Viking diaspora.

In contrast to many other climatic events, the 536 event seems to have struck all regions of the globe. Evidence indicates far-reaching consequences for all advanced societies at that time, although the various regions were almost certainly affected differently by the dust veil. For this reason, the 536 CE event is an important test case for comparing the environmental resilience of different societies.

Neolithic Agricultural Revolution, c. 10,000 BCE

Edmund Russell, University of Kansas, USA

I nominate the Neolithic agricultural revolution. It revolutionized the way people interacted with other species, which revolutionized

the way people interacted with each other as well. Almost everything historians study has been a byproduct of the agricultural revolution.

Crossing of Wallace's Line, c. 60,000 BCE

Libby Robin, Australian National University, Canberra, Australia

Perhaps one of the crucial moments in the Big History of the world was the crossing of Wallace's Line by modern humans some 50,000-60,000 years ago. The sea barrier between Bali and Lombok (in Indonesia, in today's geography) had isolated biological evolution, and the extraordinary endemism of this part of the world still reflects its isolated evolutionary history. The species of the large Sahul continent (Australia and its continental plate, which included New Guinea and Tasmania) never met any primates other than fully modern humans, so never had the opportunity to adapt or evolve ways of dealing with less technologically advanced primates.

The continent was biogeographically isolated, and its biota had evolved independently of other places. Then, in the words of environmental historian George Seddon, "it had a radically new technology imposed upon it, suddenly, twice". The two waves of human arrivals each brought major technological shocks to the ecosystems. Aboriginal people hunted and modified the landscape with fire. The British settlement brought simultaneous agricultural and industrial revolutions.

New Zealand shared the shock of British settlement, but its "first shock wave", the Maori, arrived from the east only one millennium before its second came from the other direction. Its "double shock" history was much more compressed and its island biota much more limited – indeed its "people and environment" story is more like that of other islands, including the Galapagos and Hawaii.

Australia, so often portrayed as a "new land" because of its recent settler history, is actually an ancient geological land, with a long odyssey northwards from its Gondwanan parent. Its extraordinary indigenous history is still being discovered. This ancient continent of Sahul has thus captured an exceptional joint history of people and environments, and its biodiversity and environmental catastrophes

(it leads the world in mammalian extinctions in the twentieth century) are part of the history of people as well as plants and animals.

Chicxulub, c. 65 Million BCE

Christof Mauch, Rachel Carson Center, Munich, Germany

There are few events that humans around the globe owe more to than the incident that occurred in Chicxulub on Mexico's Yucatán Peninsula some 65 million years ago. At that point in time a huge asteroid hit the earth, releasing over a billion times more explosive energy than the atomic bombs that hit Hiroshima and Nagasaki. The crater that resulted from this event is 100 miles in diameter and is visible from space. The impact of the asteroid created a huge ball of fire, global firestorms, earthquakes, landslides, and tsunamis. Materials that were ejected into the atmosphere blocked sunlight, shrouding the earth in darkness; this caused a cold period and eventually led to global warming. To be sure, even before the Chicxulub event, the earth had not been the most comfortable place for dinosaurs to live and survive. Volcano eruptions in India and earlier asteroid strikes had contributed to an unstable climate and to fragile ecosystems. But the strike in Yucatán dealt dinosaurs the final blow and made room for our primate ancestors.

What happened in Mexico was not observed by humans, of course. However, it left a memory in stone and in dust, one that all humans share. The cataclysm helped humans to evolve and multiply and take over the planet, and the site in Yucatán reminds us that Big History and environmental history are, indeed, intertwined.

Future-quake: The Tokyo Bay Mega-Quake of 20-Something, Undated

Greg Bankoff, University of Hull, UK

The earthquake struck just before dawn on Monday. Measuring more than 8.4 on the Richter scale, it was not the largest earthquake

to hit Japan in the past half-century, but then none of the others had had an epicenter so close to one of the largest urban conglomerations, Tokyo-Yokohama, in the world. Most people were asleep when the first shockwave hit, jolting the lucky ones awake; the less fortunate did not wake up at all. Downtown buildings incorporating shock absorbers, sliding walls, and Teflon foundation pads fared better but they, of course, were largely empty at that time; many residential blocks, on the other hand, simply crumpled in on themselves. People said later how lucky it was that the quake had not happened during the rush hour when the capital's 11 million daily commuters fill the subway trains and highway overpasses to capacity.

There had been many devastating earthquakes in Tokyo before: in 1855, the Great Ansei earthquake killed over 7,000 people and destroyed 50,000 houses, and in 1923 the Great Kantō earthquake left 140,000 dead and 447,000 houses uninhabitable. Over half the world's population is now urban, as people throng overcrowded cities located in often risk-prone coastal areas. Present-day Tokyo was one such site, with a population in excess of 12 million. The damages, therefore, were proportionately greater, making the earthquake a worldwide mega-catastrophe, the first of the twenty-first century with a death toll in excess of one million people and infrastructural losses of over $500 billion. Even Japan's well-trained and equipped emergency services were completely overwhelmed by the sheer scale of the disaster, while government direction was temporarily paralyzed by the loss of so many head offices and key personnel. The devastation was especially extensive in the reclaimed and alluvial deposits along the capital's rivers and bay-shore areas. Here landfilling had been underway for decades in an attempt to meet the insatiable demand for more space on which to build everything from residential houses to shopping malls and factories. As in past events, extensive fires raged through certain parts of the city and adjacent areas. Rumors, later shown to be unfounded, had it that the imperial family had been injured, perhaps even fatally when the roof of their private residence in the Fukiage Gardens collapsed.

Even as the city was struck by repeated aftershocks, news of the disaster spread across the globe through both formal news chan-

nels and social media networks. Within minutes, graphic images of death and destruction were uploaded onto the internet and were being viewed by millions. Share prices dropped precipitously, first in East Asia and then around the world. The Hang Seng Index that monitors the largest companies on the Hong Kong stock market fell 15,000 points, finishing the day under half its starting value. The Tokyo Stock Exchange, the third largest in the world, did not open at all. As government ministries and boards of multinationals sought to stem the panic that gripped world markets, and the United Nations agencies, Japan's principal allies and the world community mobilized their resources to come to the aid of the millions of injured and homeless citizens of Tokyo, the leadership of the Democratic People's Republic of Korea chose this opportunity to launch an all-out desperate attack on their southern compatriots, plunging the world into a military crisis that rivaled the financial and humanitarian one. Clearly disasters of this magnitude were no longer confined to any one country or even region; their effects had become truly global. Some pundits warned that Tokyo was only the beginning and that other mega-catastrophes might be expected, perhaps even more than one at the same time. Unfortunately such predictions have proven only too prescient, with the subsequent earthquakes in Tehran, Mexico City and Los Angeles.

In 2013, of course, all this is still science fiction.