# Global Warming as a "Weapon of Mass Destruction"

**The Chairman of Lloyd's of London believes that global warming is a bigger threat than international terrorism. Hans Blix agrees. What do they know that George W. Bush doesn't?**

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Lord Peter Levene, board chairman of Lloyd's of London, says that terrorism is not the insurance industry's biggest worry, despite the fact that his company was the largest single insurer of the World Trade Center. Levene said that Lloyd's, like other large international insurance companies, is bracing for an increase in weather disasters related to global warming. Following his assignment as chief weapons inspector in Iraq, Hans Blix said: "To me the question of the environment is more ominous than that of peace and war. We will have regional conflicts and use of force, but world conflicts I do not believe will happen any longer. But the environment, that is a creeping danger. I'm more worried about global warming than I am of any major military conflict." Sir John Houghton, co-chair of the Intergovernmental Panel on Climate Change, agrees. "Global warming is already upon us, he said. "The impacts of global warming are such that that I have no hesitation in describing it as a weapon of mass destruction."

So what do they know that George W. Bush doesn't?

Weather is the story; climate is the plot. The innate variability of daily weather sometimes masks longer-term trends. Climatic news comes to us in snapshots: thousands die of excessive heat in Europe. Corals bleach under heat stress, and polar bears go hungry, lacking seasonal ice from which to hunt seals. Long-range trends go largely unnoticed. Consider:

**We are carbonizing the oceans, with dire implications for life in them. As the twenty-first century dawned, carbon-dioxide levels were rising in the oceans more rapidly than any time since the age of dinosaurs, according to a report published September 25, 2003 in *Nature*. Oceanographers Ken Caldeira and Michael E. Wickett wrote: "We find that oceanic absorption of CO2 from fossil fuels may result in larger pH changes over the next several centuries than any inferred in the geological record of the possible 300 million years, with the possible exception of those resulting from rare, extreme events such as bolide impacts or catastrophic methane hydrate degassing. (A "bolide" is a large extraterrestrial body, usually at least a half mile in diameter, perhaps much larger, that impacts the Earth at a speed roughly equal to that of a bullet in flight.)**

Rising carbon-dioxide levels in the oceans could threaten the health of many marine organisms, beginning with the plankton at the base of the food chain. "If we continue down the path we are going, we will produce changes greater than any experienced in the past 300 million years -- with the possible exception of rare, extreme events such as comet impacts," Caldeira, of the Lawrence Livermore National Laboratory, warned. Since carbon-dioxide levels began to be measured on a systemic basis world-wide in 1958, its concentration in the atmosphere has risen 17 per cent.

Until now, some climate experts have asserted that the oceans would help to control the rise in carbon-dioxide by acting as a filter. Caldeira and Michael Wickett said, however, that carbon dioxide that is removed from the atmosphere enters the oceans as carbonic acid, gradually altering the acidity of ocean water. According to their studies, the change over the last century already matches the magnitude of the change that occurred in the entire 10,000 years preceding the industrial age. Caldeira pointed to acid rain from industrial emissions as a possible precursor of changes in the oceans. "Most ocean life resides near the surface, where the greatest change would be expected to come, but deep ocean life may prove to be even more sensitive to changes," Caldeira said.

Marine plankton and other organisms whose skeletons or shells contain calcium carbonate, which is dissolved by acid solutions, may be particularly vulnerable. Coral reefs -- already suffering from pollution, rising ocean temperatures and other stresses -- are comprised almost entirely of calcium carbonate. "It’s difficult to predict what will happen because we haven’t really studied the range of impacts," Caldeira said. "But we can say that if we continue business as usual, we are going to see some significant changes in the acidity of the world’s oceans."

**Along the same line, warming seas also are devastating plankton, eroding the ocean’s food chain.** Global warming is contributing to an "ecological meltdown," with devastating implications for fisheries and wildlife. The "meltdown" begins at the base of the food chain, as increasing sea temperatures kill plankton. Fish stocks and sea-bird populations are declining as well.

Scientists at the Sir Alistair Hardy Foundation for Ocean Science in Plymouth, England, which has been monitoring plankton growth in the North Sea for more than 70 years, have said that an unprecedented warming of the North Sea has driven plankton hundreds of miles to the north. They have been replaced by smaller, warm-water species that are less nutritious. Over-fishing of cod and other species has played a role, but fish stocks have not recovered after cuts in fishing quotas. The number of salmon returning British waters are now half of what they were 20 years ago, and a decline in plankton populations is a major factor.

"A regime shift has taken place and the whole ecology of the North Sea has changed quite dramatically," said Dr Chris Reid, the foundation’s director. "We are seeing a collapse in the system as we knew it. Catches of salmon and cod are already down and we are getting smaller fish. We are seeing visual evidence of climate change on a large-scale ecosystem. We are likely to see even greater warming, with temperatures becoming more like those off the Atlantic coast of Spain or further south, bringing a complete change of ecology."

Research by the British Royal Society for the Protection of Birds has established that seabird colonies off the Yorkshire coast and the Shetlands this year suffered their worst breeding season since records began, with many simply abandoning nesting sites. Sea-bird populations are falling in large part because sand eels are declining. The sand eels feed on plankton. This survey concentrated on kittiwakes, one breed of sea birds, but other species that feed on the eels, including puffins and razorbills, also have been seriously affected. Dr Euan Dunn of the RSPB commented: "We know that sand eel populations fluctuate and you do get bad years. But there is a suggestion that we are getting a series of bad years, and that suggests something more sinister is happening."

Sand eels also comprise a third to half of the North Sea catch, by weight. They have heretofore been caught in huge quantities by Danish factory ships, which turn them into food pellets for pigs and fish. During the summer of 2003, the Danish fleet caught only 300,000 English tons of its 950,000-ton quota, a record low.

**The feedback loop: Payback for today's emissions in three to five decades.** Yesterday's SUV exhaust does not become today's rising temperature, not immediately. Through an intricate feedback loop, fossil fuel burned today is expressed in warming 30 to 50 years later. Today we are seeing temperatures related to fossil-fuel emissions from roughly 1960, when fossil fuel consumption was much lower. Today's fossil-fuel emissions will be expressed in the atmosphere about 2040.

**Ozone depletion and global warming are related.** Increasing levels of greenhouse gases near the surface hold heat there, impeding radiation into the upper layers of the atmosphere. As the surface warms, the stratosphere cools. The chemical reactions that consume the ozone that protects us from ultraviolet radiation accelerate as the air chills. Thus, the area of depleted ozone over Antarctica remains at near-record size respite the fact that chloroflourocarbons (CFCs), the culprits on ozone depletion, have now been banned for more than 15 years. Solution of ozone depletion depends on progress against global warming.

**Beware the "Methane Burp."** In his book, *When Life Nearly Died: The Greatest Mass Extinction of All Time* (London: Thames and Hudson, 2003), Michael J. Benton describes a mass extinction at the end of the Permian period, about 250 million years ago, when at least 90 per cent of life on Earth died. The extinction probably was initiated by massive volcanic eruptions in Siberia. According to present theories, the eruptions injected massive amounts of carbon dioxide into the atmosphere, causing a number of biotic feedbacks that accelerated global warming of about 6 degrees C. In a chapter titled "What Caused the Biggest Catastrophe of all Time?" Benton sketches how the warming (which was accompanied by anoxia) may have fed upon itself:

> The end-Permian runaway greenhouse may have been simple. Release of carbon dioxide from the eruption of the Siberian Traps [volcanoes] led to a rise in global temperatures of 6 degrees C. or so. Cool polar regions became warm and frozen tundra became unfrozen. The melting might have penetrated to the frozen gas hydrate reservoirs located around the polar oceans, and massive volumes of methane may have burst to the surface of the oceans in huge bubbles. This further input of carbon into the atmosphere caused more warming, which could have melted further gas hydrate reservoirs. So the process went on, running faster and faster. The natural systems that normally reduce carbon dioxide levels could not operate, and eventually the system spiraled out of control, with the biggest crash in the history of life.

The oxygen-starved aftermath of this immense global belch of methane left land animals gasping for breath and caused the Earth's largest mass extinction, suggests new research. Greg Retallack, an expert in ancient soils at the University of Oregon in Eugene, has speculated that the same methane "belch" was of such a magnitude that it caused mass extinction via oxygen starvation of land animals. Bob Berner of Yale University has calculated that a cascade of effects on wetlands and coral reefs may have reduced oxygen levels in the atmosphere from 35 per cent to just 12 per cent over 20,000 years. Marine life also may have suffocated in the oxygen-poor water.

Events 250 million years ago are of more than academic interest today because the 6 degrees C. that Benton estimates triggered these events is roughly the same temperature rise forecast for the Earth by the I.P.C.C. by the end of this century.

**The Sudden Nature of Climate Change.** In *Abrupt Climate Change* (2002), Richard B. Alley wrote that climate may change rapidly (as much as 16 degrees C. within a decade or two) "when gradual causes push the Earth system across a threshold. Just as the slowly increasing pressure of a finger eventually flips a switch and turns on a light" Half the North Atlantic warming since the last ice age was achieved, writes Alley, within one decade. The temperature record for Greenland, according to Alley's research, more resembles a jagged row of very sharp teeth than a gradual passage from one epoch to another.

According to Alley: "Model projections of global warming find increased global precipitation, increased variability in precipitation, and summertime drying in many continental interiors, including 'grain belt' regions. Such changes might produce more floods and more droughts." Human emissions of greenhouse gases may provide enough of a change to trigger such a rapid change.

**Drought and deluge: By 2000, the hydrological cycle seemed to be changing more quickly than temperatures.** Warmer air holds more moisture, making rain (and sometimes snow) more intense. Warmer air also increases evaporation, paradoxically intensifying drought at the same time.

With sustained warming, usually wet places generally seem to be receiving more rain than before; dry places often receive less rain, and become subject to more persistent drought. In many places, drought or deluge is becoming the weather regime *du jour*. Atmospheric moisture increases more rapidly than temperature; over the United States and Europe, atmospheric moisture increased 10 to 20 per cent from 1980 to 2000. "That's why you see the impact of global warming mostly in intense storms and flooding like we have seen in Europe," Kevin Trenberth, a scientist with National Center for Atmospheric Research (NCAR) told London's *Financial Times*.

As if on cue to support climate models, the summer of 2002 featured a number of climatic extremes, especially *vis a vis* precipitation. Excessive rain deluged Europe and Asia, swamping cities and villages and killing at least 2,000 people, while drought and heat scorched the United States' Western and Eastern cities. Climate skeptics argued that weather is always variable, but other observers noted that extremes seemed to be more frequent than before. A year later, following episodic floods during the summer of 2002, Europe

experienced some of it highest (and longest-sustained) temperatures in recorded history, causing (by various estimates) between 19,000 and 35,000 excess deaths. Farmers whose crops drowned in 2002 watched them wither and die in 2003. As much as 80 per cent of the grain crop died in Eastern Germany, site of some of 2002's worst floods.

"In a hotter climate, your chances of being caught with either too much or too little are higher," said Dr. John M. Wallace, a professor of atmospheric sciences at the University of Washington. Government scientists have measured a rise in downpour-style storms in the United States during the last century. "Over the past 50 years, said Wallace, winter precipitation in the Sierra Nevada has been falling more and more in the form of rain, increasing flood risks, instead of as snow, which supplies farmers and taps alike as it melts in the spring."

The World Water Council report compiled statistics indicating that between 1971 and 1995 floods affected more than 1.5 billion people worldwide, or 100 million people a year. An estimated 318,000 were killed and more than 18 million left homeless. The economic costs of these disasters rose to an estimated U.S. $300 billion in the 1990s from about U.S. $35 billion in the 1960s. Global warming is causing changes in weather patterns as growing populations migrate to vulnerable areas, increasing costs of individual weather events, said William Cosgrove, vice president of the World Water Council. "The forecast is that it's going to continue to get worse unless we start to take actions to mitigate global warming," Cosgrove said. Scientists cited by the World Water Council expect that climate changes during the twenty-first century will lead to shorter and more intense rainy seasons in some areas, as well as longer, more intense droughts in others, endangering some crops and species and causing a drop in global food production.

Examples abound of increasing extremes in precipitation. November (2002), December (2002) and January (2003) were Minneapolis-St. Paul's driest in recorded history. These followed the wettest June through October there in more than 100 years. In December, 2002, Omaha recorded its first month with no measurable precipitation. In March 2003, having endured its driest year in recorded history during 2002, Denver, Colorado recorded 30 inches of snow in one storm. Some areas of the drought-parched Front Range received as much as ten feet of snow in the same storm. After that one storm, drought conditions returned.

Roughly half the United States was under serious drought conditions during the summer of 2002. The drought was occasionally punctuated by torrential rains. On September 13, 2002, for example, drought-stricken Denver was inundated by floods from a fast-moving thunderstorm that caused widespread flooding. Similar events took place south of Salt Lake City. Ten days later, a flooding cloudburst inundated similarly drought-stricken Atlanta. On September 10, 2002, six months' worth of rain fell in a few hours in the Gard, Herault, and Vaucluse departments in the south of France, drowning at least 20 people. In the village of Sommieres, near Nimes, a usually-tiny stream exploded to a width of 300 meters, cutting off road traffic.

Suburbs of Chicago received 8 to 13 inches of rain the night of August 12, 2002, in a summer that included devastating floods in Prague and Dresden, as well as parts of southern China. India had a variable monsoon -- some areas flooded, while others went dry.

Severe summer floods in Europe during 2002 may be an indicator of an emerging pattern, according to Jens H. and Ole B. Christensen, who modeled precipitation patterns in Europe under warming conditions of a type that may be prominent in the area by 2070 to 2100. "Our results," they wrote in *Nature*, "indicate that episodes of severe flooding may become more frequent, despite a general trend toward drier summer conditions." The trend toward drought or deluge will intensify as warming distorts the hydrological cycle. A warming atmosphere will contain more water vapor, which will provide "further potential for latent-heat release during the buildup of low-pressure systems, thereby possibly both intensifying the systems and making more water available for precipitation," Christensen and Christensen wrote. This is one of many prospects that worries insurance companies as well as scientists.

Annual mean precipitation amounts over the United States have been increasing at 2 per cent to 5 per cent per decade, according to atmospheric scientists Ken Trenberth and colleagues (writing in the *Bulletin of the American Meteorological Society*), with "most of the increase related to temperature and hence in atmospheric water-holding capacity.There is clear evidence that rainfall rates have changed in the United States.The prospect may be for fewer but more intense rainfall -- or snowfall -- events." Individual storms may be further enhanced by latent heat release which supplies even more moisture during individual storms.

Generally, higher temperatures enhance evaporation, with some compensatory cooling when water is available. Increased evaporation also intensifies drought which, to some degree, compounds itself as moisture is depleted, leading "to increased risk of heat waves and wildfires in association with such droughts; because once the soil moisture is depleted then all the heating goes into raising temperatures and wilting plants."

In mountain areas, wrote Trenberth, "The winter snowpack forms a vital resource, not only for skiers, but also as a freshwater resource in the spring and summer as the snow melts. Yet warming makes for a shorter snow season with more precipitation falling as rain rather than snow, earlier snowmelt of the snow that does exist, and greater evaporation and ablation. These factors all contribute to diminished snowpack. In the summer of 2002, in the western parts of the United States, exceptionally low snowpack and subsequent low soil moisture likely contributed substantially to the widespread intense drought because of the importance of recycling [in the hydrological cycle]. Could this be a sign of the future?"

The insurance companies, whose business is making book on the future, are watching the weather -- and they are worried.

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