Policy Study 393
September 2011

Wealth and Safety: The Amazing Decline in Deaths from Extreme Weather in an Era of Global Warming, 1900–2010

by Indur M. Goklany
Project Director: Julian Morris

Reason Foundation

Reason Foundation's mission is to advance a free society by developing, applying and promoting libertarian principles, including individual liberty, free markets and the rule of law. We use journalism and public policy research to influence the frameworks and actions of policymakers, journalists and opinion leaders.

Reason Foundation's nonpartisan public policy research promotes choice, competition and a dynamic market economy as the foundation for human dignity and progress. Reason produces rigorous, peer-reviewed research and directly engages the policy process, seeking strategies that emphasize cooperation, flexibility, local knowledge and results. Through practical and innovative approaches to complex problems, Reason seeks to change the way people think about issues, and promote policies that allow and encourage individuals and voluntary institutions to flourish.

Reason Foundation is a tax-exempt research and education organization as defined under IRS code 501(c)(3). Reason Foundation is supported by voluntary contributions from individuals, foundations and corporations. The views are those of the author, not necessarily those of Reason Foundation or its trustees. While the authors of this study and Reason Foundation may hold some differing views about the proper role of government in society, Reason Foundation believes this study offers valuable policy analysis and recommendations.

Wealth and Safety: The Amazing Decline in Deaths from Extreme Weather in an Era of Global Warming, 1900–2010

By Indur M. Goklany
Project Director: Julian Morris

Executive Summary

Proponents of drastic curbs on greenhouse gas emissions claim that such emissions cause global warming and that this exacerbates the frequency and intensity of extreme weather events, including extreme heat, droughts, floods and storms such as hurricanes and cyclones. But what matters is not the incidence of extreme weather events per se but the impact of such events—especially the human impact. To that end, it is instructive to examine trends in global mortality (i.e. the number of people killed) and mortality rates (i.e. the proportion of people killed) associated with extreme weather events for the 111-year period from 1900 to 2010.

Aggregate mortality attributed to all extreme weather events globally has declined by more than 90% since the 1920s, in spite of a four-fold rise in population and much more complete reporting of such events. The aggregate mortality rate declined by 98%, largely due to decreased mortality in three main areas:

- Deaths and death rates from droughts, which were responsible for approximately 60% of cumulative deaths due to extreme weather events from 1900–2010, are more than 99.9% lower than in the 1920s.

- Deaths and death rates for floods, responsible for over 30% of cumulative extreme weather deaths, have declined by over 98% since the 1930s.

- Deaths and death rates for storms (i.e. hurricanes, cyclones, tornados, typhoons), responsible for around 7% of extreme weather deaths from 1900–2008, declined by more than 55% since the 1970s.

To put the public health impact of extreme weather events into context, cumulatively they now contribute only 0.07% to global mortality. Mortality from extreme weather events has declined even as all-cause mortality has increased, indicating that humanity is coping better with extreme weather events than it is with far more important health and safety problems.

The decreases in the numbers of deaths and death rates reflect a remarkable improvement in society's adaptive capacity, likely due to greater wealth and better technology, enabled in part by use of hydrocarbon fuels. Imposing additional restrictions on the use of hydrocarbon fuels may slow the rate of improvement of this adaptive capacity and thereby worsen any negative impact of climate change. At the very least, the potential for such an adverse outcome should be weighed against any putative benefit arising from such restrictions.

Table of Contents

Part 1

Introduction

Proponents of drastic reductions in anthropogenic emissions of "greenhouse gases" such as carbon dioxide (CO_2) argue that, without such action, global warming will, among other negative consequences, exacerbate the frequencies and magnitudes of extreme weather events and increase the resulting death toll and economic losses. The suggested mechanism is that warmer temperatures would intensify the hydrological cycle through greater evaporation, and cyclones and hurricanes would acquire greater energy. Built-up water vapor and energy would be released in more frequent and intense rainfall and storms. At the same time, some areas would see droughts, and yet others, extreme heat waves.[1]

These concerns have attracted considerable media attention. Citing recent weather-related disasters—the Central European floods of 2002, the 2003 European heat wave, and the back-to-back disastrous Atlantic hurricane seasons of 2004 and 2005—the popular magazine *Time* warned in a 2006 special issue devoted to global warming that we should "be worried, very worried" about its consequences.[2]

International humanitarian agencies and non-governmental organizations (NGOs) have been particularly vocal and insistent about the relationship between global warming and extreme weather. For example, Bekele Geleta, secretary general of the International Federation of Red Cross and Red Crescent Societies, and Sir John Holmes, United Nations undersecretary general for humanitarian affairs, wrote in a letter to the UN Framework Convention on Climate Change (UNFCC) that: "[I]n the coming decades, climate change is expected to exacerbate the risks of disasters, not only from more frequent and intense hazard events, but also through greater vulnerability to the existing hazards."[3]

Based partly on the notion that weather-related disasters have increased—and will continue to increase—because of global warming, Kofi Annan, erstwhile UN secretary-general, and president of the now-defunct Global Humanitarian Forum (GHF), declared:

> *Climate change is a silent human crisis. Yet it is the greatest emerging humanitarian challenge of our time. Already today, it causes suffering to hundreds of millions of people most of whom are not even aware that they are victims of climate change. We need an international agreement to contain climate change and reduce its widespread suffering.*[4]

This study does not address the causes of any warming that may have occurred or may occur in the future. Instead, it examines whether deaths and death rates due to weather-related extreme events have increased globally since the beginning of the 20th century. It also puts these deaths and death rates into perspective by comparing them with the total mortality burden from other causes, and briefly discusses what trends in deaths and death rates imply about human adaptive capacity. In this way, this study also tests the contention that humanity is unable to adapt to an increase in the frequency and severity of such events.[5]

Part 2

Global Trends in Mortality and Mortality Rates

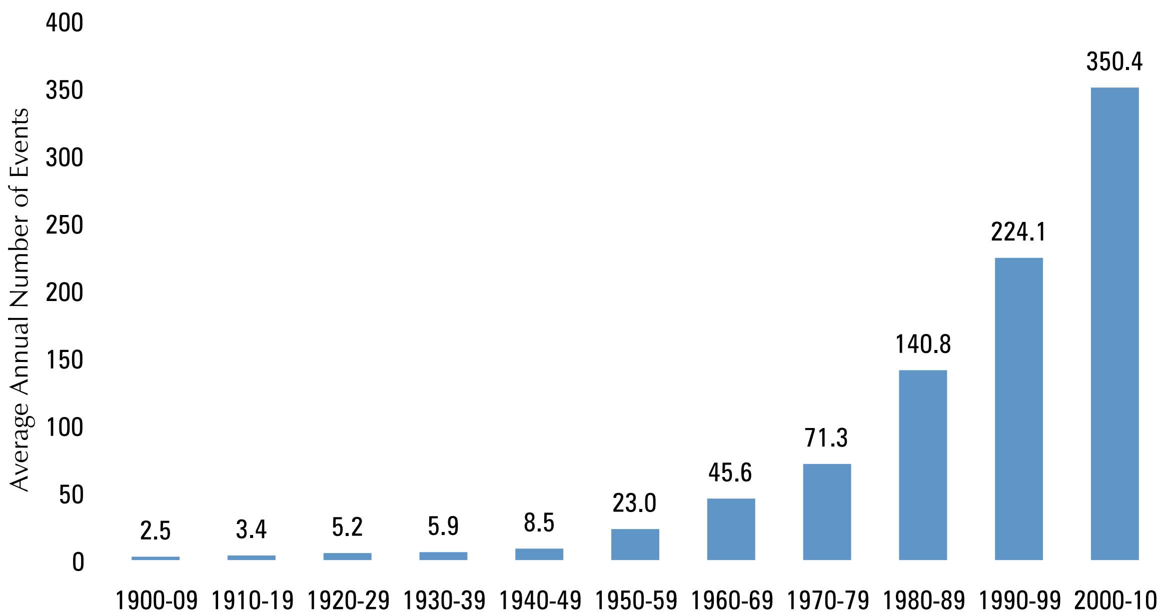
In general, if a phenomenon such as global warming could affect the frequency, intensity and/or duration of extreme weather events such as floods, droughts, storms and extreme temperatures, some locations might experience increased events for some periods ranging from days to months, while other locations might experience a decrease. Some of the effects of these changes will tend to offset each other and/or be redistributed over space and time. For instance, an increase in deaths due to heat waves in the summer at one location might be offset by a decline in deaths due to fewer or less intense cold waves during the winter at the same or another location. Alternatively, global warming might redistribute the temporal and spatial pattern of rainfall, droughts and other such events. Accordingly, to estimate the net impact, if any, of global warming on mortality, it is probably best to examine cumulative deaths at the global level aggregated over all types of extreme weather events. Because of the episodic nature of extreme events, such an examination should ideally be based on several decades, if not centuries, worth of data. Any such examination should, of course, recognize that the quality of the data, data coverage, adaptive capacity and exposure of human populations to risk also change over time.

In particular, one should examine mortality *rates* so as to filter out the effect of population growth on the magnitude of the population at risk. However, use of mortality rates may be insufficient to account for the fact that as the population becomes larger, people will migrate to riskier and more vulnerable locations as the less vulnerable locations are occupied. In addition, inappropriate government policies, including subsidized insurance, create "moral hazard," whereby individuals are—perversely—encouraged to live in hazardous places because they do not bear all the financial risk of so doing. This may also place even wealthier populations at greater physical risk.[6]

A. Data Sources

This study uses data on deaths from all 9,167 climatological, meteorological and hydrological events for each year from 1900 through 2010 in the EM-DAT's International Disaster Database (EM-DAT 2011). This database is maintained by the Office of Foreign Disaster Aid and Center for Research on the Epidemiology of Disasters (CRED) at the Université Catholique de Louvain in Brussels, Belgium. Specifically, for the number of deaths, this study uses data on droughts, extreme temperatures (both extreme heat and extreme cold), floods, wet mass movement (i.e., slides, waves and surges), wildfires and storms (e.g., hurricanes, cyclones, tornados, typhoons, etc.). The EM-DAT database is compiled from various sources, including UN agencies, NGOs, insurance companies, research institutes and press agencies. For a disaster event to be entered into the database, one or more of the following criteria must be met: (a) at least ten people must have been reported killed, (b) at least 100 people must have been reported as affected, (c) a state of emergency must have been declared, or (d) there should have been a call for international assistance.

Figure 1: Average Number of Extreme Weather Events per Year by Decade, 1900–2010



Note: For the last period, 2000–2010, the annual number of events is based on an 11-year average. Statistics from the last "decade"—2000–2010—and the data for 2010 and perhaps even 2009 must necessarily be considered preliminary at this writing (March 2011).
Source: EM-DAT (2011).

Figure 1 shows the average annual number of events recorded in the EM-DAT database for each "decade" since the 1900s.[7] This figure shows that the average number of records (i.e., events) increased from 2.5 per year in the 1900s to 8.5 per year in the 1940s, after which the numbers escalated rapidly, reaching 350.4 per year for 2000–2010. Some advocates of greenhouse gas controls have asserted without proof that much of the increase in recent decades could be due to global warming.[8] However, one should expect that even if there were no change in climate or climate variability, the proportion of events recorded in the EM-DAT would increase over the decades with (a) the advance of telecommunications, (b) broader news coverage, (c) globalization of international aid, and (d) an increased tendency by authorities to declare natural disaster emergencies for a variety of reasons.

Regarding the last point, the explanation is that as nations become wealthier—and almost all did during the 20th century[9]—political leaders have more resources to afford emergency declarations. Meanwhile, the number of democracies has also increased during this period [10] and in democracies political leaders tend to declare emergencies early and often as an automatic qualification for funding. Elected politicians apparently like to be photographed emerging from a helicopter at a disaster scene, especially with relief money in hand.

In addition, the quadrupling in global population since 1900 is likely to have increased the number of recorded events at least proportionately. Not only are there four times as many people potentially exposed (and most likely more than four times as many breaking EM-DAT's threshold of 10 people killed and 100 affected, because of the consequent increase in density of populations), but there are also four times as many observers. Thus, the number of events—and associated mortality—is likely to have been systematically under-reported in the early decades of the 20th century in the EM-DAT database; the earlier, the greater the degree of under-reporting. In fact, CRED, the keeper and compiler of the EM-DAT database, itself attributes increases until about 1995 partly to better reporting of disasters in general, and partly due to real increases in certain types of disasters. According to a report by Andrew Revkin, CRED claims that "the data in the most recent decade present the least bias and reflect a real change in numbers…especially…for floods and cyclones."[11] This is questionable. For example, it is difficult to imagine that the most rapid increase in communication in the history of the world (the simultaneous Internet and cell phone revolutions) really had no impact on the declaration and reporting of natural disasters. In any case, CRED is reported to have gone on to note, "Whether [the change in numbers] is due to climate change or not, [CRED is] unable to say."[12]

While the EM-DAT has certain shortcomings, for example it tends to bias long-term trends in deaths upward, this study nevertheless uses its death estimates. Note that for crude death rates this study provides estimates of deaths for every million people. Thus trends in death rates are not adjusted for changes in the age distribution of the population.

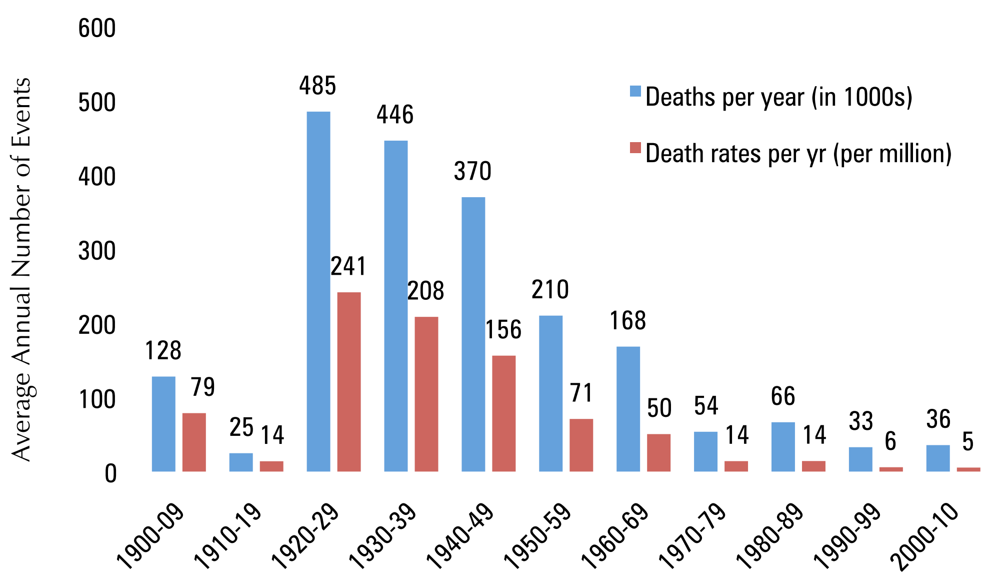
Trends in deaths and death rates, while of intrinsic interest for public policy purposes, may also have a bearing on trends in economic losses. First, wealthier societies will inevitably have more property at risk. Second, it has been suggested that although a wealthier society may take extra effort to limit loss of life, it may also be less concerned about property losses.[13]

Similarly, at the level of the individual, some may be less concerned about putting property at risk once physical safety is assured. This suggestion finds some support in findings that the ratio of death-to-property-loss for tornados in the U.S. has declined in recent decades.[14]

B. Aggregate Trends

Figure 2 shows the average annual deaths and death rates from all weather- and climate-related extreme events for each decade starting in 1900 through the eleven-year period from 2000–2010.[15] This figure shows that both death and death rates have declined at least since the 1920s. Specifically, comparing the 1920s to the latest (2000–2010) period, the annual number of deaths declined from 484,900 to 35,700, a 92.6% decline, while the death rate per million dropped from 241.5 to 5.4, a decline of 97.8%.

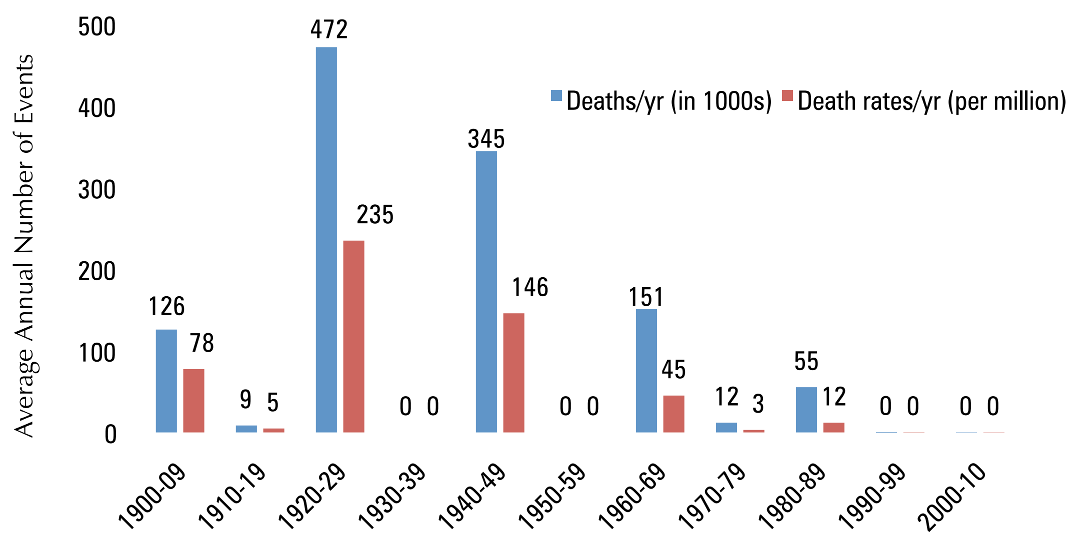
Figure 2: Global Death and Death Rates Due to Extreme Weather Events, 1900–2010



Note: For the last period, 2000–2010, annual deaths and death rates are based on an 11-year average.
Source: I. M. Goklany, "Deaths and Death Rates from Extreme Weather Events: 1900-2008," 2009, *Journal of American Physicians and Surgeons*, vol. 14 (4), pp. 102–09. Available at http://www.jpands.org/vol14no4/goklany.pdf; EM-DAT: The OFDA/CRED International Disaster Database, 2011, Université Catholique de Louvain, Brussels, Belgium. Available at http://www.em-dat.net. Accessed Mar 26, 2011; C. McEvedy, R. Jones, Atlas of World Population History (New York, N.Y.: Penguin, 1978); and WRI [World Resources Institute], 2011, EarthTrends Database. Available at www.wri.org. Accessed Mar 23, 2011.

Figure 3 shows that for droughts, the single most deadly category for the entire period, both deaths and death rates apparently peaked in the 1920s. Since then, they have declined by 99.98% and 99.99% respectively.

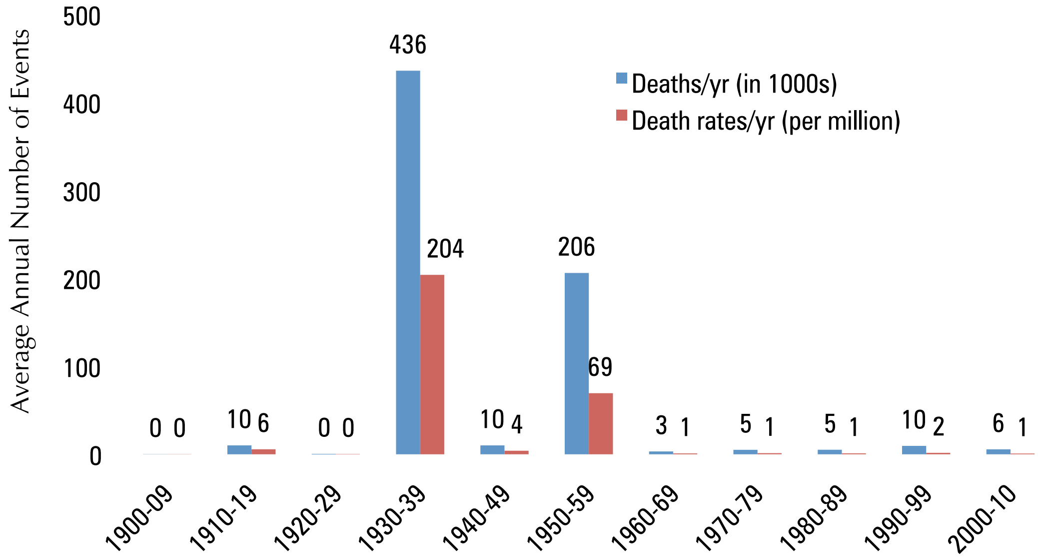
Figure 3: Droughts: Global Deaths and Death Rates, 1900–2010



Note: For the last period, 2000–2010, annual deaths and death rates are based on an 11-year average.
Source: I. M. Goklany, "Deaths and Death Rates from Extreme Weather Events: 1900-2008," *Journal of American Physicians and Surgeons*, vol. 14 (4), pp. 102-09. Available at http://www.jpands.org/vol14no4/goklany.pdf; EM-DAT: The OFDA/CRED International Disaster Database, 2011, Université Catholique de Louvain, Brussels, Belgium. Available at http://www.em-dat.net. Accessed Mar 26, 2011; C. McEvedy, R. Jones, Atlas of World Population History (New York, N.Y.: Penguin, 1978) and WRI [World Resources Institute], 2011, EarthTrends Database. Available at www.wri.org. Accessed Mar 23, 2011.

Figure 4 shows that deaths and death rates for floods, the second most important category and responsible for a third of the deaths recorded in EM-DAT for the entire period, crested in the 1930s. By 2000–2010, they were down by 98.7% and 99.6%, respectively.

Figure 4: Floods: Global Deaths and Death Rates, 1900–2010

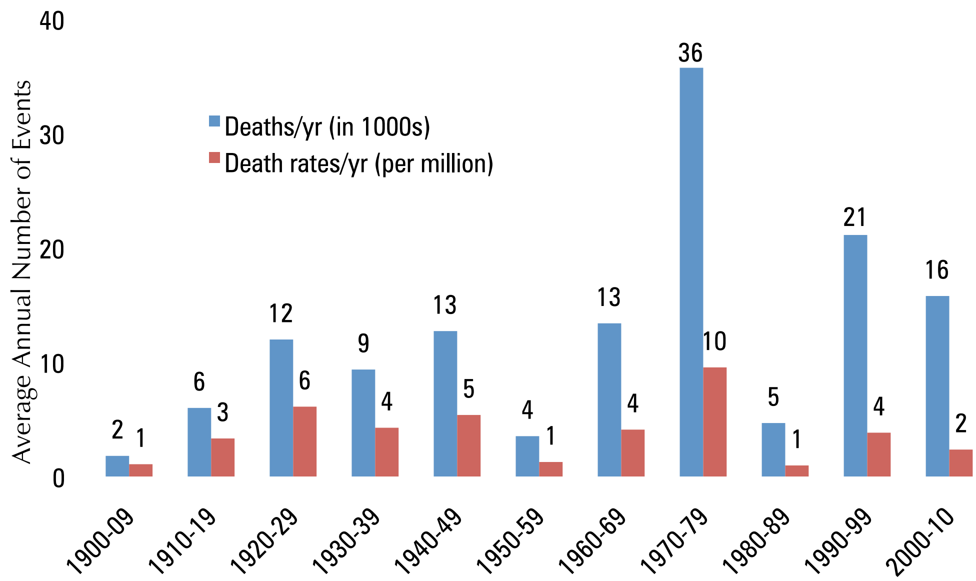


Note: For the last period, 2000–2010, annual deaths and death rates are based on an 11-year average.

Source: I. M. Goklany, "Deaths and Death Rates from Extreme Weather Events: 1900-2008," *Journal of American Physicians and Surgeons*, vol. 14 (4), pp. 102-09. Available at http://www.jpands.org/vol14no4/goklany.pdf; EM-DAT: The OFDA/CRED International Disaster Database, 2011, Université Catholique de Louvain, Brussels, Belgium. Available at http://www.em-dat.net. Accessed Mar 26, 2011; C. McEvedy and R. Jones, Atlas of World Population History (New York, N.Y.: Penguin, 1978) and WRI [World Resources Institute], 2011, EarthTrends Database. Available at www.wri.org, Accessed Mar 23, 2011.

Figure 5 shows that deaths and death rates from storms have declined by 55.8% and 75.3%, respectively, after peaking in the 1970s.

Figure 5: Storms (including hurricanes, cyclones, tornados, typhoons): Global Deaths and Death Rates, 1900–2010



Note: For the last period, 2000–2010, annual deaths and death rates are based on an 11-year average.

Source: I. M. Goklany, "Deaths and Death Rates from Extreme Weather Events: 1900-2008," *Journal of American Physicians and Surgeons*, vol. 14 (4), pp. 102-09. Available at http://www.jpands.org/vol14no4/goklany.pdf; EM-DAT: The OFDA/CRED International Disaster Database, 2011, Université Catholique de Louvain, Brussels, Belgium. Available at http://www.em-dat.net. Accessed Mar 26, 2011; C. McEvedy and R. Jones, Atlas of World Population History (New York, N.Y.: Penguin, 1978) and WRI [World Resources Institute], 2011, EarthTrends Database. Available at www.wri.org, Accessed Mar 23, 2011.

C. Annual Deaths and Death Rates for 1900–1989 vs. 1990–2010

Table 1 provides a breakdown of the average annual global deaths and death rates for the various categories of extreme events for 1900–1989 and 1990–2010. The rows are arranged in order of declining mortality ascribed to the various events (highest to lowest) for the former period.

The deadliest extreme weather events during much of the 20th century were droughts, followed by floods and storms. Over the 111-year record, droughts and floods were responsible for 58% and 34% of all fatalities worldwide due to all extreme weather events, while storms contributed an additional 7%. Thus, these three categories together accounted for 99% of the fatalities due to extreme weather events.

Aggregate Mortality

Aggregate annual mortality for the six categories of extreme events declined from 217,000 to 34,300 between the 1900–1989 and 1990–2010 periods. This is a decline of 84%. The average annual mortality rate dropped by 94%. Mortality declines between the two periods were mainly attributable to declines in annual fatalities owing to the two most deadly categories: droughts and floods.

Mortality from Droughts

Annual drought fatalities between the two periods shown in Table 1 declined by a remarkable 99.8%, from 130,000 to 200. Annual death rates dropped an even more remarkable 99.9%. Both declines are explicable largely by the fact that available food supplies outstripped even the unprecedented population increases of the 20th century, which combined with a dramatic increase in societies' ability to move food, medicines and other supplies from surplus areas to deficit areas, particularly in times of drought and other stresses.

Food supplies increased for a number of reasons:

- Greater use of existing technologies (i.e. irrigation, fertilization and pesticides) and the development of new technologies (i.e. the suite of technologies constituting the Green Revolution), which resulted in increased crop yields on the farm and reduced pre-and post-harvest losses and wastage at every stage of the food chain.

- Expanded commerce allowed food to move rapidly and in unprecedented quantities from surplus areas to deficit areas.

- Greater wealth increased the purchasing power of consumers and governments in developing countries, allowing imports to compensate for shortfalls in production. It also allowed developed countries and charities to establish food aid programs to help out in both chronically food-short areas and during emergencies.[16]

Essential to each of these factors was increased availability of relatively cheap electricity and petroleum-based fuel and other products for transportation, fertilizer, food packaging, refrigeration and pesticides.[17]

Mortality from Floods

The 90% decline in annual flood fatalities between 1900–89 and 1990–2010 from 75,200 to 7,500 possibly reflects better control, prevention and management of floods through construction of dams and other infrastructure, supplemented by better emergency response measures facilitated by improvements in transportation systems, flood forecasting and management of water facilities, among other things.

Mortality from Storms

Average annual mortality from storms increased by 66% from around 11,000 to 18,300 between the two periods. However, this was largely due to the increase in population since the annual mortality rate declined by 24%.

Annual mortality rates dropped for every category except extreme temperatures and wet mass movement. However, the contribution of these two categories to the total mortality burden from extreme weather events is relatively minor. The spike in deaths and death rates owing to extreme temperatures during the 1990–2010 period, which occurred because of the 2003 European heat wave, was over the long term much more than offset by declines in flood and drought fatalities. Notably, the latest version of the EM-DAT assigns 72,225 deaths to the 2003 European heat wave. In 2005, the EM-DAT had ascribed 45,700 deaths to that event.[18]

Table 1: Global Deaths and Death Rates for Various Types of Events, 1900–1989 and 1990–2010

	Deaths per year		Death rates per year (per million people)	
	1900–1989	1990–2010	1900–1989	1990–2010
Droughts	130,044	203	58.19	0.04
Floods	75,169	7,515	31.87	1.24
Storms	11,018	18,326	4.00	3.06
Mass Movement—Wet	441	704	0.15	0.12
Extreme Temperatures	124	7,503	0.03	1.15
Wildfires	22	78	0.01	0.01
TOTAL	216,819	34,330	94.24	5.61

Source: I. M. Goklany, "Deaths and Death Rates from Extreme Weather Events: 1900-2008," *Journal of American Physicians and Surgeons*, vol. 14 (4), pp. 102-09. Available at http://www.jpands.org/vol14no4/goklany.pdf; EM-DAT: The OFDA/CRED International Disaster Database, 2011, Université Catholique de Louvain, Brussels, Belgium. Available at http://www.em-dat.net. Accessed Mar 26, 2011 C. McEvedy and R. Jones, Atlas of World Population History (New York, N.Y.: Penguin, 1978) and WRI [World Resources Institute], 2011, EarthTrends Database. Available at www.wri.org, Accessed Mar 23, 2011.

Part 3

Mortality from Extreme Weather Events in Perspective

To place the public health consequences of extreme weather events in a wider context, consider that the average annual death toll for 2001–2010 due to all weather-related extreme events was 38,321.[19] By contrast, the World Health Organization (2002) estimates that in 2004 a total of 58.8 million people died worldwide from all causes, including 3.9 million from various kinds of accidents.[20] Of these, road traffic was responsible for 1.3 million deaths, violence (other than war) for 0.6 million, and war for 0.2 million. Thus, while extreme weather-related events, because of their episodic nature, garner plenty of attention worldwide, their contribution to the global mortality burden — 0.07% of global deaths —is relatively minor. Their contribution to the global burden of disease should be similarly small. Even the contribution of extreme weather events to mortality from accidental causes of death (at 1.0%) is minor, if not minuscule.

Moreover, despite the quite inordinate, though all-too-human, focus by authorities and the media on extreme weather events, systematic data, where available, suggests that the death toll from chronic conditions exacerbated by cold—but not necessarily extremely cold—conditions far exceeds the toll from extreme events.[21] Studies done in cold and temperate climates in both the Northern and Southern Hemispheres show that many more people die during the colder months than during the rest of the year. It is estimated that excess winter deaths in various countries in the mid- to high-latitudes range from 315 per year in Cyprus to 108,500 per year in the U.S. in the Northern Hemisphere to 6,900 per year in Australia.[22]

Although these numbers are for a handful of countries, together they overshadow the 38,300 deaths per year worldwide from all extreme weather events estimated above for 2001–2010. Unfortunately, no study has been undertaken to determine whether and how many more people die in winter worldwide since few analyses of the seasonality of deaths have been undertaken outside of the developed countries, although a study for São Paolo, Brazil, which is at the Tropic of Capricorn, found a 2.6% increase in all-cause mortality per degree increase in temperature above 20°C for the elderly, but a 5.5% increase per degree drop below 20°C, after adjusting for confounding factors such as air pollution; the relationships for children were similar, but somewhat weaker for (non-elderly) adults.[23]

Notably, over at least the last 50 years the general decline in annual mortality due to extreme weather events (see Figure 2) has occurred despite an increase in all-cause mortality. That is, extreme weather events are becoming less significant as a contributor to mortality, even as people's awareness of such events seems to be have been heightened by the extensive media coverage of natural disasters.

A review paper in *Nature* estimated that a global death toll of 150,000 was attributable to global warming in 2000.[24] This estimate was based on McMichael, *et al*.'s (2004) analysis published under the auspices of the World Health Organization as part of the 2002 Global Burden of Disease study (WHO 2002). The WHO assigned to global warming 77,000 of about 250,000 deaths from protein malnutrition, 47,000 of about two million deaths from diarrheal disease, and 27,000 of more than one million deaths from malaria. It also ascribed 2,000 deaths to floods in 2000, based on the EM-DAT database. However, as acknowledged by the underlying study[25] and noted elsewhere,[26] these estimates were derived using methodologies that used scientific shortcuts. But even using these problematic estimates, global warming would currently account for less than 0.3% of all global deaths. Thus, unsurprisingly, comparative analysis of the global mortality and disease burden shows that other public health issues far outrank effects attributed to global warming by advocates of draconian emissions controls.[27]

Table 2: Ranking of 26 Risk Factors Based on Disability Adjusted Life Years (DALYS) and Mortality for 2000

Risk factor	DALYs (000)	Rank	Risk factor	Total Mortality (000)	Rank
Underweight	137,801	1	Blood pressure	7,141	1
Unsafe sex	91,869	2	Tobacco	4,907	2
Blood pressure	64,270	3	Cholesterol	4,415	3
Tobacco	59,081	4	Underweight	3,748	4
Alcohol	58,323	5	Unsafe sex	2,886	5
Unsafe water, sanitation and hygiene	54,158	6	Low fruit and vegetable intake	2,726	6
Cholesterol	40,437	7	Overweight	2,591	7
Indoor smoke from solid fuels	38,539	8	Physical inactivity	1,922	8
Iron deficiency	35,057	9	Alcohol	1,804	9
Overweight	33,415	10	Unsafe water, sanitation and hygiene	1,730	10
Zinc deficiency	28,034	11	Indoor smoke from solid fuels	1,619	11
Low fruit and vegetable intake	26,662	12	Iron deficiency	841	12
Vitamin A deficiency	26,638	13	Urban air pollution	799	13
Physical inactivity	19,092	14	Zinc deficiency	789	14
Risk factors for injury	13,125	15	Vitamin A deficiency	778	15
Lead exposure	12,926	16	Unsafe health care injections	501	16
Illicit drugs	11,218	17	Risk factors for injury	310	17
Unsafe health care injections	10,461	18	Airborne particulates	243	18
Lack of contraception	8,814	19	Lead exposure	234	19
Childhood sexual abuse	8,235	20	Illicit drugs	204	20
Urban air pollution	7,865	21	Global warming	154	21
Global warming	5,517	22	Lack of contraception	149	22
Noise	4,151	23	Carcinogens	146	23
Airborne particulates	3,038	24	Childhood sexual abuse	79	24
Carcinogens	1,421	25	Ergonomic stressors	0	25
Ergonomic stressors	818	26	Noise	0	26
TOTAL for the 26 factors	800,965			40,719	
TOTAL FROM ALL CAUSES	1,472,392			55,693	
TOTAL from Extreme Weather Events (2001–10 avg)				38.3	

Source: WHO (2002); Indur M. Goklany, "Climate change is not the biggest health threat," *Lancet*, vol. 374, pp. 973-975.

Part 4

Summary and Conclusions: Wealthier is Safer

The above analyses indicate that:

- Based on 2001–10 data, extreme weather events are responsible for about 0.07% of all global deaths (38,300 deaths vs. 59 million, annually). That is, despite the media attention to such events, extreme weather events have a minor impact on global public health.
- Long-term (1900–2010) data show that average annual deaths and death rates from all such events declined by 93% and 98%, respectively, since cresting in the 1920s. These declines occurred despite a vast increase in the populations at risk and more complete coverage of extreme weather events.
- Deaths and death rates from droughts were responsible for the majority (58%) of all deaths due to extreme weather events from 1900–2010. They also peaked in the 1920s. Since then, they have been reduced by 99.98% and 99.99%, respectively.
- For floods, responsible for another 34% of aggregate deaths, deaths and death rates have declined by 98.7%–99.6% since the 1930s.
- For storms, responsible for 7% of deaths from 1900–2010, deaths and death rates declined by 55.8%–75.3% since the 1970s.
- These trends indicate that the total risk of death from all extreme weather events has actually declined despite claims that the number and intensity of extreme weather events has increased.
- The decline in deaths from extreme weather events occurred despite an increase in deaths from all causes, indicating that the world is coping with the former much better than it is with far more significant sources of deaths and disease.

One factor contributing to the decline in the death toll from droughts, in particular, is that global food production has never been higher than it is today. This is largely due to improved seeds, fertilizers, pesticides, irrigation and farm machinery.[28] This entire suite of technologies also enabled the Green Revolution. But fertilizers and pesticides are manufactured from fossil fuels, and energy is necessary to run irrigation pumps and machinery. Without them, the benefits of improved seeds would be for naught. And in today's world, like it or not, energy for the most part is synonymous with fossil fuels—because these offer the most reliable, cost-effective and readily accessible energy options.

The resulting increase in yields and food production helped reduce food prices worldwide, which reduced hunger by making food more affordable.[29] Additional CO_2 in the atmosphere has also contributed to higher yields and food production[30] because it provides carbon, the basic building block of life, and also increases the efficiency with which plants use water helping offset declines in water availability, if any.

Yet another factor critical to reining in food prices and reducing hunger worldwide is trade within and between countries, which enables food surpluses to be moved to food-deficit areas.[31] But it takes fossil fuels to move food around in the quantities and the speed necessary for such trade to be an integral part of the global food system, as it indeed is. Moreover, fossil-fuel-dependent technologies such as refrigeration, rapid transport and plastic packaging ensure that more of the crop that is produced is actually eaten by the consumer. That is, they increase the overall efficiency of the food production system, which helps lower food prices and contain hunger worldwide.

The second important factor is better disaster preparedness and more rapid response and delivery of humanitarian aid when disaster strikes. Timely preparations and response are major factors that have contributed to the reduction in death and disease that traditionally were caused by or accompanied disasters from extreme weather events.[32] Their success hinges on the availability of fossil fuels to move people, food, medicine and critical humanitarian supplies before and after events strike. Economic development also allowed the U.S. and other developed countries to offer humanitarian aid to developing countries in times of famine, drought, floods, cyclones and other natural disasters, weather-related or not. Such aid, too, would have been virtually impossible to deliver in large quantities or in a timely fashion absent fossil-fuel-fired transportation.

These improvements, which occurred despite increases in the populations at risk, can be attributed largely to the combination of greater economic development and technological change. Together they enable society to protect against—and cope with—adversity in general, and extreme weather events in particular.[33]

The role of economic development in reducing the death toll from natural disasters is confirmed by analyses undertaken by Kahn[34] and Van der Vink, *et al*.[35] Kahn's analysis of natural disasters for 73 nations from 1980–2002 found that an average nation with a population of 100 million and gross domestic product (GDP) per capita of US$2,000 would in 1990 have experienced 944 deaths from natural disaster. However, had GDP per capita been raised to US$14,000, its death toll would have fallen to 180 per year, an 81% decline.[36] Although both studies covered weather- and non-weather-related disasters, their findings should be generally applicable to all types of natural disasters, whether weather-related (or not). Both also found that nations that were less democratic and scored lower on measures of good governance suffered a higher death toll. Kahn also concluded that greater income inequality led to higher death tolls.

These findings are generally consistent with recent experience on natural disasters. For instance, while no two disasters are alike in terms of risk and population exposure, it is notable that an estimated 222,600 people died in the 7.0 magnitude Haiti earthquake in January 2010, while the death toll from the much stronger 8.8 magnitude Chilean earthquake in February 2010 was 600 people.[37] Similarly, despite the one-two punch of an even stronger (magnitude 9.0) earthquake followed almost immediately by a major tsunami, the provisional death toll from Japan's recent disaster is unlikely to exceed 30,000, despite its much larger population and even greater population density.[38]

Figure 6: GDP per capita, Carbon Dioxide Emissions from Fossil Fuels and Cement Manufacturing, and Death Rates per million, 1920–2010

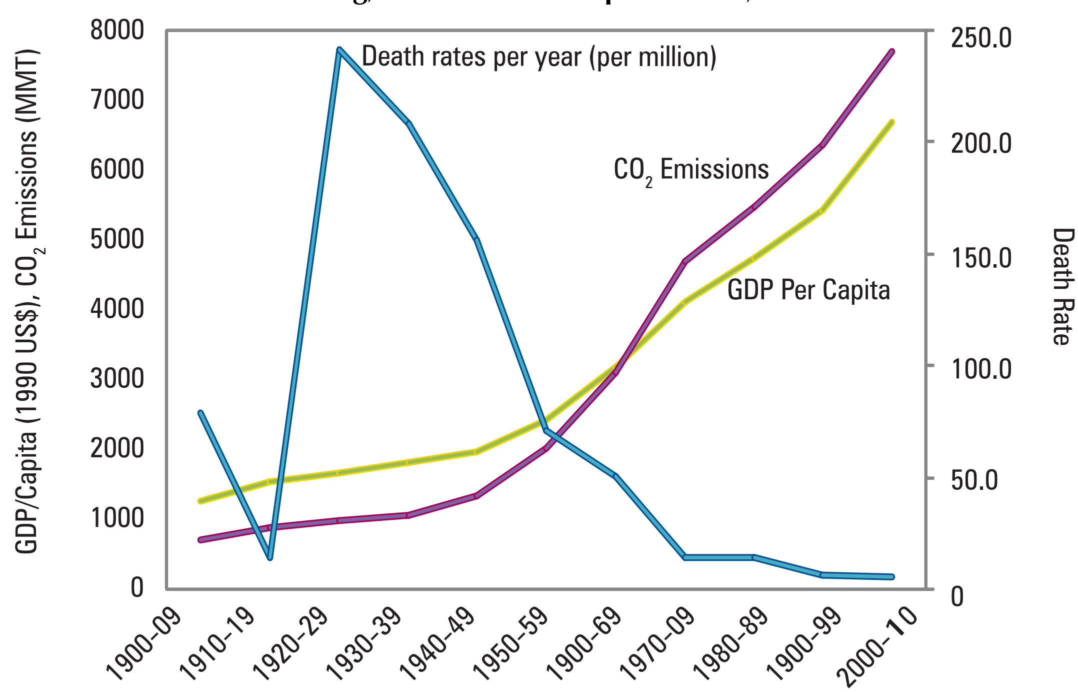


Figure 6. GDP/Cap is calculated in 1990 Geary-Khamis dollars; data points for each decade from the 1900s to the 1940s are interpolations based on data for 1900, 1913, 1940 and 1950; for 1950s through the 1990s, data points are averages of annual data; for 2000-2010, it is the average for 2000-2009, using Angus Maddison's estimate for 2000 from *Statistics on World Population, GDP and Per Capita GDP*, 1-2008 AD. Available at http://www.ggdc.net/MADDISON/Historical_Statistics/horizontal-file_02-2010.xls. Accessed 11 May 2011 and applying the annual growth rates from World Bank's World Development Indicators Database (http://data.worldbank.org/data-catalog/world-development-indicators. Accessed 11 May 2011). Death rates are as for figure 2. Carbon Dioxide emissions are from the Carbon Dioxide Information Analysis Center (TA Boden, G. Marland , and RJ Andres, 2010, *Global, Regional, and National Fossil-Fuel CO_2 Emissions*. Available at http://cdiac.esd.ornl.gov/trends/emis/overview_2006.html and *Preliminary 2008-09 Global & National Estimates by Extrapolation*. Available at http://cdiac.ornl.gov/ftp/trends/co2_emis/Preliminary_CO2_emissions_2009.xls. Both accessed 11 May 2011).

Figure 6 shows the relationships between average per capita economic output, carbon dioxide emissions from fossil fuel usage and cement manufacturing, and average death rates from all weather and climate-related extreme weather events for 1900–2010. In general, as per capita output and carbon dioxide have risen, death rates have fallen. Both per capita income and carbon dioxide emissions rise together, which is not surprising given the dependence of economic development on usage of energy, particularly fossil fuel energy, in all sectors—agriculture, manufacturing, transportation and the service sector. Although the service sector is not as energy-intensive as the other sectors, it is often overlooked that it also depends on electricity for lighting, comfort, communications and information technology.

Finally, over the long term, despite population increases, cumulative mortality from extreme weather events has declined globally, even as total (all-cause) mortality continues to increase. That is, humanity is coping better with extreme weather events than with far more important health and safety problems. Currently, many people advocate spending trillions of dollars to reduce anthropogenic greenhouse gases, in part to forestall hypothetical future increases in mortality from global-warming-induced increases in extreme weather events. Spending even a fraction of such sums on the numerous higher priority health and safety problems plaguing humanity (Table 2) would provide greater returns for human well-being.[39] No less important, efforts to reduce greenhouse gas emissions would slow economic development and/or make fossil fuels scarcer and more expensive, thereby militating against the very factors that have reduced death rates from extreme weather events.

About the Authors

Indur M. Goklany, Ph.D. is an author and a researcher who was associated with the Intergovernmental Panel on Climate Change off and on for 20 years as an author, expert reviewer and U.S. delegate to that organization. He is the author of *The Improving State of the World: Why We're Living Longer, Healthier, More Comfortable Lives on a Cleaner Planet* (Cato Institute, Washington, DC, 2007). Opinions and views expressed by Dr. Goklany are his alone, and not necessarily of any institution with which he is associated.

Julian Morris is vice president of research at Reason Foundation, a non-profit think tank advancing free minds and free markets.

Julian graduated from the University of Edinburgh with a Masters in economics. Graduate studies at University College London, Cambridge University and the University of Westminster resulted in two further masters' degrees and a Graduate Diploma in Law (equivalent to the academic component of a JD).

Julian is the author of dozens of scholarly articles on issues ranging from the morality of free trade to the regulation of the Internet, although his academic research has focused primarily on the relationship between institutions, economic development and environmental protection. He has also edited several books and co-edits, with Indur Goklany, the Electronic Journal of Sustainable Development (www.ejsd.org).

Julian is also a visiting professor in the Department of International Studies at the University of Buckingham (UK). Before joining Reason, he was the executive director of International Policy Network (www.policynetwork.net), a London-based think tank he co-founded. Before that, he ran the environment and technology program at the Institute of Economic Affairs, also in London.

Acknowledgements

This paper draws upon and updates Dr. I.M. Goklany, “Deaths and Death Rates from Extreme Weather Events: 1900–2008,” *Journal of American Physicians and Surgeons* 14 (4): 102-09 (2009), available at http://www.jpands.org/vol14no4/goklany.pdf. I thank Dr. Jane Orient and Dr. Lawrence Huntoon for giving me permission to use that article as the basis for this chapter.

Endnotes

[1] Intergovernmental Panel on Climate Change (IPCC), *Impacts, Vulnerability, and Adaptation* (Cambridge, England: Cambridge University Press, 2001), p.7.; *The Lancet* and University College London Institute for Global Health Commission (The Commission) 2009. "Managing the health effects of climate change," *The Lancet,* vol. 373, pp. 1693-1733, available at: http://www.ucl.ac.uk/global-health/ucl-lancet-climate-change.pdf ; Jeffrey Kluger, "Special report: global warming: Be worried. Be very worried. Global warming heats up," *Time,* Apr 3, 2006; J. Anderson and C. Bausch, *Climate change and natural disasters: scientific evidence of a possible relation between recent natural disasters and climate change,* Policy Brief for the EP Environment Committee, IP/A/ENVI/FWC/2005-35,[STILL NEED THIS CLARIFIED]WHAT DOES IP/A/ENVI/FWC/2005-35 MEAN?]Available at www.europarl.eu.int/comparl/envi/pdf/externalexpertise/ieep_6leg/naturaldisasters.pdf.Accessed Apr 27, 2006.

[2] Kluger,"Special report: global warming."

[3] Bekele Geleta, "Climate Change and Development," address to a public event at Houses of Parliament, Palace of Westminster, London, Mar 18, 2009. Available at www.odi.org.uk/events/2009/03/18/430-transcript-bekele-geletas-speech.pdf.Accessed Sep 26, 2009.

[4] Global Humanitarian Forum (GHF), "Climate Change responsible for 300,000 deaths a year," press release, May 29, 2009. Available at http://ghfgeneva.org/Media/PressReleases/tabid/265/EntryId/40/Climate-Change-responsible-for-300-000-deaths-a-year.aspx. Accessed Sep 26, 2009.

[5] Jonathan Patz, "Climate change: health impacts may be abrupt as well as long-term," *British Medical Journal,* vol. 328, 2004, pp. 1269–1270. Anthony J. McMichael and Rosalie Woodruff, "Climate Change and Risk to Health,"*BMJ,* vol.329, 2004, pp. 1416–1417.

[6] I. M. Goklany, "Potential consequences of increasing atmospheric CO_2 concentration compared to other environmental problems," *Technology* 2000, vol. 7S, pp. 189–213.

[7] Technically, the first decade of the 1900s actually started in 1901. Also, note that the last bar in all the figures in this paper represents an 11-year period.

[8] Geleta, "Climate Change and Development"; McMichael and Woodruff, "Climate Change and Risk to Health."

9 I. M. Goklany, *The Improving State of the World: Why We're Living Longer, Healthier, More Comfortable Lives on a Cleaner Planet* (Washington, D.C.: Cato Institute; 2007).

10 Ibid.; Gregory E. Van der Vink, Peter DiFiore and Andy Brett, et al., "GDP and natural disasters," *Geotimes* 2007, vol. 52(10), pp. 36-39.

11 Andrew C. Revkin, "Gore pulls slide of disaster trends," Dot Earth Blog, Feb. 23, 2009. Available at: http://dotearth.blogs.nytimes.com/2009/02/23/gore-pullsslide-of-disaster-trends/. Accessed Sep10, 2009.

12 Ibid.

13 Goklany, "Potential consequences of increasing atmospheric CO_2 concentration compared to other environmental problems."

14 Charles A. Doswell III, Allen R. Moller, and Harold E. Brooks, "Storm spotting and public awareness since the first tornado forecasts of 1948,"*Weather and Forecasting* 1999, vol. 14, pp. 544–557; Harold E. Brooks and Charles A. Doswell III, "Normalized damage from major tornadoes in the United States: 1890–1999, "*Weather and Forecasting* 2001, vol. 16, pp. 168–176.

15 To calculate death rates, it is necessary to estimate global population for each year from 1900 through 2008. For 1900–1925, population was computed for each year based on interpolation of McEvedy and Jones (1978) estimates for 1900 and 1925, assuming exponential growth between these two end points. For 1926–1949, population was calculated similarly, using McEvedy and Jones' 1925 estimate and the 1950 estimate from the World Resources Institute EarthTrends database (WRI 2011). Population for 1950 through 2010 population was taken directly from the latter source.

16 I. M. Goklany "Saving habitat and conserving biodiversity on a crowded planet," *BioScience,* 1998, vol. 48, pp. 941-953.

17 Indur. M. Goklany and Merritt W. Sprague*, Sustaining development and biodiversity: productivity, efficiency and conservation*, Policy Analysis No. 175,(Washington, D.C.: Cato Institute; 1992); Goklany, "Saving habitat and conserving biodiversity on a crowded planet;" Goklany, *The Improving State of the World.*

18 I. M. Goklany, "Death and death rates due to extreme weather events: global and U.S. trends, 1900–2006" in *The Civil Society Report on Climate Change* (London: International Policy Press; 2007), Available at: www.csccc.info/reports/report_23.pdf. Accessed May 20, 2009.

19 EM-DAT: The OFDA/CRED International Disaster Database, Université Catholique de Louvain, Brussels, Belgium. Available at http://www.em-dat.net.Accessed Mar 26, 2011.

20 World Health Organization (WHO), *Global Burden of Disease 2004 Update — Disease and injury regional estimates for 2004* (2008). Available at http://www.who.int/entity/healthinfo/global_burden_disease/DTH6%202004.xls. Accessed Aug 13, 2010.

[21] J. D. Healy, "Excess winter mortality in Europe: a cross country analysis identifying key risk factors," *Journal of Epidemiol Community Health* 2003, vol. 57, pp. 784-789 doi:10.1136/jech.57.10.784; M. E. Falagas, et al., "Seasonality of mortality: the September phenomenon in Mediterranean countries,"*CMAJ* 2009, vol181(8), pp. 484-6;I. M. Goklany,"Global health threats: Global warming in perspective,"*Journal of American Physicians and Surgeons,* 2009, vol. 14, pp. 69-75; I. M. Goklany, "Winter Kills: Excess Deaths in the Winter Months. Watts Up With That," January 9, 2010. Available at http://wattsupwiththat.com/2010/01/06/winter-kills-excess-deaths-in-the-winter-months/.

[22] Goklany,"Winter kills."

[23] Nelson Gouveia, Shakoor Hajat and Ben Armstrong," Socioeconomic differentials in the temperature–mortality relationship in São Paulo, Brazil," *International Journal of Epidemiology* 2003, vol. 32, pp. 390-397.

[24] Jonathan A. Patz, D. Campbell-Lendrum, T. Holloway, et al., "Impact of regional climate change on human health," *Nature*, 2005, vol. 438, pp. 310-317.

[25] Anthony J. McMichael, D. Campbell-Lendrum, S. Kovats, et al., "Global climate change," In *Comparative Quantification of Health Risks: Global and Regional Burden of Disease due to Selected Major Risk Factor* (Geneva: World Health Organization, 2004) pp. 1543–1649.

[26] Goklany, "Global health threats: Global warming in perspective," pp. 69-75.

[27] I. M. Goklany,"Climate change is not the biggest health threat." *The Lancet,* 2009, vol. 374, pp. 973–975.

[28] Goklany, "Death and death rates due to extreme weather events."

[29] Ibid.

[30] Intergovernmental Panel on Climate Change (IPCC) 2001, *Impacts, Vulnerability, and Adaptation,* pp. 254–257, 285.

[31] I. M. Goklany, "Strategies to enhance adaptability: technological change, economic growth and free trade," *Climatic Change,* 1995, vol. 30, pp. 427–449; Goklany, "Saving habitat and conserving biodiversity on a crowded planet," pp. 941-953.

[32] Goklany, "Death and death rates due to extreme weather events."

[33] Intergovernmental Panel on Climate Change (IPCC) *Impacts, Vulnerability, and Adaptation;* Goklany, "Strategies to enhance adaptability," pp. 427-449; Goklany, *The Improving State of the World*; I. M. Goklany, "Is climate change the 'defining challenge of our age'?" *Energy & Environment* 2009, vol. 20(3), pp. 279–302.

[34] Matthew Kahn, "The Death Toll from Natural Disasters: The Role of Income, Geography, and Institutions," *Review of Economics and Statistics* 2005, vol. 87(2), pp. 271–284.

[35] Van der Vink, DiFiore, Brett, et al., "GDP and natural disasters," pp. 36-39.

[36] Kahn, "The Death Toll from Natural Disasters," p. 280.

[37] EM-DAT: The OFDA/CRED International Disaster Database, 2011.

[38] Earthquake Report 2011,"Japan tsunami : A massive update for our CatDat Situation Report (Part 15)."Available at http://earthquake-report.com/2011/05/09/japan-tsunami-a-massive-update-for-our-catdat-situation-report-part-15/. Accessed May 12, 2011.

[39] Goklany, "Climate change is not the biggest health threat," pp. 973-975; Goklany, "Is climate change the 'defining challenge of our age'?" pp. 279–302.

Reason Foundation
3415 S. Sepulveda Blvd., Suite 400,
Los Angeles, CA 90034
310/391-2245
www.reason.org