GLOBAL WARMING POLICIES MIGHT BE BAD FOR YOUR HEALTH

Dr Indur Goklany

Foreword by Professor Paul Reiter

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Dr Indur Goklany
Indur Goklany, an independent scholar and author, is co-editor of the Electronic Journal of Sustainable Development. He was a member of the U.S. delegation that established the IPCC and helped develop its First Assessment Report. He subsequently served as an IPCC reviewer.

Professor Paul Reiter
Paul Reiter is Professor of Medical Entomology at the Pasteur Institute in Paris, France, and a widely respected specialist in the epidemiology and control of mosquito-borne diseases.

Foreword

Polarisation is the curse of the global warming debate. "Experts" who, in the name of science, forecast imminent climatic apocalypse are pitted against others—reviled as "sceptics" and "deniers"[1] —who denounce them as false prophets, corrupters of science and latter-day Savonarolas. Scientists who enter the fray risk being tarred with the brush of one group or the other. For this reason, most retreat to the shadows, enfeebled spectators in a bar room brawl.

Public health has centre place in the arena. To the lay person this may seem reasonable: infectious disease and hot climates appear to go together so the hotter it gets the more dysentery, malaria, famine, deadly hurricanes and all the rest. And indeed, for nearly 20 years, time and time again, the message from the World Health Organization (WHO), the Intergovernmental Panel on Climate Change (IPCC) and other United Nations' bodies, plus governmental agencies, prominent politicians and high profile advocacy groups, has been unequivocal: global warming is a real and present danger, particularly in (currently) temperate regions but also in the hottest parts of the world, and human health will be a key casualty. Their literature is rife with reviews that are rich in intuitive but speculative statements—evidence for events that have yet to occur is hard to come by—whereas arguments based on hard science tend to be more important to sceptics than to soothsayers.

A deplorable feature of the debate is that "experts" who write such reviews are poised to seize on current events as portents of the future. A single example from the UN camp will suffice. In the summer of 2007, a man with a fever flew from India to a tiny village in northern Italy where an alien mosquito, the "Asian Tiger", had recently become established. It has long been known that the mosquito, an accidental import from Japan, can survive sub-zero temperatures and can transmit an unpleasant febrile disease called chikungunya. Within a week, members of the man's family fell ill and the virus (it was chikungunya) began to spread. There was nothing really surprising about this: the Asian Tiger survives the Korean winter; why shouldn't it enjoy the Italian summer? Moreover, summer temperatures in that village were higher than in many tropical countries where the virus thrives. Nevertheless, a spokesperson for the WHO office in Rome told the press: "We cannot say that the disease was caused (my emphasis) by climate change, but the conditions in Italy are now suitable for the Tiger Mosquito". Her Director in Geneva was more forthright: "This is the first case of an epidemic of a tropical disease in a developed, European country. Climate change creates conditions that make it easier for this mosquito to survive…this is a real issue… it is not something a crazy environmentalist is warning about…."

The allusion to environmentalism is beguiling because environmentalists,

1 This epithet is surely beneath contempt, a clear allusion to "holocaust deniers", people who claim that the Nazi extermination camps are a political myth.

crazy and otherwise, consistently quote the IPCC, the Environmental Protection Agency (EPA) and the WHO to vindicate their claims. The latter confer freely with environmentalist groups (the IPCC refers to them as "NGOs and other interested parties") in writing their reports. To the exasperation of many scientists, their conjoined groups are intransigent, a firewall against rational dialog.

Indur Goklany's study is a breath of fresh air. His objective is to offer perspective on the significance of (claimed) global warming health threats in the context of public health as a whole. For this he has dissected, analysed and summarized thousands of pages of articles, reports and UN documents. His conclusions, rigorously based on these sources, are indisputable: "the threat of global warming…is now and through the foreseeable future outranked by numerous other health threats". There is no need for "denial": the rankings are unequivocal, as is his statement: "Many of these higher ranking threats are diseases of poverty". His conclusion is pragmatic and fair: "Exaggerating the importance of global warming seriously risks misdirecting the world's priorities and its resources in its efforts to reduce poverty and improve public health". It will be interesting to see whether his effort moderates the debate or kick-starts more exaggeration.

Paul Reiter

Executive Summary

Global Warming Does Not Currently Rank Among the Top Public Health Threats

- The World Health Organization (WHO) attributes 141,000 deaths and 5.4 million lost Disability-Adjusted Life Years (DALYs) in 2004 to global warming. This is only 0.2% of all deaths and 0.4% of the burden of disease (Figure 1; WHO 2008a, 2009).

- This estimate, however, does not account for the health outcomes that are the major contributors to the long-known phenomenon of excess winter mortality (see Table 1).

- Deaths from excess winter mortality in Japan and the U.S. alone (about 159,000 per year) exceed deaths currently attributed to global warming (141,000 per year) (Table 4).

- WHO analysis indicates that at least 22 other health risks currently outrank global warming as a global public health threat (based on data for 2004) (Figure 1; WHO 2009).

- Global warming would exacerbate existing diseases of poverty rather than create any significant new health risks. More than 99.9% of the burdens of death and disease attributed to global warming by WHO are in developing countries (Figure 1, WHO 2009).

The Contribution of Much-Publicized Extreme Weather Events to Global Mortality is Negligible, and Declining.

- Despite the emphasis in the popular press on extreme weather events (e.g., droughts, floods, heat waves, hurricanes, cyclones and other storms), their global contribution to mortality, at 0.07%, is negligible (EM-DAT 2011).

- Global mortality attributed to all such events has declined by 93% since the 1920s, while total mortality rate declined 98% (EM-DAT 2011).

- Mortality from extreme weather events has declined but all-cause mortality has increased. That is, humanity is coping better with extreme weather events than it is with far more important health and safety problems (EM-DAT 2011; UNPD 2011).

Poverty is a Much Larger Public Health Threat than Global Warming

- The contribution of diseases of poverty (e.g., underweight, malnutrition, unsafe water, poor sanitation and hygiene) to the global burden of death and disease is currently 70–80-fold larger than that of global warming. (Table 2; Figure 1; WHO 2009)

- Deaths from diseases of poverty and excess winter mortality are real (WHO 2009; Falagas 2009), whereas those from global warming are based on hypotheses and models which short-circuited the scientific method and have not been tested rigorously (McMichael et al. 2004, p. 1546).

Other Factors Will Outweigh Warming as a Public Health Risk through the Foreseeable Future

- Through the foreseeable future, global warming may contribute no more than 13% to mortality from hunger, malaria and extreme weather events, even under the warmest IPCC scenario. Therefore, rolling back climate, i.e. temperature, precipitation and other climatic variables, to 1990 levels—currently infeasible, regardless of cost—would at most reduce mortality from these causes by less than 13% (Figure 6).

Either Focused Adaptation or Economic Development Would Provide Greater Health Benefits at Lower Costs than Mitigation

- By contrast, measures focused on reducing vulnerability to hunger, malaria and extreme weather events would target 100% of the above mortality and cost much less (Goklany 2009b).

- Such "focused adaptation", designed to reduce vulnerability more broadly to today's urgent health problems that would be exacerbated by warming, would, therefore, deliver greater reductions in deaths at a lower cost than mitigation.

- Alternatively, reductions in poverty, which depends on greater economic growth, should also help eliminate death and disease from not just hunger, malaria, extreme weather events but all the other diseases of poverty. Poverty, moreover, can be reduced at a fraction of the cost of substantial mitigation.

- No less important, reducing poverty should provide other ancillary benefits beyond improved public health, e.g., better education and economic opportunities.

Emission Reduction Policies May Add to Death and Disease

- Mitigation policies that would retard economic development or increase the price of agricultural inputs and output would slow down reductions in poverty and, thereby, increase net death and disease, and retard improvements in human welfare.

- Mitigation policies designed to replace fossil fuels with biofuels in particular may have, by adding to world hunger and poverty, contributed 200,000 additional deaths and 6.7 million lost DALYs in 2010 without significantly reducing the public health impact of global warming. (De Hoyos and Medvedev 2009; Goklany 2011)

- Mitigation policies, if successful, would retard progress toward reducing excess winter mortality. If unsuccessful, that too would exacerbate excess winter mortality if it reduces economic development and/or increases heating fuel costs.

- Policies to reduce global warming may be doing more harm than good for public health in both developing and industrialized countries.

Introduction: How Sound Is the Basis for Popular Claims of Global Warming's Health Impacts?

Claims that global warming is among the most important, if not the most important, global threats to public health are based on the notion that global warming would add to the global burden of death and disease by increasing hunger through reductions in agricultural productivity, increasing the frequency and intensity of extreme weather events such as droughts, floods, storms and heatwaves, and facilitating the spread of vector-borne diseases such as malaria, dengue, and other infectious diseases (McMichael et al. 2004, 2006; Patz et al. 2005; Campbell-Lendrum and Woodruff 2006).

The above claims owe their legitimacy in large part to a modeling study sponsored by the World Health Organization (WHO)—the United Nations' agency which has primacy for directing and coordinating activities related to public health—that attributed 154,000–166,000 deaths worldwide and 5.5 million lost Disability-Adjusted Life Years (DALYs) to global warming in 2000 (McMichael et al. 2004). That study noted that:

> "[C]limate change occurs against a background of substantial natural climate variability, and its health effects are confounded by simultaneous changes in many other influences on population health…. Empirical observation of the health consequences of long-term climate change, followed by formulation, testing and then modification of hypotheses would therefore require long time-series (probably several decades) of careful monitoring. While this process may accord with the canons of empirical science, it would not provide the timely information needed to inform current policy decisions on GHG emission abatement, so as to offset possible health consequences in the future." [Emphasis added]. [McMichael et al. 2004, p 1546]

Despite the authors' revelation that they shortchanged the scientific method in pursuit of a policy agenda, this study's results were reported in the WHO's flagship annual publication, The World Health Report 2002, along with other results from the Global Burden of Disease study for 2000 (GBD 2000). Once reported, they were repeated in several influential scientific and medical publications, including the Intergovernmental Panel on Climate Change's latest assessment (IPCC 2007), and major review papers in Nature (Patz et al. 2005), Lancet (McMichael et al. 2006), and Environmental Health Perspectives (Campbell-Lendrum and Woodruff 2006), among others.

Drawing upon the above claims, the WHO devoted the 2008 World Health Day to "Protecting health from climate change" (WHO 2008), and a joint University College London-Lancet Commission, in a widely-cited report in *The Lancet*, declared that "climate change is the biggest global health threat of the 21st century" (Costello et al. 2009).

Clearly, global warming seems firmly ensconced in the global public health agenda.

Since then, in late 2009, the WHO published a new study, Global Health Risks (WHO 2009) as part of its ongoing Global Burden of Disease study which updated the earlier estimates of death and disease for 24 risk factors (for 2004), including global warming. Because WHO (2009) updates the heavily-cited results from GBD 2000, it presumably is an improvement.

Accordingly, in this paper, I will use the estimates from WHO (2009) to ascertain whether global warming should be ranked among the more important health risks facing humanity now and through the foreseeable future. This analysis will, for the sake of argument, take these newer estimates for granted, and follow their implications to their logical conclusions. I will also examine deaths, and trends in deaths, from extreme weather events in the wider context of mortality from all causes. After undertaking these comparative analyses, I will address the efficacy of policies to limit global warming in alleviating death and disease.

In this paper the burden of disease is measured using "disability-adjusted life years" (DALYs) lost to disease. This is the cumulative sum over the population of (a) the number of years lost due to premature death from disease, and (b) the number of years spent in a disabled condition due to disease, weighted by the severity of the disease.

Note that this paper is based on previous work, listed in the Bibliography, which I shall draw upon without specific attribution.

Where Does Global Warming Rank as a Public Health Risk Today?

According to WHO (2009), global warming will exacerbate death and disease from diarrhoea, malaria, undernutrition, and 34 other associated causes (see Table 1 on the next page). Humanity has a long-standing history with each of these 37 causes. Each is virtually absent in the industrialized world, including the ones that used to be endemic there (e.g., diarrhoea, malaria, undernutrition, and others listed in the top half of the table). In fact, today these 37 listed causes of death and disease are associated with poverty and its corollary, poor health services. Thus, according to the WHO, global warming would not create new health problems as much as it would worsen existing, poverty-related health problems.

Notably, neither stroke nor cardiovascular disease is listed in Table 1.

Potential Outcomes	Mortality (000s)	Lost DALYs (000s)
Diarrheal diseases	64.9	2,174.9
Malaria	27.0	1,041.0
Lower respiratory infections	16.7	592.1
Measles	6.2	217.1
Pertussis	5.6	211.5
Protein-energy malnutrition	5.0	476.4
Other unintentional injuries	3.0	166.9
Other infectious diseases	2.4	89.6
Tetanus	2.3	76.6
Birth asphyxia and birth trauma	2.1	92.5
Neonatal infections and other conditions	2.0	70.4
Meningitis	1.9	82.9
Syphilis	0.9	32.1
Tuberculosis	0.4	13.9
Upper respiratory infections	0.2	7.8
Prematurity and low birth weight	0.2	5.9
Diphtheria	0.1	7.4
Leishmaniasis	0.1	3.5
Dengue	0.1	2.6
Japanese encephalitis	0.1	2.4
Chlamydia	0.0	1.5
Gonorrhoea	0.0	0.6
Other STDs	0.0	3.4
Poliomyelitis	0.0	0.5
Hepatitis B	0.0	3.5
Hepatitis C	0.0	0.3
Trypanosomiasis	0.0	0.3
Chagas disease	0.0	0.1
Schistosomiasis	0.0	0.2
Lymphatic filariasis	0.0	18.1
Onchocerciasis	0.0	0.0
Leprosy	0.0	0.7
Trachoma	0.0	0.0
Ascariasis	0.0	5.5
Trichuriasis	0.0	0.0
Hookworm disease	0.0	0.0
Other intestinal infections	0.0	0.1
Otitis media	0.0	1.7
TOTAL	141.3	5,403.9

Table 1: Deaths and lost DALYs attributed to global warming by disease or injury outcomes for the year 2004. Source: WHO, *Global Health Risks* (2009).

However, as we will see below, more people die in winter than in summer in many parts of the world. This phenomenon, known as "excess winter mortality," is in large part due to the seasonal increases in deaths from these two conditions during the colder months (see, e.g., Woodhouse 1993; Keatinge 2002). Thus, WHO (2009) apparently does not account for any reduction in mortality from higher temperatures during winter.

WHO (2009) attributes 141,000 deaths and 5.4 million lost DALYs in 2004 to global warming. These translate to 0.2% of all deaths and 0.4% of the burden of disease. Given this, Figure 1 (see next page), also based on WHO (2009), not surprisingly shows that global warming ranks second-last based on global mortality (see the left-hand panel of Figure 1 on next page) or last based on the global burden of disease, i.e., lost DALYs (see the right-hand panel of Figure 1). The rankings are unchanged if one focuses only on developing countries. If one considers only industrialized countries, global warming

should be ranked 23rd based on mortality, and 21st based on the burden of disease.

Clearly, regardless of the criterion, based on its current health impact, global warming does not rank high as a global public health risk.

Which Is the Greater Health Risk—Poverty or Global Warming?

Table 2 (see page 13) shows the 24 risk factors arranged in descending order of the sensitivity of the disease burden to poverty, based on estimates provided in WHO (2009). The higher it is listed on this table, the more sensitive it is to poverty, that is, the greater its relative toll in poorer countries. Sensitivity is determined using the ratio of the disease burden per capita for low-income countries to that of lower-middle-income countries (right-most column).

These ratios range from 11.9 to 0.6, with global warming having the highest ratio. This is consistent with the previous finding that global warming exacerbates diseases of poverty. In fact, of the 141,300 global deaths in 2004 attributed to warming, about 100 (0.08%) were in the industrialized countries. Similarly, with respect to the burden of disease, only 3,000 (0.06%) of the 5.4 million lost DALYs were in industrialized countries.

I will deem arbitrarily that those risk factors that have relative disease burden ratios exceeding 2 are poverty-related. Ten risk factors meet this criterion. 99.4% of the death and disease attributed to these ten risk factors were in developing countries.

In addition to global warming, these risk factors are: underweight (largely synonymous with chronic hunger); zinc deficiency; Vitamin A deficiency; unsafe sex; unsafe water, sanitation and hygiene; unmet contraceptive needs; indoor smoke from solid fuels; sub-optimal breast feeding; and iron deficiency. As Figure 1 indicates, three of these listed—underweight; unsafe sex; and unsafe water, sanitation and hygiene—are the top three health risk factors for developing countries based on their contribution to the burden of disease.

Cumulatively, WHO (2009) attributed 11.2 million deaths and 379 million lost DALYs to these nine poverty-related risk factors. By contrast, 0.14 million deaths and 5.4 million lost DALYs were attributed worldwide to global warming (see Figure 1). Obviously, at present, the health consequences of global warming are trivial relative to the cumulative non-global warming

Figure 1: Ranking global public health priorities based on mortality and disability-adjusted life years (DALYs) lost prematurely in 2004 for 24 health risk factors. The total length of each bar indicates the magnitude of deaths or DALYs lost globally to the specific health risk factor. For developing countries, the ranking of global warming is unchanged, whereas for industrialized countries, it would rank second last on the basis of deaths, and fourth last on the basis of DALYs lost. Source: WHO (2009).

impact of hunger and poverty. Under either criterion, poverty-related health risks easily outrank global warming as global priorities.

The 70- to 80-fold mismatch in scale between the diseases of poverty and global warming indicates that even a small increase in poverty due to, for example, either lower economic growth induced by efforts to reduce greenhouse gas emissions or an increase in biofuel production, could

		Ratio of Low Income to Lower Middle Income	
		Ratio for Deaths per capita	Ratio for Disease Burden per capita
1	Global warming	13.2	11.9
2	Underweight	13.1	10.7
3	Zinc deficiency	9.3	9.0
4	Vitamin A deficiency	8.9	9.0
5	Unsafe sex	8.1	7.9
6	Unsafe water, sanitation, hygiene	6.1	5.2
7	Unmet contraceptive need	8.7	4.7
8	Indoor smoke from solid fuels	1.9	4.7
9	Sub-optimal breastfeeding	4.1	4.0
10	Iron deficiency	5.1	2.6
11	Child sexual abuse	1.8	1.8
12	Lead exposure	1.7	1.6
13	High cholesterol	1.1	1.3
14	High blood glucose	1.2	1.1
15	Unsafe health care injections	0.7	1.1
16	Physical inactivity	0.9	1.1
17	Illicit drug use	1.3	1.0
18	Low fruit and vegetable intake	0.8	0.9
19	Occupational risks	0.7	0.9
20	High blood pressure	0.7	0.9
21	Urban outdoor air pollution	0.5	0.8
22	Alcohol use	0.6	0.6
23	Tobacco use	0.6	0.6
24	Overweight and obesity	0.5	0.6

Table 2: Poverty-related Health Risks Arranged in Order of Sensitivity to Poverty. These are identified based on the ratio of disease burden rates for lower income and lower middle income groups. The grey shaded rows indicate risk factors for which the ratio for disease burden rates exceeds 2. Source: Goklany (2011) calculated from WHO, *Global Health Risks* (2009).

outweigh the public health benefits from the associated greenhouse gas reductions (Tol and Dowlatabadi 2001; Tol and Yohe 2006).

In fact, the improvements in public health since the start of the Industrial Revolution can, in large measure, be attributed directly or indirectly to economic growth, which has been underpinned, in large part, by fossil fuel energy usage in all sectors—agricultural, manufacturing, transportation, service, and residential. This is illustrated in Figure 2 (opposite page), which indicates that as carbon dioxide emissions and economic growth began to take off in the late 18th century, life expectancy, which had been static for millennia, started to increase more or less continuously. The long-term increase in life expectancy can also be viewed as a result of continual reductions in poverty due to economic growth, and its consequences for public health.

What is the Contribution of Extreme Weather Events to Total Mortality?

The wall-to-wall media coverage that accompanies extreme weather-related natural disasters (e.g., droughts, floods, heat waves, hurricanes, cyclones, tornadoes and other storms), give many the impression that such disasters are significant contributors to global mortality. In fact, their collective contribution verges on the negligible, and has been declining for several decades.

There were an average of 210,000 global deaths from extreme weather events and 50 million all-cause deaths annually in the 1950s (EM-DAT 2011; UNPD 2011). By the 2000s, the average annual global death toll from extreme weather events had declined to 38,300, but all-cause deaths had increased to 56 million. Thus, the contribution of extreme weather events to total mortality declined from 0.42% to 0.07% from the 1950s to the 2000s. That is, humanity is apparently coping much better with extreme weather events than it is with far more important health and safety problems (EM-DAT 2011; UNPD 2011). Perhaps public health would advance farther and faster if resources expended on global warming-related public health issues were instead expended on these other health risks.

Are Deaths from Extreme Weather Events Increasing?

Contrary to the impression one may get from media coverage, aggregate deaths and death rates from extreme weather events have been declining.

Consider tornadoes in the U.S. Despite the very active 2011 tornado season, both deaths and death rates for tornados peaked in the 1920s. As of November 11, with the deadliest portion of the tornado season over, the U.S. had suffered 548 deaths from tornadoes in 2011 (NWS 2011). This makes 2011 the fourth deadliest tornado year since 1900. But in terms of death rates, as shown in Figure 3 (see next page), it ranks 23rd. In fact, Figure 3 indicates that over the long term, death rates from tornadoes have been declining.

More broadly, aggregate deaths and death rates from all extreme weather events have been declining globally since at least the 1920s. Comparing the 1920s to the latest (2000–2010) period, the annual deaths from all extreme events declined from 485,000 to 37,000, a 93% decline, while the death rate per million dropped from 241 to 5.4, a decline of 98% (see Figure 4 on page 17).

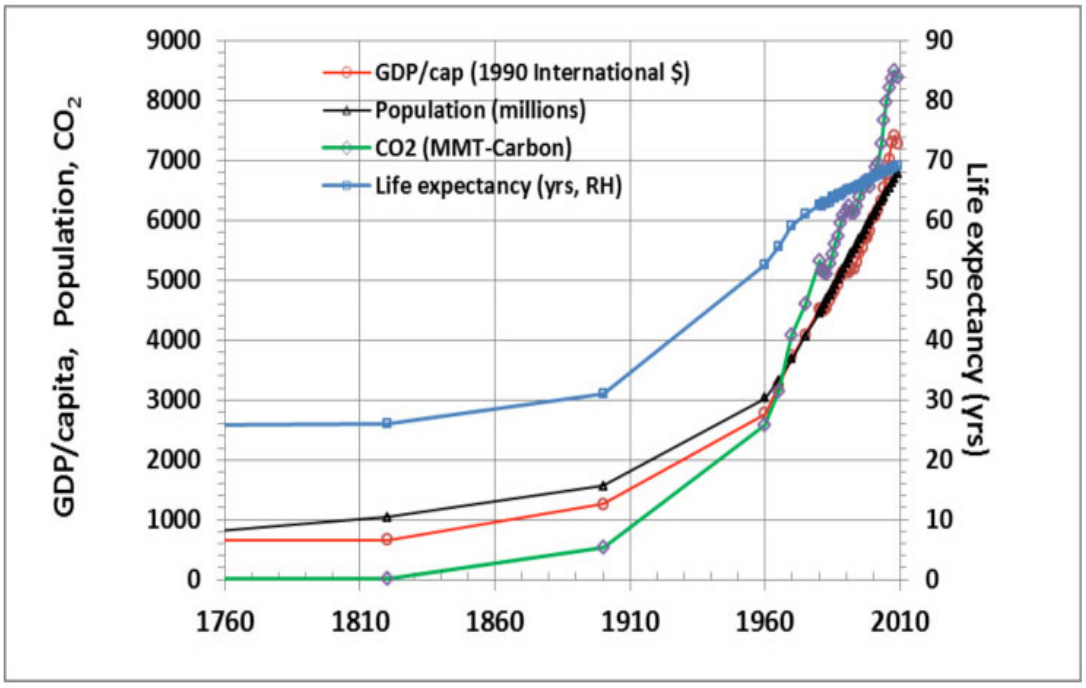

Figure 2: Global Carbon Dioxide Emissions from Fossil Fuels, GDP per Capita, and Life Expectancy, 1760–2009. Sources: Boden et al. (2010), CDIAC (2011), Maddison (2003, 2010), World Bank (2011).

Would Future Health Risks from Global Warming Outweigh Other Health Risks?

Despite being outranked by numerous other health risks based on present day estimates of death and disease, the health impacts of global warming may advance in future rankings if global warming—and, more importantly, its impacts—increases. But neither WHO (2009) nor any other study has made future projections of mortality or lost DALYs for a group of health risks that also includes global warming. So it is not possible to rank global warming relative to other health risks for the foreseeable future, as was done in Figure 1 for 2004.

In the absence of any such analysis, in order to gauge the significance of global warming as a health threat, one can draw upon the "Fast Track Assessments" (FTAs) of the global impacts of global warming sponsored by the British government (Arnell et al. 2002; Parry 2004) to estimate the contribution of global warming to total mortality from hunger, malaria, and extreme weather events for the year 2085.

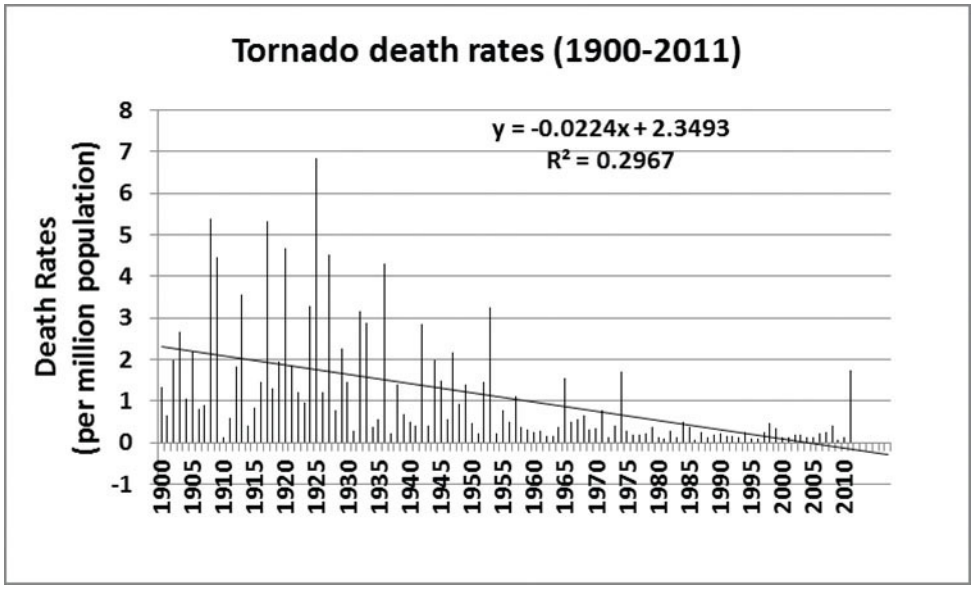

Figure 3: U.S. tornado death rate, 1900–2011. Sources: Brooks (2009); USBC (2011); NWS, Storm Prediction Center, Annual U.S. Killer Tornado Statistics, at http://www.spc.noaa.gov/climo/torn/fataltorn.html, visited 11 November 2011.

The FTA studies were undertaken by an international group of scientists and, from the perspective of the champions of the so-called consensus view of climate science, the FTAs' provenance is impeccable. Many of their authors were intimately involved in the writing of the IPCC's second (1995), third (2001) and fourth (2007) assessments (IPCC 1995, 2001, 2007). For example, the FTAs' hunger study (Parry et al. 2004) was led by Professor Martin Parry, co-chair of IPCC Work Group 2 during the preparation of the IPCC's latest (2007) assessment. More than half the burden of disease attributed to global warming in the WHO's original estimate of the health impacts of global warming (WHO 2002) was derived from an earlier version of the FTA's hunger study. That study was also authored by a team led by Professor Parry (Parry et al. 1999; see McMichael et al. 2004). Similarly, the authors of the FTA studies on water resources (Arnell 2004) and coastal flooding (Nicholls 2004) were lead authors of corresponding chapters in the IPCC's Fourth Assessment Report. Not surprisingly, these studies were considered to be state-of-the-art at the time the IPCC's Fourth Assessment Report was prepared.

Nevertheless, FTA estimates of future global warming impacts are plagued with uncertainties and, more significantly, systematic biases (Goklany 2007a, 2009e). Specifically, like virtually all other climate change impact assessments, they substantially overestimate the negative impacts of warming, while simultaneously underestimating its positive impacts because they fail to fully consider, if at all, future advances in adaptive capacity due to (a) secular technological change, and (b) higher levels of future economic development than were assumed in the development of the emission scenarios used to derive the IPCC's estimates of global warming.

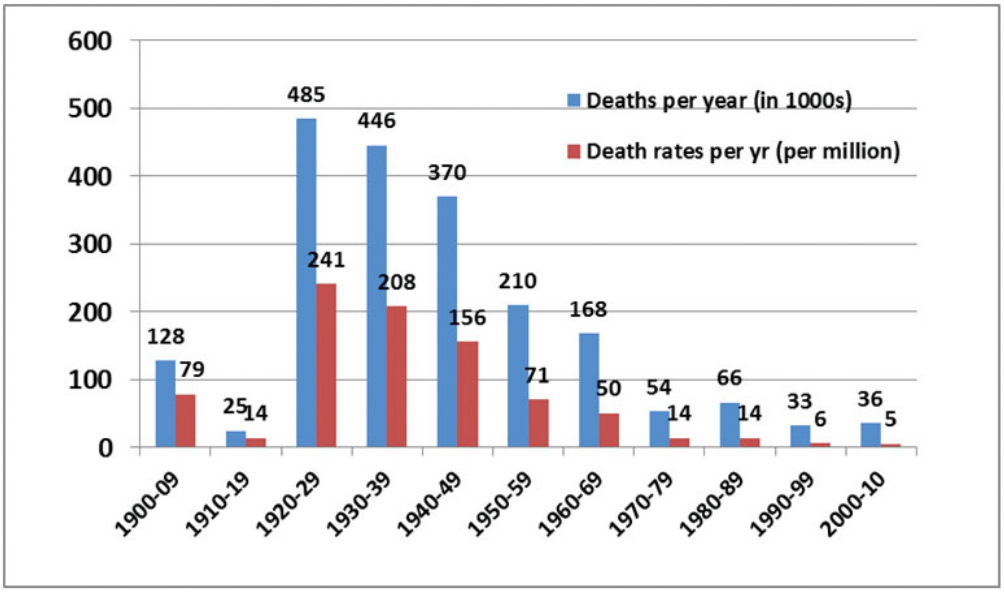

Figure 4: Global Death and Death Rates Due to Extreme Weather Events, 1900–2010. Note: For the last period, 2000–2010, annual deaths and death rates are based on an 11-year average.
Source: Updated from Goklany (2009c).

This not only violates the IPCC's methodological guidelines for impact assessments (Carter et al. 2007a: 136, footnote 2) which require consideration of "autonomous" or automatic adaptations (such as would be driven by the advances in adaptive capacity). It also means that these assessments are internally inconsistent.

Under the IPCC scenarios, which are projected to increase average global temperature by 2.1°C–4.0°C from 1990 to 2085, the average net GDP per capita of developing countries in 2100 is projected to range from US$10,000–US$62,000 (in 1990 US$) even after adjusting GDP downward to account for the upper bound estimate of losses due to global warming per the Stern Review (2006) (see Figure 5 below). To put these numbers in context, consider that:

- The Stern Review estimates include losses from market effects, non-market effects from environmental and public health impacts, and the risk of catastrophe. Thus, the net GDP per capita is a surrogate for human welfare.

- The Stern Review overestimates the costs and damages from global warming (e.g., Carter et al. 2007b; Tol 2008). To quote Tol (2008), it "lies beyond the 95th percentile—that is, it is an outlier."

- In 2006, average GDP per capita for industrialized countries was $19,300; for the United States, $30,100; and for developing countries, $1,500.

Accordingly, even if one assumes no technological improvements through

2100, Figure 5 indicates that future adaptive capacity for even developing countries should substantially exceed current levels under each IPCC scenario. Moreover, if the IPCC's assumptions regarding economic growth out to 2100 are to be trusted, then regardless of which scenario the world follows, there should be few, if any, people living in absolute poverty as currently defined ($1.25 per day in 2005 US dollars, or $456 per year). In fact, absolute poverty is most likely to be eradicated under the wealthiest scenario (A1FI). But this is also the warmest scenario, under which the net GDP per capita in developing countries should be $62,000 in 2100, double the U.S.'s in 2006 ($30,100).

Thus, all else being equal, death and disease from global warming should also be greatly diminished, if not eliminated. Yet the FTA studies, for the most part, ignore this.

For example, the FTA's malaria study (van Lieshout et al. 2004) did not consider any advances in adaptive capacity after the base year (1990), even though its analysis extended to 2085. However, Tol and Dowlatabadi (2001) have estimated that malaria is functionally eliminated once a country's average GDP per capita exceeds $3,100 (also in 1990 US$). Accordingly, by 2085, for practical purposes, malaria should be eliminated (as should other vector-borne diseases).

Even more egregious, the FTA study of water resources (Arnell 2004) did not consider any adaptation at all, even though adaptations to alleviate water

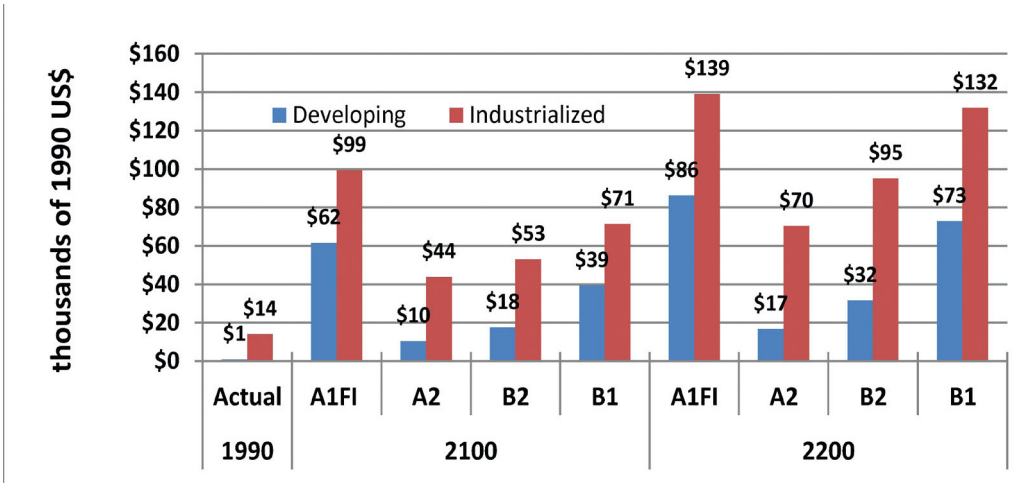

Figure 5: : Net GDP per capita, 1990-2200, after accounting for losses due to global warming for four major IPCC emission and climate scenarios. For 2100 and 2200, the scenarios are arranged from the warmest (A1FI) on the left to the coolest (B1) on the right. The average global temperature increase from 1990 to 2085 for the scenarios are as follows: 4°C for AIFI, 3.3°C for A2, 2.4°C for B2, and 2.1°C for B1. For context, in 2006, GDP per capita for industrialized countries was $19,300; the United States, $30,100; and developing countries, $1,500. Source: Goklany (2009e).

resource problems are among mankind's oldest adaptations. As noted, this is clearly inappropriate and contradicts the IPCC's methodological guidelines, which require that automatic adaptations be included in any assessment.

The FTA's hunger analysis (Parry et al. 2004) is somewhat less prone to systematic error. It allows for increases in fertilization and irrigation because of economic development. It also provides for a modest annual increase in yields from the base year (1990). However, it did not allow for any new technologies subsequent to the mid-1990s. But we know that several new or improved technologies have become available since then and even more should become available by 2085, e.g. bioengineered crops and precision agriculture, which could substantially reduce the negative impacts of global warming on agriculture while taking advantage of any positive outcomes.

But experience informs us that long-term prospective analyses that neglect economic and technological advances will, likely, overestimate future negative impacts by an order of magnitude (Goklany 2009d). For example, an assumption that there would be no advance in adaptive capacity with respect to various water-related diseases—dysentery, typhoid, paratyphoid, other gastrointestinal disease, and malaria—between 1900 and 1970, for instance, would have implied that U.S. death rates for these diseases would be frozen at their 1900 levels. But, in fact, from 1900 to 1970 these death rates declined by between 99.6% and 100.0 percent. Similarly, globally, deaths and death rates from extreme weather events declined by 93% and 98% since the 1920s (EM-DAT 2011). Thus, it is quite likely that due to the combination of economic development assumed under the IPCC scenarios and secular technological change, global warming should, at best, have a trivial impact on public health by 2100.

Nevertheless, despite the tendency of the FTAs to systematically overestimate health impacts, one can use their results to estimate the contribution of global warming to mortality from various climate-sensitive health risks in 2085. In order to do this, assume that mortality for each type of climate-sensitive health risk is proportional to its population-at-risk, as estimated by the FTA studies,[1] and that the population-at-risk of floods is a good surrogate for the population-at-risk of all extreme weather events.

Next, compare the FTA's estimates of the populations-at-risk in 1990 from hunger (Parry et al. 2004) and malaria (Arnell et al. 2002) to estimates of deaths from the WHO for the early 1990s to calculate the coefficients of proportionality between populations-at-risk and deaths. Then apply these relationships to the FTA estimates for the populations-at-risk in 2085 for hunger, malaria and extreme weather events to calculate corresponding mortalities, both with and without global warming for 2085.

1 Because the more recent FTA study for malaria (van Lieshout et al. 2004) neglected to provide estimates of the populations-at-risk (PAR) of malaria in the absence of global warming, Goklany (2009a) used the results of the previous FTA malaria study (Arnell et al. 2002). That study provided estimates of PAR in 2085 in (a) the absence of warming and (b) a warming of 3.2 °C. Per Goklany (2009b), it was also assumed that the additional population-at-risk due to global warming varies with the square of the global temperature change in order to develop estimates consistent with the temperature increases estimated under the various IPCC scenarios.

A similar methodology is used for extreme weather events, except that the FTA estimates of population-at-risk for coastal flooding (Nicholls 2004) is used as a surrogate for extreme weather events, and the mortality estimate for calculating the coefficient of proportionality was obtained from EM-DAT (which compiles the global disaster database).

The results are shown in Table 3 (see opposite page). They indicate that in 2085, global warming should contribute between 7% and 13% to total mortality from hunger, malaria, and extreme weather events, depending on the IPCC scenario that one adopts (see Figure 6 on page 22).

Thus, with respect to these outcomes, other factors are more important than global warming, at least for the foreseeable future.

How should we deal with global warming in the context of other more significant health threats?

Which Would Improve Public Health More—Adaptation or Mitigation?

Focused Adaptation

Figure 6 shows that even if it were possible to roll climate - i.e. temperature, precipitation and other climatic variables - back to 1990 levels through drastic emissions reductions, it would at best reduce mortality from hunger, malaria, and extreme events in 2085 by 13% under the warmest (A1FI/4°C) scenario, while adding a net 1.2 billion people to global PAR of water stress (Figure 7, based on Arnell 2004). Such a rollback would require emissions to be reduced to significantly below 1990 levels, which is infeasible with present technology without incurring astronomical economic and social costs.

Alternatively, one could focus on reducing vulnerability to hunger, malaria, and extreme weather events. Such "focused adaptation" efforts would target 100% of the mortality (compared to a maximum of 13% for emission reductions) while allowing society to benefit from positive impacts of global warming on water stress, even as it tries to reduce its negatives.

For malaria, focused adaptation efforts could include methods to improve antenatal care for expectant mothers in vulnerable areas, developing a malaria vaccine, indoor residual spraying with DDT, insecticide-treated bed nets, and otherwise improving public health services (Reiter 2008). These measures, according to the U.N. Millennium Project (2005a), would reduce malaria by 75% at a cost of $3 billion a year. By contrast, the maximum

Table 3: Mortality in 2085 from Hunger, Malaria, and Extreme Weather Events. Source: Goklany (2009a).

	1990	2085 Scenarios			
	Baseline	**A1FI**	**A2**	**B2**	**B1**
Population in 2085 (billions)		7.9	14.2	10.2	7.9
Global temp change (°C) in 2085		4.0	3.3	2.4	2.1
Mortality in absence of global warming (thousands)					
Hunger	3,240	407	2,976	904	349
Extreme events	25	7	184	87	12
Malaria	1,120	1,657	2,977	2,143	1,657
(Subtotal)	***4,385***	***2,072***	***6,137***	***3,134***	***2,018***
Upper-bound estimate for change in mortality due to global warming (thousands)*					
Hunger	0	109	-35	19	39
Extreme events	0	104	689	164	85
Malaria	0	95	96	44	26
(Subtotal)	***0***	***308***	***750***	***228***	***150***
Total mortality	**4,385**	**2,380**	**6,887**	**3,362**	**2,168**

reduction in malaria mortality that could be obtained in 2085 from emissions reduction is 5% (under the warmest scenario) (see Table 3) were climate to be—implausibly—rolled back to its 1990 level.

For hunger, focused adaptation could include measures to develop crops that would do better in poor climatic or soil conditions (drought, waterlogging, high salinity, or acidity) that could be exacerbated by global warming, and under the higher CO2 and temperature conditions that might prevail in the future. The UNMP (2005b) estimates that a 50% reduction in hunger could cost an additional $12-15 billion per year (see Table 3), a bargain compared to the cost of rolling back post-1990 global warming.

For extreme weather events, focused adaptation would include improved early warning systems, evacuation and response plans, transportation networks and machines to move people, food, medicine and other critical humanitarian supplies before and after events strike, and building technologies.

This approach—focused adaptation—can be extended to all the 37 disease and injury outcomes listed in Table 1. Specifically, this entails reducing vulnerability to today's climate-sensitive global health problems that might be exacerbated by global warming. This has the advantage that it would reduce death and disease from each of these outcomes, regardless of whether it is caused by global warming or something else, whereas mitigation would only address that portion caused by global warming.

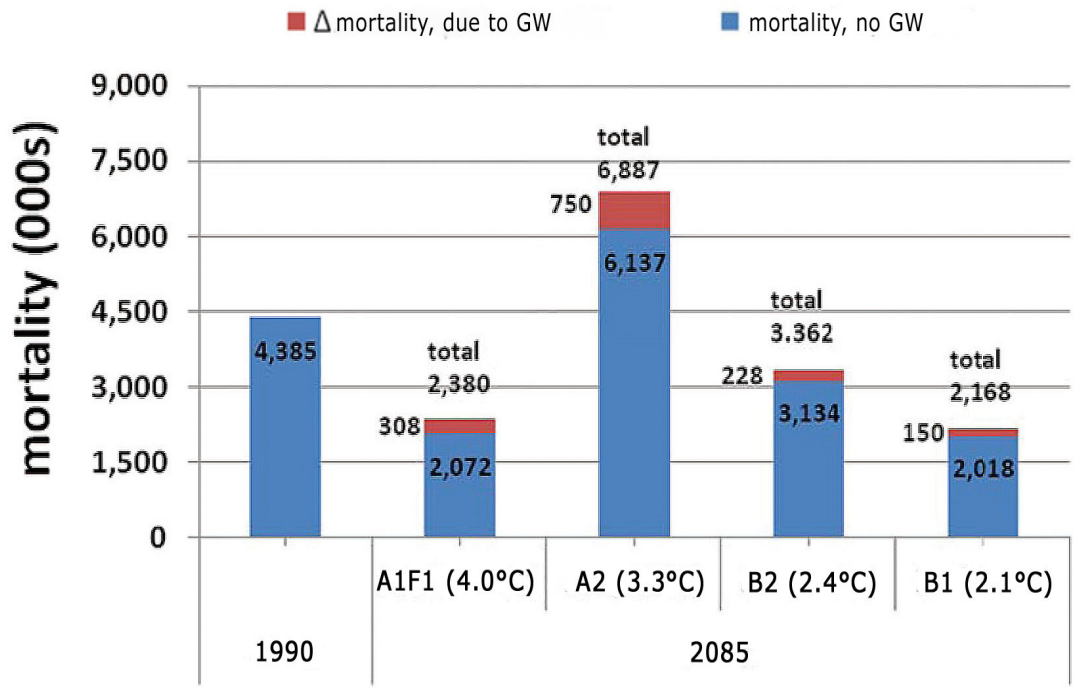

Figure 6. Deaths in 2085 Due to Hunger, Malaria and Extreme Events, with and without Global Warming. Only upper bound estimates are shown for mortality due to global warming. Average global temperature increase from 1990-2085 for each scenario is shown below the relevant bar. Source: Goklany (2009a).

In other words, focused adaptation would address the whole iceberg, while mitigation would only address its tip, and at a much larger cost—essentially paying more for less.

Economic Development and Poverty Reduction

Another approach to addressing the health threats posed by global warming through the foreseeable future would be to strive to increase economic development, which would reduce poverty.

Figure 5 indicates that under the wealthiest-but-warmest (A1FI) scenario, the average net GDP per capita in "developing" countries in 2100 (after accounting for global warming impacts) would be double the U.S.'s present level. It is, therefore, very unlikely that there would be much, if any, absolute poverty under this scenario. Realizing this scenario should, therefore, for practical purposes also eliminate the diseases of poverty, which currently are responsible for 11.3 million deaths and 384 million lost DALYs. Additionally that would eliminate global warming as a public health threat because, as indicated in Table 1, global warming would exacerbate the diseases of poverty, rather than create brand new health risks.

No less important, the benefits of economic growth extend beyond reductions in death and disease to virtually all other aspects of human welfare (Goklany 2007b).

A comparison of the two adaptive approaches—focused adaptation and economic development—with mitigation of global warming indicates that either adaptive approach will, for a fraction of the cost of any significant emission reductions, deliver greater benefits for human health and well-being. These greater benefits would also be delivered faster because any benefits from emission reductions would necessarily be delayed by several decades due to the climate system's inertia. No less important, they would accrue to humanity with greater certainty because, while the reality of hunger, malaria, and extreme events is uncontested, the contribution of global warming to these problems is, at best, uncertain, as discussed previously.

Yet another benefit of the adaptive approaches is that they allow societies to take advantage of the positive consequences of higher carbon dioxide concentrations and global warming (e.g., higher crop productivity due to carbon fertilization, longer growing seasons in some areas, or lower water stress in some heavily populated areas—see Figure 7). On the other hand, mitigation indiscriminately reduces both the positive and the negative impacts associated with global warming. Essentially the adaptive approaches are scalpels compared to mitigation, which is necessarily a meat axe.

Are Global Warming Policies Deadlier than Global Warming?

Among the policy responses to the perceived threat of global warming are subsidies and mandates for the production and use of biofuels, including ethanol and biodiesel. This has helped fuel an increase in food prices which, in turn, has increased the number of people suffering from chronic hunger (FAO 2009a, 2009b). It has also added to the number of people living in "absolute poverty" worldwide, particularly in developing countries (World Bank 2009a).

A World Bank Policy Research working paper, based on analysis covering 90% of the world's population, estimates that the number of people living in absolute poverty, i.e., the "poverty headcount", in developing countries would decline from 1,208 million in 2005 to 798 million in 2010 because of economic development (De Hoyos and Medvedev 2009). But it also estimates that higher food prices induced by increased biofuel production

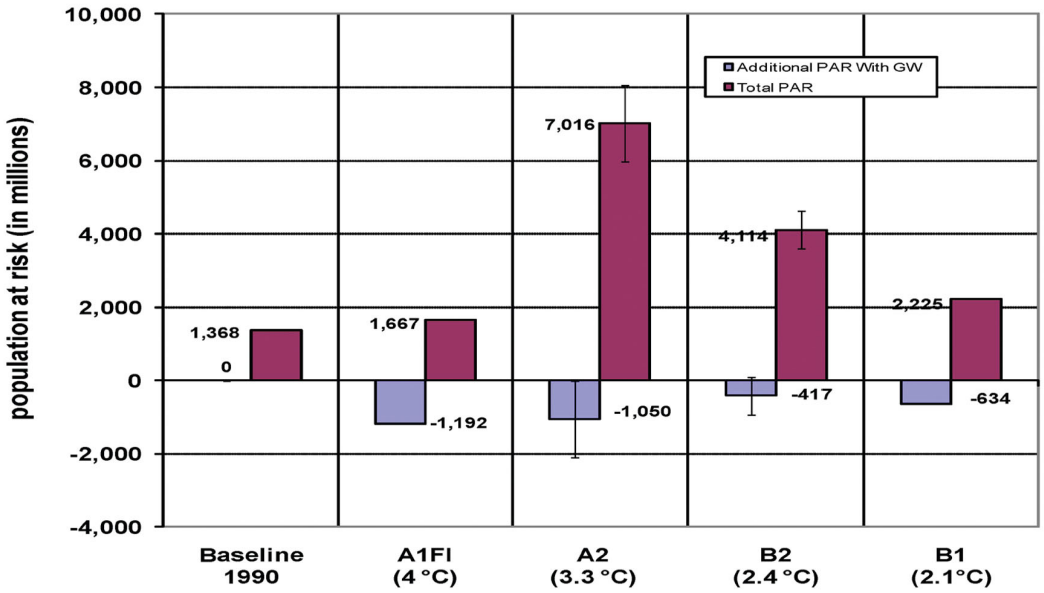

Figure 7. Population-at-risk (PAR) from Water Stress in 2085, With and Without Global Warming. [20, 37] The vertical bars indicate the PARs based on the mid-point estimates of several model runs, while the vertical lines indicate the range of estimates. Source: Goklany (2009a) derived from Arnell (2004).

over the 2004 level would drive an additional 32 million into absolute poverty in 2010. In other words, biofuel policies are retarding humanity's on-going battle against poverty.

If one (a) adjusts this estimate upward to account for the less-than-total coverage of the world's population and (b) assumes proportionality between the headcount of people living in absolute poverty on one hand and, on the other, death and disease in developing countries due to poverty-related diseases per WHO (2009), then one can (c) calculate the increase in death and disease due to increases in biofuel production. Using this methodology, I estimate that the increase in biofuel production between 2004 and 2010 may have led to 192,000 additional deaths and 6.7 million additional lost DALYs in 2010 alone (Goklany 2011).

By contrast, WHO (2009) "attributes" 141,000 deaths and 5.4 million lost DALYs in 2004 to global warming. Given the climate system's inertia, the reduction in these numbers from any slowing of global warming due to the increased use of biofuels is, most likely, negligible. Moreover, death and disease due to poverty is real whereas death and disease attributed to global warming is hypothetical and, as already emphasized, based on unverified models and scientific short cuts, according to the very researchers who developed those estimates (McMichael et al. 2004: 1546). Thus, biofuel policies motivated, in part, by the high-minded desire to mitigate global warming in order to reduce death and disease in the developing world may have made matters worse.

Nor are industrialized countries, despite their wealth and advanced adaptive capacity, immune from the unintended consequences of global warming policies. Mortality data from a variety of industrialized countries show that average daily mortality is substantially higher in cold months than in warm months.

This is shown in Figure 8 (see next page), which is based on ten years' data for the US and Canada. It shows that average daily mortality peaks in January at 7,400 deaths in the U.S., and 680 in Canada. Its low is in August (6,100 daily deaths in the U.S. and 570 in Canada).

Table 4 (on page 27) shows the "excess winter mortality" for several industrialized countries in both the Northern and Southern Hemispheres. This is calculated as the increase in the number of deaths during the four coldest months—January, February, March and December in the Northern Hemisphere, and June through September in the Southern Hemisphere—over the number of deaths that would have occurred had daily death rate stayed at the average level during the other eight months of the year. It shows, for example, that excess winter mortality was 108,500 for the U.S. in 2008 (NCHS 2009), 25,400 for England and Wales in the winter of 2009-2010 (UKONS 2011), and 50,887 for Japan (averaged over 2006 and 2007) (Falagas et al. 2009).[2] Notably, the aggregate excess winter mortality from the U.S. and Japan alone (159,000) exceeds the WHO's latest estimate of deaths from global warming (141,000)!

Figure 9 (on page 28) shows that the excess winter mortality for England and Wales has declined more or less continuously from 106,400 in the winter of 1950/51 to 25,400 in the winter of 2009/10 (UKONS 2011). While some of this reduction might conceivably be due to global warming, the majority of the reduction is probably due to higher living standards—better housing, better economic access to heating, adequate clothing, and generally better health. Poorer nutrition may also have contributed to the high death levels in the early 1950s, considering that food rationing was in effect until 1954.

The phenomenon of excess winter mortality may also be present in warmer areas of the world and in developing countries. Marie et al. (2009) showed that in Cuba, deaths from heart diseases and cerebrovascular diseases, which accounted for 37% of all deaths in that country from 1996–2006, were highest in the colder (winter) months. Seto et al. (1998) found that in Hawaii, mortality from carotid artery disease was 22% higher in the winter. Douglas et al. (1991) found that mortality was higher in the winter in Kuwait. Woodhouse (1993) reported that more deaths occurred in winter in a number of countries including Tunisia and Hong Kong, but not in Egypt. Even for São Paolo, Brazil, which is at the Tropic of Capricorn, Gouveia et al. (2003) 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

2 Calculations for England and Wales are done using the meteorological year rather than calendar year, starting in August of the previous year (see UKONS 2011).

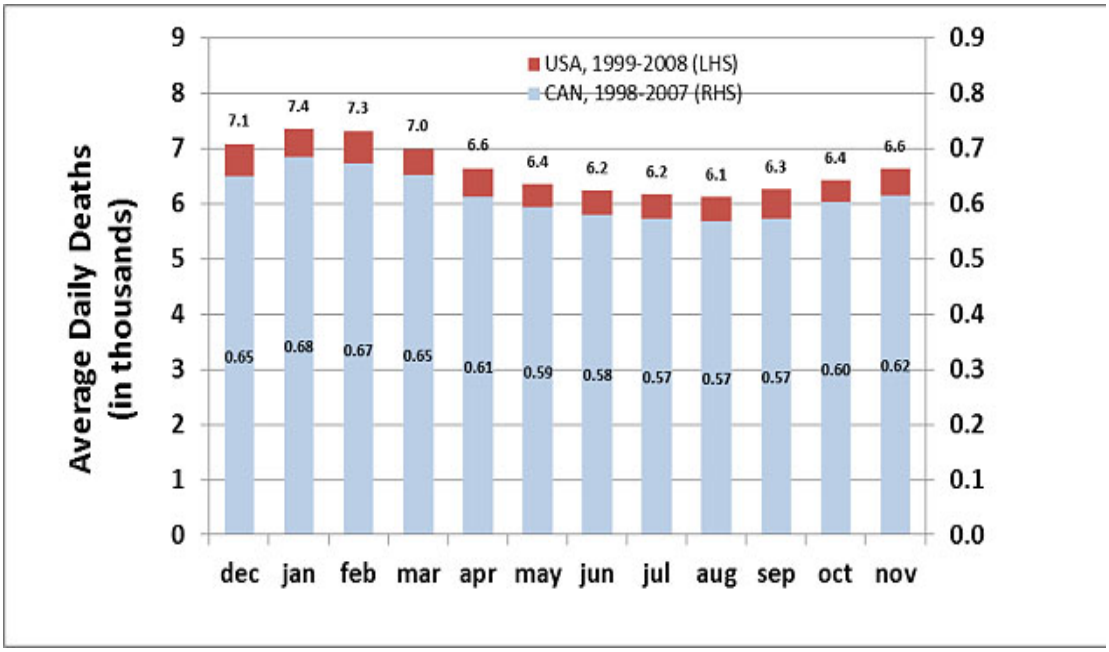

Figure 8: Average daily deaths for each month, United States, 1999-2008, and Canada, 1998-2007. Sources: NCHS (2008, 2009, 2010) and Statistics Canada (2010).

children were similar, but somewhat weaker for adults. Shanghai, China also has more deaths in winter than in other months (Kan et al. 2003), but this is less surprising given its latitude.

Finally, Duschenes and Moretti (2009) estimate that 4%–7% of the total gains in life expectancy in the U.S. population from 1970 to 2000 may be due to continuing migration from the cold Northeastern states to the warmer Southern states.

For the future, Tol (2002) estimates that net mortality from cardiovascular disease (from heat and cold stress) and respiratory disease (due to heat stress) may decline by half a million in 2050, and 1.5 million in 2200, because reductions in mortality due to lower cold temperatures would more than offset increases due to hotter weather. Similarly, Kovats (2004) estimates that through the 2050s, global warming would reduce net mortality in Europe. Bosello et al. (2006), however, have a mixed result. Their estimates indicate that net mortality from cardiovascular and respiratory diseases should decline by 1.4 million worldwide in 2050 for a 1 °C temperature increase from 1997 to 2050; however, they also estimate an increase in the burden of disease of 4.2 million (based on additional years spent in a diseased condition). However, they do not account for secular technological change.

All this indicates that claims that global warming would increase net mortality should be viewed with scepticism unless there is specific—and accurate—accounting for changes in mortality that would result from increases in year-round temperature that might occur not only because of greater warming during the summer months, but lesser cooling in the winter months.

Table 4: Excess Winter Mortality in Various Industrialized Countries.

	Excess Winter Mortality (deaths per year)	Basis	Years for data	Source
US	**108,500**	2008	2008	US NCHS (2009)
Canada	**10,266**	2007	2007	Statistics Canada (2010)
England & Wales	**25,400**	winter of 2009-2010	2009-2010	UKONS (2011)
Australia	**6,779**	2008	2008	Australian Bureau of Stat (2009)
New Zealand	**1,532**	2008	2008	Statistics New Zealand (2010)
Japan	**50,887**	avg	2006-07	Falagas et al. (2009)
France	**24,938**	avg	1995-2006 exc 2004	Falagas et al. (2009)
Italy	**37,498**	avg	1950-2007	Falagas et al. (2009)
Spain	**23,645**	avg	1960-70, 1975-2007	Falagas et al. (2009)
Sweden	**4,034**	avg	1987-2007	Falagas et al. (2009)
Greece	**5,820**	avg	1960-2005	Falagas et al. (2009)
Cyprus	**317**	avg	1996, 1998-2000, 2002-2006	Falagas et al. (2009)
NOTE: Winter months = Jan, Feb, Mar, Dec in Northern Hemisphere; Jun, Jul, Aug, Sep in Southern Hemisphere				

Moreover, mitigation policies that would increase the price of fossil fuels have a number of detrimental public health effects. First, an increase in the price of agricultural inputs and the price of food would, similar to the case of biofuel production, exacerbate hunger and its public health consequences.

Second, higher fuel prices would leave the poor more vulnerable to cold-related health problems, and this problem would only worsen if mitigation policies indeed result in colder temperatures.

To summarize, policies to reduce global warming may be doing more harm than good for public health in both developing and industrialized countries.

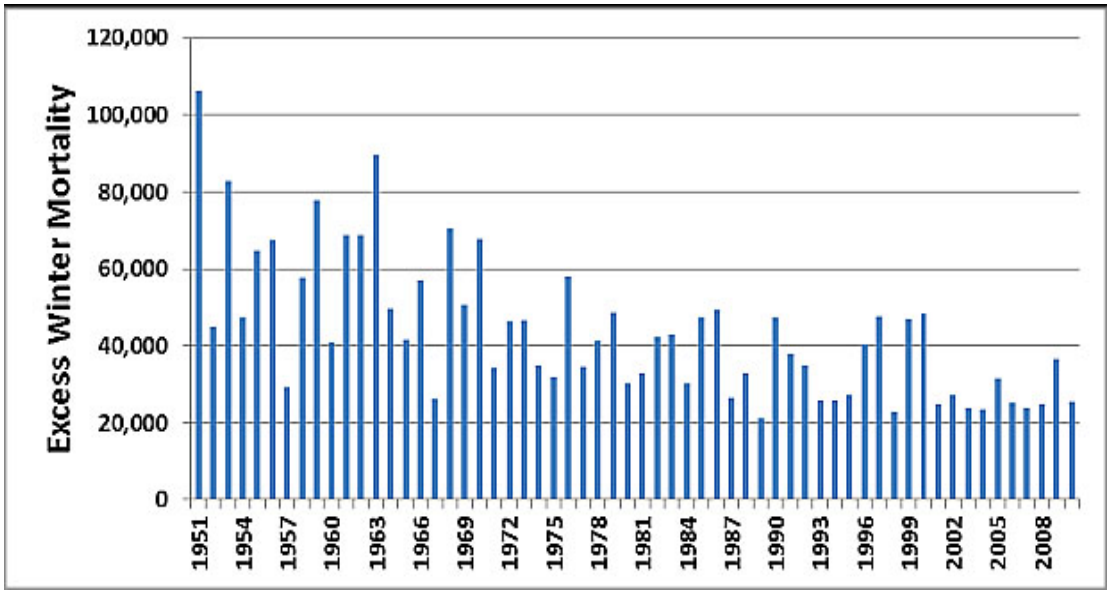

Figure 9: Excess Winter Mortality, England and Wales, from the winter of 1951 to the winter of 2010. This is calculated as winter deaths (deaths occurring in December of the previous year to March of the current year) minus the average of non-winter deaths (April to July of the current year and August to November of the previous year). Source: UKONS (2011).

Conclusion: Reducing the Urgent Health Risks that Global Warming Would Exacerbate

Even on the basis of speculative analysis that tends to systematically overestimate the threat of global warming, it is now, and for the foreseeable future, outweighed by numerous other health threats. Many of these greater threats are diseases of poverty.

Exaggerating the importance of global warming seriously risks misdirecting the world's priorities and its resources in efforts to reduce poverty and improve public health. Equally importantly, policies to curb global warming would, by increasing the price of energy and reducing its usage worldwide, slow down, if not reverse, the pace of economic growth. As economic development is central to the fight against poverty, such policies would tend to perpetuate the diseases—and all the other problems—associated with poverty. Specifically, since the diseases of poverty are currently responsible for 70–80 times more death and disease than global warming, such policies may well be counterproductive. They would, moreover, slow advances in society's adaptive capacity, and otherwise retard improvements in human well-being (Goklany 2009e).

For example, the increase in biofuel production between 2004 and 2010, partly as a consequence of policies designed to reduce dependence on fossil fuels, is estimated to have increased the population in absolute poverty in the developing world by over 35 million, leading to about 200,000 additional deaths in 2010 alone. Moreover, to the extent that mitigation may have reduced the rate of warming (which is the best that mitigation can hope to achieve given current technologies and the inertia of the climate system), it may have slowed the reduction in excess winter mortality, a phenomenon that isn't only restricted to the higher latitudes.

Since global warming would mostly amplify existing health risks that are associated with poverty, tackling these underlying health risks (e.g., hunger, malaria and other vector-borne diseases listed in Table 1) would also address any incremental health risks attributable to global warming. Accordingly, global health and well-being would, for the foreseeable future, be advanced farther, faster, more surely and more economically through (a) focused adaptation, that is, efforts focused on reducing vulnerability to today's urgent poverty-related health problems that may be exacerbated by global warming, or (b) increasing adaptive capacity, especially of developing countries, through economic and technological development rather than on (c) quixotic and, most likely, counterproductive, efforts to reduce energy usage.

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For further information about the GWPF or a print copy of this report contact:

The Global Warming Policy Foundation
1 Carlton House Terrace, London SW1Y 5DB
T 020 7930 6856
M 07553 361717
www.thegwpf.org

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