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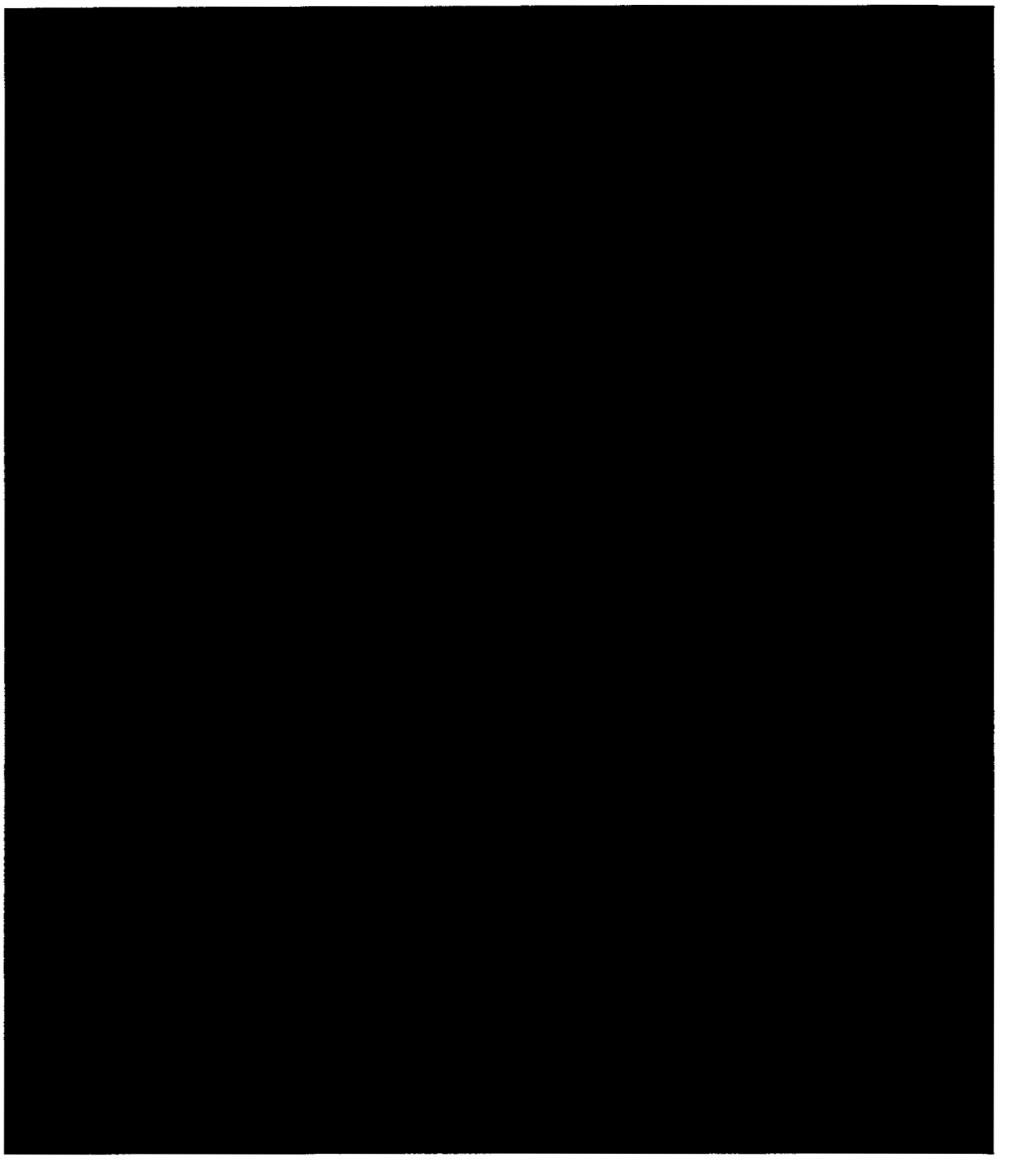

a position paper of the
american council on science and health

special report

global climate change and human health

a position paper of the american council on science and health

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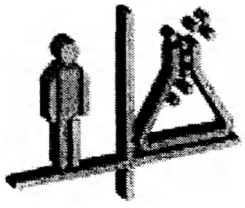

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Abbreviations Used in This Report

ACSH .....American Council on Science and Health
C .....Celsius
CC&HH .....*Climate Change and Human Health*
FCCC .....United Nations Framework Convention on Climate Change
GBDS .....*Global Burden of Disease Study*
GHG .....greenhouse gas
IPCC .....Intergovernmental Panel on Climate Change
WHO .....World Health Organization
WHR .....*World Health Report*

Position Statement

The following statements summarize the position of the American Council on Science and Health (ACSH) on dealing with the potential health effects of projected climate change.

- Nearly all of the potential adverse health effects of projected climate change are significant, real-life problems that have long persisted under stable climatic conditions. Bolstering efforts to eliminate or alleviate such problems would both decrease the current incidence of premature death and facilitate dealing with the health risks of any climate change that might occur.

- Policies that weaken economies tend to weaken public health programs. Thus, it is likely that implementation of such policies would (a) increase the risk of premature death and (b) exacerbate any adverse health effects of future climate change.

Infectious diseases have always been a major cause of premature death for humans. In 14th-century Europe, for example, successive epidemics of bubonic plague depopulated 200,000 towns and killed 25 million people.[1] Over subsequent centuries life expectancy in Europe gradually increased as scientific, technological, agricultural, and industrial revolutions improved food supplies, housing, and public sanitation and made clean clothing more affordable. By the early 19th century, advances in chemistry, microbiology, epidemiology, and medicine had vastly improved understanding of the nature of diseases. European life expectancy continued to increase steadily, largely because of smallpox immunization and improvements in supplies of food and water. Organic chemistry and other biological sciences set the stage for the creation of new pharmaceuticals for treatment of infectious diseases.

In the United States, where most infectious diseases have been largely controlled, life expectancy has increased from 46 years in 1900 to 76 years in 1996. All of the numerous causes of this increase in life expectancy derive from science, technology, and industry. Those causes include water processing, immunization, antibiotic therapy, the use of pesticides to control disease-spreading organisms, and improvements in the availability, safety, and essential-nutrient content of foods.

In developing countries, increases in life expectancy in recent years have also been substantial. Between 1960 and the early 1990s, life expectancy in developing nations increased from 46 years to 64 years. Nevertheless, infectious and parasitic diseases continue to constitute the main cause of premature death (i.e., death at any age below 65) in developing nations. Of the 52 million people who died worldwide in 1996, about 30 million died prematurely. About half the premature deaths were due to preventable infectious diseases, such as malaria and many intestinal illnesses. Many infectious diseases are spread by insects, mites, and ticks.

There is good reason to expect further improvement in the control of vectors—the insects and other organisms that transmit sources of disease. According to *The Global Burden of Disease Study* (1996)—a worldwide public health survey compiled by the World Health Organization (WHO), the Harvard School of Public Health, and the World Bank—poverty is a frequent reason that people die from vector-borne diseases. It has been estimated that in 1995 malaria killed as many as 2.7 million people world-

wide and newly afflicted as many as 500 million.[2] But the authors of *The Global Burden of Disease Study* projected that malaria, the 11th most common cause of death in 1990, would be the 29th most common cause in the year 2020.

Recently, concern has been raised that future climate change due to human actions will complicate the control of malaria and other infectious diseases. According to *Climate Change and Human Health*[3] (*CC&HH*)—the 1996 report by a Task Group of the World Health Organization, the World Meteorological Organization, and the United Nations Environment Programme—if warming of the Earth's surface occurs, the incidence of infectious diseases may increase. *CC&HH* states that such warming could increase the range of the organisms that transmit the sources of these diseases. For example, the *CC&HH* Task Group estimated that global warming may increase the annual number of new malaria cases by 50 million by the year 2100.

The Task Group also suggested that global climate change may cause additional deaths by increasing the incidence of extreme weather events (e.g., severe storms, heat waves, and droughts) and by raising the sea level. The effects of climate change could be direct, as in drowning due to a flood, or indirect, as in starvation due to crop failure. Because future climate change could increase health risks, the Task Group recommended stringently limiting human-induced emissions of carbon dioxide, methane, and other greenhouse (heat-trapping) gases termed "minor."[4]

From the standpoint of public health, stringently limiting such emissions at present would not be prudent. Fossil-fuel combustion, the main source of human-induced greenhouse-gas emissions, is vital to high-yield agriculture and other practices that are fundamental to the well-being of the human population. A significant short-term decline in such actions could have adverse health repercussions.

What, then, is the optimal policy for dealing with the hypothetical adverse health effects of projected human-induced global climate change? Having reviewed the pertinent literature, the American Council on Science and Health has reached the following conclusions. These are based on the working assumption that the predictions of the Intergovernmental Panel on Climate Change concerning the magnitude of human-induced global climate change and its adverse effects on weather and human health are correct.

- The global burden of disease is formidable. Well-understood public health measures could significantly decrease the current incidence of premature death. But resources for applying these measures are currently inadequate. Thus, work toward increasing these resources is prudent regardless of the prospect of climate change.

- Measures to adapt economies, healthcare systems, and living conditions to existing and foreseeable challenges to human health (for example, infectious diseases, undernourishment, and weather disasters) should be the focus of any policy concerning climate change and human health.

- The optimal approach to dealing with prospect of climate change would (a) include improvement of health infrastructures (especially in developing countries) and (b) exclude any measures that would impair economies and limit public health resources.

Dealing with current and future public health problems should include increased investment:

- in improving drinking water and sanitation in developing countries;

- in cost-effective control of organisms that spread disease, especially in developing countries;

- in improving food production and distribution in developing countries;

- in systems of emergency responses to extreme weather events;

- in the economic and health infrastructures of developing countries to increase access to medical services;

- in development of additional vaccines and antibiotics against infectious diseases;

- in research concerning energy technologies that entail low greenhouse-gas emissions; and

- in research concerning the potential health effects of projected climate change.

Executive Summary

According to some forecasters, adverse impacts on the health of the human population may result from anthropogenic (human-induced) climate change—specifically, rises in the average temperature of the Earth's surface due to human actions that increase atmospheric concentrations of carbon dioxide and other greenhouse (heat-trapping) gases.

Computer simulations of the Earth's climate project that, *if* atmospheric concentrations of greenhouse gases increase as predicted, the average global temperature will increase by 1 to 3.5 degrees Celsius (C) by the year 2100. Simulations *based on this estimate* project changes in environmental conditions that may be detrimental to human health, including increases in:

- exposure to infectious diseases,
- the incidence of extreme weather events (e.g., heat waves), and
- coastal flooding due to sea level rise.

In this report the American Council on Science and Health (ACSH) reviews recent assertions concerning the potential adverse health effects of projected human-induced global climate change. Sourcebooks included *Climate Change and Human Health, The Global Burden of Disease Study* (1996),[5] the *World Health Report 1996*,[6] and the *World Health Report 1997*.[7] It was not ACSH's intention to evaluate the hypothesis that such climate change will occur. Our guiding questions were:

- How might global climate change affect the health of the human population?
- How should policymakers respond to the prospect of climate-change–related health effects?

Current proposals for dealing with projected climate change focus on mitigating (lessening) predicted human-induced global warming through severe compulsory limiting of developed countries' greenhouse-gas emissions. Implementation of these proposals would significantly weaken the global economic system. The optimal approach to dealing with the prospect of adverse climate-change–related health effects would be largely *adaptational*: its primary goal would be to suit economies, healthcare systems, and living conditions to lasting—i.e., existing and foreseeable—challenges to human health. Such a strategy would focus on preventing adverse health effects of ongoing natural climate change without impeding the global economic system. Regardless of whether human-induced climate change will occur, we need policies for coping with infectious diseases and severe weather impacts of natural origin. Implementation of policies for dealing with present-day climatic impacts adverse to human health would facilitate coping in the future with any adverse health impacts of human-induced climate change.

According to most computer simulations, global climate change would develop slowly. Timely, vigorous, well-financed medical-research and public health efforts against major real-life health problems should provide tools that would be effective against most of the potential adverse 21st century health effects of projected climate change.

I. Introduction

According to recent controversial studies, future global climate change due to human actions would have an adverse impact on human population health. Some researchers have theorized that global climate change—projected from possible atmospheric increases in greenhouse gases (GHGs) such as carbon dioxide—would increase human mortality by increasing:

- the incidence of vector-borne diseases (for example, malaria, yellow fever, and dengue, which are caused by mosquito-transmitted parasites);
- the incidence of flooding;
- the incidence of droughts; and
- heat and relative humidity.

The poor, the elderly, the ill, and children would be particularly susceptible to events whose incidence future global climate change may increase.

A. What Is Climate Change?

Below are definitions of some of the more important terms used in this paper.

weather: The short-term state of the atmosphere in a locality. The values of atmospheric parameters—such as temperature, relative humidity, and precipitation—can change significantly within a day.

climate: The average weather in a relatively large area over years.

climate change: A change in atmospheric parameters (e.g., average yearly temperature) over a moderately long period (e.g., decades) that is either regional (e.g., New England, North America, southern hemisphere) or global.

global warming: An increase in the average surface temperature of the Earth.

Climate change has long impacted life on Earth and will continue to do so. Natural (non–human-induced) climate change can be rapid, geologically speaking. Global climatic upheavals—as when the average global temperature falls by 5 to 8 degrees C and great masses of ice move over land—can occur within one millennium. Ice ages are periods of widespread coverage of land by glaciers. The last ice age ended approximately 12,000 years ago. For the last 10,000 years Earth's climate has been relatively warm; this warm climate has contributed to cultural development and to the growth and geographic expansion of the human population. But the historical record shows that even during this epoch, modest variations in climate have sometimes had severe consequences, especially at the edges of climatic zones.[8] Climate change is therefore an important policy consideration.

B. The Potential Human Factor in Climate Change

Concern has arisen that certain human actions may adversely affect the health of the human population through effects on both the Earth's mean climate and its variability.

Key to the industrial development that began in the late 18th century has been the large-scale burning of fossil fuels, such as coal, gas, and oil. The considerable increase in energy production led to an historic increase in human productivity; to the development of high-speed transportation, communication, and computation; to major advances in agriculture; and to the development of science-oriented medicine. Industrialization and technological progress resulted in an alleviation of human suffering and an increase in human life expectancy.

But the large-scale burning of fossil fuels has also increased the atmospheric concentrations of carbon dioxide and other greenhouse gases. Gases termed "greenhouse" are those that tend to prevent the transference of heat from the atmosphere to outer space. Recent projections from computer climate simulations by the United Nations Intergovernmental Panel on Climate Change (IPCC) suggest that, at current rates of GHG emissions, the Earth's average surface temperature will increase by 1 to 3.5 degrees C by the year 2100.[9] Projections from some climate simulations also suggest that regional climate changes will cause events deleterious to humans.

The potential health impacts of projected human-induced climate change are the focus of *Climate Change and Human Health* (*CC&HH*), the 1996 report by a Task Group of the World Health Organization, the World Meteorological Organization, and the United Nations Environment Programme.

C. ACSH's Approach to the Issue

According to *CC&HH*, climate change would most seriously affect human population health: (1) by causing shifts in ecological systems that could increase the incidence of vector-borne infectious diseases; (2) by increasing the incidence of extreme weather events (e.g., heat waves); and (3) by raising the sea level.[10]

Accurate descriptions of existing health problems are essential for sound health-policy development. In 1995 infectious diseases killed 17 million people, 11 million of whom were children. The potential impact of projected climate change on the spread of infectious diseases is a major theme in *CC&HH*. Our approach to the climate change–human health issue was to compare the health-related predictions of *CC&HH* with the content of three other major documents: *The Global Burden of Disease Study* (*GBDS*), the *World Health Report 1996*, and the *World Health Report 1997*.

The *GBDS* is the result of a cooperative effort by the World Health Organization (WHO), the Harvard School of Public Health, and the World Bank. The book features: (a) a review of health statistics that pertain to the period of 1950 to 1990 approximately, and (b) forecasts of global rates of death, disease, and disability to the year 2020. Global climate change was not a consideration in these forecasts.

The *World Health Report* (*WHR*) is an annual that describes the actions of the WHO. The 1996 and 1997

Table 1. Sources of Information on World Health Used in the Preparation of this Report

Title	Period Covered	Comment on Infectious Disease	Primary Focus
Climate Change and Human Health	1800–1996 (real data) 1996–2100 (projected threat analysis)	The spread of infectious diseases will increase by 2100 because of climate change.	hypothetical future health problems due to projected climate change
The Global Burden of Disease Study	1950–1990 (real data) 1990–2020 (projected data)	Infectious diseases are on the decline.	worldwide human health status (no mention of climate change)
World Health Report 1996	1995	"Fatal complacency is now costing millions of lives."	worldwide human health status (passing mention of climate change)
World Health Report 1997	1996	Health providers should address the "double burden" of infectious disease and chronic illness.	worldwide human health status (passing mention of the WHO's support of the work of the International Panel on Climate Change)

editions were used in preparing this ACSH special report.

Table 1 briefly describes the aforementioned four books.

The chief assumption underlying the following analysis is that global climate change will occur as projected by the IPCC (the *CC&HH* Task Group made this assumption). Mortality was the only health parameter used in the analysis. Nearly all governments require reporting of mortality. Other parameters of health—disability, for example—were not considered.

D. Health Policy Implications

By cosponsoring the publication of *CC&HH*, the WHO has suggested that it will consider human-induced climate change in its development of future global health policy. Regarding climate change and health, *CC&HH* (p. 6) states: "It is anticipated that most of the impacts would be adverse." To support this statement, the *CC&HH* Task Group reviewed how "natural climate fluctuations" have affected human population health during the industrial age (approximately 1800 to the present).

Adverse weather is local, short-term, and largely unpredictable. Extreme weather events cause considerable human suffering, and in some areas systems for coping with weather disasters are inadequate. Efforts should be made to improve responses to adverse weather and its consequences. If the focus of policy decisions changes from coping with weather calamities to limiting GHG emissions, a misallocation of resources would occur that could have an adverse impact on human population health. If, as the IPCC has suggested, decades will pass before hypothetical human-induced global climate change has significant consequences, the opportunity exists to develop technology that would ameliorate or even cost-effectively avoid most of the projected health consequences.

The cost of decreasing human-induced emissions of GHGs could significantly weaken the global economic system.[11,12,13] Severe limiting of GHG emissions seems unnecessary at present: If hypothetical human-induced global climate change occurs as projected—i.e., slowly and moderately—there is time to develop affordable mitigative technology before future global climate change has a significant impact on human population health.[14]

In any case, focusing on the broader issue of natural climate change is desirable because such change has occurred repeatedly for millennia and its recurrence is inevitable.

E. Minor Hypothetical Health Outcomes of Projected Global Climate Change

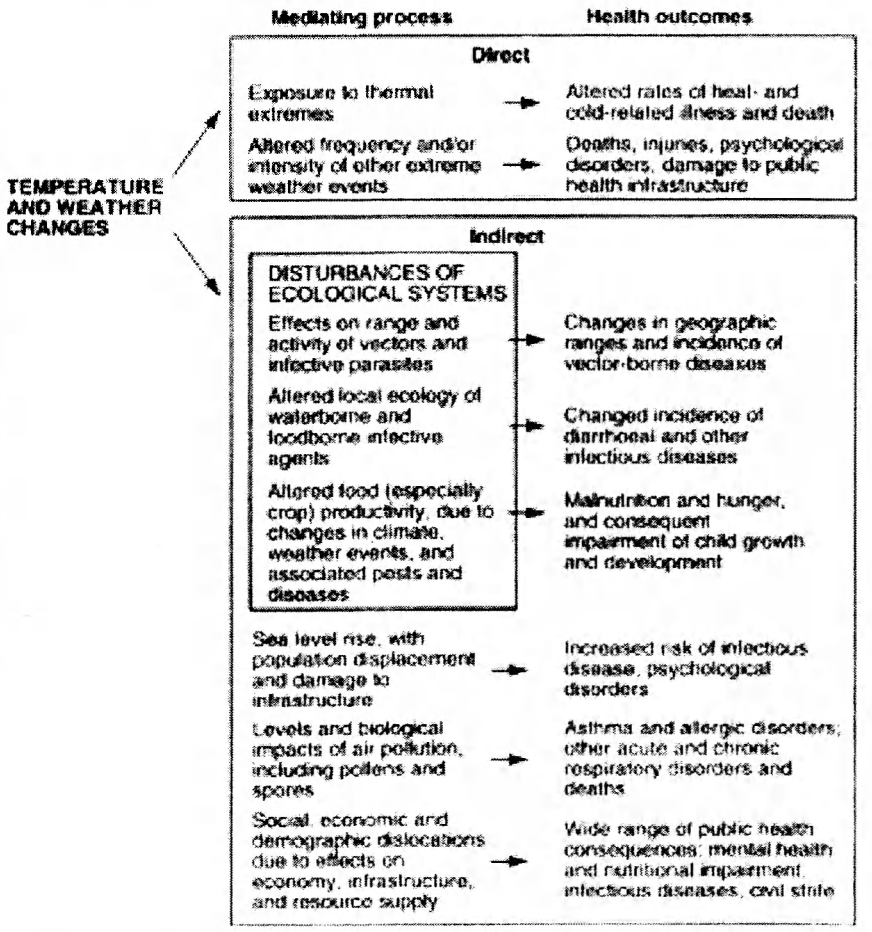
Some of the hypothetical outcomes of global climate change indicated in Figure 1 are much more serious than others. One serious hypothetical outcome is an increase in the incidence of malaria and other vector-borne infectious diseases—a subject addressed in Section F (page 11). Two questions can help distinguish major from minor hypothetical outcomes of global climate change: (1) How many human deaths would the mediating process (e.g., sea level rise) cause? (2) How strong is the link between projected global climate change and the mediating process and outcome?

Heat-Related Deaths

A globally averaged warming of 1 to 3.5 degrees C by the year 2100 probably would not affect the incidence of heat-related death. The worldwide number of deaths in 1995 due to heat waves (successive days with temperatures above 90 degrees Fahrenheit) probably constituted a very small fraction of the total number of 1995 deaths.[15] An increase in mortality during a heat wave is usually followed by a decrease,[16] because the people most susceptible to heat waves are those for whom death from other causes is likely within several weeks of the heat wave.[17] Furthermore, it is possible that a decrease in cold-related deaths would offset a long-term increase in heat-wave–related deaths.[18] In any case, according to 1996 IPCC computer simulations, most of the warming would occur in winter and at high latitudes.

Figure 1

Possible major types of impact of climate change on human health



Adapted from McMichael et al. *Climate Change and Human Health.* 1996.

Psychosocial Problems

Climate change might impair economies, infrastructures, and resource supplies and thus might displace populations. But how such problems would affect human health would depend largely on the pre-impact economic and sociopolitical status of the affected community and of adjacent areas. In any case, political factors (e.g., war) would probably be much more important than climate change as a cause of psychosocial problems.

Respiratory Disorders

The link between projected climate change and respiratory disorders is perhaps the weakest of the climate-change–outcome links: (1) Although tuberculosis and influenza will probably be important infectious diseases in the 21st century, neither has been linked to global climate change. (2) Even if future global climate change does affect lung-cancer factors in the 21st century, smoking would continue to be the principal cause of lung cancer. (3) Acute respiratory illness, which kills millions of chil-

dren each year in developing countries, is primarily related to unsanitary living conditions (especially overcrowding) and lack of medical services.

Undernourishment

There is no scientific consensus on how projected climate change might affect global agricultural productivity. That climate change would increase productivity is plausible. First, elevated atmospheric carbon dioxide increases plant growth. Second, projections suggest (a) that high-latitude regions in the northern hemisphere would benefit agriculturally from global warming (though not evenly) because of longer growing periods; and (b) that the agricultural effect of global warming on most other regions would be small.[19,20]

In any case, undernourishment will continue to be a major health problem in the 21st century, because the predominant cause of undernourishment is not underproduction, but poverty-related maldistribution of food (as a result of political upheaval, for example). Today, about 700 million people do not have enough food for a healthy, productive life.[21] Furthermore, the United Nations has projected that the worldwide human population will have increased from the 5.3 billion of 1990 to over 11 billion by the end of the 21st century, and that nearly all of this growth will occur in countries currently underdeveloped.[22]

F. Major Hypothetical Health Outcomes of Projected Global Climate Change

Some of the hypothetical adverse health effects of projected climate change that *CC&HH* covers are well-known public health problems that will require attention regardless of whether significant human-induced climate change occurs:

Vector-borne Diseases

According to *CC&HH*, climate change would cause shifts in ecological systems that could increase the incidence of vector-borne infectious diseases. Such diseases (malaria and dengue fever, for example) are real-life major health problems. Efforts to control the mosquitoes, ticks, flies, and rodents that transmit diseases to humans are integral to public health. Intensification of vector-control efforts would be extremely beneficial regardless of the prospect of global climate change.

Injury due to Extreme Weather Events

According to *CC&HH*, climate change would increase the incidence of extreme weather events (e.g., heat waves). Extreme weather events can kill both directly and indirectly. Weather forecasting, preparation for emergencies, and speedy evacuation can prevent, for example, drowning in floods. But major disasters due to "natural climate fluctuations" (in *CC&HH*, the primary meaning of this expression seems to be "abnormally bad weather") continue to occur. For example, in November 1970 a typhoon-driven tidal wave from the Bay of Bengal in East Pakistan (now Bangladesh) killed nearly 750,000 people.[23] Bangladesh remains vulnerable to a disaster of this magnitude.

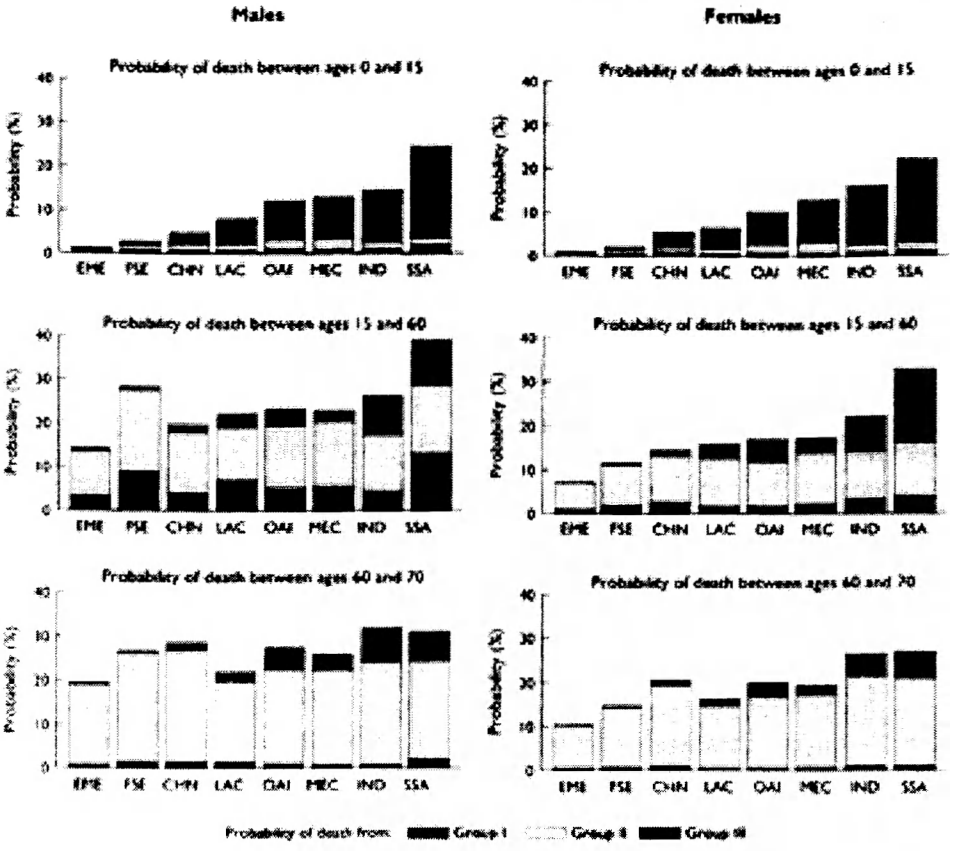
Waterborne Diseases

The mixing of sewage and drinking water that occurs during floods and severe storms is a recurrent problem that may worsen if storms occur more frequently. Diarrheal disease, which is directly linked to unclean drinking water, is a major killer of children. Bottled water is unaffordable in most developing countries. The availability of clean tap water would facilitate the control not only of many waterborne diseases, but also of many foodborne diseases.

According to a study of population sustainability[24]:

- Nearly half the human population suffers from diseases related to insufficient or contaminated water. Virtually all such people live in developing countries, and the majority of sufferers in developing countries are poor.
- Two billion people are at risk of waterborne and foodborne diarrheal diseases.
- Waterborne and foodborne diarrheal diseases kill nearly four million children each year.
- Schistosomal (worm) eggs infect some 200 million people per year through human contact with water that contains the eggs.
- Ten million people per year contract dracunculiasis through drinking water that contains the parasitic worm *Dracunculus medinensis*.
- Millions of people per year contract diseases transmitted by insects whose larvae live in water. More than 250 million people per year thus contract malaria; 90 million, filariasis (e.g., elephantiasis);

Figure 2 **Regional probabilities of death by age, sex and broad cause Group, 1990**



EME	Established Market Economies
FSE	Formerly Socialist Economies of Europe
CHN	China
LAC	Latin America & Carribean
OAI	Other Asian & Islands
MEC	Middle Eastern Crescent
IND	India
SSA	Sub-Saharan Africa

Group I	communicable, maternal, perinatal & nutritional conditions
Group II	non-communicable diseases
Group III	injuries

Source: Murray and Lopez. *The Global Burden of Disease Study.* 1996.

30 to 60 million, dengue fever; and 18 million, river blindness (onchocerciasis).

Water chlorination and improvement in sanitation could greatly improve drinking water in developing countries.

II. Current Causes of Death

A. The Global Burden of Disease

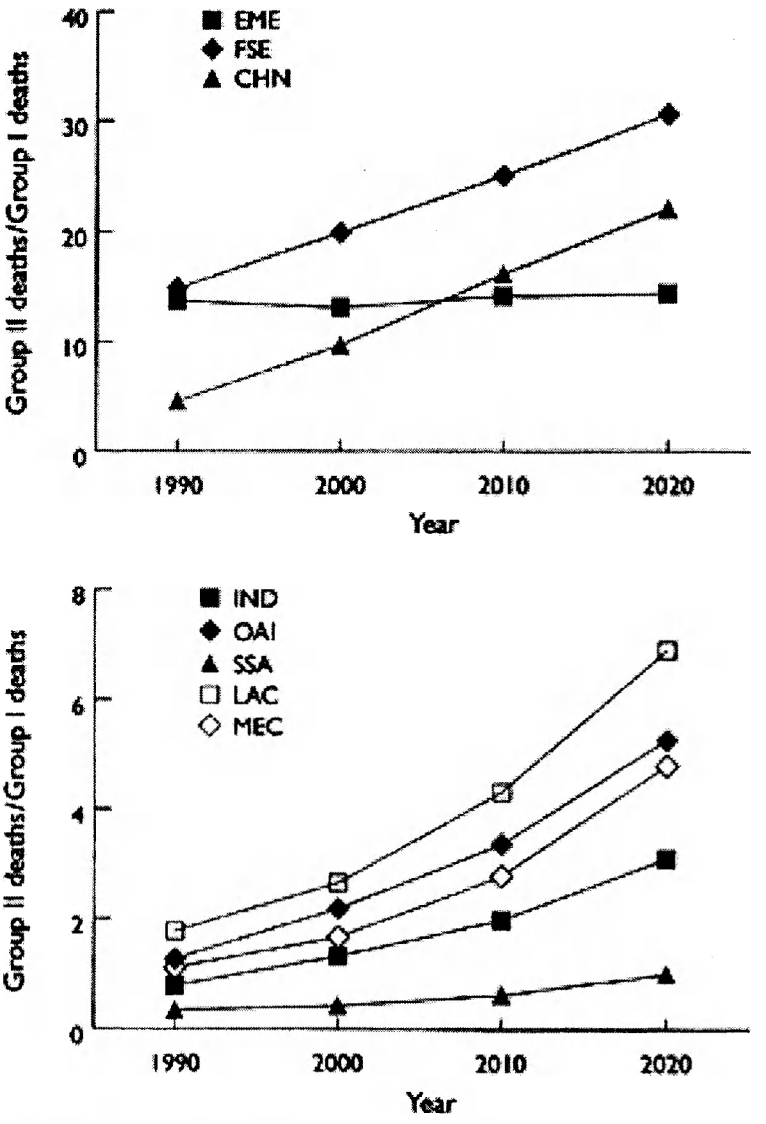
The fact lists published as accompaniments to the *WHR* are summaries of worldwide human health status. According to "Fifty facts from the World Health Report 1997," the world population increased by 80 million during 1996, reaching 5.8 billion by midyear. Of the more than 52 million deaths worldwide in 1996, over 17 million were due to preventable infectious and

parasitic diseases. Infectious and parasitic diseases accounted for 43 percent of the 40 million deaths in developing countries, where 11 million children died before the age of five.

The 1996 edition of the *WHR* states: "Malaria is endemic in 91 countries, with about 40% of the world's population at risk. . . . Up to 500 million cases occur every year, 90% of them in Africa, and there are up to 2.7 million deaths annually." According to the Malaria Foundation, malaria kills more people each year than have died from AIDS in the last 15 years. Most of the victims are children. The parasites that cause malaria—a disease for which no vaccine exists—have become more resistant to antimalarial drugs.[25] Global warming in the 21st century could increase the geographical range of malaria-transmitting mosquitoes.[26] That a globally averaged warming of 3 degrees C by the year 2100 could increase the annual number of malaria cases by 50–80 million has been hypothesized.[27] But timely, vigorous, well-financed public health efforts against the disease would prevent such an increase.

Optimal allocation of resources is critical. Should we invest now in efforts to decrease atmospheric GHG concentrations in the *hope* of limiting the future incidence of malaria? Or should we invest in efforts to control the mosquito population, prevent malarial infection, and eliminate the disease?

Figure 3 **Ratio of Group II to Group I deaths, by region, both sexes combined, 1990–2020**



EME	Established Market Economies
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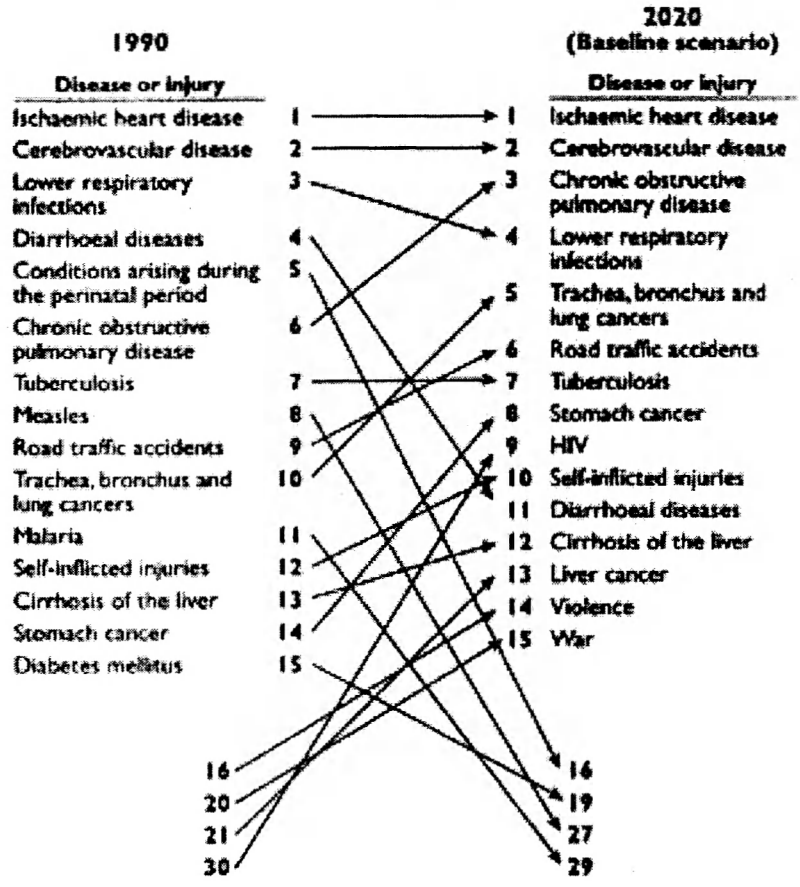
SSA	Sub-Saharan Africa

Group I	communicable, maternal, perinatal & nutritional conditions
Group II	non-communicable diseases
Group III	injuries

Source: Murray and Lopez. *The Global Burden of Disease Study.* 1996.

Figure 4 **Change in rank order of deaths for the 15 leading causes, world, 1990–2020**



Source: Murray and Lopez. *The Global Burden of Disease Study.* 1996.

The Executive Summary of the 1996 edition of the *WHR* enumerates "obstacles" to fighting disease:

- poverty-related exposure to infectious diseases and lack of regular access to essential drugs
- overcrowding and unhygienic living conditions due to continuing global population growth and rapid urbanization
- migration and mass population displacement due to wars, civil turmoil, or natural disasters
- collapse of, or inability to establish, adequate health systems
- rapid intercontinental transport of pathogenic organisms due to increasing international air travel, trade, and tourism
- changes in global food trade, including the shipment of livestock; new modes of food production, storage, and marketing; and altered food preferences
- "The effects of climate change *may* [emphasis added] allow some diseases to spread to new geographical areas. Microbes continue to evolve and adapt to their environment, adding antimicrobial resistance to their evolutionary pathways."

Clearly, dealing with the first six obstacles—real-world problems—outweighs dealing with the last "obstacle," which is an eventuality. Furthermore, progress against the real-world obstacles would increase the likelihood of dealing effectively with the hypothetical obstacle.

B. Future Trends in Disease Independent of Global Climate Change

CC&HH, the *GBDS*, and the *WHR* have different slants on the same diseases. *CC&HH* suggests that some diseases, particularly the vector-borne and waterborne diseases of developing countries, will become more prevalent and spread to developed countries.

The *GBDS*, whose health projections do not factor prospective global climate change, is more optimistic about certain infectious diseases, particularly those that kill large numbers of children. It underscores the importance of economic vitality to health by comparing eight World Bank regions in terms of their disease statistics. Such comparison shows a correlation between extremes of wealth and poverty and extremes of health and sickness. Wealth tends to bring health and longevity; poverty tends to bring infec-

Table 2. Trends in Group III [Injury] Deaths (in Thousands)

Year	1990	2000	2010	2020
All Injuries	5,084	6,099	7,157	8,381
Unintentional Injuries (thousands)	3,233	3,812	4,380	5,053
1. Road traffic accidents	999	1,391	1,837	2,338
2. Poisonings	242	265	278	293
3. Falls	292	347	388	439
4. Fires	265	298	325	354
5. Drownings	504	497	475	469
6. Other unintentional	932	1,013	1,076	1,160
Intentional Injuries (thousands)	1,851	2,287	2,778	3,328
1. Self-inflicted injuries	786	929	1,080	1,229
2. Violence	563	702	864	1,052
3. War	502	656	834	1,047
World Population (millions)	5,267	6,160	7,000	7,844
World Total Deaths (thousands)	50,467	56,116	60,828	68,337
% Unintentional	6.4	6.7	7.2	7.4
% Intentional	3.7	4.0	4.6	4.9
% Group III [Injury] Deaths	10.0	11.0	12.0	12.0

Source: Murray and Lopez. *The Global Burden of Disease Study.* 1996.

tious disease, high infant and childhood mortality, and short life spans.

The *GBDS* classifies causes of death as: Group I—communicable diseases and maternal, perinatal, and nutritional conditions; Group II—noncommunicable diseases; and Group III—injuries. The greatest opportunity for improving the human population health lies in preventing Group I problems. These are more viewable as diseases of poverty than are noncommunicable diseases or injuries. Noncommunicable diseases are, to some degree, diseases of old age.

Figure 2 (page 12) presents by age group, sex, and region the probability of death due to each of the three disease–injury groups.[28] Group I diseases predominate in childhood (ages 0 to 15) and are most prevalent in developing countries. Per capita gross product is inversely related to childhood mortality. The ratio of noncommunicable-disease deaths to Group I deaths is a rough indication of the health status of a regional population: the higher the proportion of noncommunicable diseases, the better the health. Figure 3 (page 13) shows expected trends in the ratio of noncommunicable to Group I diseases in the eight World Bank regions to the year 2020.

A comparison between the major causes of death in 1990 and expected causes in 2020 is also instructive. Figure 4 (from the *GBDS;* page 13) shows the following trends.

- Heart attack and stroke will continue to be the world's top killers.
- The relative importance of infectious diseases, except tuberculosis and HIV disease, will decrease.
- The relative importance of diseases of old age will increase.
- The relative importance of war, violence, and self-inflicted injury will increase.

C. Special Issues

New and "Emerging" Diseases

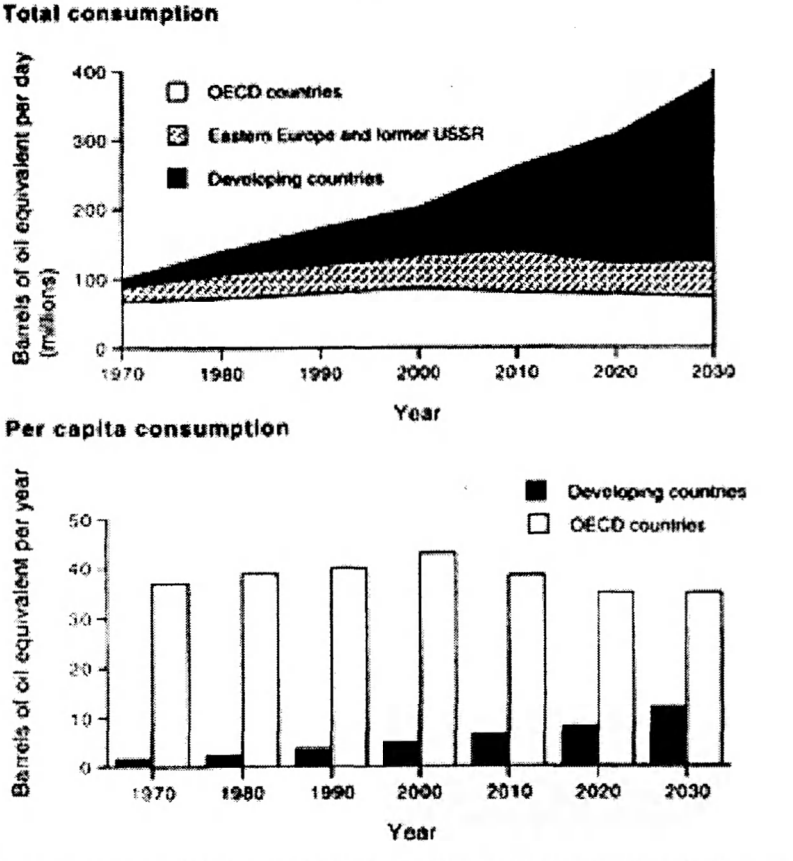
Global climate change might (a) cause mutations or biological events that would accelerate the genesis of microorganisms (i.e., contribute to an increase in their diversity), and (b) affect the incidence of rare diseases. But how such events would affect humankind is unforeseeable. The overall result might be harmful, negligible, or even beneficial.

Injuries

The *CC&HH* Task Group has suggested that global climate change would increase the incidence of extreme

Figure 5

Energy consumption, by country group: total and per capita consumption, 1970–2030. (Note: an "energy-efficient" scenario is assumed, i.e. growth in total consumption of one to two percentage points below the trend rate.)



Source: Murray and Lopez. *The Global Burden of Disease Study.* 1996.

weather events. Although extreme weather events can have a long-term impact on public health infrastructures, injuries are usually considered the direct causes of weather-related death. According to the *GBDS* (see Table 2, page 15):

- The percentage of Group III deaths will increase by only two percent between 1990 and 2020.
- Drowning incidence will decrease between the present and 2020.
- Deaths due to road-traffic accidents, self-inflicted injuries, violence, and war are on the rise.

Natural disasters are direct causes of only a small percentage (probably less than one percent) of Group III deaths. Group III deaths occur predominantly in people aged 15 to 60. The incidence of such deaths in children under 6 years old is greatest in the least developed countries. Developed countries have emergency response systems that limit considerably the incidence of deaths related to natural disasters.

III. Approaches to Dealing with Projected Global Climate Change

A. Mitigation Measures

The centerpiece of the 1992 United Nations Framework Convention on Climate Change (FCCC) was the goal of stabilizing "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system." But the FCCC did not specify such a level. Moreover, while *attempting* to return GHG emissions to 1990 levels is obligatory for some FCCC signatory nations, most—more than 130 countries—have no such obligation.

Carbon dioxide has received more attention than other GHGs for two reasons: (1) most of the human-induced increases in atmospheric concentrations of GHGs are due to increases in carbon-dioxide concentration; and (2) the other GHGs' energy input to the atmosphere can be expressed in carbon-dioxide equivalents.

Measures to decrease human contributions to atmos-

Table 3. Adaptational Responses

Population-Level Public Policy Measures	
Reduction of heat-related mortality and morbidity	• Insulate buildings and apply other design features that reduce heat load. • Plant trees within cities, and select materials with high albedo for roads, parking lots and roofs to decrease urban "heat island" effect. • Establish new weather watch/warning systems that focus on health-related adverse conditions, such as oppressive air masses. • Create public education campaigns regarding precautions to take during heat waves and establish weather watch/warning systems. • Implement work schedules for outdoor workers that avoid peak daytime temperatures.
Reduction of transmission of vector-borne diseases	• Assess the vector-borne disease implications of development projects and policies that could increase vector-borne disease transmission, and where possible implement environmentally sound measures to prevent or mitigate such increases. • Improve use of climate forecasts in order to stockpile vaccines, pesticides, and other control tools more efficiently, and prepare measures for control of any expected disease outbreaks. • Undertake public education to encourage elimination of human-made vector breeding sites (e.g., small water containers). • Install mosquito and fly screens in buildings in endemic areas. • Promote the judicious use of pesticides and biological control methods. • Undertake education campaigns to sensitize healthcare workers in geographically vulnerable areas. • Expand the coverage of existing vaccination programs aimed at the elimination of diseases such as yellow fever, which are likely to increase in incidence after climate change.
Reduction of agricultural stresses	• Reduce monoclonal farming, to reduce dependence on chemicals for pest control. • Promote land reforms that favor environmentally sound land use. • Develop climate-adjusted plant species through genetic engineering.
Reduction of impacts of extreme weather events and sea level rise	• Maintain and strengthen emergency management and disaster preparedness programs, including local public health service capacity to conduct rapid health needs assessments and to make psychological support interventions. • Implement engineering measures such as strengthening of seawalls and ensure strict adherence to building regulations and standards in hurricane-prone areas. • Adopt land-use planning to minimize erosion, flash-flooding, poor siting of residential areas, and deforestation.
Reduction of General Population Vulnerability	• Reduce poverty and socioeconomic inequalities. • Maintain biodiversity. • Protect cultural resources. • Carry out effective monitoring of the environment, biological indicators, and human health.
Personal Adaptive Measures	
Education to demonstrate	• the need (particularly among the chronically ill and the elderly) to increase hydration and mineral intake levels during extremely hot weather • the need to reduce skin cancer risk by avoiding sun exposure, wearing protective clothing and sun glasses, and—particularly among children and adolescents—using sunscreen • the need to use mosquito nets impregnated with pyrethroid compounds or appli cation of insect repellents to reduce malaria transmission (particularly among babies, children and pregnant women)

Derived from *CC&HH.*

pheric GHGs fall into a response category called "mitigation." Some mitigation measures listed in *CC&HH* could have serious side effects.

B. The Cost of Mitigation Measures

The FCCC calls for stabilization of *atmospheric concentrations* of GHGs, *not* stabilization of emissions. Substantial decreases in emission rates would be necessary to stabilize atmospheric concentrations: perhaps a 60-percent decrease in GHG emissions worldwide. Such a decrease would cause considerable—perhaps intolerable—disruption of the global economic system.

Even lesser emission decreases could cause significant damage. Economists Alan S. Manne and R. S. Richels estimated that if the U.S. returns GHG emissions to 1990 levels by the year 2000 and then decreases them by an additional 20 percent by 2020, the annual Gross Domestic Product (GDP) loss would be nearly 1.8 percent—well over 100 billion dollars in today's economy.[29] Yet an emissions decrease of this magnitude by developed countries only would prevent about 0.1 degree C of warming.[30] According to the Economic Policy Institute, implementation of the *least restrictive* current proposal—which calls for returning U.S. GHG emissions to 1990 levels by 2010—could result in a loss of 1.5–2.6 million new jobs and a GDP decrease of $17 trillion from 2005 to 2015.[31]

The FCCC divides signatory nations into two groups: developed countries and developing countries. According to the FCCC, developed countries must bear the burden of mitigation efforts so that the economies of developing countries are not hampered. Figure 5 (page 16) illustrates the futility of this concept as an approach to decreasing total carbon-dioxide emissions. Increased fuel consumption in China alone could neutralize any decrease in GHG emissions achieved in developed countries.

Mitigation measures may be unnecessary (whether increases in GHG emissions would cause significant global climate change is uncertain) and may be ineffective in decreasing total GHG emissions. Furthermore, mitigation measures may disrupt the economies of developed nations, may impoverish developing nations, and may hamper international-aid and public health programs.

C. Adaptational Measures

Measures to suit human actions to current and foreseeable problems may be termed "adaptational." The goal of adaptational measures is to prevent or control real-life problems rather than hypothetical future problems. Throughout human history, societies have adapted to environments by modifying their behavior—for example, by planting crops whose growth the different climate favored. Several adaptational measures are paramount today and will continue to be important regardless of whether global climate change occurs:

- emergency-response and international-relief programs;
- programs to control disease-spreading insects;
- adequate sewage treatment and the provision of potable water;
- the provision of adequate nourishment; and
- the provision of basic medical services, especially pre- and perinatal care and immunization.

Table 3 (page 17) lists other proposed adaptational measures, most of which are sound.

The *GBDS* predicts that by 2020 the incidence of infectious diseases will have decreased dramatically in many developing countries. And the IPCC estimates that by that year the maximal global warming will be a few tenths of a degree C. Thus, a prudent approach to future global climate change would be to fight infectious diseases and improve sanitation and nutrition; to try to resolve the many uncertainties about global climate change; and to implement stringent mitigation measures if and when the need for them becomes clear.

IV. Conclusion

The health risks from projected human-induced global climate change discussed in *Climate Change and Human Health* (*CC&HH*) have been compared with current and foreseeable health problems discussed in three other documents: *The Global Burden of Disease Study* and the 1996 and 1997 editions of the *World Health Report*. Most assertions of adverse health effects of projected human-induced climate change rest on computer simulations.

One should consider the uncertainty of the hypothetical health outcomes of projected human-induced climate change in light of the 922,000 deaths in India in 1990 from preventable diarrheal disease. This is not to say that the possibility of human-induced climate change is an unimportant consideration in policymaking. But if

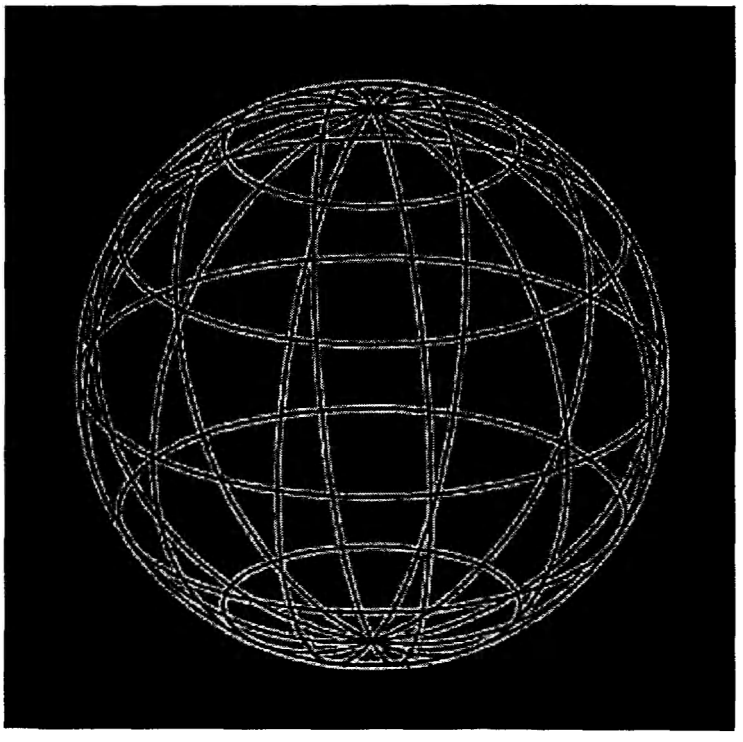
global climate change occurs as gradually as the Intergovernmental Panel on Climate Change has predicted, policymakers can safely take several decades to plan a response, and scientists will have enough time to develop cost-effective anti–climate-change strategies.

Implementation of current proposals for mitigation measures—measures to stabilize the concentration of greenhouse gases in the atmosphere—would be both costly and ineffective.

Adaptational measures—measures to suit economies, healthcare systems, and living conditions to real-life, imminent, and foreseeable challenges to human health (for example, infectious diseases and weather disasters)—should be the central component of any policy whose theme is the potential health impact of global climate change. Implementation of adaptational measures would improve human population health regardless of whether global climate change occurs. Such measures include:

- improvement in emergency responses to extreme weather events, with coordinated international efforts as required;
- intensive cost-effective control of arthropod vectors, especially in developing countries, to decrease mortality from infectious diseases;
- improvement in drinking water and sanitation in developing areas;
- continued investment in climate change research;
- continued investment in medical research, particularly in the area of infectious diseases;
- continued investment in research concerning energy technologies that entail low greenhouse-gas emissions; and
- continued improvement in the economic and health infrastructures of developing countries.

Implementation of all of the aforementioned measures is imperative now, regardless of the prospect of human-induced climate change.



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12. *See* Manne AS. *Global Carbon Dioxide Reductions—Domestic and International Consequences. Special Report.* American Council for Capital Formation Center for Policy Research. Washington DC, April 1995. According to the Center: (a) Under proposed measures, the U.S. would agree to stabilize its carbon-dioxide emissions between 1990 and 2000, decrease them to 80 percent of this level by 2010, and stabilize them thereafter. (b) Accomplishing this would result in a Gross Domestic Product decrease of 1 percent annually by the year 2000 and a GDP decrease of nearly 2.5 percent annually after 2020.

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