# Protecting **Health** from **Climate Change**

## CONNECTING SCIENCE, POLICY AND PEOPLE

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Protecting health from climate change: connecting science, policy and people.

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# CONTENTS

# SUMMARY

## Climate change puts at risk the basic determinants of health

There is now widespread agreement that the earth is warming, due to emissions of greenhouse gases caused by human activity. It is also clear that current trends in energy use, development and population growth will lead to continuing – and more severe – climate change.

The changing climate will inevitably affect the basic requirements for maintaining health: clean air and water, sufficient food and adequate shelter. Each year, about 1.2 million people die from causes attributable to urban air pollution, 2.2 million from diarrhoea largely resulting from lack of access to clean water supply and sanitation, and from poor hygiene, 3.5 million from malnutrition and approximately 60 000 in natural disasters. A warmer and more variable climate threatens to lead to higher levels of some air pollutants, increase transmission of diseases through unclean water and through contaminated food, to compromise agricultural production in some of the least developed countries, and to increase the hazards of extreme weather.

Climate change also brings new challenges to the control of infectious diseases. Many of the major killers are highly climate sensitive as regards temperature and rainfall, including cholera and the diarrhoeal diseases, as well as diseases including malaria, dengue and other infections carried by vectors. In sum, climate change threatens to slow, halt or reverse the progress that the global public health community is now making against many of these diseases.

In the long run, however, the greatest health impacts may not be from acute shocks such as natural disasters or epidemics, but from the gradual build-up of pressure on the natural, economic and social systems that sustain health, and which are already under stress in much of the developing world. These gradual stresses include reductions and seasonal changes in the availability of fresh water, regional drops in food production, and rising sea levels. Each of these changes has the potential to force population displacement and increase the risks of civil conflict.

## All populations are vulnerable – but some are more vulnerable than others

All populations will be affected by a changing climate, but the initial health risks vary greatly, depending on where and how people live. People living in small island developing states and other coastal regions, megacities, and mountainous and polar regions are all particularly vulnerable in different ways.

Health effects are expected to be more severe for elderly people and people with infirmities or pre-existing medical conditions. The groups who are likely to bear most of the resulting disease burden are children and the poor, especially women. The major diseases that are most sensitive to climate change – diarrhoea, vector-borne diseases like malaria, and infections associated with undernutrition – are most serious in children living in poverty.

We have a common interest in facing up to health risks wherever they occur. Ongoing climate change, coupled with globalization, will make it more difficult to contain infectious diseases within their current ranges. Health challenges arising from population displacement and conflict are unlikely to stay confined within national borders. Improved health conditions for all populations, alongside more rapid and effective international disease surveillance, constitute a vital contribution to global public health security.

## Protecting human health is the "bottom line" of climate change strategies

Climate change can no longer be considered simply an environmental or developmental issue. More importantly, it puts at risk the protection and improvement of human health and well-being. A greater appreciation of the human health dimensions of climate change is necessary for both the development of effective policy and the mobilization of public engagement.

Strengthening of public health services needs to be a central component of adaptation to climate change. The international health community already has a wealth of experience in protecting people from climate-sensitive hazards, and proven, cost-effective health interventions are already available to counter the most urgent of these. Broadening the coverage of available interventions would greatly improve health now. Coupled with forward planning, it would also reduce vulnerability to climate changes as they unfold in the future.

Many policies and individual choices have the potential both to reduce greenhouse gas emissions and produce major health 'co-benefits'. New research has shown that the range and magnitude of the potential health gains is larger than previously appreciated. More sustainable policies on household energy, electricity generation, agriculture and nutrition, transport and the built environment, could each bring significant reductions in major burdens of disease, including respiratory infections, cardiovascular disease and cancer. These local and immediate health benefits would offset a large part of the costs of climate change mitigation, and provide a strong political and personal motivation for action.

The diverse, widespread, long-term and inequitable distribution of health risks makes climate change a truly global challenge, calling for an unprecedented degree of partnership. An effective response will require actions from across society: from individuals, the health sector, as well as community and political leaders. This requires a sharing of responsibilities between the populations that make the greatest contribution to climate change and those that are most vulnerable to its effects, in order to safeguard and enhance global public health security. The skills, capacities and shared values of the public health community can make an important contribution to a fair and effective response to climate change.

# WHAT ARE THE RISKS?

## 1. Climate change: past and future

**The basic facts are now firmly established. The earth is warming rapidly, mainly because of emissions of greenhouse gases caused by human activity. If current patterns of fossil fuel use, development and population growth continue, this will lead to ongoing climate change, with serious effects on the environment and, consequently, on human lives and health.**

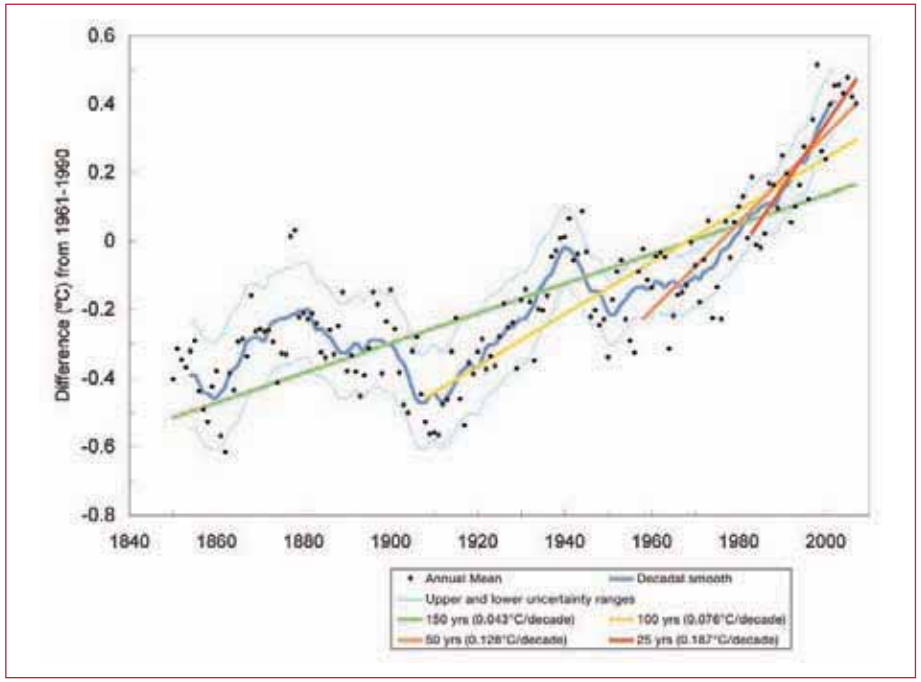
CLIMATE CHANGE IS HAPPENING NOW. Warming of the global climate is unequivocal and is shown by increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. The ten warmest years since the instrumental record of global surface temperature began in 1850, have all occurred within the last 13 years.

GLOBAL WARMING HAS ACCELERATED IN RECENT YEARS. The world warmed by approximately 0.75°C in the last 100 years (see Figure 1a). The rate of increase in the last 25 years, however, is much higher, at over 0.18°C per decade. This temperature increase is widespread over the globe, with land regions warming faster than the oceans.

SEA LEVELS ARE RISING, GLACIERS ARE MELTING AND PRECIPITATION PATTERNS ARE CHANGING. Sea levels have risen faster in the last decade than in the previous 30 years. On average, there has been a global reduction in mountain glaciers and snow cover. From 1900 to 2005, precipitation increased significantly in eastern parts of North and South America, northern Europe and northern and central Asia, but declined in the Sahel, the Mediterranean, southern Africa and parts of southern Asia. Globally, it is likely that the area affected by drought has increased since the 1970s.

EXTREME WEATHER EVENTS ARE CHANGING IN FREQUENCY AND INTENSITY. It is considered that heatwaves have become more frequent over most land areas, the frequency of heavy precipitation events has increased

**Figure 1 (a). Global temperature rise.**
Annual global mean temperatures and decadal variations for the period 1850–2005, with linear trends for the last 25, 50, 100 and 150 years.




Source: based on data from the UK Hadley Research Centre.[2]

over most areas and, since 1975, sea level has risen worldwide. There is also some evidence that intense tropical cyclone activity has increased since 1970.

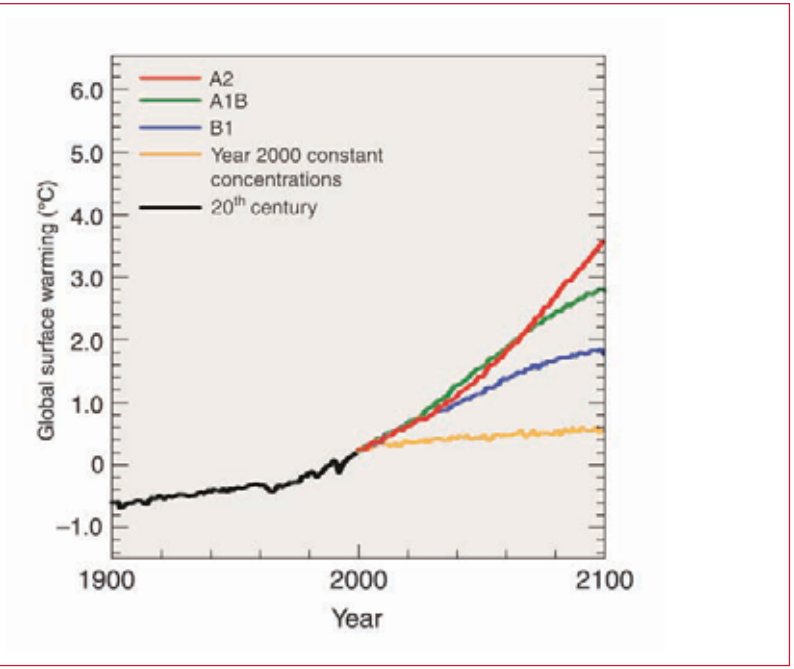
HUMAN ACTIVITIES ARE NOW THOUGHT TO BE THE MAIN CAUSE OF THE CHANGING CLIMATE. Most of the observed increase in temperatures since the mid-20th century is very likely to be attributable to the increase in

concentrations of greenhouse gases released by human activities, mainly carbon dioxide ($CO_2$) emitted by burning of fossil fuels. Levels of carbon dioxide have increased from pre-industrial levels of 280 parts per million to 386 parts per million in 2008.

CONTINUED WARMING COULD LEAD TO ABRUPT OR IRREVERSIBLE IMPACTS. Melting of ice sheets on polar land could cause several metres of sea level rise, with major inundation of low-lying areas. Drying and burning of the Amazon basin, and warming of peat bogs, could release large amounts of greenhouse gases, further accelerating climate change.

HUMAN-INDUCED CLIMATE CHANGE WILL CONTINUE FOR AT LEAST THE NEXT FEW DECADES. Even if emissions of greenhouse gases were to halt immediately, temperatures would be expected to rise by over 0.6°C in this century. The development paths that the world chooses, however, will have a strong influence on this increase (see Figure 1b). In a world that places high priority on sustainable energy use, temperatures are expected to rise by 1.8°C (likely range: 1.1–2.9°C). If societies place a lower emphasis on sustainability, temperatures are expected to rise by 4.0°C (2.4–6.4°C), with a greater probability of abrupt or irreversible impacts.[1]

**Figure 1 (b). Projected global temperature rise in the 21st century.**
Projected temperature changes (relative to 1980-1999) in selected development scenarios, from lower emphasis on sustainable development and cooperation (A2) to greater attention to environmental protection and regional integration (B1). The orange line is the projection assuming greenhouse gas concentrations were held constant at year 2000 values.




Source: Intergovernmental Panel on Climate Change (IPCC), 2007.[1]

## 2. Climate and its impact on the fundamentals of health

**Climate change will affect, in profoundly adverse ways, some of the most fundamental pre-requisites for good health: clean air and water, sufficient food, adequate shelter and freedom from disease. The global climate is now changing faster than at any point in human civilization, and many of the effects on health will be acutely felt. The most severe risks are to developing countries, with negative implications for the achievement of the health-related Millennium Development Goals and for health equity.**

EXTREME AIR TEMPERATURES AND AIR POLLUTION ARE HAZARDOUS TO HEALTH. Heatwaves are a direct contributor to deaths from cardiovascular and respiratory disease, particularly among elderly people. High temperatures also raise the levels of ozone and other air pollutants that exacerbate cardiovascular and respiratory disease, and pollen and other aeroallergens that trigger asthma.

FLOODS, DROUGHTS AND CONTAMINATED WATER RAISE DISEASE RISK. More variable precipitation is occurring, with an increase in the frequency and intensity of both floods and droughts. At the same time, higher temperatures are hastening rates of evaporation of surface waters and melting the glaciers that provide fresh water for many populations. Lack of fresh water compromises hygiene, thus increasing rates of diarrhoeal disease. In extreme cases, water scarcity results in drought and famine. Too much water, in the form of floods, causes contamination of freshwater supplies and also creates opportunities for breeding of disease carrying insects such as mosquitoes.

CLIMATIC EFFECTS ON AGRICULTURE THREATENS INCREASING MALNUTRITION. Rising temperatures and changing patterns of rainfall are projected to decrease crop yields in many developing countries, stressing food supplies.[3] For populations that depend on subsistence farming, or do not have sufficient income to buy food, this situation is expected to translate directly into wider prevalence of malnutrition. In turn, malnutrition and undernutrition increase the severity of many infectious diseases, particularly among children.

A MORE EXTREME AND VARIABLE CLIMATE CAN DESTROY HOMES, COMMUNITIES AND LIVES. Expected increases in the frequency and severity of flooding and storms will result in the destruction of homes, medical facilities and other essential services, impacting particularly on people in slums and other marginal living conditions. Gradual sea level rise, particularly coupled with stronger storm surges, will tend to lead to more frequent and more severe coastal flooding. The consequent destruction of homes and communities will eventually force unprotected populations to seek safer ground, often increasing environmental and social pressures in their new locations.

CLIMATE CHANGE BRINGS NEW CHALLENGES TO THE CONTROL OF INFECTIOUS DISEASES. Many of the major killer diseases transmitted by water and contaminated food, and by insect vectors are highly sensitive to climatic conditions and weather extremes. Climate change threatens to slow, halt or reverse current progress against many of these infections.

NOT ALL OF THE EFFECTS OF CLIMATE CHANGE WILL BE HARMFUL, BUT ON BALANCE HEALTH DAMAGES ARE PROJECTED TO OUTWEIGH THE BENEFITS. A warmer climate is expected to bring benefits to some populations, including reduced mortality and morbidity in winter and greater local food production, particularly in northern high latitudes. However, projections by WHO[4] and IPCC[5] suggest that the negative effects of climate change on health are greater and are more strongly supported by evidence than are the possible benefits (see Box 1). In addition, the negative effects are concentrated on poor populations that already have compromised health prospects, thus widening the inequality gap between the most and the least privileged.


UNEP / Still pictures


WHO / Benoist Matsha-Carpentier


Laurent Weyl / ARGOS


Thorkell Thorkelsson / Icelandic Red Cross


WHO / Madeine Decker

Climate and weather affect the fundamental determinants of health. From left: air quality in China, food availability in Mali, fresh water in Bangladesh, infection in Cambodia, shelter in Angola.

## Box 1. Climate change and the determinants of health: facts and figures

**Air.** Extreme high air temperatures can kill directly; it has been estimated that more than 70 000 excess deaths occurred in the extreme heat of summer 2003 in Europe.[6] By the second half of this century, such extreme temperatures will be the norm.[7] In addition, rising air temperatures will increase levels of important air pollutants such as ground-level ozone, particularly in areas that are already polluted. Urban air pollution currently causes about 1.2 million deaths each year,[4,8] mainly by increasing mortality from cardiovascular and respiratory diseases.

**Water.** Shifting rainfall patterns, increased rates of evaporation and melting of glaciers, combined with population and economic growth, are expected to increase the number of people living in water-stressed water basins from about 1.5 billion in 1990 to 3–6 billion by 2050.[9] By the 2090s, climate change may bring a doubling in the frequency of extreme drought events, a six-fold increase in mean duration, and a 10–30-fold increase in the land area in extreme drought.[10] Almost 90% of the burden of diarrhoeal desease is attributable to lack of access to safe water, sanitation,[4,11,12] and reductions in the availability and reliability of freshwater supplies are expected to amplify this hazard.

**Food.** Increasing temperatures and more variable precipitation are expected to reduce crop yields in many tropical developing regions. In some African countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020.[13] This is likely to aggravate the burden of undernutrition in developing countries, which currently causes 3.5 million deaths each year, both directly through nutritional deficiencies and indirectly by intensifying vulnerability to diseases such as malaria and diarrhoeal and respiratory infections.[14]

**Shelter.** By the second half of this century, climate change is projected to cause a several-fold increase in the frequency of extreme storms, heavy rainfall and heatwaves. In the absence of improvements to protection, by 2080 sea level rise could also multiply the number of people exposed to coastal flooding more than 10-fold, to more than 100 million people a year.[15] These trends will also increase the hazards of weather-related natural disasters, which killed approximately 600 000 people during the 1990s.[16] Repeated floods and droughts may force population displacement – which, in turn, is associated with heightened risks of a range of health effects, from mental disorders such as depression to communicable diseases and, potentially, civil conflict.

**Freedom from disease.** Rising temperatures, shifting rainfall patterns and increasing humidity affect the transmission of diseases by vectors and through water and food. Vector-borne diseases currently kill approximately 1.1 million people a year, and diarrhoeal diseases 2.2 million.[17] Studies suggest that climate change may swell the population at risk of malaria in Africa by 170 million by 2030,[18] and the global population at risk of dengue by 2 billion by the 2080s.[19]

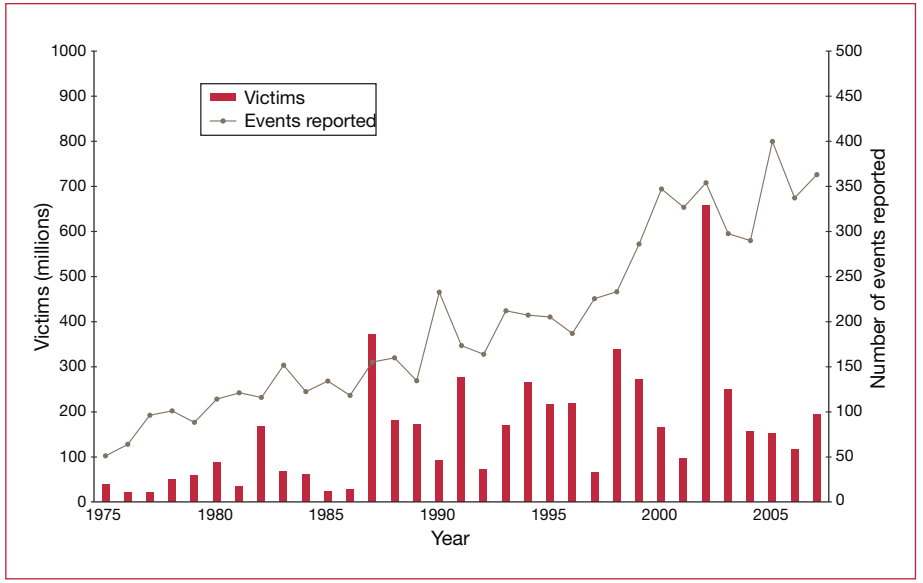
## 3. "Natural" disasters: the growing influence of climate change on heatwaves, floods, droughts and storms

**Globally, the number of reported weather-related natural disasters is mounting rapidly. Reports of natural catastrophes have more than tripled since the 1960s. In 2007, 14 out of 15 "flash appeals" for emergency humanitarian assistance were for floods, droughts and storms – five times higher than in any previous year.[20]**

MORE NUMEROUS REPORTS OF NATURAL DISASTERS ARE PARTLY DUE TO POPULATION GROWTH IN HIGH-RISK AREAS, BUT IT IS POSSIBLE THAT CLIMATE CHANGE IS ALSO A CONTRIBUTING FACTOR. The last few decades have seen rapid growth in populations living in flood plains and coastal areas, particularly in developing country cities, placing more people in the path of weather-related natural disasters. At the same time, climate change has furthered the probability of extreme high temperatures and has probably contributed to more frequent and extreme precipitation events and more intense tropical cyclone activity.[1] Together, these trends will increase weather-related hazards to human health.

EXTREME HEAT. Studies from around the world have shown that temperatures above a locally specific threshold result in higher mortality rates. The extended hot summer of 2003 in Europe produced sustained record high temperatures which resulted in markedly higher death rates, particularly among the elderly population. In total, it has been estimated that 70 000 more deaths occurred in western Europe during that extreme summer than would have been expected for the time of year.[6] Continuing global warming and possible increases in temperature variability[21] will make such events more frequent – and more severe. It is expected that European summer temperatures as high as those experienced in 2003 will be the norm by the middle of the century.[7]

**Figure 2. Number of weather-related disasters, and number of victims during 1975-2007, reported to the International Disaster Database, EM-DAT.**




Source: EM-DAT, 2008.[24]

FLOODS AND DROUGHTS. Even small changes in average precipitation can have a very large effect on the extremes of rainfall events that cause either flooding or drought, already the most frequent and deadly forms of natural disasters. For example, studies have shown that human influence on the global climate is likely to make what would currently be considered a "very wet winter" in the United Kingdom, or a "very wet summer" in the South Asian monsoon region, about five times more frequent by the second half of this century.[22] Globally, climate change is likely to widen the area affected by drought, with particularly severe impacts in areas that are already water-stressed. These trends will impact on lives and on health. Floods cause drownings and physical injuries; heighten the risk of diseases


WHO / Paul Glendell

Flooding in the United Kingdom: intense precipitation is becoming more common over many areas.

transmitted through water, insect vectors and rodents; damage homes; and disrupt the supply of essential medical and health services. The number of floods reported globally is rising rapidly – much more rapidly than disasters unrelated to weather conditions (see Figure 2). Droughts increase the risk of food shortages and malnutrition. They also increase the risk of diseases spread by contaminated food and water.

TROPICAL STORMS. Extreme winds, particularly in the tropical regions, bring death and destruction. There is evidence for a marked increase in the numbers of the most extreme cyclones in recent decades, and this trend is likely to continue. Studies indicate that a doubling of the level of carbon dioxide in the atmosphere, expected within about 80 years, will result in an increase of only about 6% in average cyclone windspeed but of 300% in the frequency of the largest (category 5) storms.[23]

## 4. Changing patterns of infection

**Infections caused by pathogens that are transmitted by insect vectors are strongly affected by climatic conditions such as temperature, rainfall and humidity. These diseases include some of the most important current killers: malaria, dengue and other infections carried by insect vectors, and diarrhoea, transmitted mainly through contaminated water.**

MALARIA DISTRIBUTIONS ARE STRONGLY AFFECTED BY CLIMATE. Transmitted by *Anopheles* mosquitoes, malaria is the most important vector-borne cause of mortality globally. It kills almost 900 thousand people each year, mainly poor children in Africa.[17] Malaria is strongly influenced by climatic conditions; it is not transmitted in the cooler temperatures associated with high altitudes and latitudes, and the number of mosquito vectors depends on the availability of freshwater breeding sites. Warmer temperatures, higher humidity and more places where water can collect generally favour malaria transmission. There is evidence that in some sites in the highlands of East Africa, a warming trend over the last 30 years has improved conditions for mosquitoes, increasing the probability of malaria transmission and highland epidemics.[25]

DENGUE PREVALENCE IS EXPANDING RAPIDLY. Transmitted by *Aedes* mosquitoes, dengue is a fast growing challenge, particularly in tropical cities in developing countries. Cases have risen dramatically in the last 40 years, as unplanned urbanization with standing water in waste and other receptacles have created mosquito breeding sites, and movement of people and goods has spread both mosquito vectors and infections. As for malaria, the distribution of dengue is also highly dependent on climate.[26] In the absence of changes in other determinants, studies suggest that climate change could expose an additional 2 billion people to dengue transmission by the 2080s (see Figure 3)[19].

CDC / James Gathany

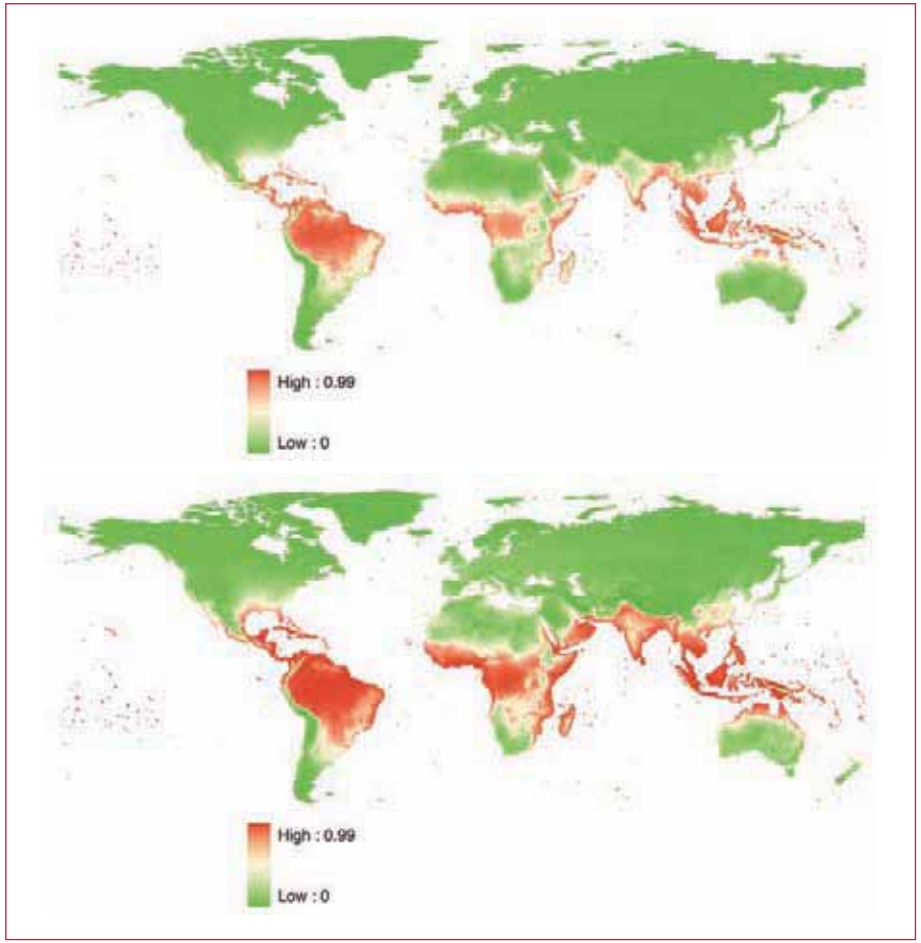
Female *Aedes aegypti* mosquito, vector of dengue and other viral diseases, and highly sensitive to climate conditions.

DIARRHOEA REMAINS ONE OF THE BIGGEST KILLERS OF CHILDREN. Viruses and bacteria transmitted through water and contaminated food can cause severe diarrhoea in children, often locking them into a vicious cycle of undernourishment, susceptibility to other infectious diseases, and eventually death. Higher temperatures and too much or too little water can all facilitate transmission of this disease. In countries with inadequate water and sanitation services, diarrhoea is much more common when temperatures are high. For example, rates of diarrhoeal disease in Lima, Peru, are 3–4 times higher in the summer than in the winter, increasing by 8% for every 1°C increase in temperature.[27] Both flooding and unusually low levels of water can also lead to water contamination and bring higher rates of illness and death from cholera and other forms of diarrhoea.[28] Warming and greater variability in precipitation threaten to increase the burden of this disease.

MANY OTHER DISEASES WILL ALSO BE AFFECTED. Any disease caused, transmitted or harboured by insects, snails and other cold-blooded animals can be affected by a changing climate. For example, climate change is projected to widen significantly the area of China where schistosomiasis transmission occurs.[29] Together, vector-borne diseases kill approximately 1.1 million people and cause the loss of almost 50 million years of healthy life, every year.[17] Effects on infectious disease will not be restricted to developing tropical regions. For example, climate change is also expected to change distributions of diseases such as Lyme disease and tick-borne encephalitis, and to increase rates of *Salmonella* and other foodborne infections in Europe[30] and North America.[31]

NEW AND UNFAMILIAR INFECTIONS STRAIN HEALTH SERVICES AND ECONOMIES. When infectious diseases appear in new locations, where people do not have immunity and health services may not have experience in controlling or treating infections, the effects can be dramatic. When an outbreak of mosquito-borne Chikungunya disease occurred in Réunion in 2005–2006, it affected 1 in 10 of the population and decreased tourism, the island's main economic sector.

**Figure 3. Changing patterns of infectious disease: the example of dengue.**
Distribution of dengue in 1990 (upper graph) and projected expanded distribution in the warmer, wetter and more humid conditions expected in the 2080s (lower graph), assuming no change in non-climatic determinants of dengue distribution. The colour code shows the predicted probability of dengue transmission occurring within each of the locations.




Source: based on data from Hales et al., 2002.[19]

## 5. Long-term stresses: water shortages, malnutrition, displacement and conflict

**In the long run, the greatest health risks may be not from natural disasters or disease epidemics, but from the slow build-up of pressures on natural, economic and social systems that sustain health. These are already under stress, particularly in the developing world.**

MOUNTING WATER STRESS FOSTERS A RANGE OF LONG-TERM PUBLIC HEALTH CHALLENGES. Climate change is projected to bring changing rainfall patterns, increased temperatures and evaporation, and salinization of water sources through rising sea levels. In addition, over the course of the century, water supplies stored in glaciers and snow cover are projected to decline. This will reduce water availability to populations supplied by meltwater from major mountain ranges, more than one sixth of the global population. In many regions, the effects of climate change come on top of pre-existing water stress and mounting pressures of population growth, as well as extraction for irrigation and contamination from agriculture and industry.[13]

LACK OF ACCESS TO CLEAN WATER SUPPLY AND SANITATION, ALONG WITH POOR HYGIENE, IS ALREADY THE MAIN CONTRIBUTOR TO THE BURDEN OF DIARRHOEAL DISEASE.[4] Decreasing and more erratic water supplies will only add to this burden. Water stress also necessitates the use of new water sources, including recycled wastewater for agriculture. Unless properly managed, the use of recycled wastewater can facilitate exposure to microbial contaminants and chemicals, including pesticides and fertilizers.[32]

PRESSURES ON AGRICULTURE THREATEN TO INCREASE THE BURDEN OF MALNUTRITION. Undernutrition and related disease is currently the greatest contributor to the global burden of disease, killing an estimated 3.5 million people per year, mostly children in developing countries.[4,14,17] It is projected that climate change will boost agricultural production in the high latitudes of developed countries, but cause decreases in many tropical developing regions. There is particular concern for sub-Saharan Africa, where people are most reliant on subsistence and rain-fed agriculture and have least money to buy imported food. Tens of millions more people are projected to become at risk of food insecurity and the health consequences of malnutrition.[13]

POPULATION DISPLACEMENT COMPROMISES HEALTH AND DAMAGES LIVES. By destroying ecological and agricultural systems and by flooding communities, climate change can eventually force people to abandon where they live in order to seek new homes and livelihoods. Forced displacement is associated with a range of health issues, including social isolation and mental disorders and, in many cases, reduced socioeconomic status and associated health problems. The recent record-breaking drought in Australia caused many rural families to abandon their farms and move to cities, with a range of negative social and health effects. When migration crosses ethnic and/or national boundaries, such as forced migration from low-lying, small island states, the social transition is more difficult and the associated health effects are likely to be more severe.

COMPETITION OVER DWINDLING OR DEGRADED NATURAL RESOURCES CAN INCREASE THE RISKS OF CONFLICT AND WAR. Although most conflicts are not directly related to natural resources, stresses on natural ecosystem services can lead to competition between population groups over, for example, freshwater supplies or fertile agricultural land. Combined with factors such as poor governance and ethnic rivalries, such competition can inflame tensions into conflict.[33]

Olav A. Saltbones / Norwegian Red Cross

Iridimi refugee camp in Chad: more frequent and intense drought can cause food shortages, and potentially population displacement and increasing tension and conflict between communities.

# WHO IS AT RISK?

## 6. Vulnerable regions: exposed populations

**All regions of the world will be affected by a changing climate, but the resulting health risks to human populations vary greatly, depending on where and how people live. People living in small island developing states and other coastal regions, megacities and mountainous and polar regions are all particularly vulnerable in different ways.[13]**

SMALL ISLAND DEVELOPING STATES AND OTHER LOW-LYING REGIONS ARE IN THE FRONT LINE. Populations in these countries are vulnerable to death and injury and destruction of their public health infrastructure from increasingly severe tropical storms, as well as salinization of water resources and agricultural land from sea level rise.[34] Many of these nations struggle to supply adequate fresh water for basic sanitation and hygiene, particularly to outlying islands and other isolated areas where populations suffer elevated rates of diarrhoea and nutritional deficiencies during droughts, floods and high temperatures.[28]

URBAN POPULATIONS, PARTICULARLY THOSE OF TROPICAL MEGACITIES, ARE EXPOSED TO A COMBINATION OF HEALTH RISKS SUCH AS HEATWAVES, FLOODS, INFECTIOUS DISEASES AND AIR POLLUTION. Rising global temperatures combine with the urban heat island effect, and can raise temperatures by 5–12° C, heightening hazards from heatwaves.[35,36] Extensive coverage with impervious surfaces, along with inadequate drainage and precarious housing, increase the risks and the health impacts of flash floods. High population densities, inadequate coverage of clean water, sanitation and waste disposal services raise vulnerability to climate-sensitive infectious diseases such as diarrhoea and dengue. Many cities also have high levels of air pollution, almost all of which results from burning of fossil fuels.[37]

MOUNTAIN POPULATIONS ARE AT INCREASED RISK OF WATER INSECURITY, FLOODS AND LANDSLIDES, AND INFECTIOUS DISEASE. Climate change at high altitudes can cause a range of health challenges.[38] The widespread retreat of glaciers threatens to deprive mountain and downstream populations of reliable summer fresh water for household use and for agriculture, from China to Peru. Swelling of the lakes that form at the bottom of glaciers increases the risks of glacier lake outburst floods, which occur suddenly and can cause injury, death and destruction in downstream communities. Furthermore, higher temperatures are intensifying the risks of transmission of vector-borne diseases, such as malaria, among high-altitude populations that lack immunity against such diseases.[25]

THE HEALTH OF INDIGENOUS PEOPLE IN POLAR REGIONS MAY BE PARTICULARLY AFFECTED BY CHANGES IN TEMPERATURE, FOOD SOURCES AND LIVELIHOODS. Rising winter temperatures in Arctic regions are expected to reduce excess winter mortality and cold-related injuries.[39] However, the traditional diet of circumpolar residents is likely to be impacted by melting snow and ice, affecting animal distributions and accessibility for hunting. Wildlife and waterborne and vector-borne diseases are expected to have a wider seasonal and geographical distribution.[40] Perhaps most importantly, changes in the physical environment will make traditional ways of life impossible, forcing changes of behaviour and means of supporting livelihoods, with associated effects on mental health and community cohesion.

Laurent Weyl / ARGOS

WHO / Chris de Bode

Guillaume Collanges / ARGOS

WHO / Benno Neeleman

Clockwise from top left: coastal flooding in Tuvalu, infectious disease risks in urban settings in Sierra Leone, disruption of livelihoods in Scandinavia and Nepal.

## 7. Children: life-long exposure to health risks from climate change

**Children, particularly in poor countries, have made the least contribution to the greenhouse gases that are causing climate change, yet they are among the most vulnerable to the resulting health risks and will be exposed longer to the health consequences of a degraded natural environment.**

CLIMATE-SENSITIVE DISEASES ALREADY PLACE AN ENORMOUS BURDEN ON CHILD HEALTH. The most important climate-sensitive diseases are those of poor children: 90% of the burden of malaria and diarrhoea, and almost all of the burden of diseases associated with undernutrition, are borne by children aged 5 years or less, mostly in developing countries.[17]

THESE MAJOR DISEASES OF CHILDREN ARE HIGHLY SENSITIVE TO VARIATIONS IN TEMPERATURE AND PRECIPITATION. The problems of undernutrition and associated diseases are most common among populations that are either directly dependent on rain-fed subsistence agriculture or who have low incomes and therefore high sensitivity to increases in food prices when harvests are diminished by floods and drought. The distribution of malaria in time and location is influenced to a large extent by temperature, humidity and rainfall. Childhood diarrhoea in developing countries has been shown to increase significantly with higher temperatures, or at times of low water availability (making hygiene more difficult) and flooding (contaminating freshwater sources).

CLIMATE CHANGE THREATENS TO INTENSIFY THESE BURDENS FURTHER. Progress towards all of the health-related Millennium Development Goals, from reduction of childhood mortality to eradication of extreme poverty and hunger, should reduce the vulnerability of children. However, progress is slower than hoped, and climate change threatens to create further setbacks. For example, unless adaptation measures are taken, climate change is projected to increase the percentage of the population of Mali at risk of hunger from 34% to 64–72% by the 2050s.[41] Several studies project that rising temperatures and changing rainfall patterns are likely to increase significantly the population at risk of malaria in Africa[18] and the number of months of exposure to transmission.[42] The resulting disease burden can be expected to affect mainly children.

CHILDREN HAVE LITTLE IMPACT ON MANY ADAPTATION AND MITIGATION DECISIONS. Children have heightened vulnerability to health risks from climate change: both because they suffer disproportionately from climate-sensitive disease and because they will be exposed longer to the accumulating damage that climate change is inflicting on the natural environment. They bear little or no responsibility, however, for past and present emissions of the greenhouse gases that are now causing climate change. The responsibility to protect and enhance the health of children therefore lies with adults, from parents to community, business and national leaders who take decisions on climate change mitigation and adaptation.

S.Chamnanrith - UNEP/Still Pictures

Thailand: some of the most severe risks, both now and in the future, are for children.

## 8. The most vulnerable: they support the greatest health burdens

**Natural disasters, such as the European heatwave of 2003 and Hurricane Katrina in the USA in 2005, show that, even in the most developed countries, health is vulnerable to weather and climate. The risks are particularly high, however, for the poorest populations, who already suffer from high burdens of climate-sensitive disease and lack effective public health systems to protect them from the increased risks associated with climate change.**

THE BURDEN OF CLIMATE-SENSITIVE DISEASES IS GREATEST FOR THE POOREST POPULATIONS. For example, the per capita mortality rate from vector-borne diseases is almost 300 times greater in developing nations than in developed regions.[17] This is because vector-borne diseases are more common in tropical climates of many developing countries, and also because of low levels of socioeconomic development and coverage of health services in these areas.

CLIMATE-RELATED HEALTH RISKS ARE OFTEN GREATER FOR POOR INDIVIDUALS WITHIN ANY POPULATION. In developing countries, individuals without adequate shelter or access to health and other critical services are more vulnerable to a range of risks related to weather and climate, from flooding to infectious diseases. For example, diseases transmitted by water, soil and vectors, such as schistosomiasis,[43] hookworm[44] and filariasis,[45] are often many times more common among people with the lowest socioeconomic status in any one location. The same pattern occurs in rich countries: in the wake of Hurricane Katrina in the USA, lower-income groups were most affected and low-income schools had double the average risk of being flooded.[46]

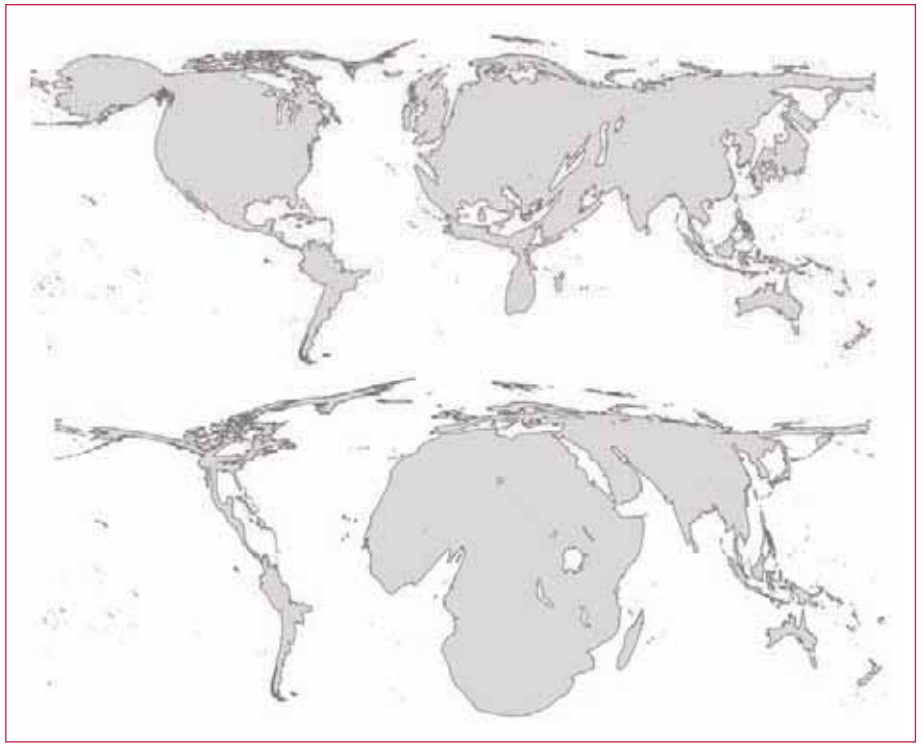
WHO / Bonno Nederman

Northern Kenya: the poorest populations are most vulnerable to drought and other consequences of climate change.

WOMEN AND CHILDREN IN DEVELOPING COUNTRIES ARE PARTICULARLY VULNERABLE TO DEATH AND ILLNESS FOLLOWING NATURAL DISASTERS. In the 1991 cyclone disasters that killed 140 000 people in Bangladesh, death rates among women were almost four times greater than those among men: rates among children under 10 years of age were more than six times greater than those of adult men.[47] Natural disasters can also result in increased suffering from domestic violence and post-traumatic stress disorders in women,[48,49] who are also often called upon to play a leading role in disaster recovery and in rebuilding shattered communities.

CLIMATE CHANGE AND ASSOCIATED DEVELOPMENT PATTERNS THREATEN TO WIDEN EXISTING HEALTH INEQUALITIES BETWEEN AND WITHIN POPULATIONS. A WHO assessment of the burden of disease caused by climate change suggested that the modest warming that has occurred since the 1970s was already causing over 140 000 excess deaths annually by the year 2004.[17] The estimated per capita impacts were many times greater in regions that already had the greatest disease burden.[4,50] Health benefits of climate change – mainly decreased mortality from cold winters – are less strongly supported by evidence; to the extent that they do occur, they are expected to benefit mainly populations in high-latitude developed countries.[5,50] The disproportion of populations that have contributed the least to climate change and are the most vulnerable to health risks is graphically presented in Figure 4. The ongoing process of climate change is likely to widen the existing health disparities between the richest and the poorest populations.

**Figure 4. Poorer countries contribute little to greenhouse gas emissions, but are most vulnerable to health impacts.**
The top image shows countries scaled by total emissions of $CO_2$ to 2002; the bottom image shows countries scaled by WHO regional estimates of *per capita* mortality from climate change in 2000[50].



Source: map projections by Patz et al., 2007.[51]

## 9. All of us: our shared health security

**Globalization has brought benefits of efficient transport and trade, with rapid flows of people, goods and services; but in an increasingly interconnected world, some health risks can quickly spread from one location to another. Now, more than ever, protecting and promoting the health of all populations is a global public good.**

CLIMATE CHANGE MAKES PROTECTING GLOBAL PUBLIC HEALTH SECURITY EVEN MORE DIFFICULT. The underlying problems of public health security are long-standing: inadequate investment in public health services and global disease surveillance and control, and failure to manage environmental risks to health.[52] Climate change brings a new dimension to this problem, exacerbating the worldwide risks of sudden shocks such as heatwaves, floods and disease epidemics, as well as accelerating long-term stresses such as the availability of fresh water. All of these changes can have impacts far beyond the locations in which they originally occur.

INFECTIOUS DISEASES CAN NOW SPREAD RAPIDLY THROUGHOUT THE WORLD. The last decades of the 20th century saw an unprecedented rate of emergence of new infectious diseases.[53] They also saw the re-emergence and regional spread of many existing climate-sensitive infections: such as cholera and Rift Valley fever in Africa, and dengue in Latin America and South Asia.[54] These outbreaks can cause major economic losses. For example, a cholera outbreak in Peru in 1991 cost approximately US$ 770 million, and the 1994 plague outbreak in India US$ 1.7 billion.[55] A warming and more variable climate, coupled with globalization, hastens the speed with which these diseases change in distribution and move across international borders. Unusual weather patterns may also contribute to the emergence of new diseases, such as hantavirus pulmonary disease in the southwestern United States and Nipah virus infection in Asia, especially in areas where human impacts on the environment have been increasing most rapidly.[53]

COMPETITION OVER SCARCER NATURAL RESOURCES, AND WIDENING INEQUALITIES, CAN FUEL REGIONAL TENSIONS. In northern Darfur, Sudan, precipitation has fallen by a third in the past 80 years. The resulting desertification, along with other environmental pressures, has added to the stress on traditional agricultural and pastoral livelihoods. By early 2008, fighting in the region had cost between 200 000 and 500 000 lives and displaced over 2.5 million people, many of whom are living in refugee camps in precarious health conditions. The conflict has resulted in deployment of troops from other African countries and has spilled over into neighbouring Chad. Ongoing climate change, particularly declining and more variable rainfall, is expected to reduce yields of staple crops by up to 70% in the most vulnerable areas.[33]

THE RISKS TO HUMAN SECURITY FROM CLIMATE CHANGE AND FOSSIL FUEL DEPENDENCE ARE NOW BEING RECOGNIZED. Surveys have shown that many populations, including those in Australia, China and Italy, place climate change high on lists of threats to their security and well-being. Military leaders and researchers have stressed that climate change, national security and energy dependence are closely related, with dependence on foreign oil heightening vulnerability to hostile attacks and involvement in foreign conflicts.[56] This concern is now reflected at the highest level; in 2007, climate change was debated for the first time at the United Nations Security Council, as well as in a special session of the United Nations General Assembly.

WHO / Banno Neeleman

Bangladesh: sheltering from heavy rainfall. Infectious diseases can now spread rapidly to any part of the world – calling for health protection for all.

# WHAT NEEDS TO BE DONE?

## 10. Putting health at the heart of the climate change agenda

**Climate change can no longer be considered simply as an environmental or a developmental issue. It will affect the health and well-being of all populations, with impacts escalating into the foreseeable future. A greater understanding of the health implications of climate change – and related development choices – can lead to improved policies and more active public engagement.**

THIS REPORT DOCUMENTS THE RANGE OF RISKS THAT CLIMATE CHANGE POSES TO HUMAN HEALTH - BUT THE IMPACTS ARE NOT INEVITABLE. The extent to which these risks translate into increased disease burdens, will depend on the efforts that we make to protect health through adaptation, and to reduce our impacts on the global climate.

HEALTH PROTECTION IS CENTRAL TO THE EXISTING GLOBAL AGREEMENT TO ADDRESS CLIMATE CHANGE. The first line of the original UN Framework Convention on Climate Change (UNFCCC) highlights the need to avoid "adverse effects"; which it defines as significant deleterious effects on "natural and managed ecosystems or on the operation of socioeconomic systems or on human health and welfare".[57] Addressing climate change should therefore be viewed as much as an effort to improve human health and well-being as it is to protect the natural environment or economic development.

HUMAN HEALTH NEEDS TO BE PLACED AT THE CENTRE OF ENVIRONMENT AND DEVELOPMENT DECISIONS. There is a growing appreciation that the natural environment should be valued not just for its own sake, but for the “goods and services” that it provides to support human societies; and that economic development is not an end in itself, but a means to improving human lives.[58] It is essential that the same reasoning be applied to climate change. The ultimate aim of mitigation and adaptation, and related development decisions, should be the protection and improvement of human well-being.

AN EFFECTIVE AND GLOBALLY EQUITABLE APPROACH TO CLIMATE CHANGE MITIGATION AND ADAPTATION IS ESSENTIAL TO ADVANCE GLOBAL HEALTH. Support for health adaptation, including through sectors such as agriculture and water, is essential to protect populations in the short- to medium-term, while mitigation is also essential to safeguard the services that ecosystems provide that support global health over the long-term. Both responses need to take account of the "common but differentiated responsibilities" specified under the UNFCCC[57], giving the necessary support to protect the most vulnerable populations from climate risks, and facilitating their access to the less polluting energy sources that are essential to improving their health.

POVERTY ALLEVIATION IS CRITICAL TO REDUCING VULNERABILITY – BUT PUBLIC HEALTH MEASURES ARE ALSO REQUIRED. There is abundant evidence that countries with a higher level of economic development tend to have better health, including reduced vulnerability to many climate-sensitive diseases. Continued economic growth in the poorest populations is therefore vital to protecting health from climate change. However, economic growth is itself at risk from climate change[59] and, depending on the development path that is followed, it can increase environmental risks to health and leave large sections of the population vulnerable. Greater attention to public health planning is necessary, particularly to safeguard the health of the most vulnerable population groups, which is, in turn, a contribution to sustained economic development.[60]

Hélène Duval / ARGOS

Shifmaref, Alaska, USA: the human face of climate change. Sea-level rise, storms and coastal erosion are not just an environmental issue – they affect the lives and well-being of people throughout the world.

## 11. Strengthening public health systems

**Protection from climate change is part of a basic, preventive approach to public health, not a separate or competing demand. The public health community has a wealth of experience in protecting people from climate-sensitive hazards. Many of the most important actions are public health interventions of proven effectiveness, from controlling vector-borne disease, to providing clean water and sanitation, and reducing reliance on energy sources that pollute the environment and harm health. Widening the coverage of these measures will save lives now, and is a critical contribution to the global effort to adapt to climate change.**

STRENGTHENING OF PUBLIC HEALTH SYSTEMS IS ALREADY NECESSARY; CLIMATE CHANGE MAKES THIS NEED EVEN MORE CRITICAL. Today's shortfalls in providing basic public health services leave much of the global population exposed to climate-related health risks. There is a need for additional investment to strengthen key functions and for forward planning to address the new challenges posed by climate change.

ENHANCED CAPACITY TO ADDRESS PUBLIC HEALTH EMERGENCIES SAVES LIVES AND PROTECTS COMMUNITIES. Acute shocks such as natural disasters and disease epidemics can overload the capacities of health systems in even the most developed nations. The number of disasters reported and the numbers of people affected have risen in recent decades.[24] Conversely, the number of people killed has fallen, as societies and individuals have become more able to protect themselves. Further reinforcing disaster risk reduction, early warning, and health action in emergencies can help to ensure that people are better protected from the increasing hazards of extreme weather and help communities recover faster following a disaster.[61]

STRENGTHENED SURVEILLANCE AND CONTROL OF INFECTIOUS DISEASE CAN PROTECT HEALTH FROM LOCAL TO GLOBAL SCALES. Effective disease surveillance and control become even more important under conditions of rapid environmental change and movement of people, disease vectors and infections. Rapid and accurate disease notification, in compliance with the International Health Regulations,[62] is the essential basis for planning disease control. Approaches such as Integrated Vector Management make the best use of proven interventions, such as bednets, insecticide spraying and environmental management, to control malaria, dengue and other vector-borne tropical diseases that may otherwise expand through climate change.[63] Improving access to primary health care ensures faster treatment for patients, alleviating suffering and containing the risks of disease spread.

IMPROVING THE ENVIRONMENTAL AND SOCIAL DETERMINANTS OF HEALTH IS CRITICAL TO PROTECTING POPULATIONS FROM CLIMATE CHANGE. Addressing known environmental risk factors could greatly improve health, while supporting sustainable development. Improving environmental conditions could prevent up to a quarter of the global burden of disease, rising to a third in the poorest countries[64,65] (see Figure 5). For example, scaling up water and sanitation services and household disinfection would immediately reduce diarrhoea and, at the same time, lessen the health impacts of decreasing and more variable water supplies. The benefits of such interventions are already several times greater than the costs,[66] and the threat of climate change makes these preventive health measures an even wiser investment. Improving social welfare, particularly educating and empowering women in developing countries, is a

fundamental requirement for improving health. It is also essential to strengthening community resilience to climate change.

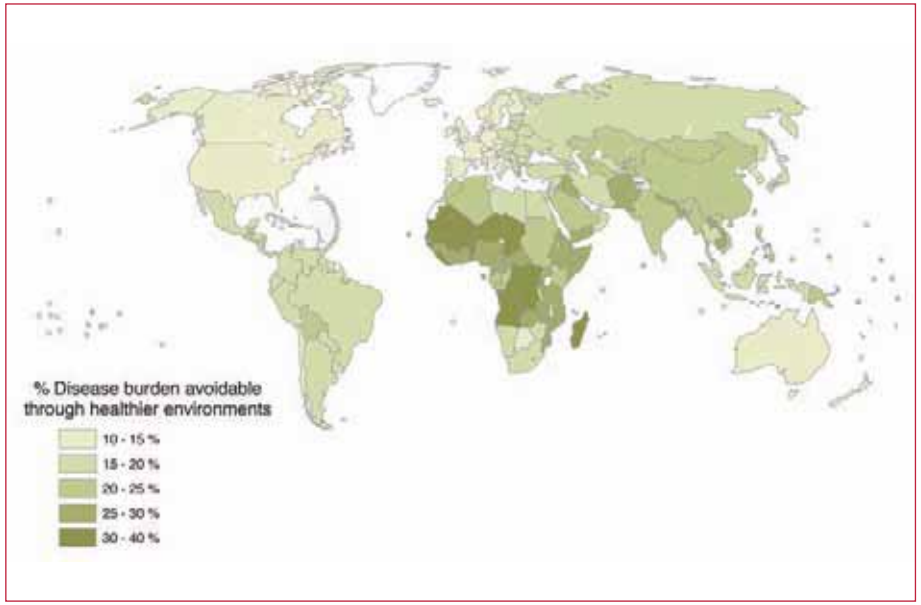
THE RISKS OF CLIMATE CHANGE CALL FOR MORE EQUITABLE ACCESS TO PUBLIC HEALTH SERVICES. The health of the poorest and most disadvantaged people is particularly threatened by climate-sensitive diseases, and by climate change. Greater emphasis will need to be placed on protecting the health of particularly vulnerable groups, in order to ensure that this emerging risk does not further widen the gaps in health outcomes between the most and the least privileged.

WHO / Jim Holmes

Indonesia: strengthening public health interventions, such as rapid surveillance and control of infectious disease, is essential to meeting the challenge of climate change.

CLIMATE CHANGE ALSO CALLS FOR MORE LONG-TERM, FLEXIBLE AND ADAPTABLE PUBLIC HEALTH PLANNING. In addition to increasing coverage of existing interventions, countries need to assess their main health vulnerabilities to climate change, and prioritize which adaptive actions will give the most protection. This should include consideration of how climate change may alter the effectiveness of specific interventions, for example considering which kinds of water and sanitation technologies will be most robust in the event of increases in floods or droughts in particular areas.[64]

**Figure 5. Estimated proportion of the total burden of disease that could be prevented through proven interventions to reduce environmental health risks.**




Source: based on data from Pruss-Üstün & Corvalán[65]

## 12. Choosing healthy paths to a low-carbon future

**Many policies and individual choices have the potential both to reduce greenhouse gas emissions and produce major health co-benefits. Actions such as shifting to cleaner energy sources, facilitating safe public and active transport, and making more sustainable dietary choices, bring important health gains to communities and individuals. These local and immediate benefits can offset a large part of the costs of climate change mitigation, and provide a strong political and personal motivation for action.**

CHOOSING MORE SUSTAINABLE DEVELOPMENT PATHS AND LIFESTYLES CAN HELP TACKLE IMPORTANT HEALTH HAZARDS, AS WELL AS REDUCING GREENHOUSE GAS EMISSIONS. Shifting to cleaner and more sustainable means of supplying basic needs, such as energy generation and transport, could eliminate much of the current air pollution in developing countries and at the same time cut greenhouse gas emissions. Sustainable urban planning, including facilitating safe public and active transport, can cut road traffic accidents, provide opportunities for physical activity and improve social cohesion. Moderating consumption of animal products and favouring foods that are lower in the food chain, has the potential both to enhance health and reduce impacts on the global climate. Box 2 describes some of the health co-benefits of sustainable living.

HEALTH CO-BENEFITS HAVE THE POTENTIAL TO OFFSET A LARGE PART OF THE FINANCIAL COSTS OF CLIMATE CHANGE MITIGATION POLICIES. A wide range of experience has shown that quantifying the benefits to health and well-being can often tip the balance in favour of more environmentally-friendly choices. For example, a cost-benefit analysis of the United States Clean Air Act showed that each dollar invested in implementing the act generated 42 dollars in societal benefits – almost entirely through health improvements.[67] The 2007 Intergovernmental Panel on Climate Change (IPCC) report showed that the costs of many mitigation interventions would be partly or wholly compensated for by health benefits.[68] These are often valued close to or higher than the 'social cost' of carbon dioxide or the 'market cost' in carbon trading schemes. They should therefore be valued and provided with incentives as much for protecting health as they are for protecting the climate.

DIRECT HEALTH BENEFITS ARE AN IMPORTANT AND NEGLECTED POLITICAL AND PUBLIC ARGUMENT IN SUPPORT OF CLIMATE MITIGATION. The health co-benefits of many mitigation decisions are more local and immediate than the long-term and globally distributed benefits of reduced damage to the global climate. For example, the motivation of city mayors to promote cleaner energy and transport to reduce deaths from urban air pollution,[69] or of individuals to walk and cycle to work to improve their cardiovascular health,[70] is likely to be at least as strong as their motivation to take these actions in order to reduce greenhouse gas emissions.

THE HEALTH COMMUNITY SHOULD PLAY A MORE ACTIVE ROLE IN THE DESIGN OF GREENHOUSE GAS MITIGATION POLICIES. The health implications of the various mitigation measures vary widely.[71] Failure to select the most health-enhancing actions would be a lost opportunity for society, and would reduce the return on investment in greenhouse gas mitigation. Some measures, however, can also bring health risks. Unless carefully managed, these may cause health damages, which would also have the side-effect of undermining support for action on climate change. Health professionals can contribute to applied research and policy guidance, to help select the best paths to a low-carbon future.


Nigel Bruce / WHO


Fedephoto


Olivier Girard


Nicola Vigilanti


Abir Abdullah / WHO

Sustainable development and lifestyle choices can bring large health benefits: From left: improved stove in Guatemala, bicycles in France, vegetable market in Kenya, renewable energy in Italy, reproductive health advice in Bangladesh.

## Box 2. Development choices to enhance health and address climate change

**Household energy.** In the least-developed countries, enabling households to move from inefficient burning of coal and biomass fuels for domestic use to cleaner sources would significantly reduce the warming effect of black carbon, and would also decrease the estimated 2 million annual deaths from indoor air pollution.[17] In India, for example, a proposed programme to introduce 150 million low-emission cooking stoves would be expected to gain approximately 12 500 years of healthy life per million population by the year 2020, roughly equivalent to eliminating half of the total cancer burden in the country.[72] In temperate, developed countries, better housing insulation can increase energy efficiency, cut household heating bills, and improve health. Research from New Zealand demonstrated that such interventions resulted in improvements in self-rated health, school and work attendance, as well as reduced visits to general practitioners.[73]

**Electricity generation.** Over the next 20 years, improved technology and reduced reliance on the most polluting fossil fuels for electricity production is expected to reduce the current 1.2 million annual deaths from outdoor urban air pollution.[4] Adding international trade in carbon emissions would help to direct cuts to where they are most efficient, bringing further gains both in reduced greenhouse gas emissions and in health: approximately 100 more healthy life years per million population annually in the EU, 500 in China, and 1500 in India.[74] The direct health benefits of improvements in household energy and electricity generation alone would offset a significant fraction of investment costs.[68]

**Urban transport systems.** Promotion of sustainable transport systems, with opportunities for safe public and active transport, could dramatically cut greenhouse gas emissions. It would also help to reduce the 3.2 million annual deaths from noncommunicable diseases associated with physical inactivity,[4] and the 1.3 million annual deaths from road traffic accidents.[17] In the United Kingdom, for example, introduction of selected policies aimed at reducing transport emissions by 60% by the year 2030, would be expected to bring major health gains: 10–20% reductions in heart disease and stroke, 12–13% in breast cancer; 8% in dementia, and 5% in depression. Health gains in rapidly developing economies are expected to be even larger.[70]

**Food and agriculture.** The food and agriculture sector contributes about 10–12% of global greenhouse gas emissions, with additional contributions from associated land-use change. Moderating meat consumption and favouring foods that are lower in the food chain has the potential both to enhance health and to reduce impacts on the global climate. For example, recent studies show that a 30% reduction in adult consumption of saturated fat from animal sources would cut heart disease in the population by around 15% in the UK, and 16% in the city of São Paulo, Brazil.[75] Such dietary changes would also be expected to reduce the 2.8 million annual deaths from overweight and obesity, as well as a range of cancers.[4]

**Family planning.** Unsustainable and inequitable patterns of production and consumption will dominate effects on the global climate over the next few decades. Over the long-term, however, population stabilization would also help to ease pressure on the local and global environment. At the same time, approximately 200 million women in developing countries express an unmet need for family planning services and supplies.[76] Supporting rights-based reproductive health services can empower women and girls, as well as helping to reduce the half-million maternal deaths, and approximately 9 million deaths of children under five, that occur every year.[17] Safeguarding reproductive health and rights can also ease population pressure, which many developing countries have identified as increasing their vulnerability to climate change,[77] as well as eventually reducing greenhouse gas emissions.

## 13. Mobilizing the strength of the health community

**Addressing climate change presents a fundamental challenge to decision-makers from the individual to the global level. It requires leadership, and an unprecedented degree of collaboration between communities and nations. The skills, capacity and shared values of the public health community can make an important contribution to a fair and effective response to climate change.**

FURTHER RESEARCH ON CLIMATE CHANGE AND HEALTH IS REQUIRED; BUT WE ALREADY KNOW ENOUGH TO BEGIN TO ACT. Stronger applied research programmes are necessary to develop new approaches and interventions, to prioritize and target the tools that we already have available and to monitor successes in protecting health. However, we already have strong evidence that there are many 'win-win' interventions that would both improve health almost immediately and support climate change adaptation and mitigation. There is no excuse to delay action.

HEALTH LEADERSHIP IS ESSENTIAL AT ALL LEVELS. The diverse, widespread, long-term and inequitable nature of health risks makes this a truly global challenge, but the impacts will be felt locally. It is critical that the health community assumes responsibility for promoting an effective and equitable global response to climate change, which also supports efforts to address other health priorities. Health agencies also need to take an active role in cross-sectoral planning processes to address climate change, such as National Adaptation Plans of Action, and supporting their implementation down to the community level.

INDIVIDUAL HEALTH PROFESSIONALS HAVE A SPECIAL ROLE TO PLAY IN ADVOCATING FOR HEALTH PROTECTION FROM CLIMATE CHANGE, AND LEADING BY EXAMPLE. The health sector is one of the largest global employers and a major consumer of energy and other resources. For example, the health-care sector in the USA is estimated to account for approximately 16% of national gross domestic product (GDP), and 8% of greenhouse gas emissions.[78] Improving the sustainability of health institutions can itself make an important contribution to reducing climate change. In addition, as respected members of the community, health professionals can lead by example, acting to ensure that their own working practices and individual lifestyles contribute to a healthier local and global environment.

THE HEALTH COMMUNITY HAS RAPIDLY SCALED UP ITS ENGAGEMENT ON CLIMATE CHANGE. Just since 2008, WHO has selected this issue as the theme for World Health Day, and the 193 nations that constitute the World Health Assembly passed a resolution calling for increased support from WHO, and stronger engagement by Member States.[79] Major professional associations from the World Medical Association, to the International Council of Nurses and the World Federation of Public Health Associations, have issued statements on the need to respond to the public health threat caused by climate change.[80,81,82]

ADDRESSING CLIMATE CHANGE IS NOT JUST AN ISSUE OF INTERNATIONAL AGREEMENTS, OR ECONOMIC COSTS; IT IS A CHOICE OF WHAT KIND OF WORLD WE WANT TO LIVE IN. Climate change is a consequence of short-sighted policies that failed to take sufficient account of the need to sustain the planet's ecological health, and to protect the most vulnerable people in society. Fundamentally we are all facing a choice about values, and the public health values of sustaining and improving lives, protecting the weakest, and fairness are equally relevant to addressing climate change.[83] The World Health Organization, on behalf of the global health community, is committed to playing its part in responding to this challenge.

Marko Kokic / WHO

Health professionals are at the front line in protecting health from climate-sensitive health risks, and demonstrating leadership in their communities: Doctor in the Democratic Republic of Congo.

## Box 3. Top ten actions for national and local policy-makers

**Advocate for strong and equitable climate change agreements.** Current and projected stresses on the Earth's life support systems (food, shelter, water and energy) require a fair, scientifically sound and globally binding commitment to reduce net greenhouse gas emissions and stabilize the global climate.

**Promote the need for «health-oriented» agreements.** Protecting health and well-being is one of the three main objectives of the original climate convention, (alongside development and environment), and should be a priority within any new agreement; the strengthening of health systems should be identified as a priority area for adaptation to climate change; and mitigation measures that bring health and other socioeconomic benefits should be prioritized.

**Establish multisectoral processes to oversee climate change and health policy development.** Utilize health impact assessments to evaluate social and economic costs of threats and prioritize action and investment areas.

**Protect the most vulnerable.** Globally, people at greatest risk of adverse health effects associated with climate change include the very young, the elderly, and the medically infirm. Socioeconomically disadvantaged groups and areas where infrastructure and/or social services (including health) are weak will have most difficulty adapting to climate change and related health hazards.

**Strengthen health system adaptive capacity.** Many of the projected impacts of climate change on health are avoidable or controllable through application of well-known and well-tested public health and health service interventions, such as public education, disease surveillance, disaster preparedness, vector control, food hygiene and inspection, nutritional supplementation, vaccines, primary and mental health care, and training. Where these capacities are weak, collaborative work must be done to enhance them.

**Take into account health co-benefits when considering different greenhouse gas mitigation options.** Reducing greenhouse gas emissions is also good for health. In countries where cars are the predominant means of transport, shifting to more walking and cycling and discouraging private car use in urban centres lowers carbon emissions, increases physical activity (which reduces obesity, heart disease and cancer), and results in less pollution and noise. In countries where solid fuels are the predominant form of household heating and cooking energy, addressing inequitable access to cleaner fuels and providing more efficient stoves will lead to fewer illnesses and deaths related to indoor air pollution. Subsidies that encourage the consumption of animal products in high consuming nations should be removed. Reducing animal fat consumption in these countries will reduce heart disease, obesity and other high-risk conditions.

**Increase funding for interdisciplinary research on climate change mitigation technologies and strategies across a range of sectors.** Build capacity by supporting the career development and training of young researchers in relevant disciplines.

**Measure public awareness and attitudes** towards current and projected adverse and inequitable health impacts of climate change, as well as the potential for significant health benefits and consequent cost savings from well-conceived climate control policies. Develop communication and social marketing plans to address perceptual and behavioural obstacles.

**Measure and address the 'carbon footprint' of your public institutions.** Encourage your public institutions to lead by example. As highly visible, high-energy-use centres, public institutions can serve as models by reducing their own carbon emissions, improving health and saving money. Seven potential action areas include: energy management, transport, procurement (including food and water), waste disposal, buildings and landscape, employment and skills, and community engagement. Good practice in these areas has been shown to improve staff health and morale, create healthier local populations, and save money.[84,85,86]

**Incentivize your workforce and all stakeholders** to reduce their personal carbon footprint including through increased use of active transport.

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