Global Climate Change and Health: Challenges for Future Practitioners

Jonathan A. Patz, MD, MPH, and Mahmooda Khaliq, Bloomberg School of Public Health of Johns Hopkins University, Baltimore, Md

OVERVIEW
Global climate change is expected to have broad health impacts.1 If current warming trends continue, heat waves, floods, and droughts and their attendant physical effects are likely to become more frequent and severe. Warmer air temperatures can influence the concentration of regional air pollutants and aerollergens. Less direct health impacts may result from the disruption of ecosystems and of water and food supplies, which in turn could affect infectious disease incidence and nutritional status. Finally, sea-level rise could lead to major population displacement and economic disruption.

Climate Change Science
Human activities related primarily to the burning of fossil fuels and changes in land cover such as deforestation are changing the concentration of atmospheric constituents or properties of the earth’s surface that help to absorb or scatter radiant energy.2 Since the preindustrial mid-1800s, increases in concentrations of three major greenhouse gases, carbon dioxide, methane, and nitrous oxide, have exceeded past changes that occurred over the last 10,000 years; carbon dioxide alone has increased by 30% since the late 1800s.3 Warmer air, such as that resulting from the greenhouse effect, can hold more moisture and more quickly evaporate surface water, thereby increasing the frequency of severe storms, floods, and droughts.1

According to the United Nations Intergovernmental Panel on Climate Change (IPCC), “An increasing body of observations gives a collective picture of a warming world and other changes in the climate system.”4 During the 20th century, global average surface temperature increased about 0.6°C, global average sea level rose 10 cm to 20 cm, and snow and ice cover decreased.2 The latest IPCC report predicts that if current trends continue, sea level rise will rise 45 cm and global temperatures will increase by 3°C by the year 2100.3

Temperature-Related Morbidity and Mortality
Small changes in global mean temperatures can produce relatively large changes in the frequency of extreme temperatures.2 Mortality rates increase at both hot and cold extremes of temperature.4 Increases in temperature have a direct and substantial impact on excess mortality for elderly individuals and individuals with pre-existing illnesses. Much of the mortality attributable to heat waves is a result of cardiovascular, cerebrovascular, and respiratory disease.5 A 1995 heat wave in Chicago that caused 514 heat-related deaths (12 per 100,000 population)6 may be part of a recent trend of longer, more frequent heat waves and record-setting temperatures.7 Long-term global warming trends are further exacerbated by the “heat island” effect, whereby high concentrations of heat-retaining surfaces such as asphalt and tar roofs sustain higher temperatures through the night. Heat waves also have the secondary effect of worsening urban air pollution. Ozone, which forms chemically from precursor pollutants, is the most temperature-dependent air pollutant and may contribute to the development of asthma in children.8

Health Effects of Extreme Weather Events
Higher average ambient air temperatures are likely to induce more vigorous cycles of evaporation and precipitation. Indeed, a trend of increasing climate variability and extreme precipitation events has been observed over the past century, and recent models strongly correlate this trend with anthropogenic production of greenhouse gases.9,10

Human health impacts are most likely to occur where extreme weather and population vulnerability converge. At highest risk are communities that are most exposed (eg, in floodplains and coastal zones) and that have the fewest technical and social resources.11 The health impacts of extreme weather events include physical injury; poorer nutritional status, especially in children; increases in respiratory and diarrheal diseases due to overcrowding of flood survivors and limited access to potable water; increased risk of water-related diseases due to disruption of water supply or sewage systems; and release of dangerous chemicals from storage sites and waste disposal sites into flood waters.11,12

El Niño. An El Niño occurs approximately every 3 to 7 years when warm equatorial water shifts from the western to eastern Pacific Ocean.13 The 1997-1998 El Niño event was one of the two strongest of the past century. It was associated with extremely dry conditions and devastating fires in many areas of the world and with extensive flooding in others.14 Some infectious diseases that are typically seasonal have shown marked interannual variability. Many epidemics of malaria are associated with El Niño–driven climate extremes.15 The 1997-1998 El Niño resulted in torrential rain in parts of East Africa and a subsequent malaria epidemic in the highlands of southwestern Uganda.16

Floods. Climate change may increase the risk of both river and coastal flooding, whose immediate effects include drowning and physical trauma.17 Longer-term effects include increases in communicable diseases such as those caused by ingestion of contaminated water (eg, cholera and hepatitis A) or contact with contaminated water (eg, leptospirosis). Respiratory infections may result from overcrowding of settlements or from overgrowth of molds in flooded homes.17
Droughts. Droughts have their largest impact on population health by threatening food supplies. In addition, diarrheal diseases, scabies, conjunctivitis, and trachoma are associated with poor hygiene and may result from inadequate sanitation as water resources become depleted. Drought-induced wildfires can cause direct injury and have the potential to affect air quality. During the 1997-1998 El Niño, biomass smoke from drought-exacerbated fires in Indonesia affected large population centers in southeast Asia. In some areas, smoke concentrations were more than six times higher than the ambient air quality standards outlined by the US Environmental Protection Agency.

Water-Related Infectious Diseases
Waterborne diseases in marine or coastal zones are especially sensitive to climate. During the 1997-1998 El Niño, the number of daily hospital admissions in Lima, Peru, for childhood diarrhea increased more than two fold over the averaged rate for the preceding four years. The increase in ambient temperature in excess of regular seasonal variability was found to be the main environmental variable affecting admissions: for each 1°C increase in mean ambient temperature, the number of admissions increased by 8%. Cholera outbreaks occur seasonally in Bangladesh, with consistent patterns associated with monsoon seasons, sea surface temperatures, rainfall, and zooplankton populations. In the marine environment, warm water and nitrogenous waste favor blooms of dinoflagellates. The resulting “red tides” can cause paralytic, diarrheic, and amnesiac shellfish poisoning. Finally, certain vector-borne pathogens, such as those that spend a part of their life cycle associated with poor hygiene and may result from inadequate sanitation as water resources become depleted. Drought-induced wildfires can cause direct injury and have the potential to affect air quality. During the 1997-1998 El Niño, biomass smoke from drought-exacerbated fires in Indonesia affected large population centers in southeast Asia. In some areas, smoke concentrations were more than six times higher than the ambient air quality standards outlined by the US Environmental Protection Agency.

Sea-Level Rise
Global mean sea level is predicted to continue to increase primarily by the loss of mass from glaciers and thermal expansion of water. Sea-level rise would especially affect coastal communities and, in some cases, may force population migration. Thirteen of the world’s 20 major megapolises are situated at sea level. Nicholls and Leatherman showed that a 1-meter rise in sea level would inundate low-lying areas, affecting 18.6 million people in China, 13 million in Bangladesh, 3.5 million in Egypt, and 3.3 million in Indonesia. Furthermore, rising seas may saline coastal freshwater aquifers and disrupt stormwater drainage and sewage disposal. Considering the health burden experienced by refugees and populations subjected to overcrowding, lack of shelter, and competition for resources, the response to displaced populations may well become the largest public health challenge posed by global climate change.

Acknowledgment: We thank Jolie Susan for her help with manuscript preparation and editing. Partial funding support for Dr Patz comes from the US EPA Global Change Research Program, cooperative agreement CR 827040.

REFERENCES