Public Health 2030: Climate Change and Environmental Threats and Impacts Driver Forecasts

Forecast Summaries

Expectable: Changing climate, vulnerable health

- Recurrent heat-related health problems deliver worst impacts on children, people with asthma, and growing proportion of Americans who are elderly, diabetic, or overweight
- Droughts, floods, and tornadoes diminish food security, with increasing hunger and worsening nutrition among low- and middle-income families and individuals
- Severe storms, flooding, and extended rain periods increase contamination of food and water supplies, incidence of gastrointestinal illness, mold and mildew exposure, and sewage overflows
- Air quality worsens, and injuries and water-, vector-, and insect-borne illnesses spread, particularly in densely populated urban areas
- Mental health worsens as emotional trauma and depression spread among U.S. climate refugees and migrants
- Damaged built infrastructure, roads, and runways lead to more driving accidents, injuries, and deaths

Challenging: Runaway climate, health emergencies

- Methane emissions contribute to runaway climate change
- Overwhelming rates of severe heat, disease, asthma, and allergy-related conditions, particularly impacting children, the elderly, the poor, and the uninsured
- New diseases and antibiotic-resistant bacteria abound
- Food security diminished as plants and animals die from illnesses, droughts, extreme weather events, wildfires, and hotter summers
- Severe storms, hurricanes, and floods become the norm by 2024 in many areas; some small cities and towns become completely uninhabitable
- Water scarcity, rising food and energy prices, and worsening physical and mental health yield thefts, black markets, and conflicts within communities for critical resources
- Forced environmental migration yields higher rates of disease and violence and widespread intolerance of climate refugees

Aspirational: Changing climate, health resilience, and a shift to foresight

- Collaborative and holistic top-down federal initiatives, bottom-up citizen science and crowdsourcing, and use of foresight for adaptation, mitigation, and prevention yield better health, environmental assessment, and policy, successfully reducing severity of expected climate change impacts on health and infrastructure
- Expanded research and deployment of GMOs, plant and forest biotechnology, and soft geoengineering techniques such as “bright water”
- Crowdsourced environmental monitoring; “geo-tagged” health and environmental data is continuously provided to social networks and online mapping platforms that use new analytics to identify local factors impeding health and to point public health officials toward innovative solutions
- Participatory gaming exercises help people prepare for, prevent, and respond to climate catastrophes, disease outbreaks, and food issues; enactment of “zero emissions” days and “no emissions” zones; and heavy investments in urban agriculture
- Greater transparency around industry practices accelerates adoption of sustainable technologies

Driver Background

There are growing challenges from environmental trends, many driven by climate change, that will affect public health's roles and activities. The difficult environmental and weather impacts of climate change have already begun to impact how many around the world perceive and enact public health and population health measures. Such climate events, such as droughts, floods, more intense hurricanes, winter storms, and tornado systems, have already occurred and are expected to grow in intensity and severity. Public health departments or others will be forced to respond more often; to develop recovery strategies; and possibly take part in national mitigation strategies.

The current and future impacts of climate change will reshape public health and public health needs over the next several decades. In recent years, public health departments have enhanced their emergency preparedness activities, including climate related emergencies. Public health organizations will be challenged to further expand their capacities to deal with environmental disasters and disease outbreaks. Many regions of the United States will have to respond to (and hopefully are able to mitigate) new health problems and environmental conditions that can negatively impact the health of their populations.

The range of potential climate change impacts on health in the United States includes[1]:

- Increases in heat-related morbidity and mortality rates
- Heat-induced difficulties in meeting air quality standards
- Increases in food-, water-, and vector-borne diseases
- Increased risks related to diseases originating outside the U.S.
- A prolonged allergy season, which will be particularly hard on the poor, children, and the elderly
- Extreme weather events (EWEs, i.e. droughts, severe storms, and floods) that aggravate conditions, cause hazard-related incidents, and undermine public health infrastructure

[1] United States. Collaboration among the Department of Agriculture, the Department of Commerce, the Department of Defense, the Department of Energy, the Department of Health & Human Services, the Department of the Interior, the Department of State, the Department of Transportation, the Environmental Protection Agency, the National Aeronautics and Space Administration, the National Science Foundation, the Smithsonian Institution, and the U.S. Agency for International Development. U.S. Global Change Research Program. *Global Climate Change Impacts in the United States 2009 Report*. Ed. Thomas R. Carl, Jerry M. Melillo, and Thomas C. Peterson. By David M. Anderson, Donald F. Boesch, Virginia R. Burkett, Lynne M. Carter, Stewart J. Cohen, Nancy B. Grimm, Jerry L. Hatfield, Katharine Hayhoe, Anthony C. Janetos, Jack A. Kaye, Jay H. Lawrimore, James J. McCarthy, A David McGuire, Edward L. Miles, Evan Mills, Jonathan T. Overpeck, Jonathan A. Patz, Roger S. Pulwarty, Benjamin D. Santer, Michael J. Savonis, H. Gerry Schwartz, Jr., Eileen L. Shea, John MR Stone, Bradley H. Udall, John E. Walsh, Michael F. Wehner, Thomas J. Wilbanks, and Donald J. Wuebbles. U.S. Global Change Research Program. Web, pp. 89-98

Forecasts

Expectable Forecast

By 2030, climate change has markedly altered the health and everyday activities of most Americans. Intensifying heat waves have repeatedly set new records for temperatures and heat-related illnesses, stress, and mortality. Diabetics, the elderly, and overweight people have all grown as a proportion of the U.S. population since the early 21st century. These groups are highly vulnerable to heat waves and heat stress. Hospitals, health centers, and clinics around the nation saw more heat-related health conditions. With shortened winters and longer, more intense allergy seasons,[2] more people arrived in emergency rooms with allergy-related emergencies as ragweed and pollen proliferated at unprecedented rates. Children, the elderly, and people with asthma suffered the most during the springtime, particularly in urban settings with worsening air quality and extreme heat. Outbreaks of foreign and re-emerging tropical diseases took place – particularly in the Southeast – as the changing environment adjusted the seasonal migration patterns of disease vector organisms such as livestock, rodents, and insects.

Droughts across the U.S. periodically lowered food output and diminished food security.[3] Many staple crops could not survive the intense summers, droughts, plant diseases, and increased attacks by pests. By the early 2020s, lower crop yields and higher food prices led to increased hunger and worsening nutrition among the poor and middle-class. Pathogens infecting animal livestock and marine organisms were more often transferred to humans as food-borne illnesses. Gastrointestinal illnesses have become more frequent after severe storms and extended rainy periods that have contaminated food and water supplies. More severe hurricanes with higher storm surges have frequently struck parts of Florida, Louisiana, and Texas. More people suffer from mold and mildew exposure and from carbon monoxide poisoning from excessive use of and damages to portable generators. Towns and cities with "combined sewer systems," such as Philadelphia, Washington, Chicago, New York, and over 750 others, suffered greatly from floods and heavy rains as intense sewage overflows claimed lives and made many people sick after storms.

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[2] Spring is arriving earlier and is proving to be warmer and more intense, and thus the allergy season is more intense. Ragweed pollen production has increased 60-90% as the climate has warmed (see http://www.livescience.com/28616-warmer-spring.html); Pollen production has intensified, and climate change has brought large amounts of rain and snow, early spring, and late-ending fall. Furthermore, this year's spring may prove to be a record for pollen production and allergy symptoms (see http://www.livescience.com/28320-climate-change-allergies.html); Pollen counts are expected to double by 2040 (http://www.livescience.com/24659-pollen-counts-rise-global-warming.html); The length of the growing season has increased since 1895, with a positive deviation from the average growing season length. The growing season length has extended more or less steadily since 1895 (see http://www.epa.gov/climatechange/science/indicators/society-eco/growing-season.html); This year's spring allergy season is expected to be longer and stronger. Trees are pollinating earlier and producing more pollen (see http://www.usatoday.com/story/news/nation/2013/03/30/spring-allergy-season/2014665/); Plants are blooming earlier, the pollen season starts earlier and lasts longer, and even Google searches regarding "pollen" have begun to start earlier in the year (see http://news.nationalgeographic.com/news/2013/01/130116-spring-earlier-global-warming-plants-trees-blooming-science/ and http://www.climatecentral.org/news/climate-change-is-increasing-seasonal-allergies-15784) . All accessed 23 May, 2013.

[3] See United States Global Change Research Program. *Human Health and Welfare in a Changing Climate: Frequently Asked Questions*. United States Global Change Research Program. United States Global Change Research Program. Web. Accessed 12 April, 2013.

Air quality worsened across the nation. As ozone concentrations rose, more people experienced lung and heart problems. Asthma was found at unprecedented rates among babies and children in the 2020s. Chronic obstructive pulmonary disorder (COPD) rates have continued to rise. Wildfires on the West Coast and in the South have become alarmingly frequent since the late 2010s, and have further degraded air quality in addition to claiming human lives.

Heavy storms and flooding helped spread water- and vector-borne illnesses and caused injuries, and damage to sewer and water systems was extensive. Rates of violent crime and theft (largely of food, generators, and water) rose in urban centers in reaction to extreme weather events (EWEs). Mental health problems have become more common, particularly among U.S. climate refugees and migrants, many of whom suffer from emotional trauma and depression. In Alaska, thawing permafrost damaged built infrastructure, roads, and runways, leading to more driving accidents, injuries, and deaths.

Local health departments (LHDs), already understaffed and underfunded, are severely stressed and not adequately prepared to react to the health impacts of climate change. Most LHDs and other public health agencies have built climate teams or expertise but some have been unable to do so, or those with climate plans or teams were not sufficient to adequately deal with the consequences of climate change. In the 2020s, there was significant infrastructure and building damage from flooding, tornadoes, and hurricanes, including LHD headquarters and other offices in many communities. Many LHDs that were damaged lacked insurance for their offices.

Challenging Forecast

The nation was not ready for the "runaway climate change"[4] that scientists had feared and that began to occur in the early 2020s as the melting of permafrost and other frozen deposits in the Atlantic Ocean, Siberia, and the Arctic drastically increased emissions of methane, a much more powerful greenhouse gas than carbon dioxide. Before runaway climate change began, the general expectation among climate scientists was that by 2030 sea levels would not rise by more than a few inches to a foot relative to 2000 levels.[5] By 2030, sea levels had risen by a staggering mean of 14 inches (since 2000 levels). This had major effects along Florida's coastal communities (which saw a 16 inch rise in sea level) and other low

[4] See https://en.wikipedia.org/wiki/Runaway_climate_change, http://www.newscientist.com/article/dn23205-major-methane-release-is-almost-inevitable.html, http://www.scoop.co.nz/stories/WO1305/S00399/un-experts-weigh-strategies-to-halt-runaway-climate-change.htm, and http://www.guardian.co.uk/environment/2008/sep/23/climatechange.scienceofclimatechange1 for information on runaway climate change. All accessed 25 May, 2013.

[5] See http://baykeeper.org/data_viz/official-sea-level-rise-projection, https://slr.s3.amazonaws.com/factsheets/Florida.pdf, http://www.broward.org/NaturalResources/ClimateChange/Documents/SE%20FL%20Sea%20Level%20Rise%20White%20Paper%20April%202011%20ADA%20FINAL.pdf, http://dels.nas.edu/Report/Level-Rise-Coasts/13389, http://usatoday30.usatoday.com/news/nation/environment/story/2012-06-22/california-sea-level-rising-2030/55764826/1, and http://phys.org/news/2012-06-higher-sea.html. All accessed 28 May, 2013.

lying coastal areas.[6] Sea level rise (SLR) was even higher in the equatorial mid-Pacific islands, bringing challenges to parts of Hawaii[7] (which experienced an 18 inch rise in sea level). Climate change had quickly reached a tipping point that shocked the United States and the world.

Children, the elderly, the poor, and the uninsured were particularly susceptible to all climate-related health conditions. Many died from intense summer heat waves. Emergency rooms were overwhelmed by patients with severe heat, disease, asthma, and allergy-related conditions. Air quality was so poor that some cities recommended protective air masks to be worn outside at all times. New diseases and antibiotic-resistant bacteria abounded, and a robust strain of West Nile Virus wreaked havoc in seemingly unrelated parts of the nation in the mid-2020s. Infectious diseases, including those acquired in crowded and overworked hospitals, spread rapidly.

Severe storms, hurricanes, extreme rainfall, and floods became the norm by 2024, ravaging almost all regions of the U.S. to varying extents. Mold and mildew exposure and carbon monoxide poisoning (from overutilization of and damages to portable generators) became so common that they were often compared to pneumonia, the common cold, and the flu. Cities with combined sewer systems experienced frequent major outbreaks of gastrointestinal illnesses, food and water contaminations, and water-borne illnesses, resulting in many deaths. Only mountain areas and Alaska were relatively sheltered from these water disasters. However, runaway climate change had not spared them. The thawing of permafrost destroyed much of the built infrastructure in certain areas of Alaska. Flash floods became more common and intense. Anybody who lived in areas that experienced heavier rains and severe flooding came to expect contaminated water and deteriorating buildings, roads, runways, and water systems. These caused many injuries, driving accidents, deaths, and serious illnesses. Some small cities and towns in these areas became completely uninhabitable in a matter of weeks.

Conflicts over water resources intensified between states and within communities. Food security diminished as plants and animals died from illnesses, extreme weather events, wildfires, droughts, and hotter summers. Levels of violent crime, "critical resource theft" (theft of food, generators, water, portable electronics, etc.), and black market bartering and selling of "critical resources" spiked sharply across the country in urban, suburban, and rural areas in the late 2010s as a result of increasing resource scarcity and worsening social and physical environments. This three-pronged spike in illegal activity continued throughout the 2020s in reaction to the increased prominence of environmental uncertainty across the country. Throughout the 2020s, millions were frequently relocated (either of their own volition or by order of the government) to less environmentally stressed areas. These climate refugees were particularly susceptible to new and re-emerging diseases, violence, and sexually transmitted diseases and infections. Many communities proved hostile to climate migrants, whether from the U.S. or abroad. A new wave of undocumented migrants began to move into the U.S. (or attempted to) as

[6] See http://www.newscientist.com/article/dn22561-projections-of-sea-level-rise-are-vast-underestimates.html and http://www.huffingtonpost.com/2012/11/28/sea-level-rise-2012-rising_n_2204402.html, explaining that sea level rise is occurring faster than initial projections from the 2007 IPCC report. Accessed 28 May, 2013.

[7] Sea Level Rise is projected to be above global averages in the Equatorial Pacific Ocean, which includes Hawaii. See http://www.sciencedaily.com/releases/2013/02/130219102449.htm, accessed 28 May, 2013.

climate refugees by the mid-2020s. The U.S. instituted new immigration restrictions for individuals who came from nations with severe outbreaks of climate-related infectious diseases, while not allocating resources to assist international climate refugees residing in the U.S. The worsening health of these groups was aggravated by the worsening conditions of U.S. "natives." Violent conflicts and discrimination increased. Police, emergency responders, and firefighters across the nation were overworked and overstressed, and endured more disease and depreciating mental health.

Understaffed and underfunded LHDs worked to prepare for and mitigate the physical and mental health impacts of climate change. However, the double-dip recession in the 2010s led to further budget cuts and a shrinking public health workforce. Many LHD staff members themselves suffered from unfamiliar diseases that had resulted from climate change, and several LHDs did not have the insurance to recover from damages in their buildings and infrastructure caused by EWEs and in some cases even riots.

Aspirational Forecast

The increasing frequency of EWEs in the 2010s inspired local communities, the federal government, and individuals to resolve and prevent climate change's adverse health impacts. A focus on health prevention and health technologies was coupled with the rising understanding of the intricate links among environments, climate, and human health. To this end, many communities and the federal government by the early 2020s had begun to seriously use foresight for health and climate adaptation and mitigation schemes. The national goals of minimizing the rise in temperature, preventing climate disasters, and adapting to climate change required (and inspired) individuals and organizations to become active in climate innovation and health. While predicted health impacts of climate change did occur with regards to disease, food, EWEs, drought, allergies, heat, etc., the federal government was able to enact large-scale, top-down research and preparation to help minimize these impacts. A combination of collaborative and holistic top-down federal initiatives and bottom-up citizen science and crowdsourcing sought to prevent or minimize the health impacts of climate change, with assessments being conducted every five years starting in 2025. In 2020 the Federal Government's *Healthy People* goal setting process was renamed the *Healthy People, Healthy Climate 2030* goals process. Ambitious climate change mitigation goals were set and there was much movement toward achieving them by 2030.

In the late 2010s, government agencies engaged leaders and employees in gaming exercises to prepare for, prevent, or respond to various climate catastrophes, disease outbreaks, and food issues. Previously controversial technologies and developments in genetically modified organisms, plant and forest biotechnology, and geoengineering were explored in more depth in the late 2010s in order to find and implement low-impact/low-cost but high-reward actions to slow or prevent future climate change and to increase resilience to climate change already occurring. Local communities implemented "zero emissions" days, and several health groups successfully implemented "no emissions" zones, hoping to mimic the fight against smoking and the creation of "no smoking" areas. Many communities had time

banking initiatives that recognized service from citizens contributing to environmental work, environmental sensing, environmental activism, and prevention, mitigation, and adaptation activities and initiatives. A culture of "buying local" had spread beyond food and in the 2020s included commodities and services. By the early 2020s, collaborative consumption practices and initiatives were being commonly used across the nation to reduce energy use and emissions, and local communities took advantage of technological innovations that enhanced self-sufficiency.

Dense urban areas, particularly those experiencing droughts, heavily invested in urban agriculture, particularly aeroponic and aquaponic innovations to provide food. Virtual conferencing was used more frequently and cut down on travel related emissions. Small-scale, "soft" geoengineering was conducted in several communities. Environmental sensors and biomonitors were frequently employed to measure the health and climate of communities. Users were able to frequently monitor the impacts and status of soft geoengineering sites[8] (such as "bright water" ponds and lakes that had been injected with air microbubbles to increase the reflectivity of water), as well as aquaponics and aeroponics facilities. By 2030, inexpensive environmental monitoring and biomonitoring devices continuously provide "geo-tagged" health and environmental data to social networks and online mapping platforms that use new analytics to identify local factors impeding health and to point public health officials toward innovative solutions. Over time, the crowdsourcing of environmental monitoring created greater transparency around industry practices, leading many individuals, organizations, companies, and agencies to accelerate their adoption of sustainable technologies. This was also enhanced by the fact that many consumers had begun to use digital health coaches by 2020, and these health coaches were designed to account for environmental factors, keeping users aware of environmental and climate changes and how their health could be or was being impacted.

LHDs shared resources and collaborated with other state and local agencies to more comprehensively address the issue of climate change and public health. In the late 2010s, some LHDs had begun to take steps to mitigate the local effects of climate change through gaining climate expertise and engaging with the local residents. In several communities, LHDs took advantage of the data shared from ordinary citizens who measured their physical environments via mobile environmental sensors. LHDs engaged with citizens for monitoring health and environmental data, and successfully advocated for policies that incorporated these data into patients' electronic health records.

Learn more about the Public Health 2030 project by the Institute for Alternative Futures at www.altfutures.org/publichealth2030.

[8] See Robert L. Olson (2012): Soft Geoengineering: A Gentler Approach to Addressing Climate Change, Environment: Science and Policy for Sustainable Development, 54:5, 29-39. http://www.see.ed.ac.uk/~shs/Climate%20change/Geo-politics/Bright%20water.pdf.