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# Leveraging Public Health Laboratory Science to Understand and Address Climate Change Health Impacts

Climate change, according to the World Health Organization, is the "single biggest health threat facing humanity,"[1] with public health expected to be impacted on a local, regional, national and international scale from both short and long-term climate change impacts. A changing climate is the result of many interconnected factors with numerous, varied effects, so a wide array of data are needed to understand the underlying issues and determine potential solutions. So far, public health laboratories—which include environmental and agricultural laboratories—have been an untapped resource for such data.

Public health laboratories work at the local, tribal, territorial, state and federal level to monitor and detect health threats, such as infectious diseases, environmental hazards, food safety issues and more. With their established testing infrastructure and scientific expertise, public health laboratories are in an excellent position to meet existing and future climate change-related public health testing and information needs. Many are already collecting data that can help scientists and decision makers understand the health and environmental effects of climate change—such as surveillance data used to define health indicators and One Health data on the interconnectedness of humans, animals and ecosystems—or could quickly shift to do so.[2]

Climate change-related health effects will not be borne equally across populations. Communities that are already socially- or economically-marginalized, or disproportionately affected by other stressors, may be less able to successfully respond to increases in disease exposure and risk.[3] Public health laboratories are in a position to help ensure health equity[4] concerns are addressed by working with these more vulnerable communities and their partners, preparing for and assessing the health of residents to inform and evaluate public health actions.

To be an effective part of climate change response efforts, however, public health laboratories need to be connected to federal, state and local partners and receive sustained investment to increase capacity and provide state-of-the-art testing.

## Health Impacts of Climate Change

Climate change will have both short- and long-term health effects. Acute weather-related emergencies—such as droughts, heat waves, storms, flooding and wildfires—can cause severe environmental hazards beyond the immediate danger of the event.[1] Prolonged changes in temperature and precipitation patterns will shift where all manner of life—humans, animals, vegetation and microbes—can thrive,[5] which will increase our risk of disease[6,7] as habitats overlap in new ways. For example, warming winters have allowed the deer tick *Ixodes scapularis* to steadily expand its territory into the northeastern US, bringing with it a surge in cases of human Lyme disease further north than ever previously seen.[8] Changing human and animal migration patterns can also lead to increased risk of exposure to zoonotic diseases,[5,6] as has been seen with recent outbreaks of mpox, Ebola and the potential threat of Highly Pathogenic Avian Influenza H5N1.

**Public health laboratories are an untapped resource for climate change-related data.**

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# Climate Change is Increasing Public Health Laboratory Testing Needs

Public health laboratories conduct a wide array of testing, a good deal of which can inform public health action in response to climate change. Testing related to environmental health, infectious diseases and food safety, in particular, can deepen our understanding of climate change-related health impacts, and allow measures to be put into place to mitigate its effects. It is important to leverage public health laboratory preparedness efforts to increase our capacity to respond effectively to new or increasing threats.

Below are specific areas of public health laboratory work that can inform climate change response or may see an increase in testing demand due to climate change-related events, or indicators, broken down by matrix and/or disease category. Public health laboratories should be prepared to see an increased demand for the testing targets laid out in the tables below, though the exact needs may vary by region.

## Environmental Health Testing

| Matrix | Target | Relevant Climate Indicator |
|---|---|---|
| **Ambient Air** | Ground-level ozone | Increased heat |
| | Chemical contaminants | Increased pesticide use |
| | Particulate matter | Drought, wildfires and temperature-related air inversions |
| **Indoor Air** | Mold | Flooding and increased precipitation |
| | Radon | Increased time spent inside because of extreme weather |
| | Chemical contaminants | Increased pesticide use for disease vectors |
| **Soil** | Chemical contaminants | Increased concentrations from droughts, floods mobilizing contaminants to other sites |
| | | Increased pesticide use for crop-eating insects and disease vectors |
| **Ground & surface waters** Including for irrigation and recreation | Fecal indicators and pathogens[a] | Warmer temperatures, potential biofilm growth on infrastructure |
| | Aquifer chemical and toxic metal contamination[b] | Changing runoff frequencies and intensities, lower groundwater tables resulting in deeper aquifer depths or creation of new aquifers |
| | Freshwater and marine toxins associated with harmful algal blooms[c] | Warmer temperatures; warmer and more nutrient-dense water due to drought or increased surface water runoff |
| **Drinking water** Surface water | Chemical contaminants | Increased concentrations from runoff and surface water evaporation |
| | *Legionella,*[d] *Naegleria fowleri*[e] and other pathogens | Higher temperatures and greater water system damage from increasingly severe storms may increase contamination of treated drinking water systems |
| **Drinking water** Groundwater | Microbial chemical and radiological contaminants | Increased reliance on groundwater |
| | Heavy metals, such as arsenic | |
| | Aquifer salinity (may impact heart health of sensitive populations) | Increased road salting |
| **Wastewater** | Fecal indicators for presence of/trends in infectious diseases, foodborne diseases, antibiotic resistance genes | Increase in climate-influenced infectious diseases and subsequent treatment |
| **Air & rainwater** | Temperature and precipitation data that can inform disease risk (e.g., Valley fever) | Warmer temperatures, increased frequency of droughts, storms, floods, disease vector abundance |

a Examples of fecal indicators and pathogens in water include *Cryptosporidium*, *Giardia* and *Naegleria fowleri*.

b Toxic metals of particular concern in ground water are uranium and arsenic.

c Biotoxins and cyanotoxins in surface water are concerning due to potential for shellfish contamination, which, if consumed by people, can lead to paralytic, amnesic, neurotoxic, and diarrhetic shellfish poisoning.

d Primary exposure route for *Legionella* is inhalation of aerosolized water.

e Primary exposure route for *N. fowleri* is water entering the body through the nose.

| Matrix | Target | Relevant Climate Indicator |
|---|---|---|
| **Marine water** | Sea surface temperature and salinity to assess *Vibriosis* risk from fish and shellfish | Warmer ocean temperatures, rising sea levels and associated increased human exposure to ocean water |
| **Clinical specimens** | Human biomonitoring to assess chemical exposures | Increased concentration due to wildfires, pesticide run-off, harmful algal toxins, etc. |

## Food Safety Testing

| Matrix | Target | Relevant Climate Indicator |
|---|---|---|
| **Food & animal samples** | Enteric pathogens[f] | Drought conditions and runoff from heavy rains lead to increased pathogen concentrations |
| | Chemical contaminants | Increased pesticide use |
| | Toxins | Increased harmful algal blooms from warmer, more nutrient dense water |
| **Clinical specimens** | Enteric pathogens, chemicals, toxins | Increased food contamination could increase human illness rates[9] |

## Infectious Disease Testing

| Disease Category | Target | Relevant Climate Indicator |
|---|---|---|
| **Vector-borne diseases** | People, animal and arthropod reservoirs/ vectors for pathogens such as malaria, dengue and Zika[g] | Increased rainfall and warmer temperatures allow for expanded habitat range of mosquitoes, ticks and other vectors |
| **Zoonotic diseases** | People, animals and their shared environments for transmissible diseases such as plague, rabies, avian influenza, Ebola and anthrax | Warmer temperatures shift animal habitat range, increased opportunities for exposure due to decreased wildlife habitat |
| **Fungal diseases** | People for fungal infections such as coccidioidomycosis (Valley Fever), histoplasmosis, blastomycosis, etc. | Increased geographic range, other factors such as dispersal and host susceptibility |
| **Respiratory diseases** | People for influenza, COVID-19 and other respiratory diseases | Increased air pollution leads to increased susceptibility of infection and disease severity |

## Public Health Preparedness and Response Testing

| Matrix | Target | Relevant Climate Indicator |
|---|---|---|
| **Environmental, food & clinical matrices** from public health threat events | Chemical, biological, radiological and nuclear analytes | Increased number and severity of natural disasters, disparity in preparation due to economic and social impacts of climate change |

f Examples of enteric pathogens include *Salmonella, Listeria, Shigella, Campylobacter, Vibriosis.*

g Examples of other vector-borne diseases include eastern equine encephalitis, western equine encephalitis, St. Louis encephalitis, California serogroup viruses (including La Crosse and Jamestown Canyon), hantavirus, Rift Valley fever, Lyme disease, chikungunya and West Nile virus.

# What Public Health Laboratories Can Do Now

## Increase Climate Change-related Testing Capabilities and Capacity

- Assess current capacity to respond to increased testing of targets outlined above and create a plan to address gaps in capabilities or capacity based on your jurisdictional priorities.
- Raise awareness of the need for investment in the public health laboratory system to sustain and expand laboratory testing.
- Educate and inform partners on the availability and potential of the laboratory to provide climate change-related data.
- Consider projects and funding that would benefit from laboratory-informed climate change data. Think broadly about this and involve existing and new partners.

## Collaborate Within and Beyond the Laboratory

- Confer with public health decision-makers and other partners about the full public health impact of their work, particularly through public health laboratory system and One Health perspectives.
- Collaborate with epidemiologists to integrate cross-sectional public health laboratory data, such as environmental, food safety or infectious disease or data.
- Raise awareness of the laboratory, its capabilities and ability to connect across state and local programs.
- Work with state and local partners to collect additional demographic information to help better explain the impact of climate change on your state's population (e.g., factoring in income, race, education level, etc.). CDC's Environmental Justice Index and US Environmental Protection Agency's EJScreen may be useful for this purpose.
- Build data infrastructure to collectively connect, view and interpret human, animal and environmental data gathered by the various public health laboratories at a local, state and federal level.
- Connect public health laboratory data with surveillance systems and programs—such as the National Outbreak Reporting System, One Health Harmful Algal Bloom System, and National Environmental Public Health Tracking program—to ensure surveillance data has the most complete and well-supported information to understand exposures and illnesses that can support additional climate change linkages.

## Strengthen the Public Health Laboratory Workforce

- Encourage participation in APHL's Career Pathways in Public Health Laboratory Science programs. Laboratory staff can become mentors and host public health laboratory interns and fellows to help build a new generation of laboratory personnel, and participate in the Emerging Leaders Program to further their own careers and bring new skills to the laboratory.
- Improve public health workforce job satisfaction and recruitment by articulating how laboratory work is connected to understanding and potentially addressing the health impacts of climate change.
- Use storytelling to make connections between climate change and public health laboratory work, using tools such as the Climate for Health ambassador's training.

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