The impact of climate variability on Valley Fever

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Figure from CDC’s Climate and Health Program
THE IMPACTS OF CLIMATE CHANGE ON HUMAN HEALTH IN THE UNITED STATES: A SCIENTIFIC ASSESSMENT

U.S. Global Change Research Program

Health2016.globalchange.gov
Executive Summary

Climate change is a significant threat to the health of the American people.

- Climate change threatens human health and well-being in the United States. The U.S. Global Change Research Program (USGCRP) Climate and Health Assessment has been developed to enhance understanding and inform decisions about this growing threat. This scientific assessment, called for under the President’s Climate Action Plan, is a major report of the sustained National Climate Assessment (NCA) process. The report responds to the 1990 Congressional mandate to assist the Nation in understanding, assessing, predicting, and responding to human-induced and natural processes of global change. The agencies of the USGCRP identified human health impacts as a high-priority topic for scientific assessment.

- The purpose of this assessment is to provide a comprehensive, evidence-based, and, where possible, quantitative estimation of observed and projected climate change related health impacts in the United States. The USGCRP Climate and Health Assessment has been developed to inform public health officials, urban and disaster response planners, decision makers, and other stakeholders within and outside of government who are interested in better understanding the risks climate change presents to human health.

Every American is vulnerable to the health impacts associated with climate change.

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Climate Change and Health

Major U.S. Climate Trends

Rising Temperatures
U.S. average temperature has increased by 1.3°F to 1.9°F since record keeping began in 1895. Warming has been the greatest in North and West while some parts of the Southeast have experienced little change.

Extreme Precipitation
Heavy downpours are increasing nationally, especially over the last three to five decades. The largest increases are in the Midwest and Northeast.

Wildfires
Wildfires in the West start earlier in the spring, last later into the fall, and burn more acreage.

Heat Waves
Heat waves have become more frequent and intense, especially in the West.

Drought
Drought has increased in the West. Over the last decade, the Southwest has experienced the most persistent droughts on record.

Cold Waves and Winter Storms
Cold waves have become less frequent and intense across the Nation. Winter storms have increased in frequency and intensity since the 1950s and their tracks have shifted northward.

Floods
Floods have been increasing in parts of the Midwest and Northeast.

Hurricanes
The intensity, frequency, and duration of North Atlantic hurricanes, as well as the frequency of the strongest (category 4 and 5) hurricanes, have all increased since the early 1980s.

Sea Level
Sea levels along the Mid-Atlantic and parts of the Gulf Coast have risen by about 8 inches over the last half century.
### Examples of Climate Impacts on Human Health

<table>
<thead>
<tr>
<th>Climate Driver</th>
<th>Exposure</th>
<th>Health Outcome</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Extreme Heat</strong></td>
<td>More frequent, severe, prolonged heat events</td>
<td>Elevated temperatures</td>
<td>Heat-related death and illness</td>
</tr>
<tr>
<td><strong>Outdoor Air Quality</strong></td>
<td>Increasing temperatures and changing precipitation patterns</td>
<td>Worsened air quality (ozone, particulate matter, and higher pollen counts)</td>
<td>Premature death, acute and chronic cardiovascular and respiratory illnesses</td>
</tr>
<tr>
<td><strong>Flooding</strong></td>
<td>Rising sea level and more frequent or intense extreme precipitation, hurricanes, and storm surge events</td>
<td>Contaminated water, debris, and disruptions to essential infrastructure</td>
<td>Drowning, injuries, mental health consequences, gastrointestinal and other illness</td>
</tr>
<tr>
<td><strong>Vector-Borne Infection</strong> (Lyme Disease)</td>
<td>Changes in temperature extremes and seasonal weather patterns</td>
<td>Earlier and geographically expanded tick activity</td>
<td>Lyme disease</td>
</tr>
<tr>
<td><strong>Water-Related Infection</strong> (Vibrio vulnificus)</td>
<td>Rising sea surface temperature, changes in precipitation affecting coastal salinity</td>
<td>Recreational water or shellfish contaminated with <em>Vibrio vulnificus</em></td>
<td><em>Vibrio vulnificus</em> induced diarrhea &amp; intestinal illness, wound and bloodstream infections, death</td>
</tr>
<tr>
<td><strong>Food-Related Infection</strong> (Salmonella)</td>
<td>Increases in temperature, humidity, and season length</td>
<td>Increased growth of pathogens, seasonal shifts in incidence of Salmonella exposure</td>
<td><em>Salmonella</em> infection, gastrointestinal outbreaks</td>
</tr>
<tr>
<td><strong>Mental Health and Well-Being</strong></td>
<td>Climate change impacts, especially extreme weather</td>
<td>Level of exposure to traumatic events, like disasters</td>
<td>Distress, grief, behavioral health disorders, social impacts, resilience</td>
</tr>
</tbody>
</table>
Engagement

• CDC’s Climate and Health Program
  – Nation’s only investment in climate change preparedness for the public health sector
  – Climate Ready States and Cities Initiative
    • 16 States and 2 Cities
Climate and Environmental Data Pathway

State and Local Health Departments

CDC Climate Ready States and Cities Initiative

Health Studies
Data Received from Many Sources

NCEI is responsible for preserving, monitoring, assessing, and providing public access to the Nation’s treasure of climate and historical weather data and information.
Coccidioidomycosis, also known as valley fever, is a fungal infection arising from inhalation of *Coccidioides immitis* and *Coccidioides posadasii* spores.

It is endemic in the southwestern United States, with the highest incidence in Arizona and California.

Inhalation of a single spore may be enough to cause illness, and approximately 40% of infected people experience symptoms that can range from mild (e.g., flu-like) to severe (e.g., community acquired pneumonia, meningitis, and disseminated infections).
Valley Fever and Climate

- *Coccidioidodes* spp. depend on climate drivers such as precipitation and temperature for spore growth and development.

- This project links climate variables (soil moisture, temperature, precipitation, and drought indices) to changes in incidence of valley fever for Arizona and California.

- By exploring relationships between climate variability and valley fever, this work can provide a way to assess vulnerability and provide early warning to health departments.
Increasing Incidence

![Graph showing increasing incidence rates for Arizona and California over the years 2000 to 2014. The graph indicates a sharp increase in Arizona's incidence rate around 2010, peaking and then declining.]
<table>
<thead>
<tr>
<th>Season</th>
<th>Both States</th>
<th>Arizona Index</th>
<th>California Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Variability</td>
<td>0.42&lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.08</td>
<td>0.62&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Overall Precip. Variability</td>
<td>-0.23&lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.16</td>
<td>-0.28&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Overall Temp. Variability</td>
<td>0.43&lt;sup&gt;1&lt;/sup&gt;</td>
<td>-0.07</td>
<td>0.61&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Overall SPEI Variability</td>
<td>0.37&lt;sup&gt;1&lt;/sup&gt;</td>
<td>-0.42</td>
<td>0.61&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fall Variability</td>
<td>0.23&lt;sup&gt;1&lt;/sup&gt;</td>
<td>-0.09</td>
<td>0.33&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fall Precip. Variability</td>
<td>-0.27&lt;sup&gt;1&lt;/sup&gt;</td>
<td>-0.50</td>
<td>-0.31&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fall Temp. Variability</td>
<td>0.25&lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.09</td>
<td>0.31&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fall SPEI Variability</td>
<td>0.33&lt;sup&gt;1&lt;/sup&gt;</td>
<td>-0.29</td>
<td>0.54&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Spring Variability</td>
<td>0.23&lt;sup&gt;1&lt;/sup&gt;</td>
<td>-0.48</td>
<td>0.42&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Spring Precip. Variability</td>
<td>-0.26&lt;sup&gt;1&lt;/sup&gt;</td>
<td>-0.26</td>
<td>-0.25&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Spring Temp. Variability</td>
<td>0.26&lt;sup&gt;1&lt;/sup&gt;</td>
<td>-0.47</td>
<td>0.43&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Spring SPEI Variability</td>
<td>0.29&lt;sup&gt;1&lt;/sup&gt;</td>
<td>-0.50</td>
<td>0.49&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Summer Variability</td>
<td>0.48&lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.10</td>
<td>0.64&lt;sup&gt;1&lt;/sup&gt;</td>
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<tr>
<td>Summer Precip. Variability</td>
<td>0.01</td>
<td>0.14</td>
<td>0.08</td>
</tr>
<tr>
<td>Summer Temp. Variability</td>
<td>0.53&lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.01</td>
<td>0.64&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Summer SPEI Variability</td>
<td>0.37&lt;sup&gt;1&lt;/sup&gt;</td>
<td>-0.34</td>
<td>0.61&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Winter Variability</td>
<td>0.18</td>
<td>0.46</td>
<td>0.11</td>
</tr>
<tr>
<td>Winter Precip. Variability</td>
<td>-0.23&lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.41</td>
<td>-0.39&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Winter Temp. Variability</td>
<td>0.24&lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.40</td>
<td>0.20</td>
</tr>
<tr>
<td>Winter SPEI Variability</td>
<td>0.08</td>
<td>-0.08</td>
<td>0.10</td>
</tr>
</tbody>
</table>
NOAA USCRN soil observations were able to determine that coccidioidomycosis incidence is inversely correlated with soil moisture levels from the previous year’s summer (and even earlier summers in California).

Atypically dry summers are likely to precede higher number of coccidioidomycosis cases in the following years.
Conclusions

1. Climate and human health are directly linked to each other.

2. Climate controls seasonal patterns that regulate the distribution of many human pathogens.

3. Understanding these relationships can provide opportunities for early warning to public health departments.

4. Climate and environmental data from NOAA provides an opportunity to unlock these relationships.

5. This project links climate variables (soil moisture, temperature, precipitation, and drought indices) to changes in incidence of valley fever for Arizona and California.

6. By exploring relationships between climate variability and valley fever, this work can provide a way to assess vulnerability and provide early warning to health departments.

7. This project demonstrates an example of the limitless opportunities that exist in combining human health data with NOAA climate data.
Thank you!

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