Evaluating the Drought and Health Relationship: Association with Mortality

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How Did I get Involved in Drought and Health Research?
How Did I get Involved in Drought and Health?

• Asked myself the question, “Is there an association between drought and health?”
• Limited research examined association between drought and mortality
  – Mental health pathway (e.g. increased suicide deaths: Hannigan et al, 2012; Guiney et al, 2012)
  – Dust storm events (Korea, Taiwan, Italy)
• No research from the U.S. and no evaluation of all-cause mortality
The Research Problem

Is there an association between drought and health in the United States?

- Target a vulnerable population (e.g. older adults are typically most susceptible)
- Focus on a geography with significant drought (e.g. western U.S. states)
- Examine premature mortality
- Consider additional health outcomes associated with dust (e.g. cardiovascular and respiratory disease)
Creating an Exposure Metric for Drought

- Utilized weekly U.S. Drought Monitor maps from 2000-2013

**U.S. Drought Monitor**

**October 6, 2015**
(Released Thursday, Oct. 8, 2015)
Valid 8 a.m. EDT

**Drought Impact Types:**
- Delineates dominant impacts
- \(S\) = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)
- \(L\) = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

**Intensity:**
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

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[Link to Drought Monitor website](http://droughtmonitor.unl.edu/)
Created three-exposure categories for health assessment

1. **Full Drought**: ≥150 consecutive days of USDM *Moderate*, *Severe*, *Extreme*, or *Exceptional* Drought

2. **Worsening Drought**: Subset of full drought, where conditions are the same or worse than the day before

3. **Worsening Drought by severity**: Subset of worsening drought, stratified into *low-severity* and *high-severity* drought conditions

   - **Non-Drought**: ≥150 consecutive days of USDM *No-Drought* or *Abnormally Dry*
Example of Drought Characterization

Drought Conditions in Los Angeles County, California (2000-2013)

U.S. Drought Monitor Classification

- No Drought
- Abnormally Dry
- Moderate Drought
- Severe Drought
- Extreme Drought
- Exceptional Drought

Drought Trend
- Non-Drought Periods
- Low-Severity Worsening Drought
- High-Severity Worsening Drought

Year:
- 2000
- 2002
- 2004
- 2006
- 2008
- 2010
- 2012
- 2014
Health Outcomes and Independent Variables

- **Health Data: Billing Claims from Medicare Enrollees**
  - Emergency admissions daily counts (both hospital and clinics)
  - ICD codes for a) **cardiovascular disease**, b) **respiratory disease**. Plus **total deaths**

- **Drought Data**
  - Categorical drought or non-drought conditions

- **Seasonal and Temporal Data**
  - Seasonality, Current Year, Day of Week

- **Environmental Data**
  - Temperature and dew point
Statistical Model

Utilized a two-stage hierarchical model

- **Stage One**: County-level Poisson models to estimate risk of emergency admission or mortality during drought events compared to non-drought events
- **Stage Two**: Combine county-level effect estimates under a Bayesian framework to estimate overall associations of health effects
An Additional Question

Do we observe variability in health risks based on frequency of drought?

- Environmental risk sometimes increases in regions where they are rare
- Is this true for drought?
- Regressed our first stage county-specific estimates with drought ratios
So What Did We Find?

- **Mortality increases by 1.55%** (95% PI: 0.17 to 2.95%) during high severity worsening drought

- **Respiratory disease decreases by 1.99%** (95% PI: -3.56 to -0.38%) during full drought conditions

- No statistically significant association between drought and cardiovascular disease…but **increasing trend with low and high-severity drought**
Geographic Variability in the County-Estimates of Mortality and Drought

% Change in Mortality During Low-Severity Worsening Drought Periods

% Change in Mortality During High-Severity Worsening Drought Periods

Larger circles denote greater certainty in estimates
Regions with Less Frequent Drought show Greater Mortality Risk

% Change in Mortality Risk During Drought Periods Compared to Non-Drought Periods

County Ratios of Non-Drought to Drought Days
Conclusions

• Identified potential **positive associations** with mortality and cardiovascular disease

• Potential **reductions in risk** for respiratory disease

• Observed **geographic differences** in risk
Other Conclusions

• Additional mortality studies have come out
  – Co-exposures with environmental hazards (heat and air pollution; Salvador et al, 2019)
    • Also identifies geographic differences in risk
  – Dust storms in the U.S. (Crooks et al, 2016)

A lot more research needs to be done

• At risk populations
• Alternative health outcomes
• Co-occurring environmental exposures
Contributions

Research Collaboration
Dr. Michelle Bell – Yale School of Forestry and Environmental Studies
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Dr. Roger Peng – Johns Hopkins School of Public Health
Dr. Francesca Dominici – Harvard School of Public Health

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Citation