

HEALTH & AIR QUALITY

EARTH SCIENCE
APPLIED SCIENCES

Identifying Public Health Applications of Satellite-derived Drought Indicators: Improved Monitoring for Respiratory Health (ROSES21)

Jesse E. Bell, PhD

March 29, 2023

Project Summary



- Title
 - Identifying Public Health Applications of Satellite-derived Drought Indicators: Improved Monitoring for Respiratory Health
- Goals
 - Use existing satellite-derived drought monitoring tools to **analyze changes in air quality during droughts, and examine health risks and vulnerabilities** associated with these changes
 - With feedback from end users, **create decision-making tools** for drought preparedness and response
- Impact
 - Improved public health preparedness and capacity for adaptation to drought

Increase in Mortality with Drought

Articles

Drought and the risk of hospital admissions and mortality in older adults in western USA from 2000 to 2013: a retrospective study

Jesse D Berryman, Keika Ebisu, Roger D Perry, Francesca Dominici, Michelle L Bell

Summary

Background Occurrence, severity, and geographic extent of droughts are anticipated to increase under climate change, but the health consequences of drought conditions are unknown. We estimate risks of cardiovascular-related and respiratory-related hospital admission and mortality associated with drought conditions for the elderly population in western USA.

Methods For this retrospective study, we analysed the 2000 to 2013 data from the US Drought Monitor for 615 counties in the western USA to identify full drought periods, non-drought periods, and worsening drought periods stratified by low severity and high severity. We used Medicare claims made between Jan 1, 2000, and Dec 31, 2013, to calculate daily rates of cardiovascular admissions, respiratory admissions, and deaths among adults aged 65 years or older. Using a two-stage hierarchical model, we estimated the percentage change in health risks when comparing drought with non-drought period days, controlling for daily weather and seasonal trends.

Findings On average, 2.1 million days were classified as non-drought periods and 0.4 million days were classified as drought periods. Compared with non-drought periods, respiratory admissions significantly decreased by -1.99% (95% posterior interval -3.56 to -0.38) during the full drought period, but not during worsening drought conditions. Mortality risk significantly increased by 1.55% (0.17 to 2.95) during the high-severity worsening drought period, but not the full drought or low-severity worsening drought periods. Cardiovascular admissions did not differ significantly during either full drought or worsening drought periods. In counties where drought occurred less frequently, we found risks for cardiovascular disease and mortality to increase during worsening drought conditions.

Interpretation Drought conditions increased risk of mortality during high-severity worsening drought, but decreased the risk of respiratory admissions during full drought periods among adults aged 65 years and older. Counties that previously had fewer drought events show larger risk for mortality and cardiovascular disease. This research describes an understudied environmental association with global health significance.

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Introduction

The UN refers to drought as "the most far-reaching of all natural disasters".¹ In 2011-12, a pan-continental drought spanned 62% of the contiguous USA land area, exceeding the historical 99th percentile for drought size and affecting nearly 150 million people.¹ California is enduring an extreme drought that has been ongoing since 2013.¹ However, although health effects of some natural disasters (eg, heat waves and floods) are well studied,^{2,3} little is known about drought, despite its global impact. Most drought and health research focuses on developing nations and indirect effects, such as vector-borne disease and malnutrition,⁴ but an almost total absence of direct health effects research exists worldwide. So far, the study of drought and health has been hampered by the unique characteristics of drought, including gradual onset, persistence, large geographical extent, and difficulty assessing when one begins or ends.^{1,2} Additionally, drought can be categorised as four distinct types:

meteorological, agricultural, hydrological, and socio-economic.² The distinct drought types can create challenges in the estimation of human exposures and health effects because each type can potentially affect disease outcomes in a different way.

The biological mechanisms through which drought affects health are unknown. Several pathways are hypothesised. Drought might act on disease through secondary exposures, increasing airborne dust or wildfire smoke and modifying the maturation and dispersal of allergenic pollen and fungal spores.^{5,6} Long-term drought has the potential to degrade the environment and affect community-level economic livelihood, inducing psychological stress.^{7,8} Chronic stress will invoke behavioural and physiological response, including haemodynamic, endocrine, and immunological dysfunction that increase risk of cardiovascular and upper respiratory disease.^{9,10} In extreme cases, this dysfunction can increase mortality. Community studies from Australia found associations

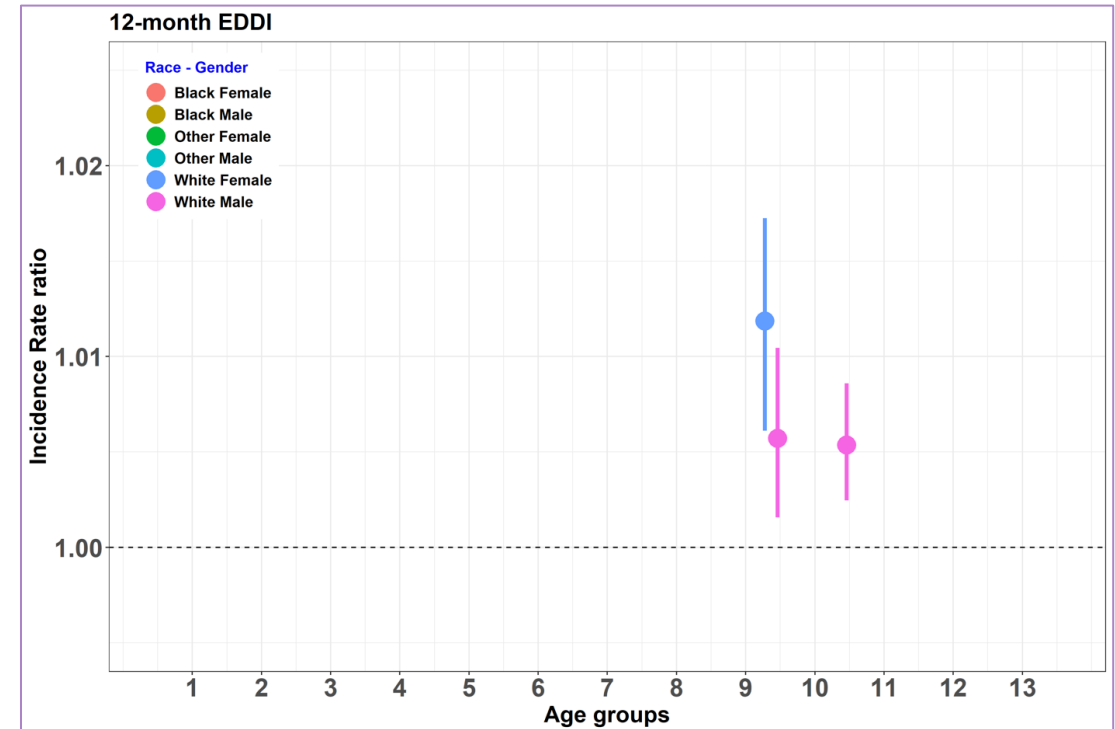
 

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See Comment page e422

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Drought Mortality in Nebraska



- white females aged 45-54
- white males aged 45-64

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The association between drought conditions and increased occupational psychosocial stress among U.S. farmers: An occupational cohort study



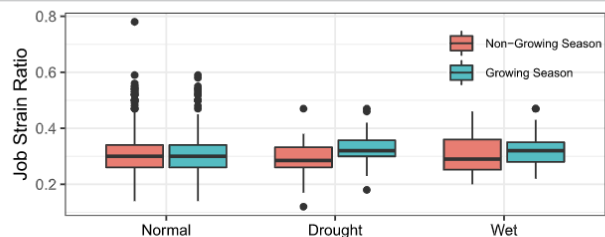
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HIGHLIGHTS

- Drought risk for farmer occupational psychosocial stress is unknown.
- Farmers are a vulnerable population to extreme weather events.
- A linear mixed effects longitudinal model evaluated farmer job strain.
- Growing season drought increased farmers occupational psychosocial stress.
- Drought planning should consider occupational psychosocial stress effects.

GRAPHICAL ABSTRACT



ARTICLE INFO

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ABSTRACT

Background: Drought represents a globally relevant natural disaster linked to adverse health. Evidence has shown agricultural communities to be particularly susceptible to drought, but there is a limited understanding of how drought may impact occupational stress in farmers.

Methods: We used repeated measures data collected in the *Musculoskeletal Symptoms among Agricultural Workers Cohort* study, including 498 Midwestern U.S. farmers surveyed with a Job Content Questionnaire (JCQ) at six-month intervals in 312 counties from 2012 through 2015. A longitudinal linear mixed effects model was used to estimate the change in job strain ratio, a continuous metric of occupational psychosocial stress, during drought conditions measured with a 12-month standardized precipitation index. We further evaluated associations between drought and psychological job demand and job decision latitude, the job strain components, and applied a stratified analysis to evaluate differences by participant sex, age, and geography.

Results: During the growing season, the job strain ratio increased by 0.031 (95% CI: 0.012, 0.05) during drought conditions, an amount equivalent to a one-half standard deviation change (Cohen's D = 0.5), compared to non-drought conditions. The association between drought and the job strain ratio was driven mostly by increases in the psychological job demand (2.09; 95% CI: 0.94, 3.24). No risk differences were observed by sex, age group, or geographic region.

Conclusions: Our results suggest a previously unidentified association between drought and increased occupational psychosocial stress among farmers. With North American climate anticipated to become hotter and drier, these findings could provide important health effects data for federal drought early warning systems and mitigation plans.

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Local

Kansas farmer on alarming suicide rate: 'Nothing gets farmers more down than a drought'

By: Emily Younger

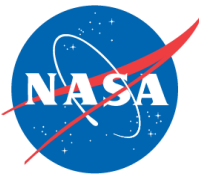


Posted: May 21, 2018 09:34 PM CDT
 Updated: May 21, 2018 11:34 PM CDT



Drought Causes Stress in Farmers

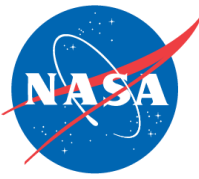
The effect estimate for drought was 4x greater magnitude than people reporting pain in multiple body parts.



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Schedule & Milestones

- Next 6 months
 - Use EPA Air Quality System Data to reconstruct historical changes
 - CDC National Center for Health Stats Detailed Mortality Data for US – access and formatting
 - Put together historical data from USDM, VegDRI, GRACE Soil Moisture Anomaly
- Next 12 months
 - Evaluating changes in air quality with drought
 - Start a comprehensive air quality modeling system to simulate the underlying processes linking drought to air quality



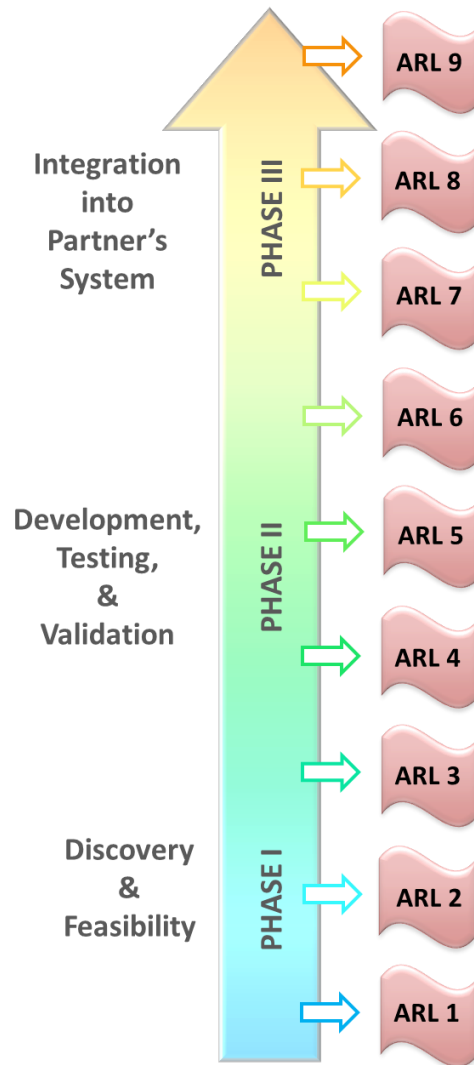
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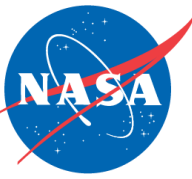
Schedule & Milestones

- Year 2
 - Understanding links to health outcomes from drought
 - Understanding links to health outcomes from air quality
 - Evaluate at-risk populations
 - Determine regional differences
- Year 3
 - Working with end-users for pre-product development
 - Product development
 - Workshop with end-users
 - Transition products to CDC and NIDIS

ARL Performance

- Start-of-Project ARL = 1: Basic Research
- Goal ARL = 8: Application Completed and Qualified
- Current ARL = 4: Initial Integration and Verification (as of *Feb 13, 2023*)

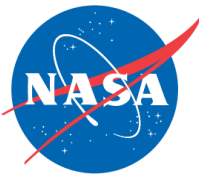




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Current ARL-Supporting Evidence

- Components of eventual application system brought together and technical integration issues worked out
 - Have all of the data
 - Already identified some of these health relationships with drought
- Organizational challenges and human process issues identified and managed
 - Have project management support to work keep milestones on track
 - Additional team members are brought together on a biweekly basis to go over project tasks

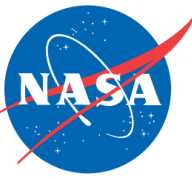


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Challenges and Risks

- No foreseeable risks currently
- All data are available
- Possible that analysis and data integration take longer than expected (T)
- Product transition to partners seems promising
 - CDC EH Tracking Program
 - FEMA HQ

* Please designate risk type as: Technical (T), Budget (B), End-User/Stakeholder (ES), or Project Management (PM)



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Accomplishments since Last Update

- NASA DEVELOP PNW Health and Air Quality Project
 - In development stage for summer of 2023
 - This project will be working with NIDIS and health departments in the PNW to identify how drought impacts air quality
- Engaged with Principle Investigator of the DoD/IC components of LIS
 - Interested in integration of LIS
 - Possible future collaborations

Thank you!

- Jesse Berman, PhD – University of Minnesota
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