Drought and Health: Focus on Heat

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Water for Food
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Relationship of Climate to Health

Climate is Affecting Your Health

Direct

Affecting Health Directly

- Extreme Heat
- Air Pollution
- Extreme Weather

Indirect

Spreading Disease

- Diseases Spread by Insects, Ticks, and Rodents
- Contaminated Water
- Contaminated Food

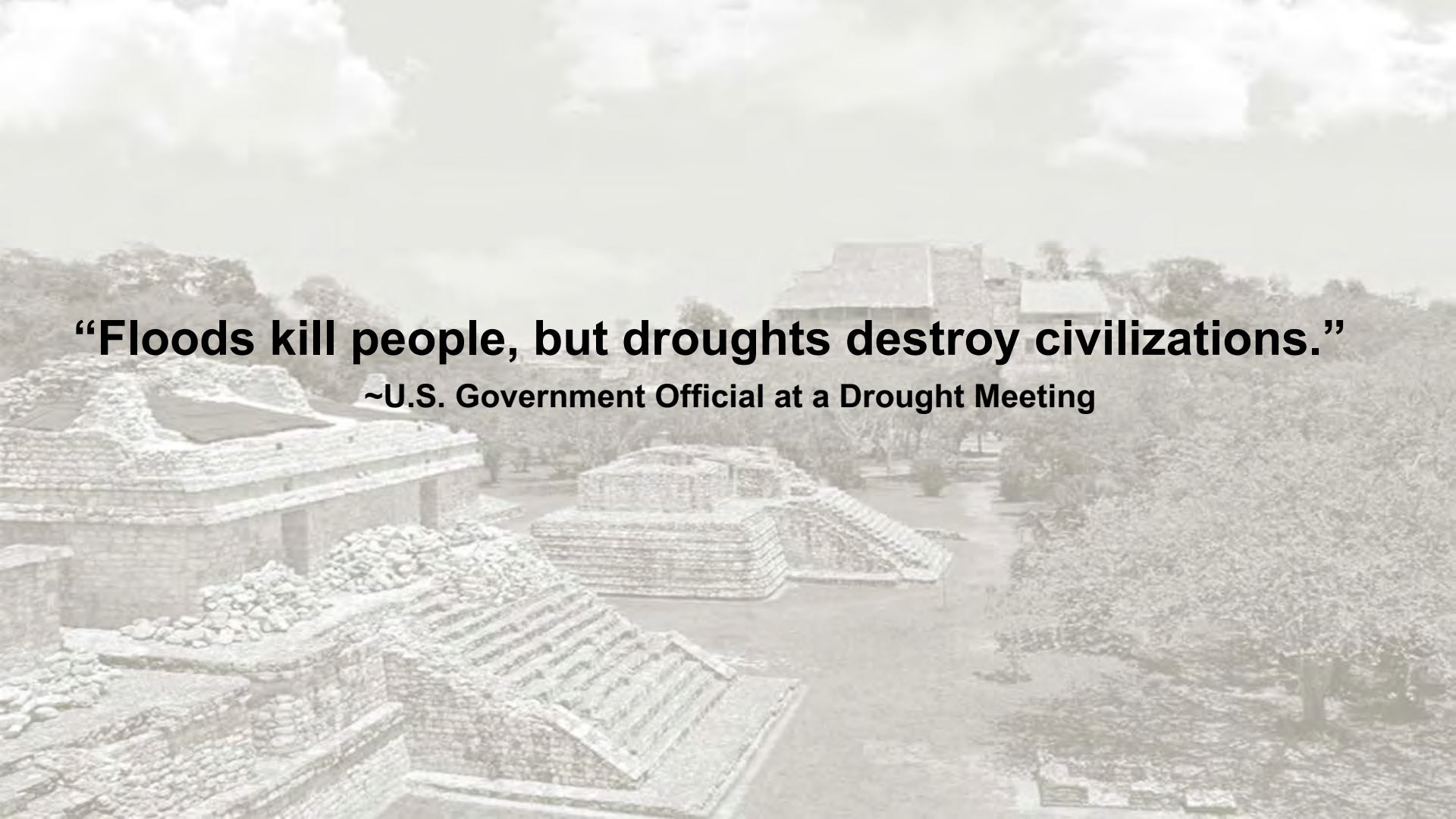
Destroying & Disrupting Food Supplies

- Hunger and Malnutrition

Disrupting Well-Being

- Mental Health Problems
- Conflict and Displacement

Drought has shaped society

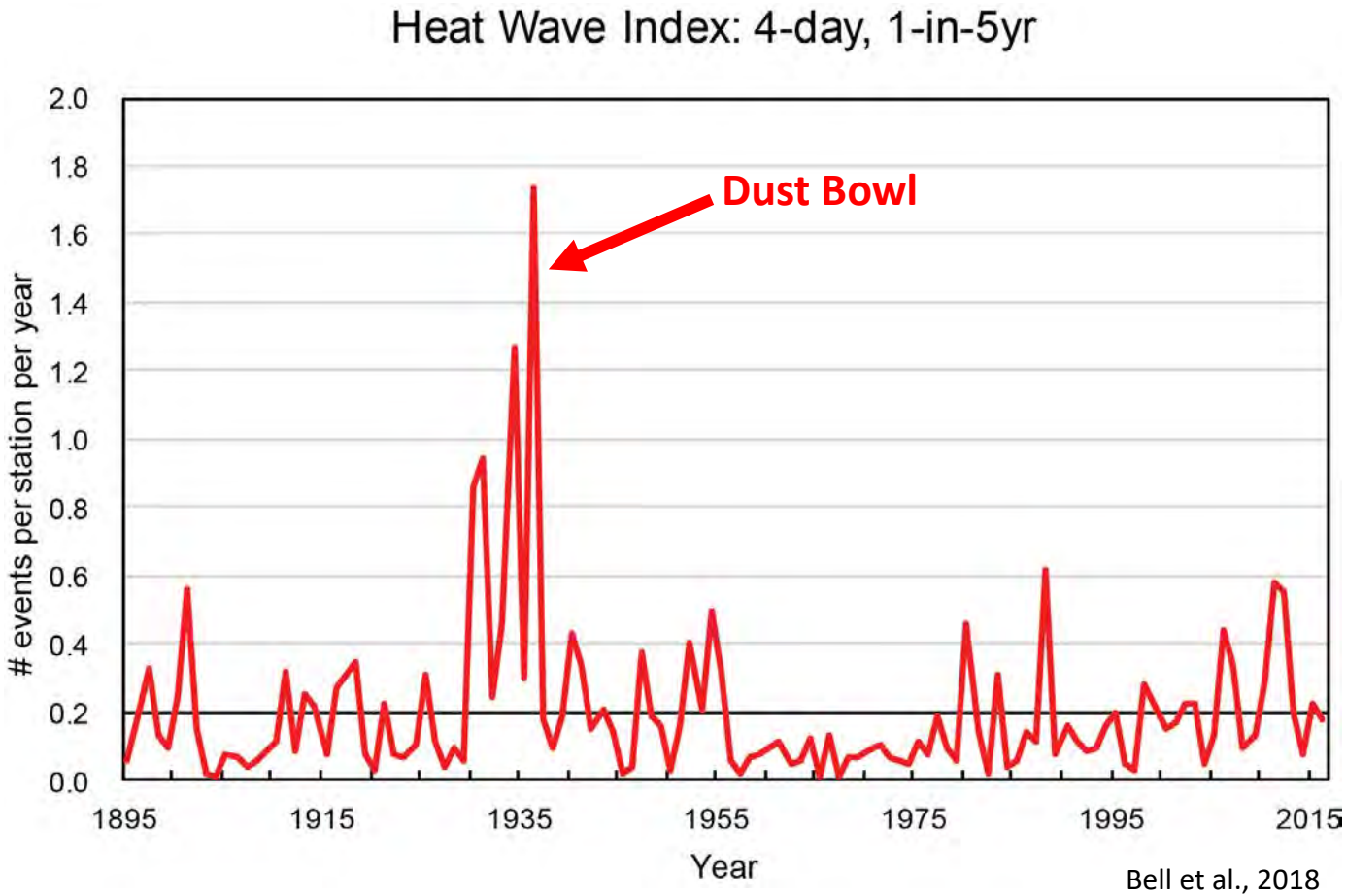


“Floods kill people, but droughts destroy civilizations.”

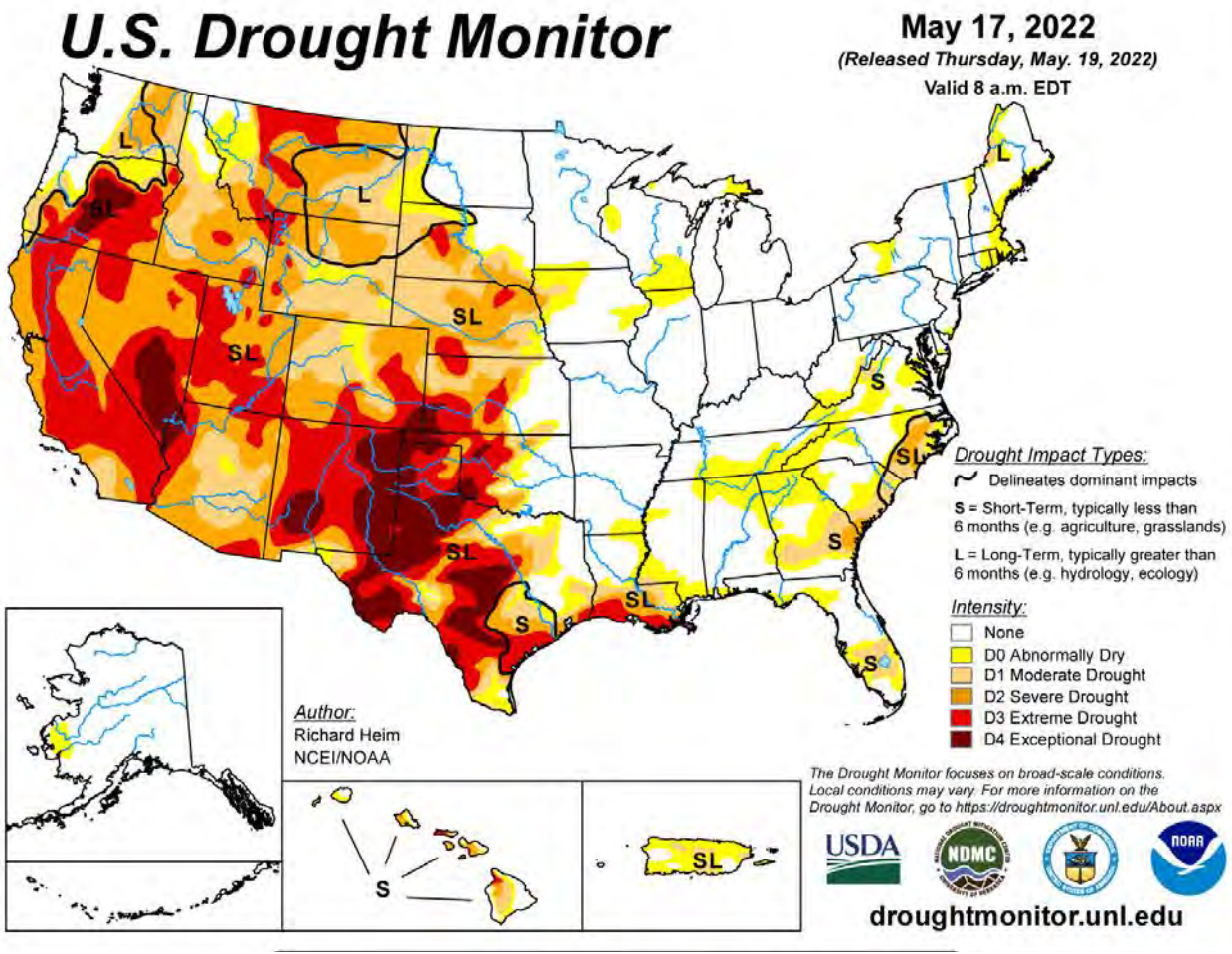
~U.S. Government Official at a Drought Meeting

Dust Bowl of the 1930s

Extreme Heat and Drought

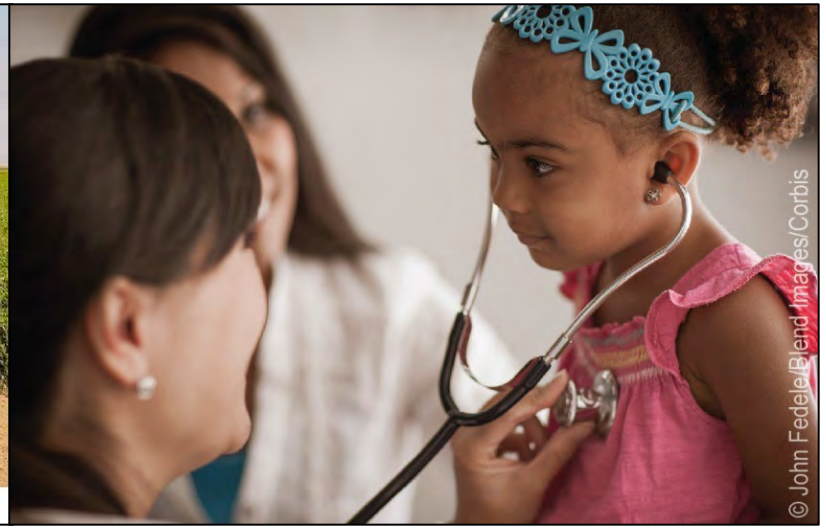


Bell et al., 2018

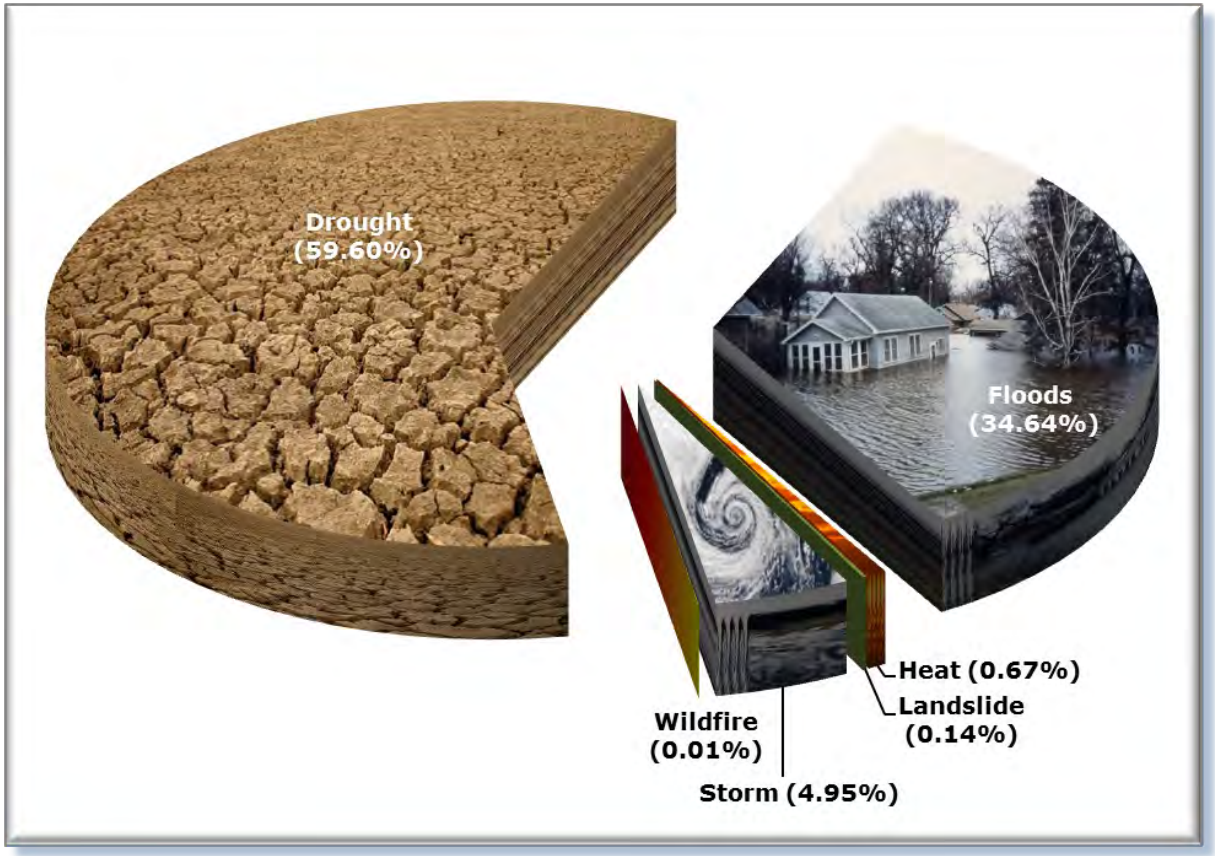

U.S. Drought Monitor
May 17, 2022
(Released Thursday, May. 19, 2022)
Valid 8 a.m. EDT
Drought Impact Types:
Delineates dominant impacts
S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)
L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)
Intensity:
None
D0 Abnormally Dry
D1 Moderate Drought
D2 Severe Drought
D3 Extreme Drought
D4 Exceptional Drought
Author:
Richard Heim
NCEI/NOAA
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx
USDA
NDMC
NOAA
droughtmonitor.unl.edu

Connecting Drought to Health

he difference between the fields on either side of dairy farmer Tom Barcellos is water. (Tomas Ovalle / For The Times)

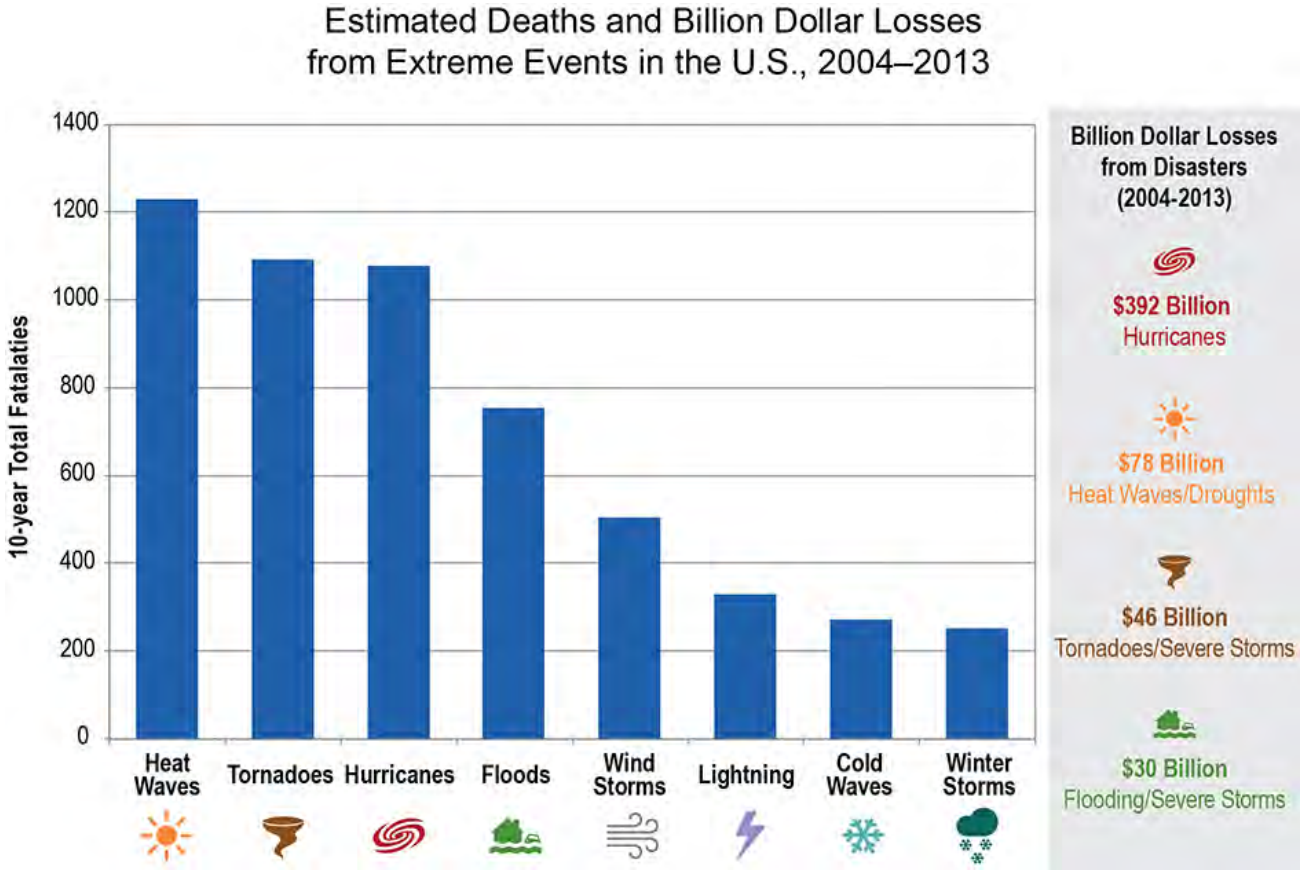


Percentage of disaster-deaths worldwide according to each category of climate-related hazard, (1900-2013)



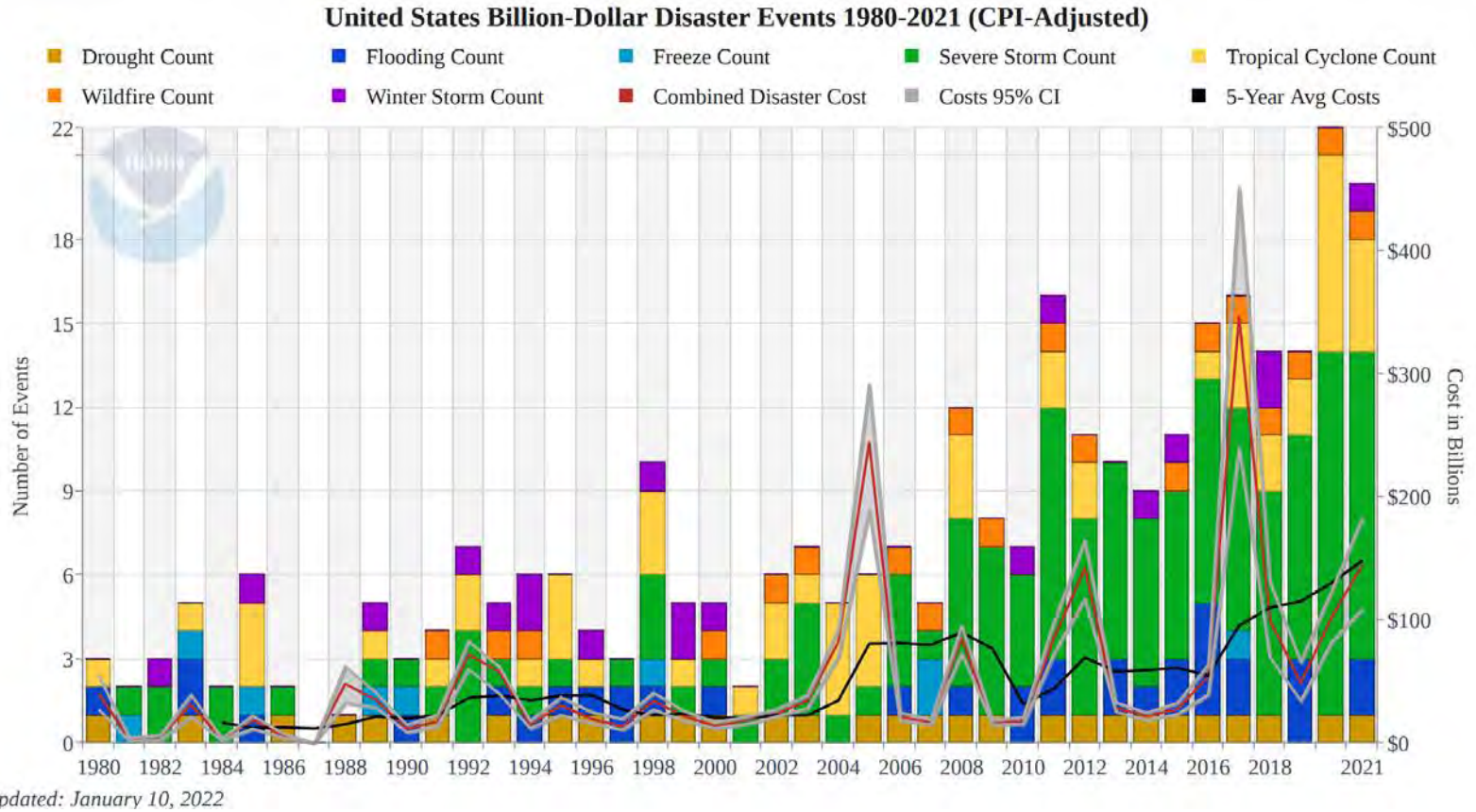
Source: Adapted from EM-DAT: The OFDA/CRED International Database, Belgium 2012
Keim, ME Extreme Weather Events: the role of public health

Drought Impacts



Bell et al., 2016

Billion-Dollar Disasters are Increasing



Summary Statistics

Billion-dollar events to affect the United States from 1980 to 2021 (CPI-Adjusted)

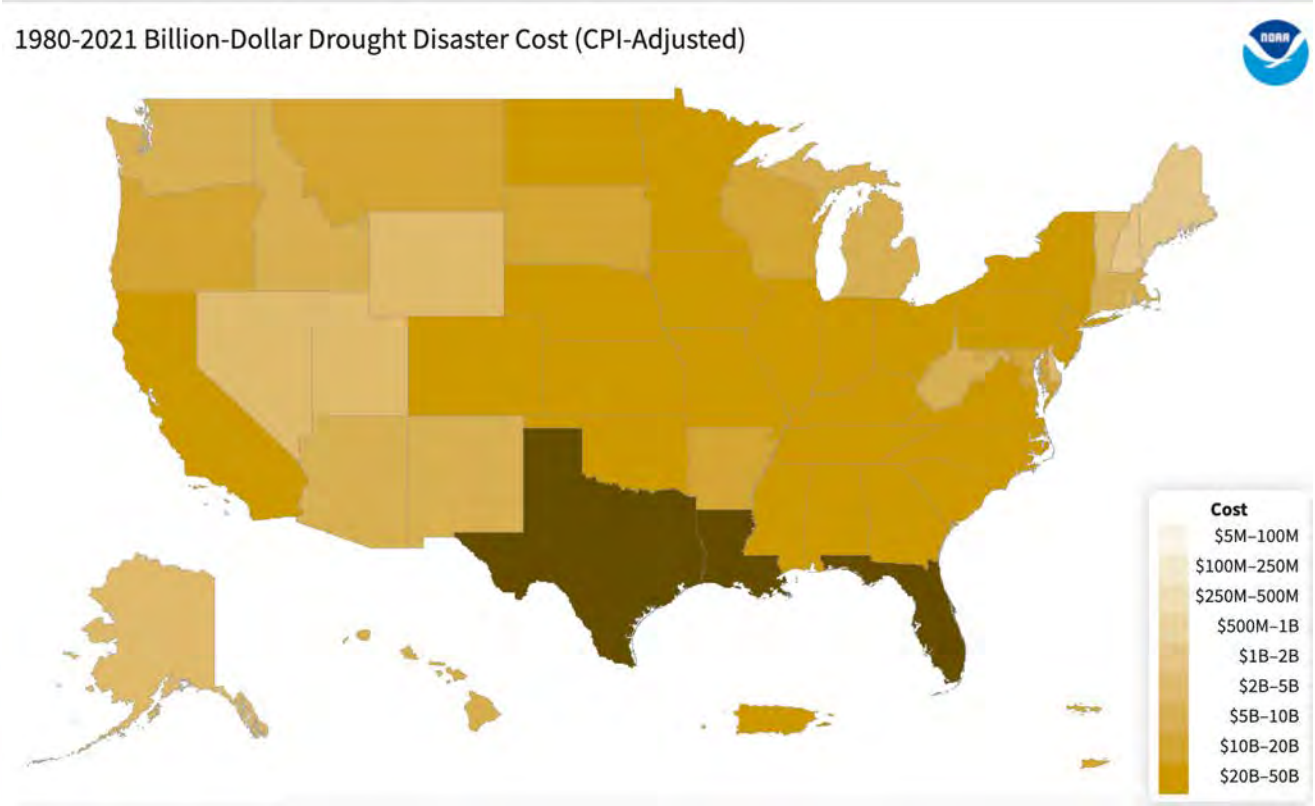
Disaster Type	Events	Events/Year	Percent Frequency	Total Costs	Percent of Total Costs	Cost/Event	Cost/Year	Deaths	Deaths/Year
Drought	29	0.7	9.4%	$285.4B (CI)	13.2%	$9.8B	$6.8B	4,139†	99†
Flooding	35	0.8	11.3%	$164.2B (CI)	7.6%	$4.7B	$3.9B	624	15
Freeze	9	0.2	2.9%	$32.8B (CI)	1.5%	$3.6B	$0.8B	162	4
Severe Storm	143	3.4	46.1%	$330.7B (CI)	15.3%	$2.3B	$7.9B	1,880	45
Tropical Cyclone	56	1.3	18.1%	$1,148.0B (CI)	53.2%	$20.5B	$27.3B	6,697	159
Wildfire	19	0.5	6.1%	$120.2B (CI)	5.6%	$6.3B	$2.9B	401	10
Winter Storm	19	0.5	6.1%	$78.6B (CI)	3.6%	$4.1B	$1.9B	1,277	30
All Disasters	**310**	**7.4**	**100.0%**	**$2,159.9B (CI)**	**100.0%**	**$7.0B**	**$51.4B**	**15,180**	**361**

†*Deaths associated with drought are the result of heat waves. (Not all droughts are accompanied by extreme heat waves.)*

Flooding events (river basin or urban flooding from excessive rainfall) are separate from inland flood damage caused by tropical cyclone events.

The confidence interval (CI) probabilities (75%, 90% and 95%) represent the uncertainty associated with the disaster cost estimates. Monte Carlo simulations were used to produce upper and lower bounds at these confidence levels (Smith and Matthews, 2015).

1980-2021* NOAA Billion-Dollar Drought Disasters (CPI-Adjusted)



29 Events

$285 Billion Lost

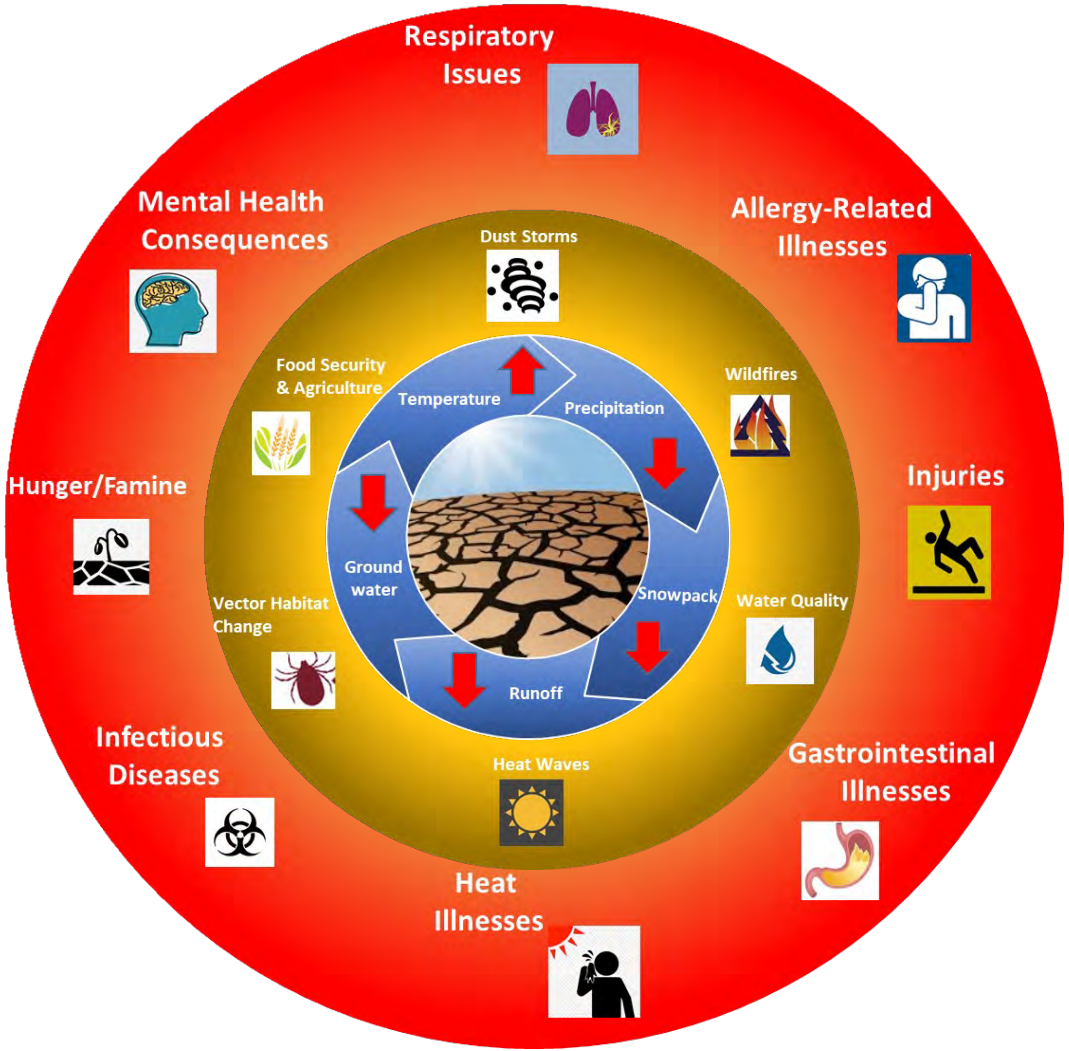
4,139 Deaths

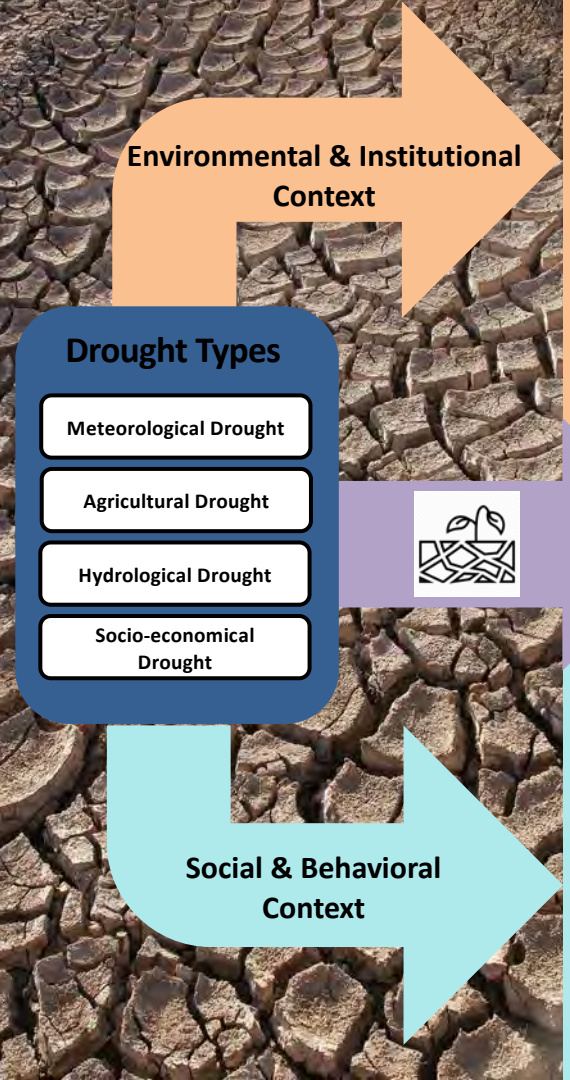
NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2018). https://www.ncdc.noaa.gov/billions/

Health Surveillance Data

- ✓ Drought can be a slow evolving
- ✓ The impacts are not immediate
- ✓ Can require multiple steps for health outcomes
- ✓ Surveillance is not designed to connect drought and health

Drought → ? → Health Outcome


Respiratory Issues
Allergy-Related Illnesses
Injuries
Gastrointestinal Illnesses
Heat Illnesses
Infectious Diseases
Hunger/Famine
Mental Health Consequences
Dust Storms
Wildfires
Water Quality
Heat Waves
Vector Habitat Change
Food Security & Agriculture
Temperature
Precipitation
Snowpack
Runoff
Ground water



Environmental & Institutional Context

Water Supply

Local Environmental Conditions

Preparedness of Health Departments

Agricultural Management Practices

Power, Transportation, Communication and Healthcare Infrastructure

Drought Types

- Meteorological Drought
- Agricultural Drought
- Hydrological Drought
- Socio-economical Drought

Exposure Pathways

- Increase in Dust and dust Storms
- More Frequent Wildfires
- Decrease in Water Quality and Quantity
- More Frequent and More Intense Heat Waves
- Change in Vector Habitat and Range
- Loss of Agriculture and Food Security

Health Outcomes

- Respiratory Issues
- Allergy-related Illnesses
- Injuries
- Infectious Disease
- Hunger/Famine
- Heat Illnesses
- Gastrointestinal Illnesses
- Mental Health Consequences

Social & Behavioral Context

Social Determinants of Health

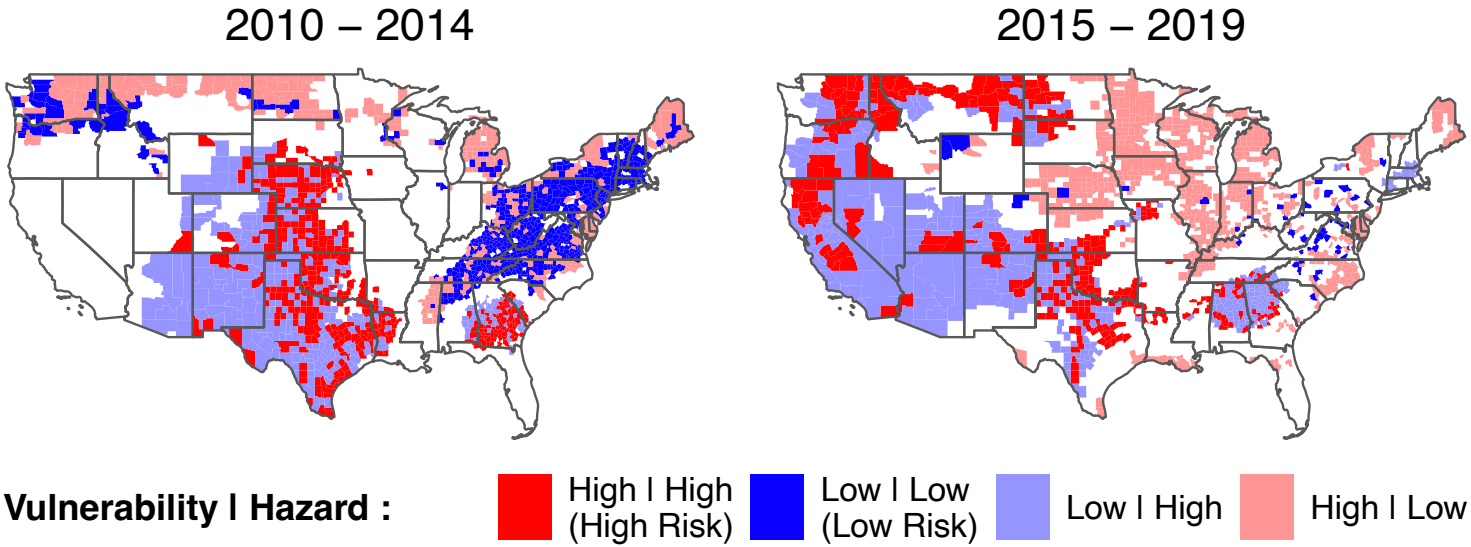
Occupation

Rural/Urban

Race/Literacy/Age

Dependence on Caregivers and Medication

Health Risks from Drought Change



Fard et al. Evaluating Changes in Health Risk from Drought Over the Contiguous United States. IJERPH just accepted

Threat Multiplier

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 Berman, Keith J Ebisu, Roger D Peng, 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 418 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 0·6 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 droughts 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 droughts, but decreased the risk of respiratory admissions during full drought periods among adults aged 65 years and older. Counties that grow heavily rain-fed crops or counties with fewer droughts show larger risk for mortality and cardiovascular disease. This research describes an understudied environmental association with global health significance.

Funding The Yale Institute of Biospheric Studies, the National Institute of Environmental Health Sciences, the US Environmental Protection Agency.

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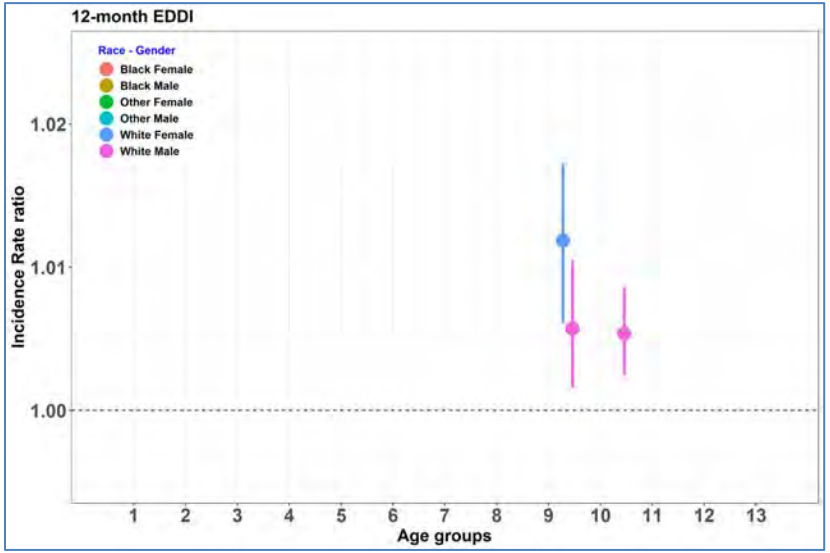
Introduction

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.[2] California is facing an extreme drought that has been ongoing since 2013.[3] However, although health effects of some natural disasters (eg, heat waves and floods) are well studied,[4] 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 extents, and difficulty assessing when one begins or ends.[5,6] Additionally, drought can be categorised as four distinct types: meteorological, agricultural, hydrological, and socioeconomic.[7] 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.[8,9] Long-term drought has the potential to degrade the environment and affect community-level economic livelihood, inducing psychological stress.[10,11] Chronic stress will invoke behavioural and physiological response, including haemodynamic, endocrine, and immunological dysfunction that increase risk of cardiovascular and upper respiratory disease.[8,9] In extreme cases, this dysfunction can increase mortality. Community studies from Australia found associations

Drought Mortality in Nebraska



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

Courtesy of Dr. Azar Abadi

Compromised Quantity and Quality of Water

Surface Water

Courtesy of USGS

Groundwater

Courtesy of USDA

USGS
science for a changing world

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Drought May Lead to Elevated Levels of Naturally Occurring Arsenic in Private Domestic Wells

Release Date: MARCH 18, 2021

An estimated 4.1 million people in the lower 48 states are potentially exposed to arsenic levels that exceed EPA's drinking water standards

A new U.S. Geological Survey study highlights the importance of homeowners testing their well water to ensure it is safe for consumption, particularly in drought-prone areas. The first-of-its-kind national-scale study of private well water, conducted in collaboration with the Centers for Disease Control and Prevention, showed that drought may lead to elevated levels of naturally occurring arsenic and that the longer a drought lasts, the higher the probability of arsenic concentrations exceeding U.S. Environmental Protection Agency's standard for drinking water.

Researchers estimate that during drought conditions, 4.1 million people in the lower 48 states who use private domestic wells are potentially exposed to unsafe levels of arsenic. This is an increase of 54% from the estimated 2.7 million people exposed to unhealthy arsenic levels in private wells during normal, non-drought conditions.

Arsenic is a metal that can occur naturally in bedrock and sediments around the world and is commonly reported in drinking-water supply wells. However, chronic exposure to arsenic from drinking water is associated with an increased risk of several types of cancers, including bladder, lung, prostate and skin cancers. Other adverse effects include developmental impairments, cardiovascular disease, adverse birth outcomes and impacts on the immune and endocrine systems.

The study's findings can help public health officials and emergency managers notify well owners in areas potentially affected and further refine their strategies for addressing the issue. The EPA regulates public water supplies, but maintenance, testing and treatment of private water supplies are the

Jacks Pond in Hancock, New Hampshire. Groundwater from this area supplies nearby private wells. (Credit: Melissa Lombard, USGS.

Contacts

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U.S. Geological Survey

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Melissa A Lombard

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New England Water Science Center
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Phone: 603-226-7816

Secondary/Related Events

- Extreme heat
- Wildfires
- Dust storms/haboobs
- Rain/storm effects

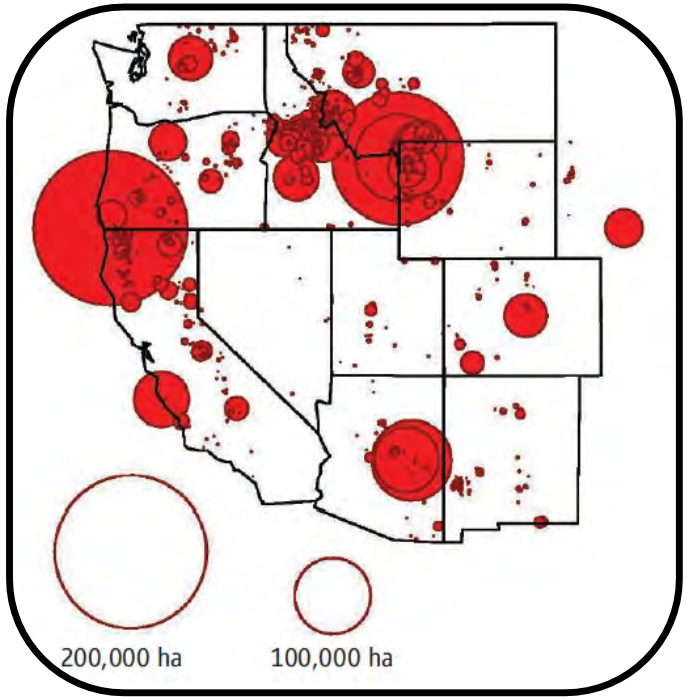
Courtesy of USGS

Courtesy of FCC

Courtesy of NOAA

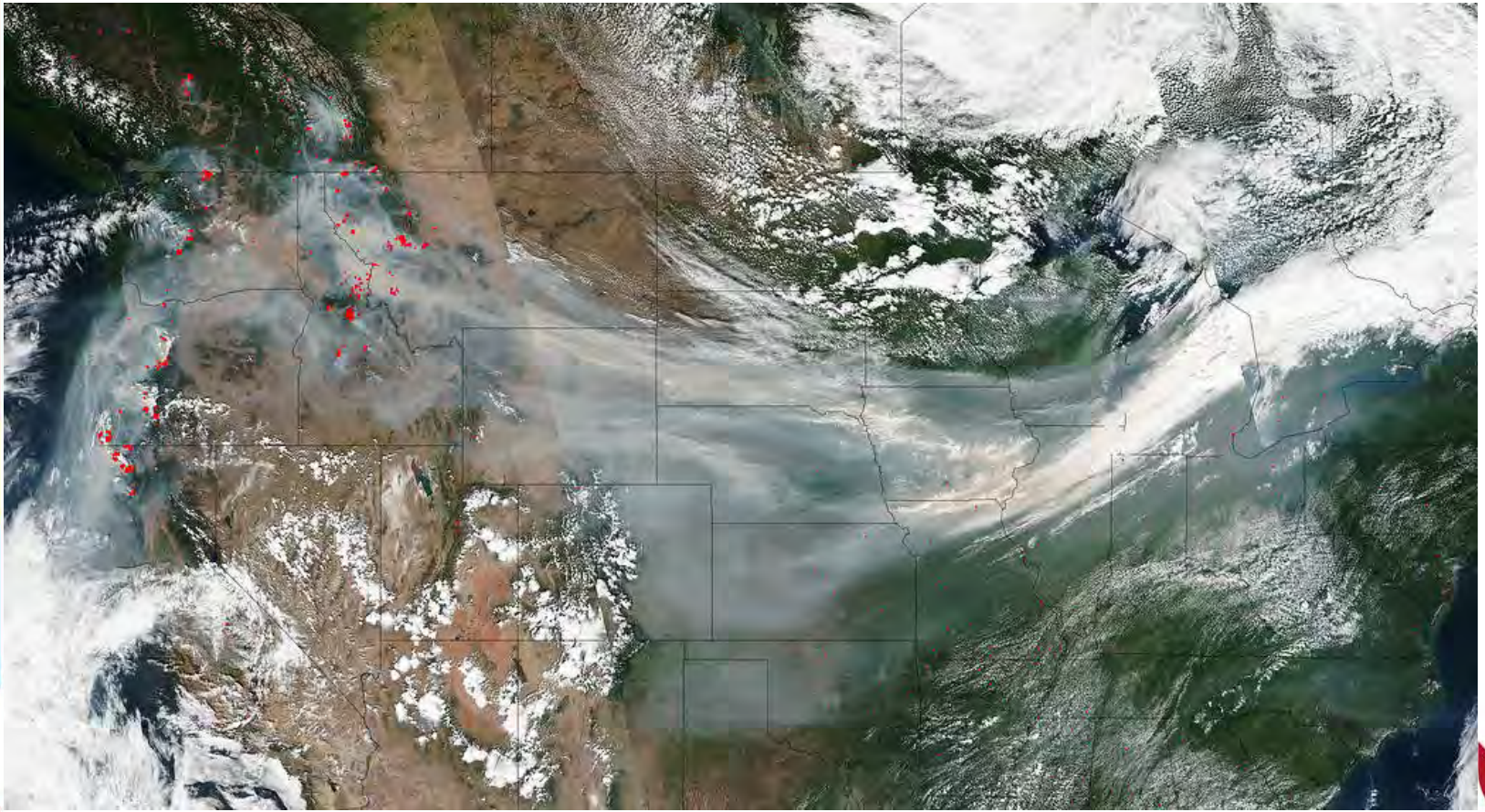
Climate Change Impacts Air Quality: Wildfire Smoke

Wildfire Activity Since 1970



- **Since 1970**
  - Western US wildfire season increased by 78 days
  - Average duration of fires increased five fold

Westerling et al. Warming and earlier spring increase western U.S. forest wildfire activity *Science*. 2006 Aug 18;313(5789):940-3



NASA image courtesy Jeff Schmaltz LANCE/EOSDIS MODIS Rapid Response Team, GSFC

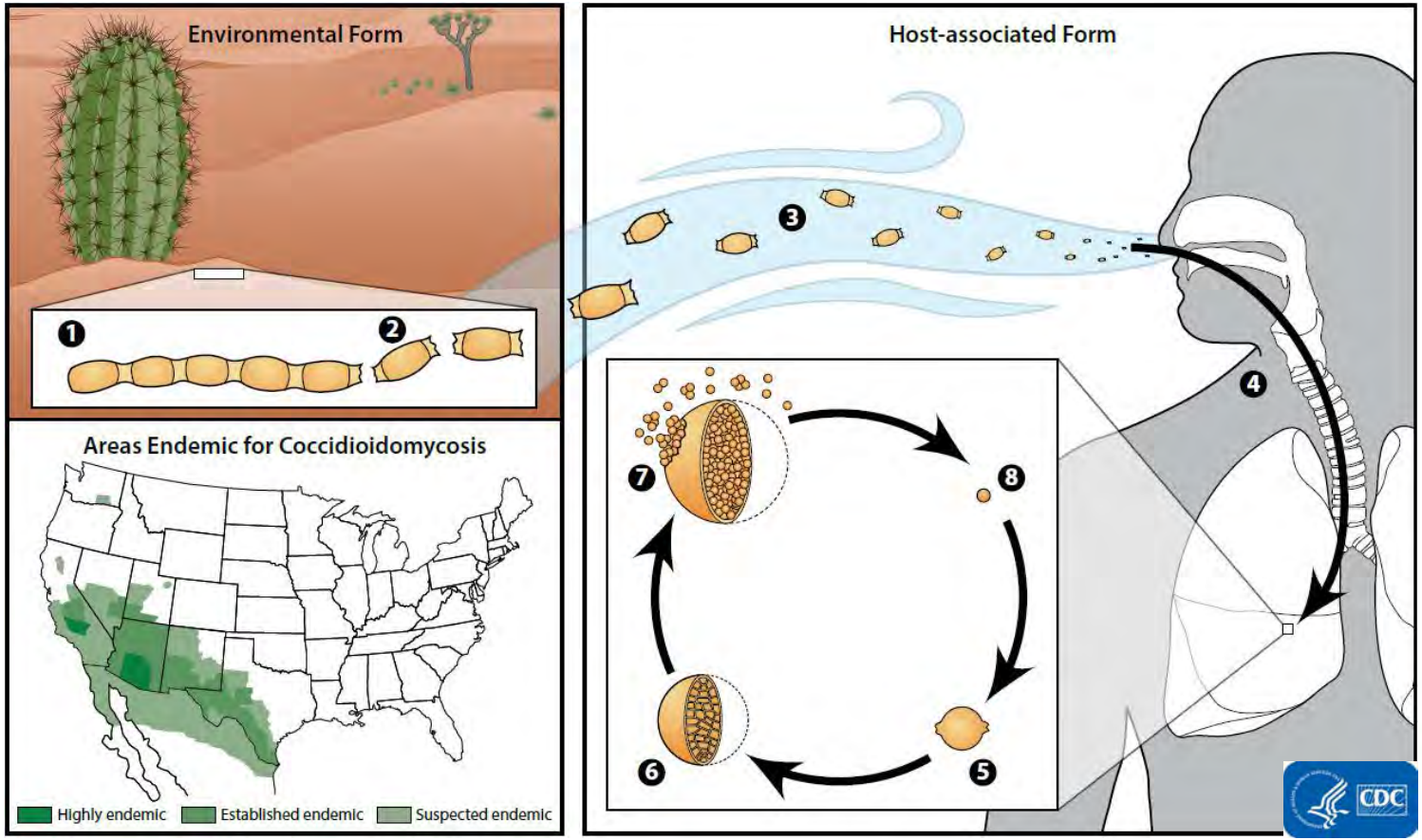
Increased Disease Incidence

- Infectious disease
- Chronic disease
- Vectorborne and zoonotic disease

Courtesy of USGS

Courtesy of NSF

Life Cycle of Coccidioidomycosis



Additional Health Risks

- Sanitation and hygiene
- Recreational risks
- Mental and behavioral health

Courtesy of CDC

Courtesy of USACE

Courtesy of House Committee on Agriculture

Complex Pathways: Mental Health

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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

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someone is killed by gun violence in the United States
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nsw act

Farmer's recovery from depression which led to two suicide attempts shows cost of drought at family level

STEVE Germon left a suicide note on the porch and set about putting down calves he couldn't feed before turning the gun on himself. Then a ute screamed towards him, his 17-year-old daughter at the wheel.

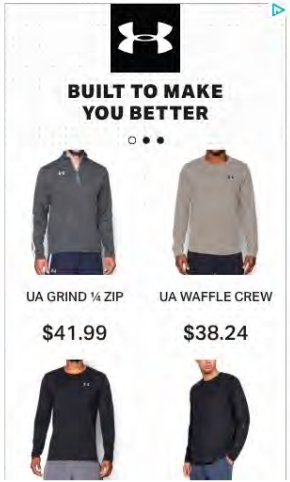
JACK MORPHET

The Sunday Telegraph JULY 1, 2018 1:00AM

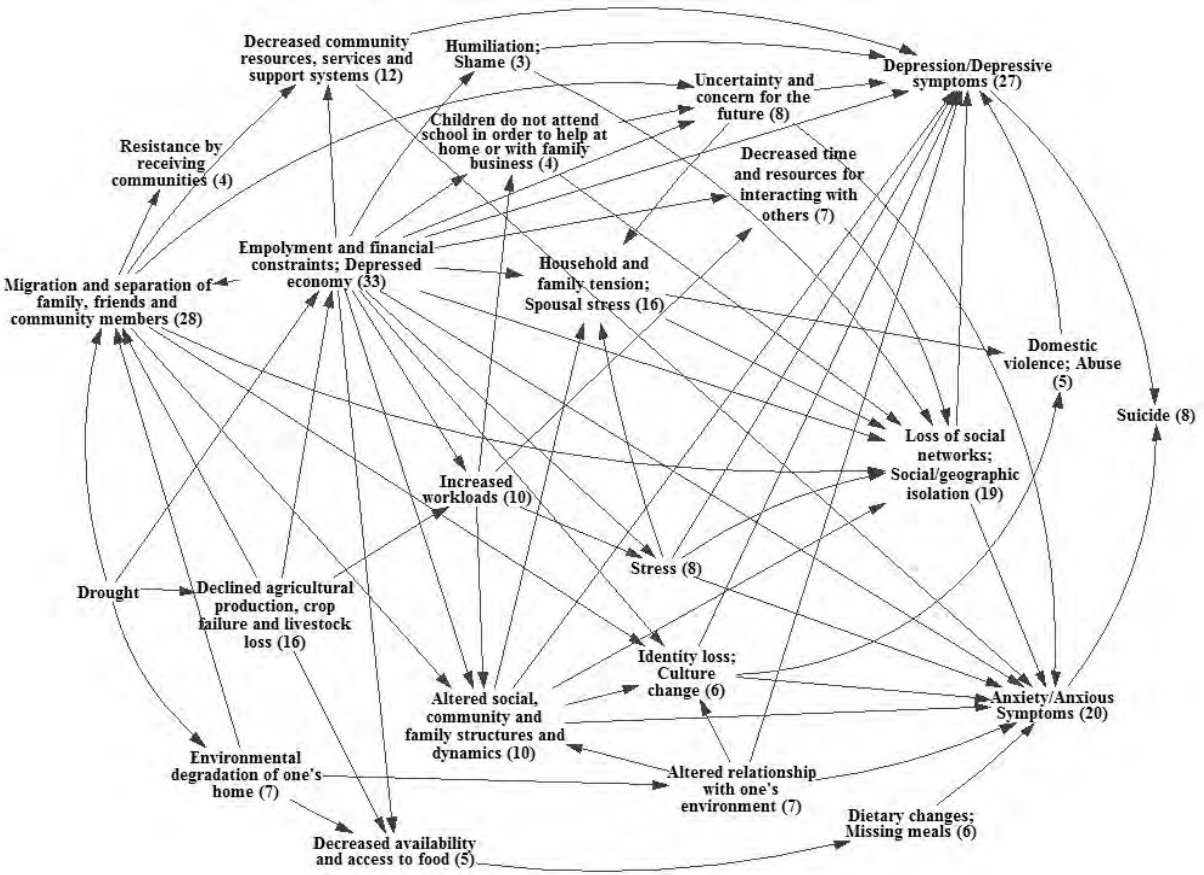
NSW stricken by severe drought

DAIRY farmer Steve Germon knows what it's like to be on the brink of suicide. He has been there twice in the past three years.

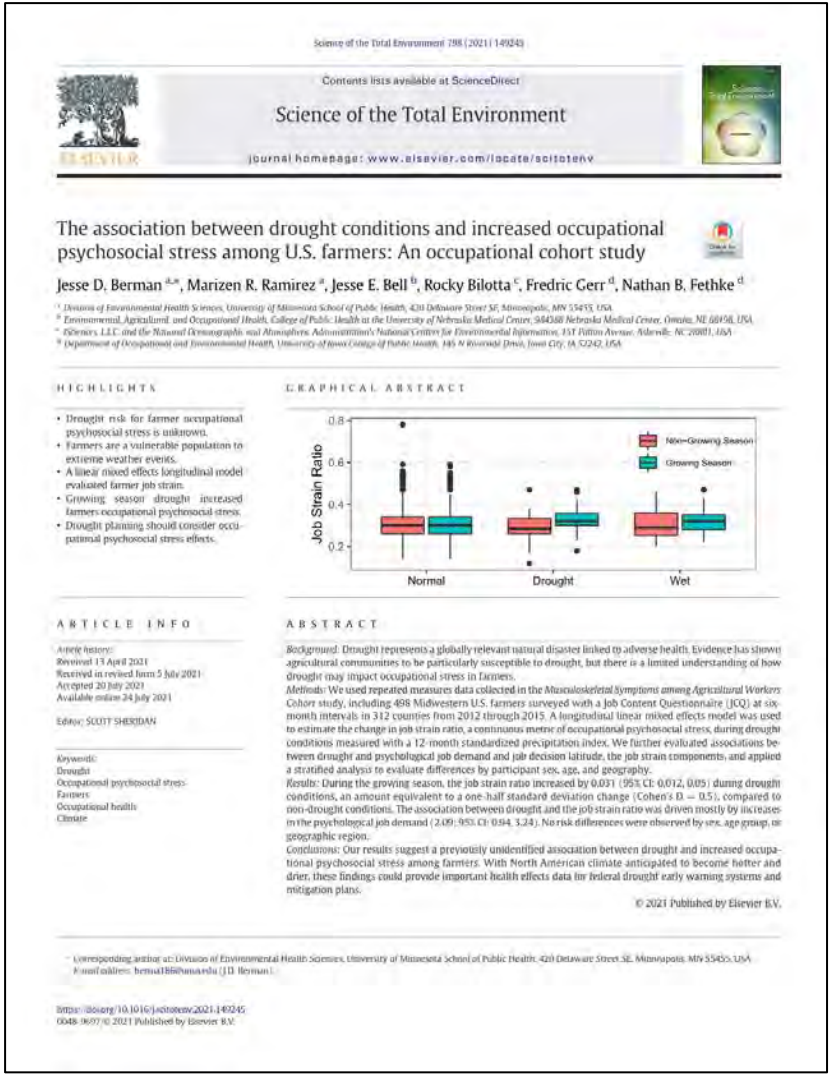
...at saved him in 2015, but those lonely moments last year



Causal Process Diagram



Vins, H., Bell, J., Saha, S., & Hess, J. J. (2015). The mental health outcomes of drought: a systematic review and causal process diagram. *International journal of environmental research and public health*, *12*(10), 13251-13275.



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Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

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

Jesse D. Berman [a,*], Marizen R. Ramirez [a], Jesse E. Bell [b], Rocky Bilotta [c], Fredric Gerr [d], Nathan B. Fethke [d]

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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

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Climate

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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E-mail address: bermanJB@umn.edu (J.D. Berman).

https://doi.org/10.1016/j.scitotenv.2021.149245
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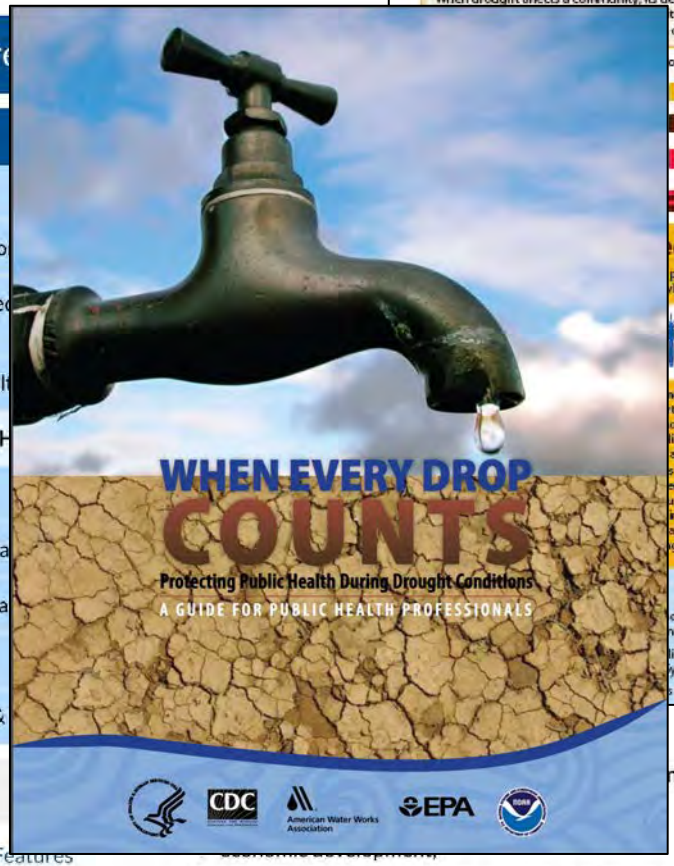
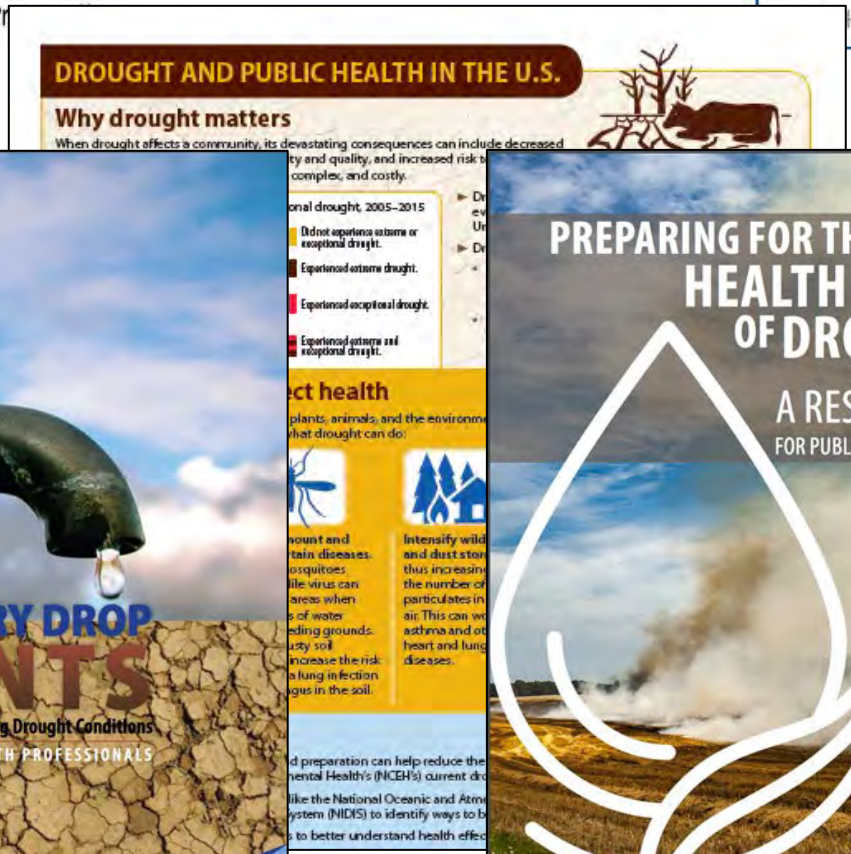
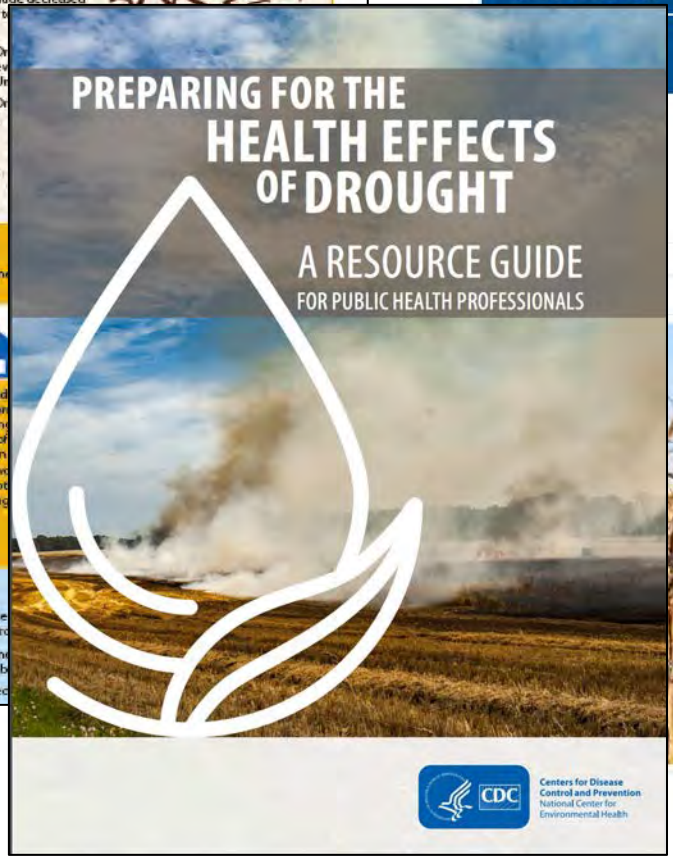
Drought Causes Stress in Farmers

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

Engagement







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- the at-risk populations living within the affected area, and

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Natural Resources Defense Council (NRDC)
UNL National Drought Mitigation Center (NDMC)

NOAA
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U.S. DEPARTMENT OF COMMERCE

NIDIS

Water for Food
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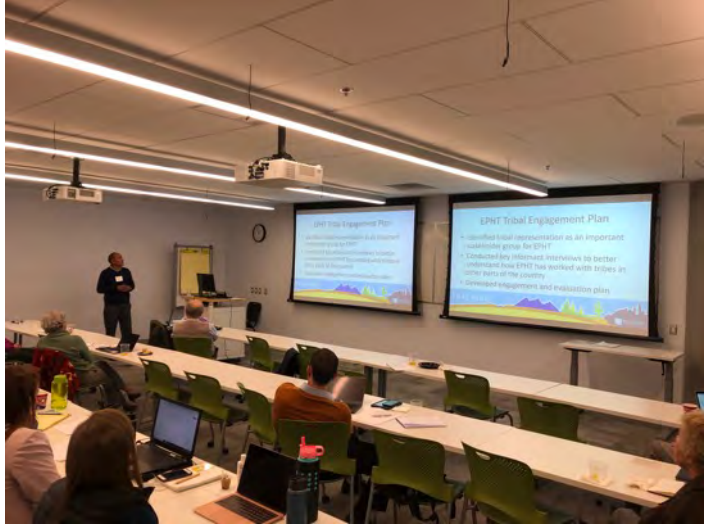

NIDIS
NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

Future Needs:

- Still much to be learned about drought and public health
  - What do public health departments need?
- Research is needed in many different areas:
  - Analysis of surveillance data
  - Improved environmental monitoring
  - Role of public health departments
  - Economic impact of drought on public health
  - Lessons learned and best practices

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