What Makes Communities Resilient to Drought?

Dan Blaustein-Rejito [1] Ian Bolliger [2] Hal Gordon [3] Andy Hultgren [3] Yang Ju [4] Kate Pennington [3] Sara Stoudt [5]

University of California, Berkeley: DS421

[1]GSPP [2]ERG [3]ARE [4]LAEP [5]Stats

danr@berkeley.edu *bolliger@berkeley.edu* *halgordon@berkeley.edu*
hultgren@berkeley.edu *yangju90@berkeley.edu* *kate.pennington@berkeley.edu*
sstoudt@berkeley.edu

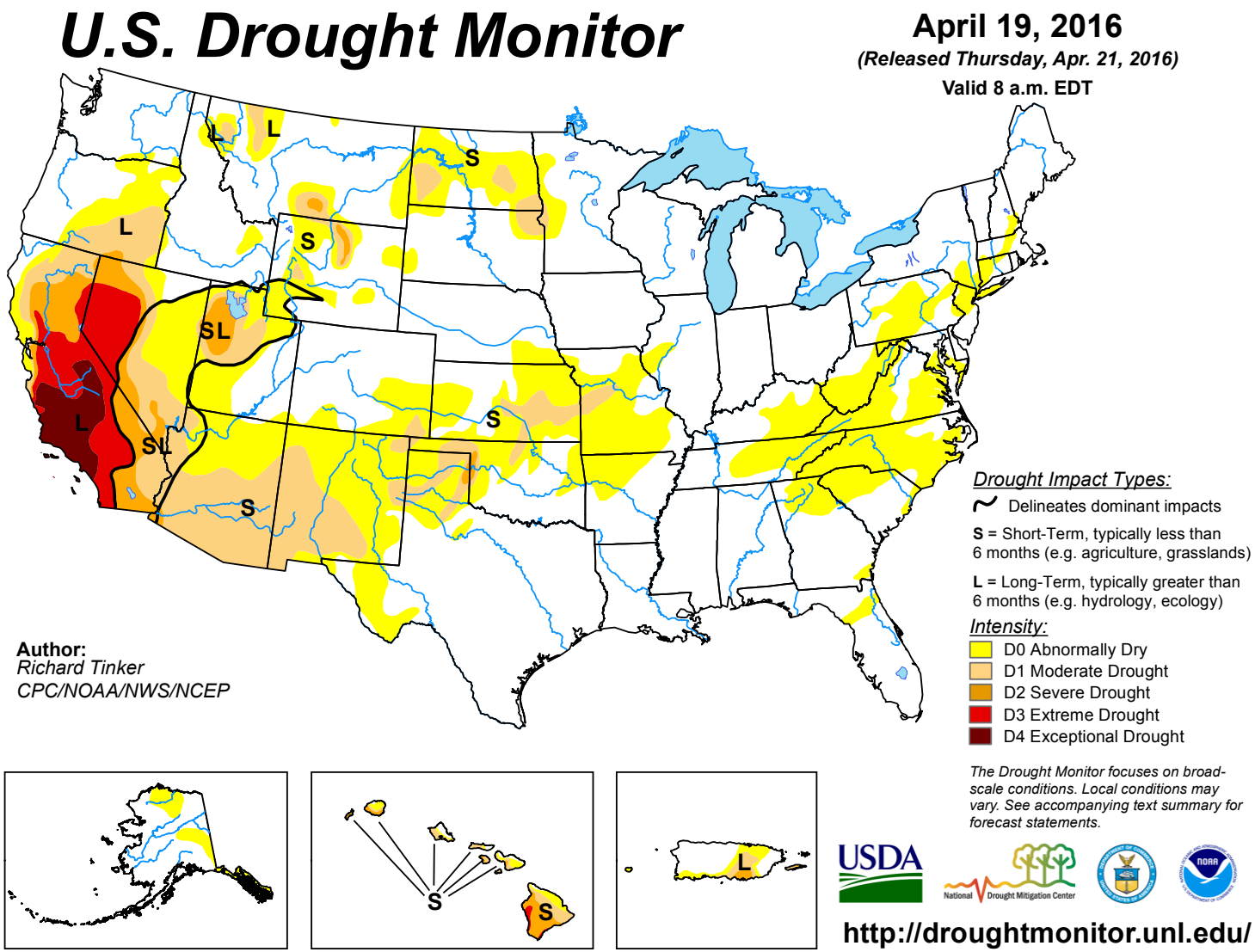
April 25, 2016

Overview

Drought

- In April 2016 in the United States:
  - 14% of land was in drought and 34% was abnormally dry.
  - 84.3 million people live in drought-affected areas, and 17.5 million live in areas experiencing exceptional drought
- In California:
  - 90% of the state is in drought and more than 50% is in severe to exceptional drought.
  - 84.3 million people live in drought-affected areas, and 17.5 million live in areas experiencing exceptional drought

Drought, April 19, 2016



Drought

- Climate change is likely to increase the length and severity
- Drought will effect all regions and populations at one time or another
- Resilience, not just risk of drought, will have far reaching implications for welfare changes from climate change.

Model

First Stage Equation

$$y_{i,t} = \beta_i D_{i,t} + \alpha_i + \tau_i t + \gamma_{s,t} + \epsilon_{i,t} \quad (1)$$

Where:

- $D_{i,t}$ refers to the number of days in U.S. Drought Survey bins 2-4 in county i and year t
- α_i are county fixed effects controlling for time-invariant differences between counties
- τ_i is the coefficient on a county level linear time trend
- $\gamma_{s,t}$ are state-by-year fixed effects controlling for state level time trends common across all counties $i \in s$

Model Details

First Stage Equation

- The state-by-year fixed effects will non-parametrically account for national trends in the outcome of interest as well as state-level trends
- The identifying variation in this model is within-county, annual deviations from the county time trend and from statewide annual average drought levels
- Standard errors will need to be corrected for serial correlation over space and time

Model

Second Stage Equation

$$\beta_i = \rho_0 + \boldsymbol{\delta}\mathbf{X}_i + \nu_i \tag{2}$$

Where:

- β_i come from Eq.(1) for a given outcome
- $\mathbf{X}_i$ represents a vector of county characteristics such as urban/rural, proportion below age 5 or above age 65, home ownership, median cost of residential water bill
- $\boldsymbol{\delta}$ is a vector of the associated coefficients for state level time trends common across all counties $i \in s$

Model Details

Second Stage Equation

- This regression is cross-sectional and therefore not well identified from a causal perspective
- Model will illustrate how "drought resilience" (a low value of β_i) covaries with a set of common county socioeconomic characteristics
- We correct OLS standard errors by clustering over space

Stage 1 Data: 2005-2014

$$y_{i,t} = \beta_i D_{i,t} + \alpha_i + \tau_i t + \gamma_{s,t} + \epsilon_{i,t}$$

Left Hand Side

- **US Drought Monitor:**
  - Scale from 0-4 updated weekly
  - we create a 1-year, 3-year, and 5-year measure

Right Hand Side

- **Mortality:**
  - Annual CDC WONDER database
  - Over-65 and all-ages
- **Yields:**
  - Annual USDA crop yield
  - Corn, soybeans, and wheat
- **Employment:**
  - United States Bureau of Labor Statistics

Stage 2 Data

$$\beta_i = \rho_0 + \boldsymbol{\delta}\mathbf{X}_i + \nu_i$$

Left Hand Side

- $\hat{\beta}$ from the first stage.

Right Hand Side

- **American Community Survey:**
  - Annual (2005-2014) survey conducted by US Census
  - Over 65, Under 5, Race, Ethnicity, Sex, Work in farming or ranching, Household Income, Household water bills
- **Water Usage**
  - EPA Facility Registry Service
  - Count of facilities from high water use industries (agriculture, manufacturing and energy) per county

Blocks of Highlighted Text

Block 1

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Integer lectus nisl, ultricies in feugiat rutrum, porttitor sit amet augue. Aliquam ut tortor mauris. Sed volutpat ante purus, quis accumsan dolor.

Block 2

Pellentesque sed tellus purus. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos himenaeos. Vestibulum quis magna at risus dictum tempor eu vitae velit.

Block 3

Suspendisse tincidunt sagittis gravida. Curabitur condimentum, enim sed venenatis rutrum, ipsum neque consectetur orci, sed blandit justo nisi ac lacus.

Multiple Columns

Heading

1. Statement
2. Explanation
3. Example

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Integer lectus nisl, ultricies in feugiat rutrum, porttitor sit amet augue. Aliquam ut tortor mauris. Solutpat ante purus, quis accumsan dolor.

Table

Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table: Table caption

Theorem

Theorem (Mass–energy equivalence)

$E = mc^2$

Verbatim

Example (Theorem Slide Code)

```
\begin{frame}
\frametitle{Theorem}
\begin{theorem}[Mass--energy equivalence]
$E = mc^2$
\end{theorem}
\end{frame}
```

Figure

Uncomment the code on this slide to include your own image from the same directory as the template .TeX file.

Citation

An example of the `\cite` command to cite within the presentation:

This statement requires citation [Smith, 2012].

References

John Smith (2012)

Title of the publication

Journal Name 12(3), 45 – 678.

The End