An overview of the health risks of extreme weather events for elderly in the United States

Extreme Events, Environmental Health and the Elderly Workshop

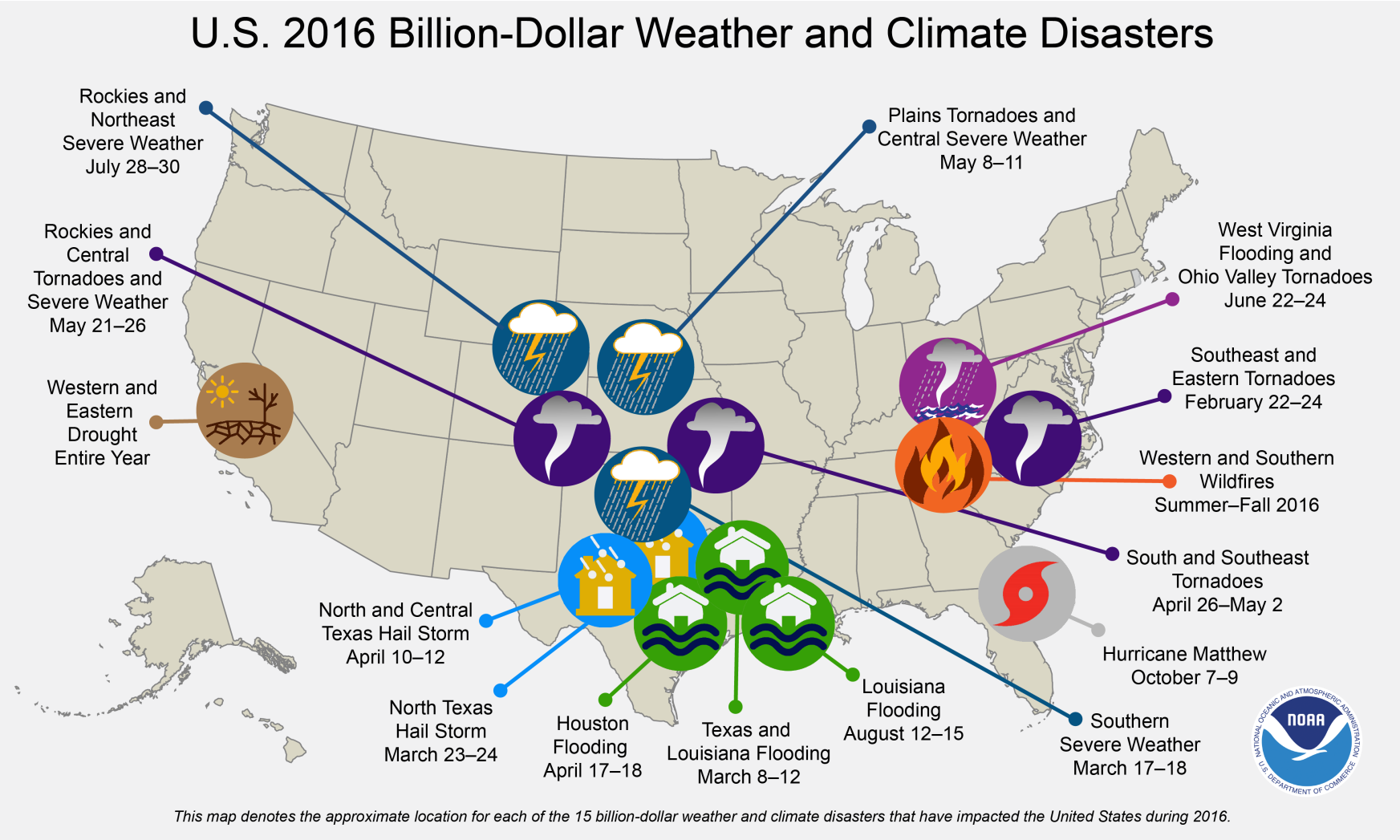
Brooke Anderson

: brooke.anderson@colostate.edu

: www.github.com/geanders

Department of Environmental & Radiological Health Sciences
Environmental Epidemiology Section
Colorado State University

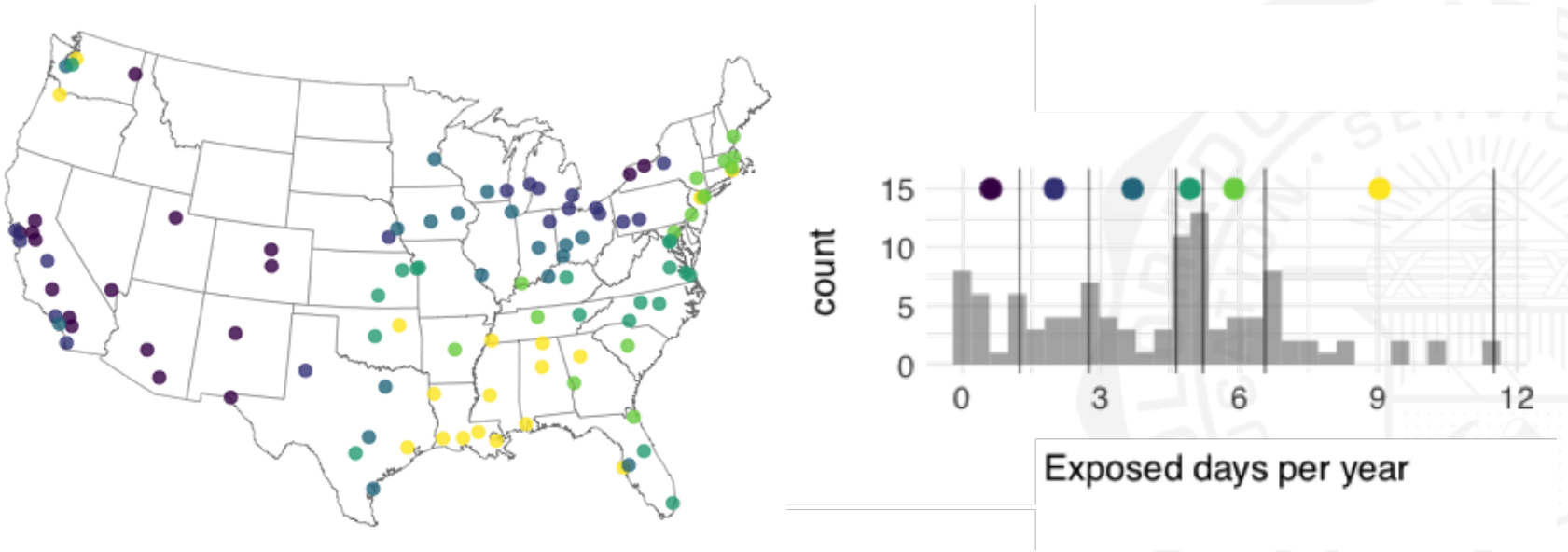
Extreme weather events in the U.S.



Source: NOAA National Centers for Environmental Information (NCEI), 2017.

Extreme precipitation exposure in U.S. communities

Exposure in 106 U.S. communities, 1987–2005



Extreme precipitation day: Any day with measured precipitation $\geq$ 30 millimeters. Precipitation data is from the county-aggregated NLDAS-2 Reanalysis data set available through the CDC WONDER database. The histogram (right) shows distributions in exposures across days. Colors of circles on the map correspond to color code in histogram sextiles.

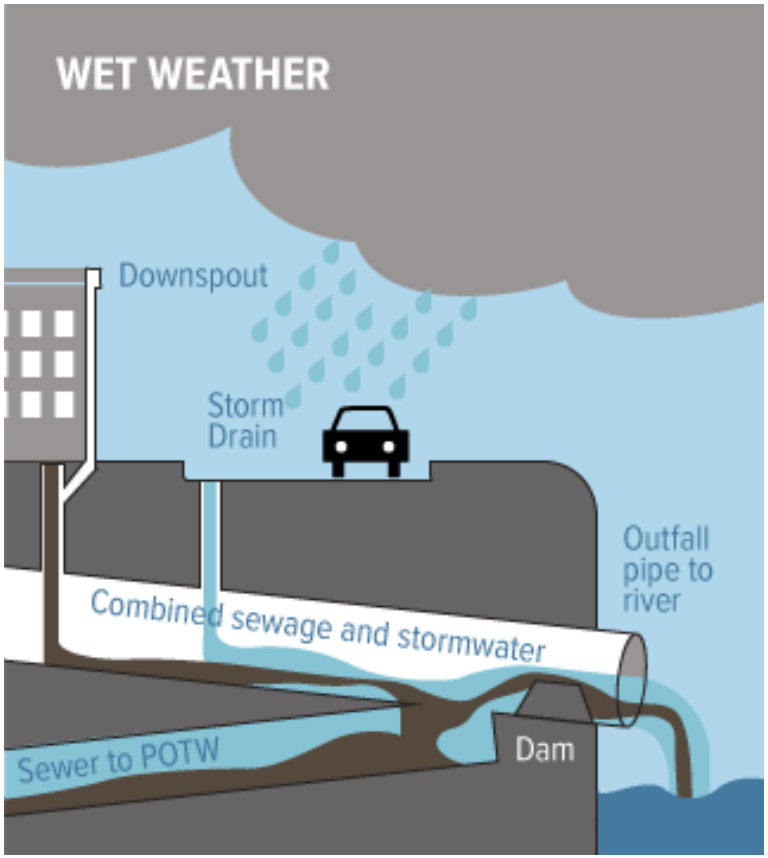
Flood exposure in the U.S.

Thirty-two most severe floods in the U.S. in the 20th century

Source: Perry, 2000. USGS Fact Sheet 024-00.

Health risks associated with extreme precipitation / floods

Combined sewer system



Source: `jerseywaterworks.org`.

Identified health risks

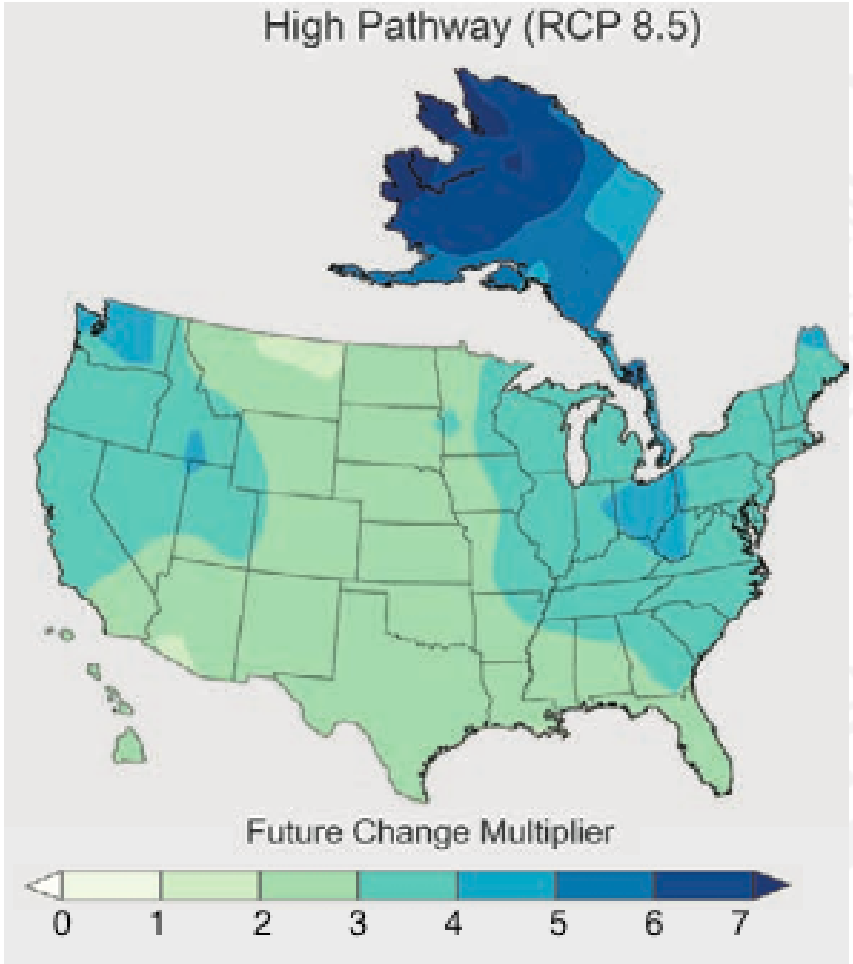
- Gastrointestinal illness (e.g., Wade et al. 2014; Tornevi et al. 2013)
  - Risks may be increased by combined sewer systems (left; Jagai et al. 2015)
- Respiratory outcomes
  - Aerosol-transmitted pathogens (e.g., *Legionella pneumophila*)
  - Asthma hospitalizations (Soneja et al. 2016)
  - Mold exposure
- Motor vehicle accidents (Ashley et al. 2015)

Trends in extreme precipitation

Trends in extreme precipitation

- Recent trend of increased exposure to extreme precipitation in all regions of the U.S., especially in the Northeast and Midwest (Peterson et al. 2014).
- Number of extreme precipitation days per year expected to increase throughout U.S. in coming decades (right; Wuebbles et al. 2014), especially in certain regions.

Expected increase in number of extreme precipitation days by end of century.



Source: Wuebbles et al. 2014.

Trends in flooding

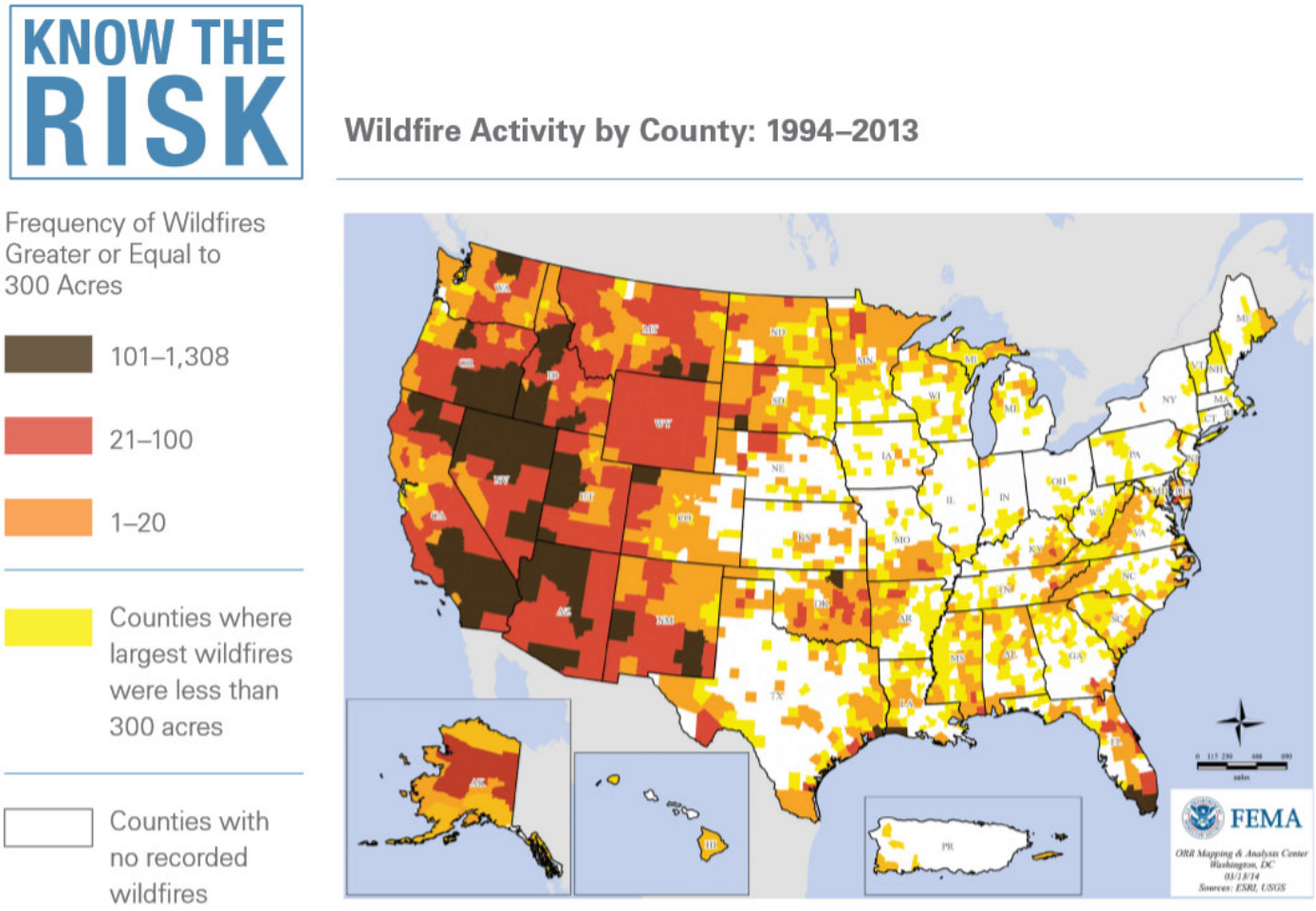
Trends in days of flood exposure, 1940–2013.

Orange, red: Significant decrease in exposure.
Blue, purple: Significant decrease in exposure.
Source: Archfield et al. 2016.

Recent and future trends

- Between 1940 and 2013, frequency of flood days has increased in some areas and decreased in others (map at left; Archfield et al. 2016).
- In future decades, flooding is expected to increase in some regions, although a lot of uncertainty in expected trends in flooding remains (Berghuijs et al. 2016).

Exposure to wildfires



Source: FEMA, 2017.

Increased health risks associated with wildfires

Widespread smoke from 2016 eastern wildfires

Sources: NASA, 2016 and Wildfire Today, 2016.

Consistent evidence

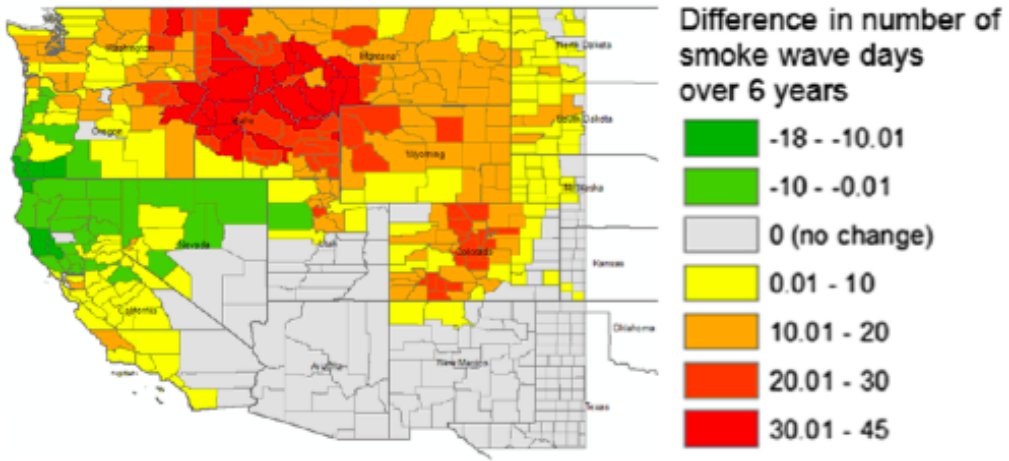
- Respiratory morbidity
- Asthma / COPD exacerbations

Mixed evidence

- All-cause mortality
- Cardiovascular outcomes

Sources: Reid et al. 2016, Liu et al. 2015.

Past and expected future trends in wildfires



Source: Liu et al. 2016. For an interactive map, see `http://khanotations.github.io/smoke-map/`.

Recent and expected future trends

- Recently, there has been a trend to more intense fires and longer fire seasons (U.S. Forest Service, 2009; Karl et al. 2009).
- In the coming decades, wildfire smoke days are expected become more frequent (left) and intense (Liu et al. 2016).

Tropical storms bring exposure from multiple hazards

Tropical storm hazards

- High winds
- Extreme precipitation
- Flood events
- Tornado events

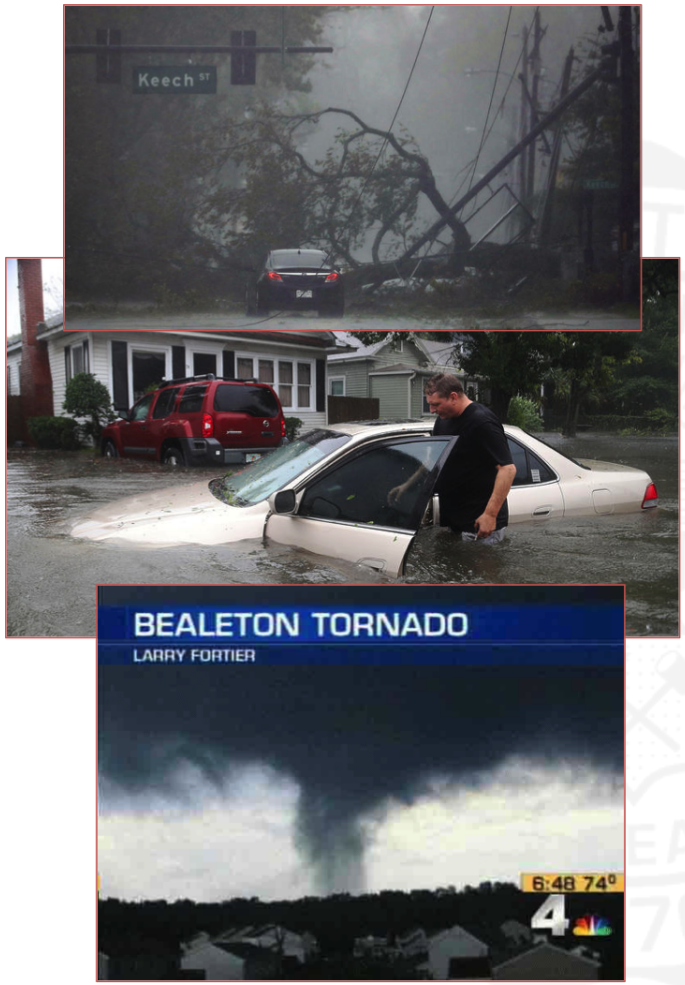
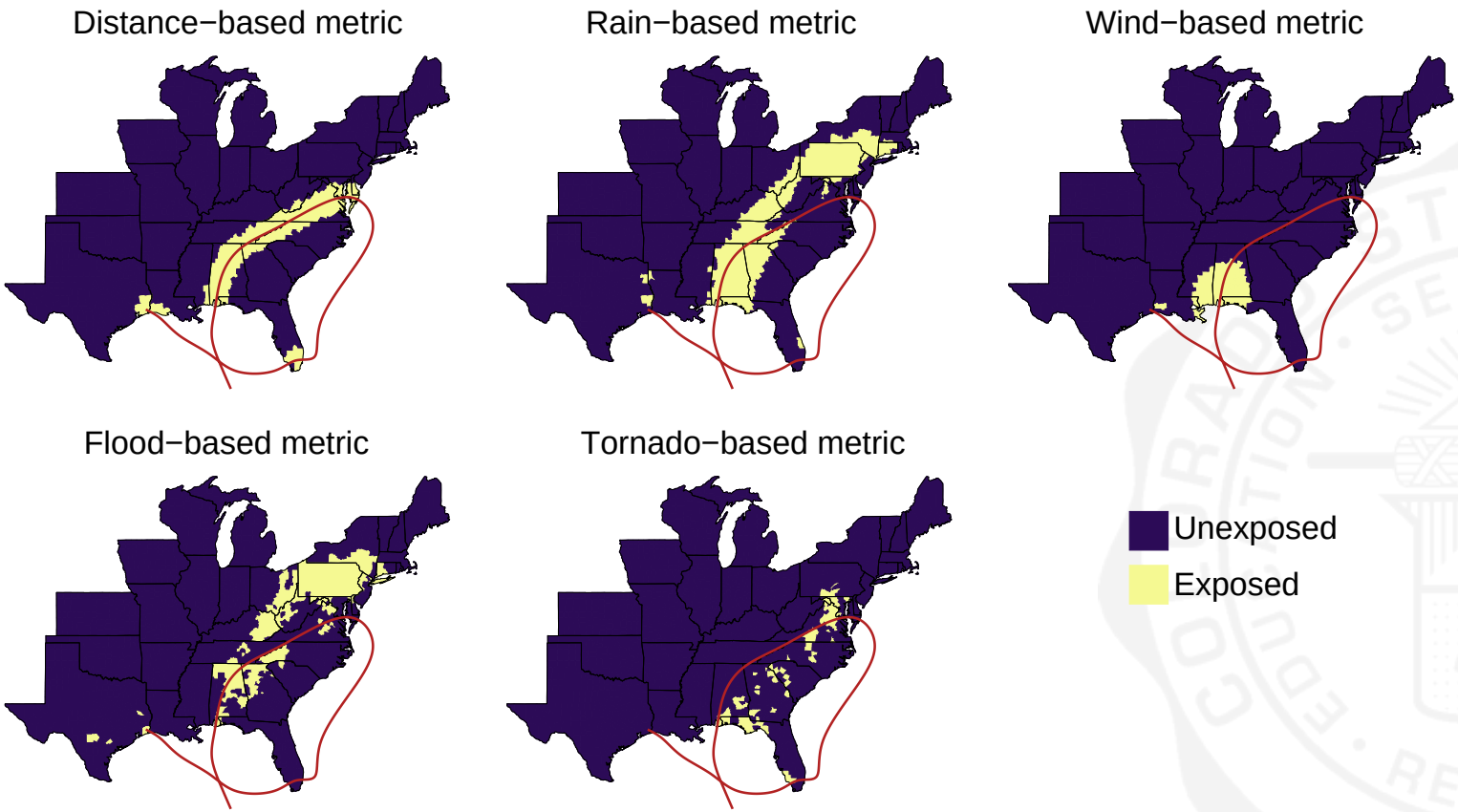


Image sources: Los Angeles Times, NBC

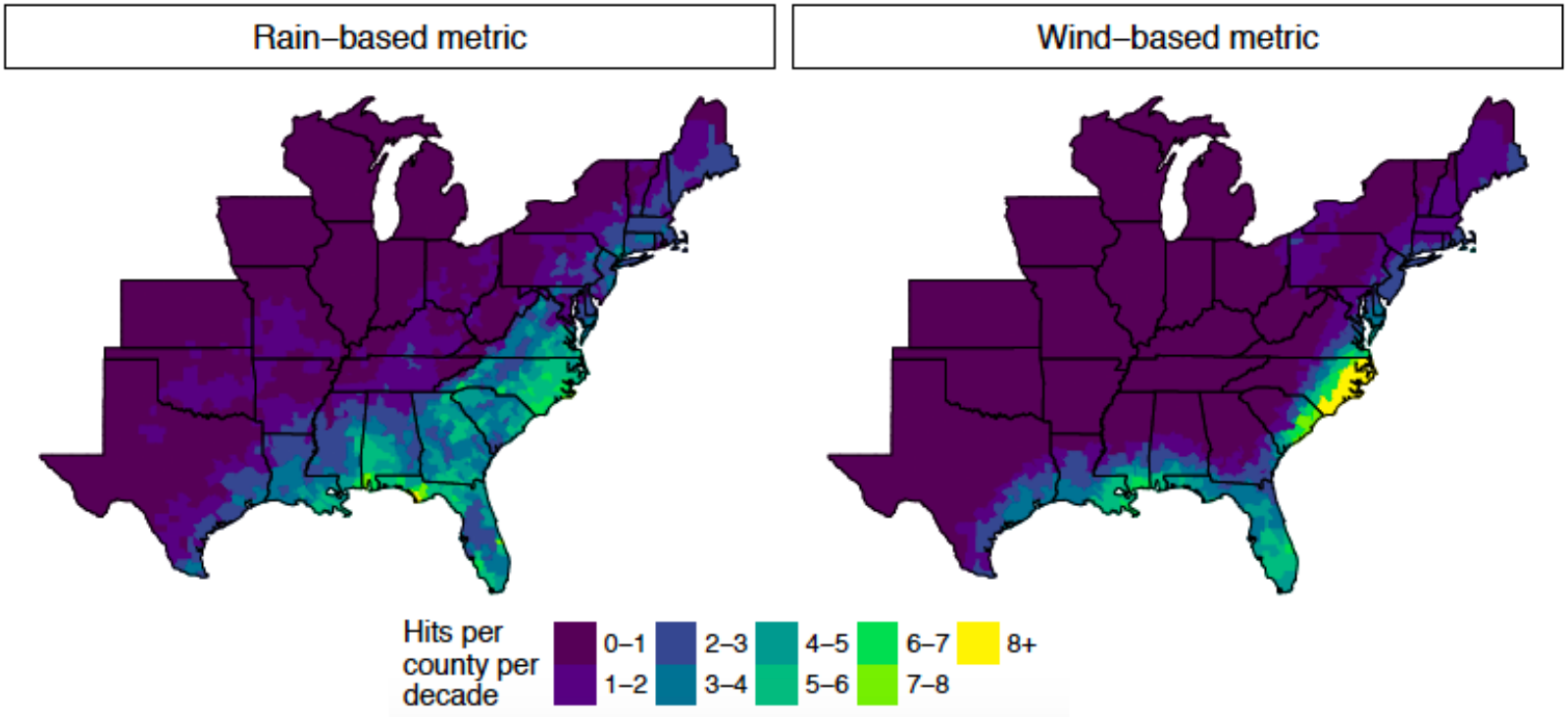
County-level exposure to Hurricane Ivan (2004)



Criteria for exposure classifications: **Distance:** Within 100 kms of storm track. **Rain:** $\geq$ 75 mm of rain total for two days before to one day after storm. **Wind:** Modeled wind of $\geq$ 15 m/s. **Flood, Tornado:** Listed event in NOAA Storm Events database.

Tropical storm exposure in U.S. counties

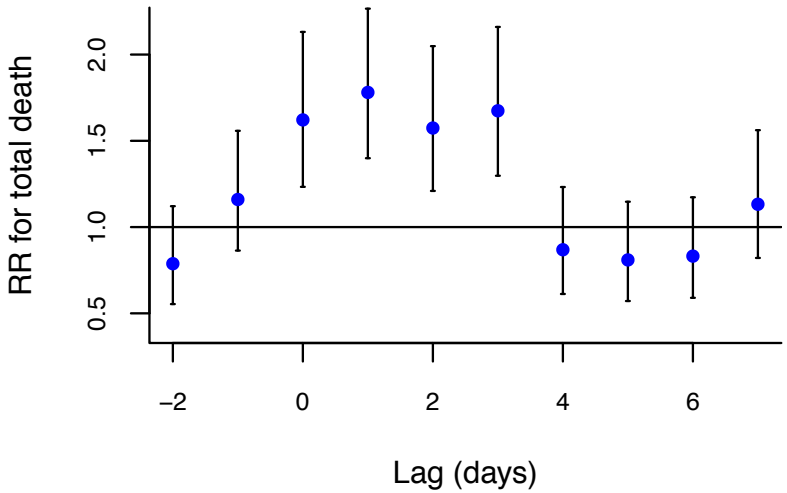
Storm hits per county per decade based on rain (left) and wind (right) exposure metrics.

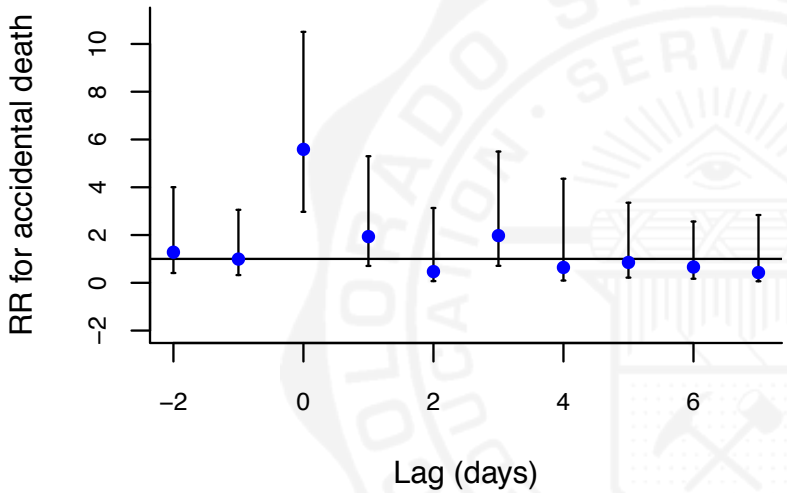


Criteria for exposure classifications: **Rain:** $\geq$ 75 mm of rain total for two days before to one day after storm. **Wind:** Modeled wind of $\geq$ 15 m/s.

Risks in Miami, FL, during Hurricane Andrew (1992)

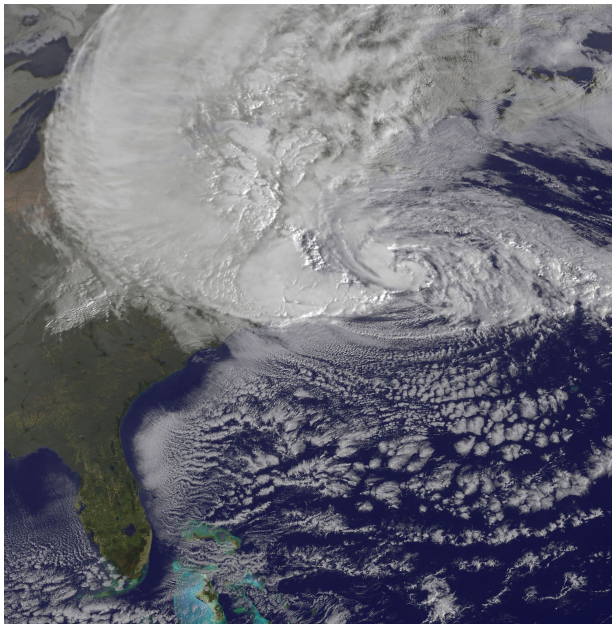
Relative risk for all-cause (left) and accidental (right) mortality in Miami, FL, at lags from the storm day (lag 0) compared to non-storm days.





Estimates were obtained by comparing storm days to matched non-storm days in the same time of year and day of week in other years. Matched days were picked to exclude days near other storms. Lag 0 represents the storm day. Negative lags represent days before the storm and positive lags represent days after the storm. Vertical lines give 95% confidence intervals.

Health risks associated with Hurricane Sandy (2012)



Source: NOAA / NASA GOES Project

Health risks in storm-affected areas

- Change in patterns of emergency department visits (Kim et al. 2016)
- Increased outpatient cases of food and waterborne disease among elderly (Bloom et al. 2016)
- Increased rate of myocardial infarctions (Swerdel et al. 2014)
- Increased hospitalizations for dehydration (Lee et al. 2016)
- Difficulty obtaining medical care, medications, and medical equipment (Davidow et al. 2016)

Conclusion

Closing comments

- Epidemiological research continues to identify new health risks associated with extreme weather.
- Infrastructure may often play a role in the pathway between extreme events and health risks.
- Patterns in exposure to several types of extreme events have changed in recent decades and are expected to continue to change in U.S. cities in the coming decades.

Acknowledgements

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