

Identifying Areas at Risk for COVID-19 and Other Natural Disasters

DSI -11- San Francisco

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Problem Statement

The COVID-19 pandemic, in some areas of the globe, will exacerbate the ongoing risk/exposure to other natural disasters. There is little understanding of the coupling of the pandemic risk and the risk of these other occurrences. A case study will show, via geospatial analysis, an overlay of the severity of the COVID-19 pandemic and the risk of floods, hurricanes, earthquakes, drought, etc.



MGN

Additional Issues

- Summer is natural disaster season for many parts of the country
- COVID is currently declining, but risk of resurgence

Increased Mobility



Home destroyed by tornado in South Carolina
(April 2020)



Increased Contact

Additional Issues

- Aid workers
- Inter-state cooperation



Evacuation shelter in California.

Agenda of Data Science Problem(s):

1. COVID-19

- *Which communities are most likely to experience severe COVID (in the near future)?*

2. Natural Disasters

- *Which communities are most likely to experience natural disasters (during the same period of time)?*

3. Convergence

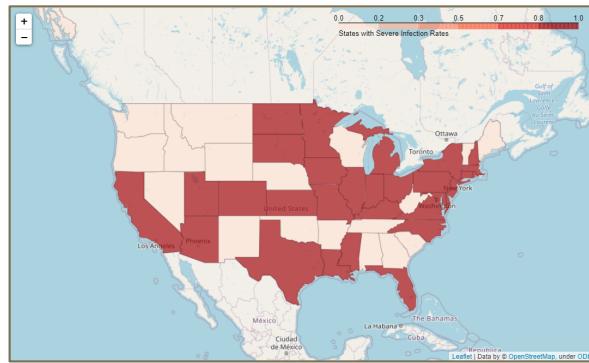
- *Which communities are most likely to experience a convergence of severe COVID and natural disasters?*

COVID -19

COVID-19

Problem:

Which communities are most likely to experience severe COVID?



Steps:

1. Data Collection
2. Data Evaluation
3. Data Wrangling
4. Data Analysis
5. Future Steps

Step 1: Data Collection

The “wild west” of COVID data

- “A tidal wave of data”

Divergent projections

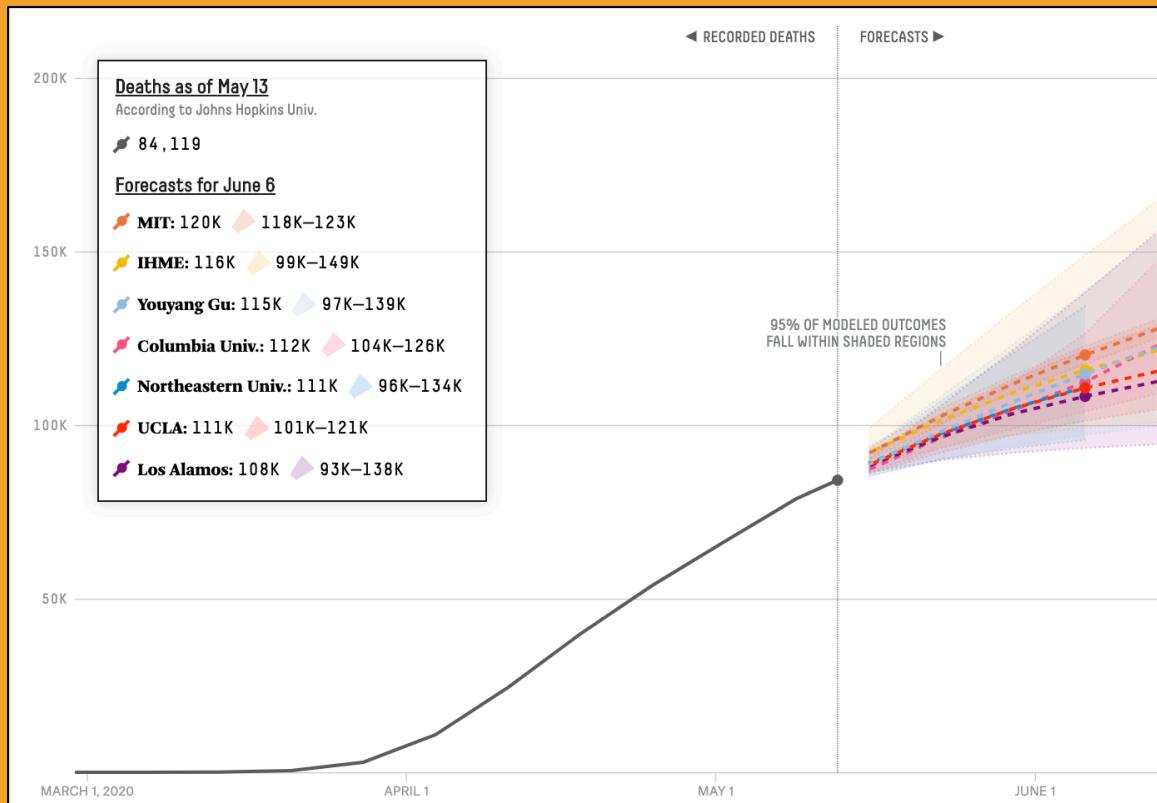
- Fatality rate variability
- Policy shifts

Historic uncertainty

- Reporting inconsistencies
- Insufficient testing

Selection criteria

- Expertise
- Transparency
- Thoughtfulness
- Distance of projection



Source: FiveThirtyEight

Sources:

Satchit Balsari , Caroline Buckee and Tarun Khanna, “Which Covid-19 Data Can You Trust?” *Harvard Business Review* (May 8, 2020).

Kevin Dayaratna and Norbert Michel, “The Challenges of Forecasting the Spread and Mortality of COVID-19”, *The Heritage Foundation* (April 15, 2020).

Maggie Koerth, Laura Bronner and Jasmine Mithani, “Why It’s So Freaking Hard to Make a Good COVID-19 Model,” *FiveThirtyEight* (March 31, 2020).

Step 1: Data Collection

1. Historic dataset (US & CA)

Center for Systems Science and Engineering (CSSE), *Johns Hopkins University*

<https://github.com/CSSEGISandData/COVID-19>

2. Projected dataset (US)

Institute for Health Metrics and Evaluation (IHME), *University of Washington*

<http://www.healthdata.org/covid>

3. Projected dataset (CA)

Mailman School of Public Health (MSPH), *Columbia University*

<https://github.com/shaman-lab/COVID-19Projection>

Step 2: Data Evaluation

1. IHME Projection Model (U Washington)

Scope: National (Global)

Units: States

Dates: May 12th – Aug. 5th

Data: CSSE + case data

Audience: Governments and hospitals

Aim: Determine impact on health systems

Focus: Track the effect of reopening

Model: “Multi-stage Hybrid”

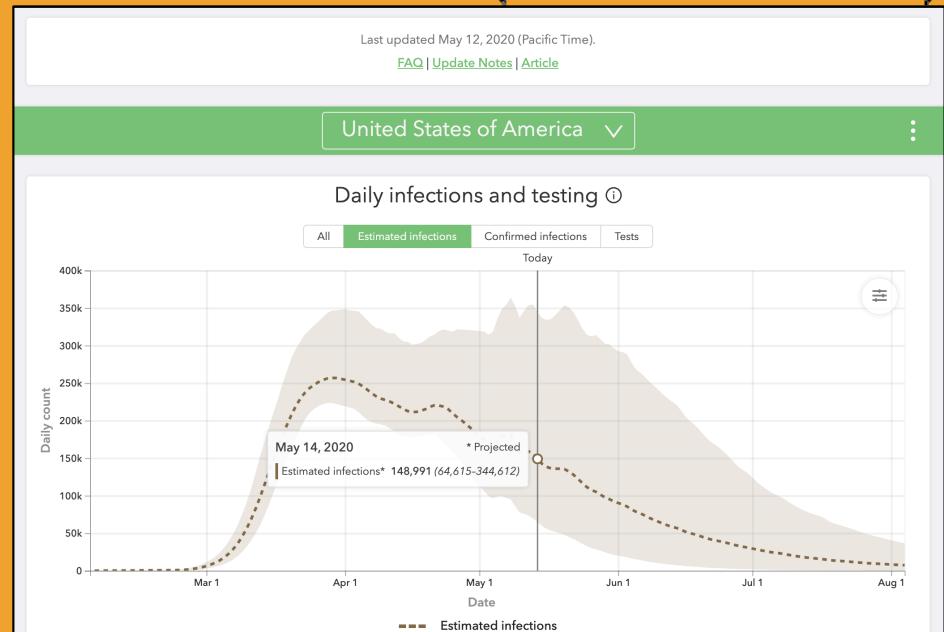
- Non-linear regression to fit curve of death rates
- Susceptible-Exposed-Infected-Recovered (SEIR)

Features:

- Mobility from anonymous cell phone data
- Temperature, testing, restrictions

Non-linear regression algorithm:

$$D(t; \alpha, \beta, p) = \frac{p}{2} \Psi(\alpha(t - \beta)) = \frac{p}{2} \left(1 + \frac{2}{\sqrt{\pi}} \int_0^{\alpha(t-\beta)} \exp(-r^2) dr \right)$$



Sources:

<http://www.healthdata.org/covid/faqs>

<https://www.medrxiv.org/content/10.1101/2020.04.21.20074732v1>

<http://www.healthdata.org/covid/updates>

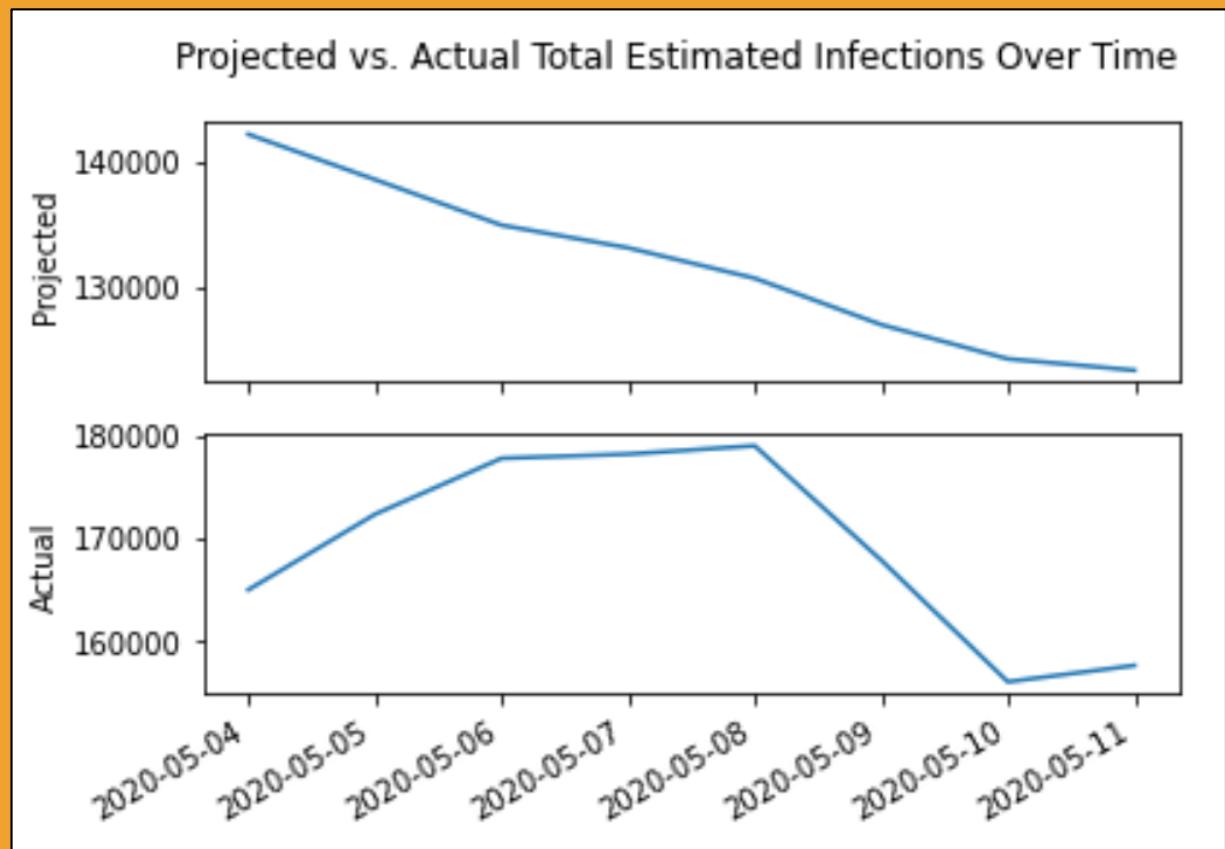
Step 2: Data Evaluation

1. IHME Projection Model (U Washington)

Model Evaluation
(May 4th – May 11)

Metrics:

- RMSE 2647
- R2 Score 0.5353



Step 2: Data Evaluation

2. MSPH Projection Model (Columbia)

Scope: California (National)

Units: Counties

Dates: May 10th – June 20th

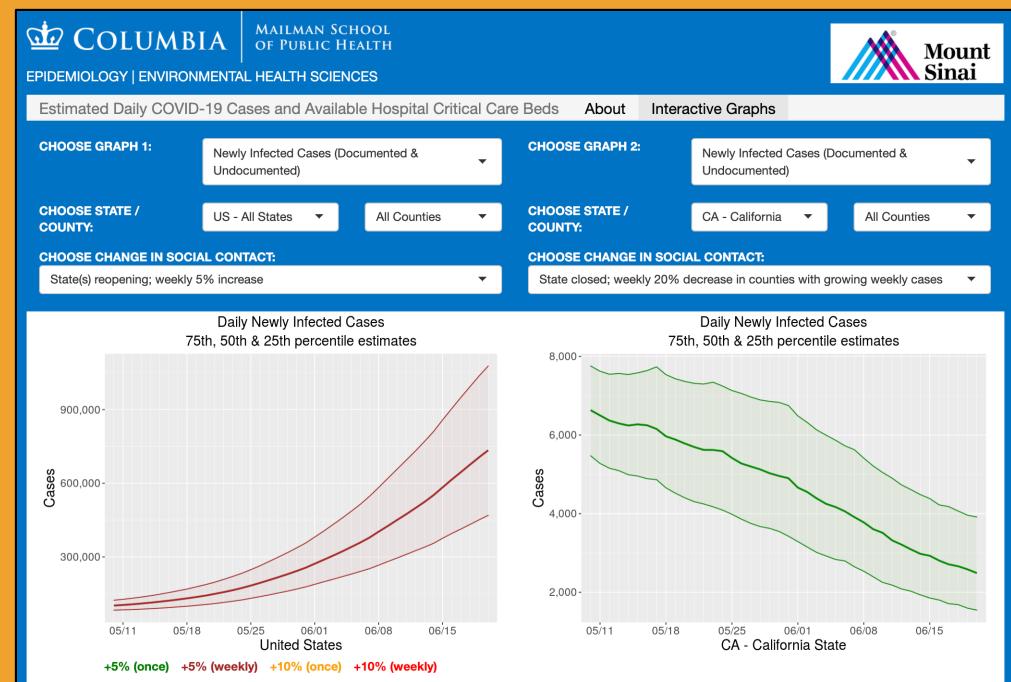
Data: USAFACTS (non-profit)

Model: Metapopulation model

- Simulates transmission of virus

Features:

- Different scenarios for rates of contact reduction.



Sources:

https://behcolumbia.files.wordpress.com/2020/05/yamana_etal_reopening_projections.pdf

http://www.columbia.edu/~jls106/pei_shaman_200324_projections.pdf

Step 3: Data Wrangling

General EDA

- Clean datasets
- Mostly reformatting
- IHME missing values

How to measure severity?

- Infections (vs deaths)
- Work back from deaths
- Variable fatality rates
- Scaled to 10 thou residents
- Threshold = 1/10 thou

Cleaned Dataframe with IHME Projections

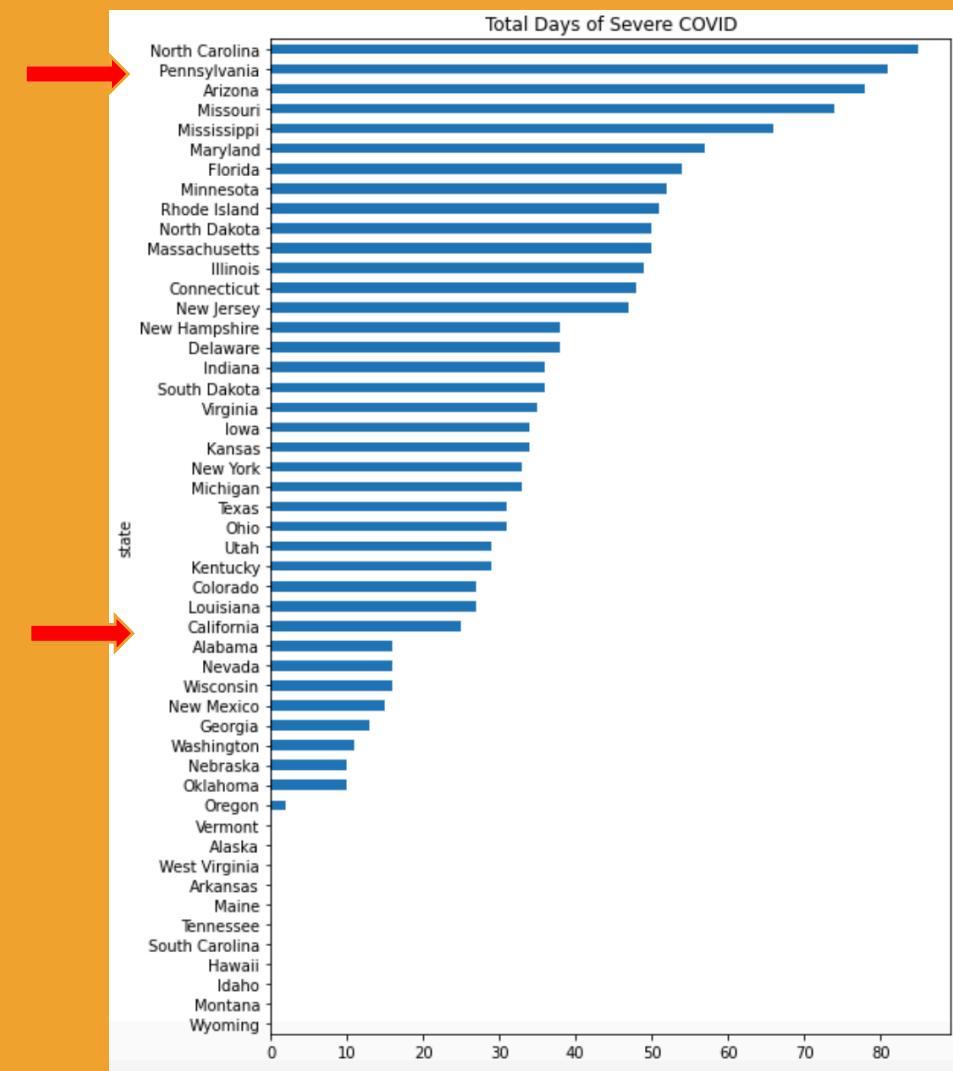
	state	date	est_new_infections	est_population	daily_infection_rate	severe
361	California	2020-06-02	4489.988918	39512223	1.136354	1
362	California	2020-06-03	4313.496519	39512223	1.091687	1
363	California	2020-06-04	4175.010712	39512223	1.056638	1
364	California	2020-06-05	4028.328279	39512223	1.019514	1
365	California	2020-06-06	3894.099070	39512223	0.985543	0
366	California	2020-06-07	3752.315407	39512223	0.949659	0
367	California	2020-06-08	3610.985939	39512223	0.913891	0
368	California	2020-06-09	3533.655590	39512223	0.894320	0
369	California	2020-06-10	3440.330730	39512223	0.870700	0
370	California	2020-06-11	3301.861736	39512223	0.835656	0



Step 4: Data Analysis

National Projections

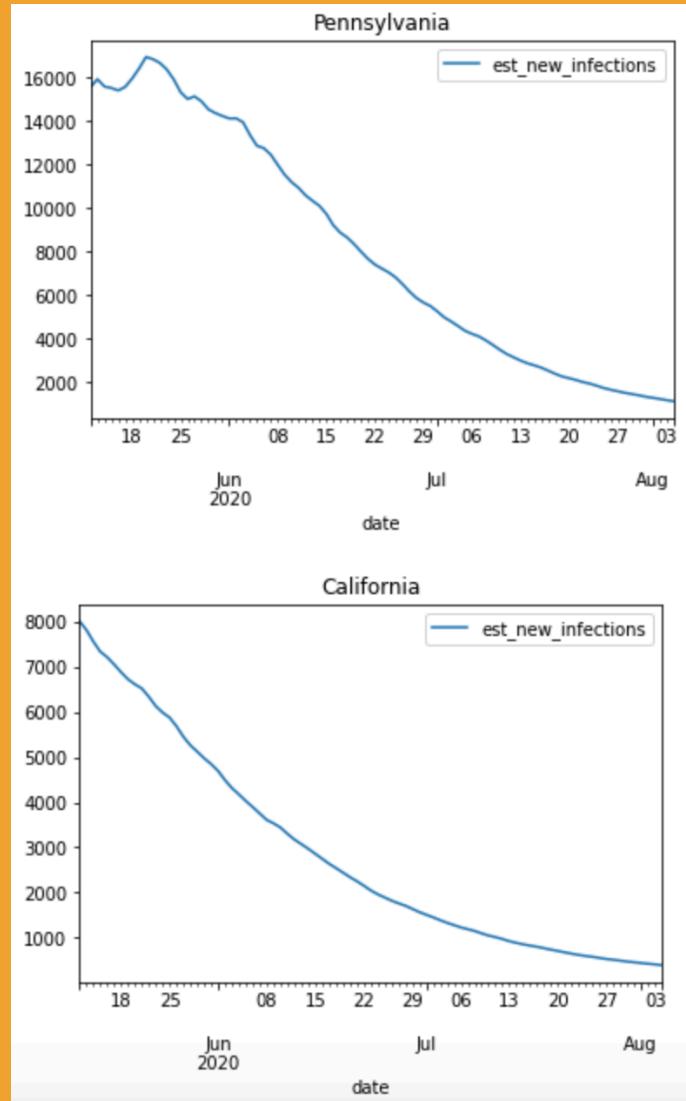
1. State rankings by severity
2. Daily infection rates



Step 4: Data Analysis

National Projections

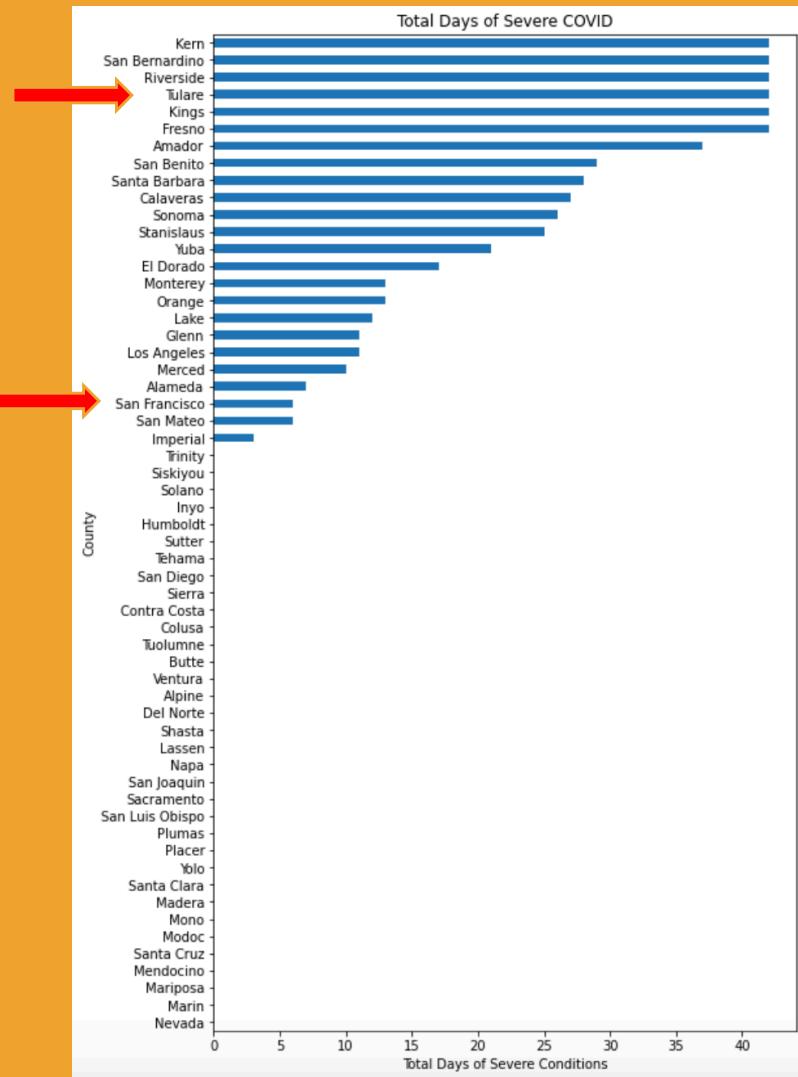
1. State rankings by severity
2. New infections daily



Step 4: Data Analysis

California Projections

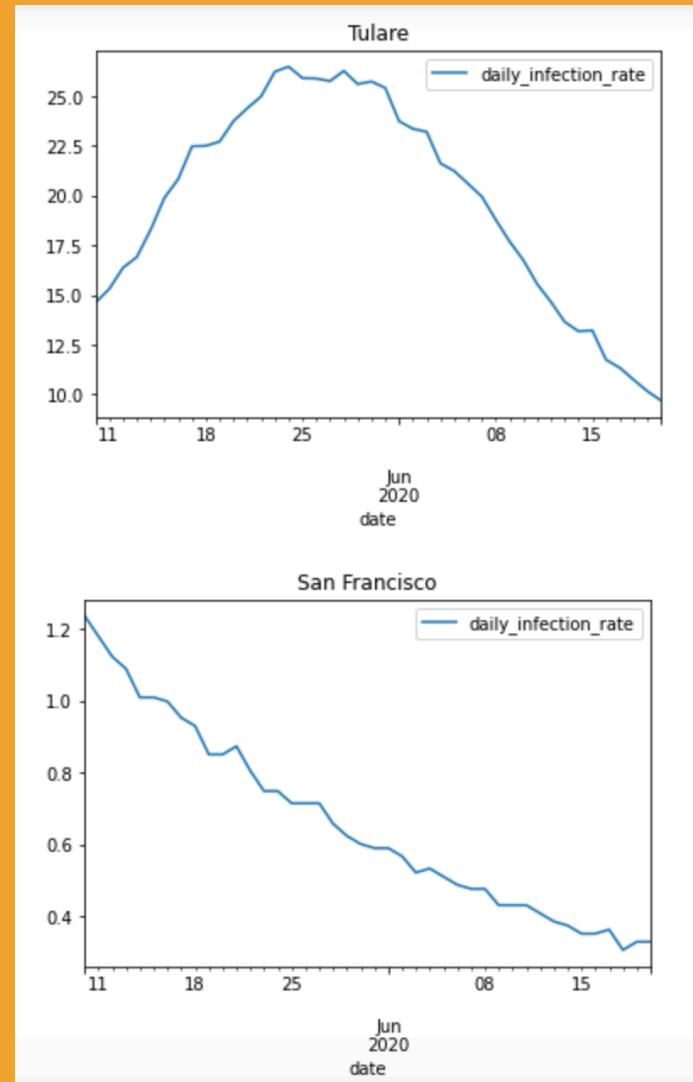
1. County rankings by severity
2. Daily infection rates



Step 4: Data Analysis

California Projections

1. County rankings by severity
2. Daily infection rates (1/10 thou)



Natural Disasters

Historic Data

FEMA: Federal Emergency Management Agency

Data: Disaster Declaration Summary

2010 - 2020

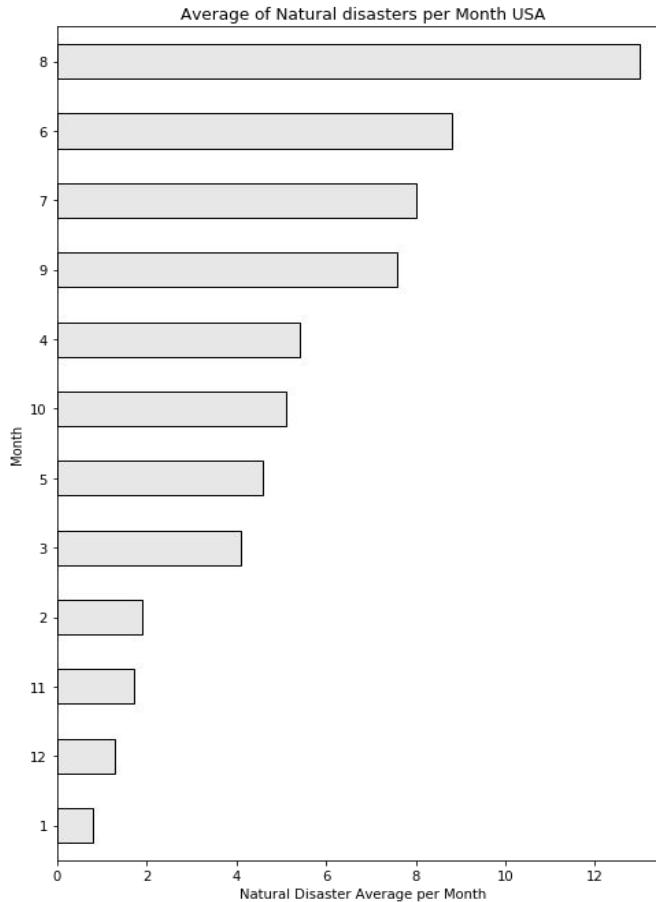
Nationwide: USA - states

State: CA - counties

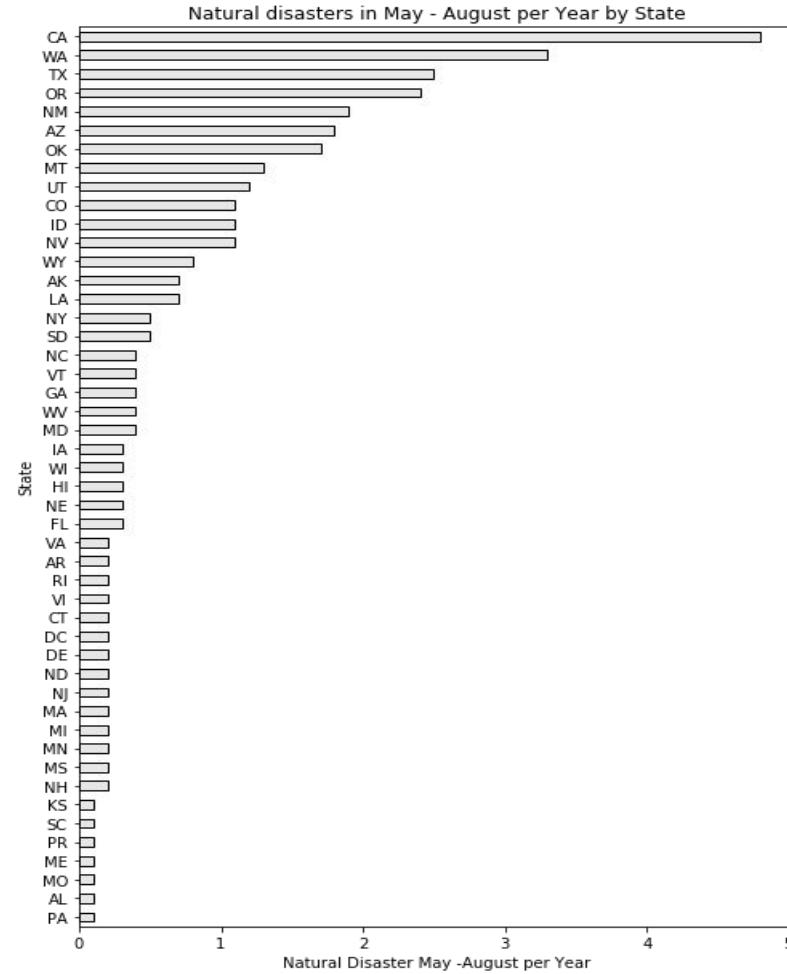
Evacuation in the Event of a Natural Disaster



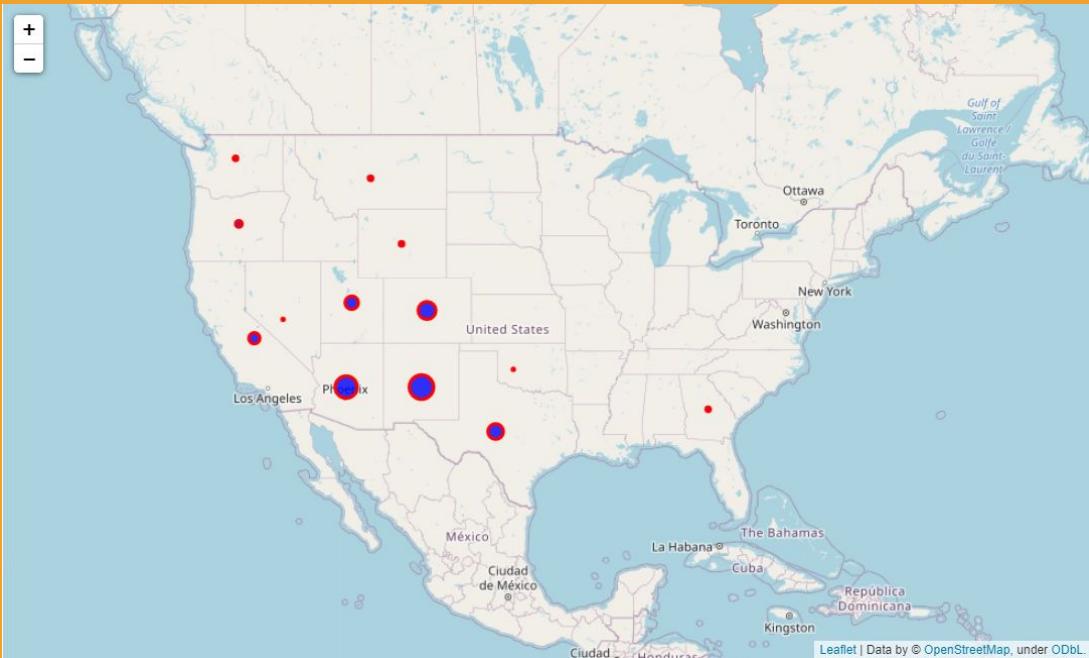
Average of Natural Disasters per Month Nationwide



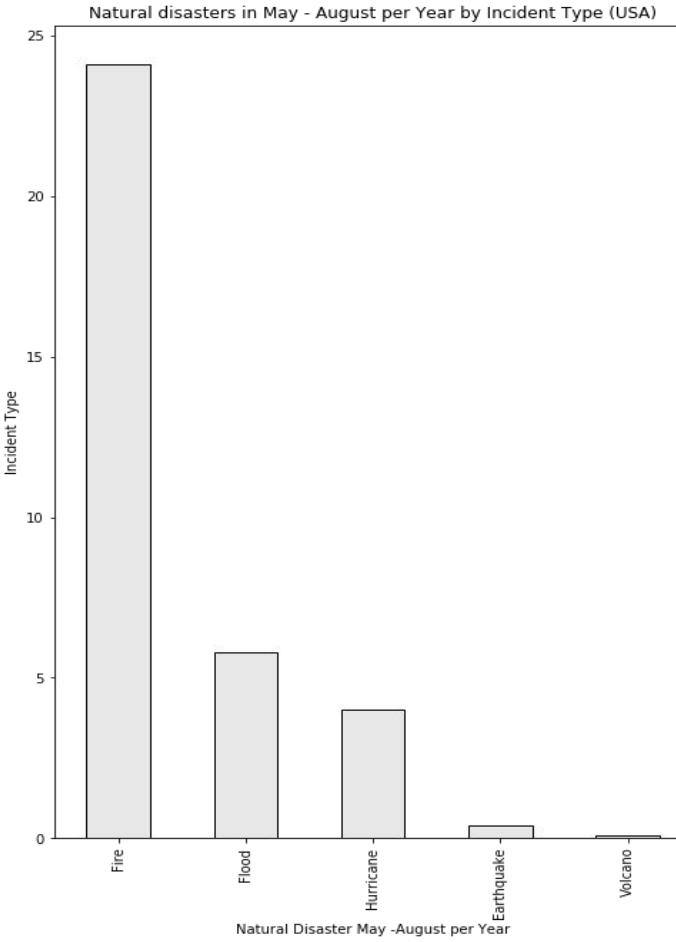
Natural Disasters from May through August per State



Natural Disasters in June by states



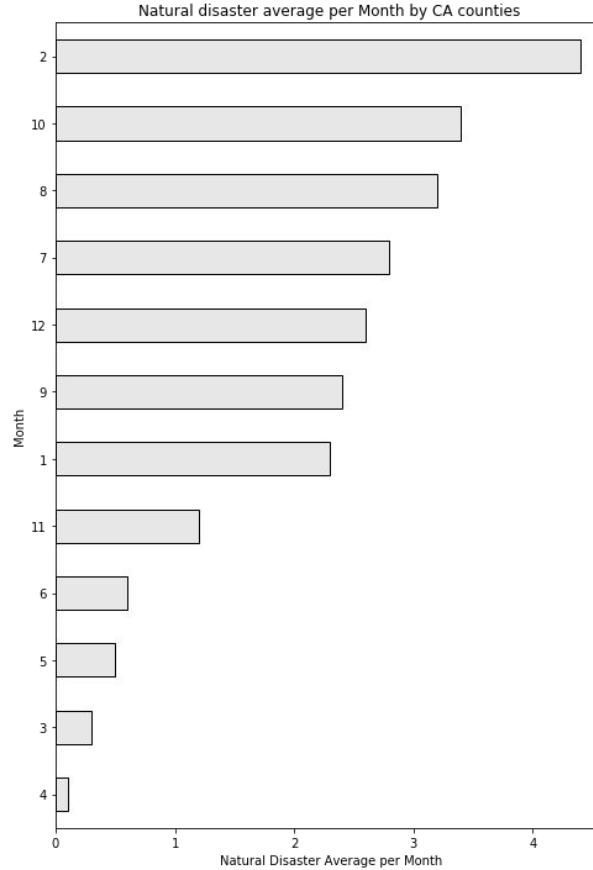
Natural Disasters from May to August per Year by Incident Type (USA)



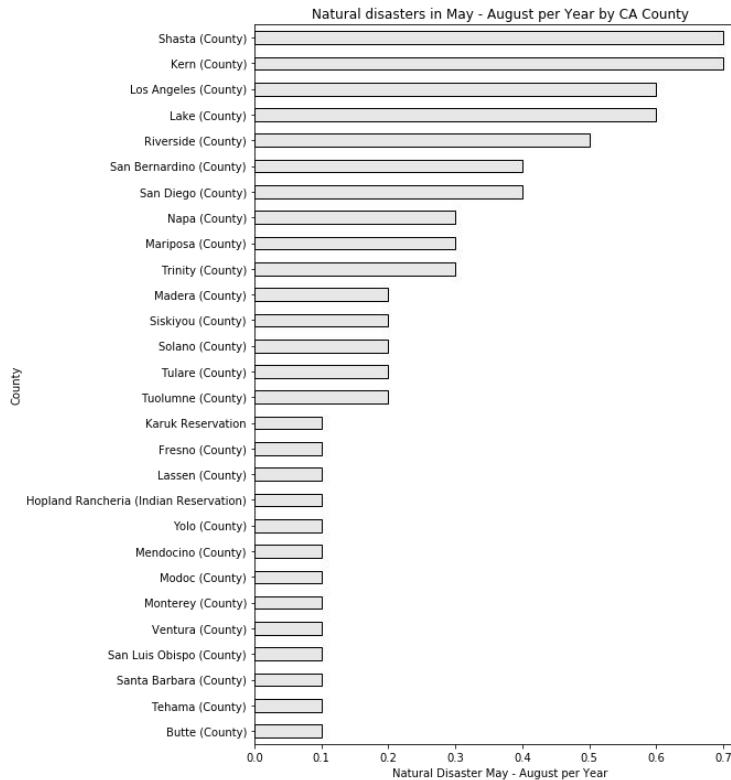


CALIFORNIA by Counties

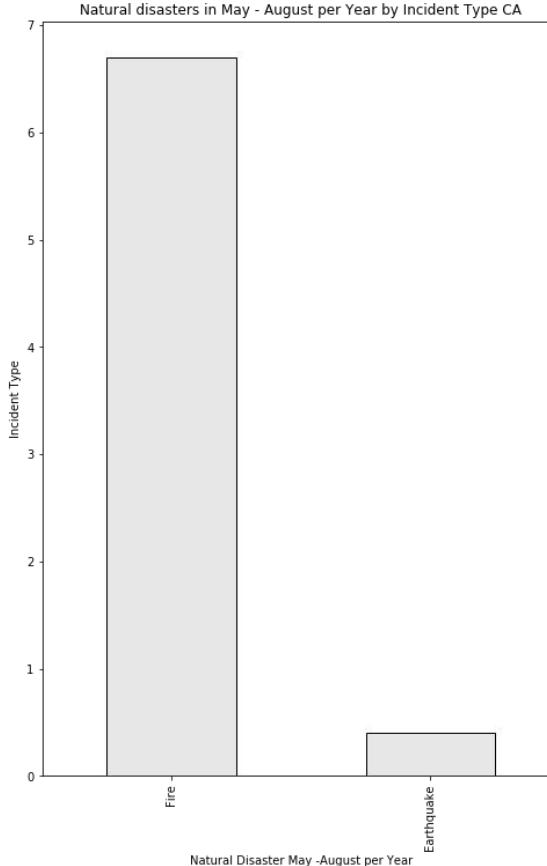
Natural Disaster Average per Month by CA Counties



Natural Disasters Average from May – August per Year by County



Natural Disasters from May to August per Year by Incident Type



-Nationwide June through August are the months with more of these 6 natural disasters.

-Fires and floods are the main natural disasters that can affect with the spread of COVID-19 nationwide.

-California is the state with more of these 6 natural disasters per year.

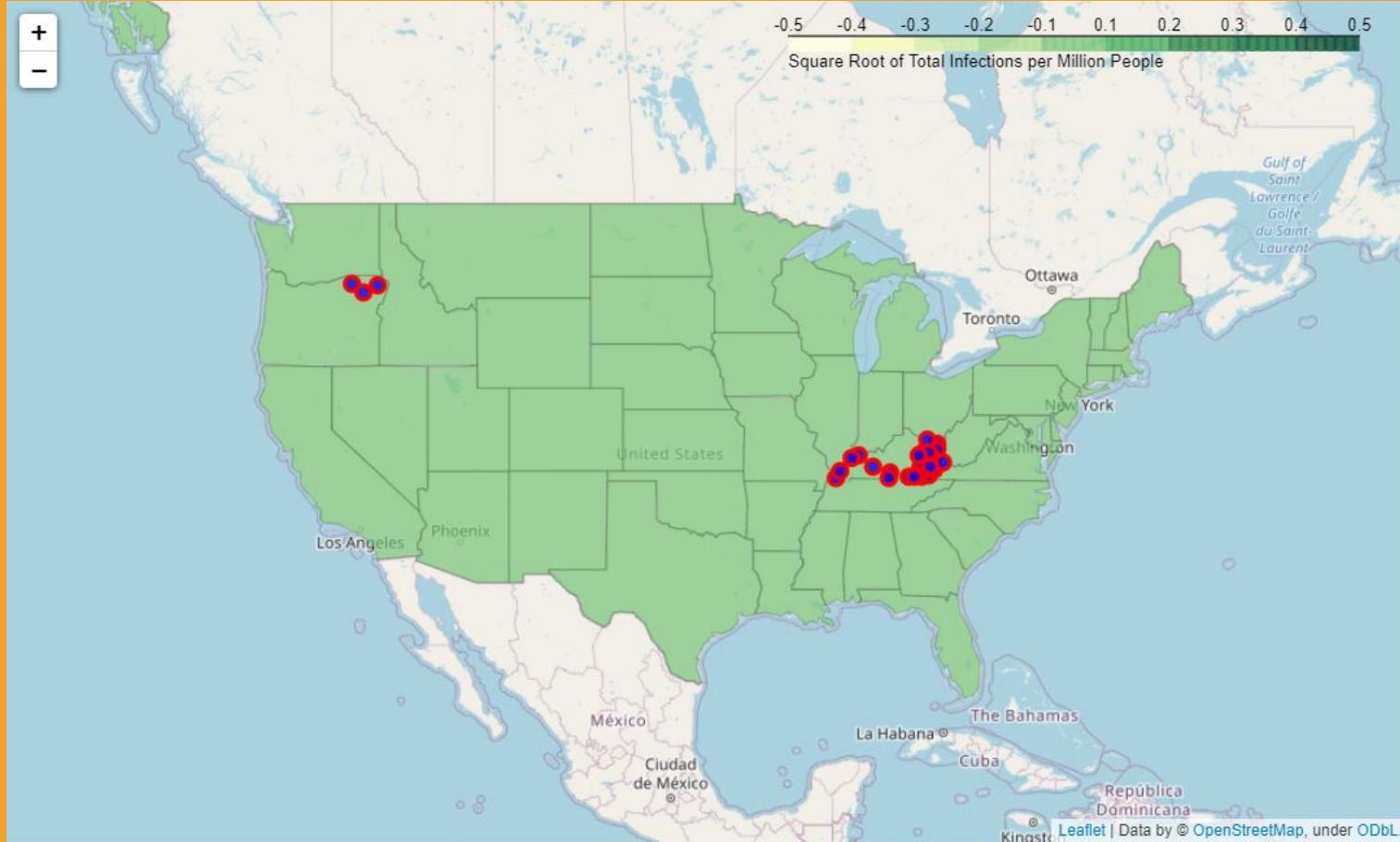
-In Feb, October and August are the months with more of these 6 natural disasters in CA.

-Fires and earthquakes are the main natural disasters that might affect the spread of COVID-19 in the state of CA.

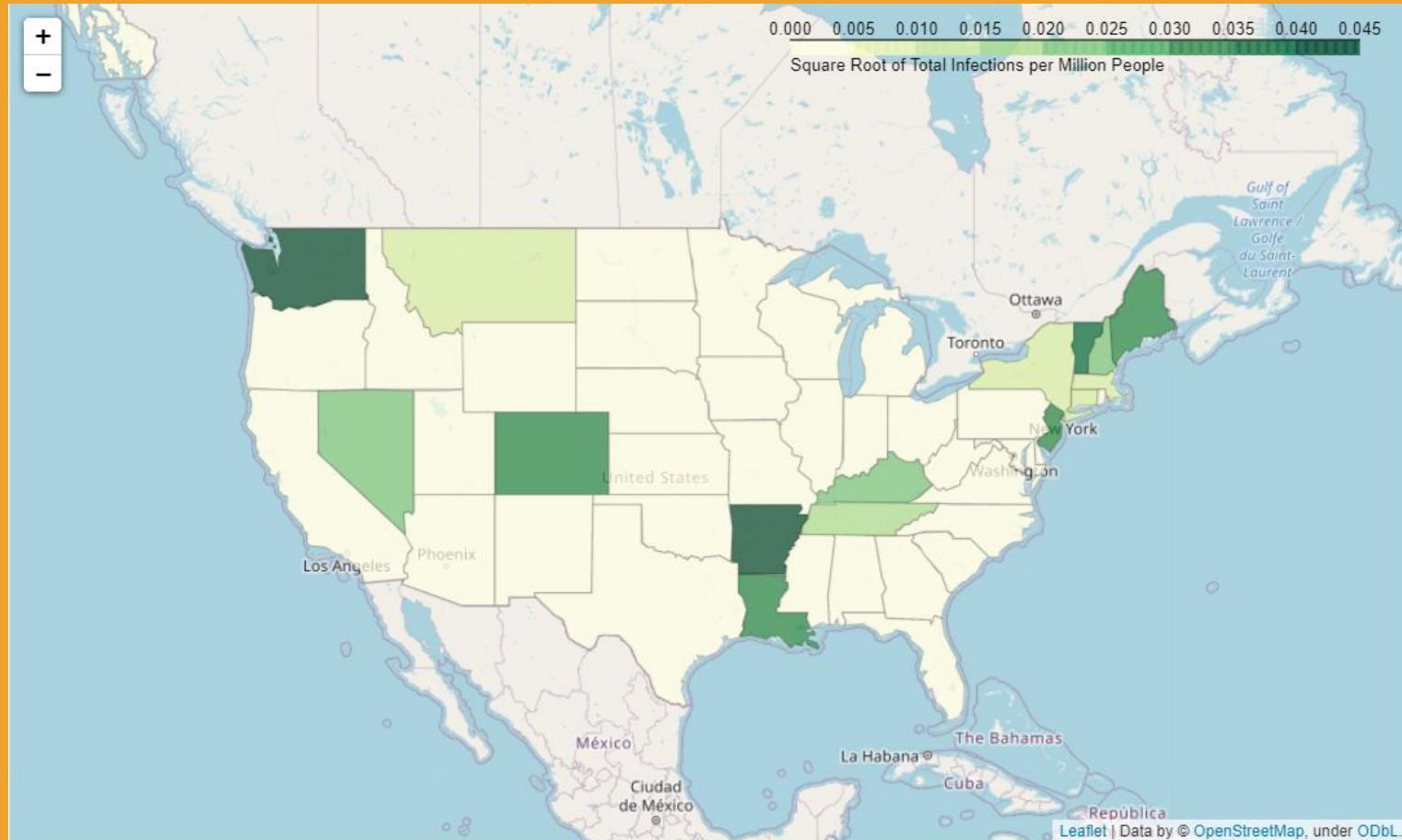
Summary

COVID / Natural Disaster 2020 History

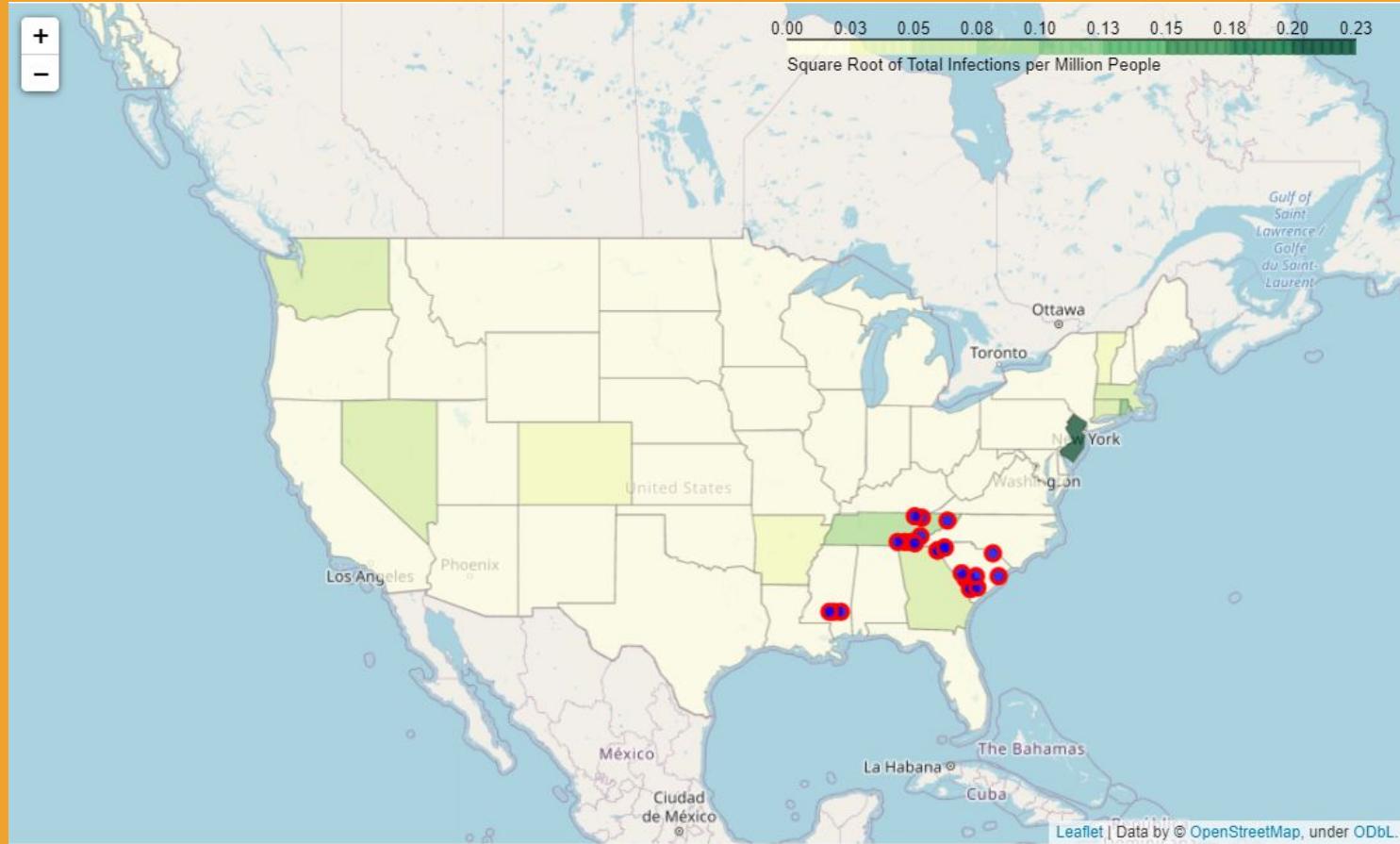
Jan 23- Beginning of COVID data



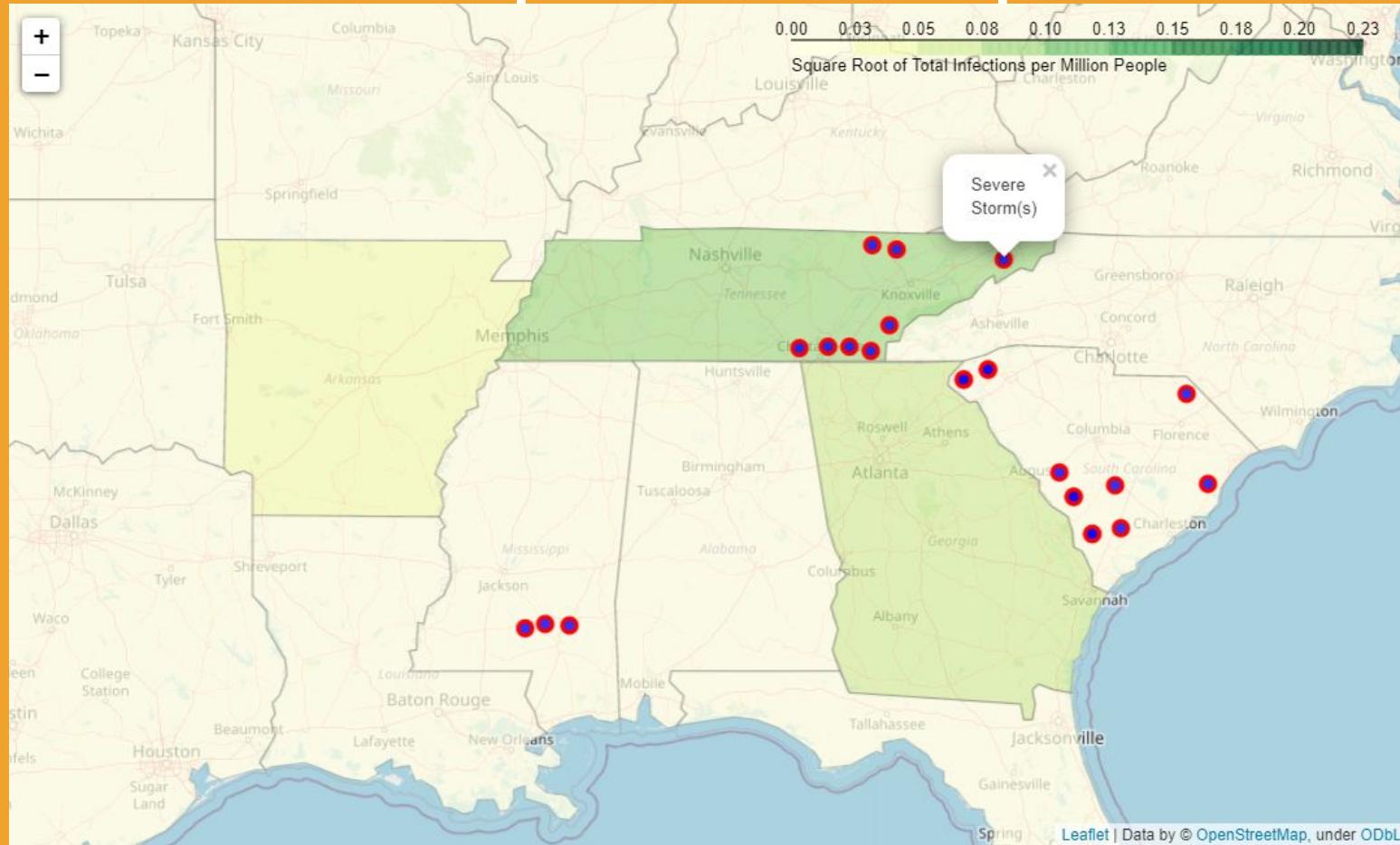
March 19 - signs of COVID emerging



April 1 - Major storms hit the southern states



April 1 - Closeup of storm path



SE Storm: Mid-April

"In Alabama, people seeking shelter from tornadoes huddled in community shelters, protective masks covering their faces to guard against the new coronavirus."

"Mississippi Gov. Tate Reeves said the storms were 'as bad or worse than anything we've seen in a decade.'"

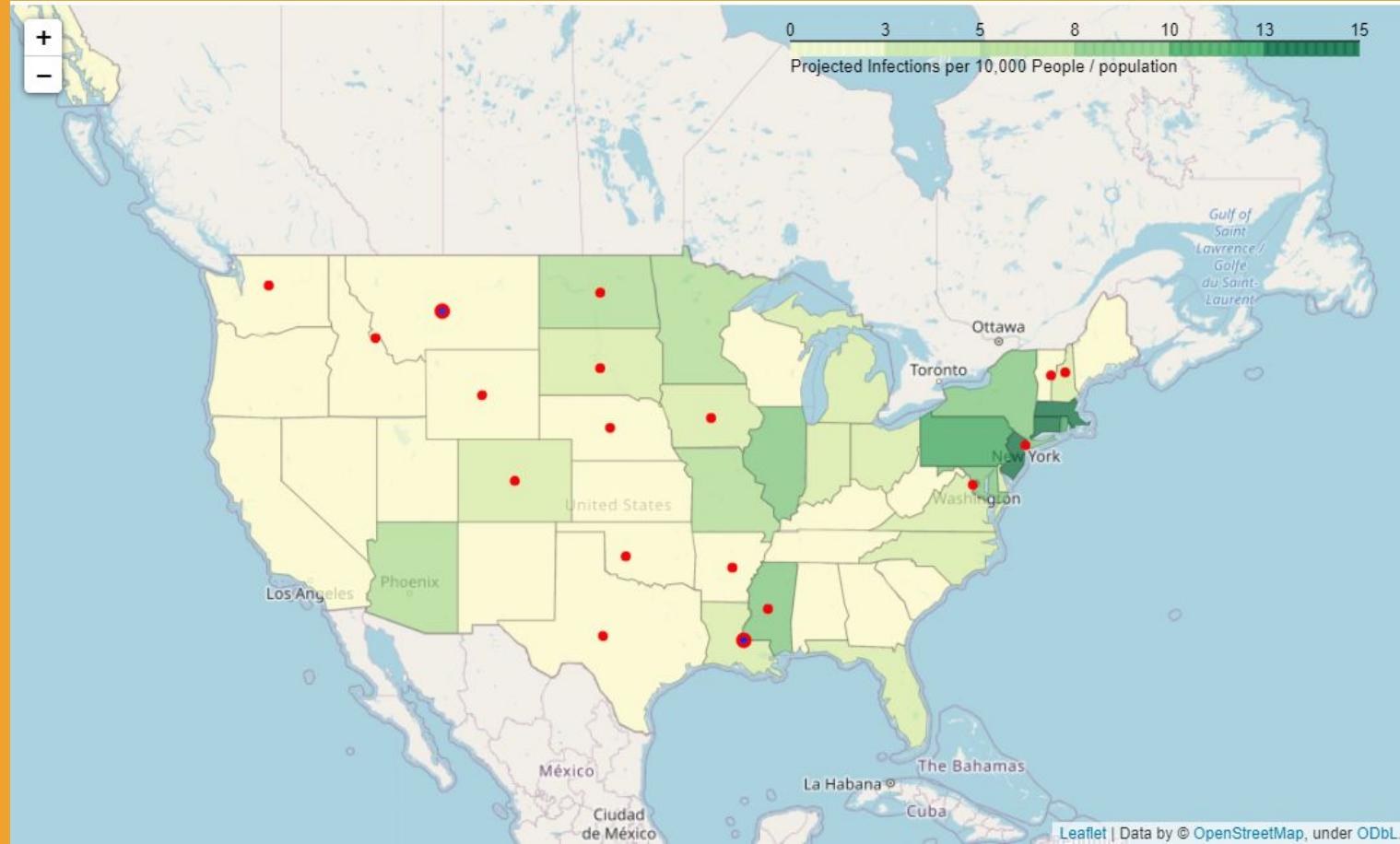
"Georgia Gov. Brian Kemp said some storm victims already were out of work because of shutdowns caused by COVID-19. 'Now they have lost literally everything they own'"

Source:

www.usnews.com/news/us/articles/2020-04-13/easter-storms-sweep-south-killing-at-least-12-people
<https://www.usnews.com/news/us/articles/2020-04-13/easter-storms-sweep-south-killing-at-least-12-people>

COVID / Natural Disaster 2020 Projected

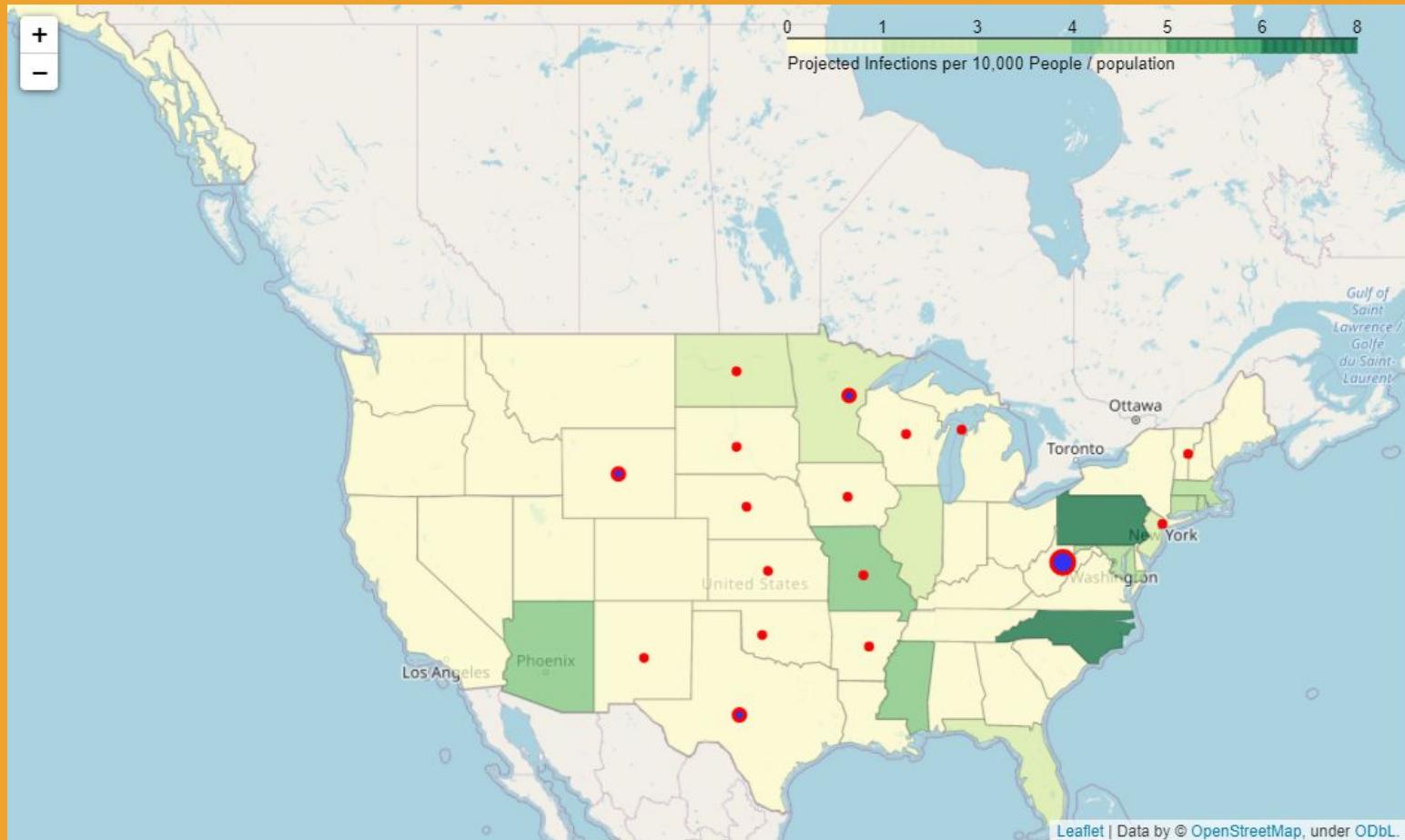
Flooding - May 15



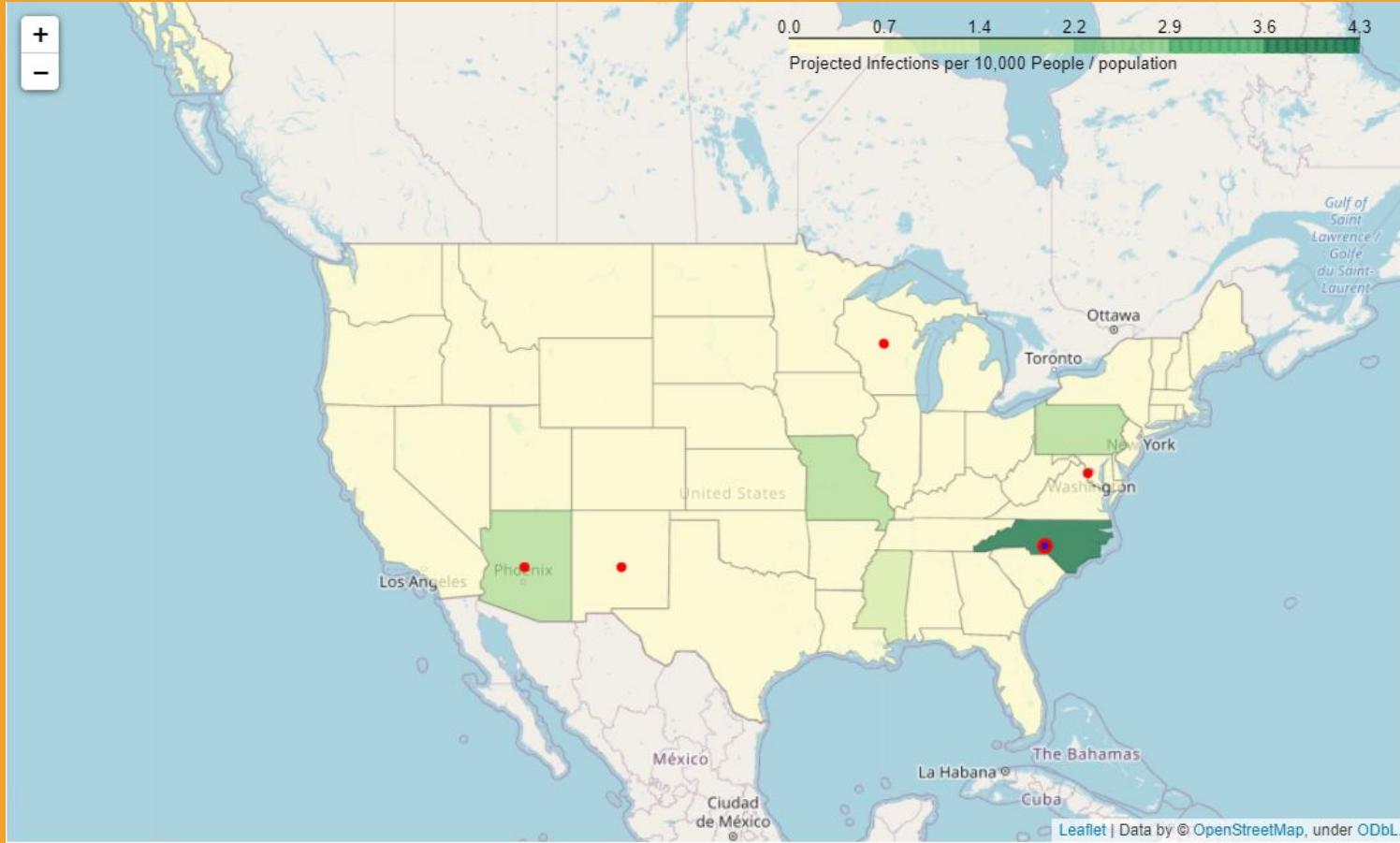
Flood Basins



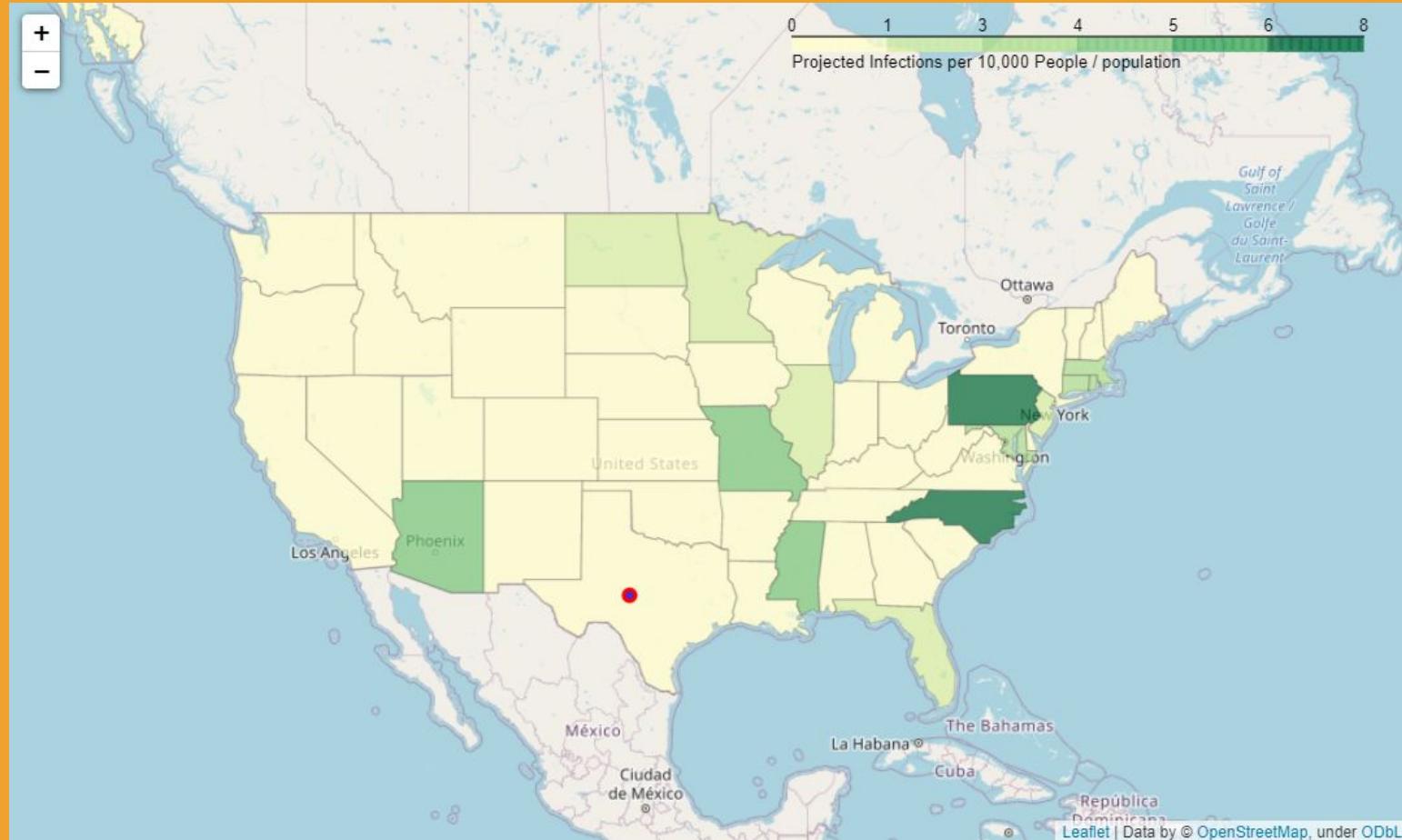
Flooding - June 15



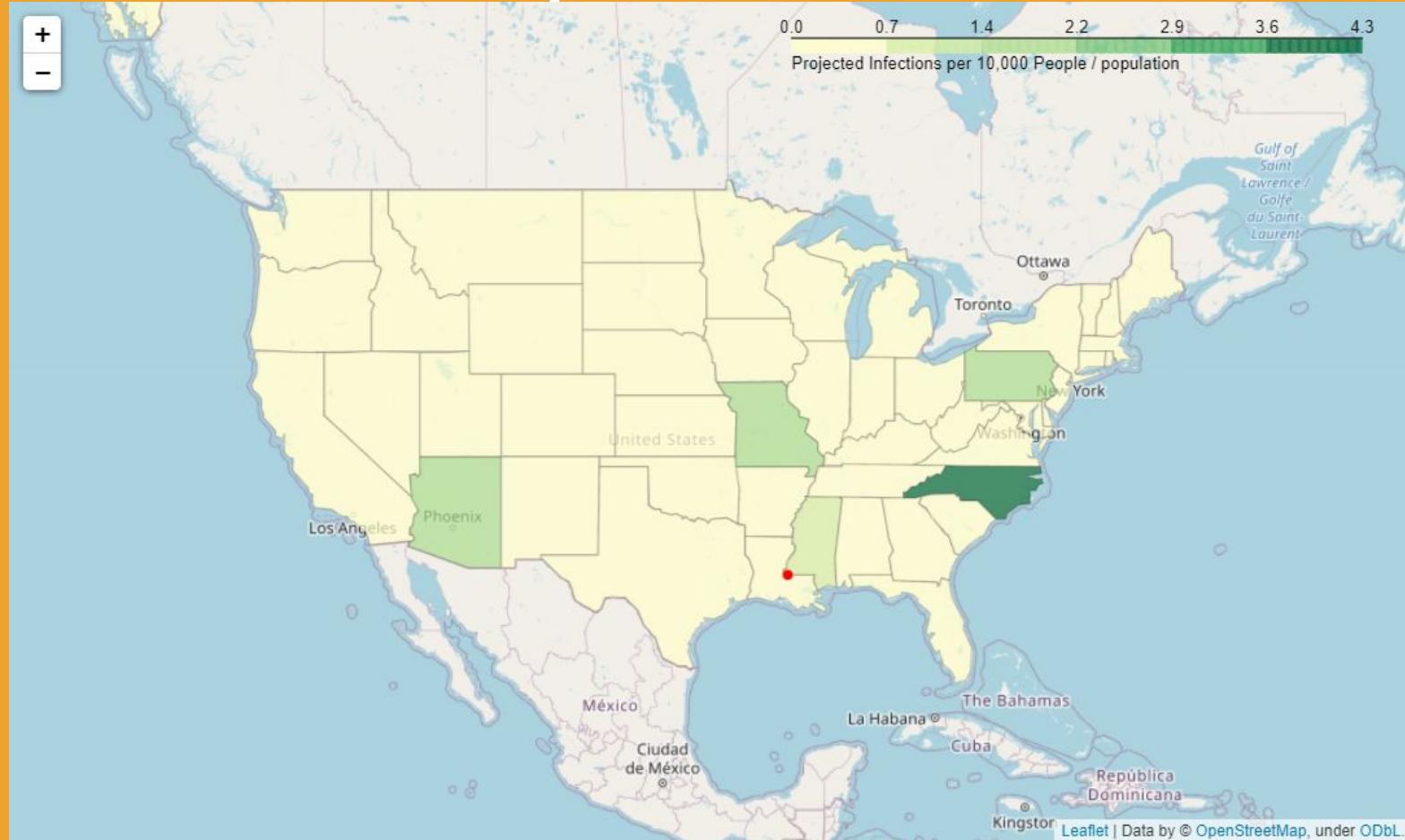
Flooding - July 15



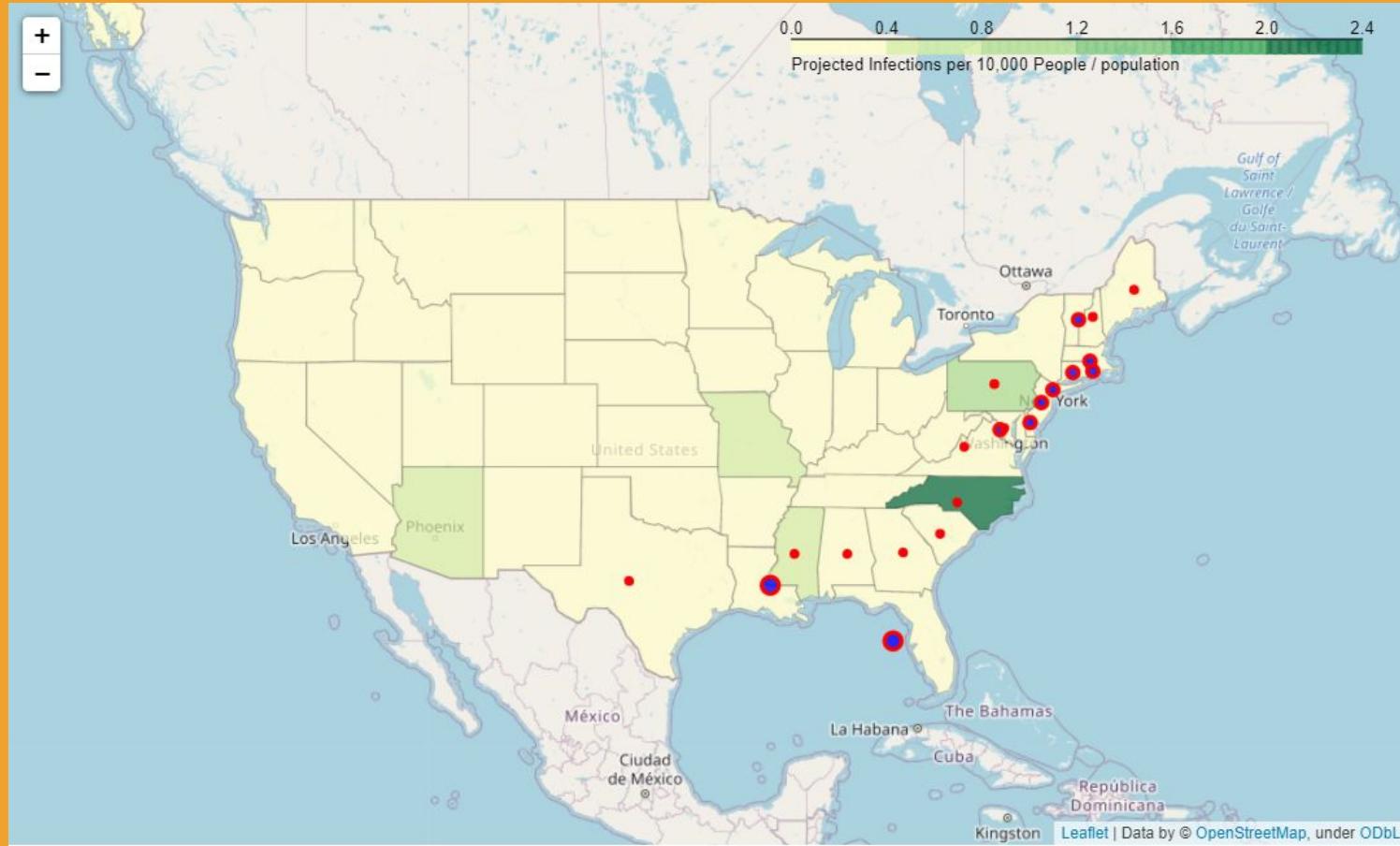
Hurricanes - June 15



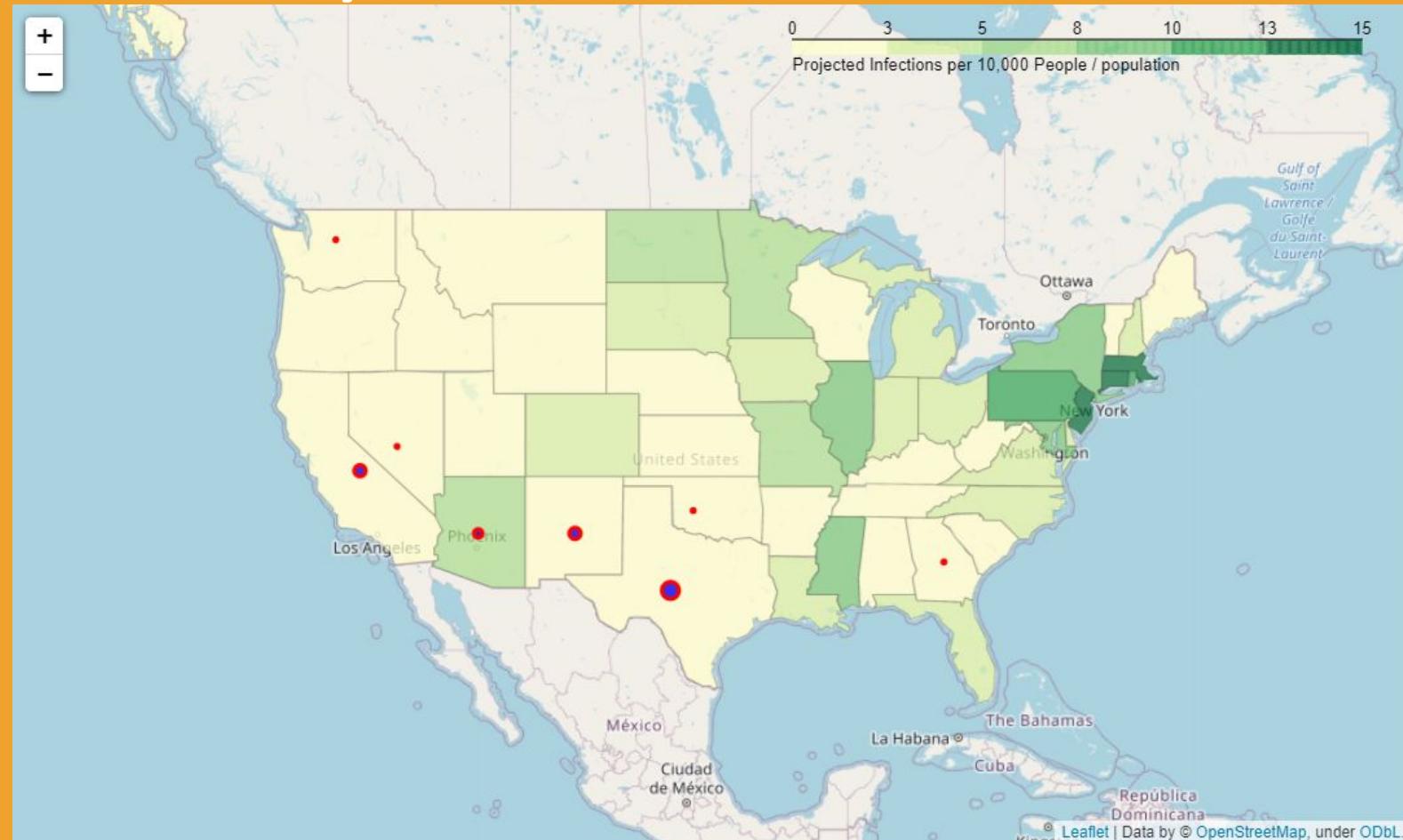
Hurricanes - July 15



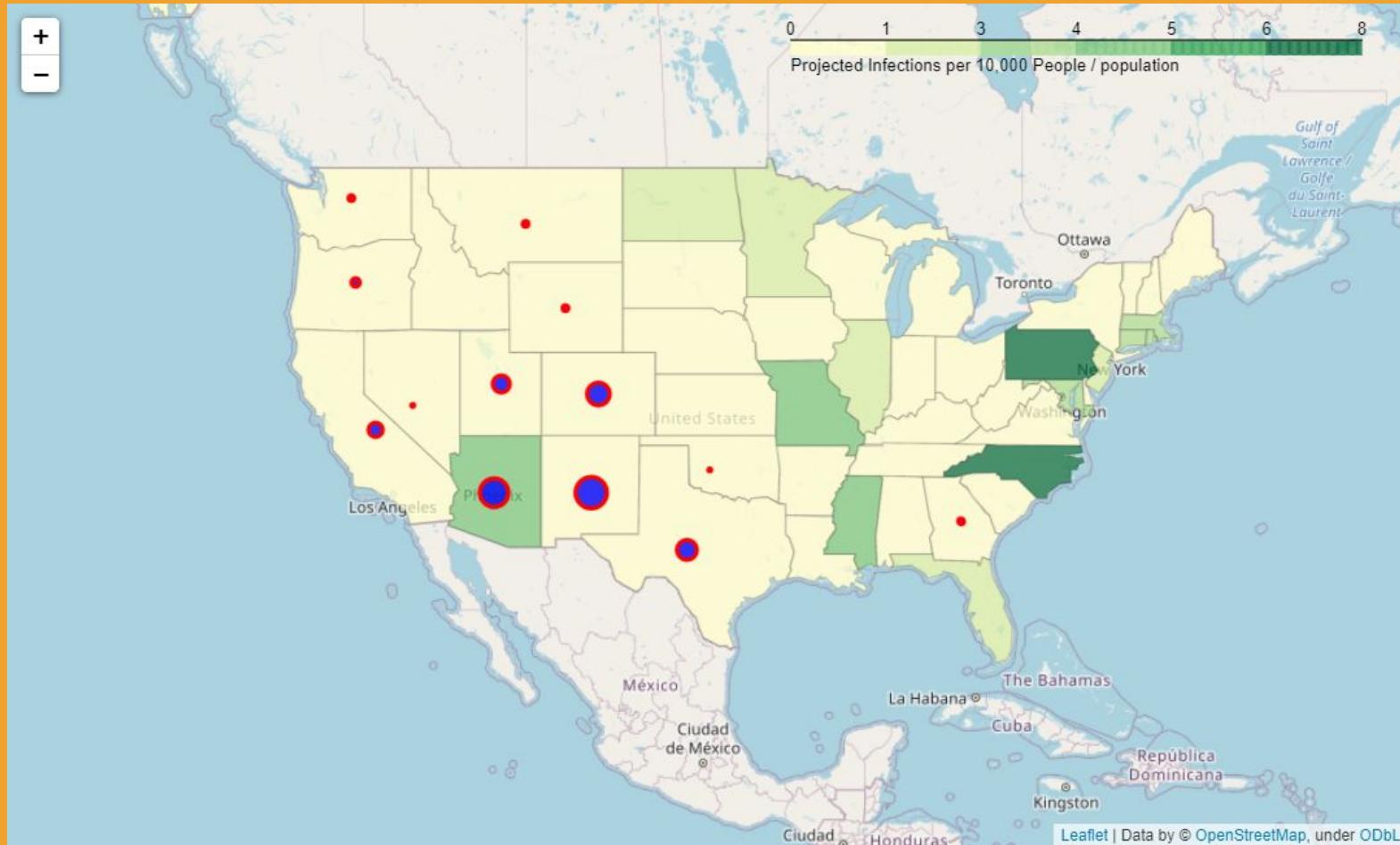
Hurricanes - August 12



Fires - May 15



Fires - June 15

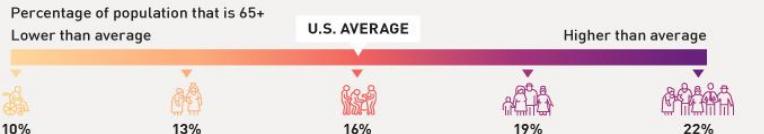




Source:

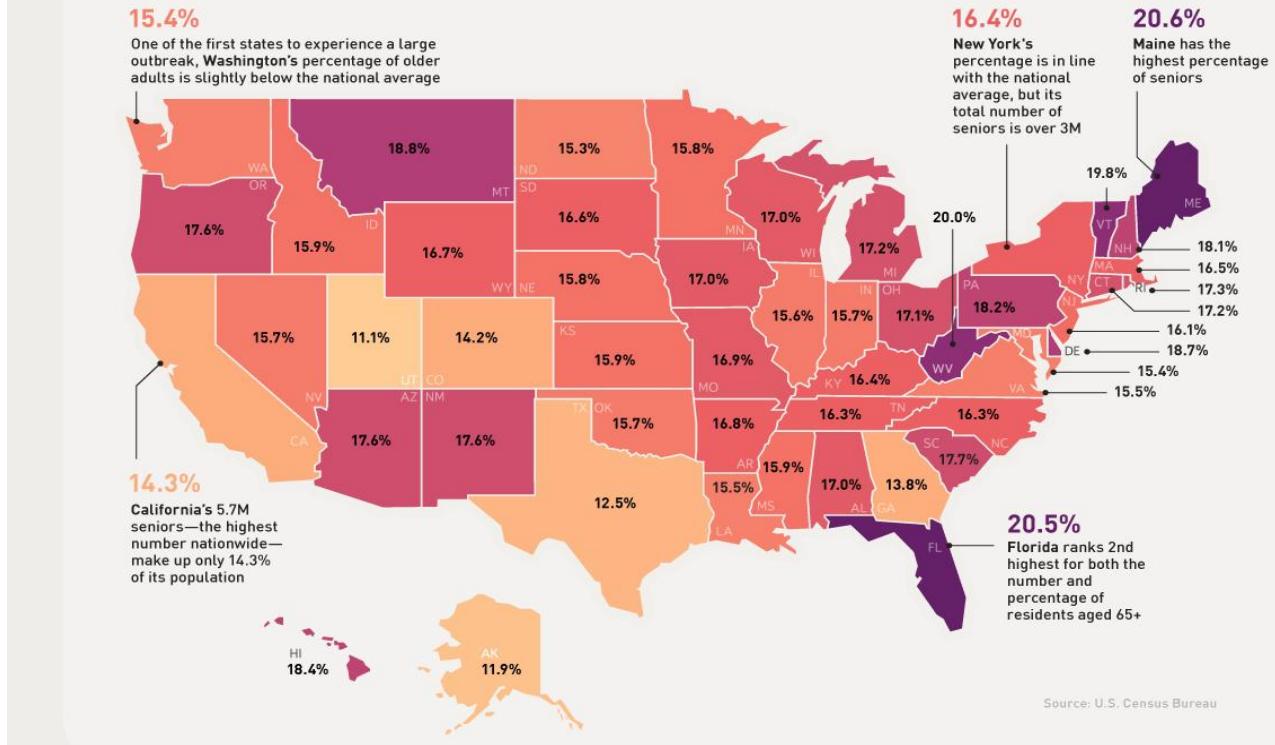
<https://www.abc15.com/news/state/navajo-nation-continues-to-be-hit-hard-by-coronavirus-as-arizona-reopens>

Below, we map the percentage of seniors by state.

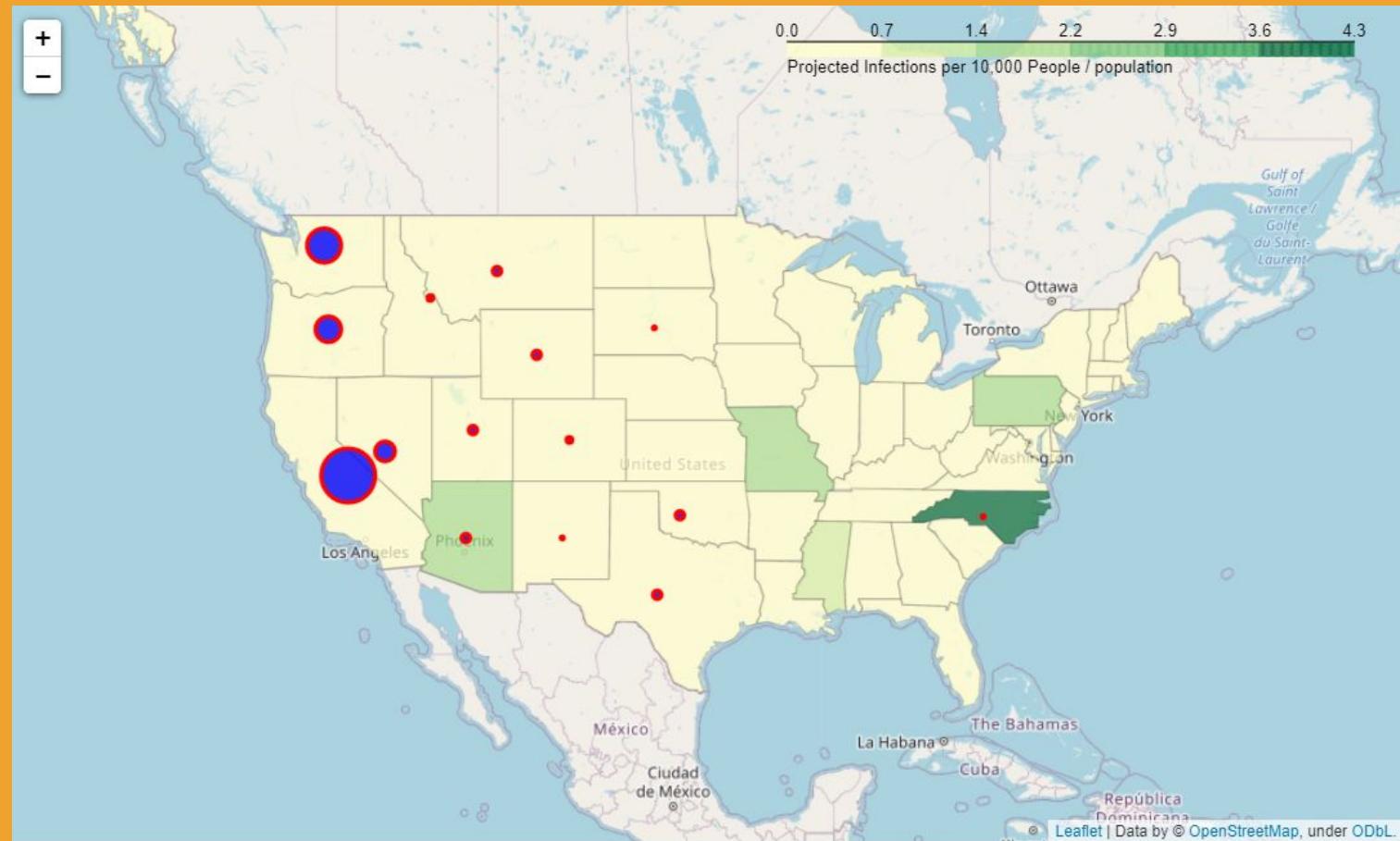


Source :

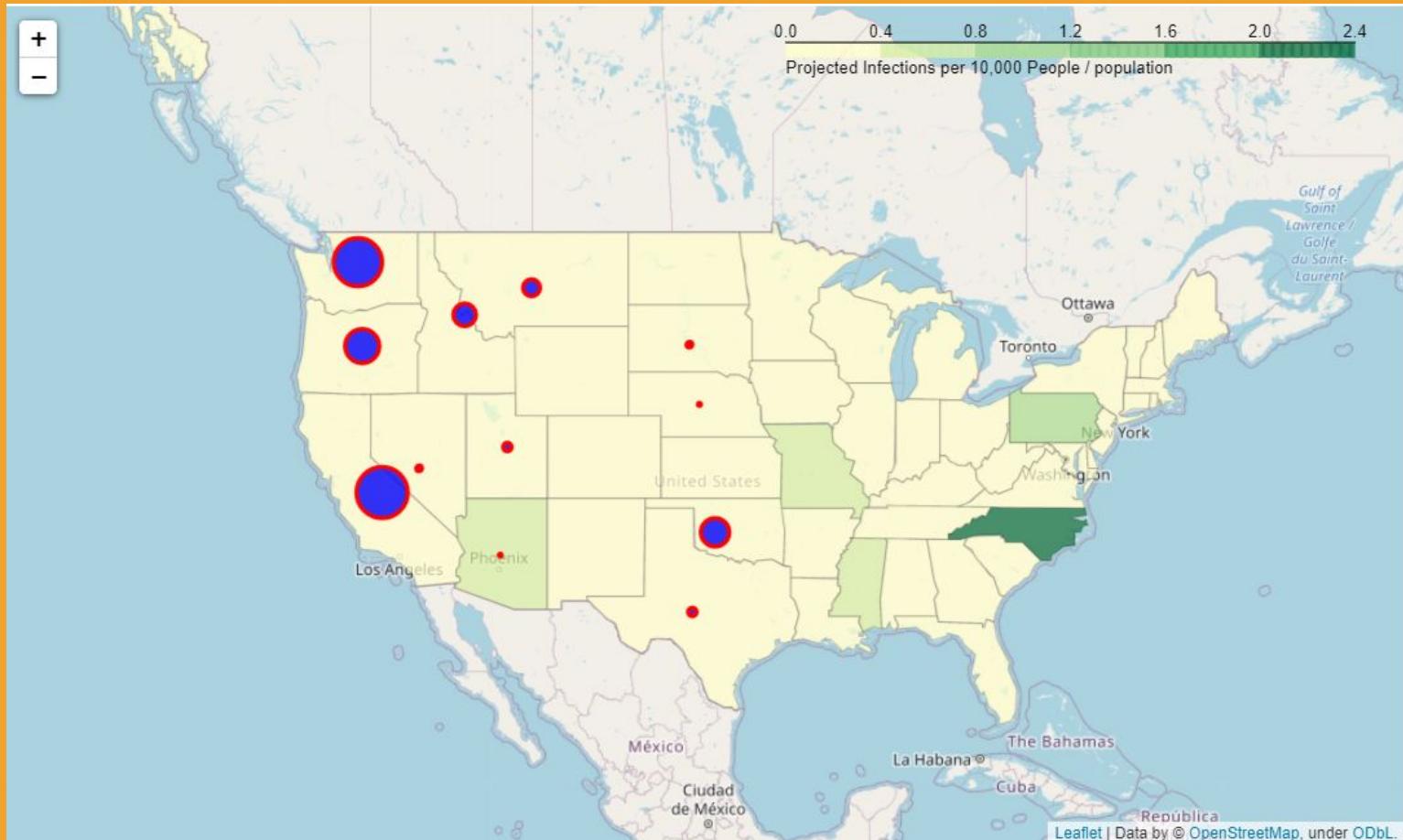
<https://www.visualcapitalist.com/mapped-us-senior-population-covid-19/>



Fires - July 15



Fires - August 12



Conclusions

Imminent threats:

- Flooding overlaps with COVID rise in basin states during May/June

Rapidly approaching threats:

- West coast fires and gulf storms

Long- term threats:

- Hurricane season overlapping with latest projected recovery states

Next Steps

- Explore financial impacts that are caused by natural disasters and how that could complicate the COVID response
- Update models with more recent natural disasters and see if there is a correlation between certain types of disasters and an increase in infection rates

Thank you

Questions?