Health GIS – Infectious Disease Response Planning

Este Geraghty, Chief Medical Officer

UN GGIM
April 8, 2020

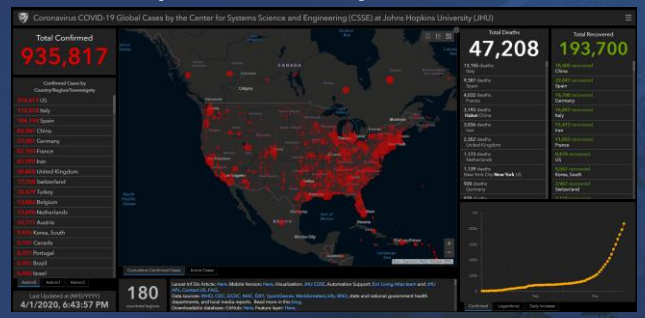
50 Years
Strong and Growing

THE SCIENCE OF WHERE

COVID-19 Is Creating Massive Public Health & Govt Challenges on a Global Scale

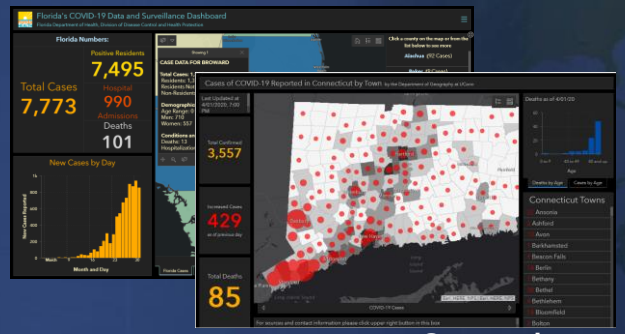
An Enterprise System For Pandemic Response

Johns Hopkins University



FEMA

State of Florida



Connecticut

Apps

Portal

Visualization and Analytic Services

Case Data

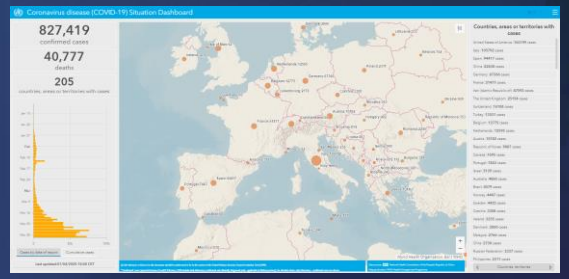
Movement Data

Facilities

Population, Demographics & Basemaps

US Military

WHO



Jamaica

Organizing Content and Applications
. . . Providing Mapping and Analysis
. . . Enabling Sharing and Better Decision Making

GIS

A Complete System for Understanding and Responding to Pandemics

Integrating All the Data, Activities and Missions . . .
. . . Empowering Collaborative Action

GIS

Provides A Framework . . .

. . . And Process

. . . Data Driven & Science Based

GIS

Provides A Framework . . .

. . . And Process

COVID – 19

Response

Health Facilities & Resources

Cases

Vulnerable Population

Demographics

Communicating

Forecasting

Impacts

Intervention

Social Distancing

Testing and Treatment Site Selection

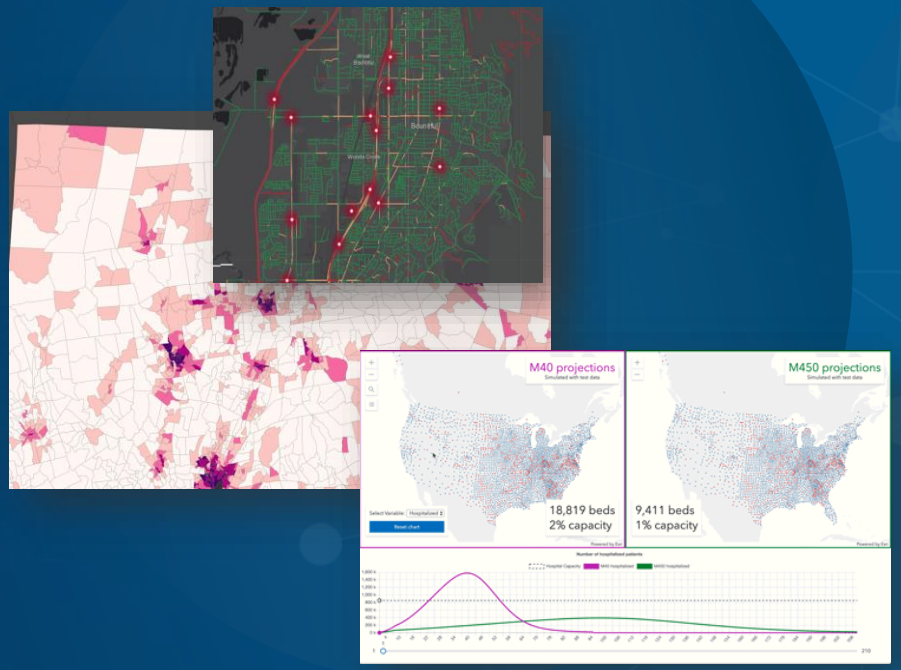
Equipment & Personnel Allocation

Community Engagement

. . . Data Driven & Science Based

Modeling & Spatial Analysis

Prediction

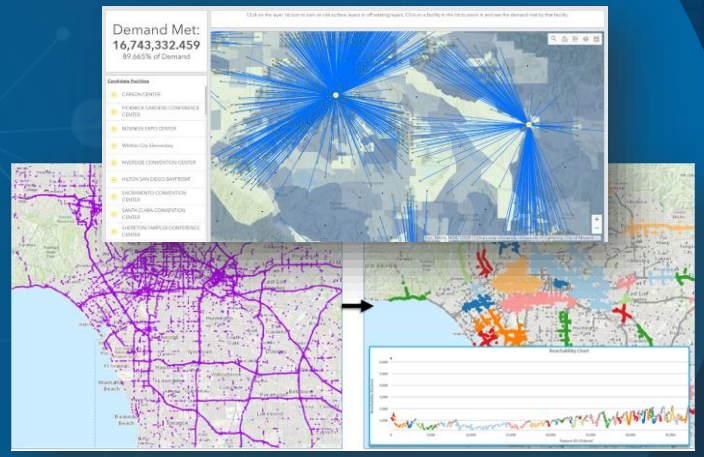


Predicting Geospatial Events/Phenomena

Pattern Detection

Finding Statistically Significant Clusters & Patterns

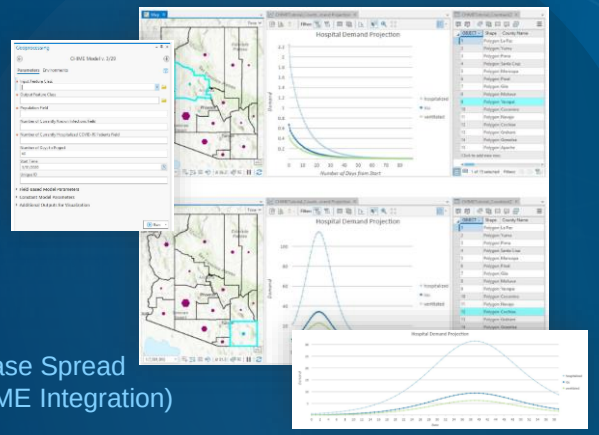
Site Selection and Resource Allocation



Helping Understand, Predict and Make Decisions . . .
. . . at Many Scales

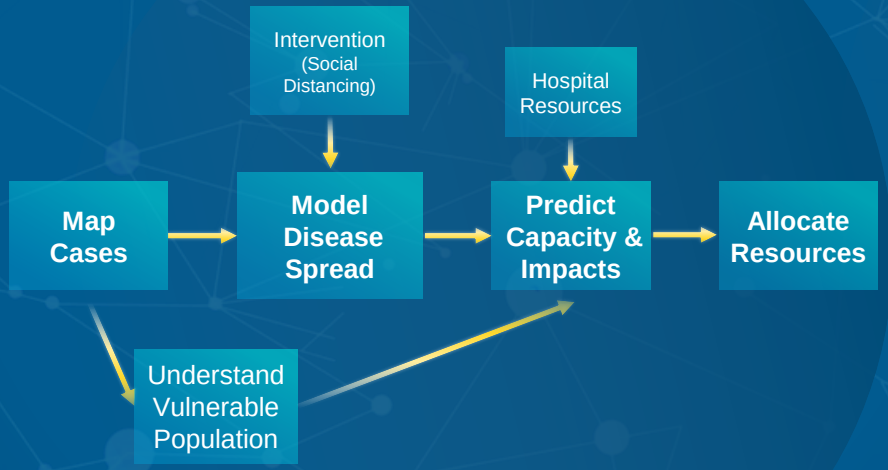
Tools and Methods for Pandemic Analysis, Modeling & Visualization

Modeling

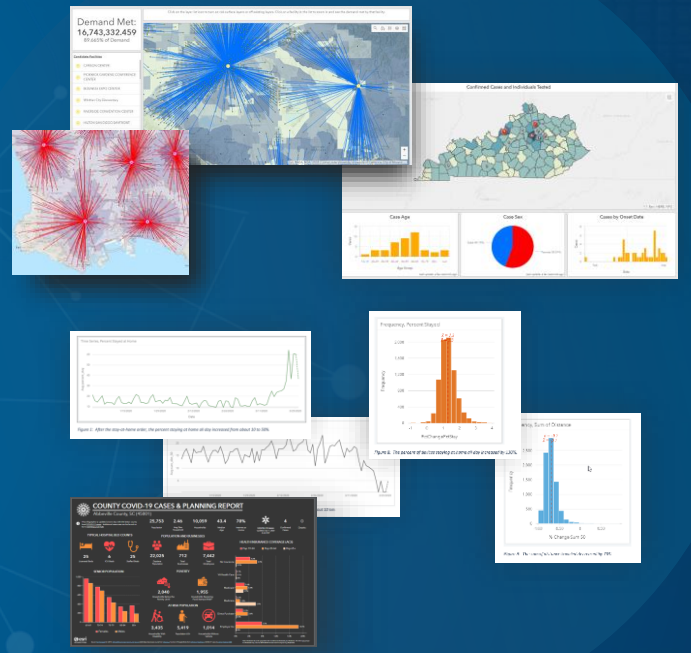


Disease Spread
(CHIME Integration)

Workflows



GIS Apps



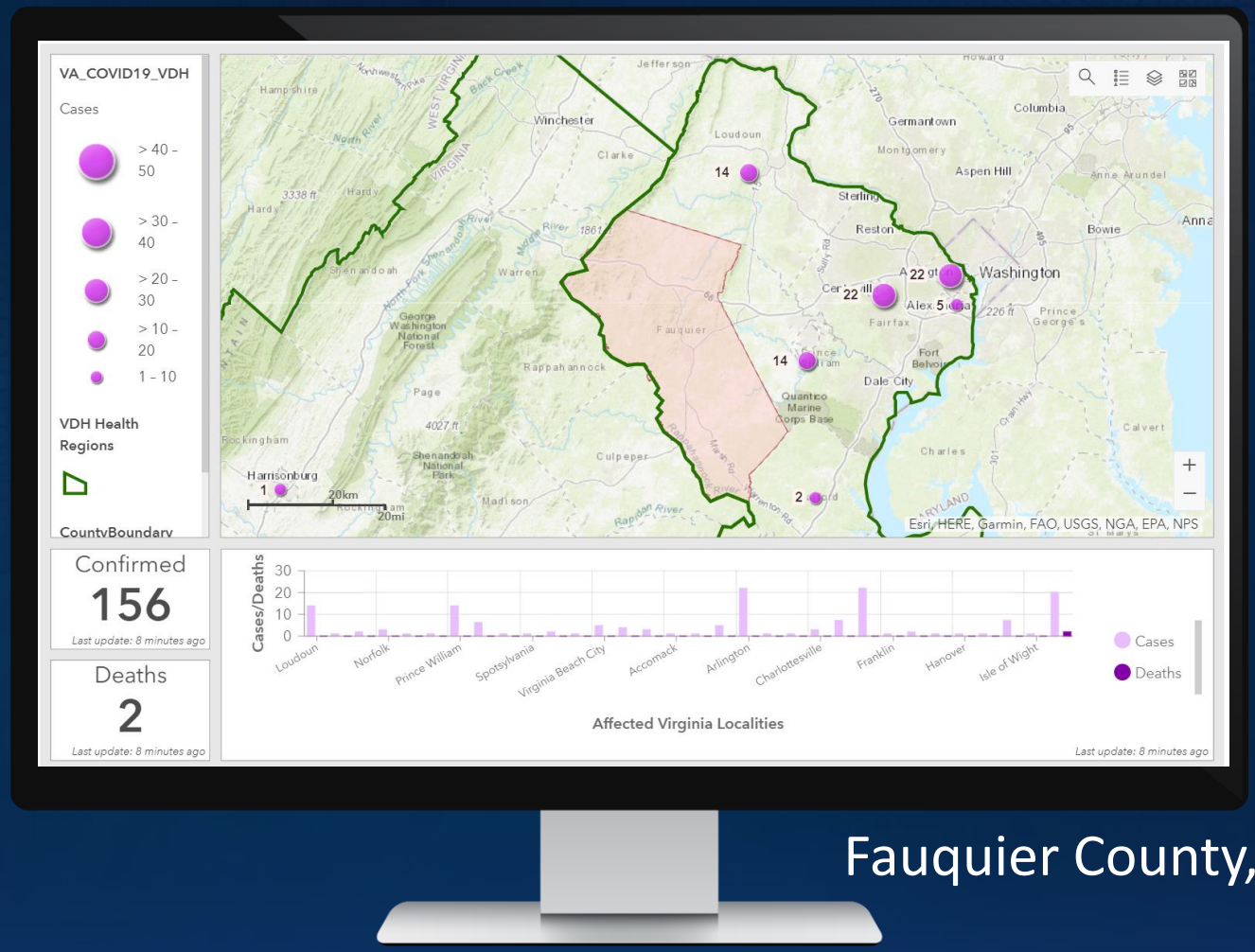
Helping Understand, Predict and Make Decisions . . .
. . . at Many Scales

Where do you start?

Understanding the Impacts of COVID-19: Five Steps

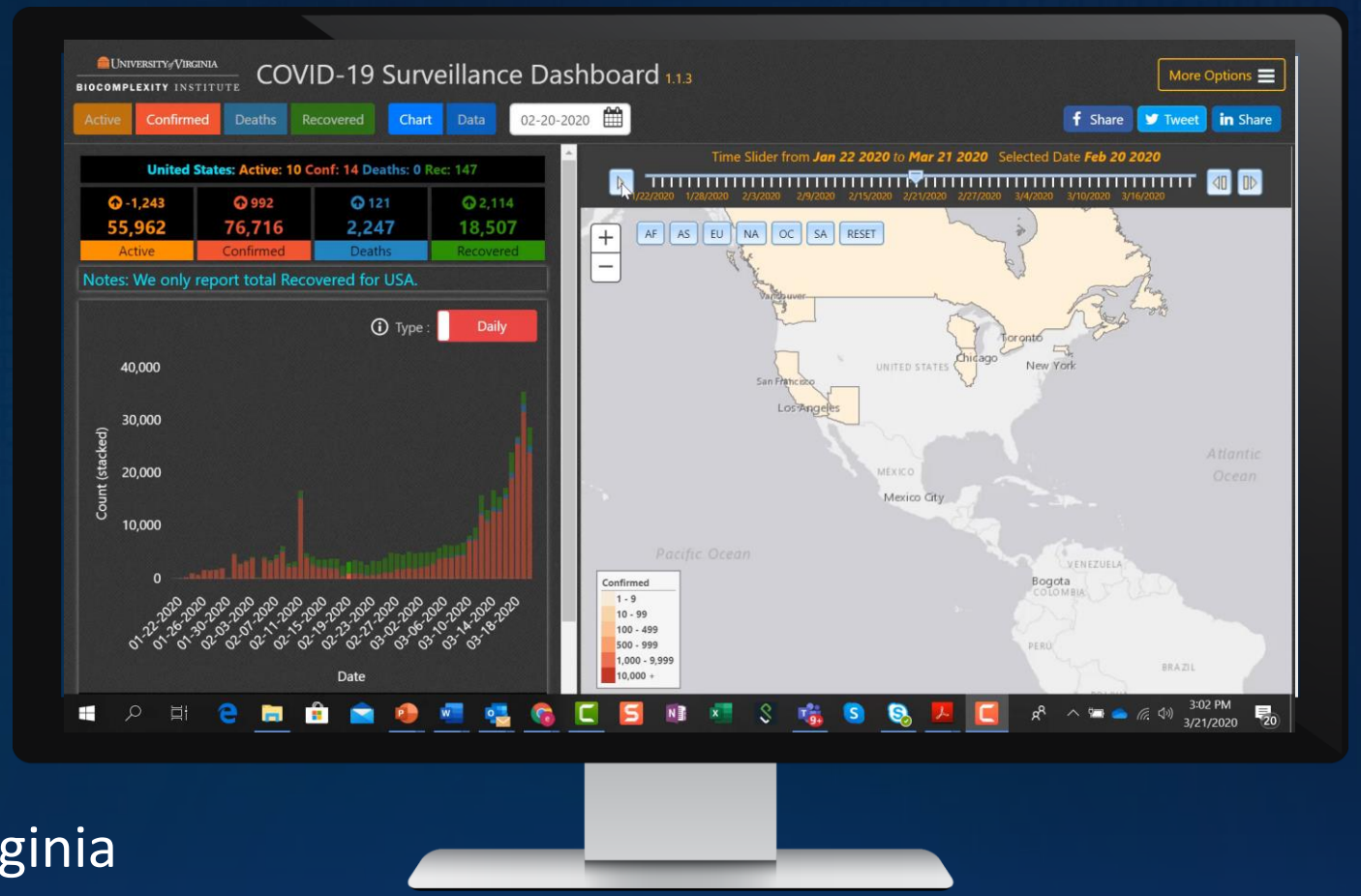
Step 1	Step 2	Step 3	Step 4	Step 5
Map the Cases	Map the Spread	Map Vulnerable Populations	Map Your Capacity	Communicate with Maps

Step 1 Step 2 Step 3 Step 4 Step 5

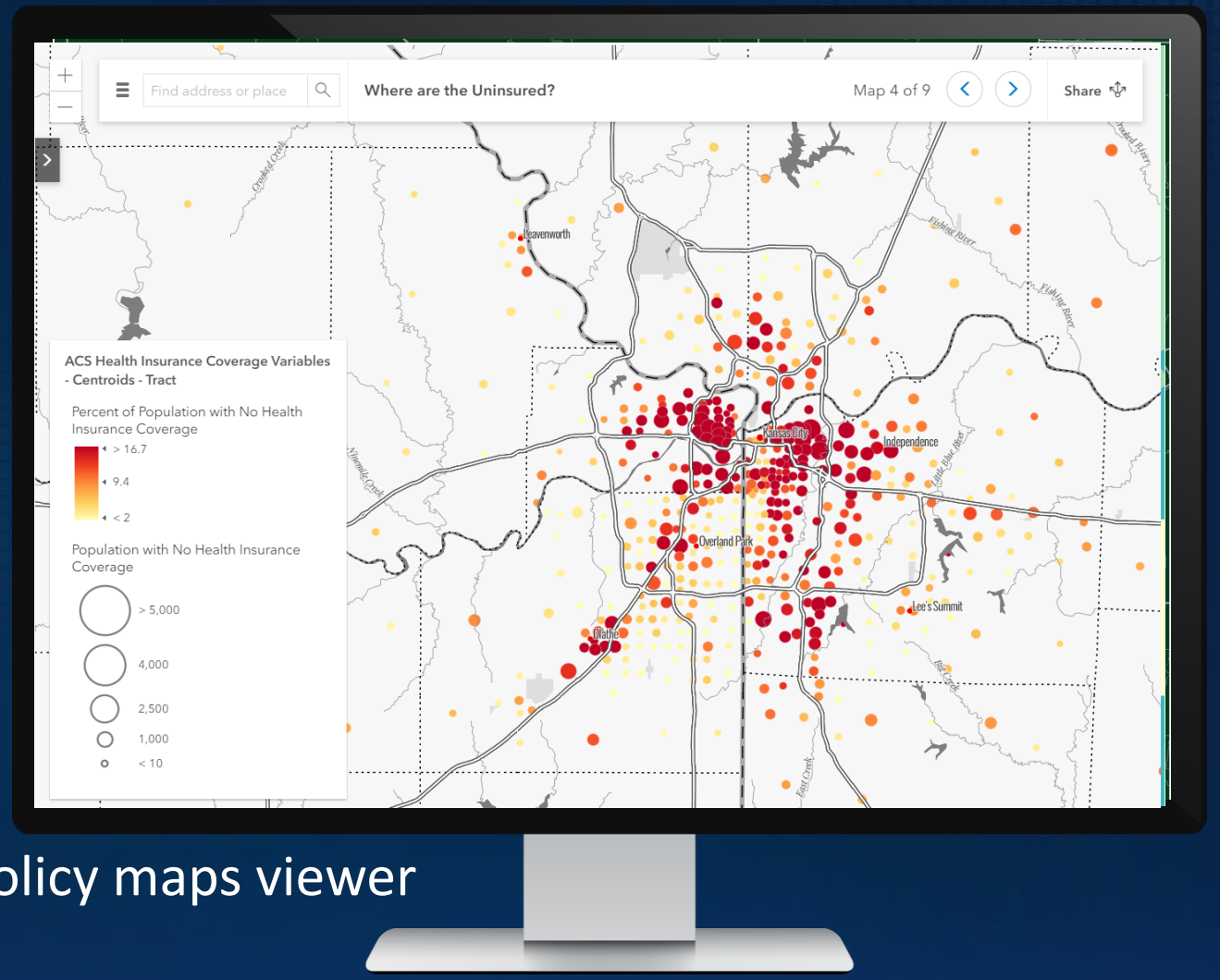


Fauquier County, VA

Step 1 Step 2 Step 3 Step 4 Step 5



Step 1 Step 2 Step 3 Step 4 Step 5



Esri policy maps viewer

Step 1 | Step 2 | Step 3 | Step 4 | Step 5

COVID-19 PLANNING: Morbidity and Mortality Estimates

20% Infection Rate

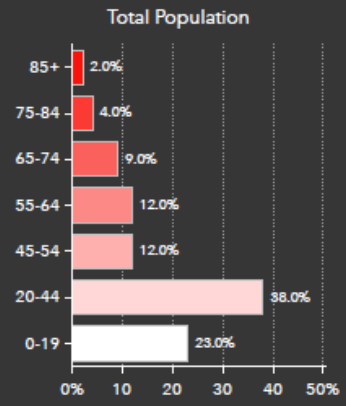
New York City, NY

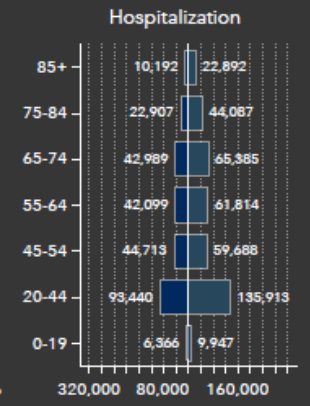
Geography: Place

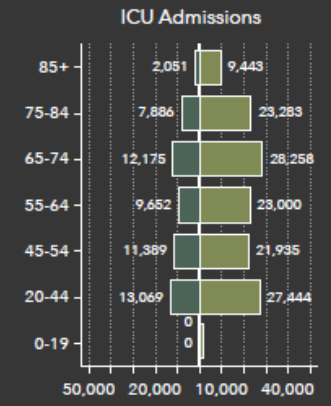
8,627,852	3,266,735	2.59	37.0	$62,062
Population	Households	Avg Size Household	Median Age	Median Household Income

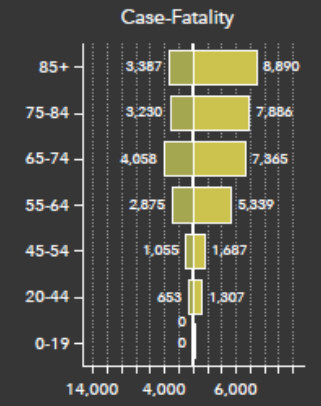
Typical Hospital Bed Availability

22,435	1,328	19,032
Licensed Beds	ICU Beds	Staffed Beds









Estimated Rates: Feb 12 - Mar 16

Ages	Hospitalized Low	Hospitalized High	ICU Admissions Low	ICU Admissions High	Case-Fatality Low	Case-Fatality High
0-19	1.6%	2.5%	0%	0%	0%	0%
20-44	14.3%	20.8%	2.0%	4.2%	0.1%	0.2%
45-54	21.2%	28.3%	5.4%	10.4%	0.5%	0.8%
55-64	20.5%	30.1%	4.7%	11.2%	1.4%	2.6%
65-74	28.6%	43.5%	8.1%	18.8%	2.7%	4.9%
75-84	30.5%	58.7%	10.5%	31.0%	4.3%	10.5%
85+	31.3%	70.3%	6.3%	29.0%	10.4%	27.3%

Source: CDC estimates for hospitalization, intensive care unit (ICU) admission, and case-fatality percentages for reported COVID-19 cases reported Feb 12 - Mar 16, 2020 , by age group.
Click here for more information on the report by the CDC dated March 18, 2020

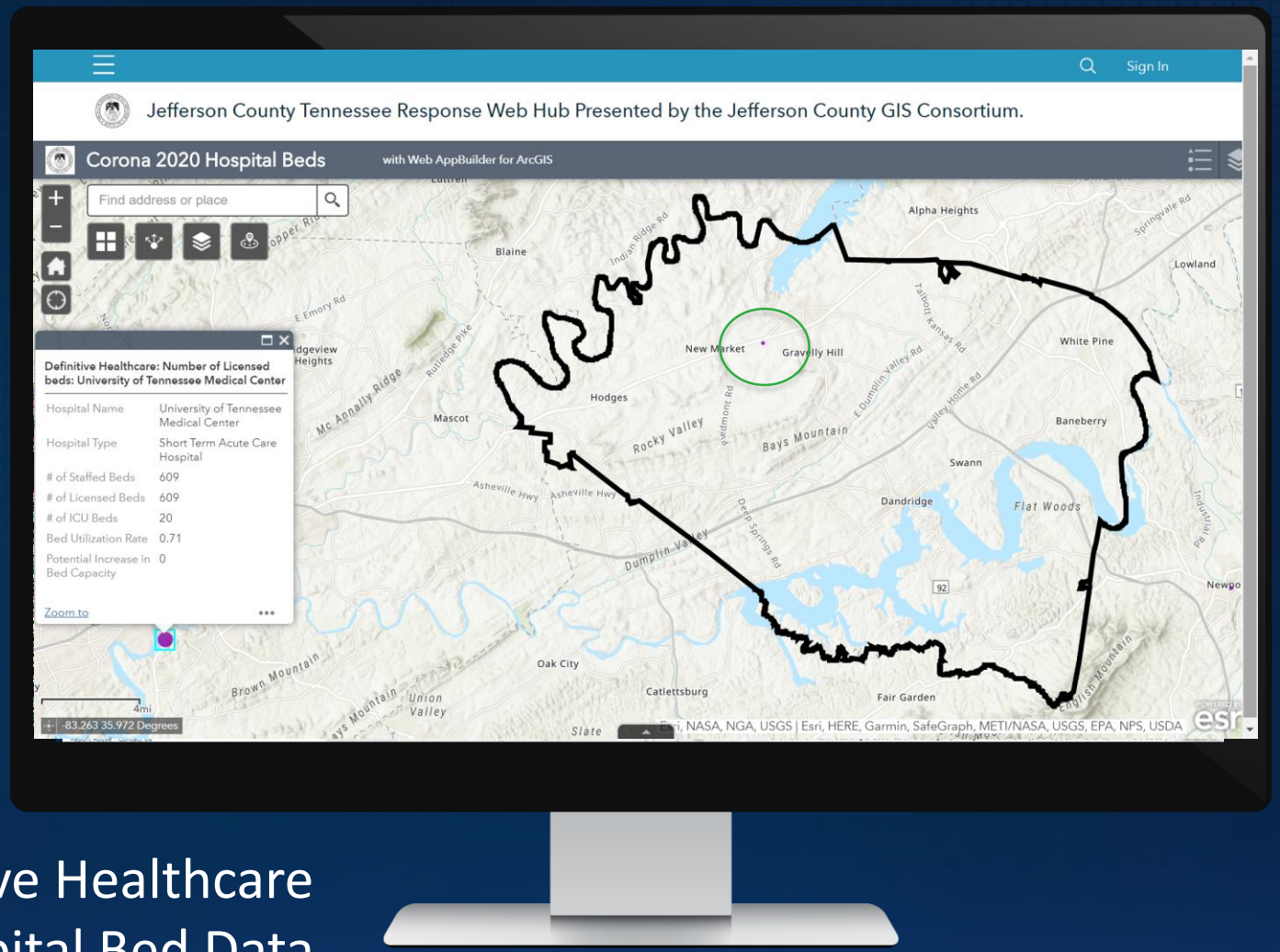
Estimated Cases: Infection Rate 20%

Ages	Population	Potentially Infected	Hospitalization Low	Hospitalization High	ICU Admissions Low	ICU Admissions High	Case-Fatality Low	Case-Fatality High
0-19	1,989,462	397,892	6,366	9,947	0	0	0	0
20-44	3,267,129	653,426	93,440	135,913	13,069	27,444	653	1,307
45-54	1,054,560	210,912	44,713	59,688	11,389	21,935	1,055	1,687
55-64	1,026,805	205,361	42,099	61,814	9,652	23,000	2,875	5,339
65-74	751,551	150,310	42,989	65,385	12,175	28,258	4,058	7,365
75-84	375,528	75,106	22,907	44,087	7,886	23,283	3,230	7,886
85+	162,816	32,563	10,192	22,892	2,051	9,443	3,387	8,890
Total	**8,627,851**	**1,725,570**	**262,707**	**399,726**	**56,222**	**133,364**	**15,258**	**32,475**

Totals may not exactly match due to rounding

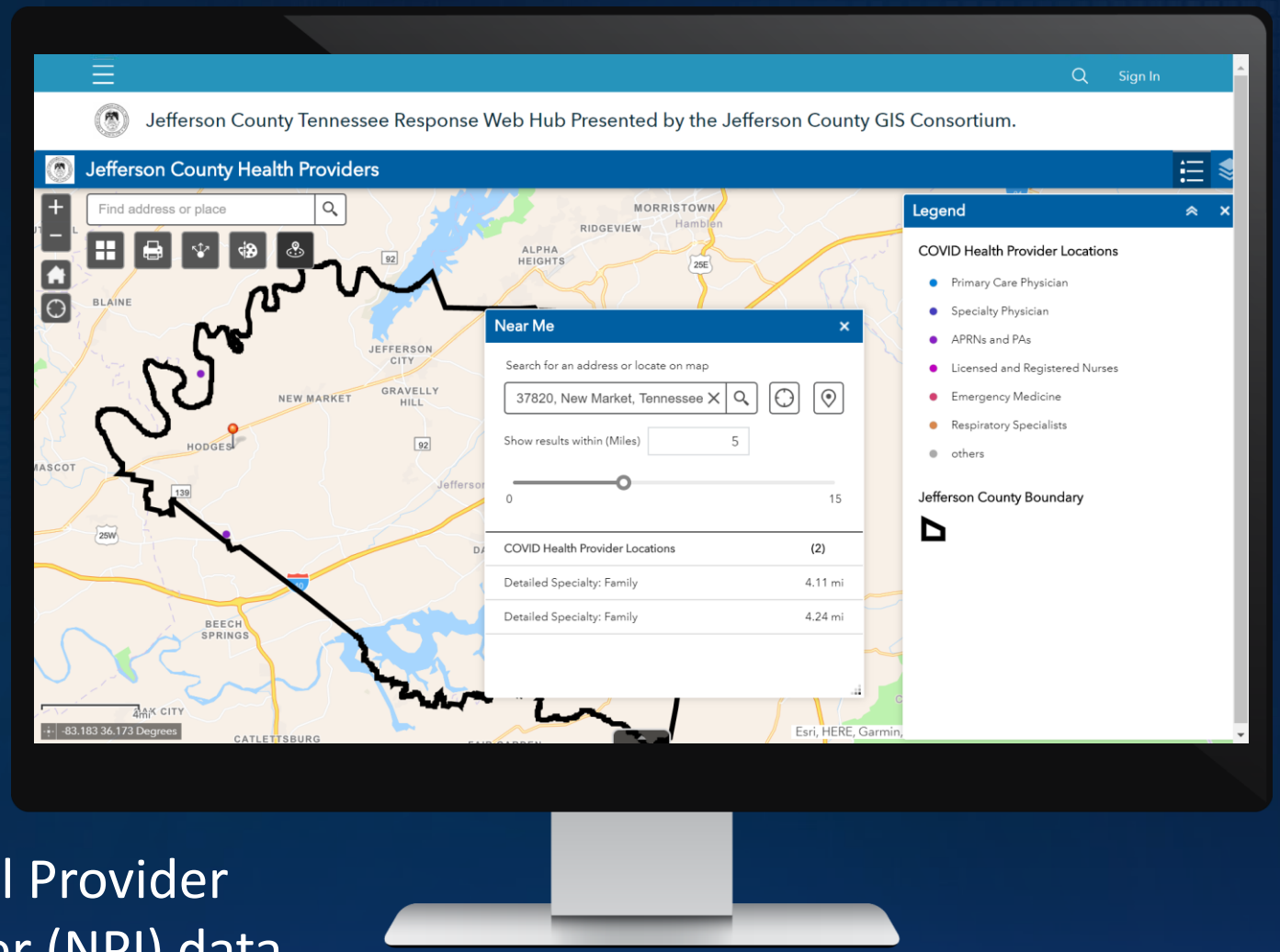
Source: Esri forecasts for 2019, 2013-2017 American Community Survey (ACS), Hospital Beds from Definitive Healthcare - Version 1.6

Step 1 Step 2 Step 3 Step 4 Step 5



Definitive Healthcare
US Hospital Bed Data

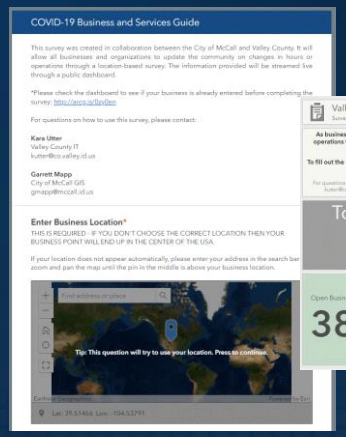
Step 1 Step 2 Step 3 Step 4 Step 5



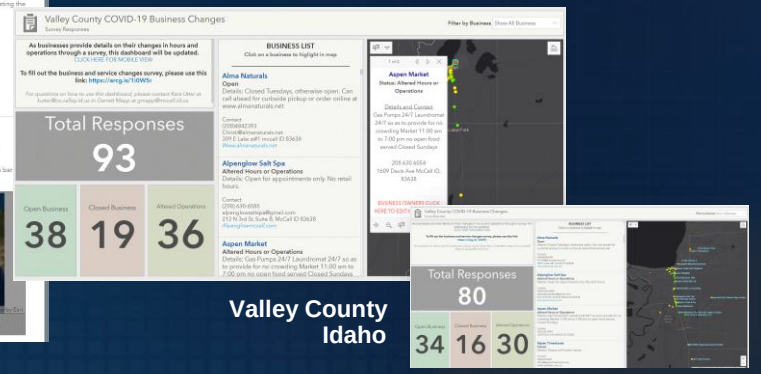
National Provider Identifier (NPI) data

Step 1 Step 2 Step 3 Step 4 Step 5

Communicating Businesses Impacted to Citizens

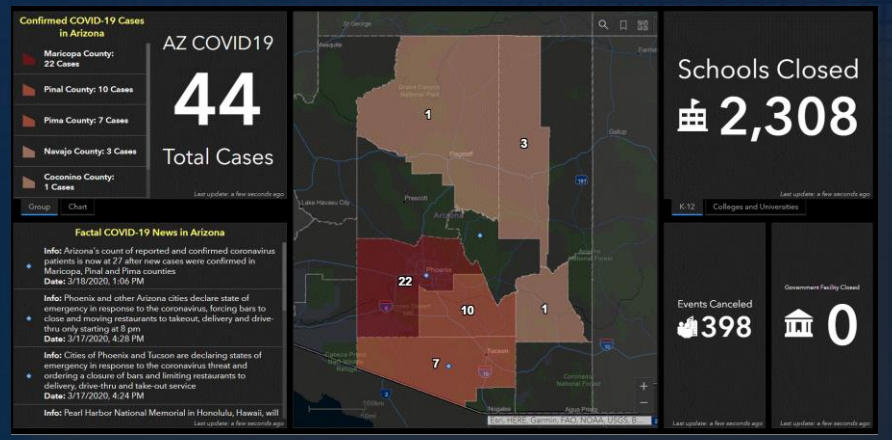


Valley County
Idaho



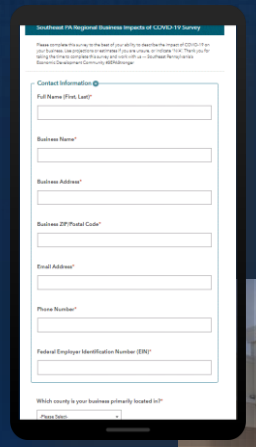
Valley County
Idaho

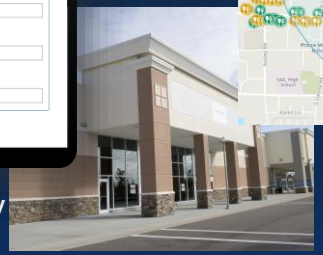
School Closures and Event Cancellations



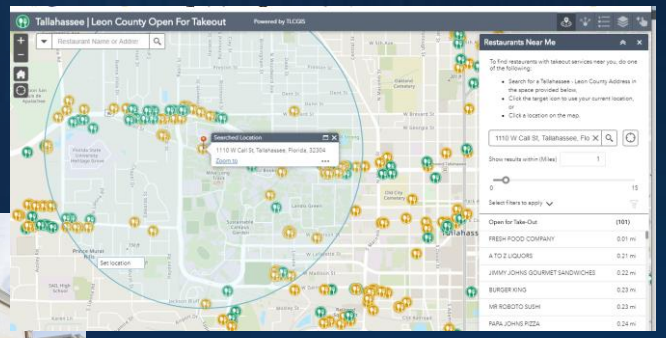
State of Arizona

Business Resilience



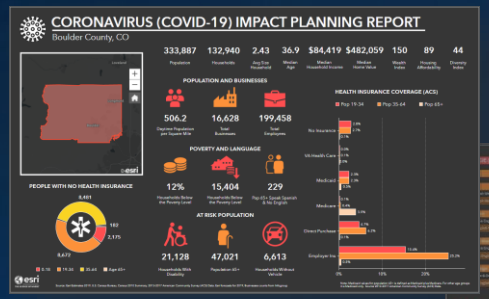


Delaware County
Pennsylvania

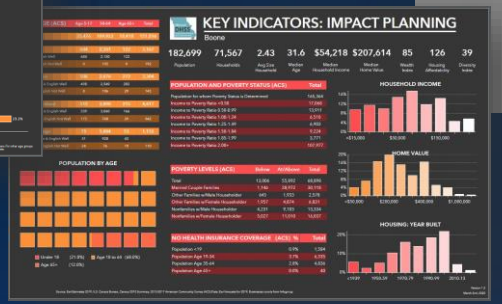


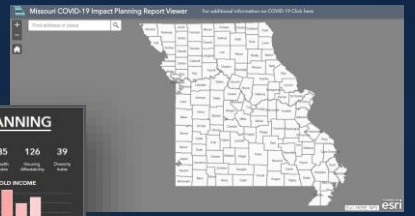
Leon County
Florida

County Impact Planning



Boulder County
Colorado

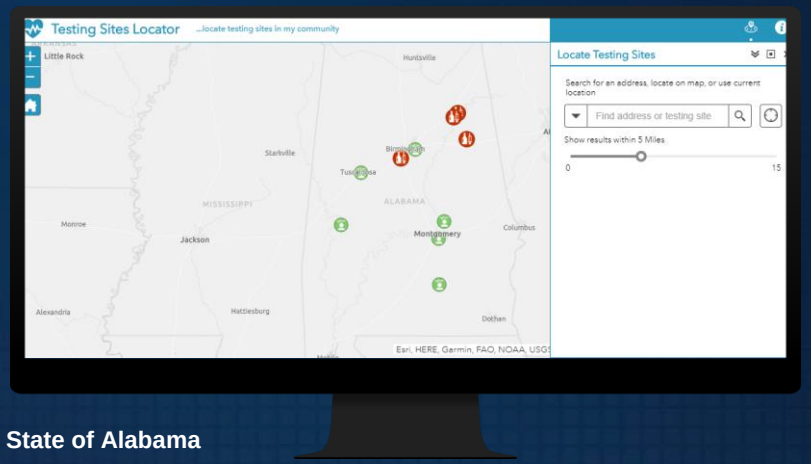




Boone County
Missouri

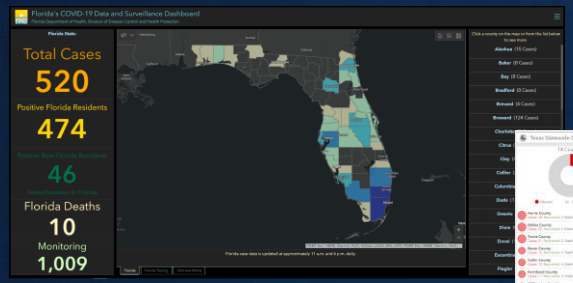
Step 1 Step 2 Step 3 Step 4 Step 5

Testing Site Locator

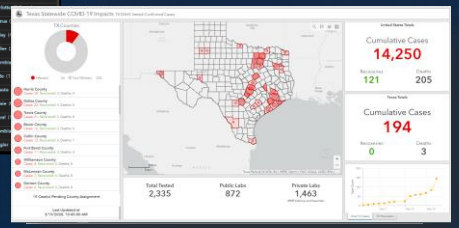


State of Alabama

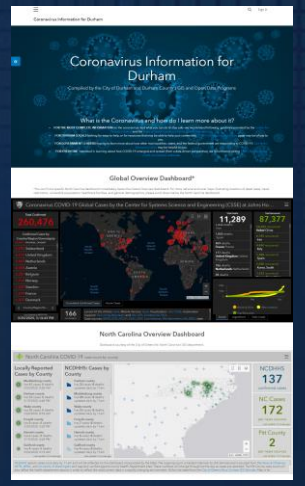
Monitoring Confirmed Cases



State of Florida

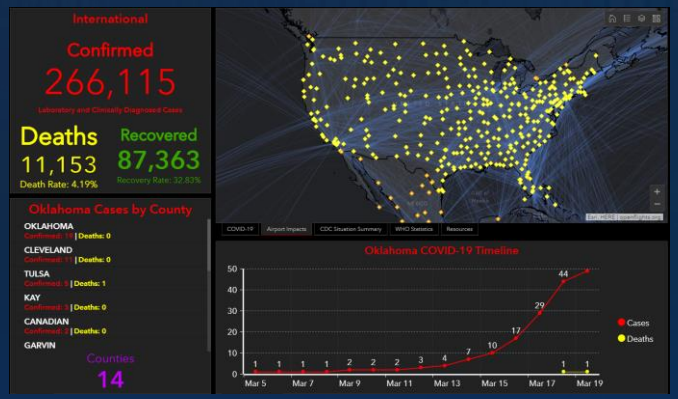


State of Texas



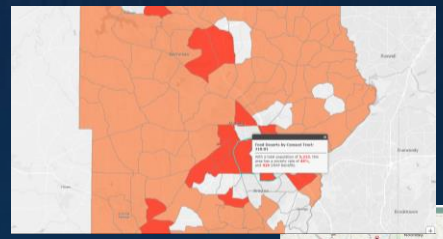
Durham County
North Carolina

Airports Impact

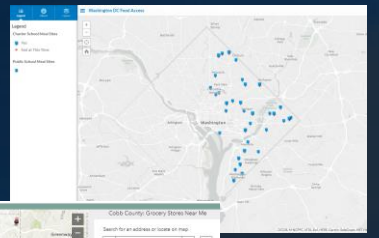


State of Oklahoma

Food Assistance Information

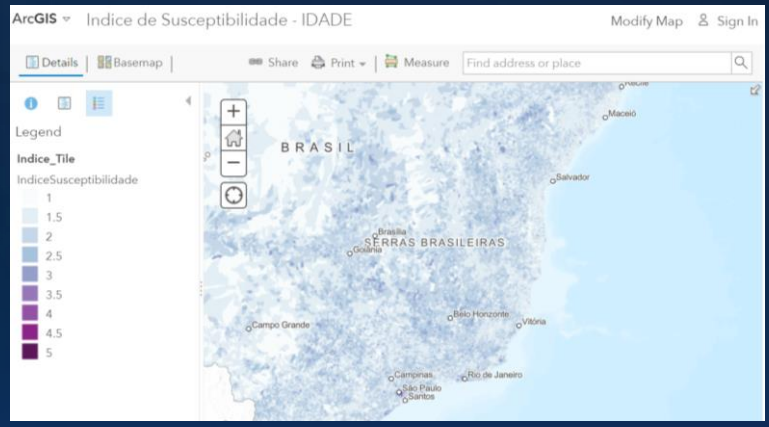


Cobb County
Georgia



Washington DC

Vulnerabilities



Brazil

Taking Action

- Implement COVID-19 Information Model (prepare GIS data layers)
- Analyze health and demographic data to understand community risk
- Leverage mobility data to measure social distancing effectiveness
- Model the Spread Of Disease
- Determine When and Where Hospital System Capacity is Exceeded
  - Forecast Impacts on Hospital Bed, ICU, and Ventilator Capacity
  - Validate and Refine Model Results Using Case and Community Behavior Indicators
- Perform location analytics to
  - Identify optimal testing and treatment sites
  - Allocate resources (beds, equipment, personnel, ...)

Information Model for COVID-19 Response

Demographics

Cases

Persons Tested

Hospitals

Forecasted Demand

Social Distance Restrictions

Mobility

Alternate Care Sites

Test Sites

Information Model for COVID-19 Response

Demographics

Cases

Persons Tested

Hospitals

Forecasted Demand

Social Distance Restrictions

Mobility

Alternate Care Sites

Test Sites

Socioeconomic

Age

Race

Health Conditions

Vulnerable Populations

Lifestyle (Tapestry)

Population / Housing Density

Information Model for COVID-19 Response

Demographics

Cases

Persons Tested

Hospitals

Forecasted Demand

Social Distance Restrictions

Mobility

Alternate Care Sites

Test Sites

Confirmed

Hospitalized

ICU

Recovered

Deaths

Information Model for COVID-19 Response

Demographics

Cases

Persons Tested

Hospitals

Forecasted Demand

Social Distance Restrictions

Mobility

Alternate Care Sites

Test Sites

Confirmed

Negative

Unknown

Information Model for COVID-19 Response

Demographics

Cases

Persons Tested

Hospitals

Forecasted Demand

Social Distance Restrictions

Mobility

Alternate Care Sites

Test Sites

Catchment Area (Service Area)
- Utilization Rate

Capacity
- General
- ICU

Occupancy
- General
- ICU

Ventilators
- Inventory
- In Use

Information Model for COVID-19 Response

Demographics

Cases

Persons Tested

Hospitals

Forecasted Demand

Social Distance Restrictions

Mobility

Alternate Care Sites

Test Sites

Peak Number of
- Beds
- ICU Beds
- Ventilators Needed

Date And Duration When Capacity Is Exceeded
- Bed
- ICU Bed
- Ventilator

Information Model for COVID-19 Response

Demographics

Cases

Persons Tested

Hospitals

Forecasted Demand

Social Distance Restrictions

Mobility

Alternate Care Sites

Test Sites

School Closed
Non-Essential Travel
Shelter-in-Place
Quarantine

Information Model for COVID-19 Response

Demographics

Cases

Persons Tested

Hospitals

Forecasted Demand

Social Distance Restrictions

Mobility

Alternate Care Sites

Test Sites

Net Change in Movement Over Time
Social Distancing Effectiveness
Average Distance Traveled
% Time at Home

Information Model for COVID-19 Response

Demographics

Cases

Persons Tested

Hospitals

Forecasted Demand

Social Distance Restrictions

Mobility

Alternate Care Sites

Test Sites

Decommissioned Hospitals and Other Facilities
Universities
Hotels
Arenas
Fairgrounds
Expo Centers
Ships

Information Model for COVID-19 Response

Demographics

Cases

Persons Tested

Hospitals

Forecasted Demand

Social Distance Restrictions

Mobility

Alternate Care Sites

Test Sites

Convention Centers
Major Sporting Arenas
Fairgrounds
Large Parking Lots with Secure Ingress and Egress
Public Buildings
Schools

Site Selection

Testing Sites

Treatment Sites

Food Distribution Sites

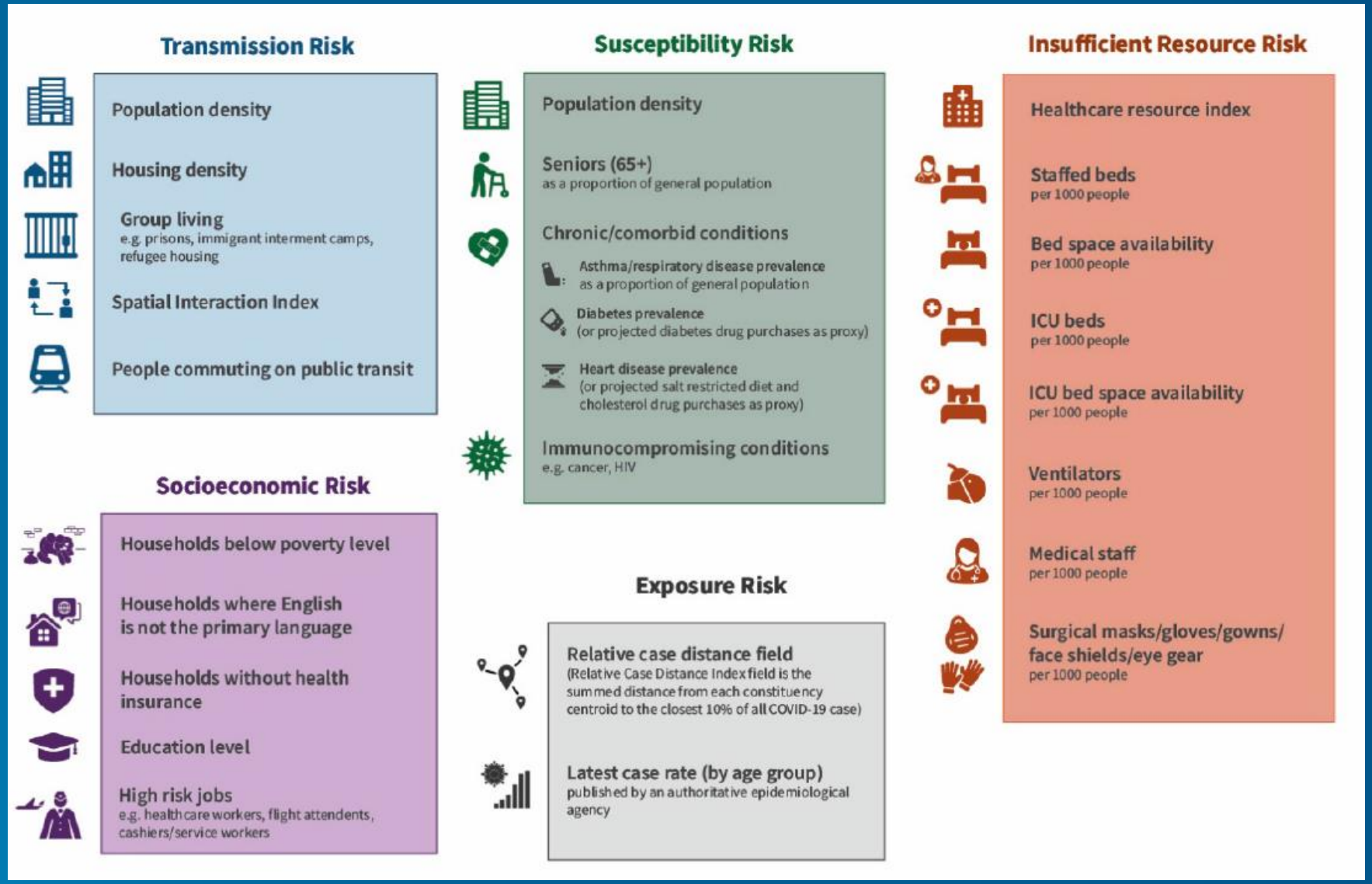
A Two-Step Approach

1. Calculate Population Demand

2. Perform location-allocation analysis

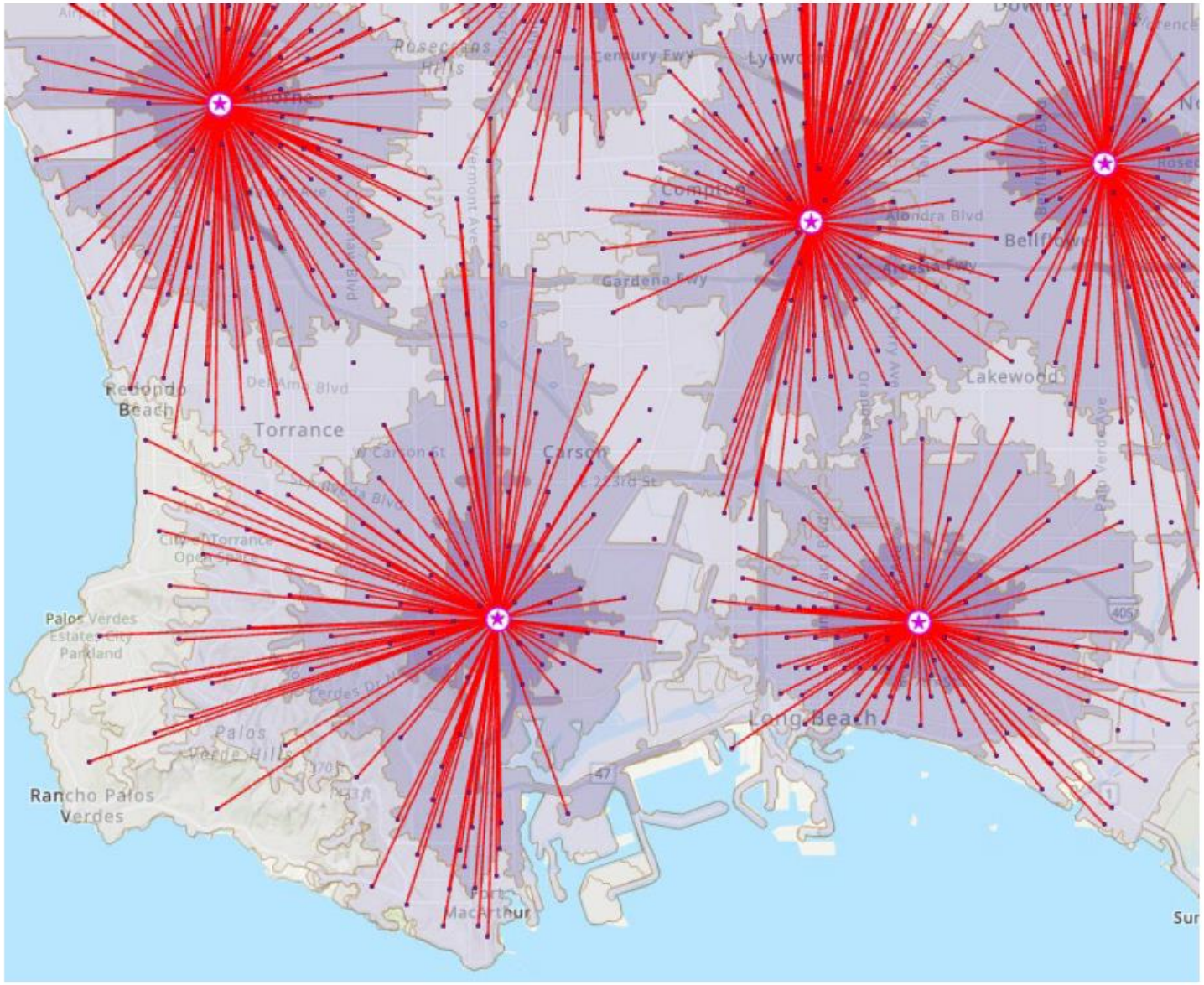
Model the spread and impact of disease

Population Demand (learn how here)

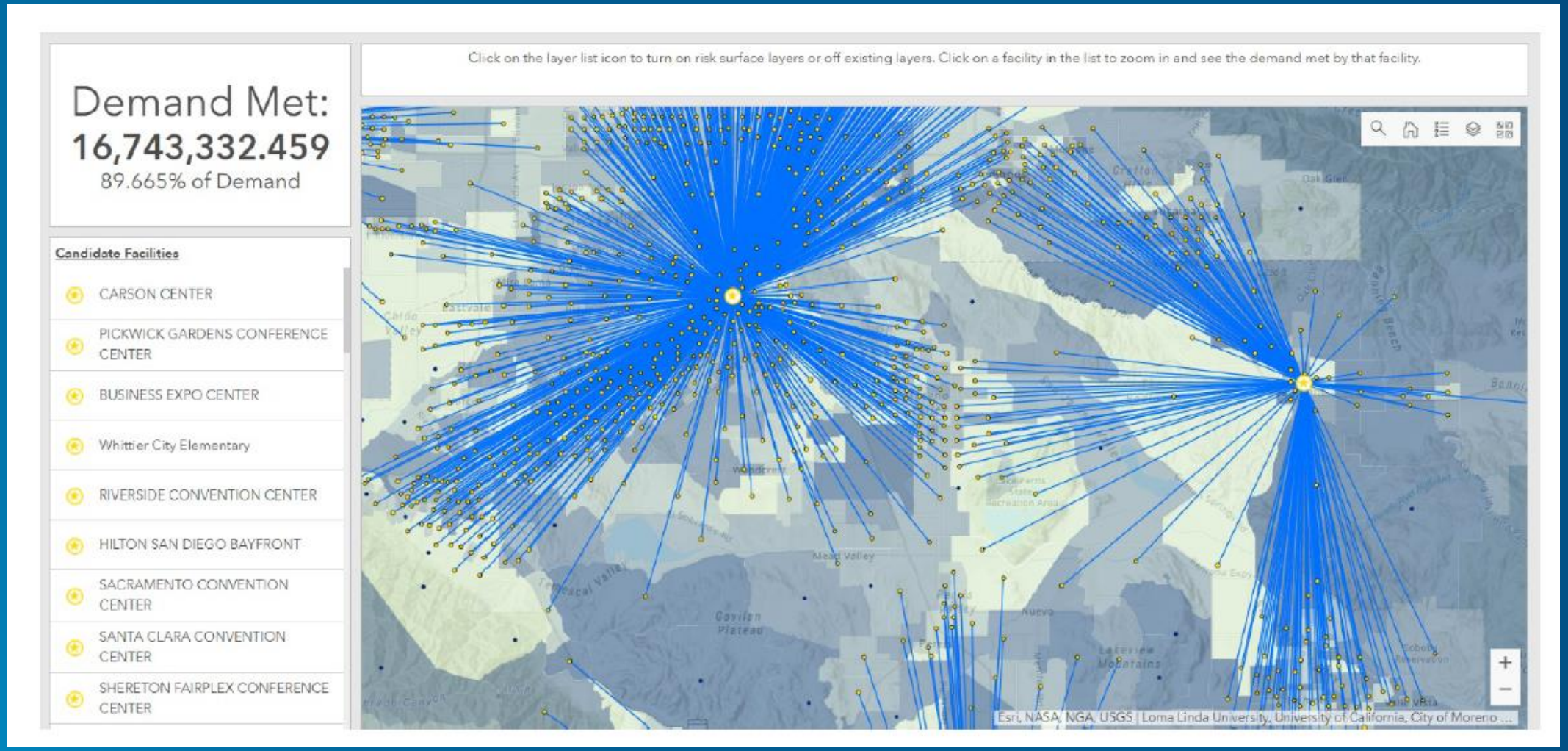


Location-Allocation

(learn how here)



Evaluate your outcomes

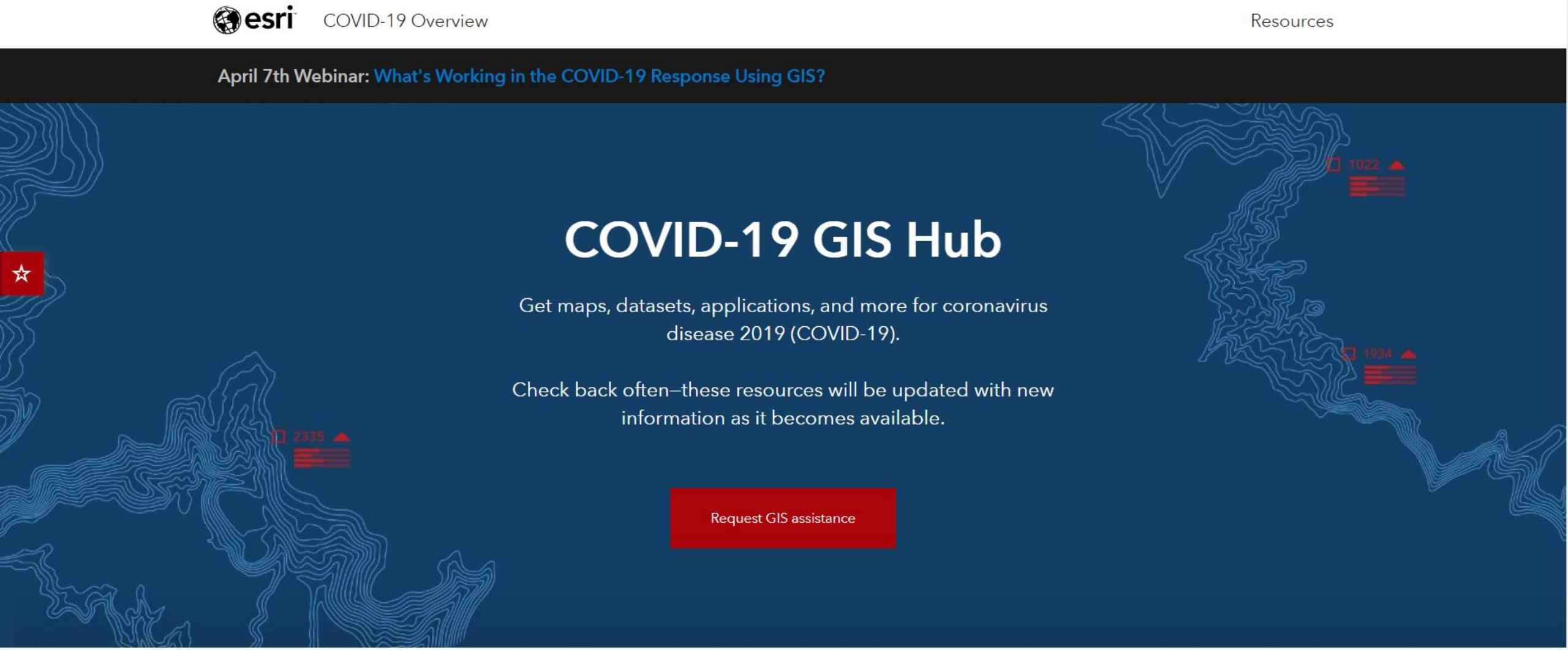


Realizing a GIS for Pandemic Response

Requires More Than Technology

- A Strong Champion
  - Understanding The Mission
  - Leadership Involvement
- Clear Strategy
  - Understanding of Benefits
  - Cost, IT, Vision, Risk Management
  - Realistic Timelines
- Ongoing Governance
- Good People - GIS Professionals

. . . and a Culture of Collaboration and Continuous Innovation



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