

NATURAL HAZARDS MISSION AREA

SAFRR Project: Science Application for Risk Reduction

Engaging with Climate Change Risks in California

Anne Wein

Western Geographic Science Center, USGS






Topics

- Winter storms
- Sea level rise and storm surges
- Earthquakes and climate change

Dale Alan Cox, Project Manager, USGS Multi-Hazards Demonstration Project
Anne Wein, Economic Consequences, Western Geographic Science Center

ARkStorm

USGS
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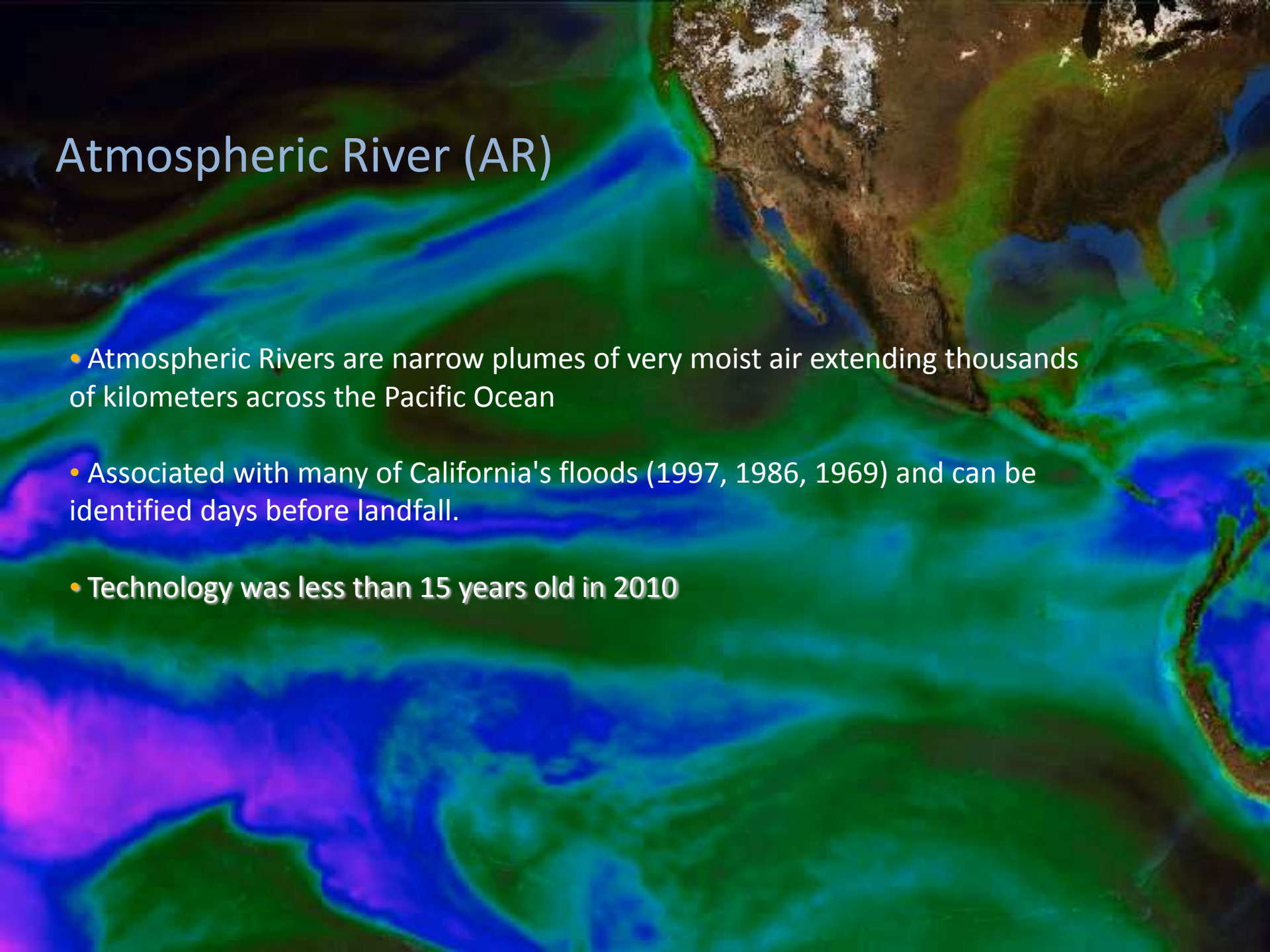
Atmospheric River (AR)

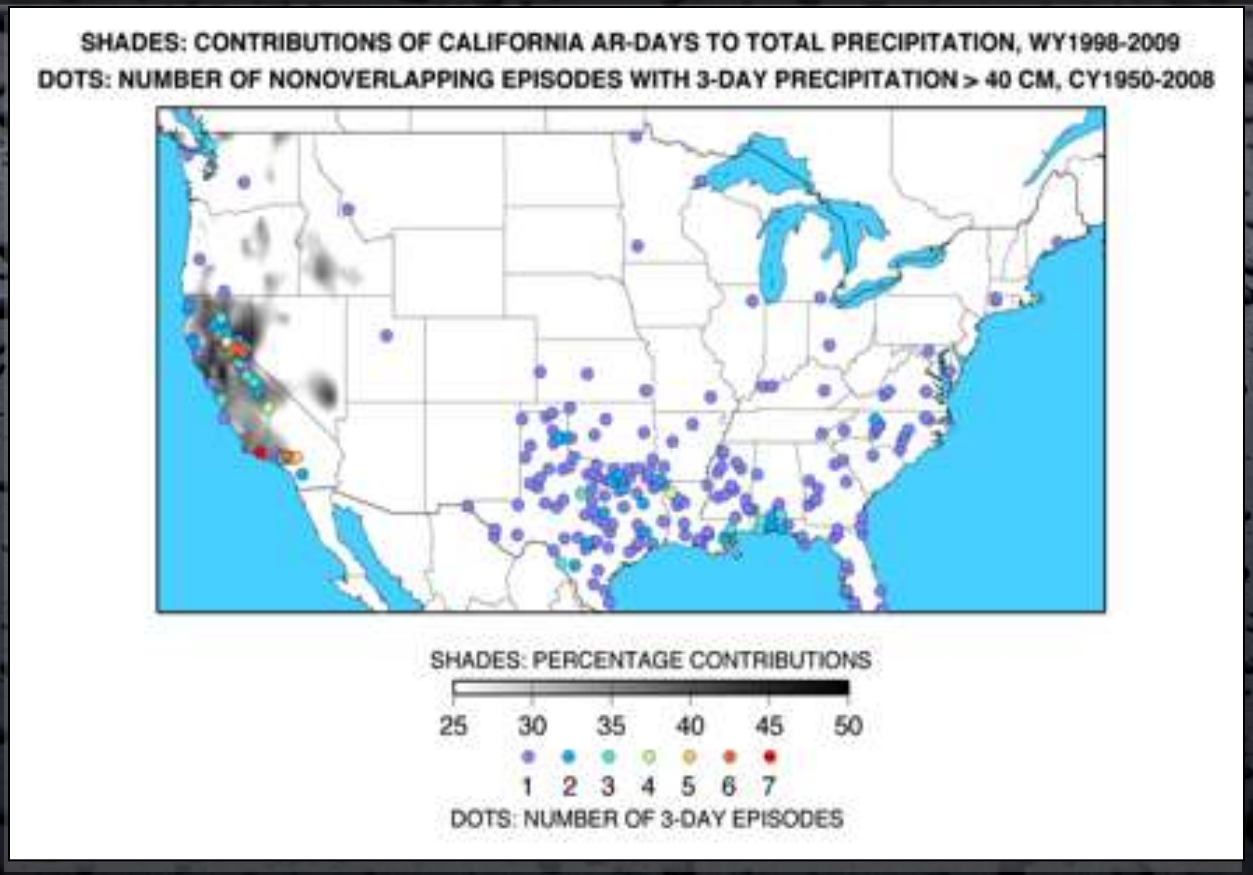


- Atmospheric Rivers are narrow plumes of very moist air extending thousands of kilometers across the Pacific Ocean

- Associated with many of California's floods (1997, 1986, 1969) and can be identified days before landfall.

- Technology was less than 15 years old in 2010

ARs AS HAZARDS AND RESOURCES



- Dots illustrate ARs as sources of West Coast hazards, comparable in some ways to southeast hurricanes!
- Shading shows the amount of overall water supply that they provide!

ARkStorm

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CLIMATE CHANGE PROJECTIONS

"Overall [in an evaluation of projections by three different Global Climate Models under a rapidly increasing greenhouse-gas emissions scenario], projections for California tend towards larger storm totals and more frequent extreme-precipitation events."

- Das, T., Dettinger, M., Cayan, D., and Hidalgo, H., in review, Potential increase in floods in California's Sierra Nevada under future climate projections: Climatic Change, 33 p.

AR Storm

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ARkStorm Movie

https://www.youtube.com/watch?v=8P-N-HA9iS8

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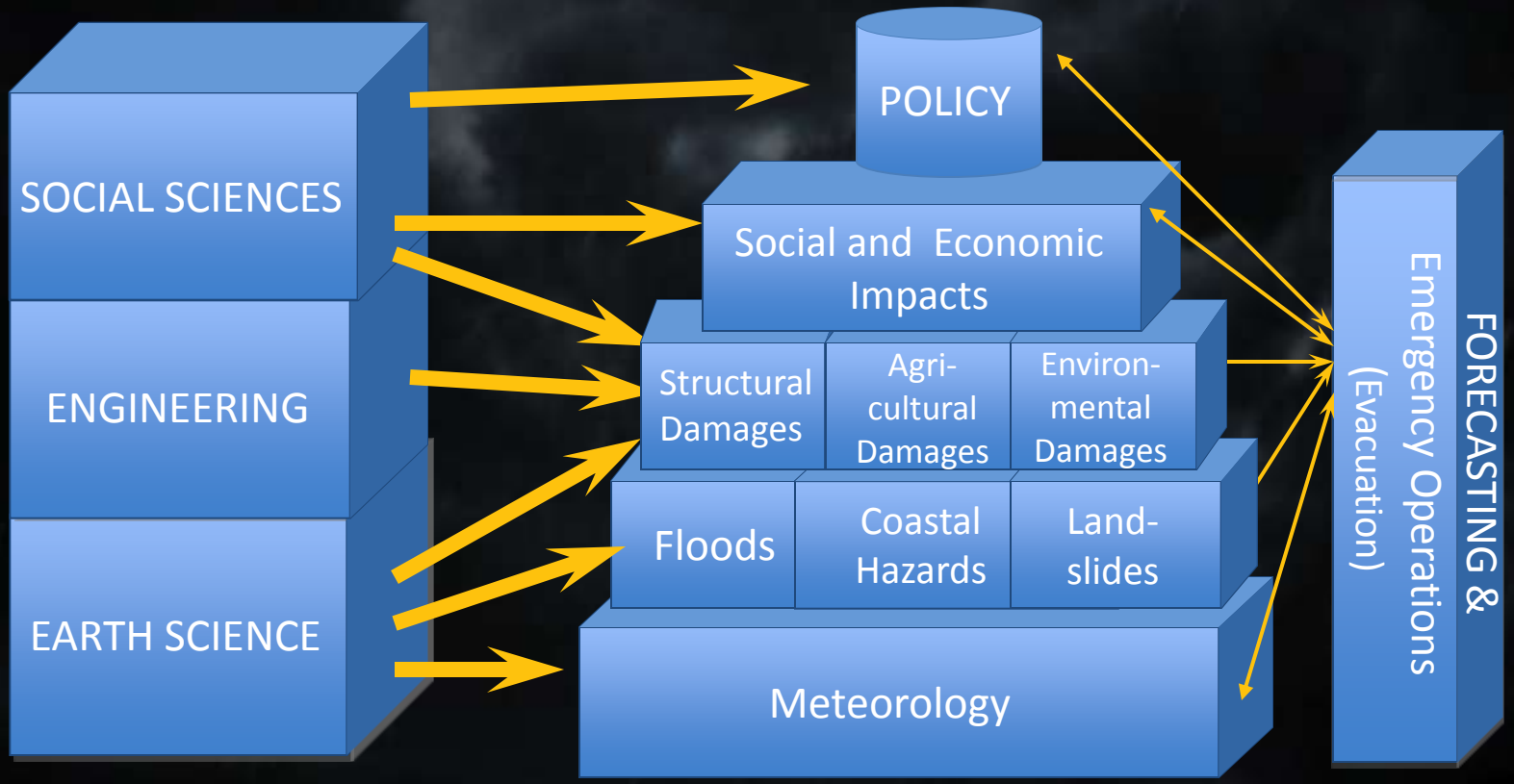
Building the ARkStorm Scenario



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Summary of ARkStorm Meteorological Events

Hydrologic and hydraulic modeling proved too time consuming and costly

ARkStorm

BUILDING DAMAGES: HAZUS inventory & damage equations

Wind Damage

$5.6 B building damage

Flood Damage

$195 B building damage
$103 B content damage

ARkSTORM HIGHWAY DAMAGE

- Flooding (blue) and landslides (yellow and red) disrupt traffic statewide
- Some bridge scour & collapses occur; Culverts can be blocked, scour roadway (green)

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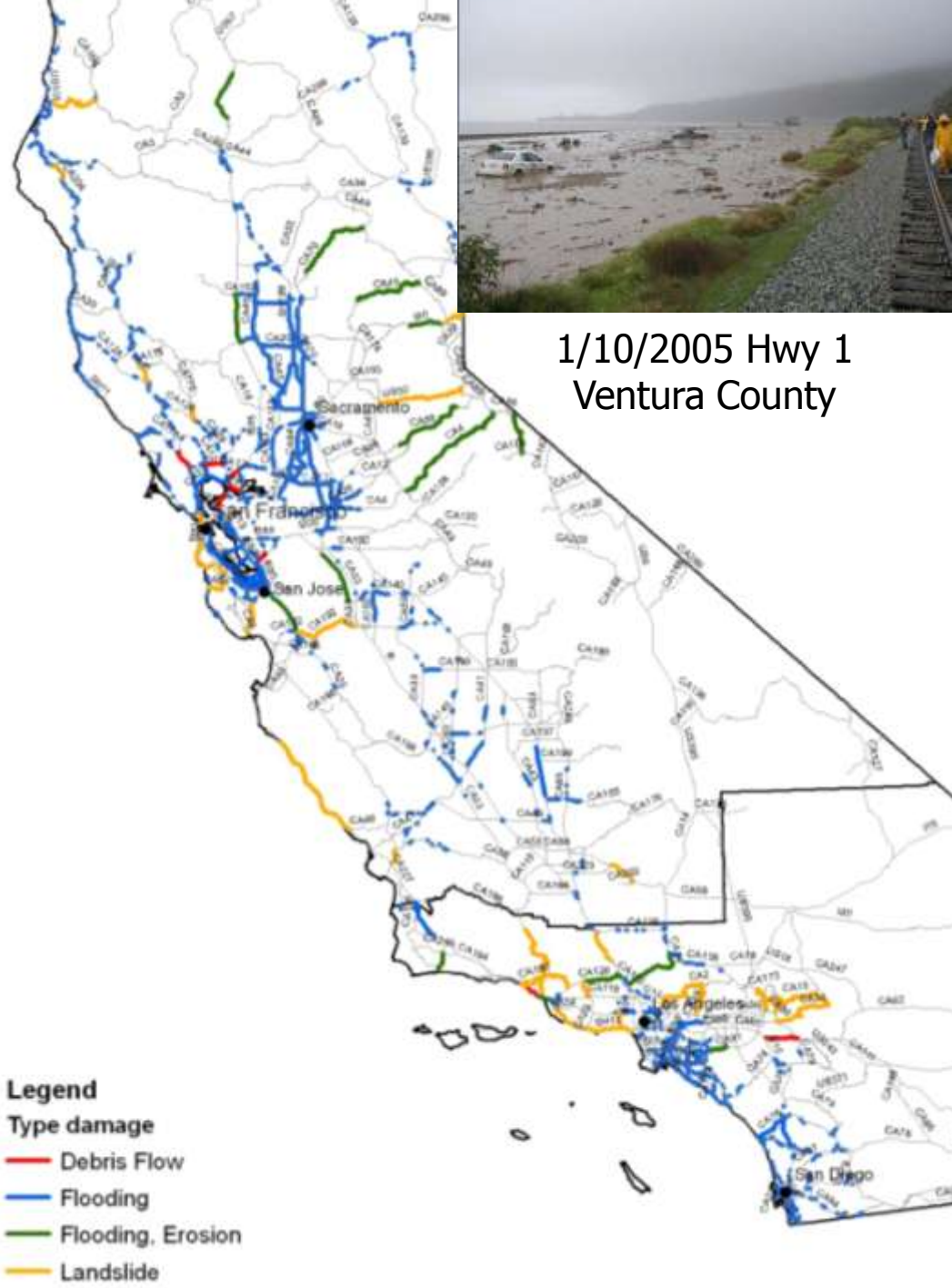
ARkStorm

1/10/2005 Hwy 1
Ventura County

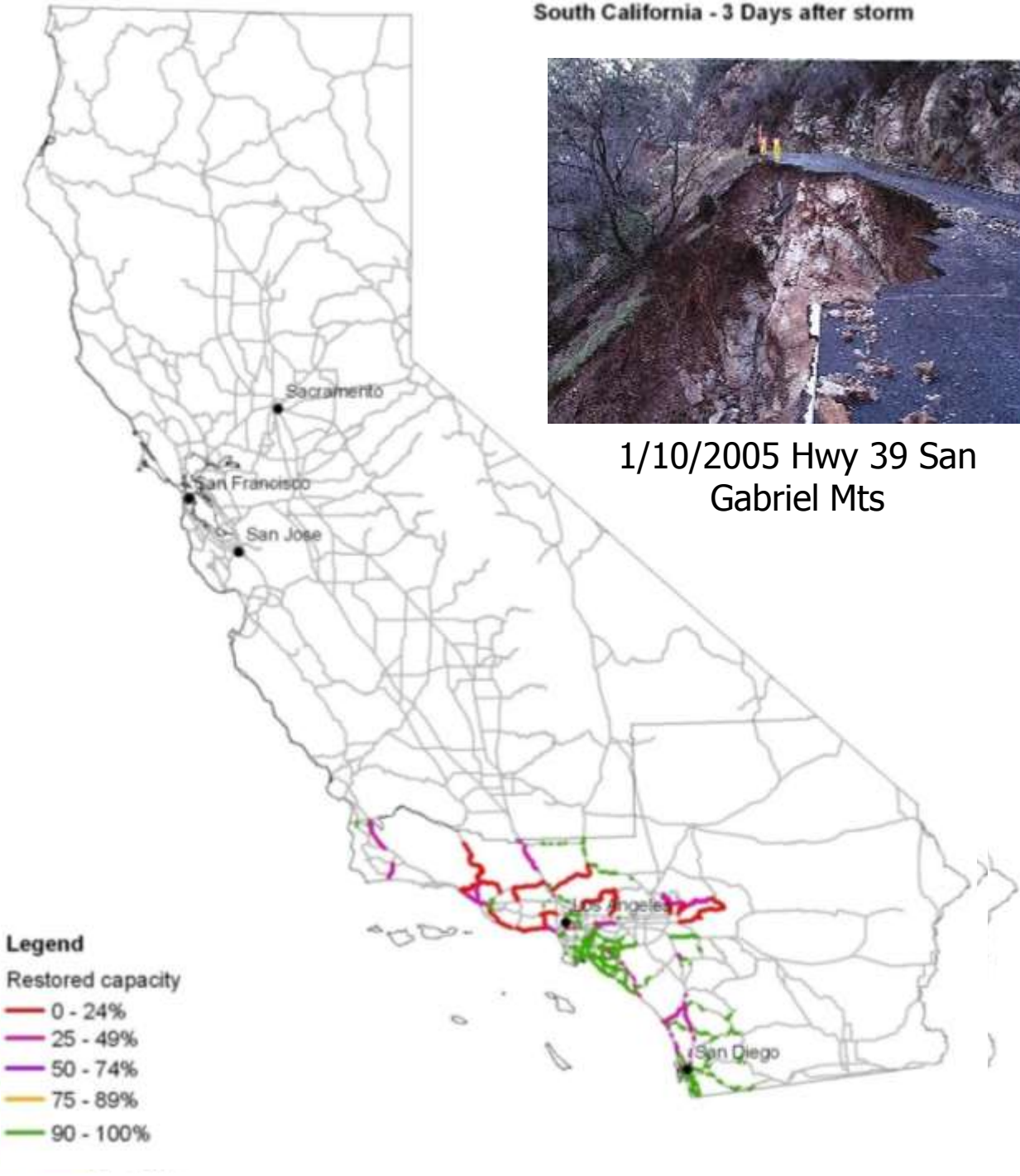


ARkSTORM HIGHWAY CAPACITIES

- Roads mostly passable once flooding recedes
- Scour, landslides & debris flows can take weeks or months to clear
- LA & Orange Counties cut off to north & west for 1-2 weeks

South California - 3 Days after storm

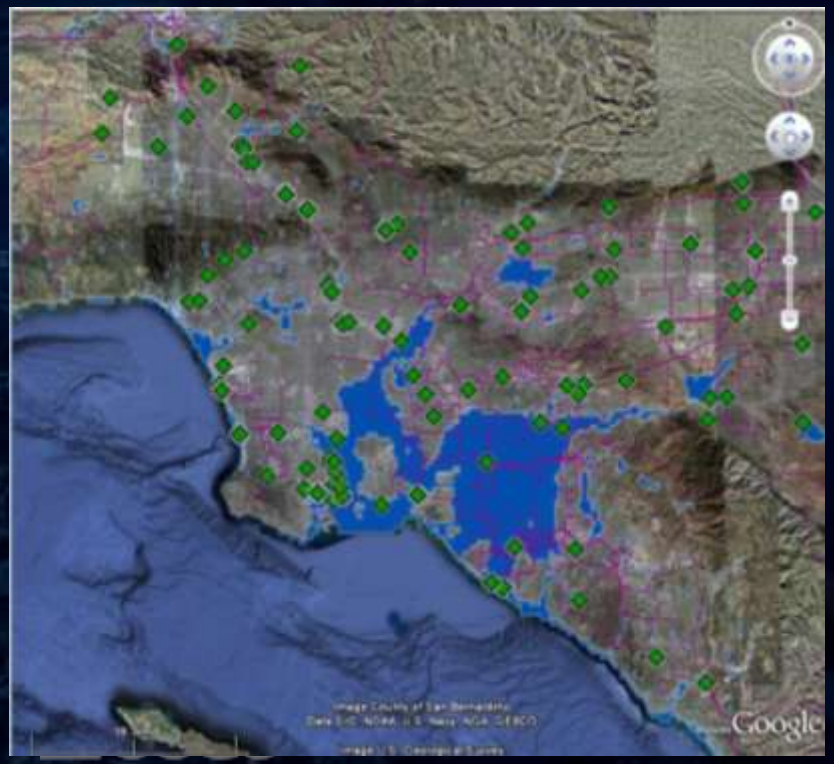
1/10/2005 Hwy 39 San Gabriel Mts

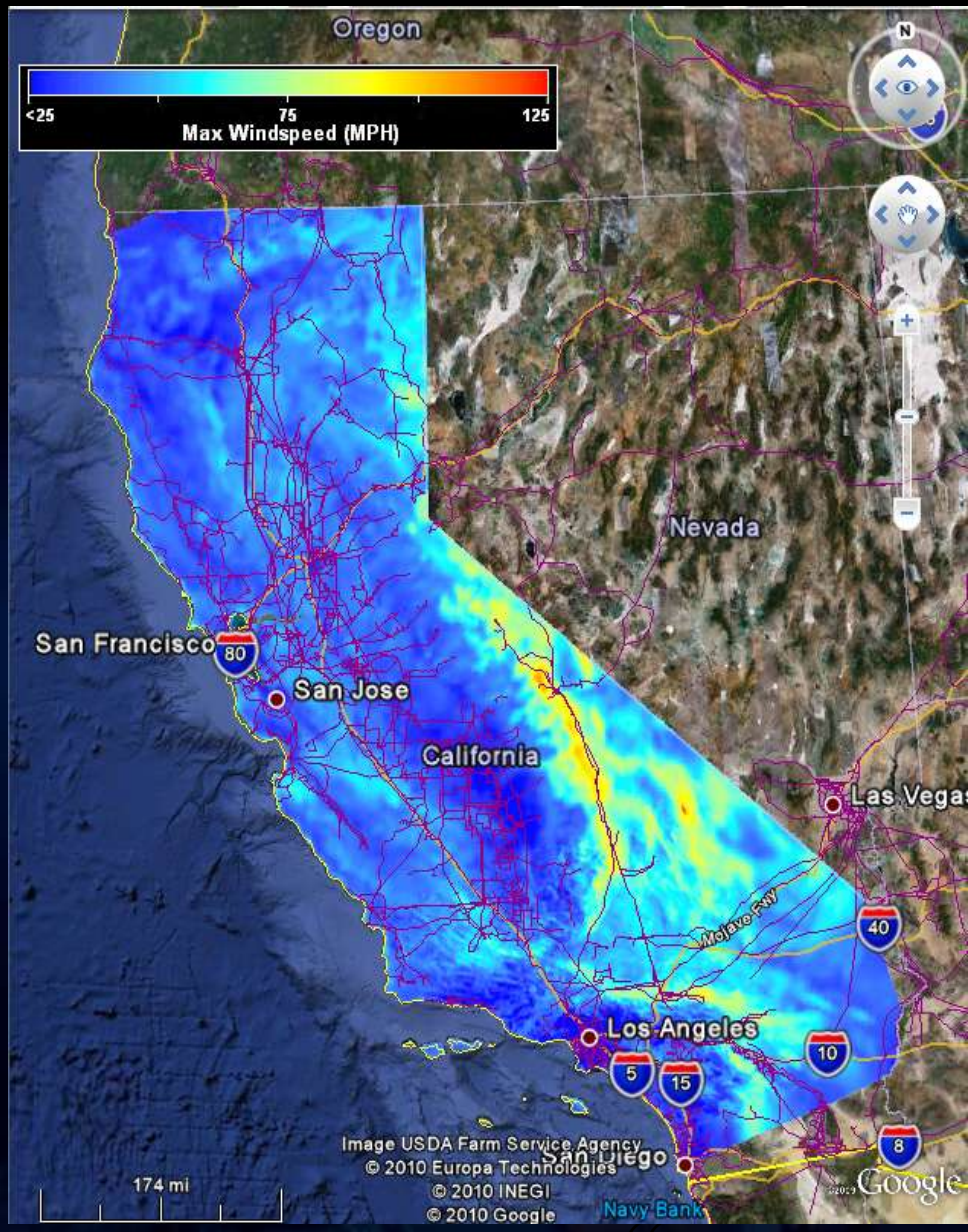


POWER OUTAGES

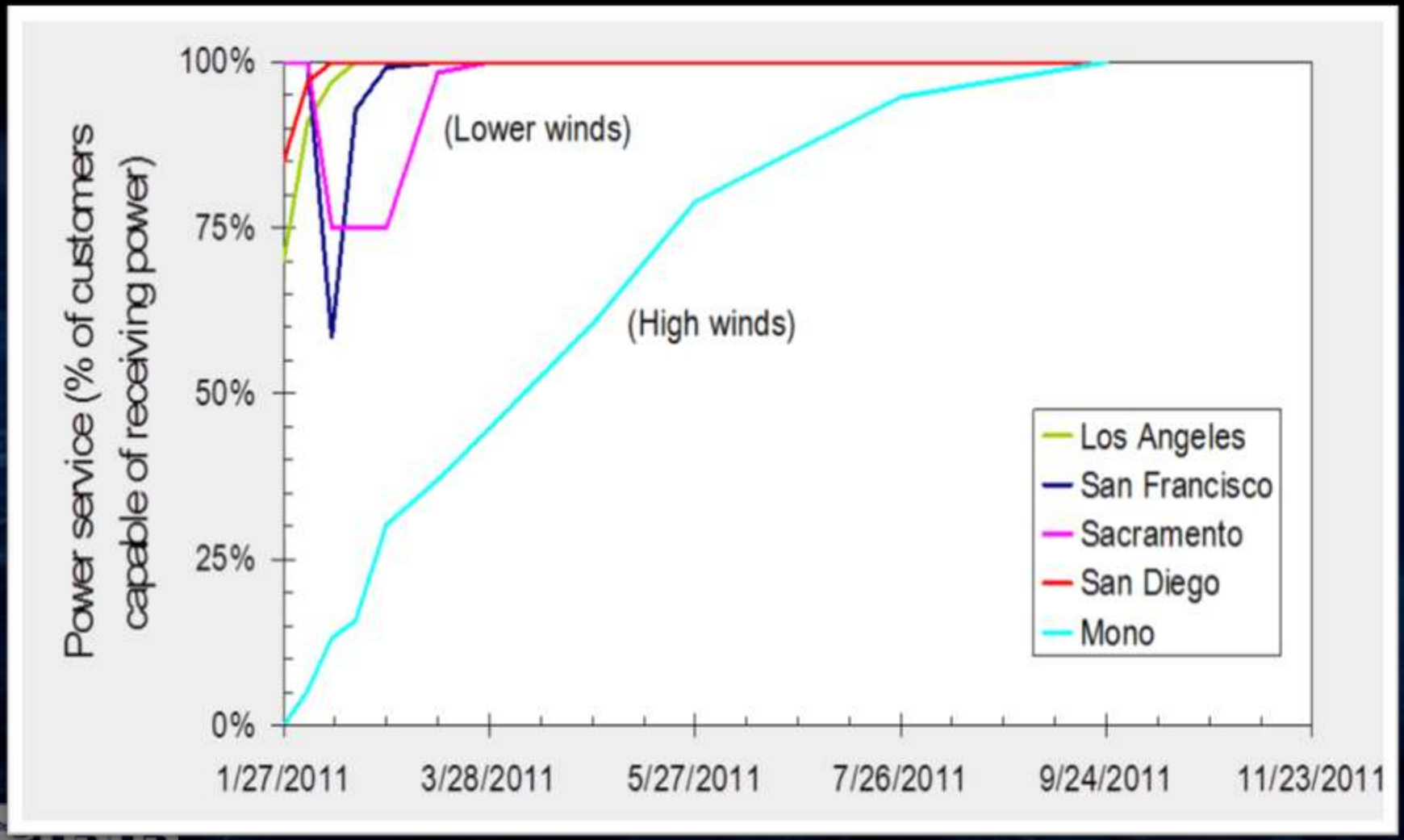
Wind & transmission lines

Flooding & power plants

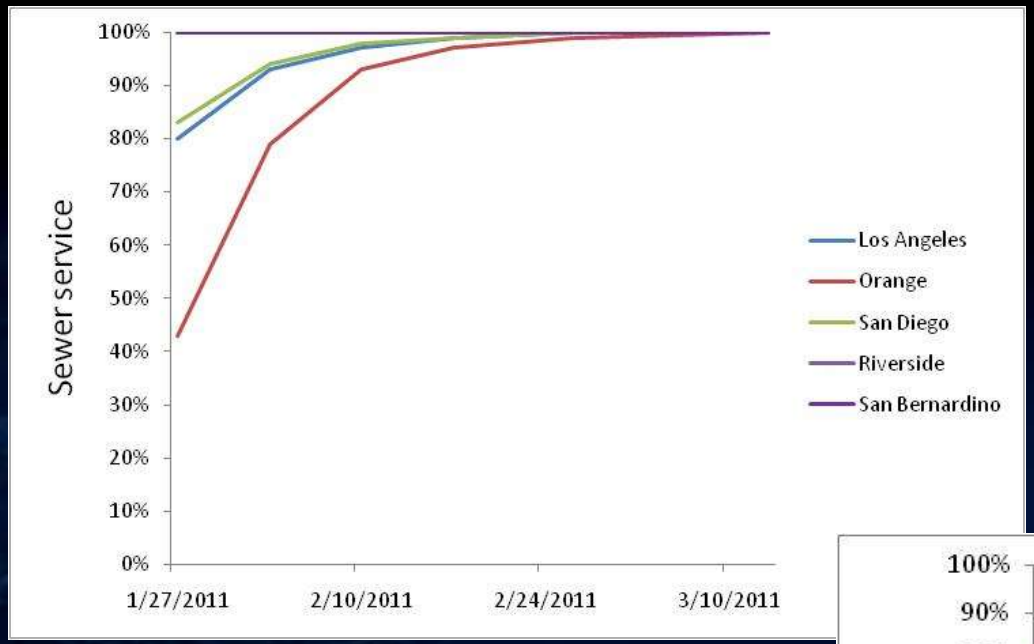


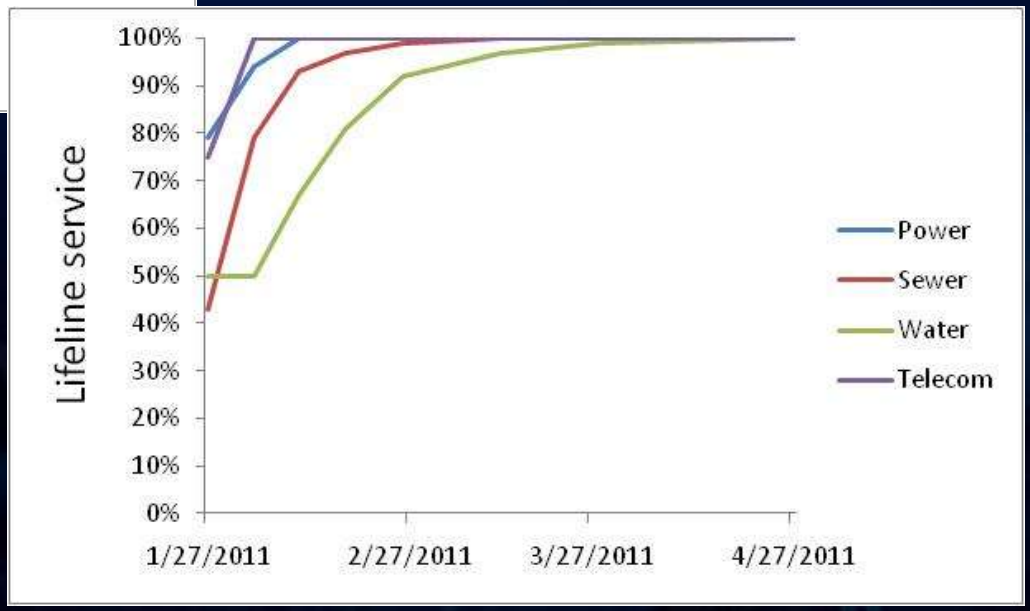


POWER OUTAGES



SEWER and ALL LIFELINE OUTAGES





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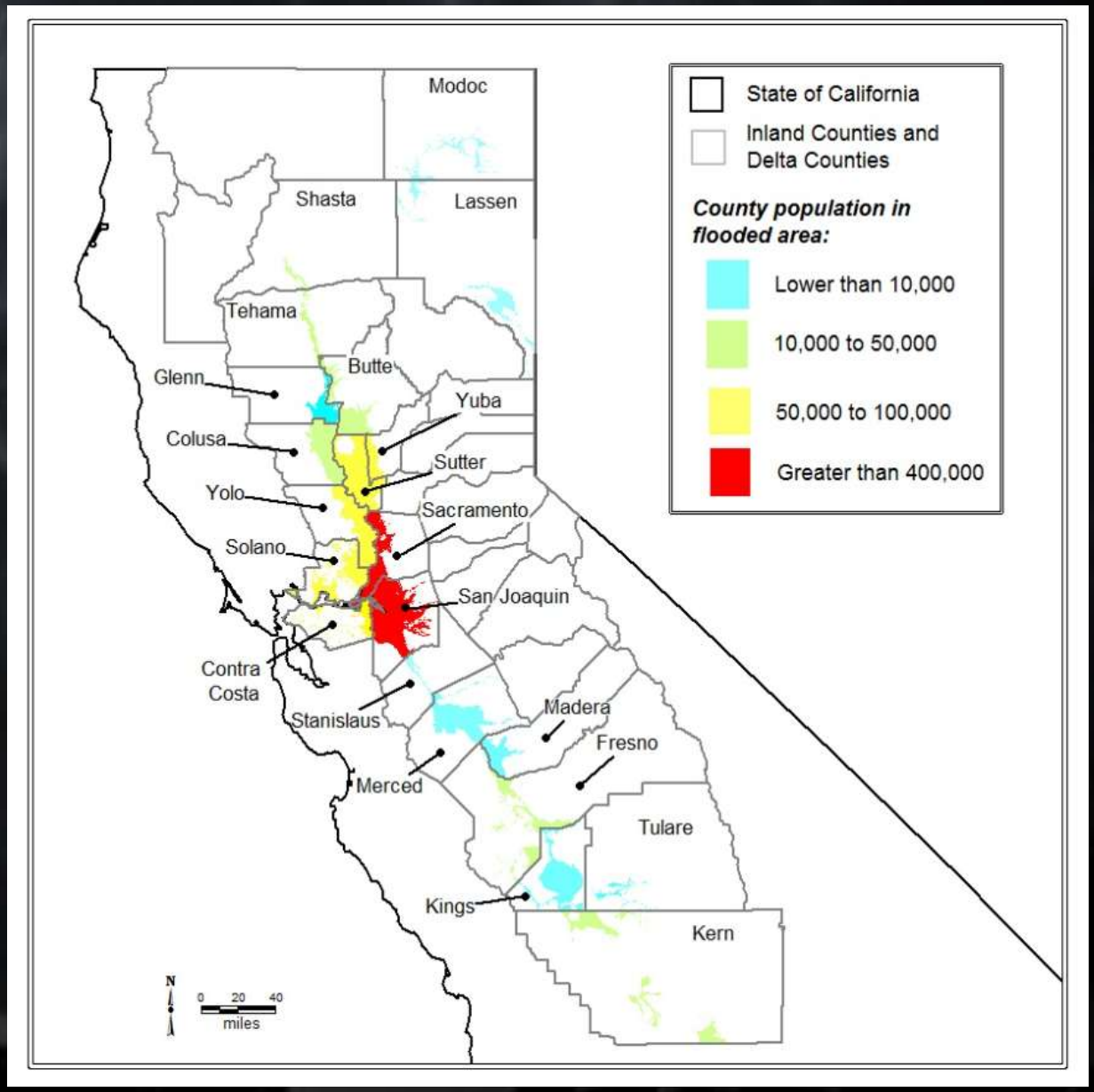
Orange county

ARkStorm Evacuation

- Inland region population in flooded area: 1.5 million people (20% of population)

- Displaced/shelter needs: 125,000 people



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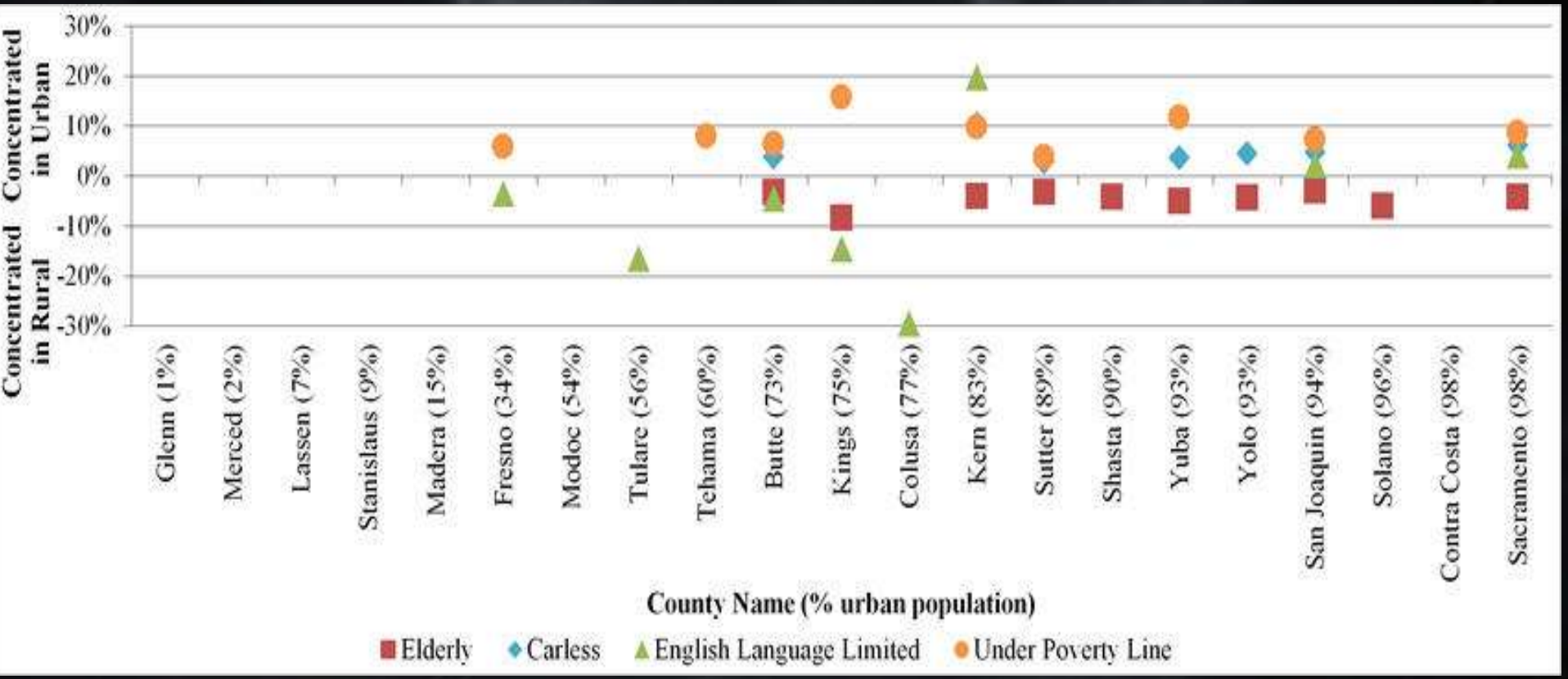
ARkStorm

ARkStorm Evacuees



EVACUEES - Historical

CA 1861-62 :

- 6-7 families sharing houses; 60 people in one room
- Scarcity of boats for evacuation; slapped together boats

CA 1938:

- 10,000s evacuated

CA 1969

- Helicopters evacuated sick and aged in isolated foothill areas

CA 1986:

- 45,000 evacuated, some refusals

CA 1997:

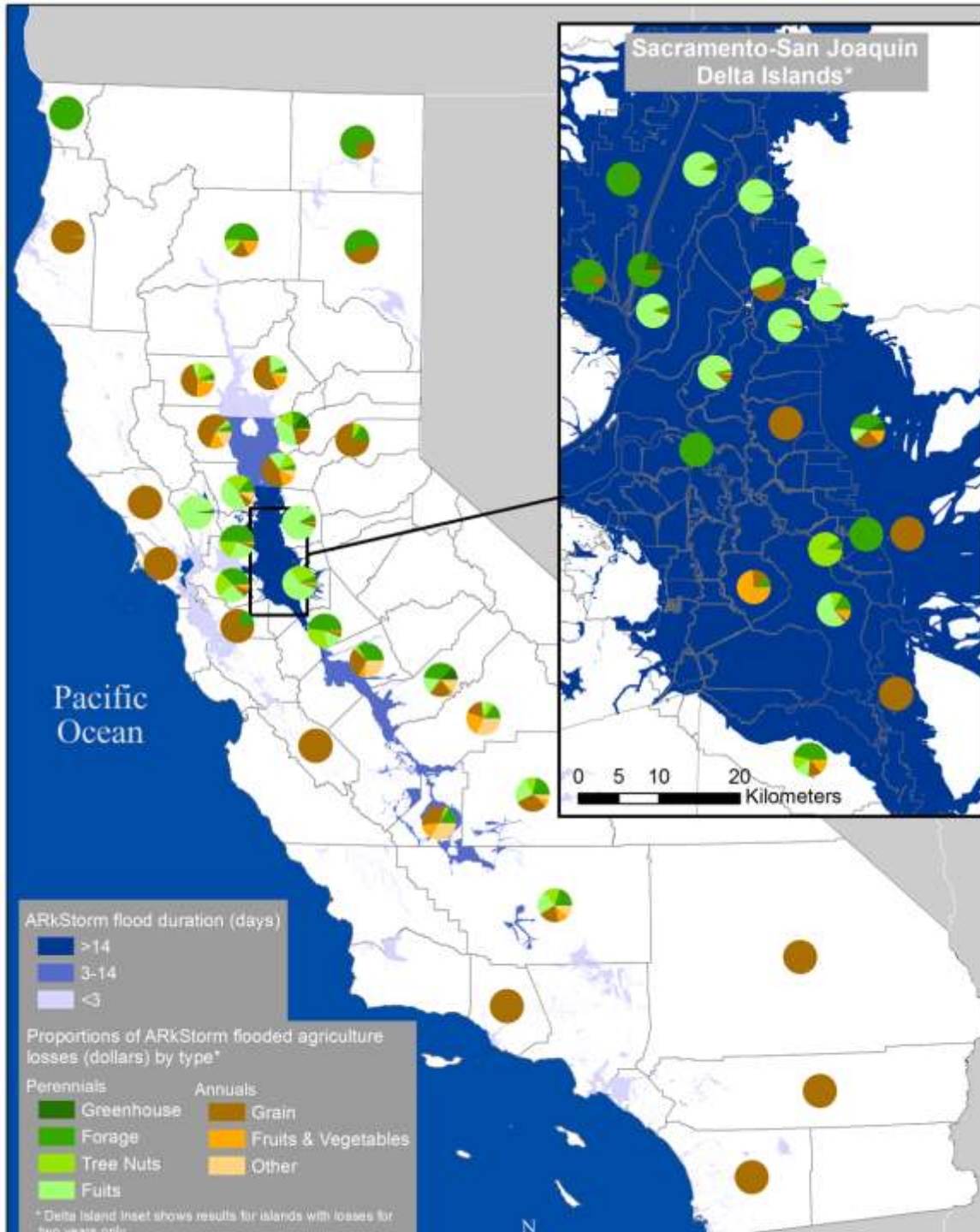
- 125,000 evacuated, some refusals (pets)

Massive Evacuations 2005

- Katrina: 1-1.2 million
- Rita: 2.5 million (models predicted .8-1 million)

ARkSTORM AGRICULTURAL LOSSES : from flooding

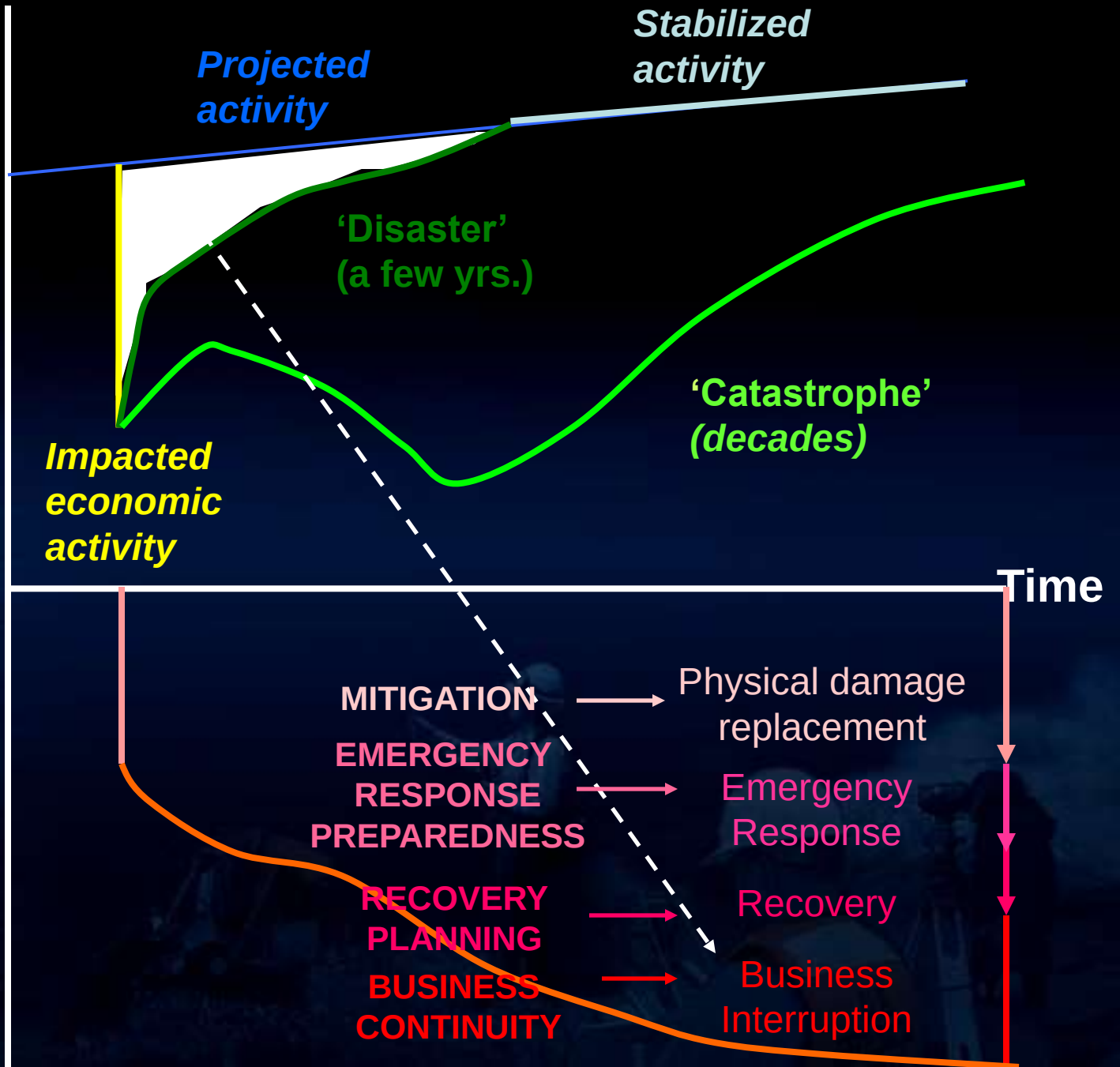
Commodity	Acres Production (1000s)	Percent Significant Damage
Annual crop	18,582	23%
Perennial crop	5,673	5%
Livestock	285	5%



Environmental Impacts: Animal feeding operations

- Flooding of waste storage lagoons and runoff from open lots, dispersal fields
- Pathogens, chemicals, carcasses posing health risks
- Approximately 9% of California dairies/feedstock operations, and poultry flooded by ARkStorm
- Hurricane Floyd flooding example

ECONOMICS OF A NATURAL DISASTER



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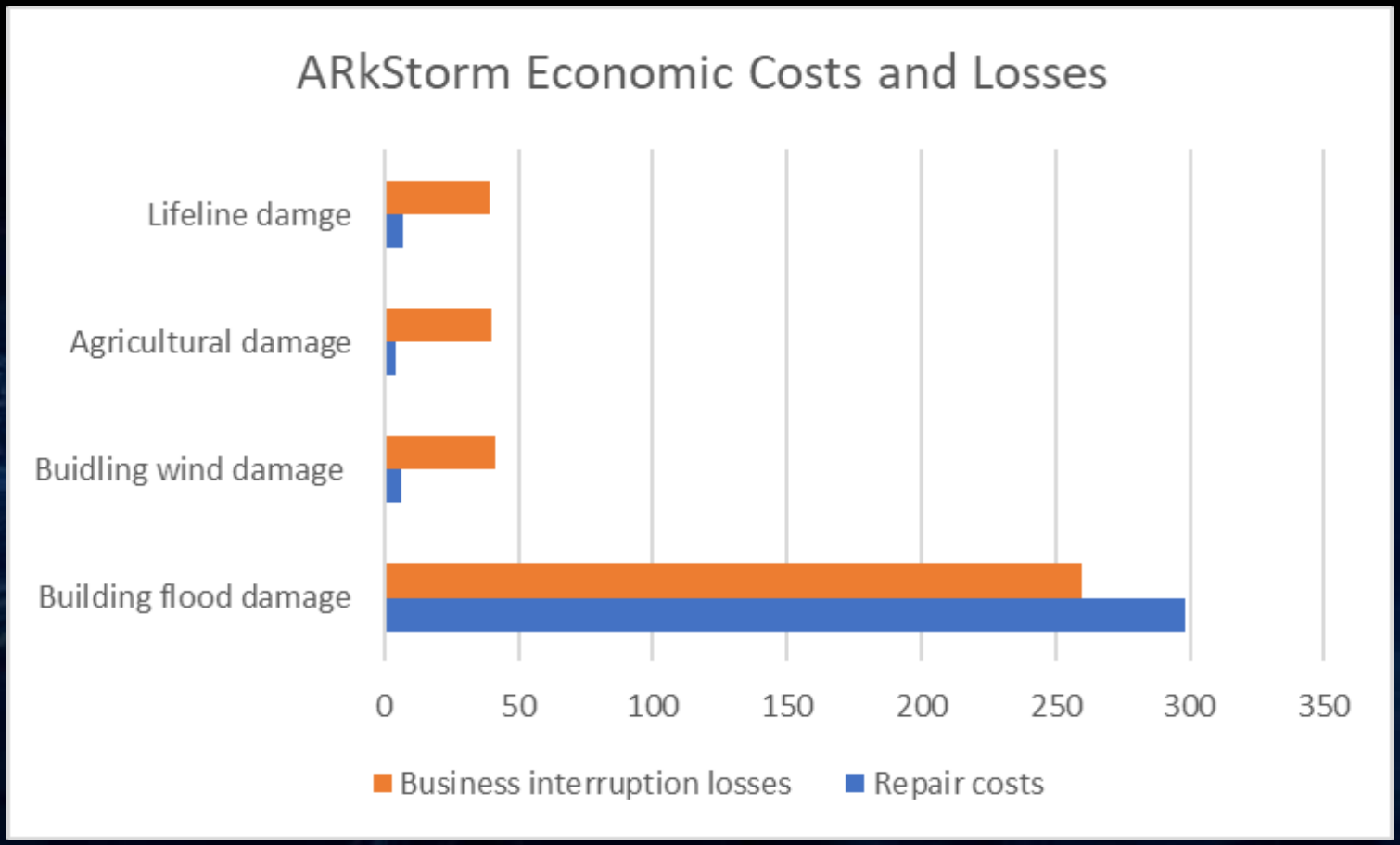
REPAIR/REPLACEMENT COSTS: $300+ B
BUSINESS INTERUPTION LOSSES: $300+ B



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Business interruption (with resilience) relative to projected GDP
Increases with delays in funding, less external funding, les resilience

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HERA: visualizing impacts of coastal storms and rising sea levels in California

www.usgs.gov/apps/hera

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U.S. Department of the Interior
U.S. Geological Survey

Hazard Exposure Reporting and Analytics (HERA)

Coastal flooding

Past El Niño storm damage in California:

- ~$1.2 billion (‘82-83)
- ~$1.1 billion (‘97-98)

Coastal storm impacts likely to worsen due to **sea level rise**, **changing wave climates**, and **changing shorelines**

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Which communities are more threatened by coastal flooding?

How will this change with rising sea levels?

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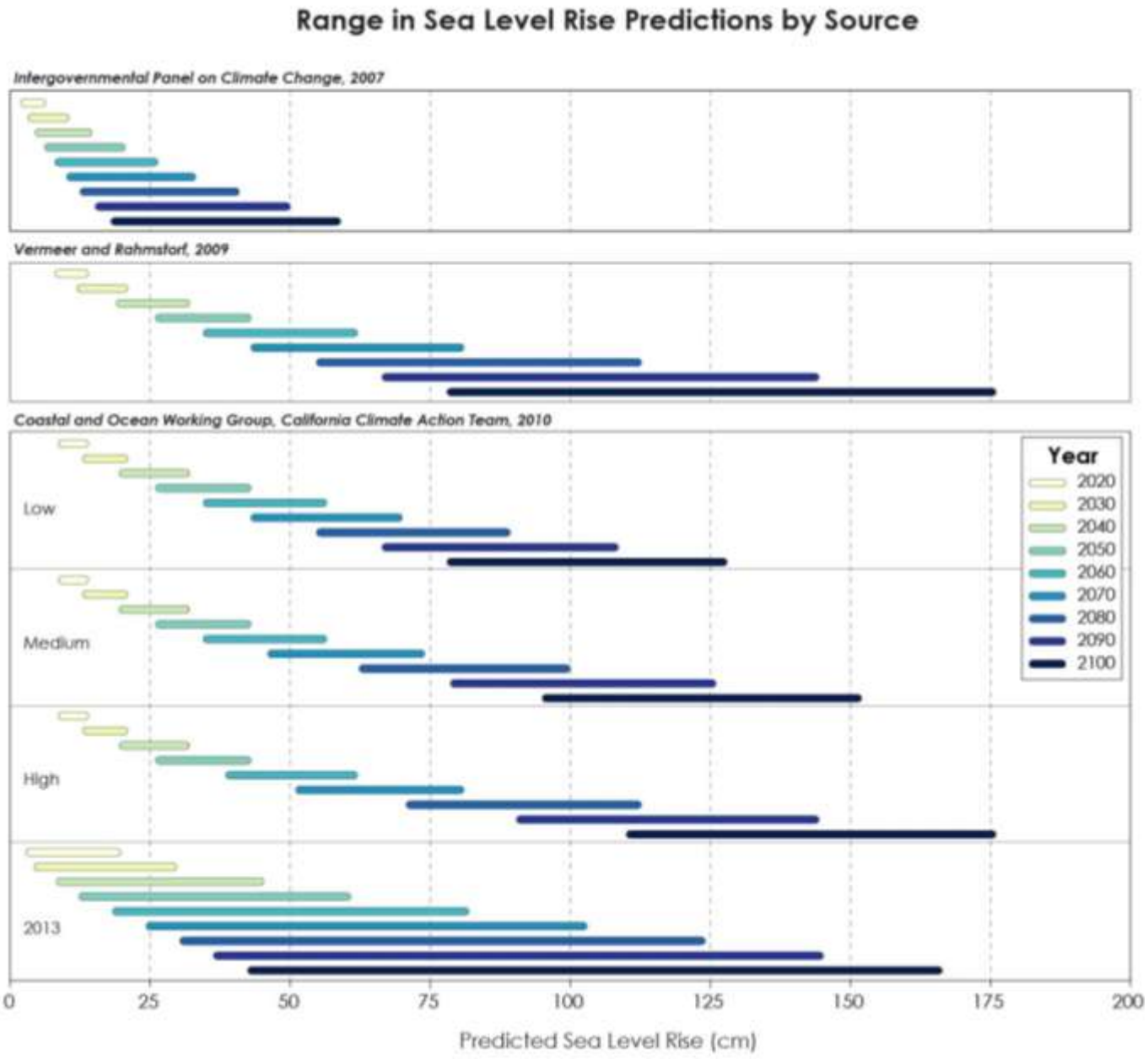
Providing Guidance on SLR Scenarios



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Providing Guidance on SLR Scenarios

OCOF
OUR COAST OUR FUTURE

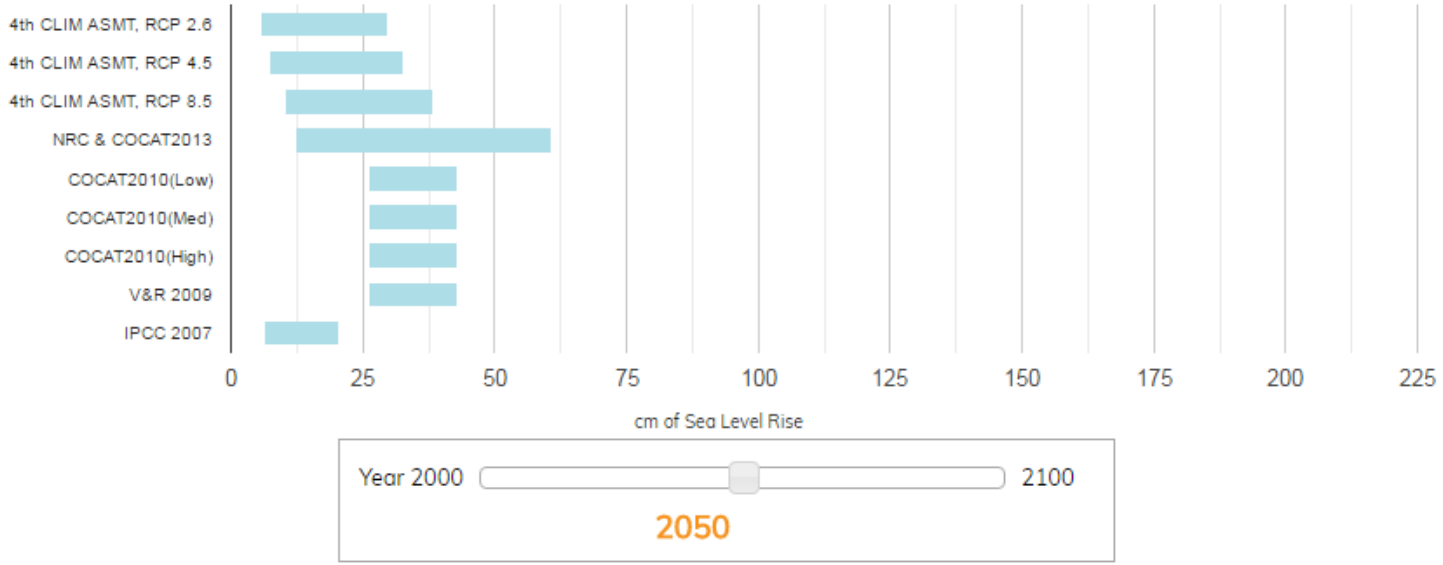
Comparing Sea Level Rise projections for California

Introduction

Your planning efforts for estimating sea level rise impacts appropriately should be derived from reputable sources of information. The graphs below provide a comparative look at some of
landscape of best projections and make more intelligent choices about which scenarios to look at more closely.

What projections are likely to occur in a given year?

Move the slider control below the graph left and right to see how different climate experts projections of sea level rise compare to one another. Hold your mouse over each bar for details.



http://data.pointblue.org/apps/ocof/tools/compare/

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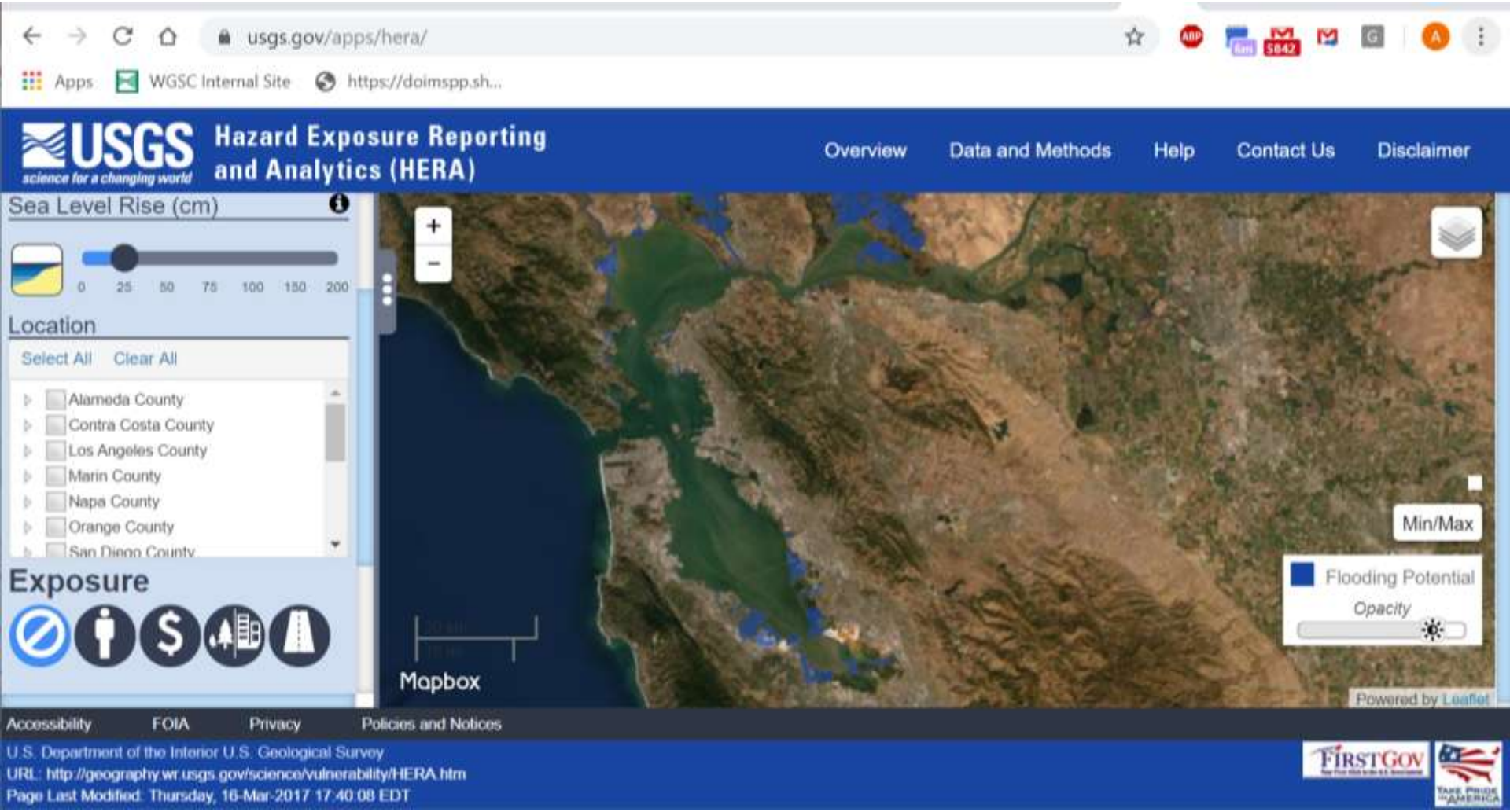
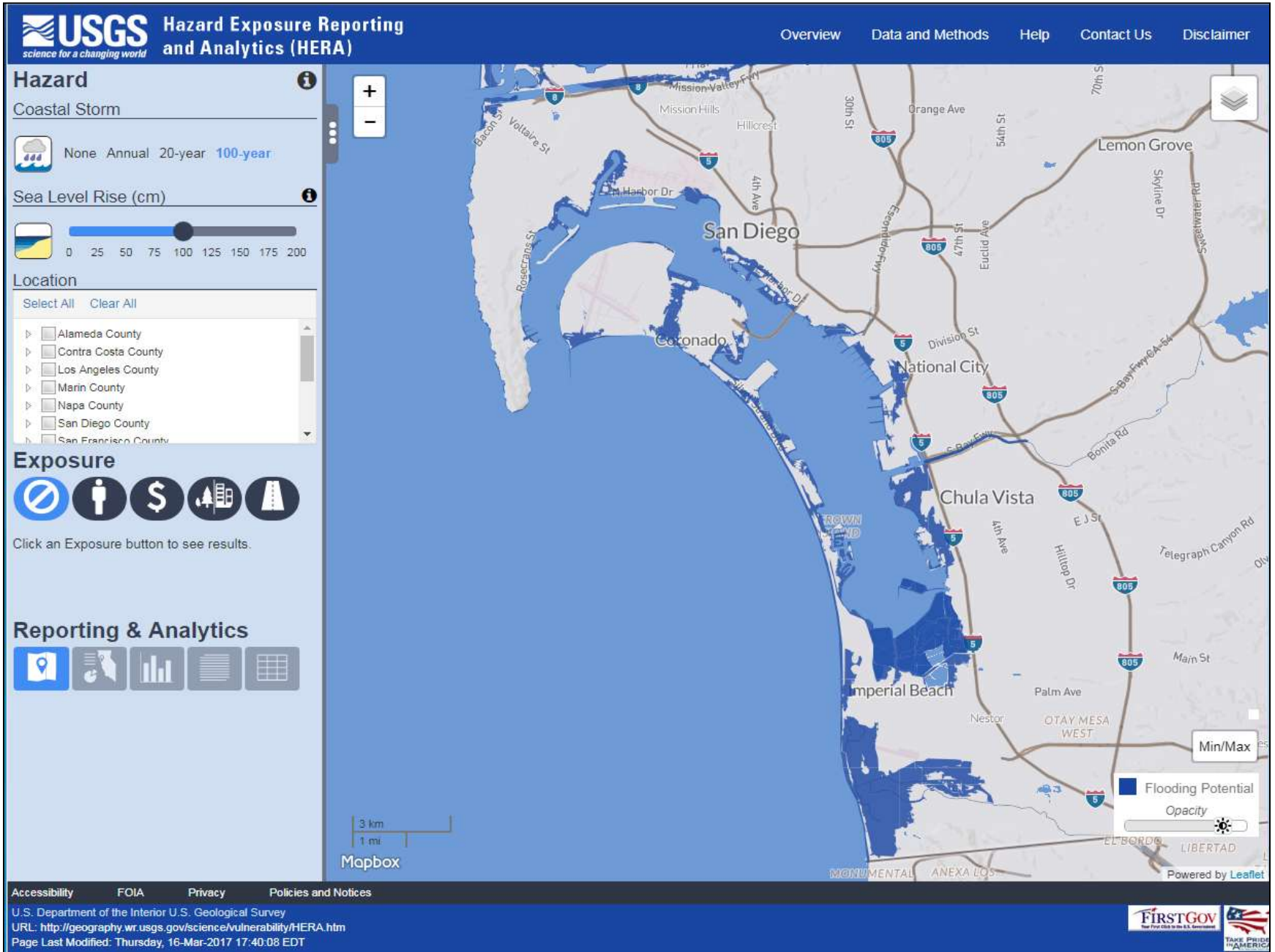
Our Coast Our Future

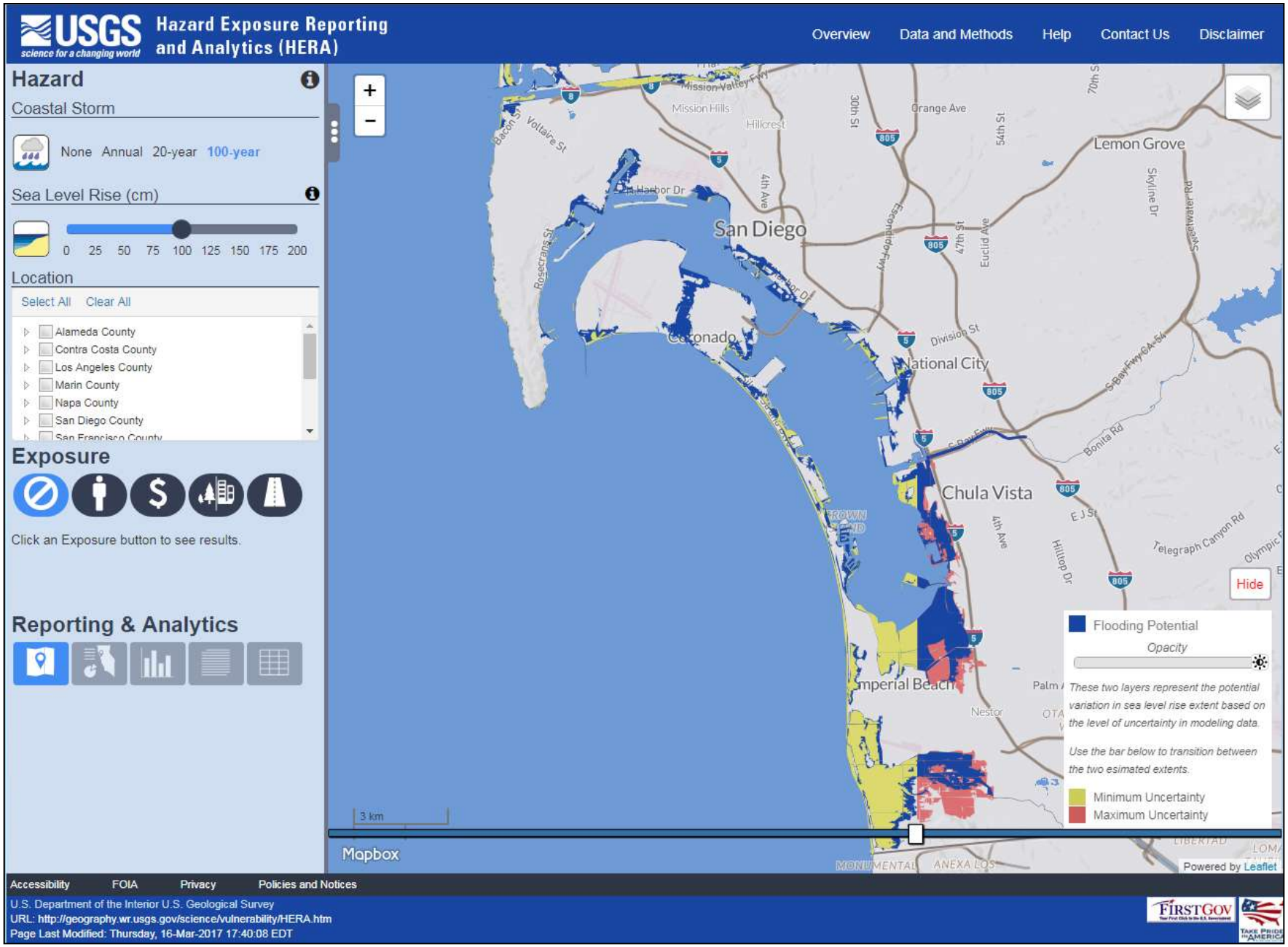
https://www.usgs.gov/apps/hera/



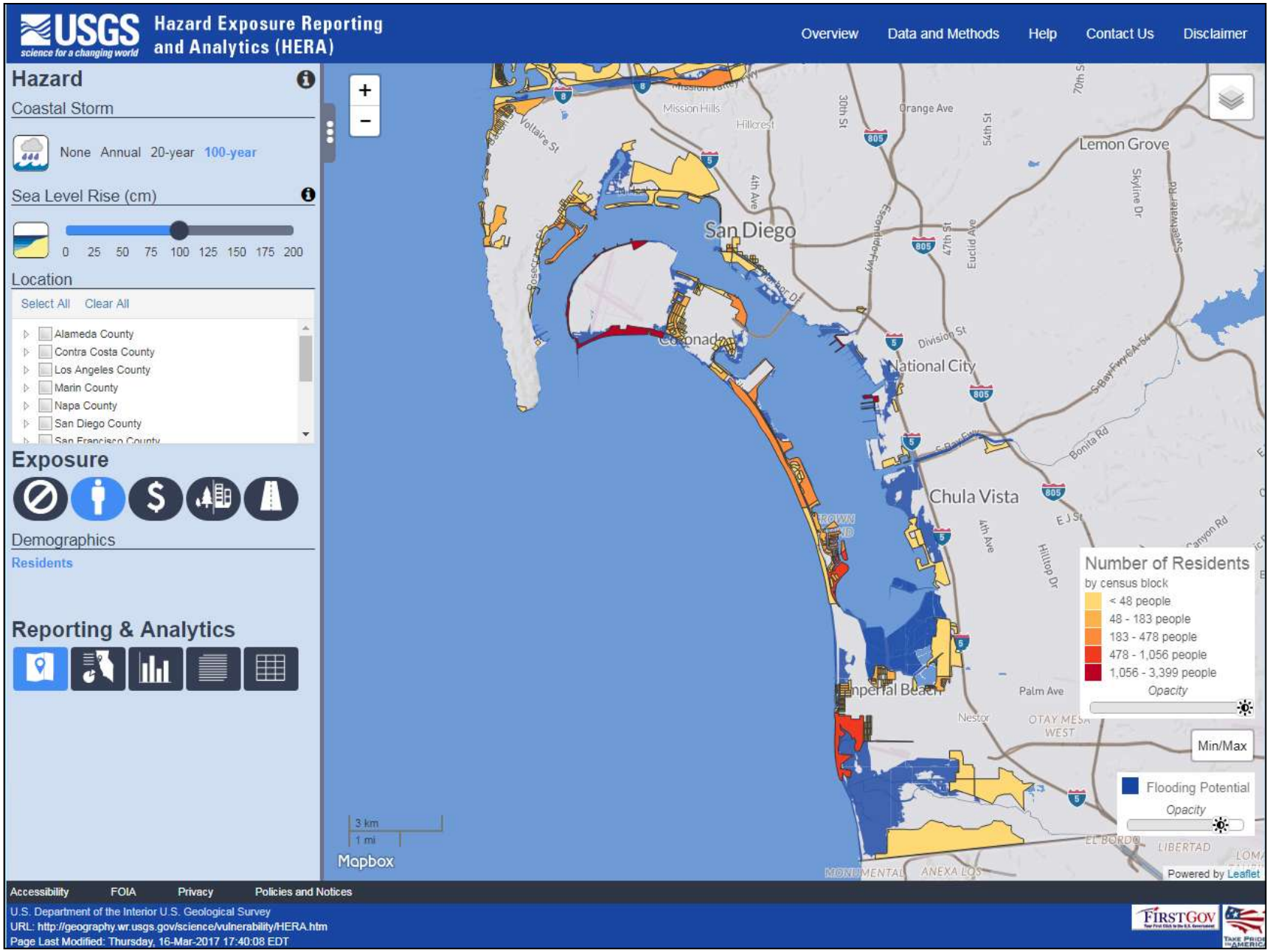
Maps of Flood Hazard Zones



Flood Hazard Zone Uncertainty

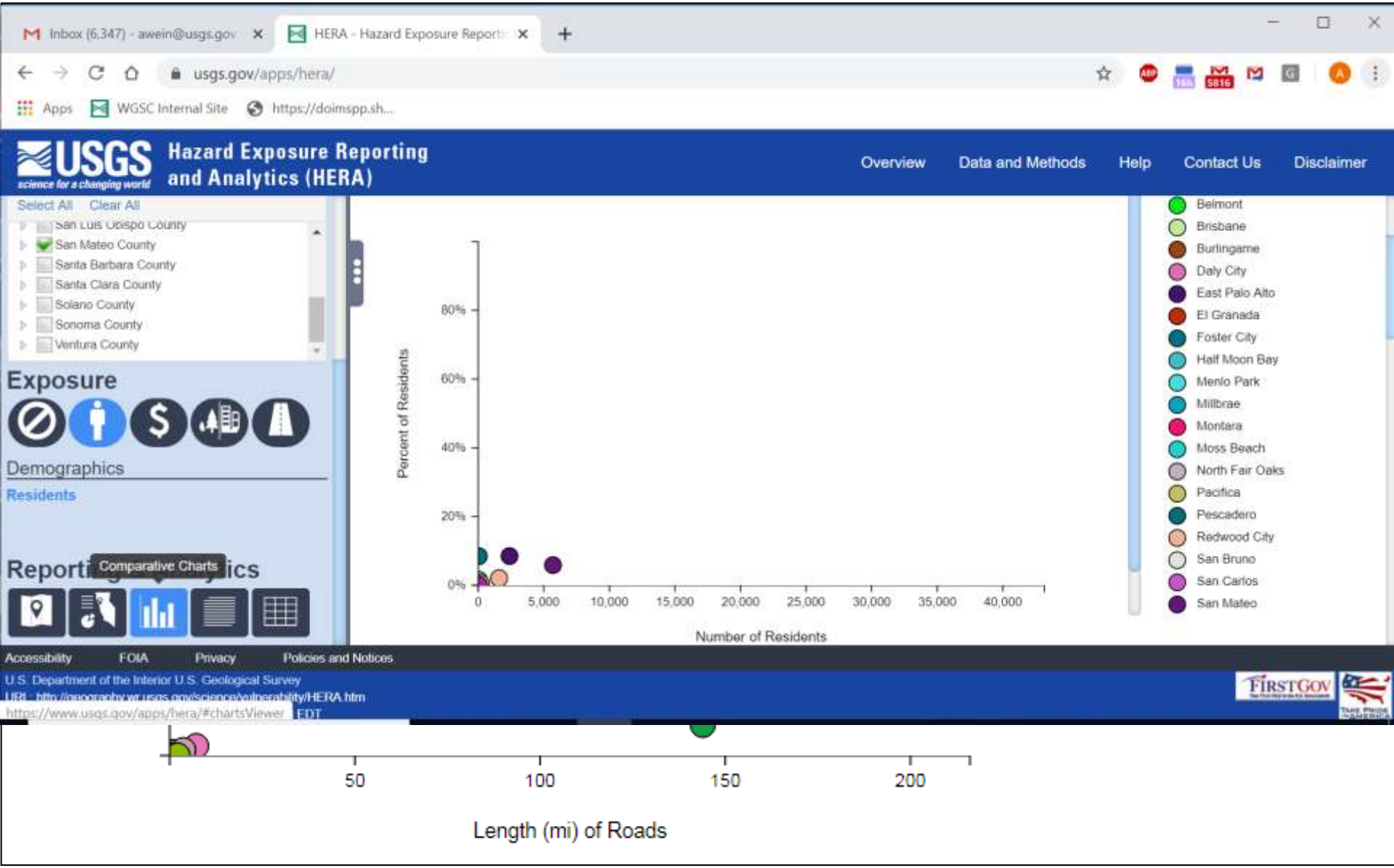


Maps of Flooding Exposure by Population/Asset



Comparative Metrics

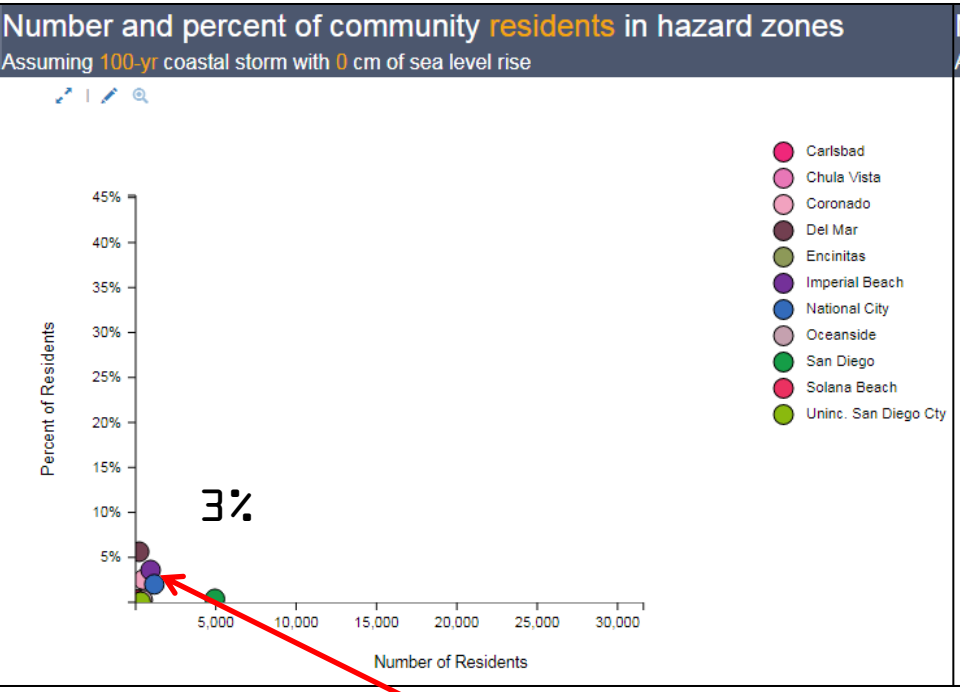
number vs. community percentage of asset in hazard zone

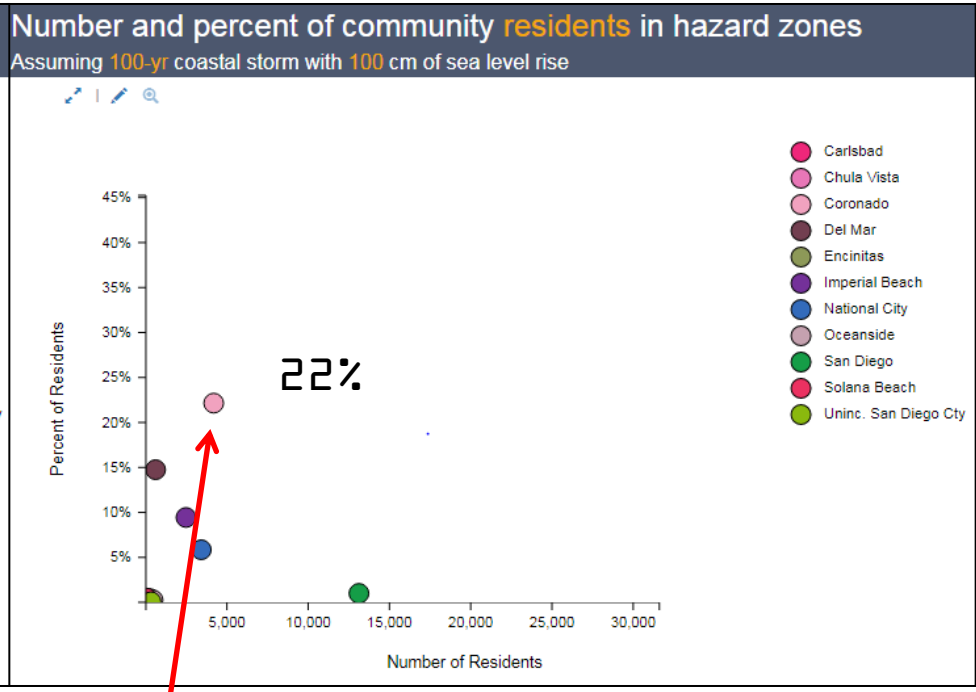


Comparative Metrics

impact of sea level rise

100 year storm, no SLR100 year storm, 100 cm





City of Coronado

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Community Exposure to Coastal Hazards in California

HAZARDS

CoSMoS

COASTAL FLOODING EXTENT based on:

STORM FREQUENCY

None
Annual
20-year
100-year

SEA LEVEL RISE SCENARIOS

0 cm	100 cm
25 cm	125 cm
50 cm	150 cm
75 cm	175 cm
	200 cm

COMMUNITIES

AVAILABLE COUNTIES

Marin
Sonoma
Napa
Solano
Contra Costa
Alameda
Santa Clara
San Mateo
San Francisco
Santa Barbara
Ventura
Los Angeles
Orange*
San Diego

*COMING SOON

ASSETS

DEMOGRAPHICS

- Total Residents
- Race: White, Black, American Indian, Asian, Pacific Islander, Other
- Ethnicity: Hispanic
- Age: Under 5, Over 65
- Total Occupied Housing Units: Owners, Renters
- Group Quarters: Institutionalized, Non-Instit.

ECONOMICS

- Total Employees
- Employment Sector: government and critical facilities, manufacturing, services, natural resources, trade
- Total Parcel Value: Land value, improved value
- Building Replacement Value: residential, commercial, industrial religion, government, education

INFRASTRUCTURE

- Roads: highways, secondary roads, surface streets
- Rail
- Critical Facilities: police stations, fire stations, schools, hospitals, medical clinics, care facilities, medical services

LAND COVER

- Developed Land
- Wetlands
- Others: pasture or crops, forest, shrub or grassland, barren or open space

Earthquakes + Climate Change

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Prepared in cooperation with the California Geological Survey

The HayWired Earthquake Scenario—Earthquake Hazards

Scientific Investigation

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The HayWired Earthquake Scenario—Engineering Implications

Scientific Investigations Report 2017–5013–I–Q

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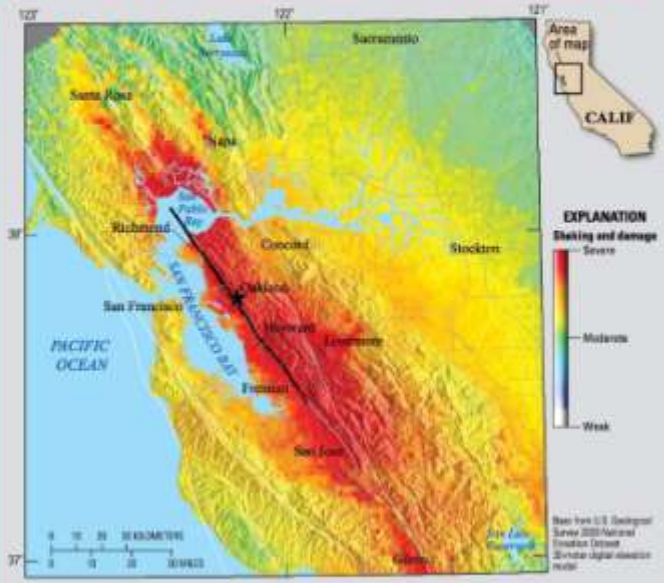
HAYWIRED

The HayWired Earthquake Scenario—

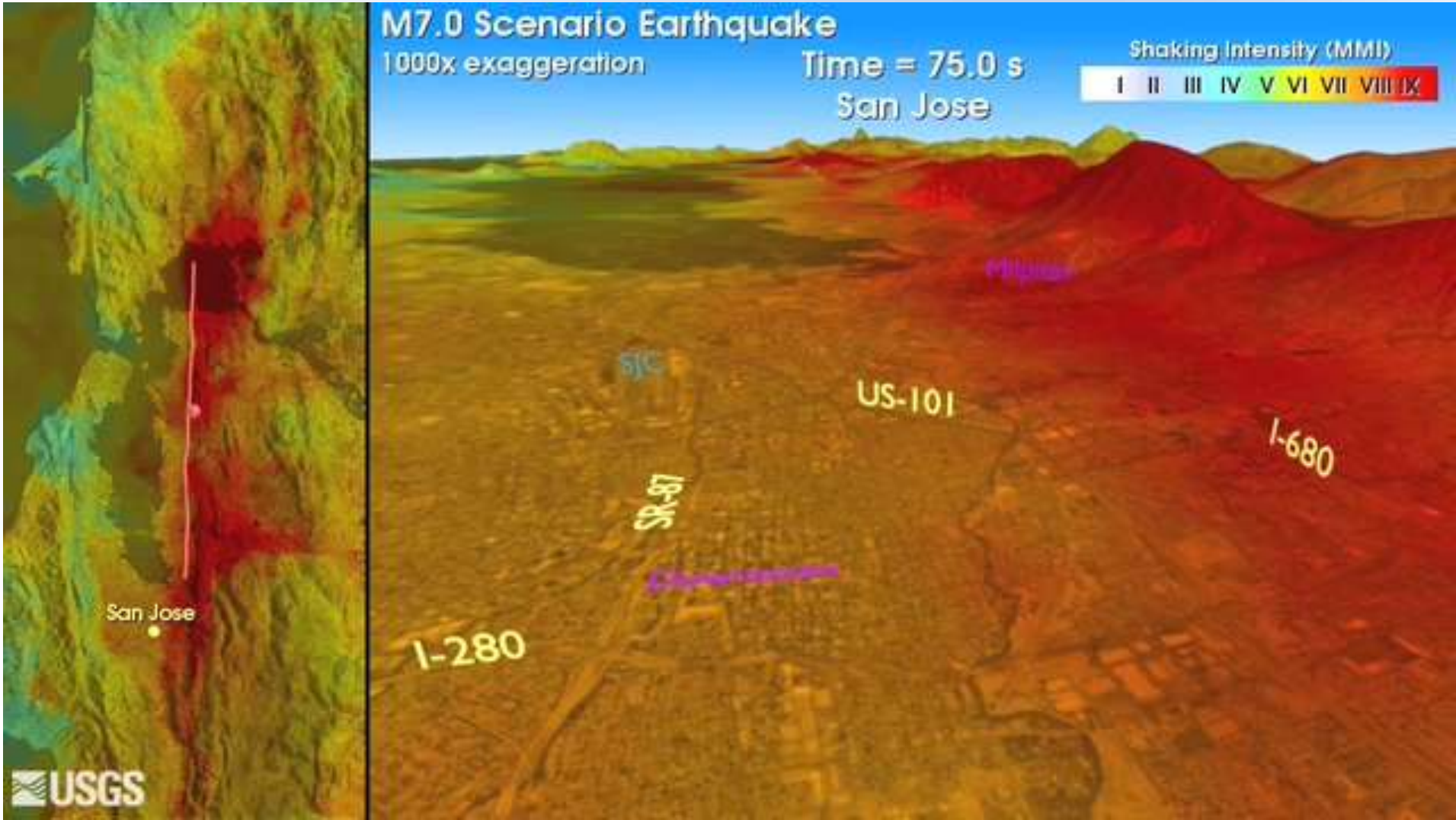
We Can Outsmart Disaster

The HayWired earthquake scenario, led by the U.S. Geological Survey (USGS), anticipates the impacts of a hypothetical magnitude-7.0 earthquake on the Hayward Fault. The fault is along the east side of California's San Francisco Bay and is among the most active and dangerous in the United States, because it runs through a densely urbanized and interconnected region. One way to learn about a large earthquake without experiencing it is to conduct a scientifically realistic scenario. The USGS and its partners in the HayWired Coalition and the HayWired Campaign are working to energize residents and businesses to engage in ongoing and new efforts to prepare the region for such a future earthquake.

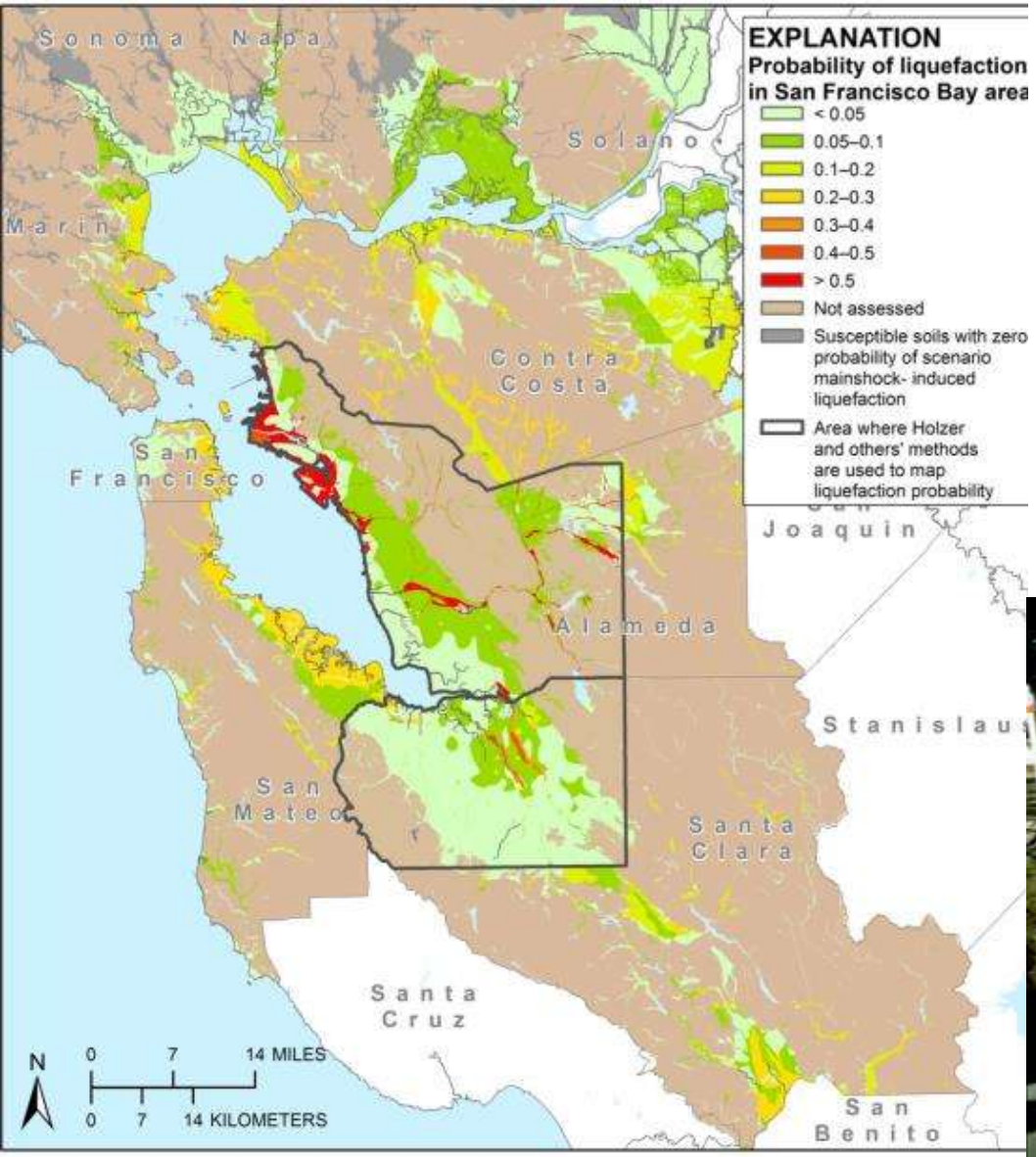


This map of the San Francisco Bay region, California, shows simulated ground shaking caused by the hypothetical magnitude-7.0 mainshock of the HayWired earthquake scenario on the Hayward Fault. Red shows the most extreme ground shaking and where damage is the worst. The mainshock begins beneath the City of Oakland (star) and causes the Hayward Fault to rupture along about 52 miles of its length (thick black line). White lines are other major faults in the region.

https://www.usgs.gov/media/videos/groundshaking-animation-hayward-fault-Oakland-epicenter
https://escweb.wr.usgs.gov/content/learn/topics/shakingsimulations/hayward/HaywardM70_OaklandEp_SanJose.mp4

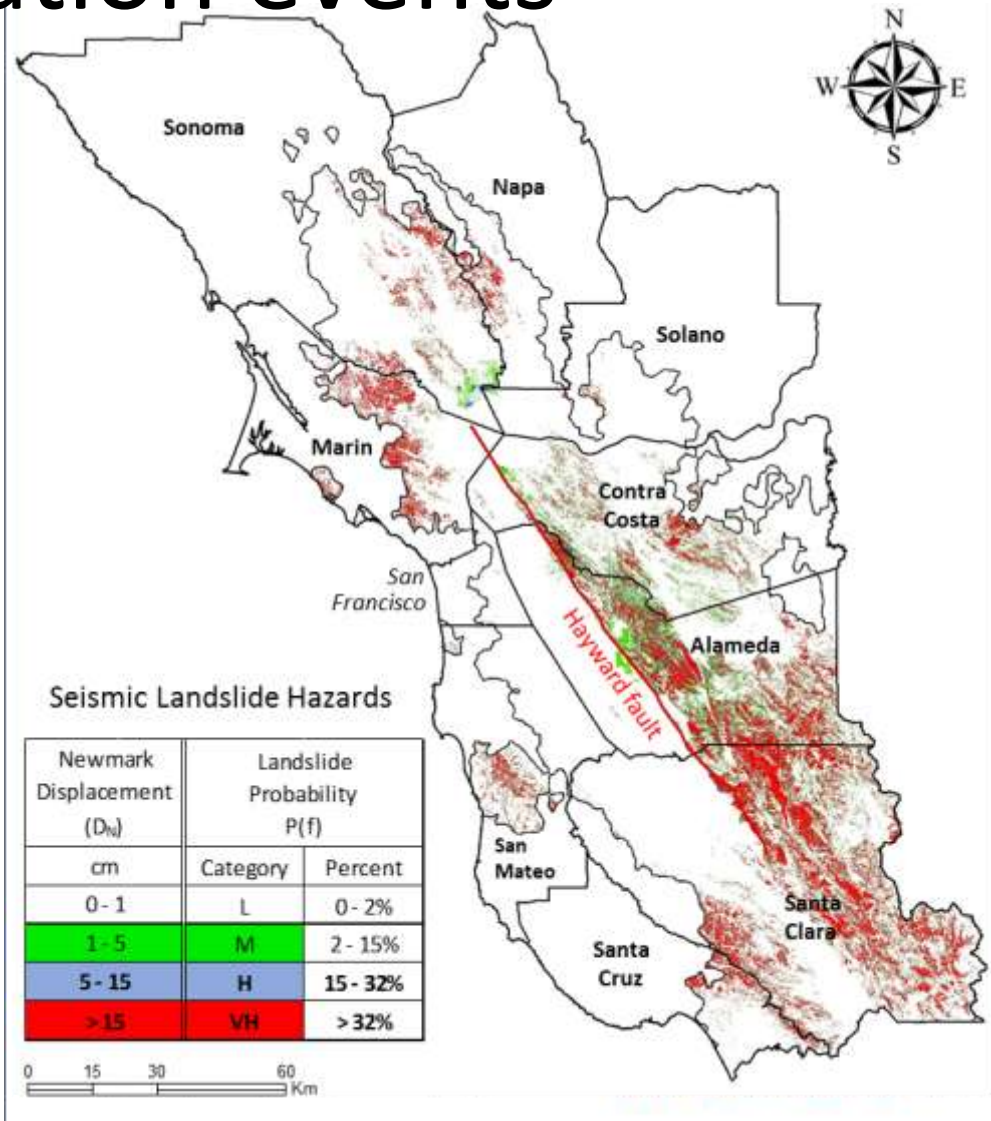


Liquefaction & groundwater (slr)

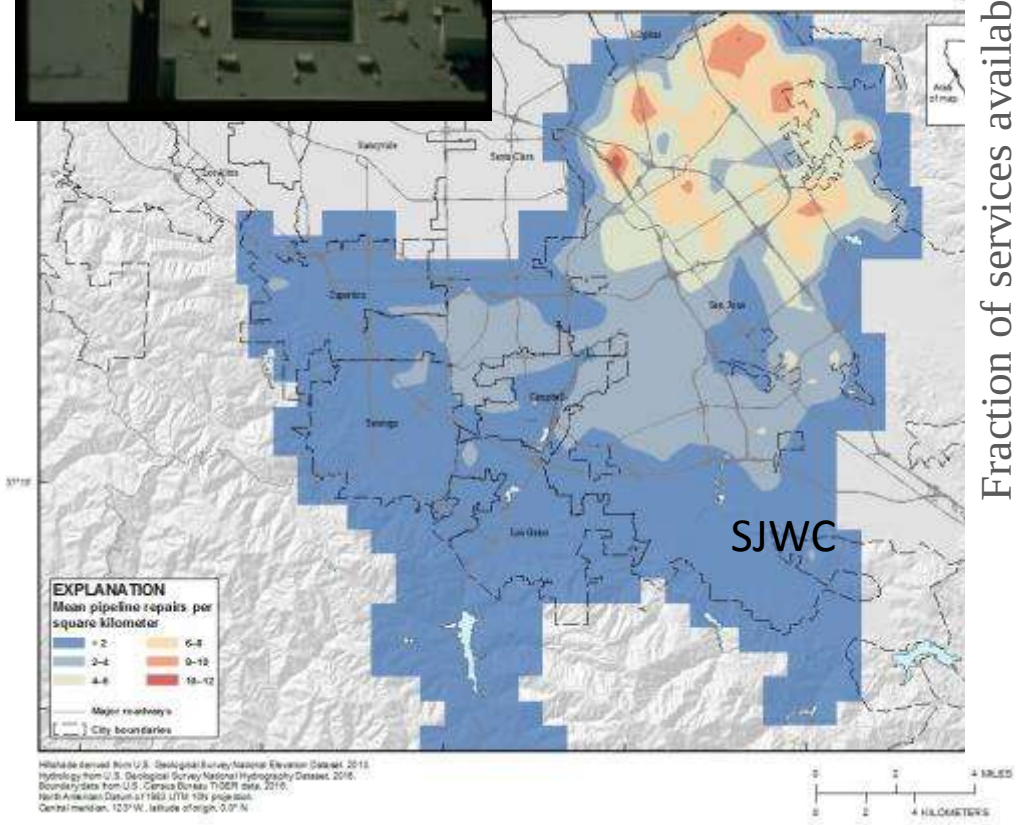


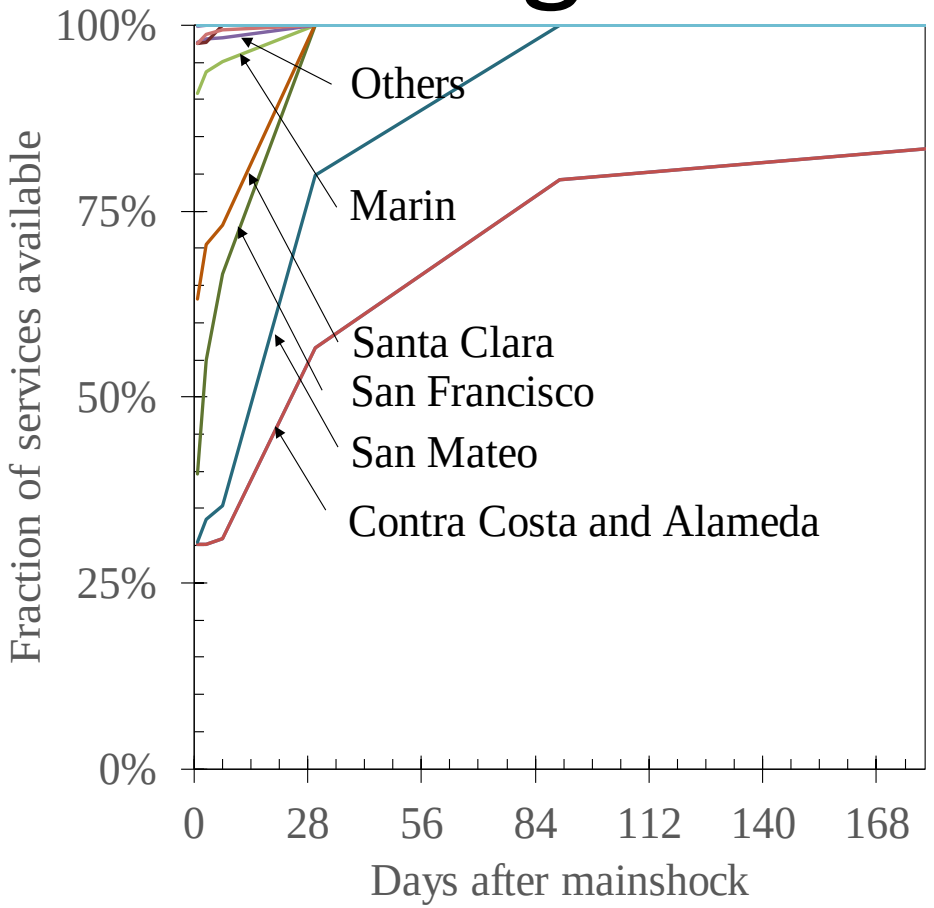
Earthquake induced landslides & extreme precipitation events

More than 32% landslide probability



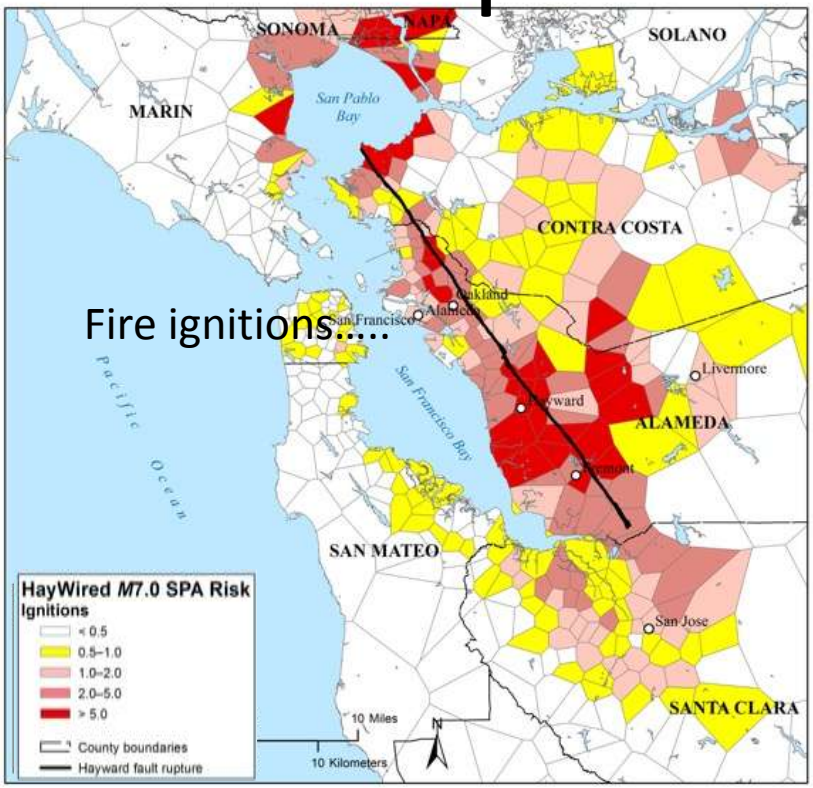
Earthquake damage of water infrastructure & extreme drought



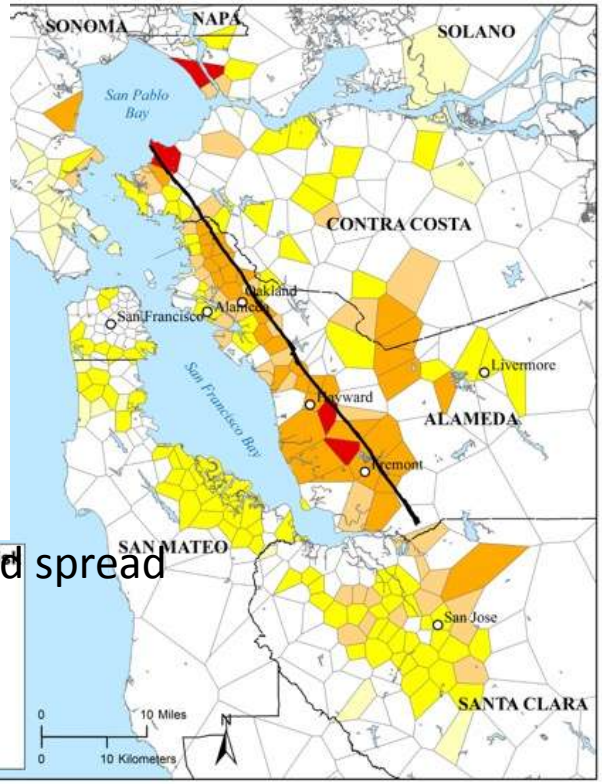


Keith Porter, 2018

Fire following earthquake



Fire ignitions…..



and spread

1994 Northridge Earthquake
www.theatlantic.com

….into the wild-land urban interface

Climate Change and Natural Hazards

- Mix of
  - Slow onset sea level rise
  - Warnings of storms and fire spread or potential
  - Sudden onset earthquakes
- New level of potential natural hazard interactions
- Learn from every event and prepare
  - PSPSs : power and communications
- Plan & Exercise: USGS HERA, USGS Scenarios
- Land use and building codes matter