



DROUGHT AND DELUGE

Climate Resiliency Strategies at Multiple Scales



TOPICS COVERED

ABOUT ME

RESEARCH QUESTION AND CONTEXT

Overview of my project, and background on Geodesign and Sustainability Goals at multiple scales

CENTRAL VALLEY

Description of the geography of the Central Valley in California, and how it functions – is it functioning well?

STUDY AREA

Description of the specific areas I'm studying and some design ideas, and anticipated stakeholder concerns

NEXT STEPS

ABOUT ME

STUDIED GEOGRAPHY, GIS, AND NATURAL RESOURCES AT HUMBOLDT STATE UNIVERSITY. DOING GIS FOR 28 YEARS, 24 OF THOSE YEARS FOR THE LOS ANGELES COUNTY DEPARTMENT OF REGIONAL PLANNING. ATTRACTED TO GEODESIGN BECAUSE OF STRONG GIS AND PLANNING BACKGROUND.



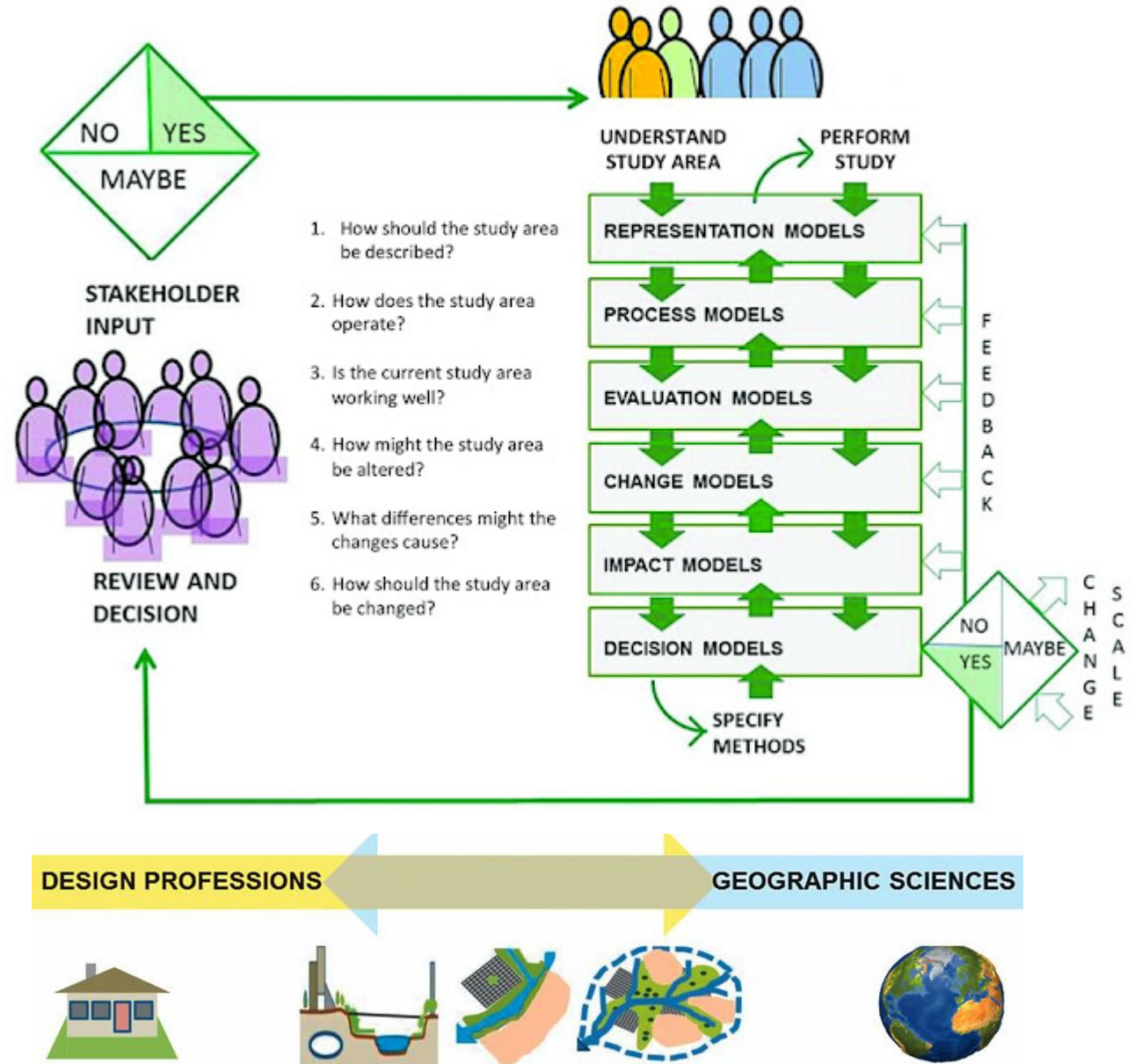
RESEARCH QUESTION: HOW CAN WE APPLY SUSTAINABILITY AND CLIMATE RESILIENCY GOALS AT MULTIPLE SCALES OF AN AREA USING GEODESIGN?



GEODESIGN

Changing Geography by Design

- Developed by Carl Steinitz – professor emeritus at Harvard University
- Jack Dangermond, president of ESRI, was one of Steinitz’s students
- A framework for assessing the systems of a landscape and intervening in some way to help solve a problem
- Models help answer questions such as, how well is a landscape working, and what are the impacts of a proposed change
- Multiple scales need to be analyzed, a study area does not exist in a vacuum, it is a part of many landscape systems
- GIS is at the core, but stakeholder input is key – this is ‘data informed’, and ‘decision driven’



Source: Carl Steinitz

Sustainability Goals – Global, National, State, Local

UN Sustainable Development Goals

- 6 CLEAN WATER AND SANITATION
- 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
- 11 SUSTAINABLE CITIES AND COMMUNITIES
- 13 CLIMATE ACTION
- 14 LIFE BELOW WATER
- 15 LIFE ON LAND

THE WHITE HOUSE
 JANUARY 27, 2021
 Executive Order on Tackling the Climate Crisis at Home and Abroad
 BRIEFING ROOM | PRESIDENTIAL ACTIONS

The Great American Outdoors Act

Global Warming Solutions Act (2006)

Sustainable Communities and Climate Protection Act (2008)

Sustainable Groundwater Management Act (2014)

California's 2030 Vision

- CAP-AND-TRADE**: Firm limit on 80% of emissions
- CLEAN ENERGY**: At least 50% renewable electricity
- CLEAN FUELS**: 18% carbon intensity reduction
- Double energy efficiency in existing buildings
- High density, transit-oriented housing
- NATURAL & WORKING LANDS RESTORATION**: 15-20 million metric tons of reductions
- Walkable & bikable communities
- On-road oil demand reduced by half
- CLEAN TRANSIT**: 100% of new buses are zero-emission
- CLEAN CARS**: Over 4 million affordable electric cars on the road
- REDUCE "SUPER POLLUTANTS"**: 40% reduction in methane and HFCs
- SUSTAINABLE FREIGHT**: Transitioning to zero emissions everywhere feasible, and near-zero emissions with renewable fuels everywhere else

Exec. Order to Achieve Carbon Neutrality (2018)

Exec. Order for Drought and Water Resilience (2019, 2020)

Exec. Order for 30x30 Goal using Nature-Based Solutions (2020)

Exec. Order for using Floodwaters for Aquifer Recharge (2023)

KINGS RIVER EAST
 GROUNDWATER SUSTAINABILITY AGENCY

Groundwater Sustainability Plan
 Adopted December 13, 2019

GOALS AND OBJECTIVES



FRAMEWORK

Use the Geodesign framework to address issues of climate resiliency and sustainable agriculture



ANALYSE

Analyse the landscape at a watershed scale and a local jurisdiction scale



CHANGE

Visualize the processes of the landscapes and how a proposed change will impact its function



IMPLEMENT

Use policy-driven climate resiliency strategies at the state level and show how these can be implemented at scale

BACKGROUND

Central Valley, CA

- Central Valley – alluvial landform between the Coastal Range and Sierra Nevada mountains
- Three major water basins forming the hydrologic system of the Valley and surrounding mountains
- Two valleys exist in the Central Valley as defined by the water basins: Sacramento Valley (Lower Sacramento) and San Joaquin Valley (San Joaquin and Tulare-Buena Vista Lakes)
- Agriculture-driven economy – important on a local, state, national and global scale
- A profoundly altered landscape to accommodate agricultural land uses and cities

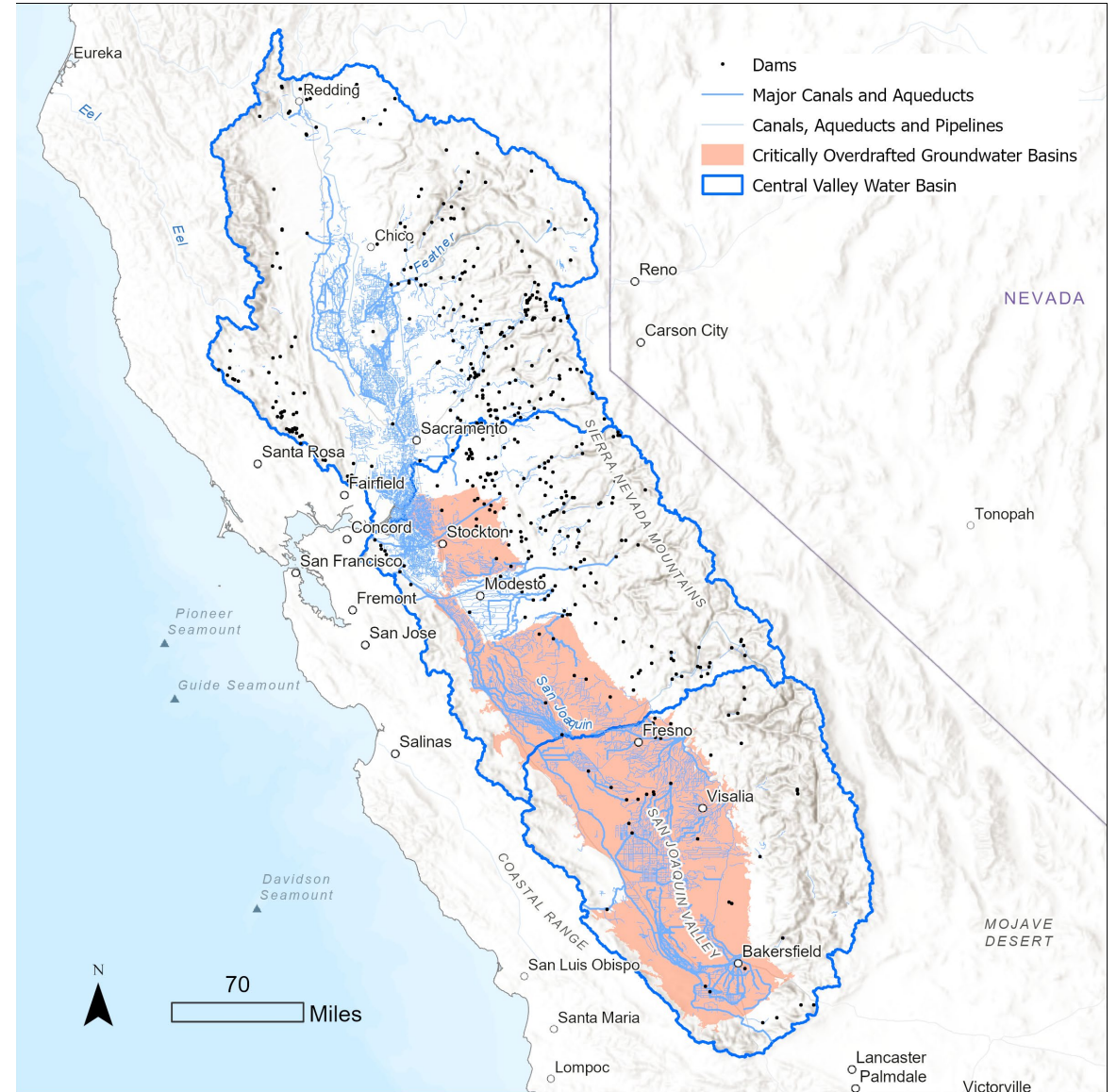


Source: USGS, ESRI

PROBLEMS

Water availability

- Climate patterns of drought and deluge have put stress on surface water availability
- Elaborate network of irrigation canals, aqueducts, reservoirs and pumping stations
- Lack of surface water availability given climate pattern has created an over-reliance upon groundwater
- Over extraction of groundwater has created land subsidence, pollution or unavailability of drinking water, inequities between larger farming corporations and small farmers
- Majority of the San Joaquin Valley have impaired groundwater basins

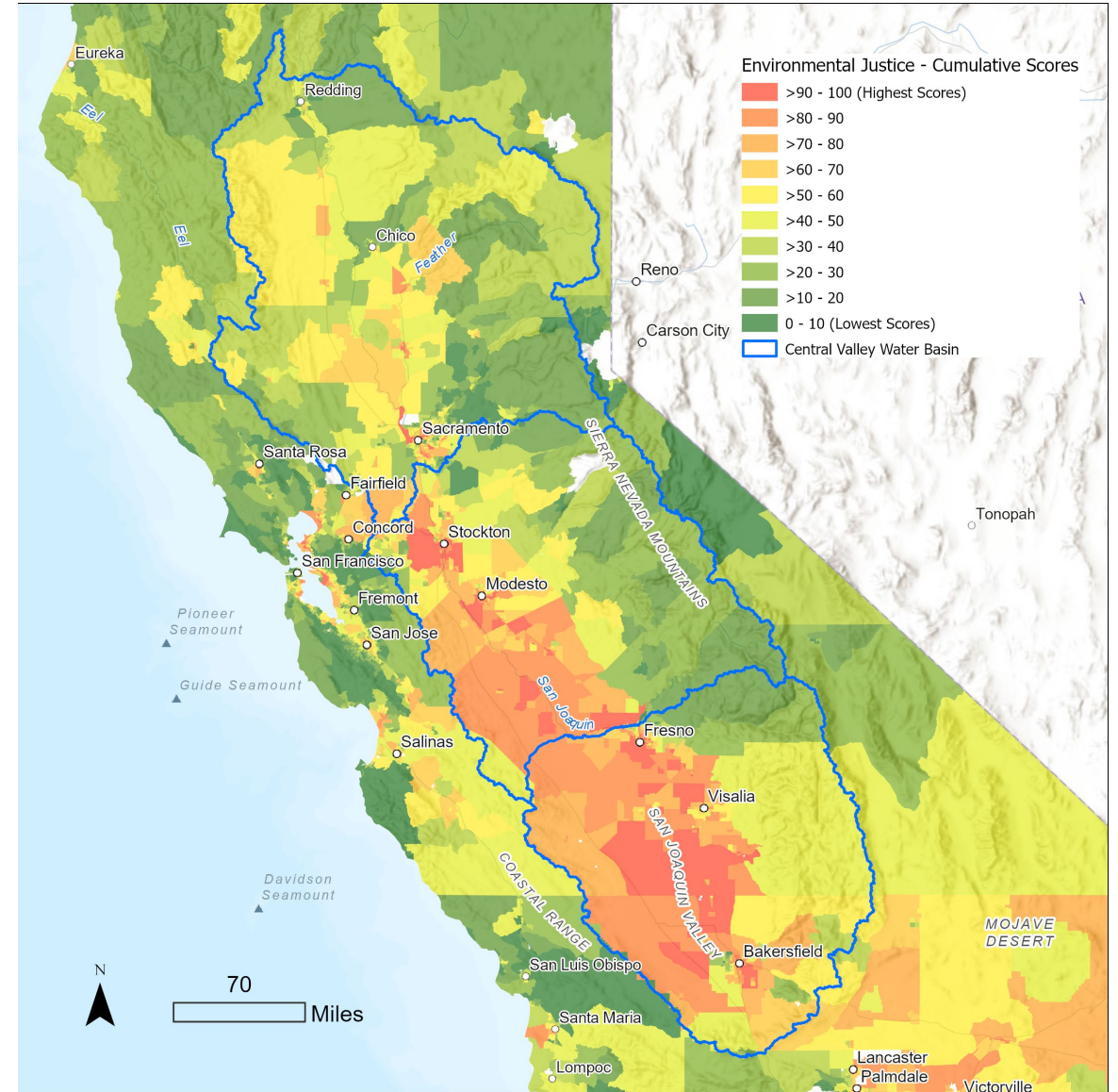


Source: CA Dept of Water Resources, ESRI

PROBLEMS

Environmental Justice

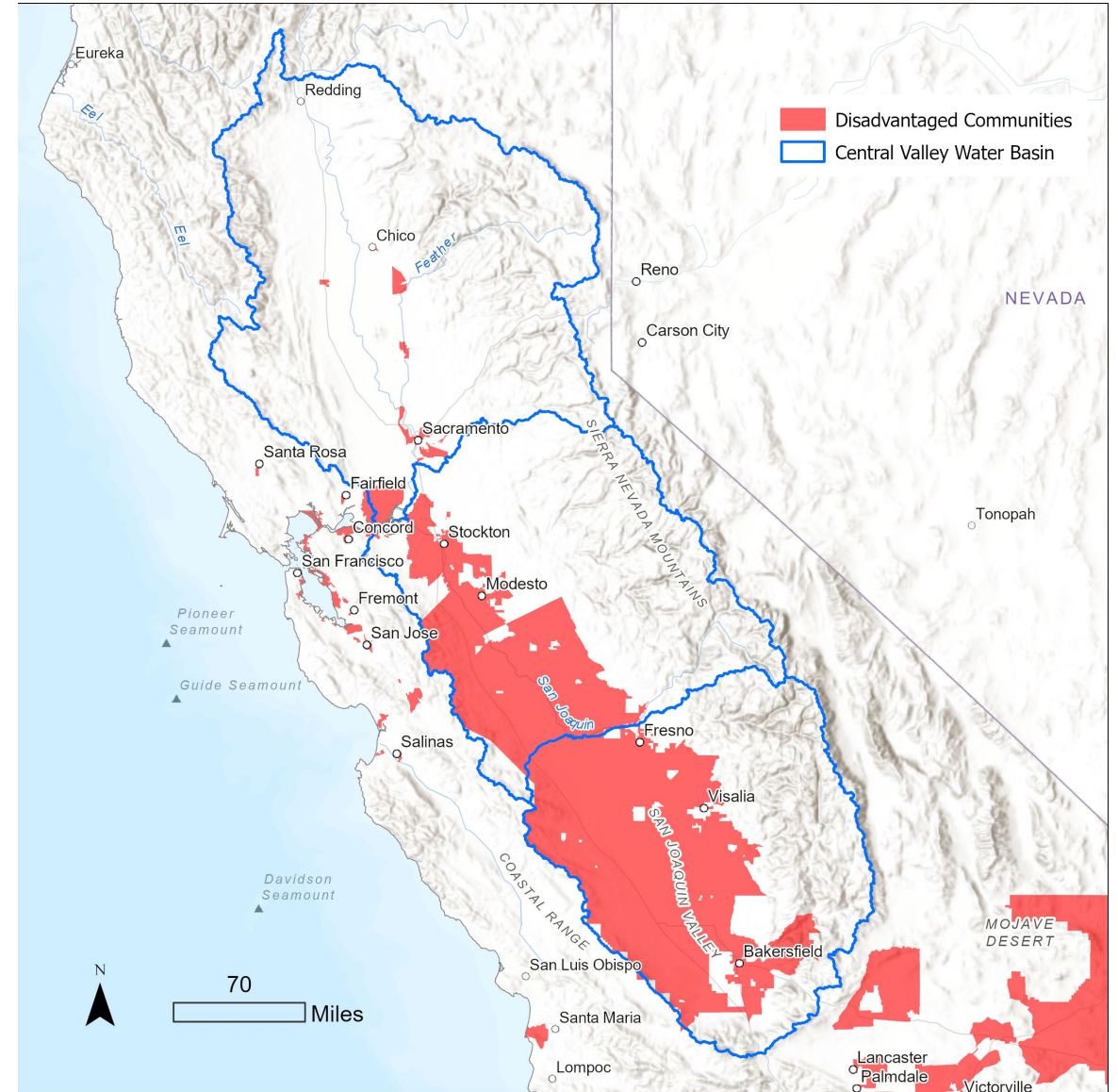
- Environmental Justice issues related to negative environmental factors affecting certain sensitive populations and socio-economic sectors
- Particulate matter (air pollution), drinking water contamination, pesticide exposure, poverty, lower educational attainment and linguistic isolation are among the most common indicators in the valley
- Most of the Central Valley is considered 'disadvantaged' as they are in the highest percentile in terms of cumulative impacts compared to the rest of the state



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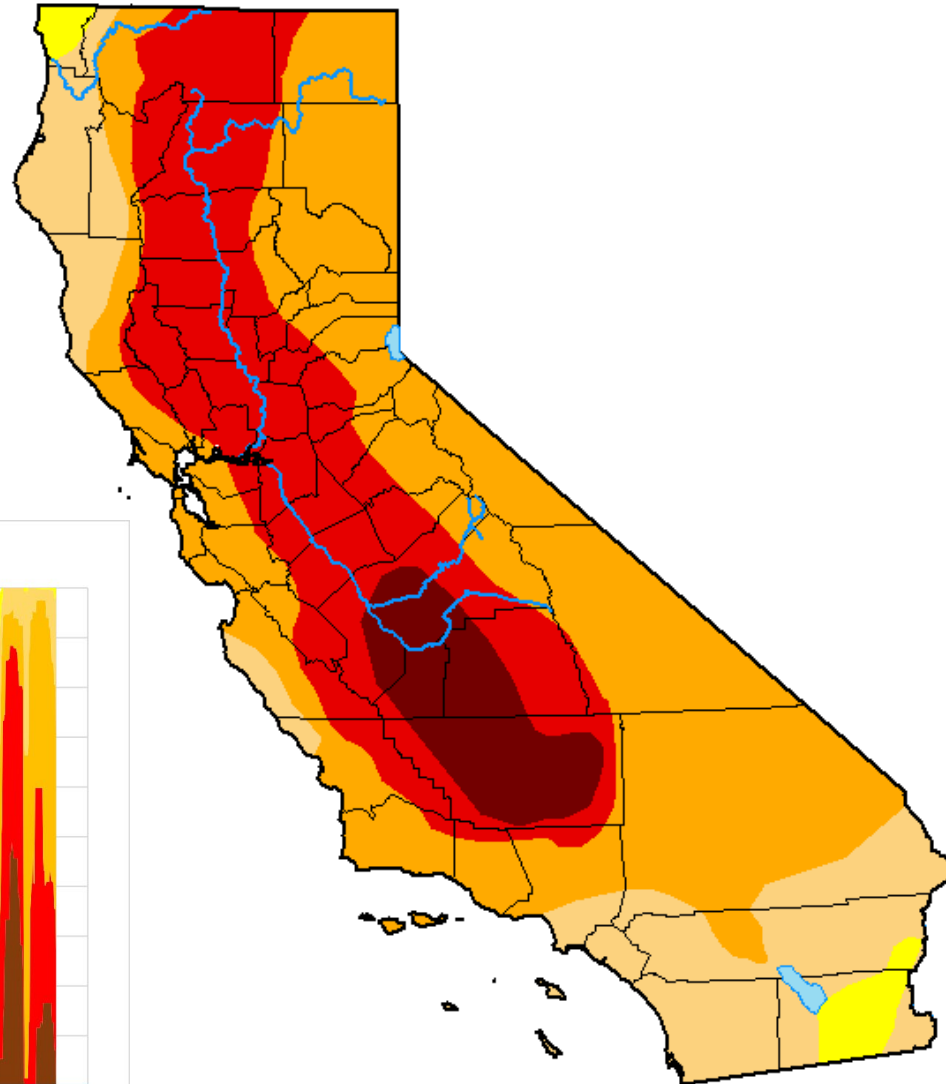
Source: CalEnviroScreen 4.0, ESRI

U.S. Drought Monitor California

December 20, 2022
(Released Thursday, Dec. 22, 2022)
Valid 7 a.m. EST

VULNERABILITY Drought and Deluge

- Extreme drought conditions throughout the state – Dec 2022
- Several major reservoirs were at historic lows



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	97.94	80.56	35.50	7.16
Last Week 12-13-2022	0.00	100.00	97.94	80.56	35.50	7.16
3 Months Ago 09-20-2022	0.00	100.00	99.76	94.06	40.91	16.57
Start of Calendar Year 01-04-2022	0.00	100.00	99.30	67.62	16.60	0.84
Start of Water Year 09-27-2022	0.00	100.00	99.76	94.01	40.91	16.57
One Year Ago 12-21-2021	0.00	100.00	100.00	92.44	79.44	23.11

Intensity:



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

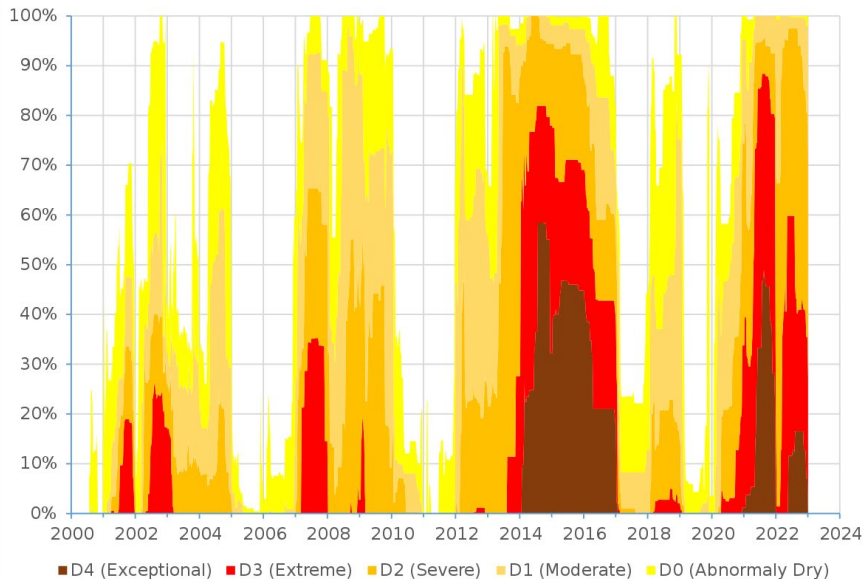
Author:

Curtis Riganti
National Drought Mitigation Center



droughtmonitor.unl.edu

Drought area in California



U.S. Drought Monitor California

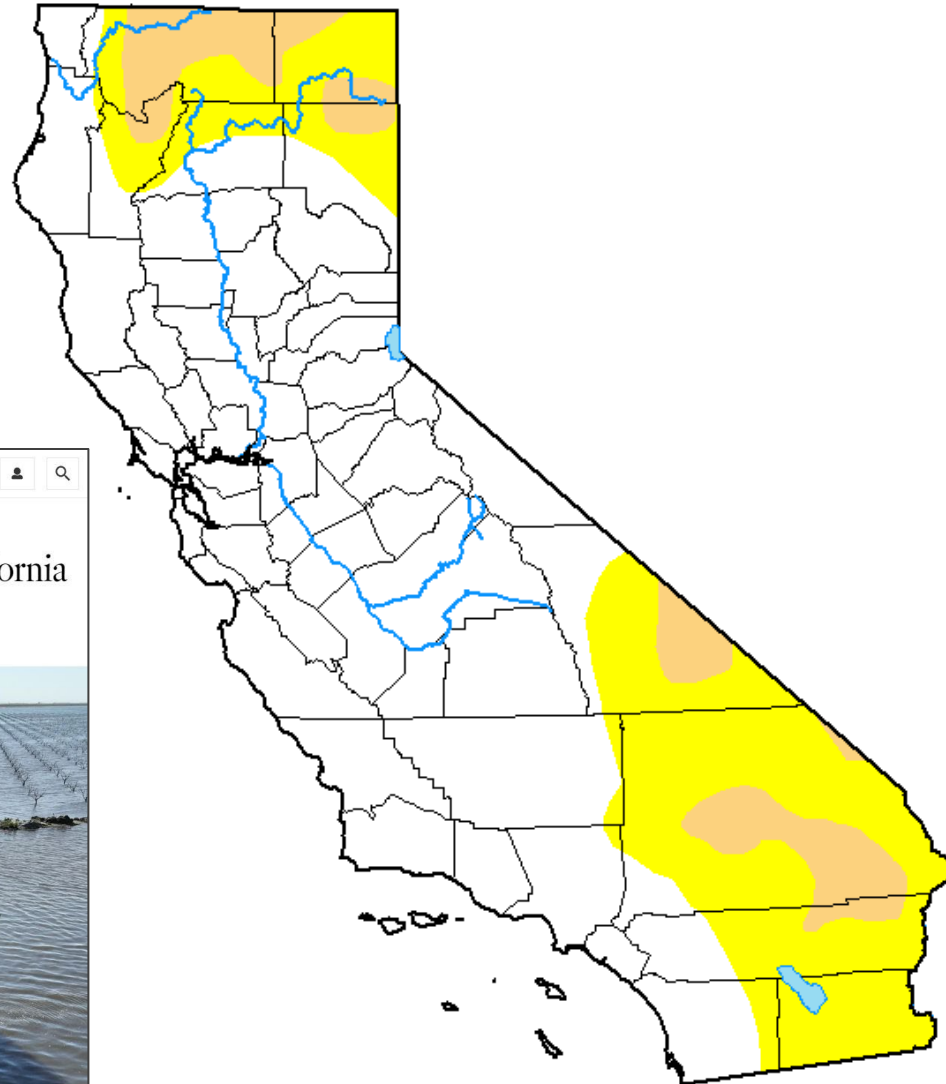
April 18, 2023

(Released Thursday, Apr. 20, 2023)

Valid 8 a.m. EDT

VULNERABILITY Drought and Deluge

- And here we are in April, 2023 after the historic rain and snow events
- All good now right???
- Well, no, there is a lot of snowmelt coming



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	65.67	34.33	8.79	0.00	0.00	0.00
Last Week <i>04-11-2023</i>	65.67	34.33	8.79	0.00	0.00	0.00
3 Months Ago <i>01-17-2023</i>	0.64	99.36	92.12	42.84	0.00	0.00
Start of Calendar Year <i>01-03-2023</i>	0.00	100.00	97.93	71.14	27.10	0.00
Start of Water Year <i>09-27-2022</i>	0.00	100.00	99.76	94.01	40.91	16.57
One Year Ago <i>04-19-2022</i>	0.00	100.00	100.00	95.18	40.81	0.00

Intensity:



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

Author:

Richard Tinker
CPC/NOAA/NWS/NCEP



Source: Los Angeles Times (4/24/23)

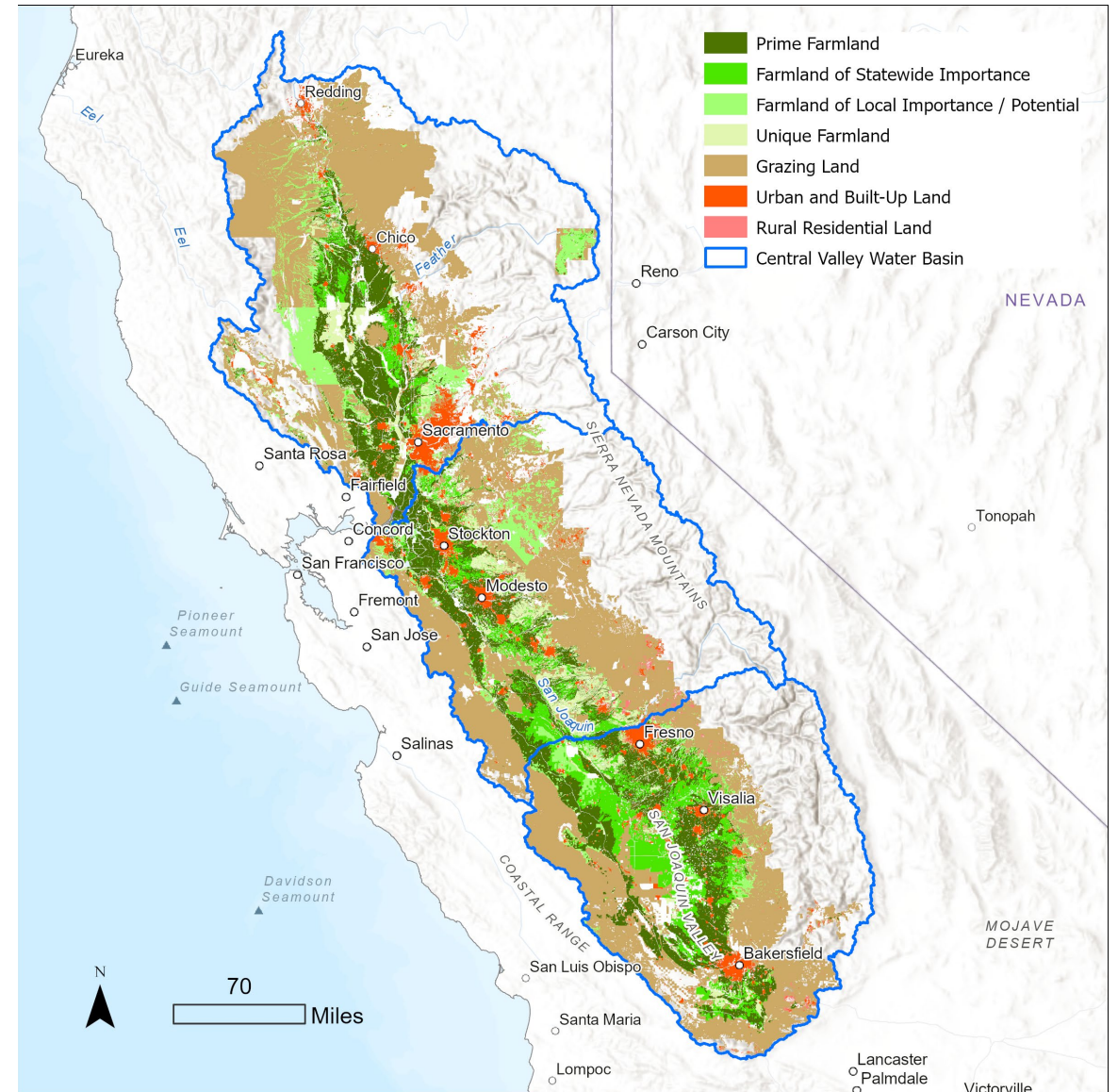


droughtmonitor.unl.edu

ATTRACTION

Farming Economy

- Farmland Mapping – categories of importance based on productivity and soil quality
- In 2021, the gross value of agricultural production in 21 Central Valley counties was over \$42 Billion
- Agricultural products are exported throughout the country and the world
- Major crops include:
 - *Almonds*
 - *Corn*
 - *Rice*
 - *Vineyards*
 - *Pistachios*
 - *Walnuts*
 - *Pistachios*
 - *Citrus*



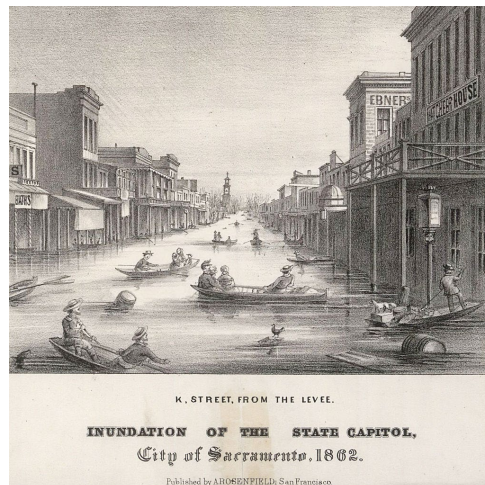
Source: CA Department of Conservation, ESRI

VULNERABILITY

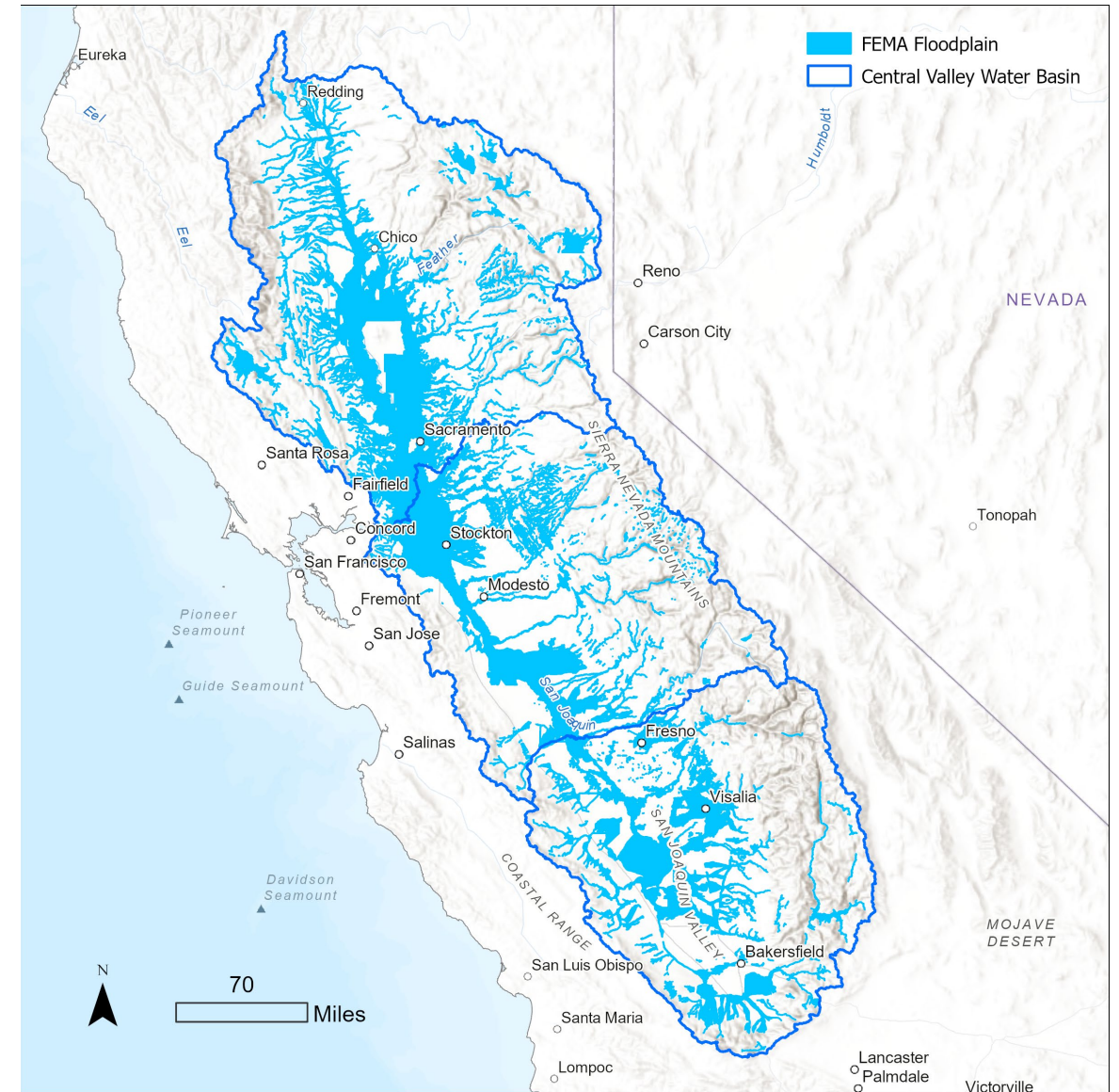
Drought and Deluge

- Floodplains are a large part of how the Central Valley functions given its topography
- Several watersheds drain the Sierra Nevada Mountains and Coastal Ranges – feeding into San Joaquin and Sacramento Rivers – emptying into San Francisco Bay and Pacific Ocean
- Natural hydrologic function of flooding and erosion from mountain ranges –why this area is so fertile

Flood of 1862 – much of the Central Valley was inundated by series of atmospheric river storms and a rapid snowmelt



Source: A Rosenfeld (publisher)

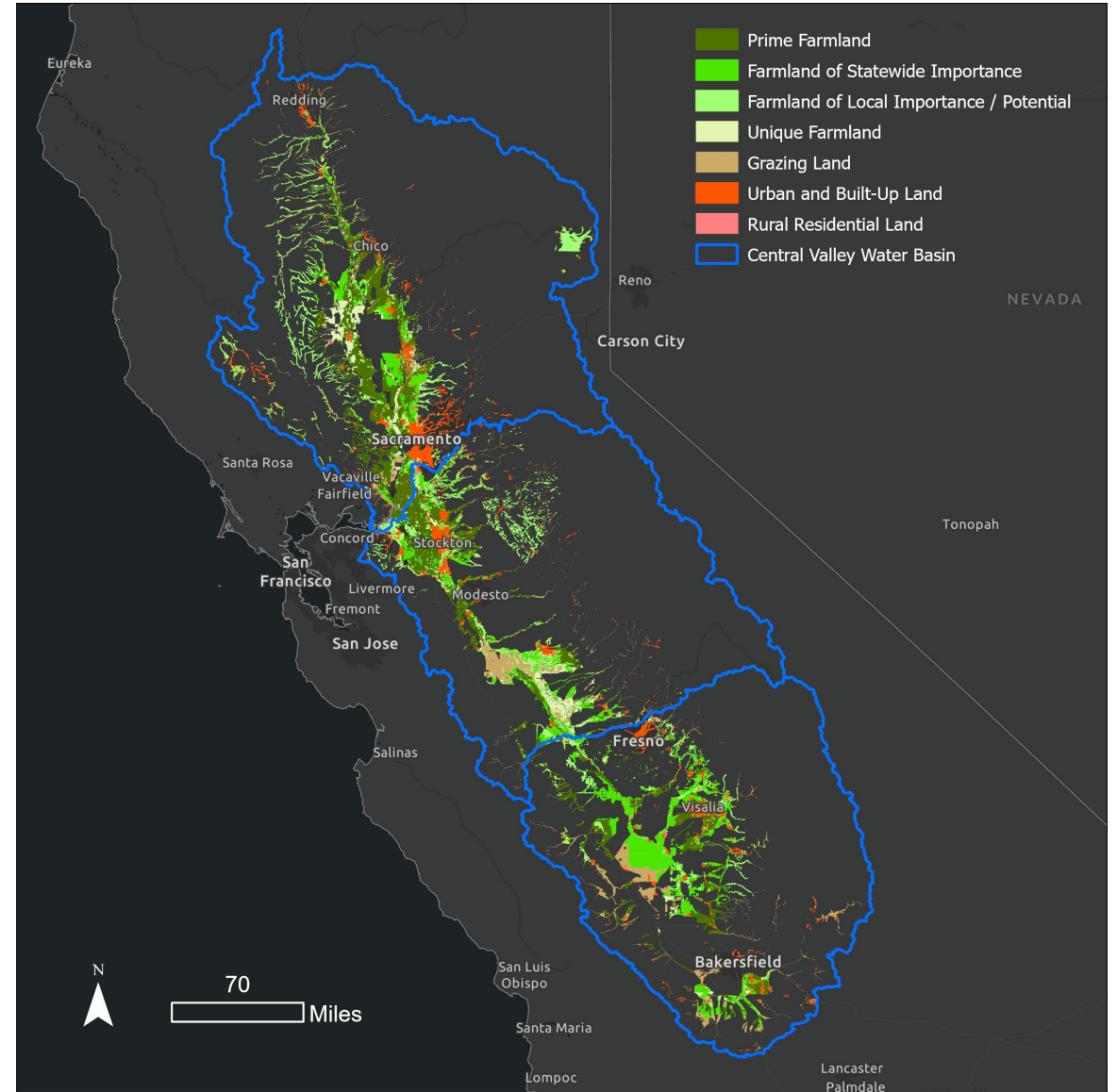


Source: FEMA, ESRI

RISK

Intersection of Potential Flooding and Human Activity

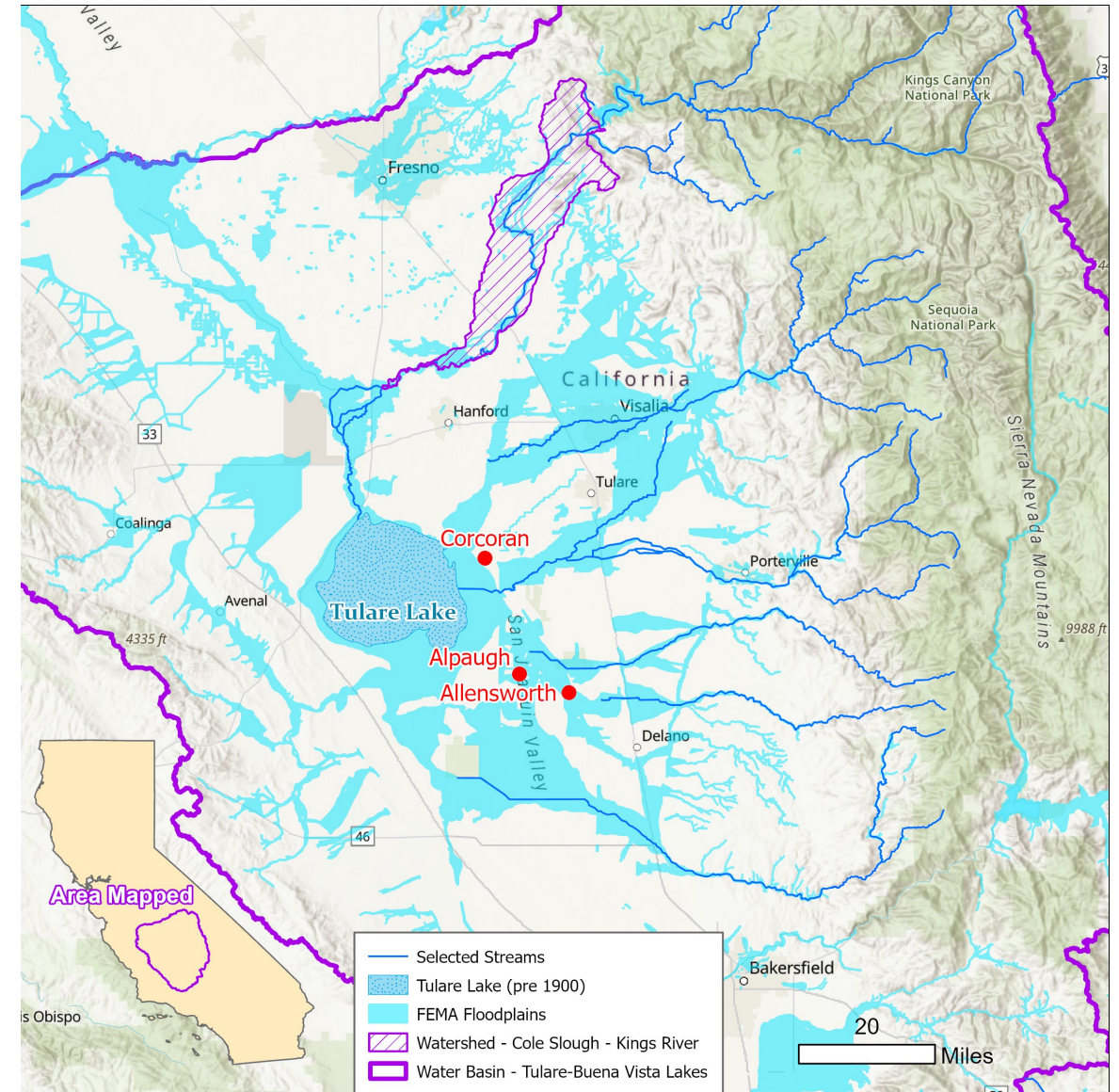
- Where areas attractive to farming and human habitation intersect with flooding = **Risk**
- Over 6,300 square miles of agriculture, cities and towns have potential for flooding
 - *2,500 sq miles Prime Farmland*
 - *1,000 sq. miles Farmland of Statewide Importance*
 - *460 sq. miles – Urban Areas – including Sacramento, Stockton, Fresno, and Visalia*
- Potential for more flooding – beyond what is mapped by FEMA
 - *Levee failure*
 - *More intense storms*



TULARE LAKE

A phantom lake re-emerges

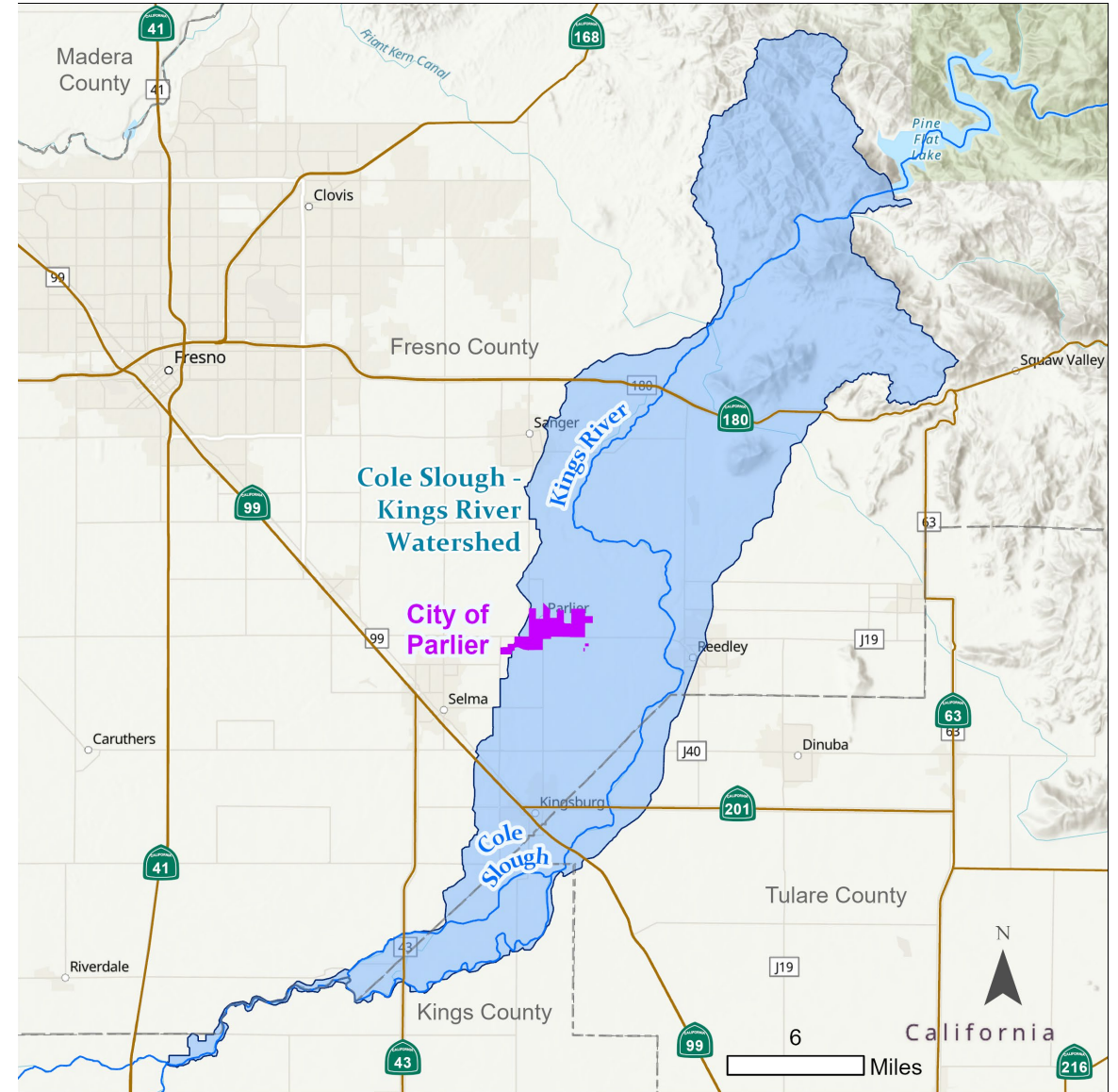
- Tulare Lake – once the largest freshwater lake in the country west of the Mississippi
- Water diversion for agriculture in 19th century dried the lake
- Dry lake basin currently being used for farming
- Atmospheric River storms of 2022 and 2023 have taxed the capacity of water conveyance system (natural and artificial)
- As with past extreme storm years, lake is refilling, flooding the towns of Alpaugh and Allensworth, and threatening the city of Corcoran
- Shows importance of managing stormwater in upriver watersheds, like the Cole Slough – Kings River



STUDY AREA

Watershed small and large scale

- Geodesign analyzes multiple scales to properly assess landscape systems and measure the impacts of change
- Cole Slough – Kings River Watershed forms a major drainage from Sierras from its namesake rivers
- Pine Flat Lake is a man-made reservoir and dam controls water flows for natural and artificial waterways, and generates hydroelectric power
- City of Parlier is the large-scale area of study that is projected to grow

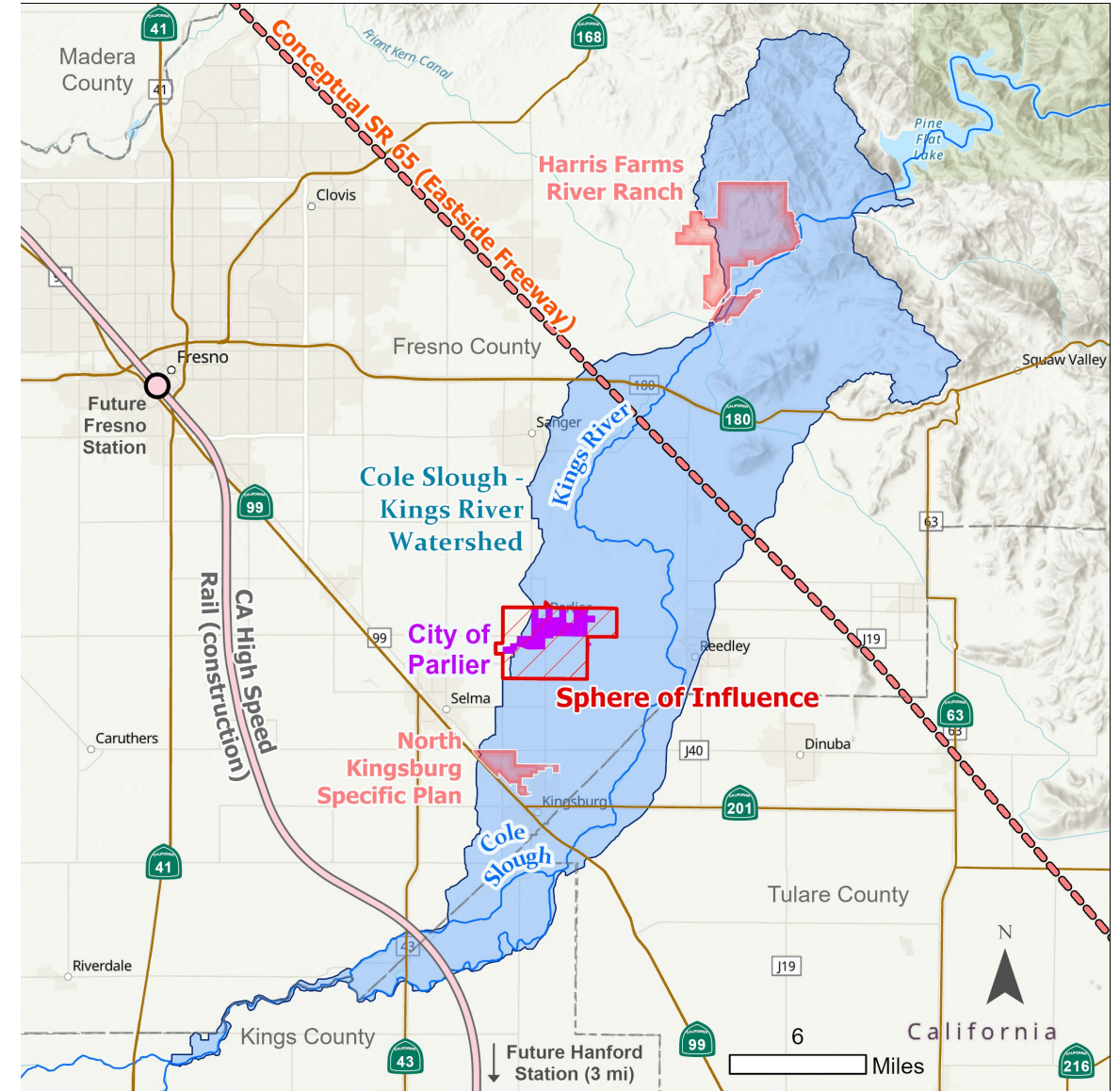


Source: County of Fresno, ESRI

STUDY AREA

Future Projects

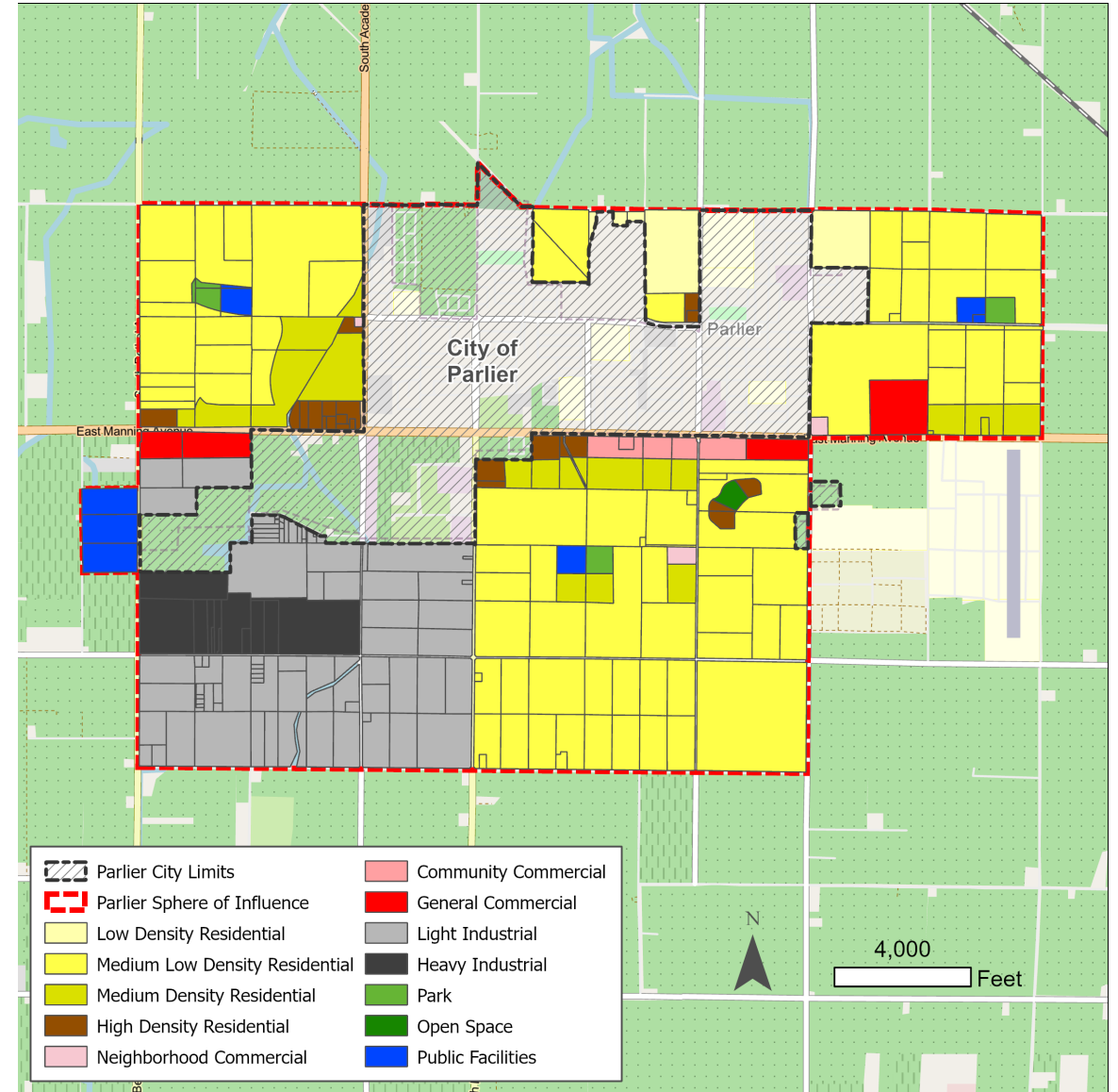
- Expected changes to occur in the future
- Sphere of Influence around the City of Parlier will expand residential and industrial uses
- City of Kingsburg is expected to grow – currently updating its General Plan and Specific Plan
- Harris Farms River Ranch is a master planned community currently in its early planning stages
- California High-Speed Rail line is under construction with future stations in Fresno and Hanford (just off map) – expected economic growth impacts around these hubs
- Future Freeway along the Sierras (SR 65) in regional growth plan – no actual alignment – still conceptual



CITY OF PARLIER

Projected growth land uses

- City is actively developing projects within the current city limits – industrial and commercial expansion
- Projected growth to the Sphere of Influence boundary shows significant additions to residential and industrial land uses – as well as expansion of commercial corridor
- Current expansion area is primarily agriculture
- Capstone project will collaborate with stakeholders to visualize sustainable development designs to align with State of CA goals
- Project will not be an official submittal to city, but will visualize future potential



AGRIHOOD

Residential / Agriculture hybrid

- Given Parlier's projected residential growth and potential loss of agricultural land, a hybrid of residential and agriculture could be a possible solution
- More sustainable as it uses green infrastructure and working lands within the town, as opposed to traditional subdivisions that greatly increase impermeable surfaces
- Can be beneficial to the local economy and be a unique asset

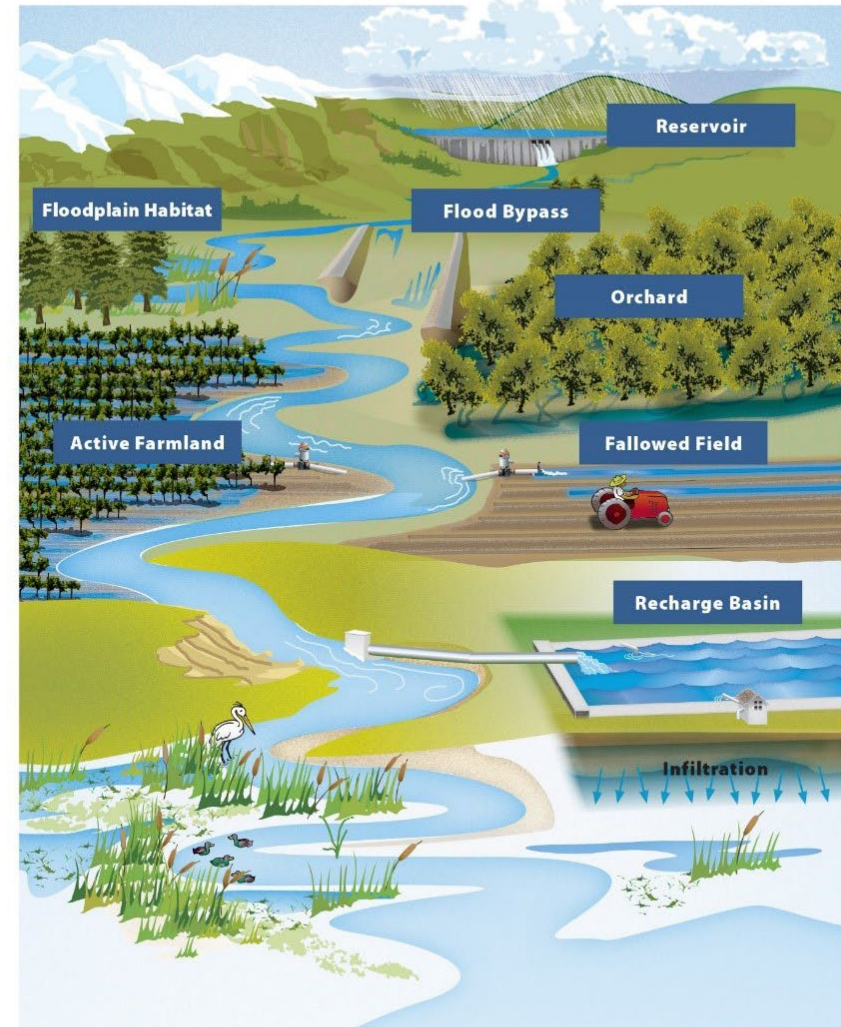


Source: City of Santa Clara

FLOOD-MAR

Managed Aquifer Recharge through Crop Flooding

- Small scale scenario – watershed level
- Voluntary flooding of cropland can be an effective way to dramatically increase the recharging of groundwater and help restore balance
- California Governor has issued an executive order to streamline permitting for this activity to take advantage of snowmelt
- **POTENTIAL RISK** – activating toxins in the soil related to pesticides and fertilizer nitrates that can infiltrate the groundwater aquifer



Source: CA Department of Water Resources

PALEOVALLEYS

Managed Aquifer Recharge through Sub-Terranean Canyons

- Incised Valley Fills – or, “paleovalleys” – are underground canyons formed by ancient rivers borne of the glacial melt from the last ice age
- Geology of these underground channels contains highly permeable material which is ideal for recharging deeper aquifers
- Currently being mapped – some of these discovered in watershed study area, and theoretically within Parlier’s sphere of influence

Los Angeles Times

From the air, scientists map ‘fast paths’ for recharging California’s groundwater



A helicopter tows an airborne electromagnetic system near Pine Flat Dam during a survey of the Kings River alluvial fan in December 2020. (Kings River Conservation District)

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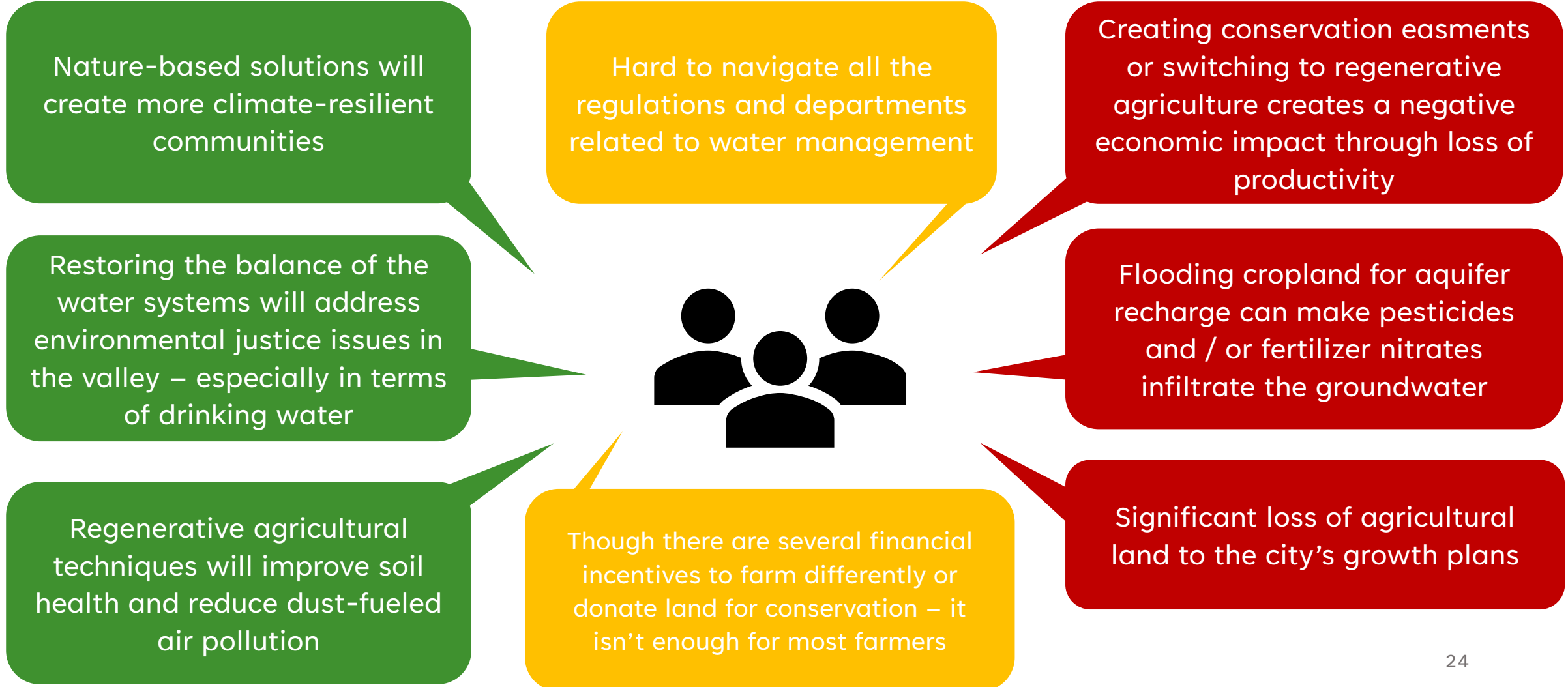
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ANTICIPATED STAKEHOLDER CONCERNS



ANTICIPATED
OUTCOMES

VISION

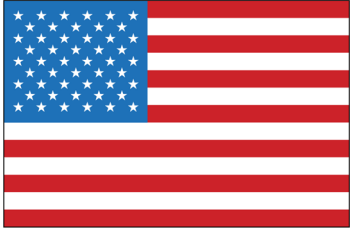
Create more climate-resilient communities utilizing nature-based solutions where feasible to enhance sustainable agricultural and water management practices

STRATEGY

Identify areas for managed flooding and green infrastructure where feasible to help bring surface water and groundwater into balance upon the landscape

TACTICS

Using a mix of gray and green infrastructure to target areas for the most effective recharge and flood mitigation – assessing risk from pesticides and nitrates

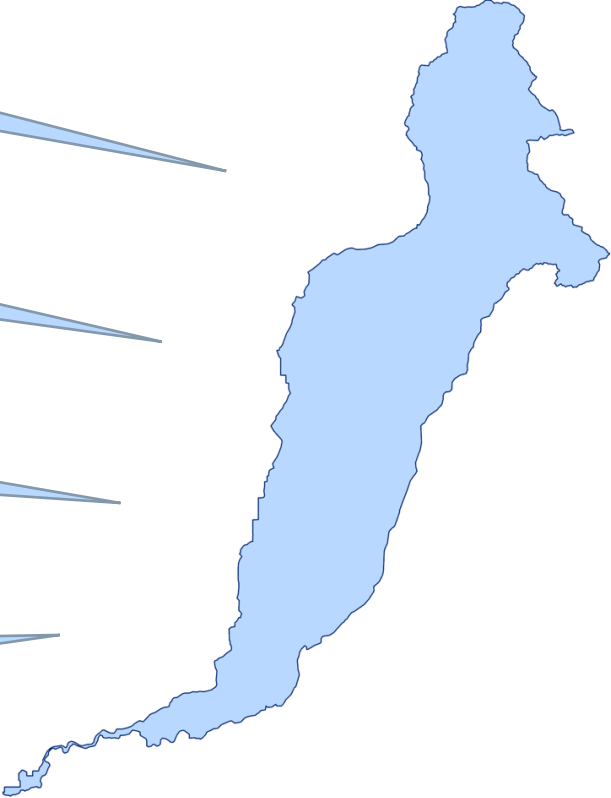


Suitability analysis for crop flooding or additional infrastructure for aquifer recharge

Measure impacts of flooding offset by proposed mitigation activities

Identify multiple benefits from managed flooding and sustainable agriculture to the natural and human ecology

Innovative financial incentives for sustainable agricultural practices



ANTICIPATED
OUTCOMES

VISION

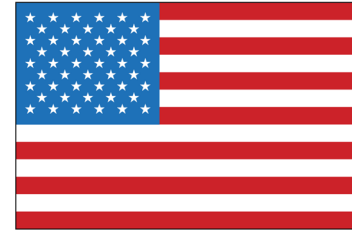
Create an attractive destination and place to settle with a thriving landscape of rural legacy and innovative design

STRATEGY

Preserve agricultural uses, stormwater enhancements, other green infrastructure into development plans

TACTICS

Collaborate with state mapping efforts to find existence of paleovalleys for recharge opportunities

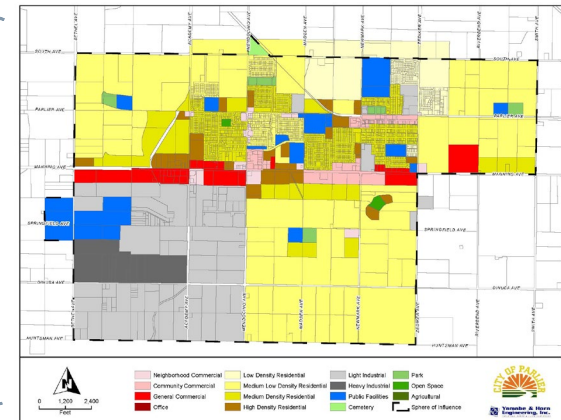


Innovative design that can accommodate agriculture, green space and population growth

Utilize industrial land uses for potential paleovalley recharge activities with other compatible industrial uses

Determine impacts of different residential designs and identify areas of targeted density to limit sprawl

Incorporate more recreation and open space opportunities aligned with Fresno County Regional Trails Plan



TOOLS

ARCGIS PRO

For managing data, geoprocessing and landscape suitability analysis

GEOPLANNER

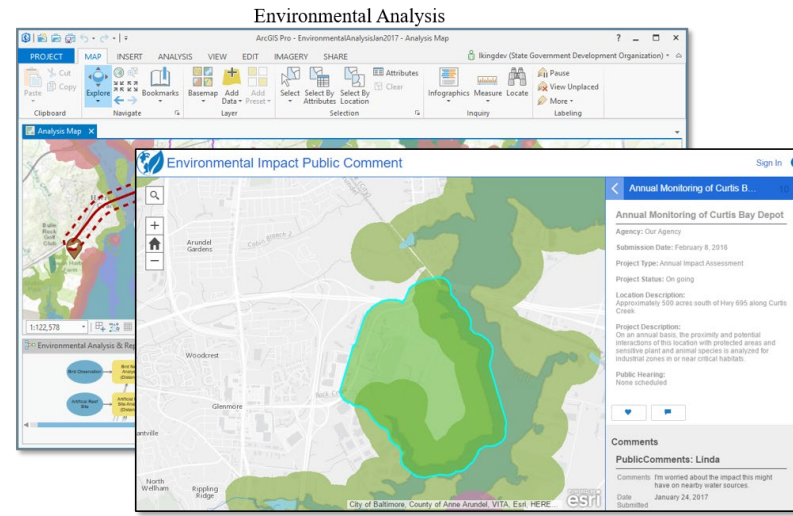
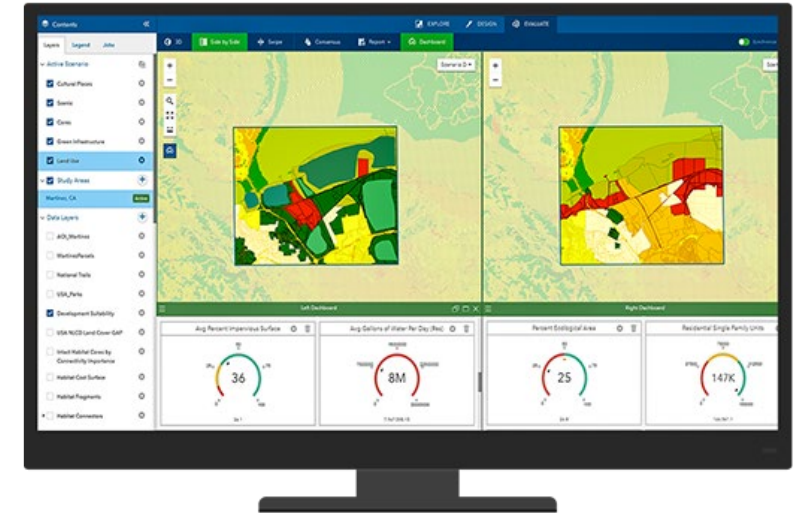
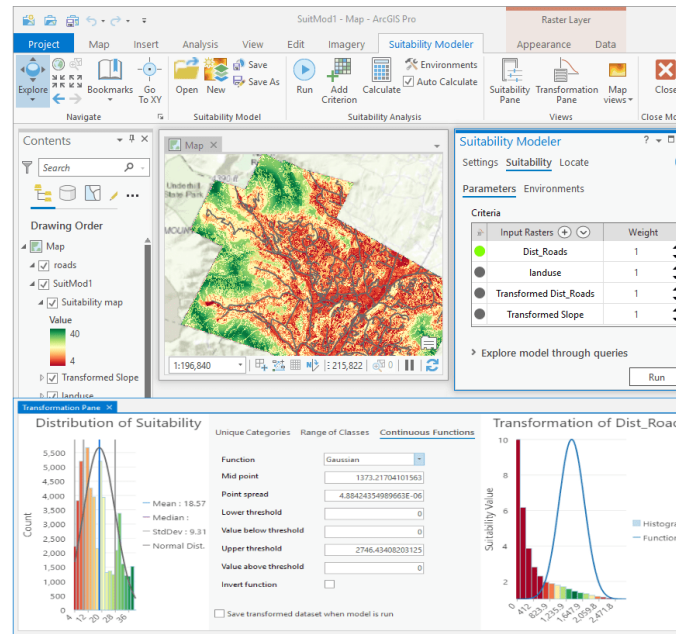
For design scenarios, measuring impacts of change, and developing performance metrics

ARCGIS ONLINE

For sharing data and scenarios, and collaborate with stakeholders

STORY MAP

For presenting my final capstone in a multi-media environment with dynamic web maps and visuals



Environmental Impact Public Comment



THANK YOU

Daniel Hoffman

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