Central Coast Regional Climate Symposium

Monday, December 10, 2018

Local Government Commission
Leaders for Livable Communities

California Energy Commission

California Natural Resources Agency

California Water Boards
Central Coast - R3

Central Coast Climate Collaborative

University of California Santa Cruz

SoCalGas
A Sempra Energy utility

Welcoming Remarks

Mayor
Heidi Harmon
City of San Luis Obispo

Welcoming Remarks

Dominic Roques

Central Coast Water Board

Welcoming Remarks

Ruth Langridge

University of California,
Santa Cruz

Overview of California's Fourth Climate Change Assessment

Laurie ten Hope

Deputy Director, Energy Research and Development Division
California Energy Commission

Key Climate Impacts in the Central Coast

Ruth Langridge

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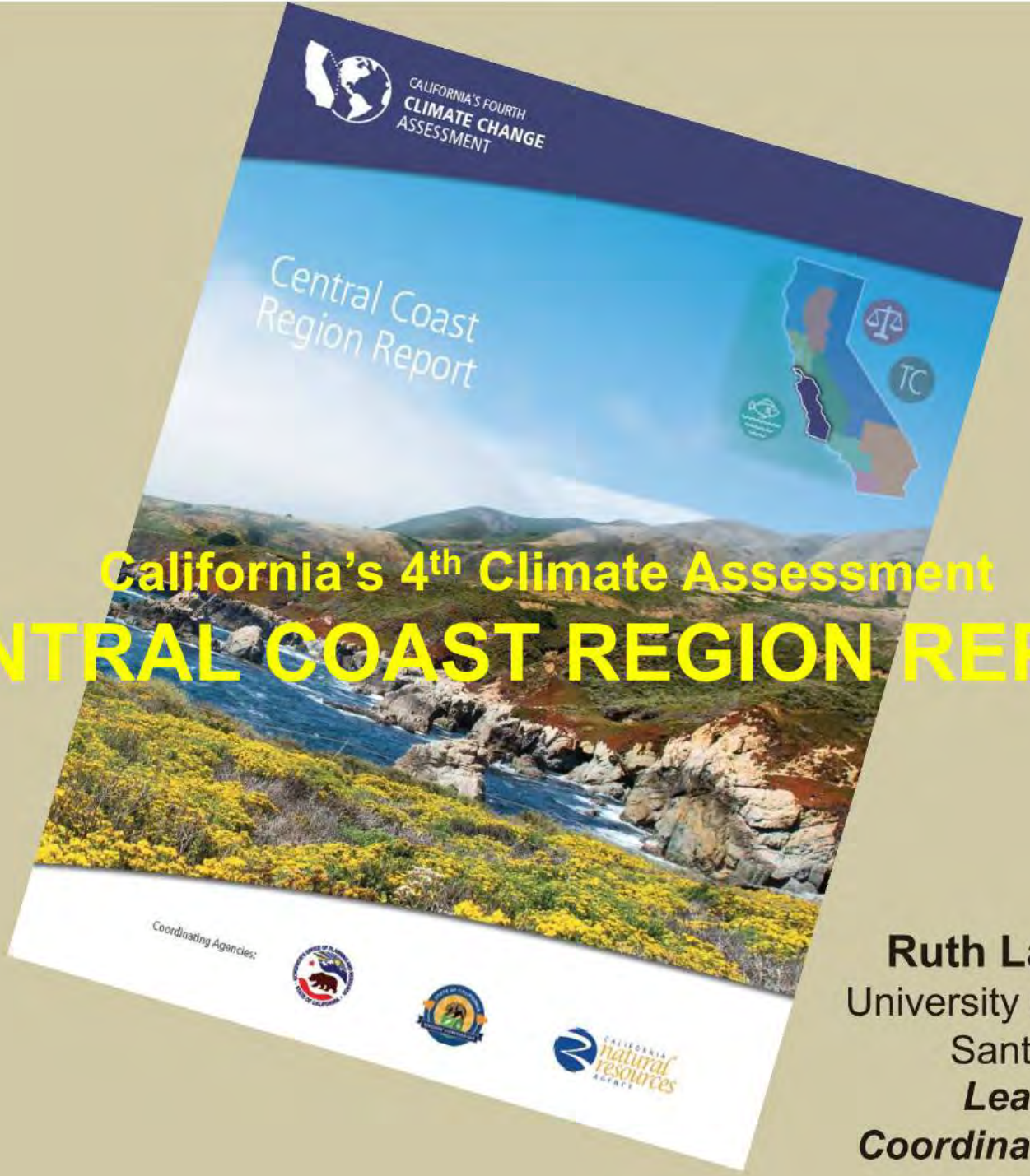
University of California, Santa Cruz



California's 4th Climate Assessment

CENTRAL COAST REGION REPORT

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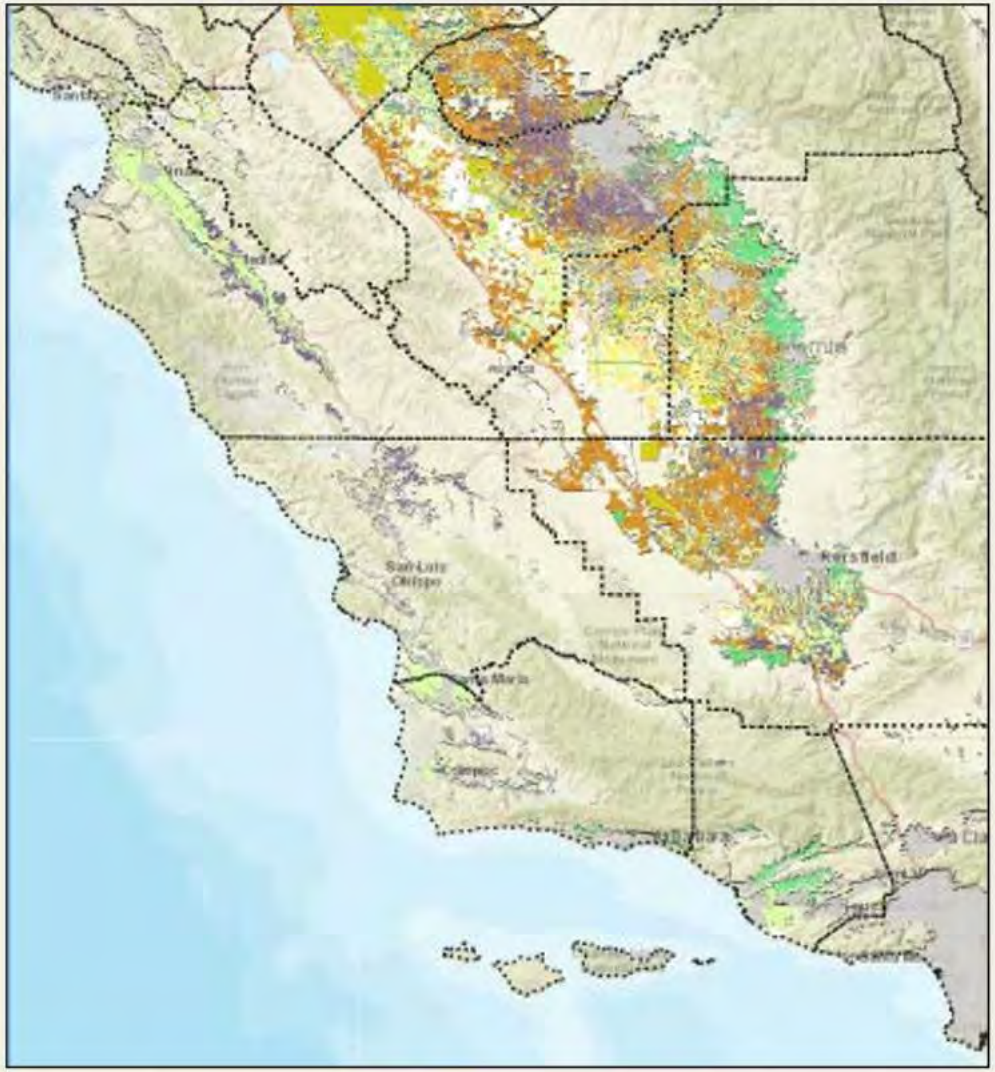
Central Coast

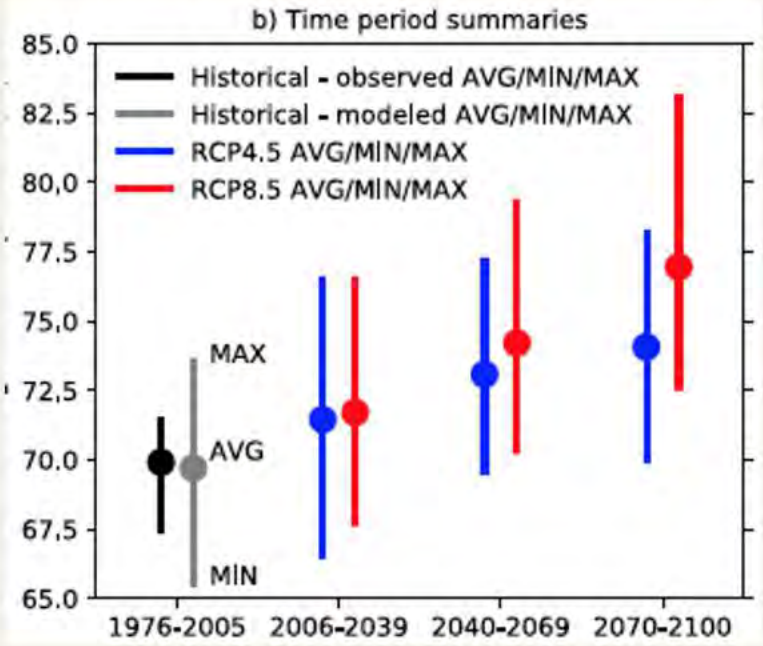


County	Santa Barbara	Monterey	San Luis Obispo	Santa Cruz	San Benito
Population	446,170	415,055	282,887	274,673	59.414

Climate

Temperature

Maximum temperature will continue to increase through the next century with greater increases inland



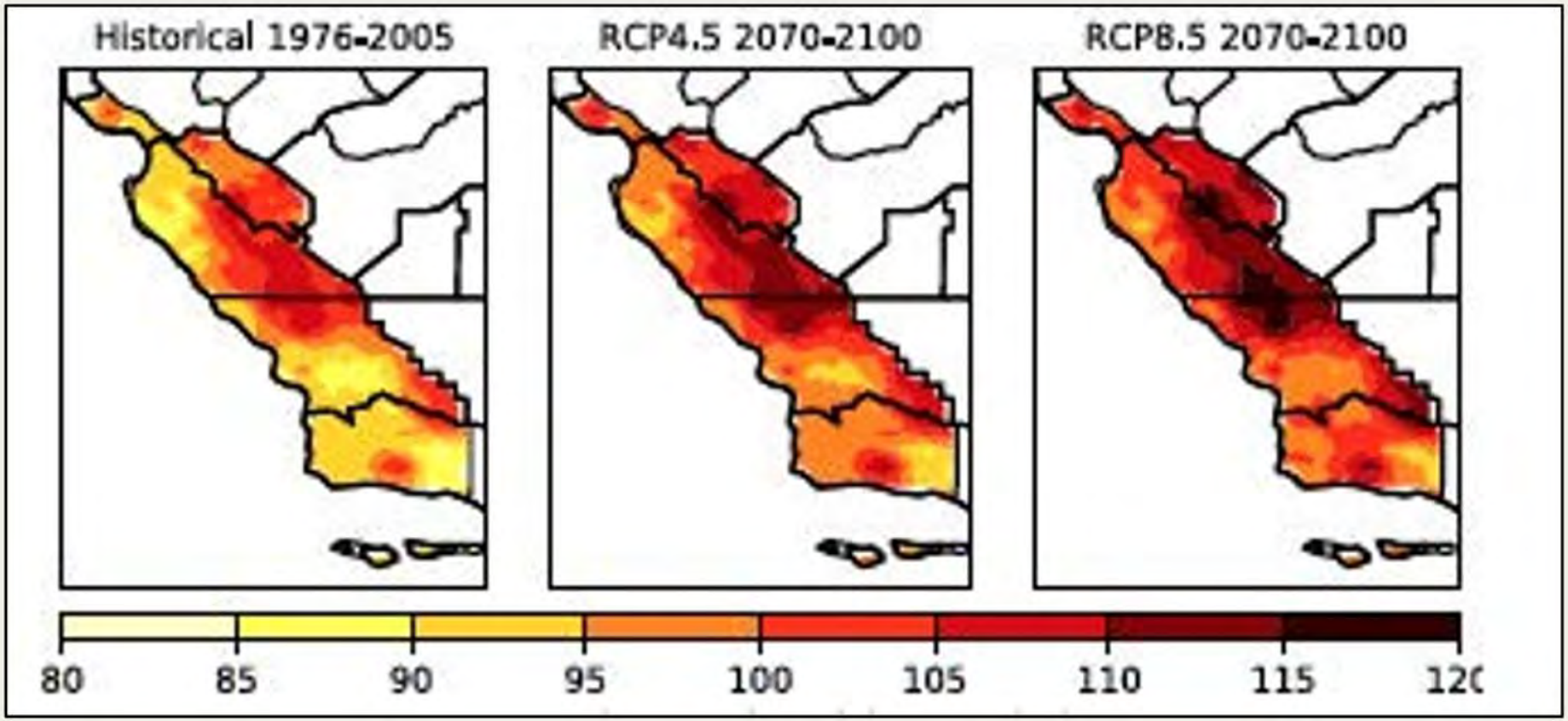
Annual average maximum Temperature (F°)

Blue = RCP 4.5

Red = RCP 8.5

County	Historical	RCP4.5	RCP8.5
	1961- 1990	2070-2099	2070-2099
Santa Cruz	67.5	71.9	74.5
San Luis Obispo	69.8	74.7	77.4

Average Hottest Day of the Year (F°)

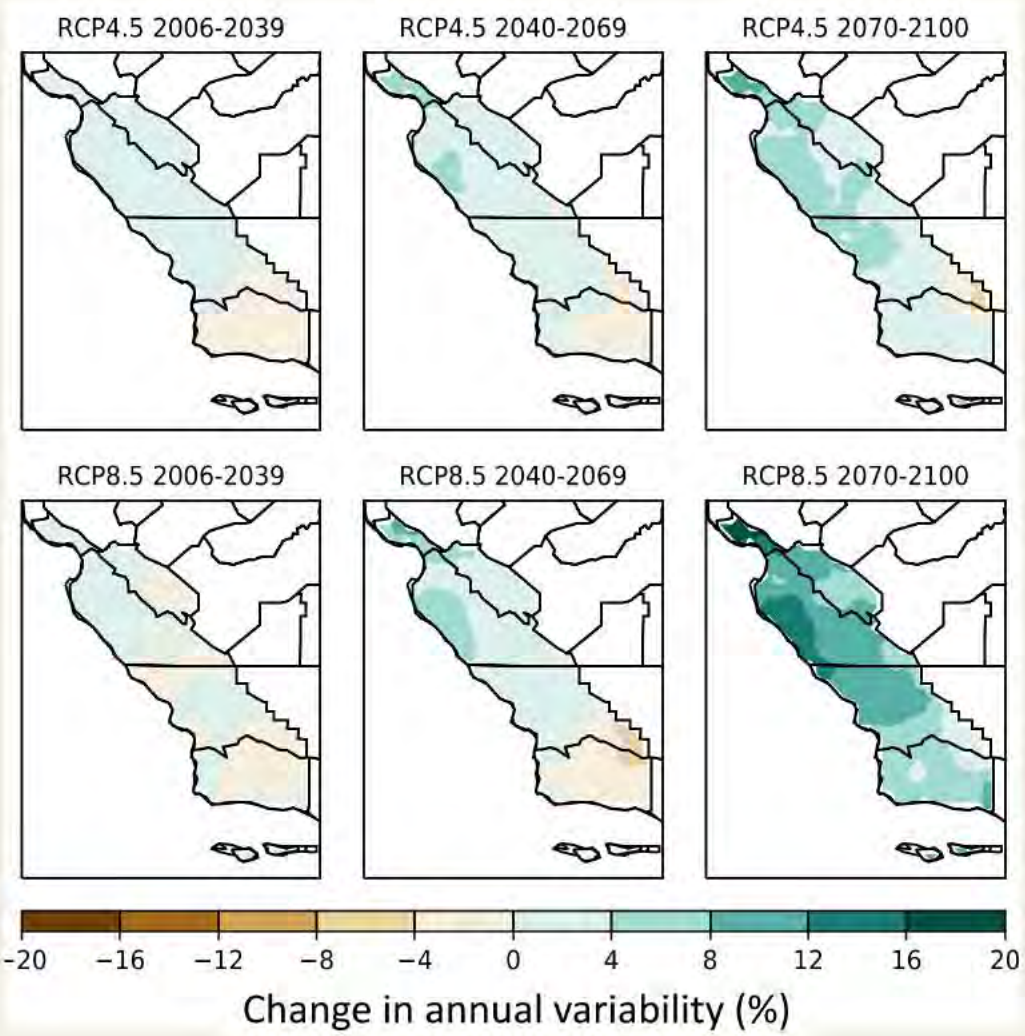


Precipitation

Average precipitation is expected to increase by a small amount, but annual variability increases by end of the century

RCP4.5

RCP8.5



Fog

• The future of fog is uncertain because system feedbacks and their response to climate change are not well characterized.

Artichoke harvesters in fog

Extreme Storm Events

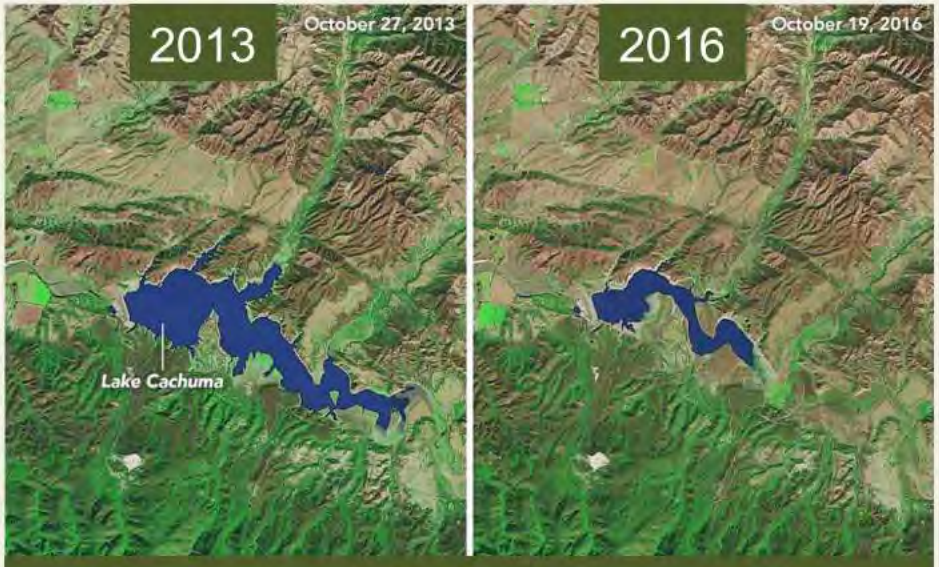
• Periodic El Niño events dominate

• Projections show a poleward migration of storm tracks and a slight decrease in wave heights compared to historical records

Extreme Drought Events

• Climate projections are for an increase in extreme dry events.

• The adverse effects of the 2011-2016 multi-year drought were not uniformly distributed, highlighting differential susceptibility to climate stresses.



Santa Barbara-Lake Cachuma water levels

Physical Impacts of Climate Change

Sea Level Rise

Recently observed & projected acceleration of SLR poses a significant threat to coastal communities.

Projected Cliff Retreat Under SLR scenarios

Colored bands around the lines represent projection uncertainty for that SLR scenario

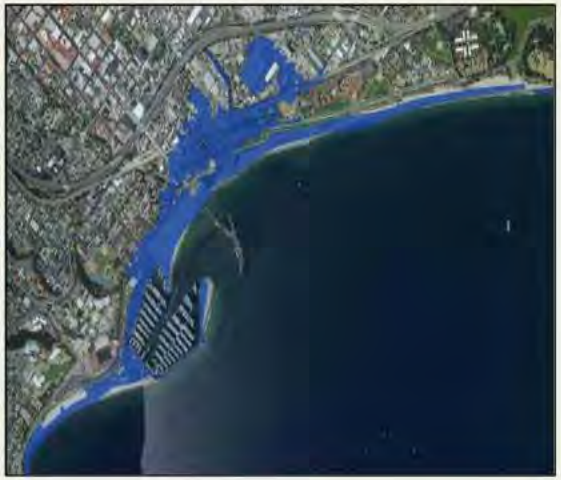
Goleta County Beach and Campus Point

Along the 101 corridor near Gaviota

Floods

- For 2 meters of SLR combined with the 100-year storm event, CoSMoS projects exposure of 11,780 residents & $2.4 billion in property across the most developed portion of Santa Barbara County
- Most vulnerable regions for future flooding --- Carpinteria, Santa Barbara Harbor/East Beach neighborhood, Goleta Slough/Santa Barbara Airport, Devereux Slough, and Gaviota State Park

Examples of Future Flood Hazards



Goleta **(top)**, Santa Barbara Harbor/East Beach **(middle)** and Carpinteria **(bottom)**, showing the 1 m SLR scenario coupled with the 100-year coastal storm from CoSMoS projections.

Wildfires

- Frequent and often large wildfires will continue to be a major disturbance.
- Air temperature in the month of ignition can increase tire size as can low precipitation in preceding 12 months.
- Expansion into the wildland urban interface will continue to increase risks.
- Post-fire recovery time may be lengthened and fire spread following ignitions will be enhanced
- Winter storms that produce abnormally high sediment export are likely to occur with greater intensity in the future

Thomas Fire Photos: Mike Eliason, SB County Fire Dept

Natural Resource Systems

Unique topography and climate make the Central Coast a special place to conserve hundreds of species as climate changes

Carrizo Plain National Monument

Plants

Redwood forests
Source: M. Loik

- High biodiversity with numerous endemic, federally-listed & sensitive that could be vulnerable to climate change
- Suitable habitat and overall resilience for chaparral, coastal sage scrub, grasses and forests will depend on the climate in which a species evolved, climatic tolerances, biotic interactions & land use.

Potential Adaptations

- Create diverse seed pools to increase population genetic diversity
- Control grazing to enhance native grasses & forbs at the expense of exotic species
- Monitor & model populations to determine best practices for stewardship (e.g. assisted migration) & to promote desirable outcomes in a future climate

Wildlife

Focus on Herpetofauna

Extinctions are already underway for

1) Northern alligator lizards (*Elgaria coerulea),*
2) Arboreal salamanders *(Aneides lugubris)*
3) California Giant Salamander *(Dicamptodon ensatus)* - *predicted to go totally extinct by 2070.*

Species may have robust climate refugia in the Santa Cruz Mountains and Santa Lucia Mountains that protect from the risk of extirpation owing to cooler temperatures, fog and higher levels of precipitation.

Impacts

- Invasion by exotic species, prevalence of wildlife disease, loss of native habitats and reduction of geographical range
- Some species have moved towards high latitudes or high altitudes but other species have failed to reestablish their habitat associations.

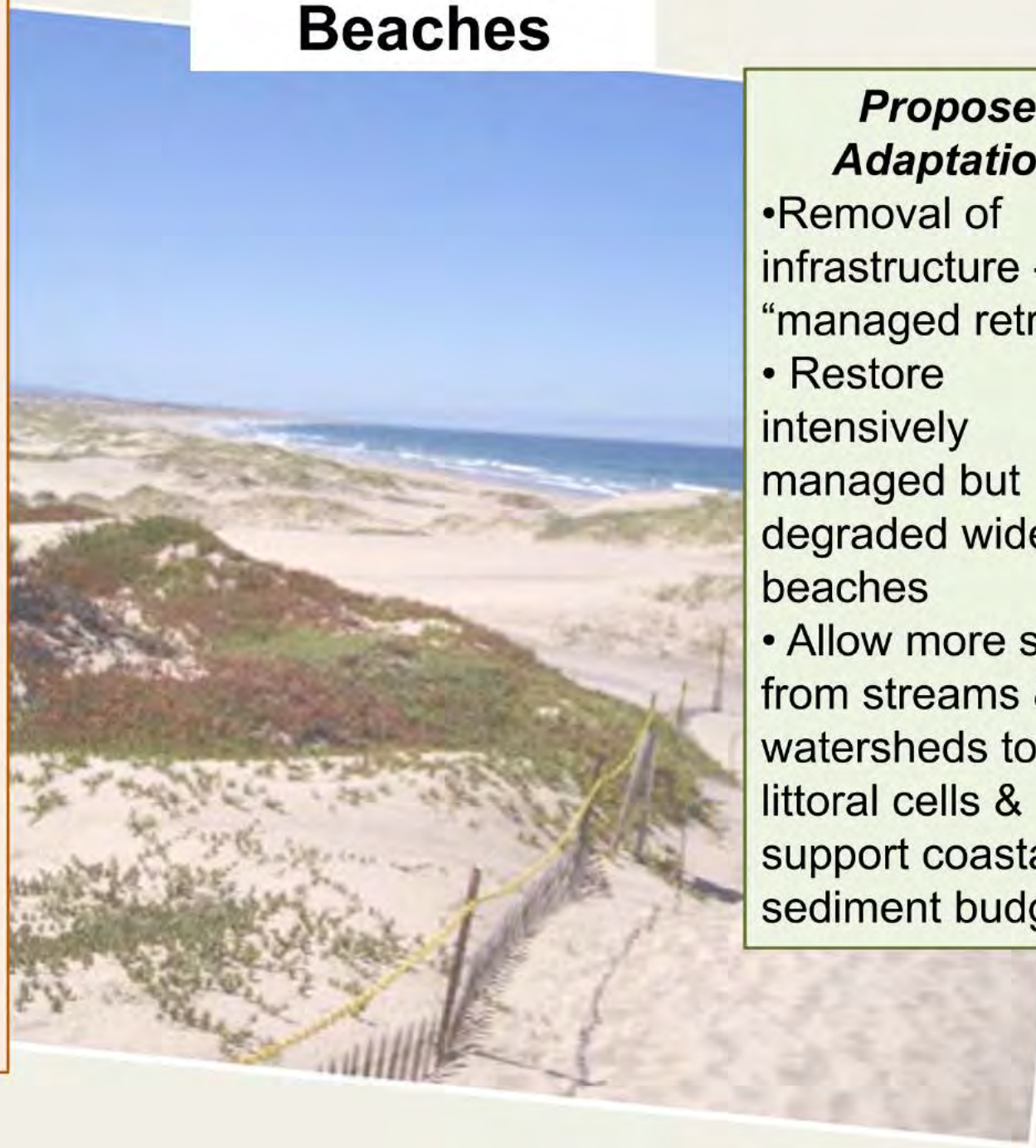
Beaches

Impacts

•SLR & extreme storms will increase rates of shoreline erosion & degrade & fragment beach habitat.

• Many beaches will narrow & may be completely lost

•Dune-backed beaches will be most resilient - those backed by bluffs and armoring structures will disappear.



Proposed Adaptations

•Removal of infrastructure - "managed retreat"

• Restore intensively managed but degraded wide beaches

• Allow more sand from streams & watersheds to enter littoral cells & support coastal sediment budgets

Tidal Estuaries and Riparian Areas

•Some marshes may drown or become shallow mudflats leading to a loss of the ecosystem services, including carbon sequestration

•Extremes from drought to floods will threaten the aquatic life of streams & rivers

• Fire & erosion will bury habitat in sediments.

This will impede survival of already endangered migratory Steelhead & Coho salmon, and could further reduce the diversity & abundance of sensitive aquatic insects.

Aerial view of Elkhorn Slough

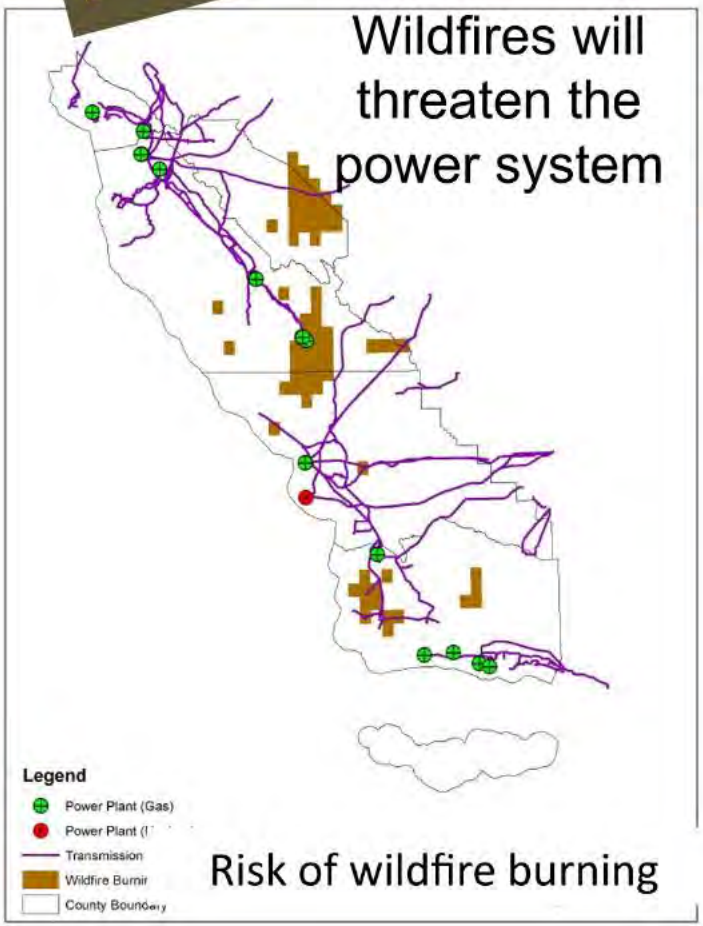
Source: Marli Miller

Sector Impacts & Adaptations

Energy

Impacts:

- Higher temperatures will: reduce electricity efficiency leading to deficits especially during peak demand; increase risk of outages; increase cooling requirements affecting electricity from gas-fired plants
- Intense storm events will affect energy infrastructure



Proposed Adaptations:

- Energy efficiency,
- Renewable energy,
- Clean fossil-fueled generation,
- Transmission infrastructure improvements,
- Roof materials to reduce the “heat island effect” in new construction

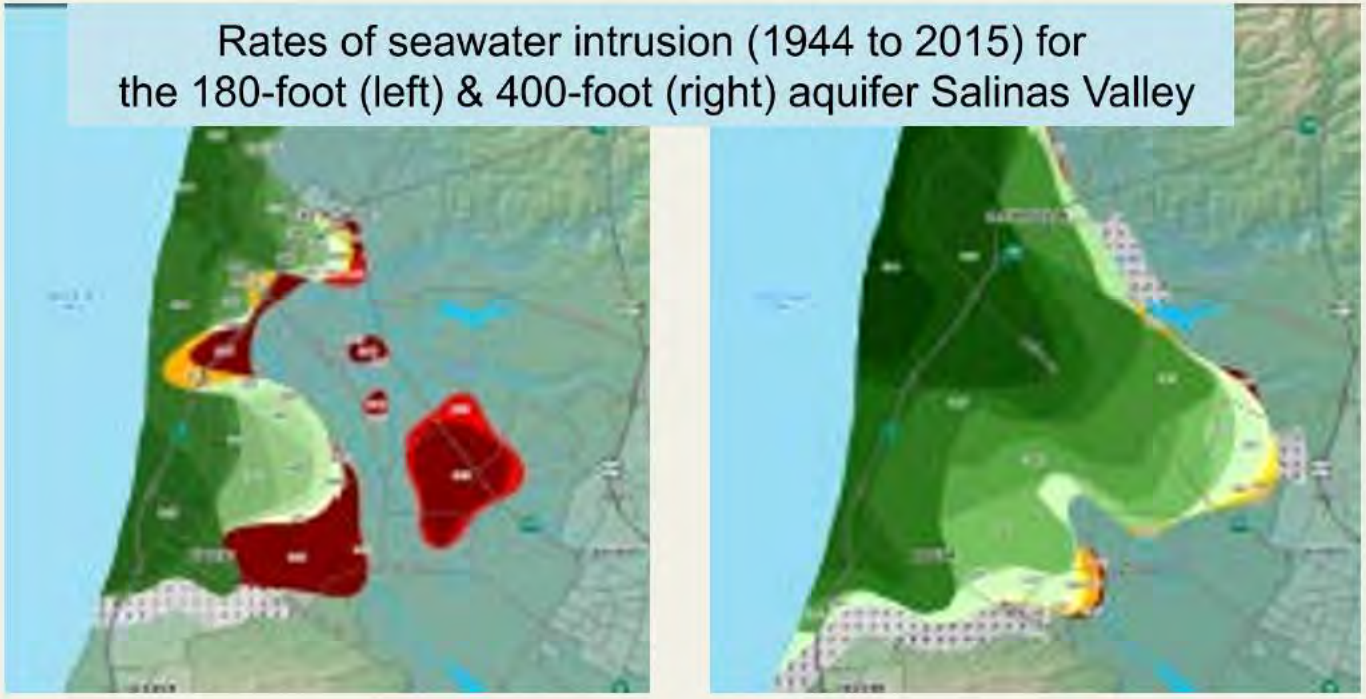
Water

Only modest changes in mean precipitation are projected, but combined with increasing temperatures, managing Central Coast's already stressed water supplies will be challenging.

Impacts

- Agricultural water use is likely to increase
- Domestic landscaping water demand will be higher
- Groundwater extraction and rate of saltwater intrusion may increase

Rates of seawater intrusion (1944 to 2015) for the 180-foot (left) & 400-foot (right) aquifer Salinas Valley



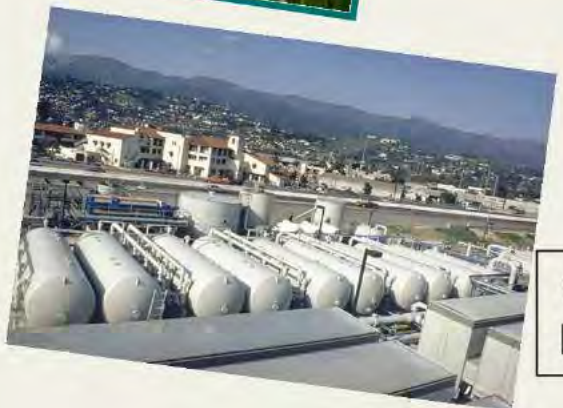
Water

More Impacts

- Lower seasonal surface flows will lead to higher pollutant concentrations and affect nitrate inputs, soil processes and agricultural productivity
- Changes in rainfall patterns will affect surface water reservoirs
- Imported water from the SWP will be less reliable and more expensive

Proposed Adaptations:

- Conservation
- Recycled water
- Desalination
- Groundwater Management (SGMA)
- Groundwater drought buffers



Charles E. Meyer Desalination Plant

Agriculture

mavensphotoblog

Changes in climate influence: crop selection, crop acreage, technology adoption, water demand

Salinas Valley is one of the most vulnerable agricultural regions under climate change.

Carlos Chavarría for The NY Times

Proposed Adaptations

- More efficient soil and irrigation management
- Improve soil retention capacity (crop rotations, tillage systems, soil cover)
- Identify potential pests & develop strategies for control
- Improve rainwater harvest, on-farm water capture & storage & groundwater recharge.

Public Health

Impacts

•Extreme heat events could increase illnesses for agricultural workers and spark wildfires releasing harmful particulate matter.

Infectious/Vector-borne diseases may worsen including Valley Fever and Pacific Coast tick fever.

•An increase in harmful algal blooms will expose animals and people to toxins released from the algae

Salinas Valley strawberry pickers.
Image California Magazine

Adaptation

In 2014, San Luis Obispo County Public Health Department initiated the first climate change and health communications campaign, co-developed with the CA Department of Public Health. It is supported by a multiple community partners

Landscape & Community Adaptations

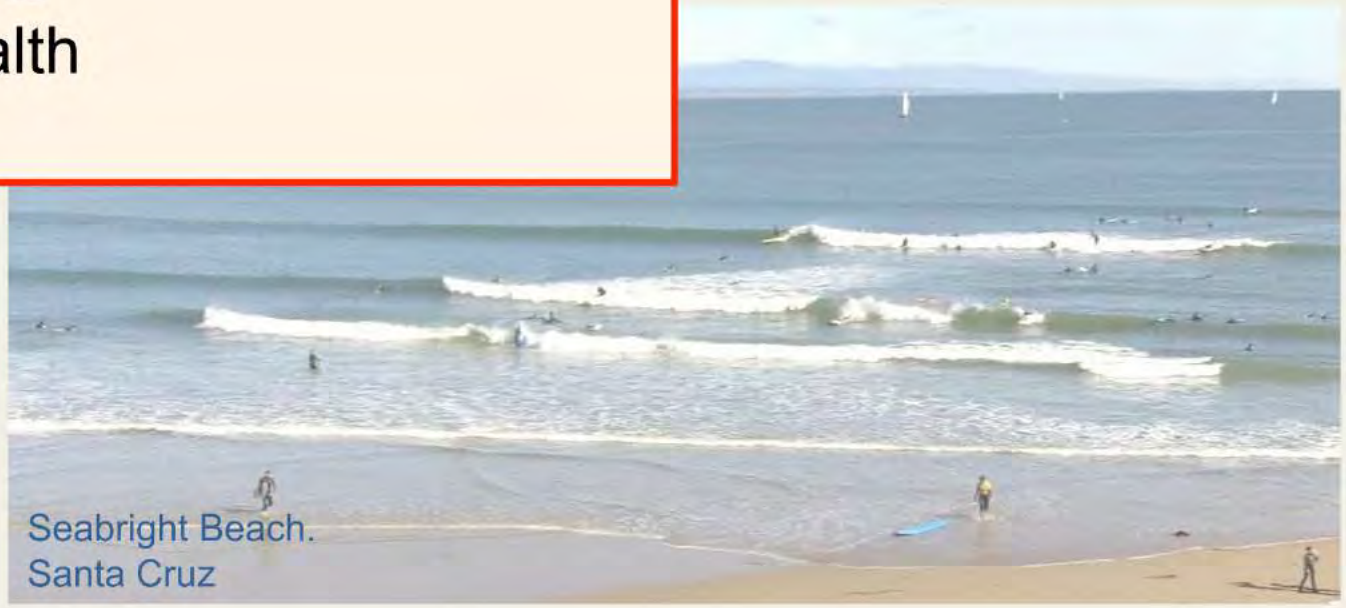
Examples of Community Efforts

- The Central Coast Climate Collaborative involving cities, counties and community groups in climate adaptation activities
- The Central Coast Action Lab focusing on youth in farmworker communities.
- Many cities counties, NGOs and colleges have completed assessments of local vulnerabilities - including coastal hazard assessments
- Some natural lands are undergoing vulnerability assessments

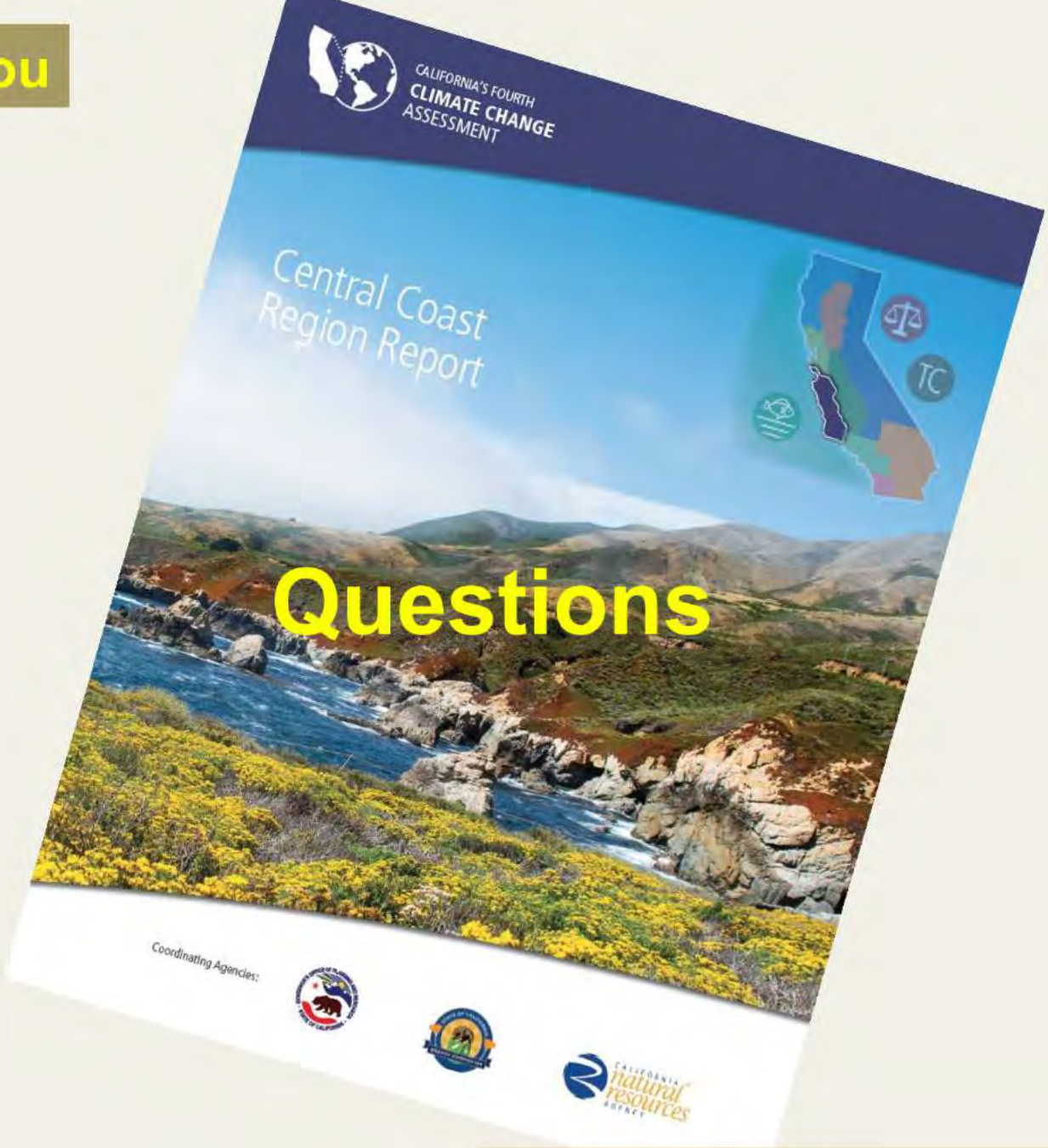
Key Critical Future Issues:

Climate extremes
Land use decisions
Development patterns
AND
Water
Fire
Agriculture
Ecosystems
Public Health
Energy


San Luis Obispo


Seabright Beach.
Santa Cruz

Thank you



Questions

www.climateassessment.ca.gov/regions/

Risks and Opportunities for California's Coast and Ocean

Gary Griggs

Geologist / Professor
UC Santa Cruz

Li Erikson

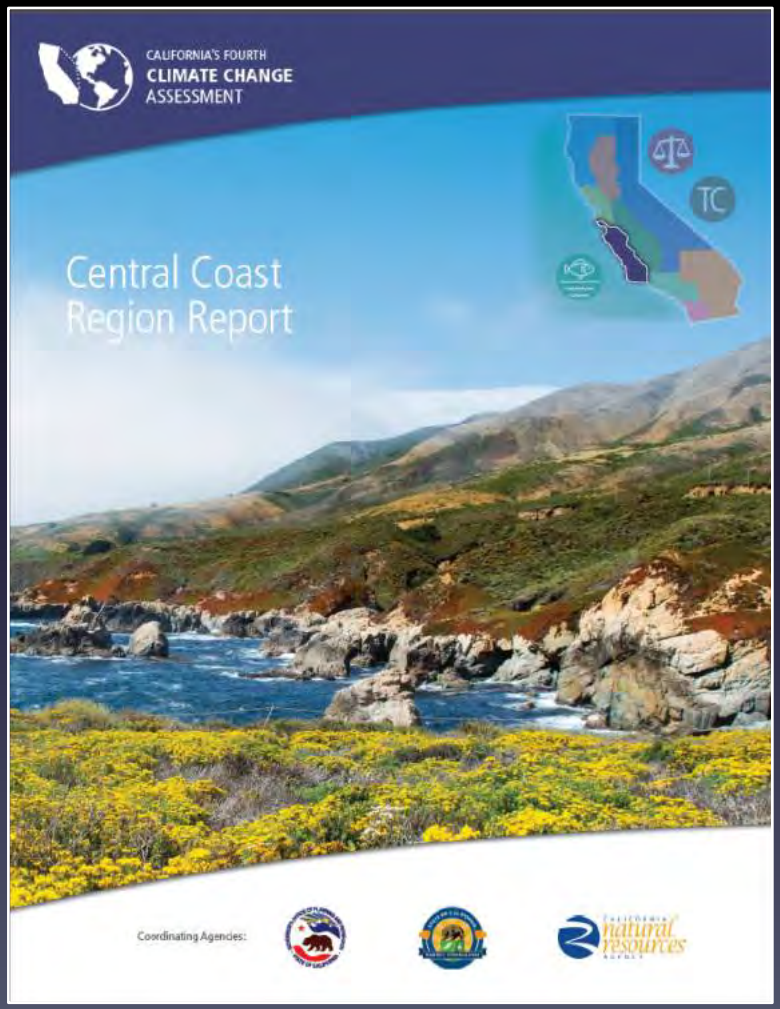
Research Oceanographer
U.S. Geological Survey

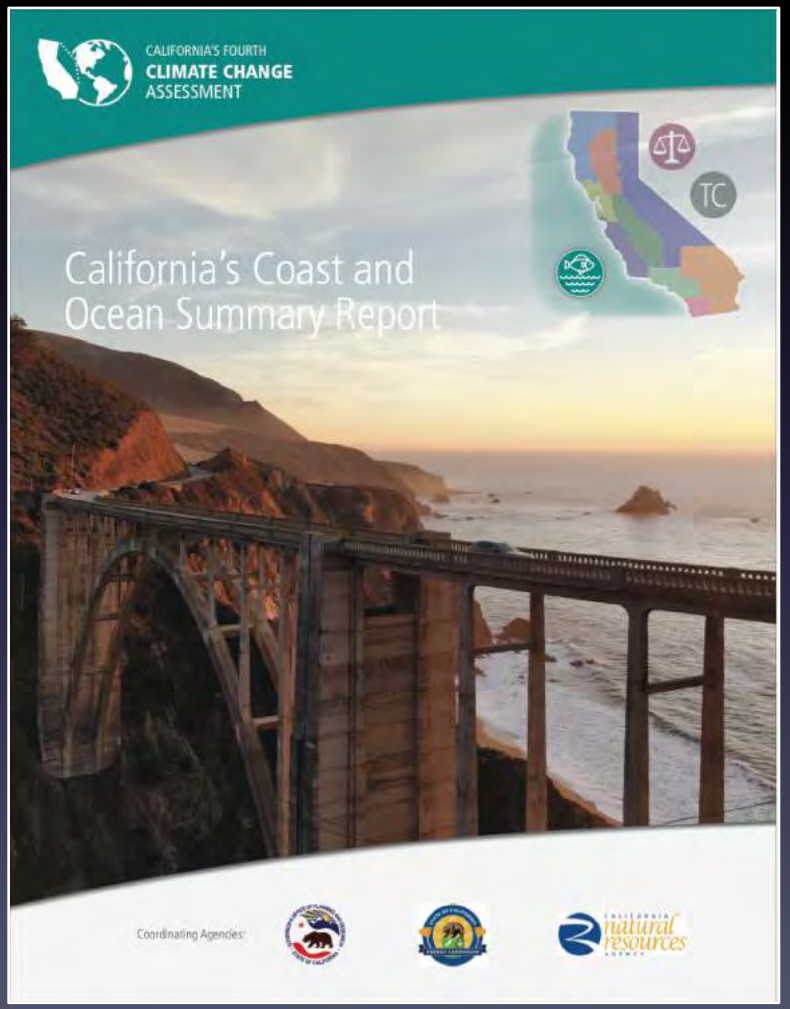
Jennifer Phillips

Senior Scientist
Governor's Office of Planning and Research

4TH CLIMATE CHANGE ASSESSMENT: CLIMATE CHANGE AND CALIFORNIA'S COAST

GARY GRIGGS
UNIVERSITY OF CALIFORNIA SANTA CRUZ





Two Scales of Climate Change Effects on Coastal California

1] Those processes or changes that are oceanic and global in scale, driven by global warming and increased carbon dioxide emissions, and where California's ability to respond is very limited:

- *ocean warming*
- *ocean acidification*
- *increasing frequency, duration and intensity of harmful algal blooms*

2] Those that are more coastal and that we have the ability to respond and adapt to:

- *sea-level rise with increase in frequency and duration of coastal flooding*

2] Those that are more coastal and that we have the ability to respond and adapt to:

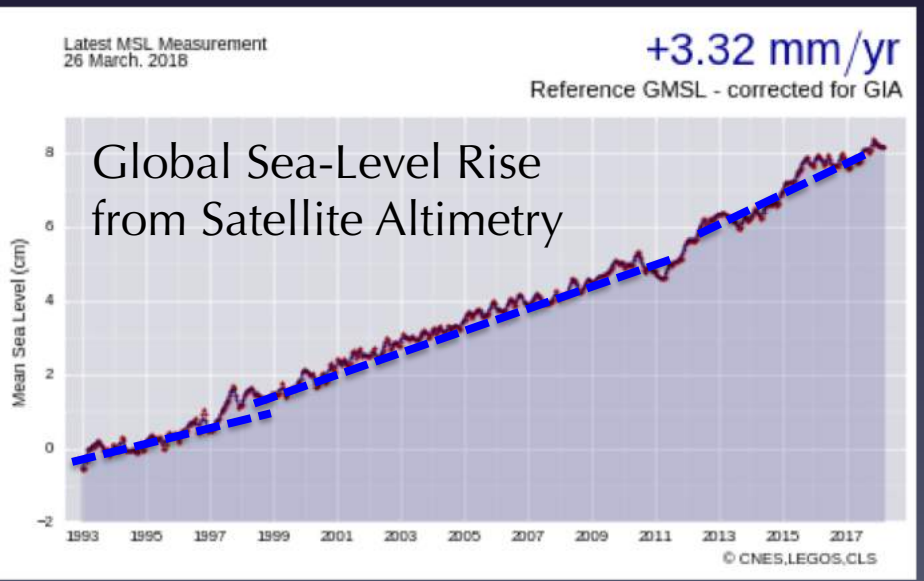
- sea-level rise with increased cliff and bluff erosion

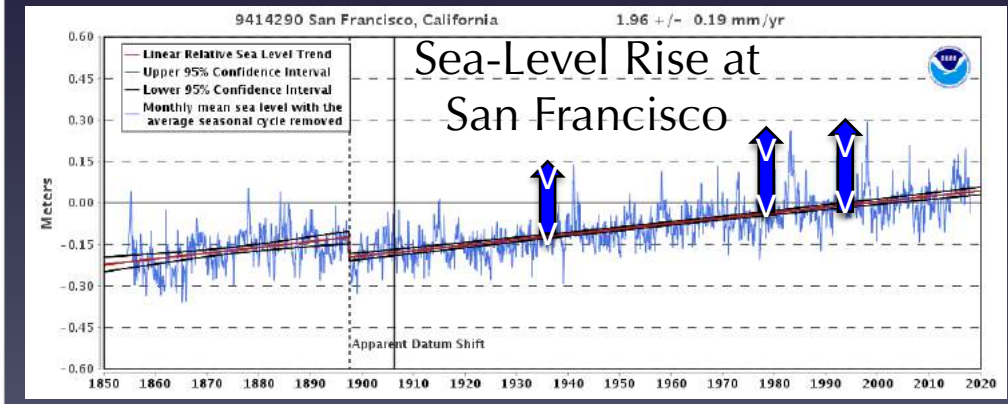
2] Those that are more coastal and that we have the ability to respond and adapt to:

- *intensively used beaches with armor or barriers at their back edge will eventually narrow and disappear with continued sea-level rise and passive erosion.*

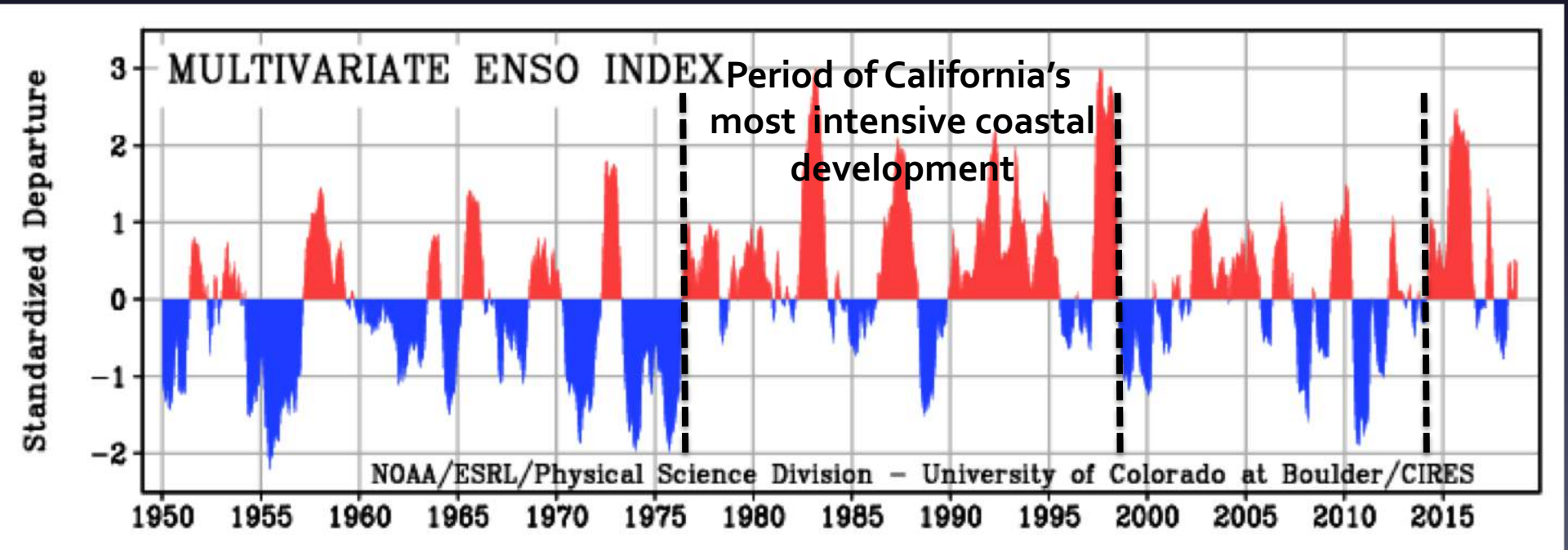
Over at least the next several decades, the extreme events (El Niños, king tides, and large wave at times of high tides) will have greater impacts on the shoreline than sea-level rise alone.

However, sea-level rise is accelerating and will be additive with extreme events presenting greater threats to California's development and infrastructure along the beaches, dunes, bluffs and cliffs after mid-century.



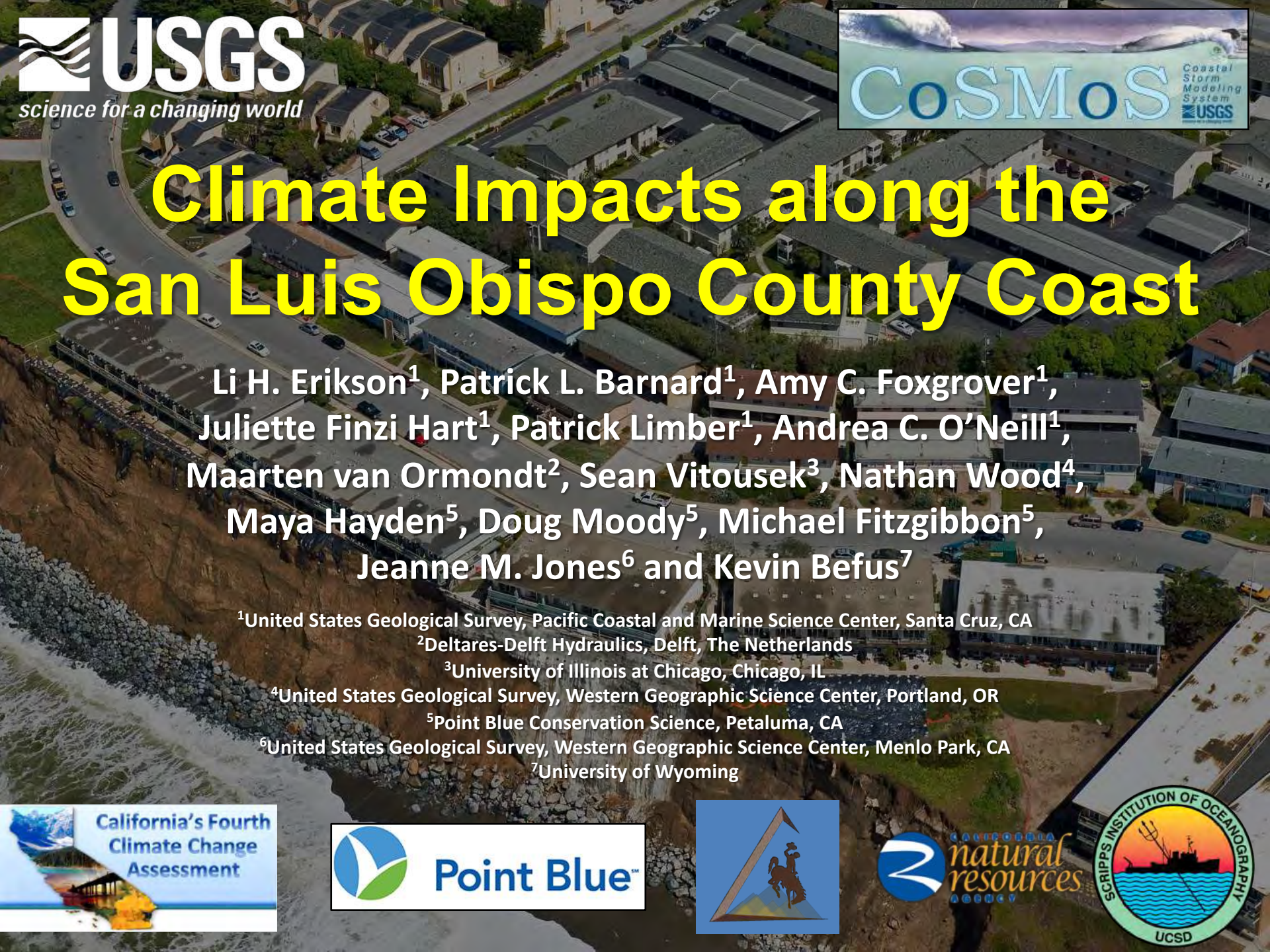


While the greatest damage to coastal property and infrastructure over the past several decades has occurred during large El Niño events, there are still significant uncertainties involved with future wave climate, and also with the future frequency and intensity of El Niño events.



Ocean warming, ocean chemistry changes, sea-level rise and other greenhouse gas driven changes to California's ocean and coast – those already occurring and projected – will have significant consequences for California's coastal economy, communities, ecosystems, culture and heritage.

Q&A



USGS science for a changing world

CoSMoS Coastal Storm Modeling System USGS

Climate Impacts along the San Luis Obispo County Coast

Li H. Erikson[1], Patrick L. Barnard[1], Amy C. Foxgrover[1], Juliette Finzi Hart[1], Patrick Limber[1], Andrea C. O'Neill[1], Maarten van Ormondt[2], Sean Vitousek[3], Nathan Wood[4], Maya Hayden[5], Doug Moody[5], Michael Fitzgibbon[5], Jeanne M. Jones[6] and Kevin Befus[7]

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California's Fourth Climate Change Assessment

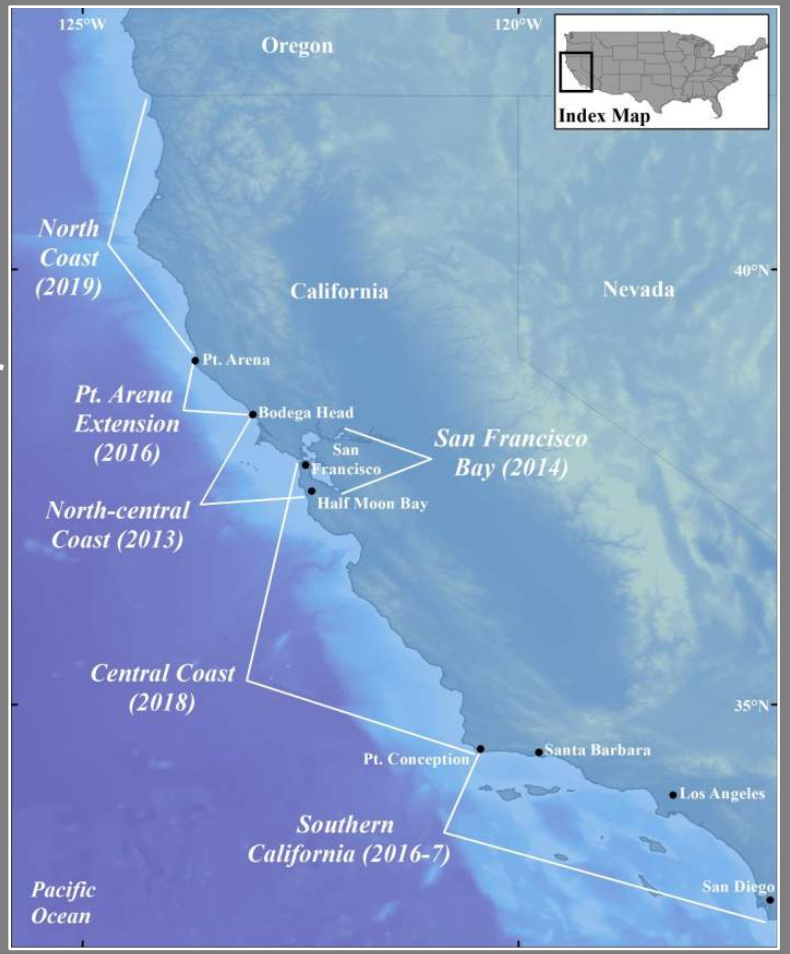
Point Blue

California natural resources agency

Scripps Institution of Oceanography UCSD

Coastal Storm Modeling System (CoSMoS)

- Physics-based numerical modeling system for assessing coastal hazards due to climate change
  - Sea Level Rise Projections
    - 0, 25, 50 ,75, 100, 150, 200, 300, 500 cm
  - Storm Projections
    - daily conditions and 1, 20, and 100 year return intervals
  - Shoreline Evolution (v3)
    - Sandy beach position & cliff retreat
- Web-based coastal vulnerability tools (developed in collaboration with federal, state, and city governments to meet their planning and adaptation needs)

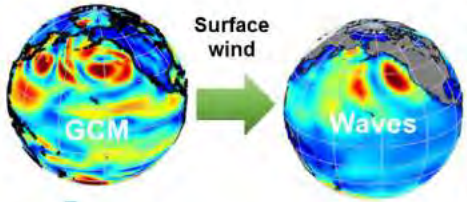


USGS

CoSMoS Framework

Global Scale

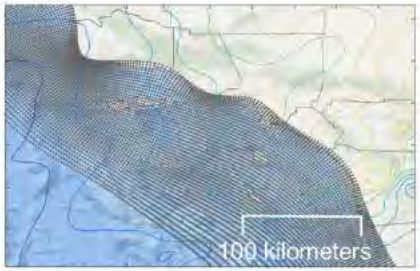
Deep water wave generation and propagation using climate change influenced future winds.



Downscaled winds and atmospheric pressures

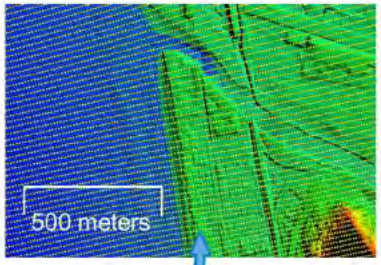
Regional Scale

Swell propagation, wave generation, storm surge, and astronomic tides.



Local Scale

High-resolution hydrodynamics: nearshore waves, wave setup and runup, storm surge, tides, overland flow, fluvial discharge.



Long-term cliff recession and shoreline change

Web-based tools for data visualization and analysis

***USGS CoSMoS for Central Coast to be completed in 2019

USGS

Coastal Storm Modeling System

http://walrus.wr.usgs.gov/coastal_processes/cosmos

OCOF
OUR COAST OUR FUTURE

Web tool for data visualization, synthesis, download
http://outcoastourfuture.org

Hazard Exposure Reporting and Analytics (HERA)

Socio-economic web tool
www.usgs.gov/apps/hera

USGS

Flood hazard web tool

Our Coast, Our Future tool: *www.ourcoastourfuture.org*

CoSMoS Coastal Storm Modeling System USGS

Available outputs

- Long term (LT) cliff recession and sandy beach shoreline change

4 coastal management scenarios + SLR

- Flood depths, extents, and low-lying vulnerable areas (including integration of LT morphodynamic change)
- Maximum water levels
- Flood duration
- Maximum wave heights
- Maximum velocities
- Maximum wave runup
- Flood extent uncertainties (model + DEM uncertainties, & vertical land motion)

40 scenarios of SLR + storms

USGS

Coastal Storm Modeling System

http://walrus.wr.usgs.gov/coastal_processes/cosmos

OCOF
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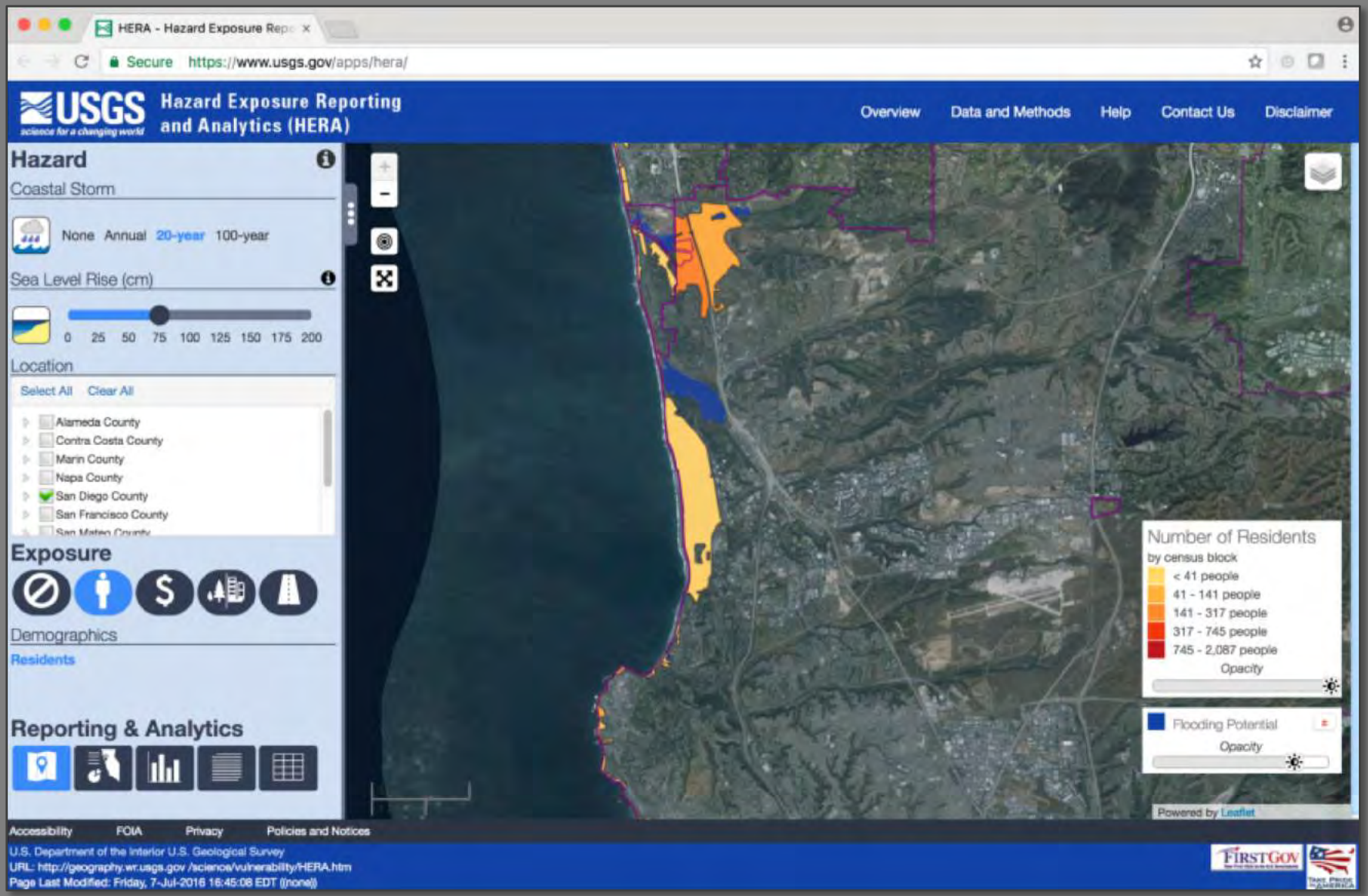
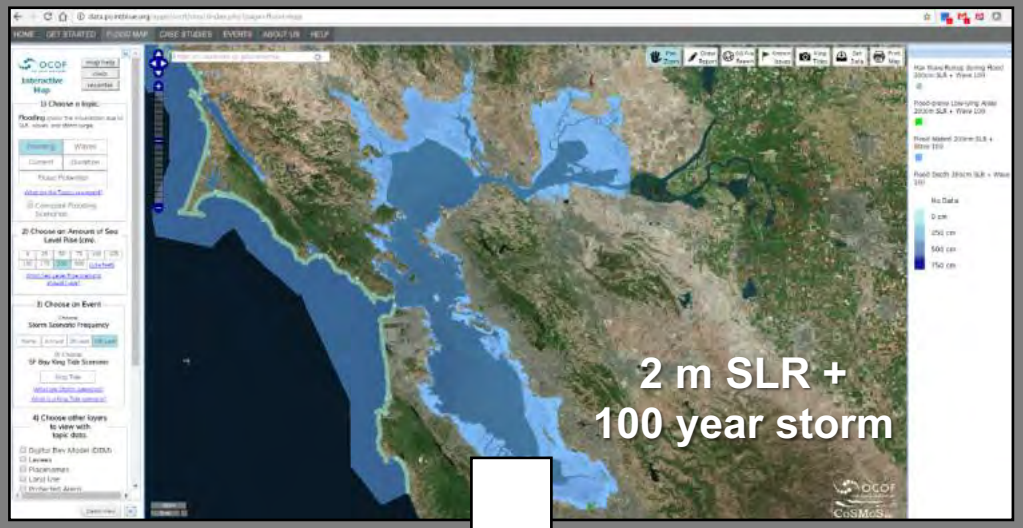
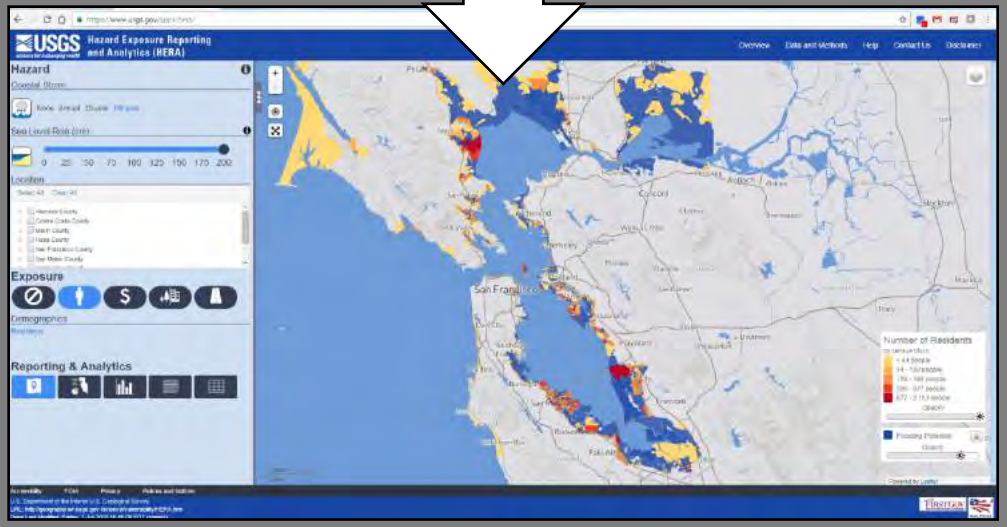


Coastal Climate Impacts





California

- 600,000+ residents
- $150 billion in property
- 4,700 km of roads
- 350 critical facilities (e.g., schools, police stations, hospitals)

USGS

Hazards Exposure Reporting and Analytics (HERA)
www.usgs.gov/apps/hera

CoSMoS Coastal Storm Modeling System USGS

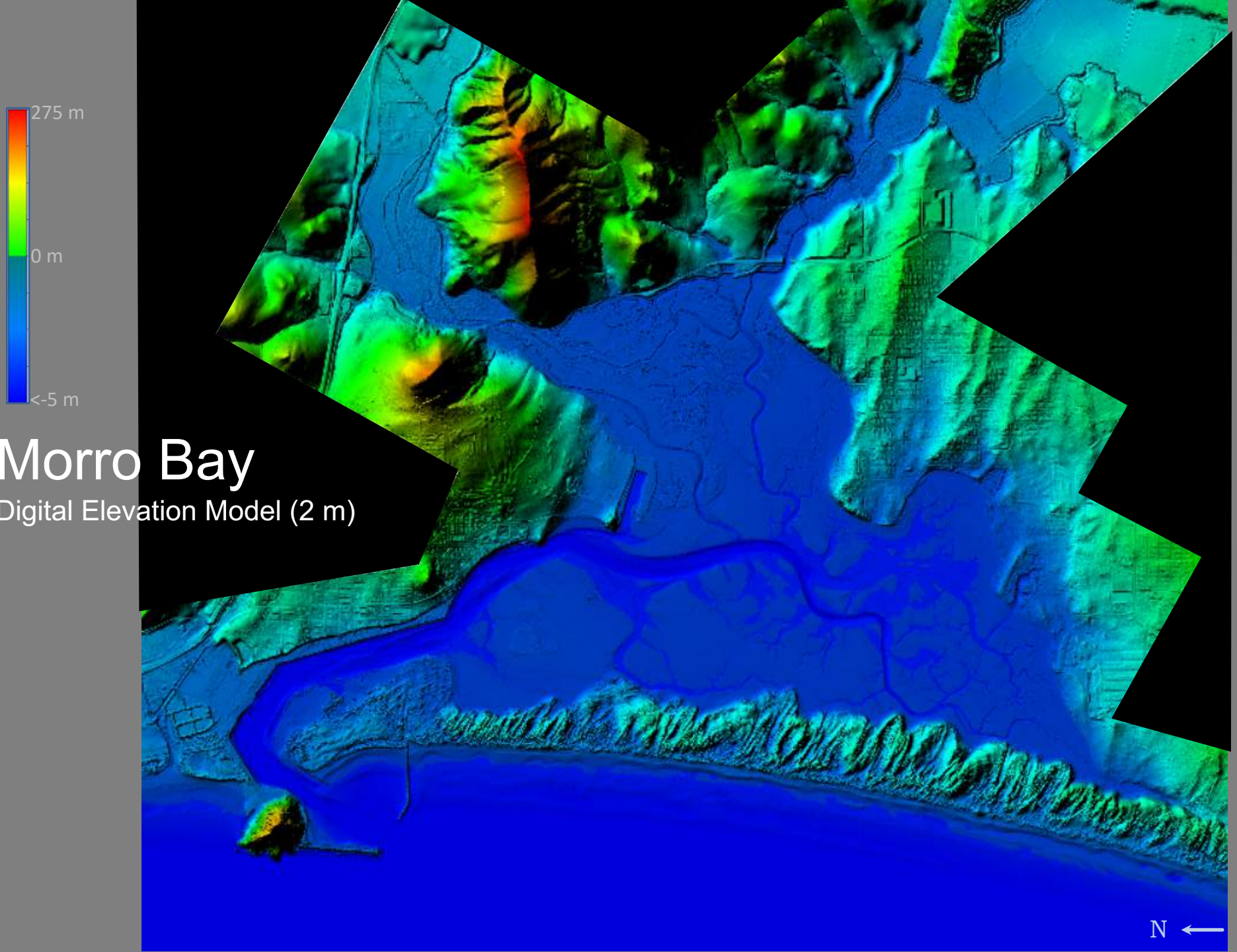
CoSMoS: Major Advancements

- Identification and selection of multiple storm scenarios for detailed deterministic modeling of local extreme events
- Long-term cliff retreat
- Long-term shoreline change
- Long-term coastal profile and DEM evolution
- Integration of climate change-driven morphodynamic change and coastal flood projections
- Development and integration of projected fluvial discharge rates
- Temporal downscaling of daily winds

USGS

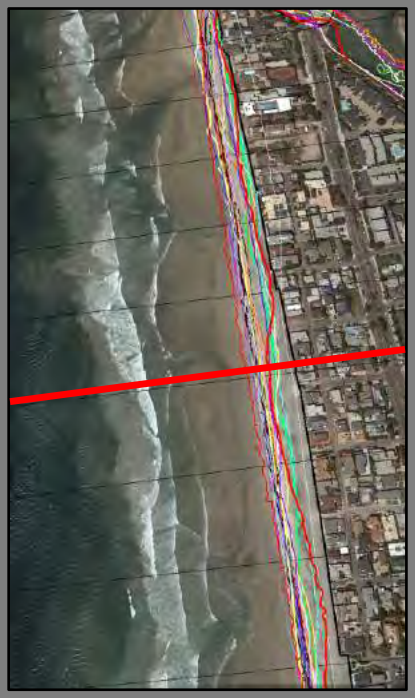
Morro Bay – Cambria

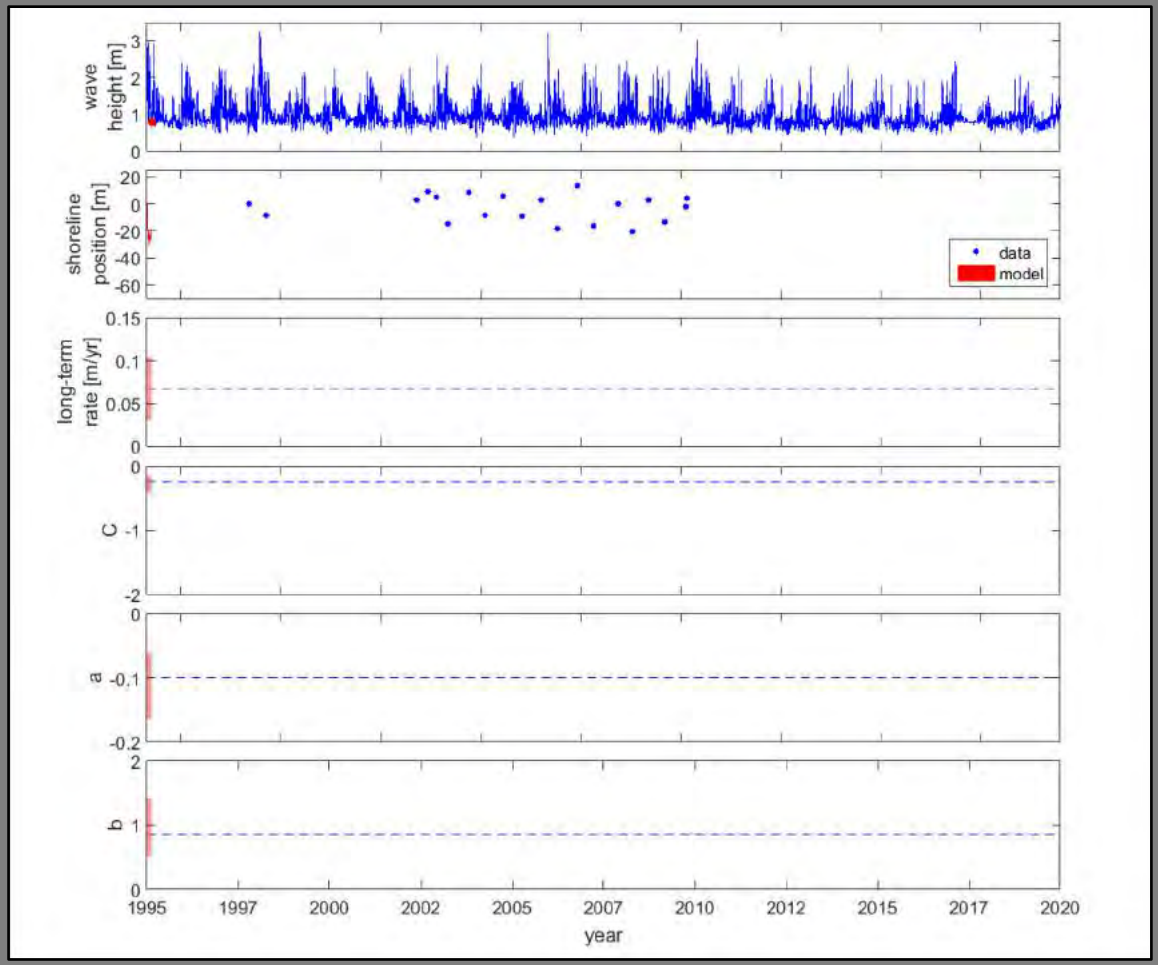
High-resolution Delft-3D grid development


275 m
0 m
<-5 m
Morro Bay
Digital Elevation Model (2 m)
N

CoSMoS-COAST: Coastal One-line Assimilated Simulation Tool

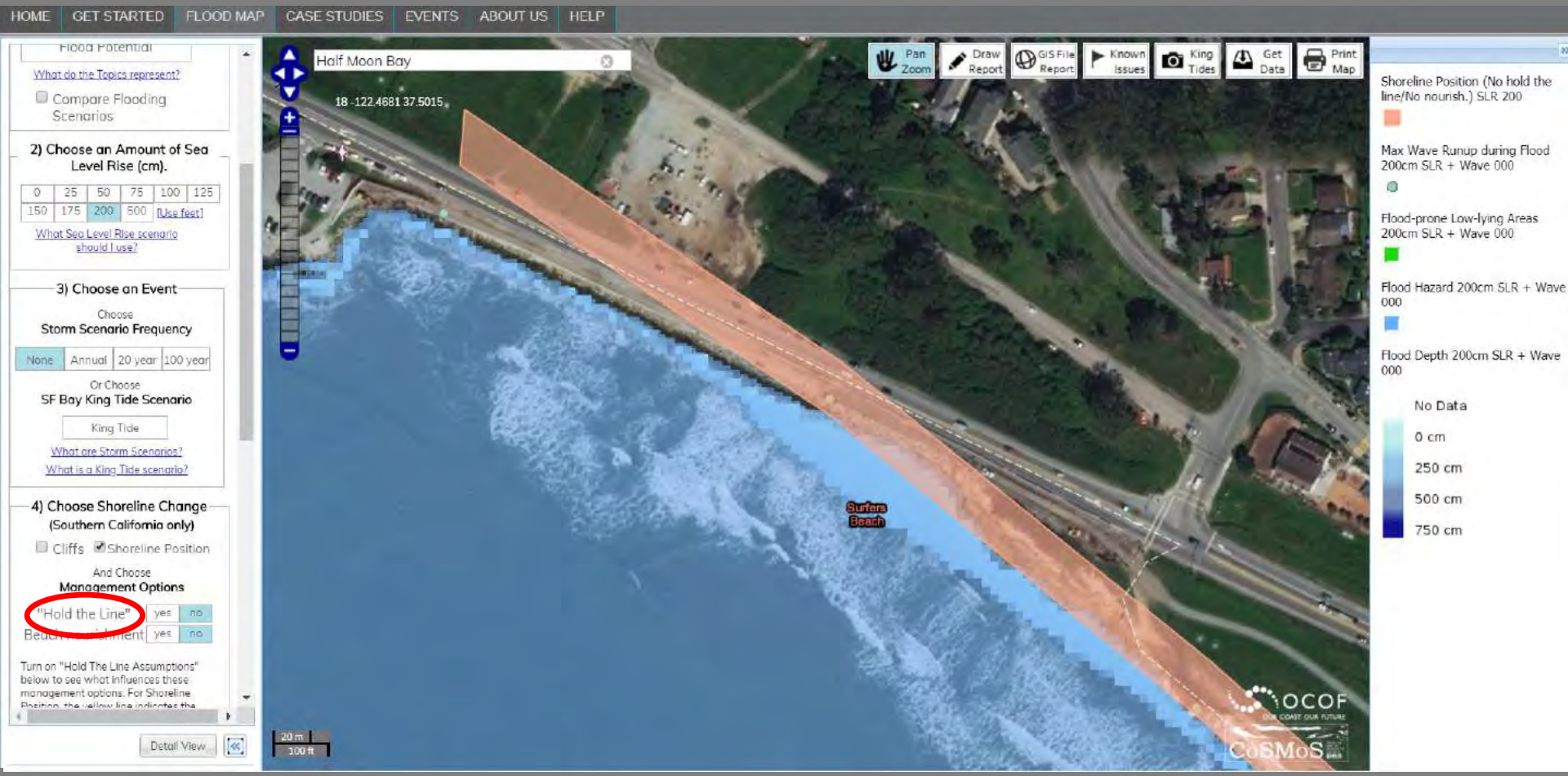
- A (hybrid) numerical model to simulate long-term shoreline evolution
- Modeled processes include:
  - Longshore transport
  - Cross-shore transport
  - Effects of sea-level rise
  - Sediment supply by natural & anthropogenic sources





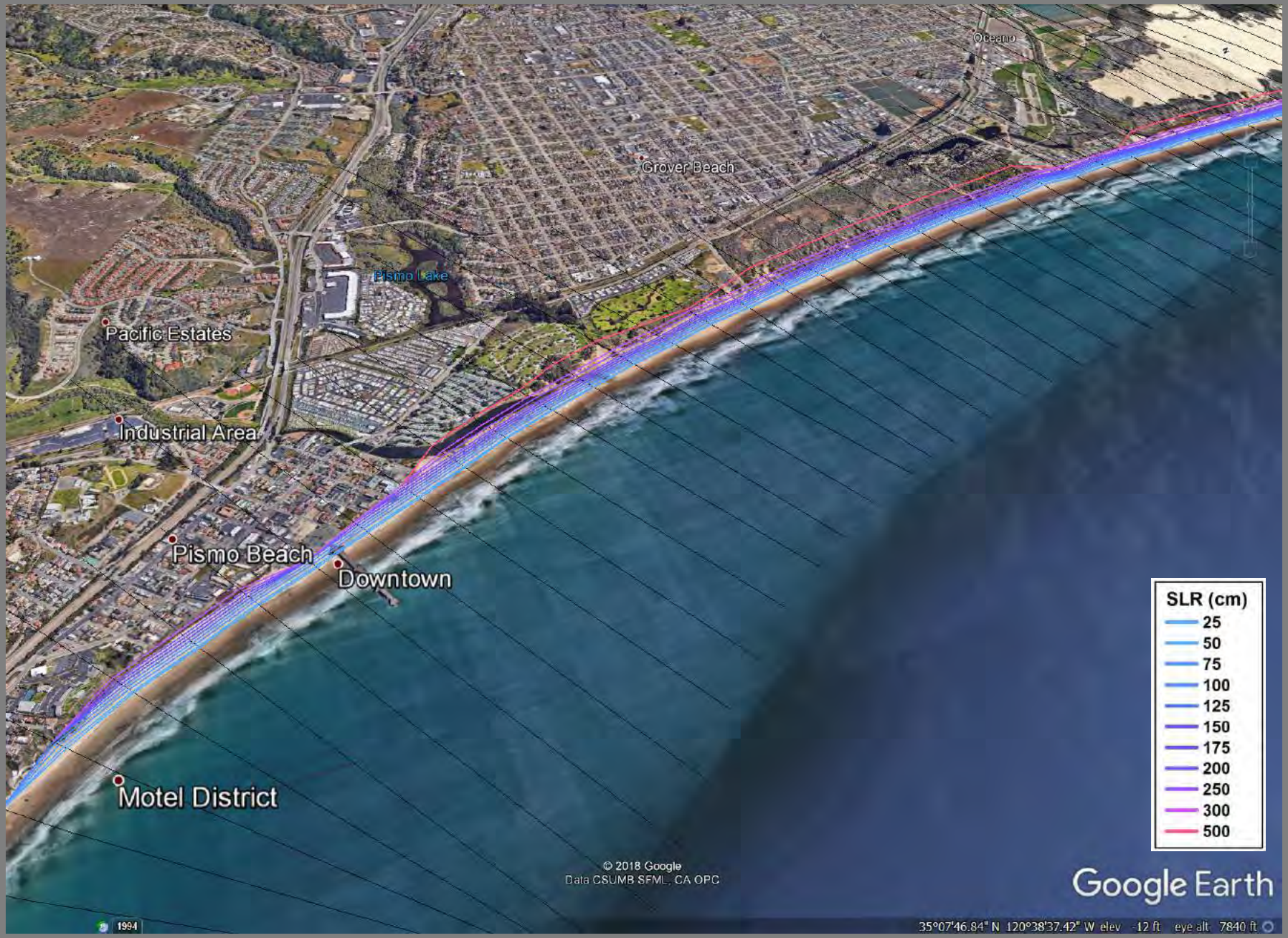
Vitousek, S., Barnard, P.L., Limber, P., Erikson, L.H. and Cole, B., 2017. A model integrating longshore and cross-shore processes for predicting long-term shoreline response to climate change. *Journal of Geophysical Research-Earth Surface*, http://dx.doi.org/10.1002/2016JF004065

Shoreline Change Projections



- 4 coastal management scenarios
  - No erosion beyond urban infrastructure (‘hold the line’), or not
  - Incorporate historical rates of change in future projections (e.g., nourishment), or not


SLR (cm)
25
50
75
100
125
150
175
200
250
300
500
Avila Beach
© 2018 Google
Google Earth
1994
35°11'50.49" N 120°44'49.53" W elev 700 ft eye alt 5462 ft


Oceano
Grover Beach
Pismo Lake
Pacific Estates
Industrial Area
Pismo Beach
Downtown
Motel District
SLR (cm)
25
50
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200
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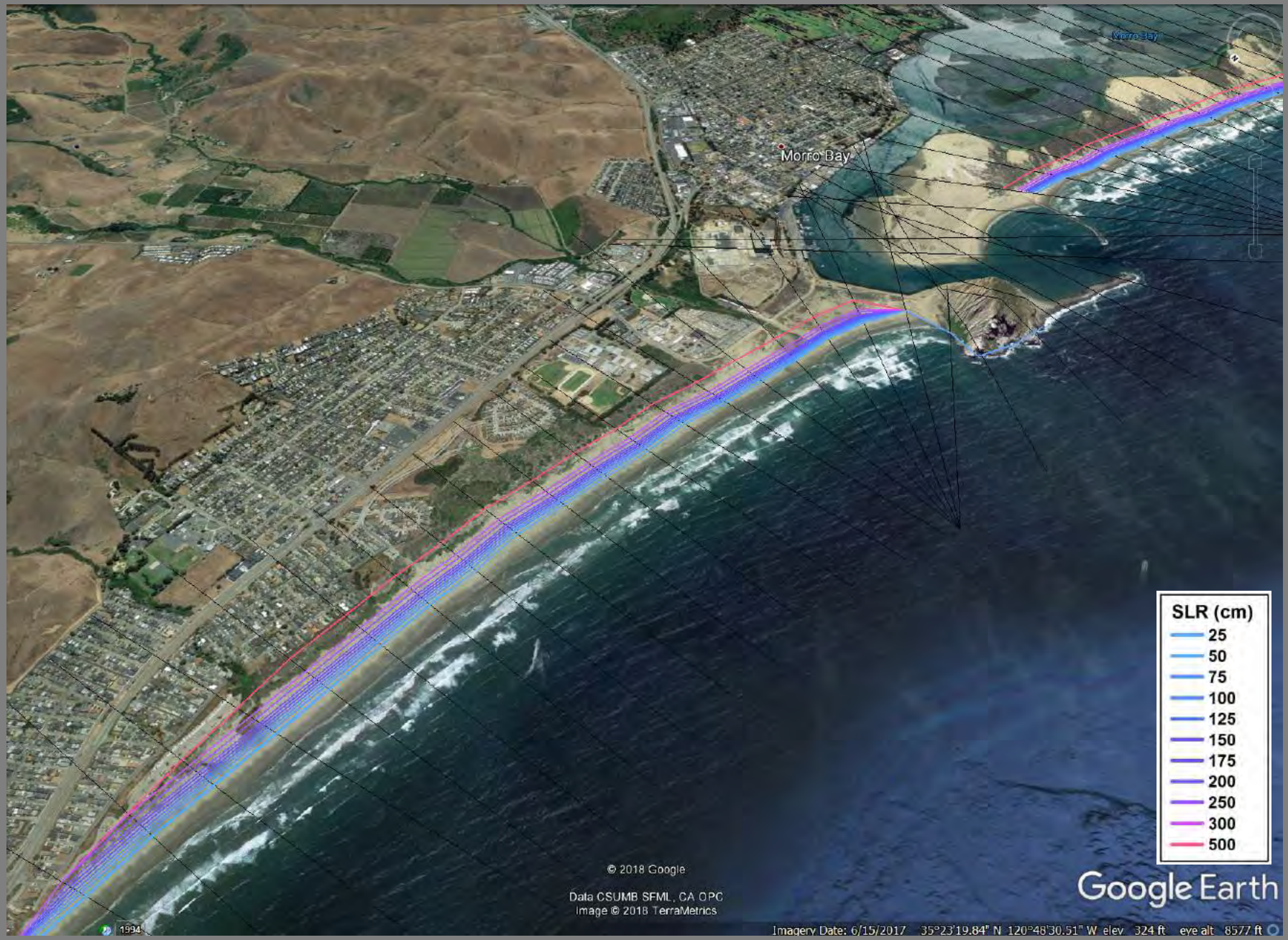
© 2018 Google
Data CSUMB SFML, CA OPC
Google Earth
1994
35°07'46.84" N 120°38'37.42" W elev -12 ft eye alt 7840 ft


Morro Bay
SLR (cm)
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© 2018 Google
Data CSUMB SFML, CA OPC
Image © 2018 TerraMetrics
Google Earth
1994
Imagery Date: 6/15/2017 35°23'19.84" N 120°48'30.51" W elev 324 ft eye alt 8577 ft


Morro Bay
Morro Bay
SLR (cm)
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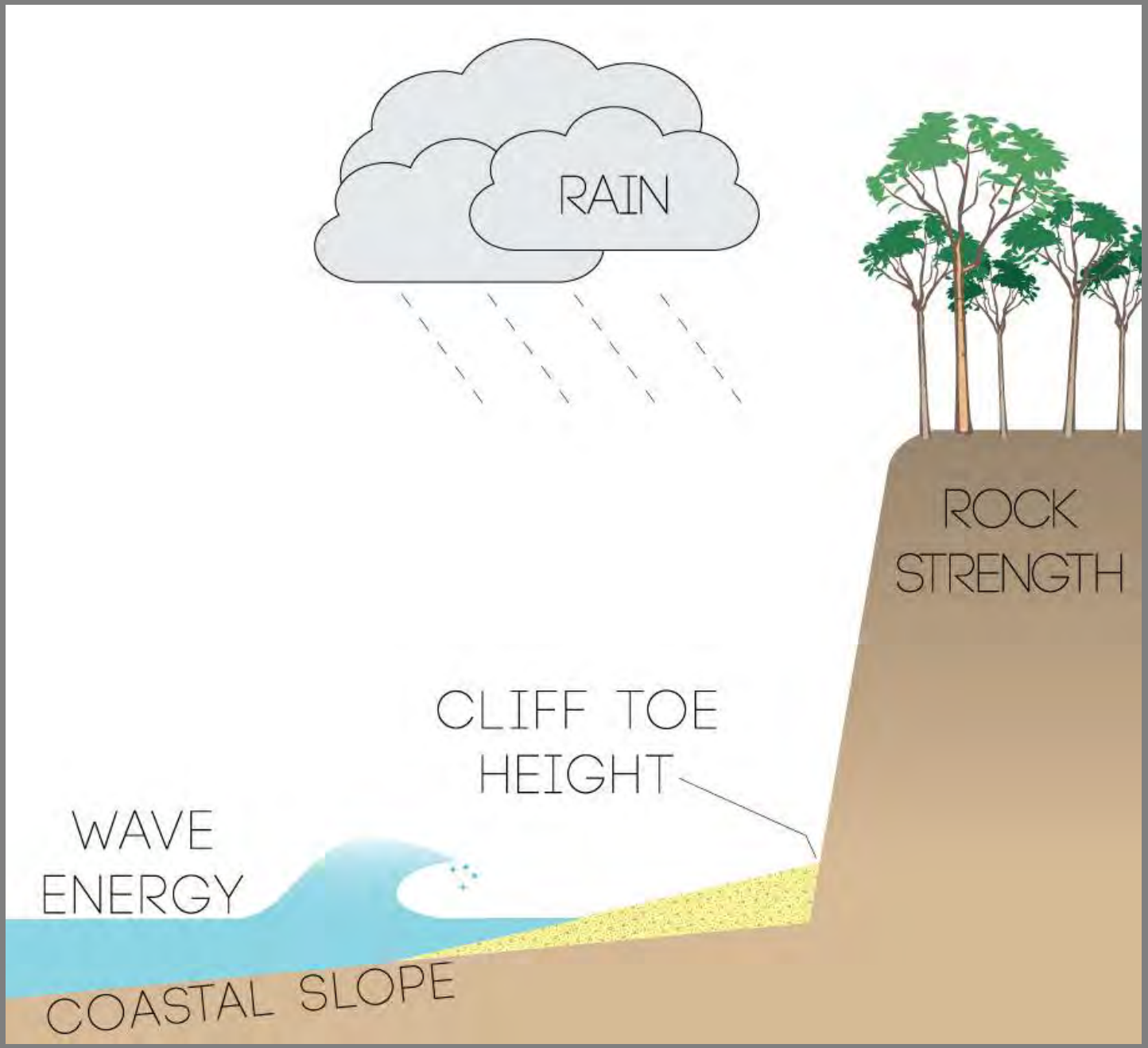
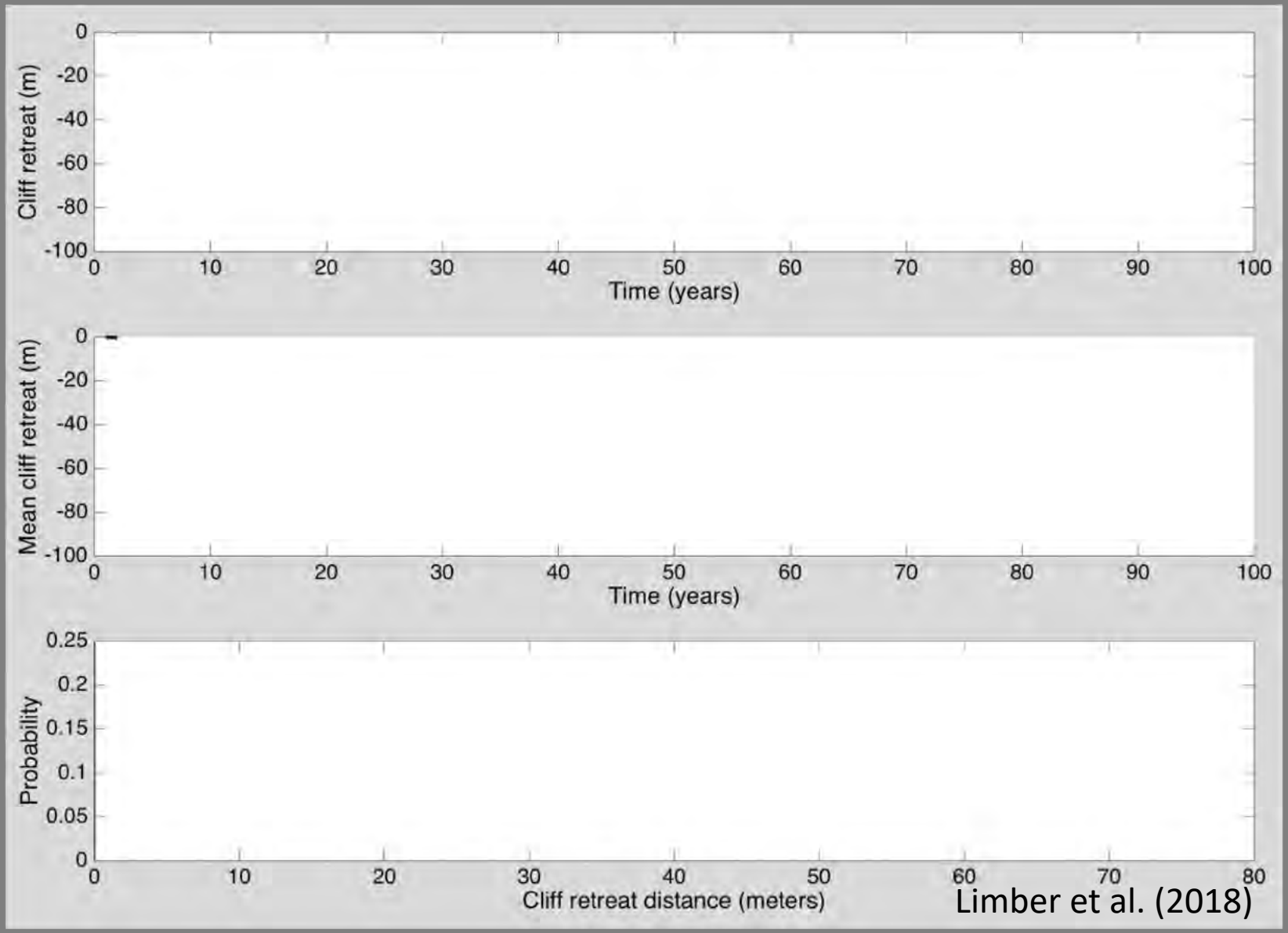
© 2018 Google
Data CSUMB SFML, CA OPC
Image © 2018 TerraMetrics
Google Earth
2004
Imagery Date: 6/15/2017 35°22'47.62" N 120°51'34.65" W elev 19 ft eye alt 9229 ft

Projected Cliff Retreat



Cliff Retreat



Limber et al. (2018)


South Palisades
North Spyglass
Spyglass
Spyglass Ridge
St Andrews
Mattie Road Annex
Spindrift
Baycliff Village
Shell Beach
Bird Rock
SLR (cm)
25
50
75
100
125
150
175
200
250
300
500
© 2018 Google
Google Earth
1994
35°09'23.84" N 120°40'31.62" W elev 51 ft eye alt 6417 ft


SLR (cm)
25
50
75
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125
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175
200
250
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1994
Data CSUMB SFML, CA OPC
© 2018 Google
Google Earth
Imagery Date: 6/15/2017 35°12'37.84" N 120°51'01.59" W elev 281 ft eye alt 7272 ft


San Simeon Bay
San Simeon
SLR (cm)
25
50
75
100
125
150
175
200
250
300
500
Data CSUMB SFML, CA OPC
© 2018 Google
Image © 2018 TerraMetrics
Google Earth


Cambria
SLR (cm)
25
50
75
100
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© 2018 Google
Google Earth
1994
Imagery Date: 6/15/2017 35°33'34.94" N 121°06'10.77" W elev 64 ft eye alt 7304 ft

Central Coast CoSMoS

- **Coastal change projections completed**
- **Flooding projections to be completed in 2019, with Our Coast, Our Future and HERA web tools**
- **Groundwater modeling completed, to be released in early 2019**

USGS CoSMoS website:

https://walrus.wr.usgs.gov/coastal_processes/cosmos/index.html

Our Coast, Our Future tool: *www.ourcoastourfuture.org*

HERA Tool: *www.usgs.gov/apps/hera*

*For more information, contact Patrick Barnard: pbarnard@usgs.gov, Andy O'Neill: aoneill@usgs.gov, Juliette Finzi Hart: jfinzihart@usgs.gov, or Li Erikson: lerikson@usgs.gov

USGS

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CoSMoS USGS

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USGS

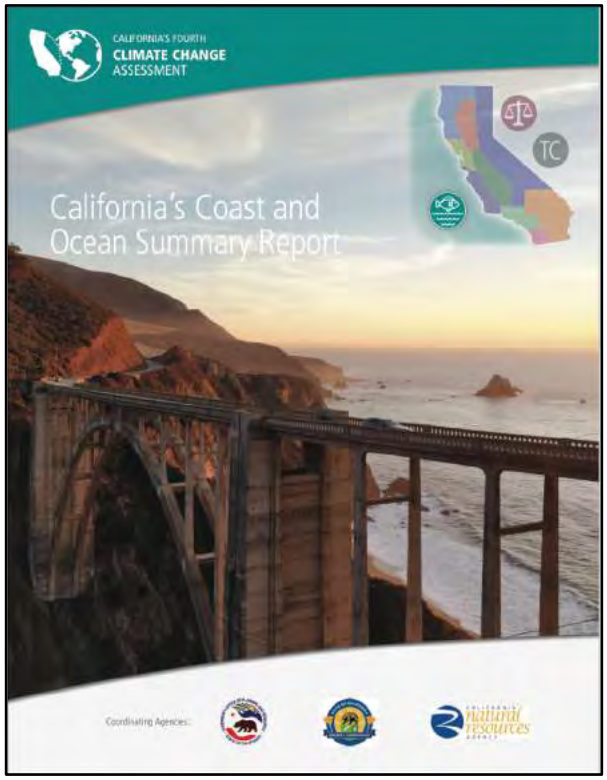
CoSMoS USGS

Q&A

USGS

CoSMoS USGS

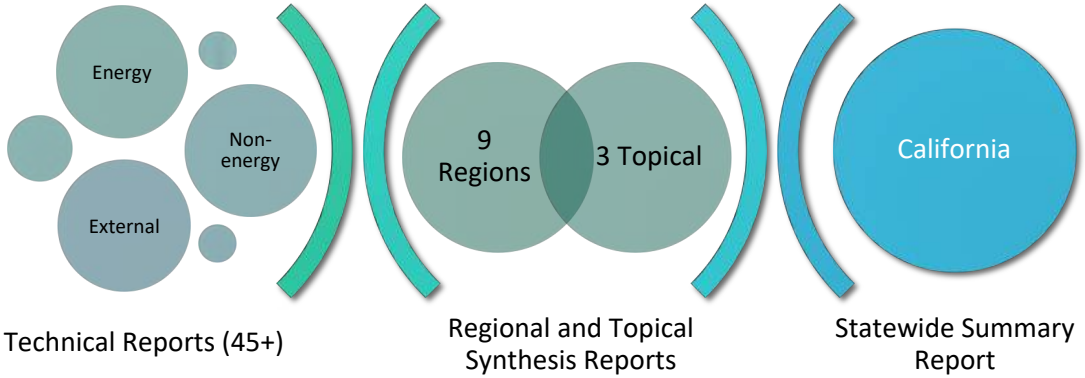
California's 4th Climate Assessment: The Coast and Ocean

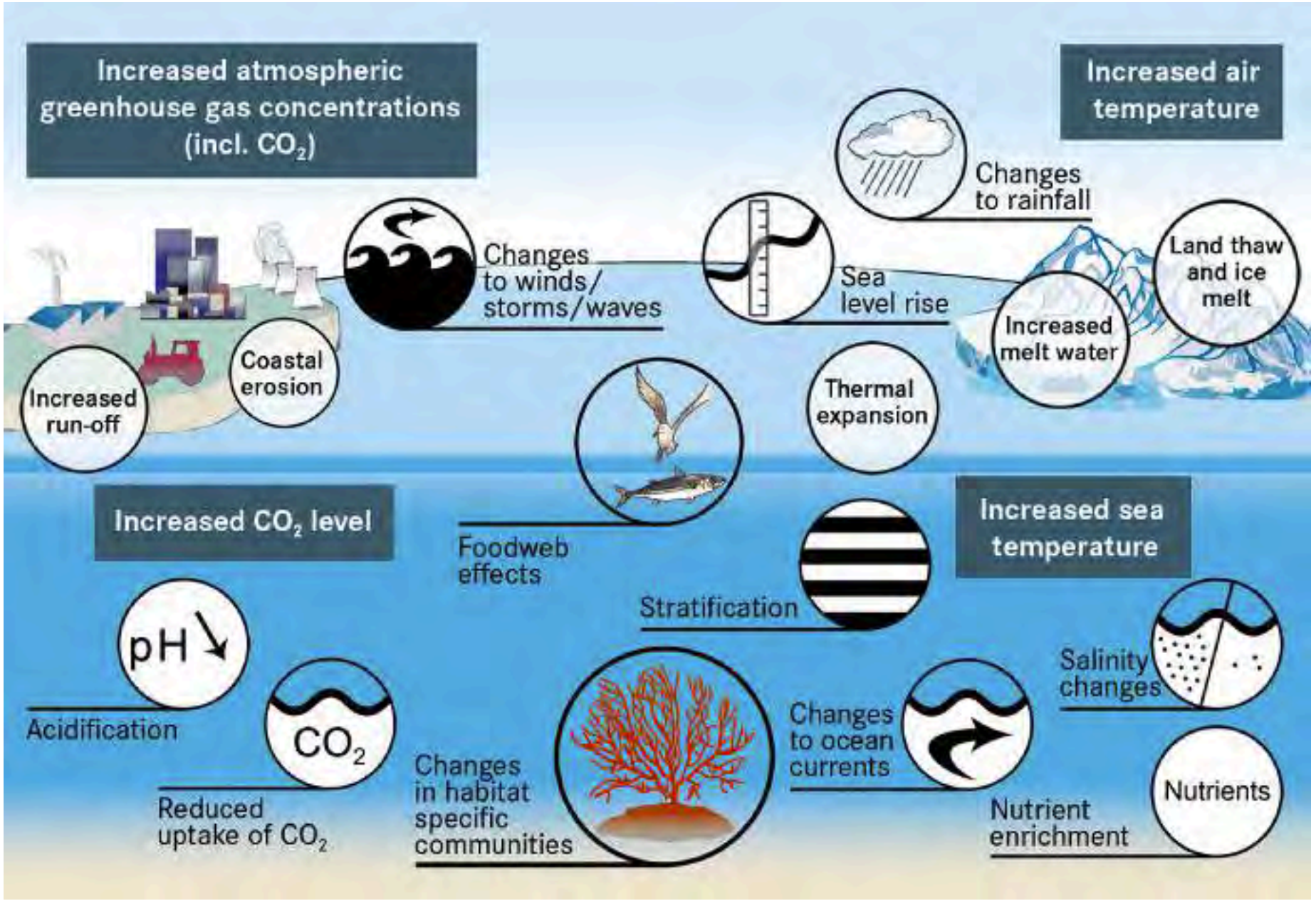


Jenn Phillips
Governor's Office of Planning & Research

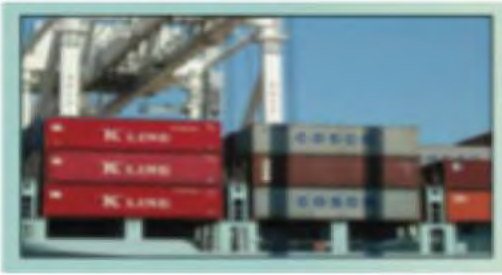
California's 4th Climate Change Assessment

- Periodic scientific assessments to understand the potential impacts of climate change in California
- Elements of the 4th Assessment **(new addition of ocean and coast topical report):**




Increased atmospheric greenhouse gas concentrations (incl. CO_2)
Increased air temperature
Changes to rainfall
Changes to winds/ storms/waves
Sea level rise
Land thaw and ice melt
Increased melt water
Coastal erosion
Increased run-off
Thermal expansion
Increased CO_2 level
Foodweb effects
Increased sea temperature
Stratification
pH
Acidification
CO_2
Reduced uptake of CO_2
Changes in habitat specific communities
Changes to ocean currents
Salinity changes
Nutrients
Nutrient enrichment

Why the coast matters for Californians…



California ports handle 60 percent of the nation's imports from the Far East and more than 70 percent of California's agricultural export trade; they are at risk from storm impacts and sea level rise.

Agriculture depends on coastal fog; reduced coastal fog and saltwater intrusion threatens some of themost valuable farming areas in the state.

Coast redwoods depend on marine fog; they may become drought-stressed if summer fog declines.

There are a number of locations along the California coast where beaches and other popular shoreline features will be permanently lost to a rising ocean.

Climate change is altering connections between the ocean and the atmosphere, potentially leading to even more severe droughts in our future.

Authors

COORDINATING LEAD AUTHORS

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- Leila Sievanen, *California Ocean Science Trust*

LEAD AUTHORS

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- Eric Hartge, *Stanford Center for Ocean Solutions*
- Tessa Hill, *University of California Davis, Bodega Marine Lab*
- Raphael Kudela, *University of California, Santa Cruz*
- Nathan Mantua, *Southwest Fisheries Science Center*
- Karina Nielsen, *San Francisco State University, OPC-SAT*
- Liz Whiteman, *California Ocean Science Trust*

Builds on and points to ocean-climate research and policy

- **Sea Level Rise**
  - Rising Seas Report and State Policy Guidance
- **Ocean Acidification and Hypoxia**
  - State of California Ocean Acidification Action Plan
- **Multi-sector engagement**
  - 4th California Climate Change Assessment
  - Safeguarding California

Major findings

- The ocean has limited terrestrial climate change impacts, but ocean's capacity to buffer rising GHGs will diminish.
- Coastal impacts will have implications for inland communities and economies.
- Sea-level rise is already affecting the coast; the greatest impacts at present are from extreme events, such as king tides and large storms.
- Climate extremes and ocean acidification are impacting species, ecosystems, industries and people who depend on them, such as aquaculture growers.
- Some of California's iconic coastal areas and species may be displaced or lost, and some new, historically uncommon species may become common.
- Vulnerable communities in coastal areas face increased risks from climate change impacts due to pre-existing socioeconomic inequities.
- Though science can continue to advance our knowledge of impacts and adaptation options, we know enough to respond now.
- Uncertainties will persist; natural and social science research can illuminate adaptation options and evaluate future actions.

Research needs

- Integrating projected future socio-economic conditions with forecasts of climate change can provide predictions and scenarios that can be used to prioritize among adaptation options.
- Improving scientific understanding of conditions or triggers for harmful algal blooms, including interactions with ocean temperature and chemistry, can protect human health.
- Understand and quantify the role that restoration or conservation of habitats play in reducing the impact of rising carbon dioxide levels on coastal marine environments.
- Maintaining and expanding monitoring of ocean acidification and dissolved oxygen can aid in developing adaptive responses and in assessing impacts of policy changes.
- Continuing to monitor short- and long-term coastal change through existing and developing tools and technologies will allow for more accurate predictions.

Adaptation measures

- State efforts to continue to evaluate, assess, and educate all Californians about how climate change is affecting the coastal zone and ocean waters can result in a more informed public and improved decision-making.
- Social inclusion will be critical to advancing coastal adaptation strategies that incorporate all sources of relevant information, are fair and just to all community members, and ultimately have a better chance of adoption and implementation.
- California can develop more transparent and information-based adaptation approaches. Better coordination of public agencies can promote opportunities for and barriers to working together.
- Opportunity exists to test and evaluate adaptation strategies in different environments as they are implemented, to assess how well they meet different needs, and to export and scale.

Formula for success

- Strengthen governance structures
- Leverage partnerships
- Cultivate ocean and climate stewards
- Couple mitigation and adaptation
- Science-informed decision making now with flexibility

A coastal tribe drying fish on the North Coast of California.
(Figure Source: Tolowa Dee-ni' Nation archive).

Thank you

Connecting the Dots between Water, Agriculture, and Ecosystems

Ruth Langridge

UC Santa Cruz

Melissa Rohde

The Nature Conservancy

Dominic Roques

Central Coast Water Board

Jennifer Phillips

Governor's Office of Planning and Research

moderated by Kif Scheuer | Climate Change Program Director, LGC

Networking Lunch

Climate Change and the Energy System

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Southern California Gas Company

California's Fourth Climate Change Assessment

Overview of key findings about the energy sector

Guido Franco
Team Lead for Climate Change and Environmental Research
California Energy Commission

Central Coast Region
Fourth Climate Change Assessment
Santa Cruz
December 10, 2018

Outline

- What is the energy sector?
- How are GHG emissions from the energy sector changing in California?
- Overall climate impacts
- How should the energy sector evolve in the next 30 years?
- Is the energy system adapting?

What is the energy sector?

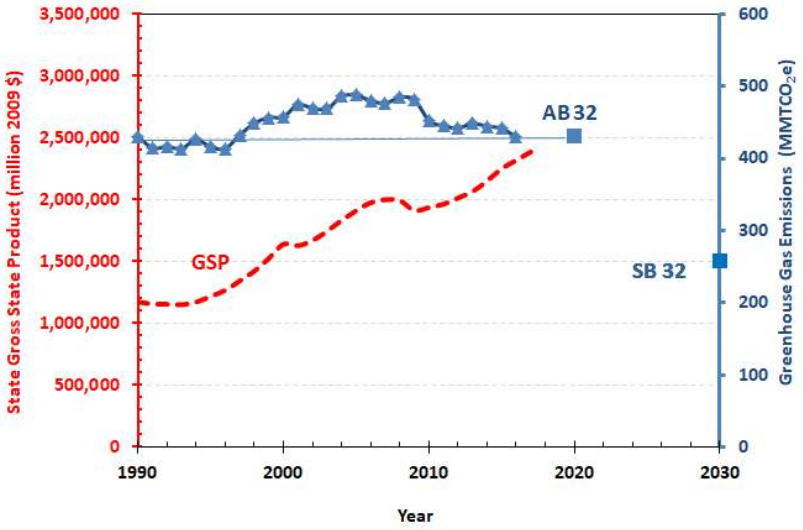
- The standard definition includes all activities providing energy services, such as mobility, illumination, and space heating and cooling

  "….. the energy system includes energy extraction, transport, conversion (such as combusting natural gas in power plants to generate electricity or producing gasoline and diesel from crude oil in refineries), and consumption for services (such as electricity for lighting, natural gas use in homes and buildings for space and water heating, and gasoline and diesel to fuel cars and trucks), as well as electricity from out-of-state plants serving California."

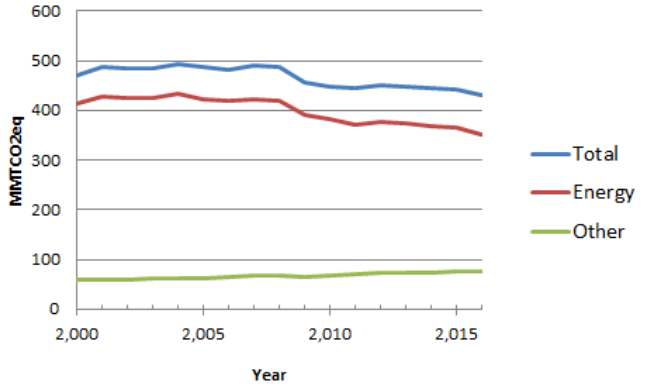
Source: California Energy Commission Staff. 2016. 2016 Integrated Energy Policy Report Update. California Energy Commission. Publication Number: CEC-100-2016-003-CMF.

How are GHG emissions from the energy sector changing in California?

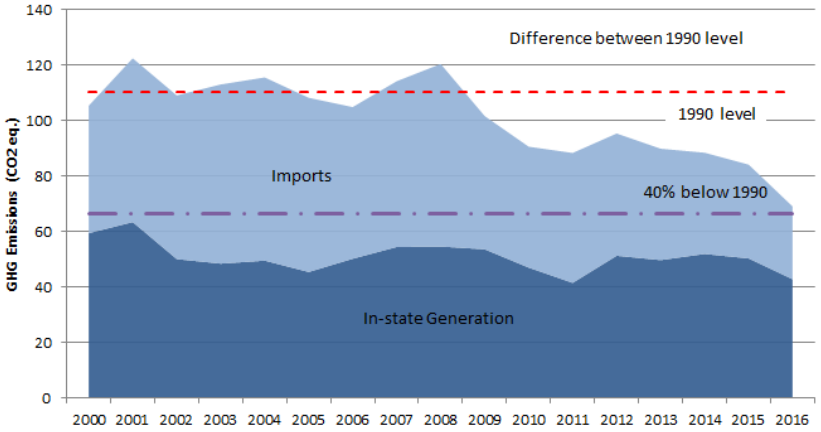
GHG Emissions in California: 1990 - 2016



Electricity generation has reduced emissions by about 37% since 1990.



The energy sector accounts for more than 80% of statewide GHG emissions.



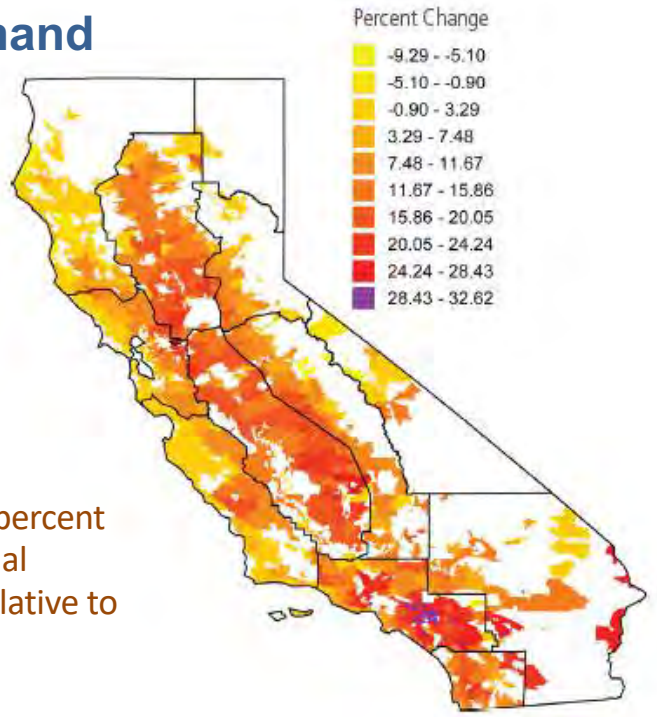
Data Source: 2018 ARB GHG Inventory

Overall climate impacts and opportunities and adaptation options

Statewide annual electricity and natural gas demands

Substantial changes in annual residential demand

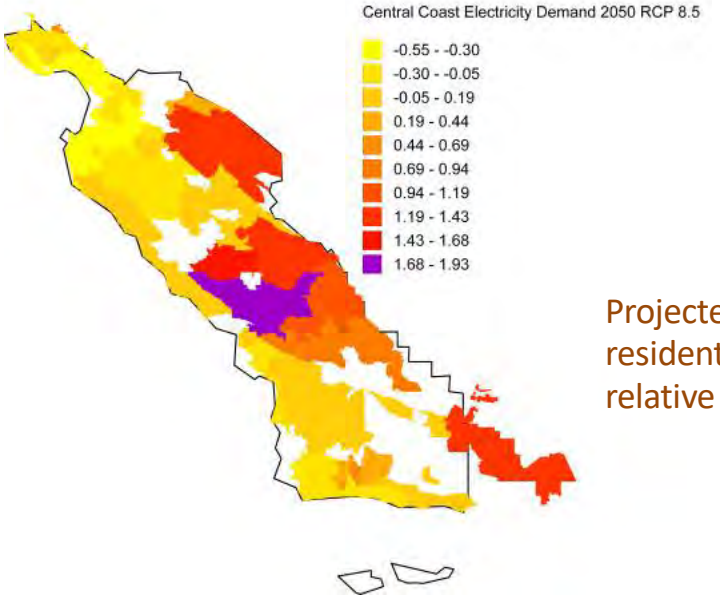
- Use of billions of monthly bills from households. Results aggregated at the zip code level.
- This study inquires about the expected changes to the existing energy system assuming the climate of the future.
- Increased residential electricity consumption approximately offset by decreased demand for natural gas (end-use basis).



Projected end-of-century percent change in annual residential electricity consumption relative to 2000-2015 baseline.

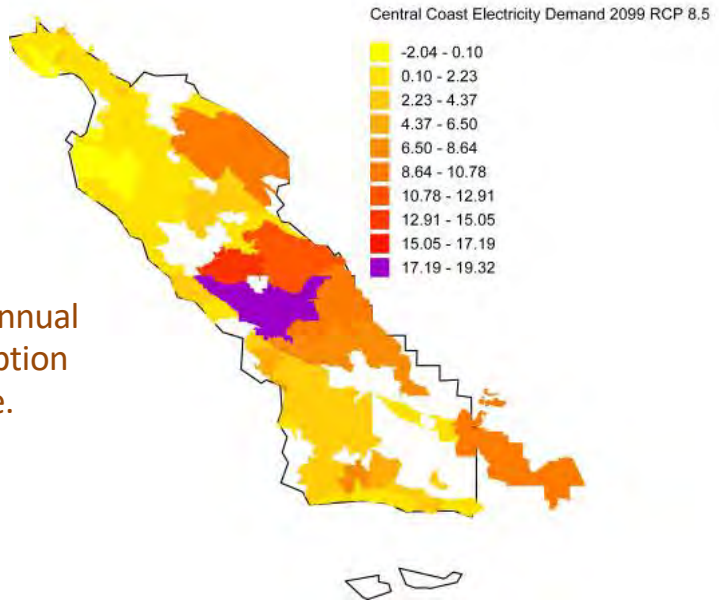
* *Data source:* Auffhammer, Maximilian (2018). *Climate Adaptive Response Estimation: Short and Long Run Impacts of Climate Change on Residential Electricity and Natural Gas Consumption Using Big Data*. Publication Number: CCCA4-EXT-2018-005. *Figure source:* Bedsworth, L., D. Cayan, G. Franco, L. Fisher, S. Ziaja (2018). *Statewide Summary Report*. Publication Number: SUMCCCA4-2018-013.

Impact in the Central Coast: annual electricity demand



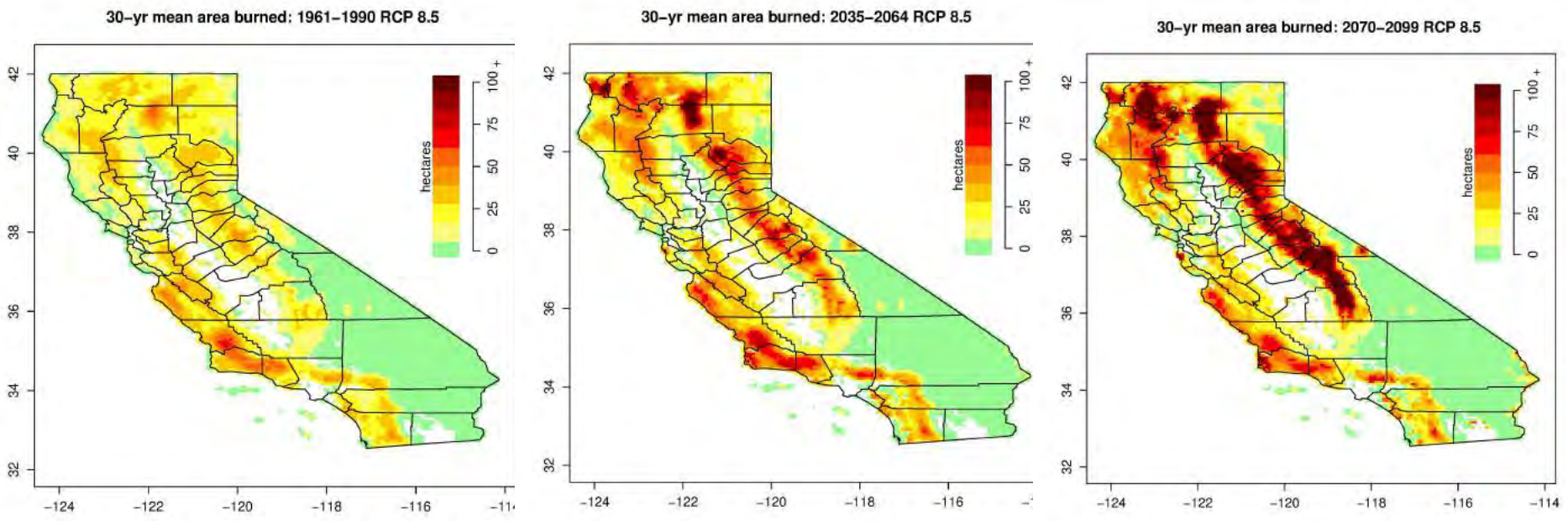
Projected percent change in annual residential electricity consumption relative to 2000-2015 baseline.

End of this century



* *Data source:* Auffhammer, Maximilian (2018). *Climate Adaptive Response Estimation: Short and Long Run Impacts of Climate Change on Residential Electricity and Natural Gas Consumption Using Big Data*. Publication Number: CCCA4-EXT-2018-005.

Potential Changes in Wildfires in California

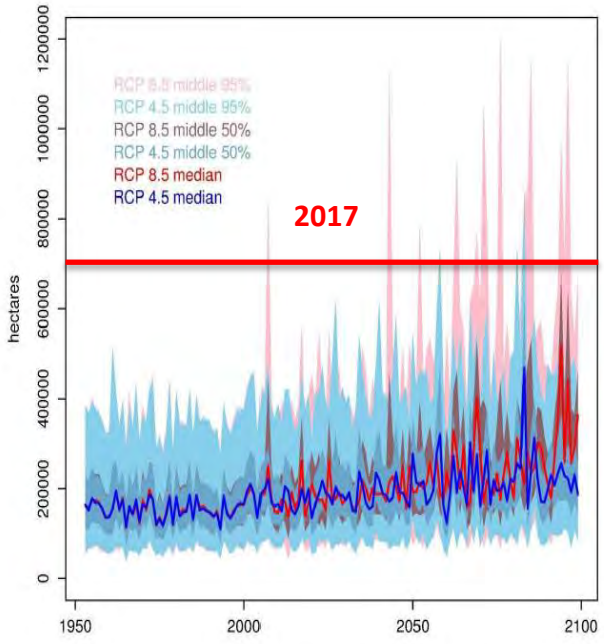


At the statewide level, increases in wildfire regimes would decrease the reliability of the electricity system

Source: Leroy Westerling 2018

Wildfire Scenarios for California

Extreme wildfire events projected to become larger and more frequent.



Adaptation action: Fuel treatments in Sierra Nevada could reduce projected increase in area burned (Westerling, 2018).

Critical research need: Understanding potential for megafires fueled by massive tree mortality.

Source: Westerling, Anthony LeRoy (2018). *Wildfire Simulations for the Fourth California Climate Assessment: Projecting Changes in Extreme Wildfire Events with a Warming Climate.* Publication number: CCCA4-CEC-2018-014.

Potential impacts to the petroleum system

- Transportation system, including airports and seaports, must contend with flood-related risks as sea level rises. The transportation system is also used to deliver fuels to consumers.
- Some oil terminals and refineries would be flooded, affecting the supply of gasoline and other petroleum products to California.
- A refinery in Wilmington could experience flooding of 40% to 50% of its area by 2040.

Figure*: Near-term (left) and end-century (right) flooding projections for Andeavor Long Beach Terminal 1, where 80% of Southern California's crude oil is offloaded from marine tankers.

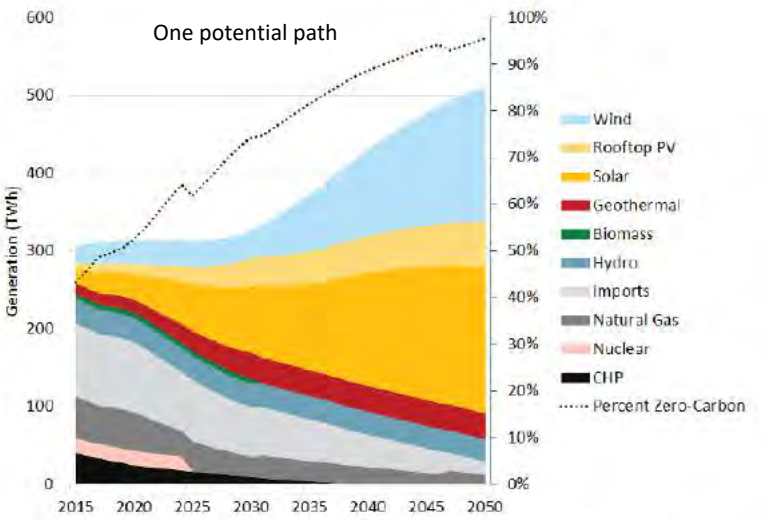
Source: Radke, J.D, G.S. Biging, K. Roberts, M. Schmidt-Poolman, et al (2018). *Assessing Extreme Weather-Related Vulnerability and Identifying Resilience Options for California's Interdependent Transportation Fuel Sector*. Publication Number: CCCA4-CEC-2018-012.

Other Statewide Impacts

- Reduction of hydropower in the hottest months of the year.
- Continuous record breaking high temperatures, which would result in unexpected increases in peak electricity demand.
- Lower performance of thermal power plants (e.g., natural gas combined cycle units) with high temperatures.
- Increased risk of exceeding design temperature limits for transmission and distribution lines, transformers, etc.

How should the energy sector evolve in the next 30 years?

- The mandate to reduce GHG emissions by 40% by 2030 and the goal of 80% reduction by 2050 requires a **drastic and rapid transformation of the energy sector**.
- SB 100 mandates 100 net zero GHG emissions from the electricity generating sector by 2045.
- The **electricity sector must decarbonize** as required by legislation and all the energy services (e.g., space heating, transport) that can be electrified must do so.
- **Natural gas should also be decarbonized**.
- The reduction of fossil fuel combustion will substantially improve air quality with estimated **public health benefits exceeding the potential postulated costs** of reducing GHG emissions.*



One potential electricity generation scenario by source type from 2015 to 2050, and percent contribution from renewable generation to total generation (dotted line and right y-axis). Generation is measured in terawatt hours (Twh). Source: Mahone et al. 2018.

*Bedsworth, Louise, Dan Cayan, Guido Franco, Leah Fisher, Sonya Ziaja. (California Governor's Office of Planning and Research, Scripps Institution of Oceanography, California Energy Commission, California Public Utilities Commission). 2018. Statewide Summary Report. California's Fourth Climate Change Assessment. Publication number: SUMCCCA4-2018-013.

Is the energy system adapting?

- YES !
- The Energy Commission has been supporting climate research for the last decade to inform the evolution of a clean and more resilient energy system.
- The CPUC and CEC have formed an adaptation working group headed by CPUC Commissioner Randolph and CEC Chairman Weisenmiller to coordinate climate adaptation policies.
- The CPUC recently released an Order Instituting Rulemaking to discuss how energy utilities could identify and implement adaptation options.

Thank you!

DISCLAIMER

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Climate Change:

The future is now for Utilities

Geoffrey Danker, Policy & Environmental Strategy
Southern California Gas Company and San Diego Gas & Electric

December 10, 2018 – Central Coast Symposium

WHO WE ARE...

SoCalGas & SDG&E Territory

Both Utilities in service for over 135 years

SoCalGas

- Largest natural gas distribution utility in the US
- Serve 12 counties (over 500 communities) and more than 21 million people
- Over 5.8 million gas meters

SDG&E

- Provides electricity and natural gas to 3.4 million people from Orange County to the Mexican border.

We are aligned in our climate goals

Governing Law – SB100

By 2030, obtain

60%

of electricity from renewable sources

Governing Law – SB1383

By 2030, reduce methane emissions

40%

below 2013 levels

Executive Order B-55-18

By 2045, economy-wide, become

Carbon Neutral

Resilience Defined

"…ability to **prepare** for and **adapt** to **changing conditions** and **withstand** and **recover rapidly** from …deliberate attacks, accidents, or **naturally occurring threats** or incidents..."

Source: Press Release (dated Feb. 12, 2013) Presidential Policy Directive - - Critical Infrastructure Security and Resilience

Different types of adaptation

Physical Protection

- Building a flood barrier to protect an asset from inundation
- Making adjustments to building design or materials selection to reduce sensitivity

Operational Adjustments

- Developing a plan to continue to provide service to most customers even if there is a disruption somewhere in the system

Recovery Efforts

- Ensuring adequate materials are on hand to make necessary repairs quickly
- Developing a plan for restoring service after a disruption occurs

Flexible Adaptation Pathways Approach

- What is it?
  - The implementation of iterative adaptation actions over time to allow for the adjustment of strategies and planning incorporating new information or circumstances

- What is the benefit?
  - Helps manage future uncertainty by allowing decision-making to adjust based on new information or conditions, (e.g., new technologies, customer needs, climate change projections, and the economic and policy landscapes)

- SoCalGas and San Diego Gas & Electric
  - Both utilities are constantly assessing vulnerabilities of their own systems while analyzing best management practices from throughout the country to safeguard our assets and continue to provide reliable energy service

Potential Impacts

- **Threat of impacts to energy infrastructure is driving state and regional agencies to develop plans and policies to reduce system vulnerability.**

- Ensure resiliency from impacts due to:
  - Sea level rise
  - Increasing Temperatures
  - Wildfires
  - Floods/Storms (including "wind" storms)
  - Changing Precipitation (e.g. Droughts)

1. California Natural Resources Agency. "Safeguarding California: Reducing Climate Risk, an Update to the 2009 California Climate Adaptation Strategy," July 2014. http://resources.ca.gov/docs/climate/Final_Safeguarding_CA_Plan_July_31_2014.pdf.

Climate Adaptation-Droughts Impacts to Pipelines

- Vertical Subsidence
  - **not the primary concern with pipeline structural integrity**
- Horizontal subsidence
  - at edge of subsidence zone creates compression and can cause buckling
- Local subsidence can create sinkholes, which cause bending stress
- Cathodic Protection effectiveness diminished

Primary Concerns for Gas Infrastructure

El Niño rain intense events can create debris flows, flash flooding or landslides, which can cause:

- **Wash outs** of access roads
- **Pipeline exposures** that can lead to corrosion
- **Increase dewatering** activities (e.g. regulator vaults)
- **Delays** in routine maintenance, repairs and construction projects
- **Workforce diversion** and potentially limited mutual assistance availability.

Lessons From the Past Hurricane Sandy

- **Electricity Supply-severe impact**
  - Biggest fragilities were Transmission & Distribution Components
    - Winds downed power lines, flooding affected dozens of substations
  - Power outages created a domino effect across other sectors
  - **Every system dependent on electricity alone was vulnerable**
    - Fueling, Information and Communication, Transportation
- **Gas System –no major impact**
  - Flooding /power outages concern at compressor stations along some interstate pipelines , but natural gas flows were not interrupted
  - One company vented gas from distribution lines causing water intrusion in flooded areas

Images Source: CNN

Hurricanes Irma and Harvey

- Hurricane Harvey (August 2017)
- Natural gas-powered combined heat and power (CHP) systems kept hospitals running despite historic flooding.

- Hurricane Irma (September 2017)
- Natural gas generators ensured AC and refrigeration units stayed on saving both lives and livelihoods.

California Wildfires

Northern California Wildfires
(October 2017)

Emergency deliveries of compressed and liquefied natural gas kept the power on at local hospitals facing electricity outages.

Southern California Wildfires and Mudslides
(December 2017 – January 2018)

SoCalGas' satellite monitoring and Advanced Meter network supported life-saving actions of first responders by pinpointing damages to customers and potential impacted areas.

Internal Initiatives

- CEC-Funded 4th Climate Assessment Projects in the SDG&E Service Area
  - Develop an understanding of climate change vulnerability and adaptation options to coastal (wave flooding, tidal inundation, coastal erosion) and inland hazards (flooding, wildfire, extreme heat, landslide)

- Risk Assessment Mitigation Phase (RAMP)
  - Adaptation assessment to provide information on potential mitigation efforts for threats posted by global climate change

- Utilizing Innovative Technologies
  - Drones
  - Satellite Monitoring
  - Advanced Meters

Climate Adaptation – Increasing Resiliency

- Link between climate change and key enterprise risks.
  - Drought increases wildfire risk; sea level rise increases infrastructure integrity risk; extreme temperatures increase electricity supply risk.
  - **Relying on electricity alone increases energy system vulnerability.**

- Increasing Resiliency:
  - Just like buying stock, **diversifying energy assets helps protect the overall** system.
  - **Need variety of energy options to increase energy system resiliency**.
  - An all electric system places great risk to critical infrastructure in the event of climate change impacts
    - E.g. Need a way to power hospitals and fire stations during power outages.

Protecting Customers from Outages: Distributed Generation

- Distributed generation technologies can isolate consumers from the electricity grid → protection from power outages.
- "Islandable", black start energy sources that provide power separate from the vulnerabilities of the grid.
- Broader, diverse mix of energy sources increases energy system security and resiliency

Realizing **California's** Renewable Energy Future

Power-to-Gas makes renewable feasible

Energy has to be available

when people need it

- Solar power generation dwindles right at the moment when electricity demand peaks.
- Reliability means keeping our everyday lives predictable, every hour and every day.

17

We're already producing a lot of

wasted energy

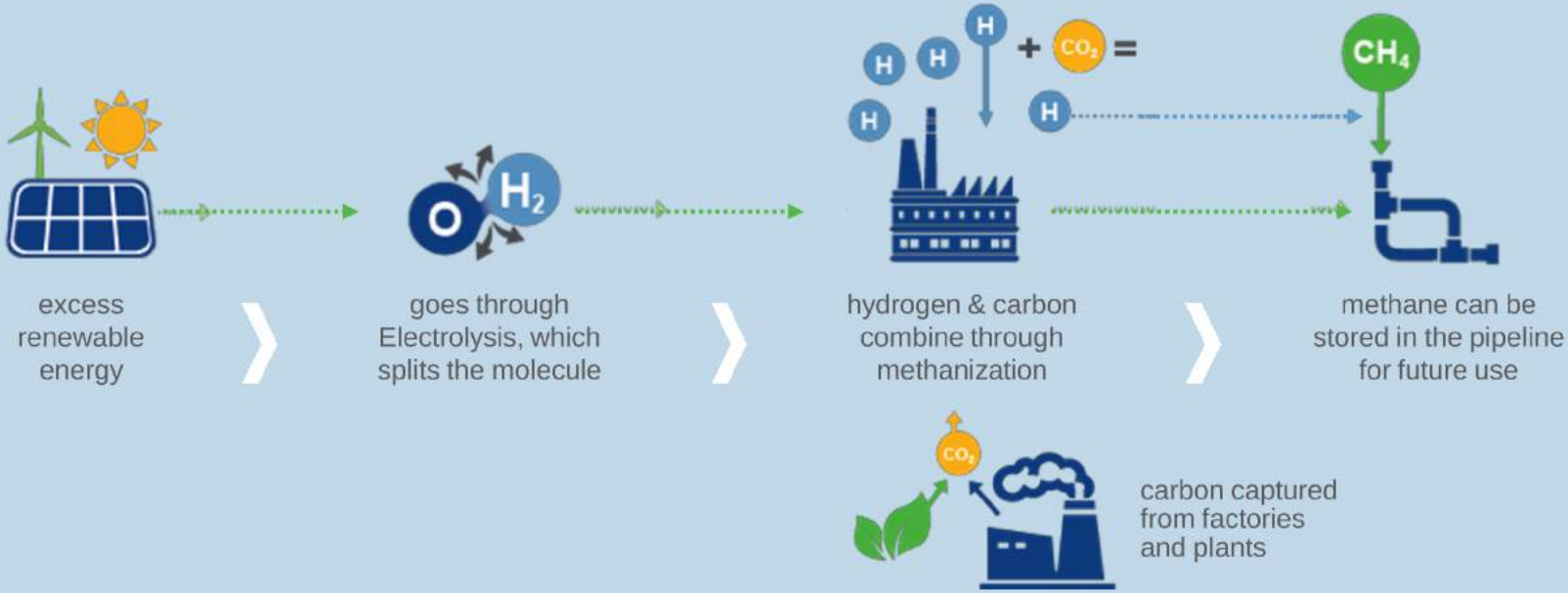
- Building more solar and wind farms leads to more over-production
- Rather than cut back and curtail solar and wind, P2G gives us a way to store it

California needs


Power-to-Gas gives
California a practical way to
store
renewable
energy
20

Power-to-gas

converts excess renewable electricity into renewable natural gas

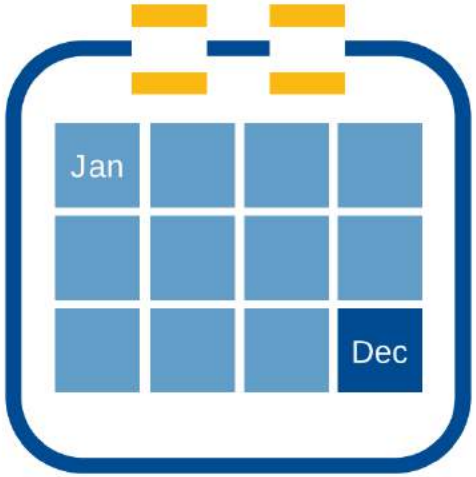


P2G provides

seasonal storage

Batteries

P2G H_2

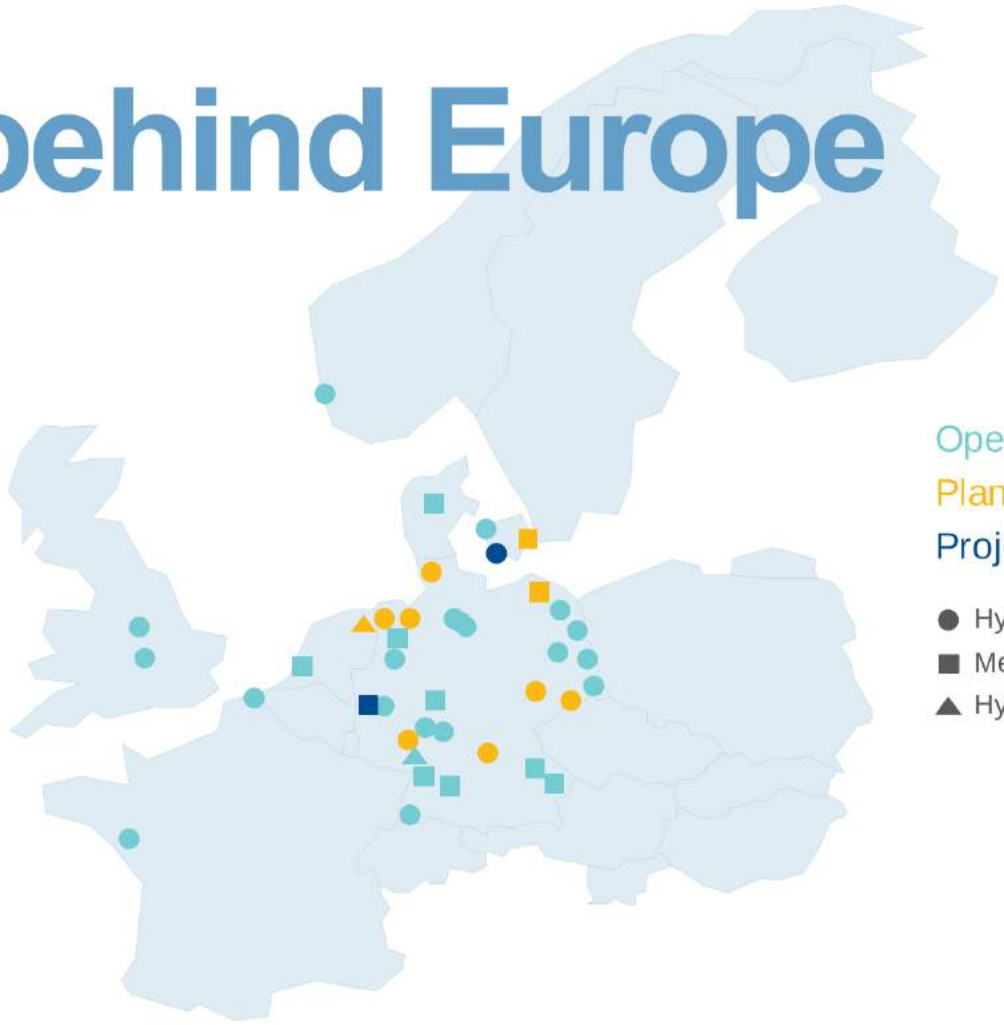


P2G CH_4

But today

we're behind Europe

- 70 Projects Now Launched In Europe
- 40 Projects Launched in Germany, with more in development
- 30 MW of installed capacity



Operational
Planned
Project Finished

- Hydrogen
- Methane
- Hydrogen/Methane

To expand renewable energy we need

renewable energy storage

Use Power-to-Gas technology for long-term renewable energy storage

Encourage the development of a Hydrogen and Renewable Natural Gas market

Support policies that will get Power-to-Gas projects up and running in California

SDGE

Southern California Gas Company

Sempra Energy utilities

Q&A

State Tools & Resources

Guido Franco

Team Lead for Climate Change and Environmental Research
California Energy Commission

Nuin-Tara Key

Resilience Program Manager
Governor's Office of Planning and Research

Data Sets for Long-term Planning in California: Climate Change

Regional Workshop: Central Coast

Guido Franco
Team Lead for Climate Change and Environmental Research
California Energy Commission

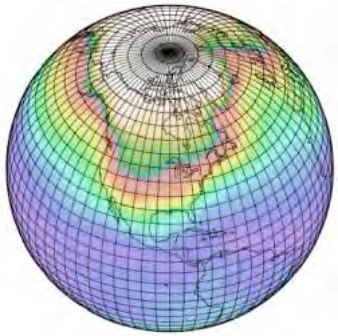
December 10, 2018
Santa Cruz

Outline

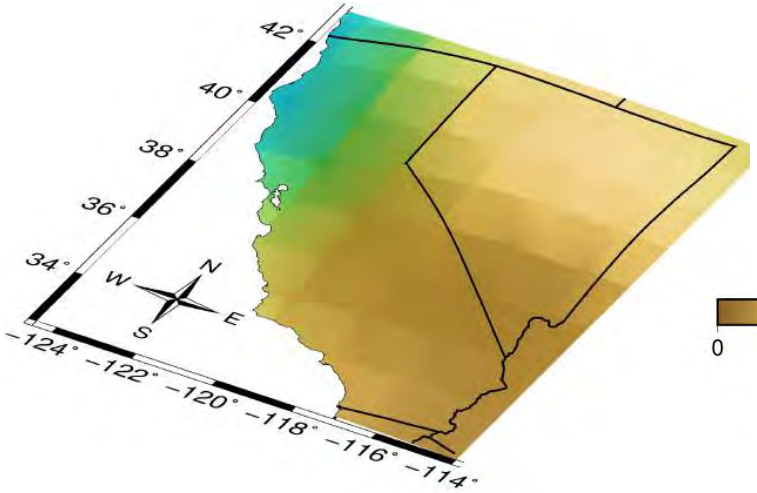
- Background information and brief historical perspective
- Scenarios created for the Fourth Assessment: Cal-Adapt
- Sources of data

Development of climate scenarios for California

- The California Energy Commission (CEC) has been developing climate scenarios for California for both research and long-term planning since 2003 (Franco et al., 2003)
- Every five or more years research centers around the world produce global climate scenarios for the IPCC Assessments, but they are not adequate for California because their geographical resolutions are too coarse and because, as expected, they have large biases for small topographically complex regions such as California.



Grids in a GCM



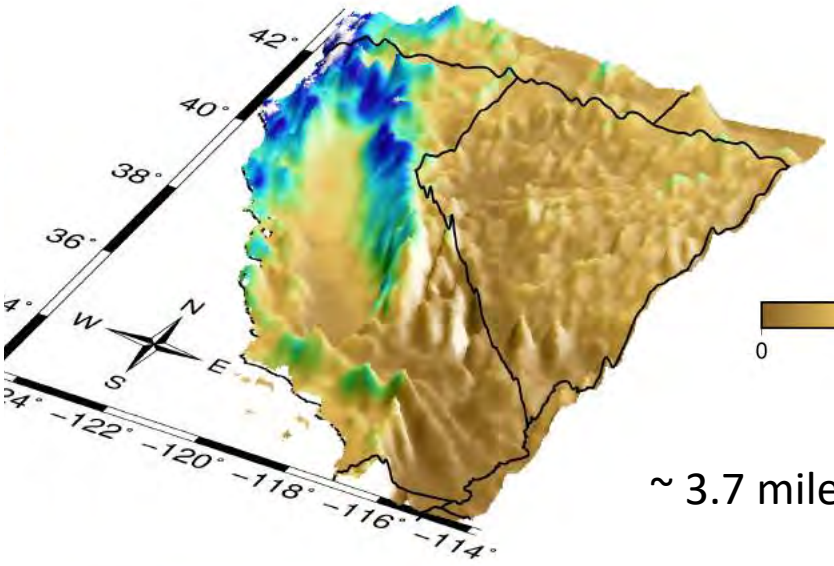
Global Climate Model (GCM)

~ 100 miles resolution

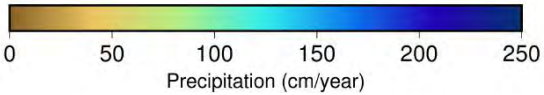
Source: Pierce et al., 2018

Development of climate scenarios for California

- With the availability of each generation of new IPCC global climate scenarios, the CEC has supported the development of "downscaled" climate scenarios for California, adequate for both research (e.g., scientific papers for the 2006, 2009, 2012, 2018 California Assessments, Climatic Change) and for long-term planning (e.g., State Forestry Plan, State Water Plan, Integrated Energy Policy Report).



Regional Climate Model "downscaled" scenario

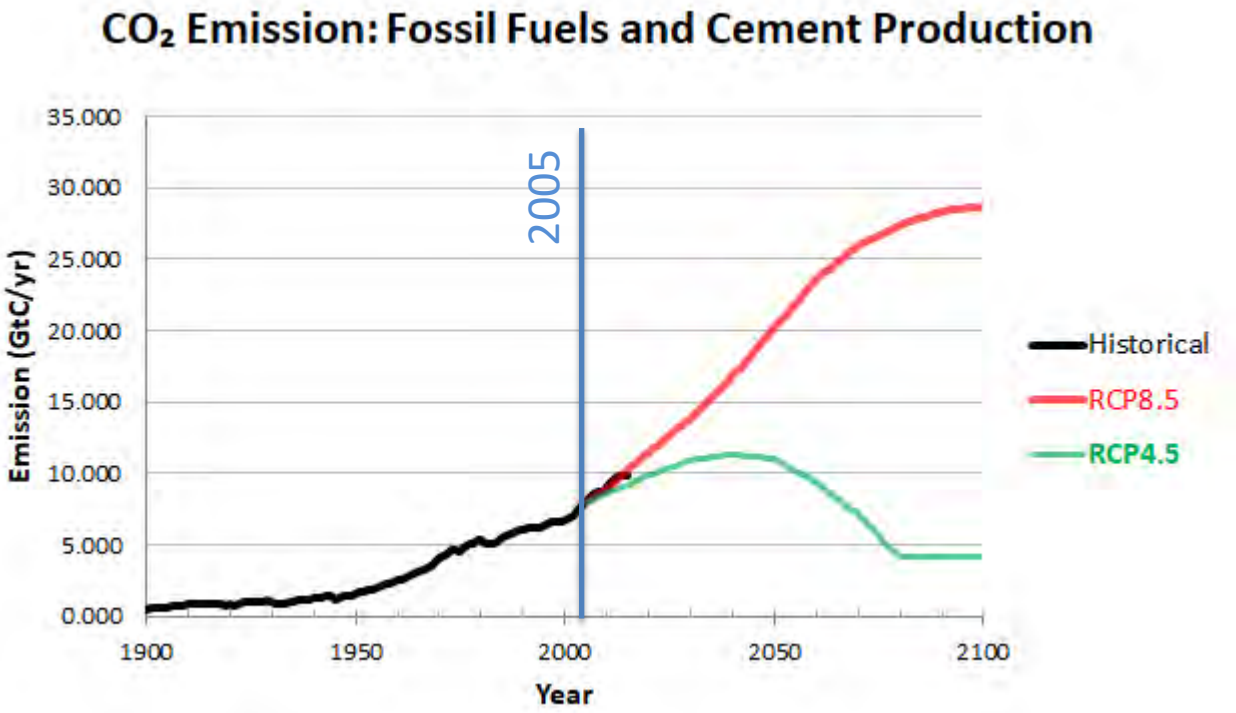


~ 3.7 miles resolution

Source: Pierce et al., 2018

Representative Concentration Pathways (RCPs)

- Historical data in the RCPs end in 2005. It is possible, therefore, to compare projections that started in 2006 with actual emissions after 2005.
- Historical emissions after 2005 are following the RCP8.5 scenario.



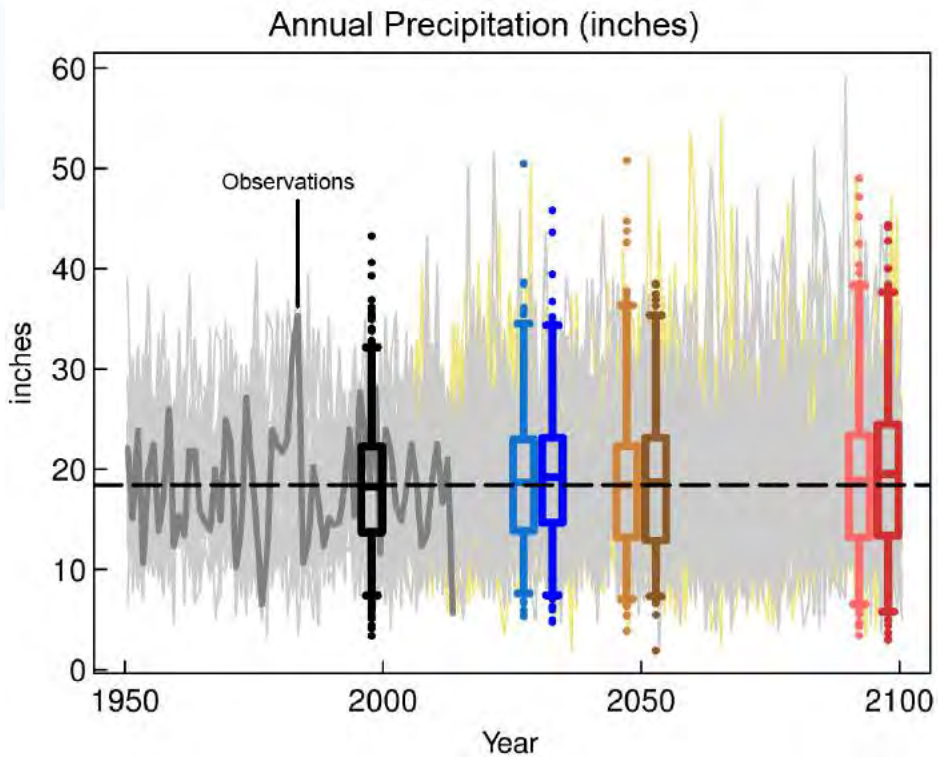
Desire to make research results available at local scales

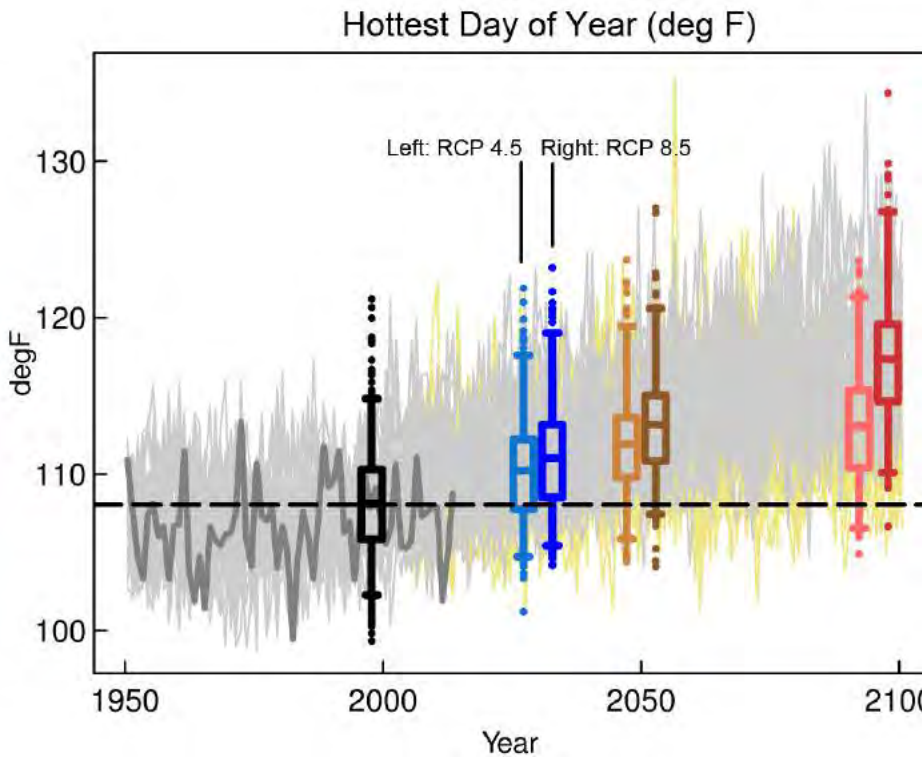
- In 2007 Dr. Amy Luers (then at Google) and I envisioned the creation of a system to make data sets created from CEC sponsored research available to the general public and managers at local scales.
- CEC and Google contributed $150K each to create CalAdapt. SEI developed a prototype using Google Earth to visualize climate data.
- The CA prototype was a resounding success and it was embraced by then Governor Schwarzenegger. He issued an Executive Order mandating the development of a full version of CalAdapt. GIF (UC Berkeley) was selected to make CalAdapt operational.
- Because the name CalAdapt was already in use, we changed the name to Cal-Adapt.
- Secretary Laird and CEC Chair Weisenmiler held a press event to announce the availability of Cal-Adapt (version 1) .
- At that time Cal-Adapt may have been the only website in the USA that allowed easy access to climate projections at the local scales.
- The level of geographical resolution was about 7 miles.

LOCA Statistical Downscaling (Localized Constructed Analogs)

- In between IPCC Assessments, when research centers around the world are improving their GCMs and/or producing new global climate projections for the IPCC, the CEC has supported enhancements of downscaling techniques (regional climate models).
- To address deficiencies of prior downscaling techniques used for the 2012 California Assessment, the CEC commissioned the development of LOCA.
- LOCA uses historical weather conditions that correlate with large atmospheric situations (analogs), relatively well simulated by GCMs to estimate temperature, precipitation, and other parameters at the local scale (grids/squares with sides ~ 3.7 miles). The use of analogs allows LOCA to be approximately physically realistic. LOCA includes a new advanced bias correction technique.
- LOCA provides information to a hydrological model known as the Variable Infiltration Capacity (VIC) model to estimate other parameters such as soil moisture, runoff, and snowpack levels.
- See the next slide for typical results for temperature and precipitation

CMIP5/LOCA predicted changes at Sacramento, CA





		Historical	2030	2050	2090
Ann Precip	RCP 4.5	7.4 18.4 32.3	7.6 18.7 34.5	7.1 18.4 36.3	6.5 18.8 38.3
(in)	RCP 8.5	7.4 18.4 32.3	7.4 19.2 34.4	7.3 18.7 35.4	5.8 19.5 37.6
Hottest Day	RCP 4.5	102 108 115	105 110 117	106 112 119	107 113 121
(°F)	RCP 8.5	102 108 115	105 111 119	107 113 120	110 117 127

The three numbers are: typical lowest, mean, and typical highest yearly value

Source: From an early 2017 presentation by David Pierce

The LOCA/VIC scenarios and long-term planning in California

- The CEC is using these scenarios to estimate the official state electricity and natural gas demand forecasts that will be reported in the 2018 IEPR and future IEPRs.
- Executive Order B-30-15 directed state agencies to integrate climate change into all planning and investment, including accounting for current and future climate conditions in infrastructure investment.
- Executive Order B-30-15 also directed OPR to convene a Technical Advisory Group to develop guidance to support implementation of the Executive Order. The guidance indicates that State agencies should "work with regionally downscaled data from at least two of the four global climate models (GCMs) that have been prioritized for California's Fourth Climate Change Assessment" and explicitly refers to the LOCA scenarios.
- The OPR guidance and the Fourth Assessment recommend using the RCP8.5 for impact and adaptation studies before ~ 2050.
- The 2016 IEPR also indicated the following:
  - Energy planning efforts should use the climate scenarios adopted for California's Fourth Climate Change Assessment and follow the OPR guidance.
  - For sea level rise, energy planning should be conducted using guidance documents approved by the Ocean Protection Council (OPC).

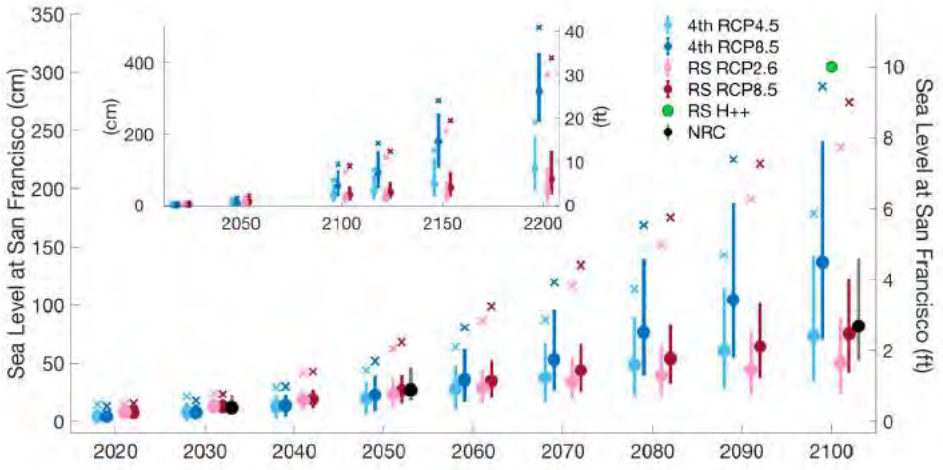
Scenarios Developed for the Fourth Assessment

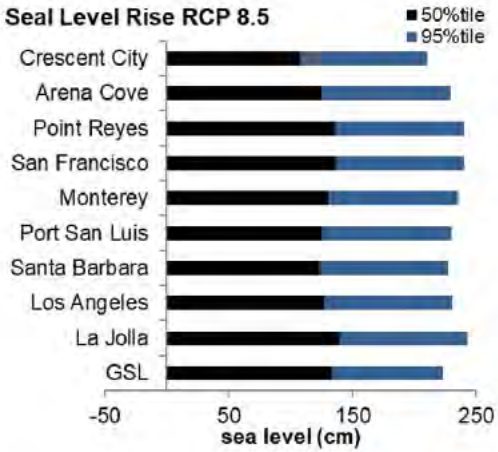
LOCA/VIC

- Results are available for 32 GCMs, but a technical advisory committee convened by the Department of Water Resources selected 10 of them as more suitable for California.
- For the Fourth Assessment research groups were asked to prioritize four of the ten models because they more or less cover the range of the 10 models, and because most groups were not able to use more than a handful of models.
- Temporal resolution: daily from 1950 to 2100 (1950 to 2005 historical simulations)
- Two future global GHG emission scenarios (RCP4.5 and RCP8.5) from 2006 to 2100
- Geographical resolution: ~ 3.7 miles
- Main Parameters:
  - Maximum and minimum daily temperatures
  - Precipitation
  - Relative humidity
  - Solar radiation
  - Wind speed
  - Runoff
  - Soil moisture
  - Snow water equivalent
  - Other variable

“Probabilistic” Sea Level Rise Scenarios

- Combination of expert opinion and numerical simulations to obtain the frequency of potential outcomes. They are not real probabilities in the statistical sense.
- The simulations consider potential high contributions from Antarctic to sea level rise.
- Potential sea level rise for 9 regions in California
- OPC issued a guidance document on what sea level rise scenarios to use for planning in California. Please consult this guidance document for planning work.





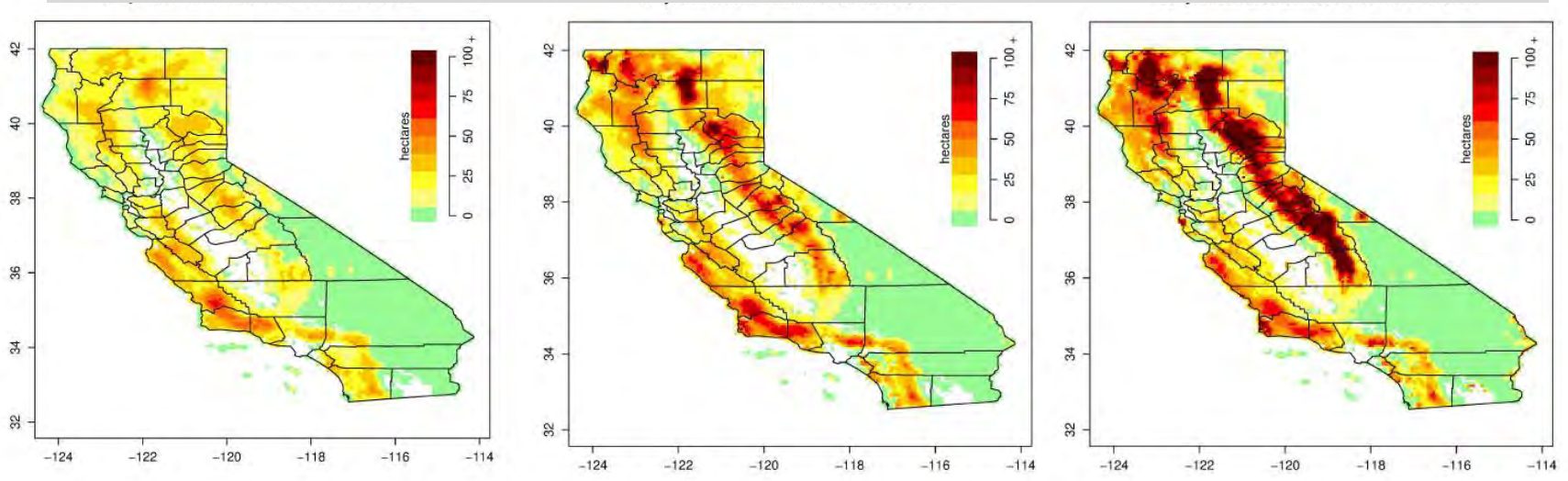
Source: Pierce et al., 2018

Common Wildfire Projections for Assessment

- **Wildfire Simulations for the Fourth California Climate Assessment.** Leroy Westerling, UC Merced
  - Statistical model trained with historical data up to 2013
  - Uses land use/land cover and climate projections developed for the Assessment
  - Projects substantial increases in area burned

Mean Area Burned (hectares)

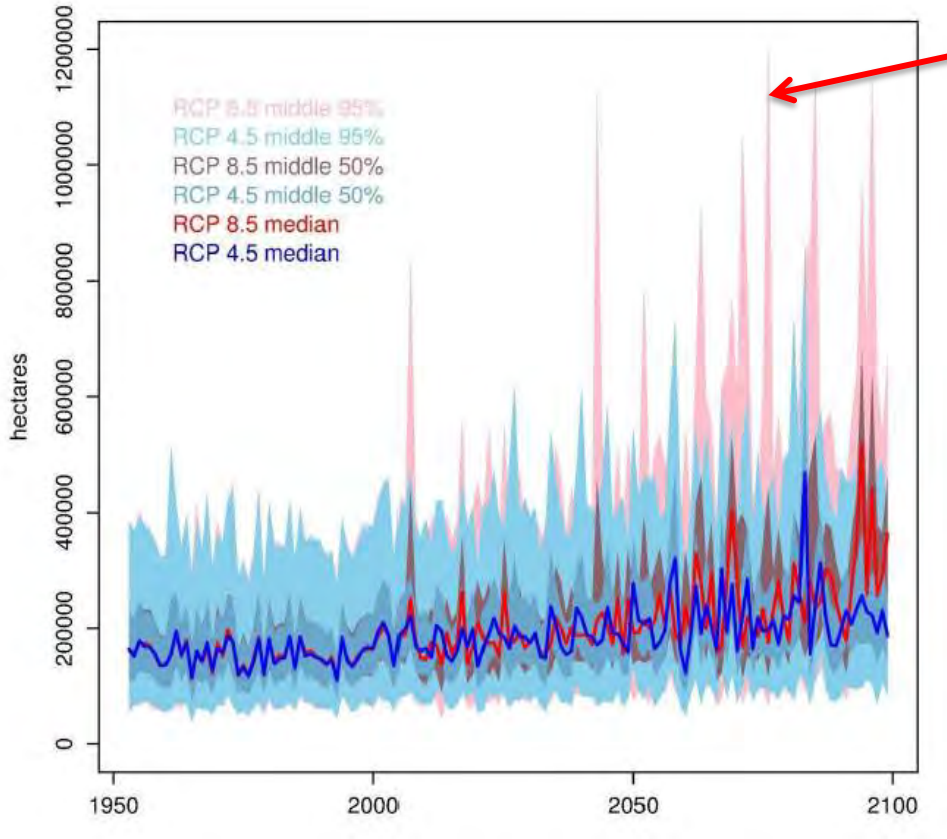
1961-1990 | 2035-2064 | 2070-2099



Source: Westerling, 2018

Simulation of wildfire extreme conditions

- The wildfire simulation used for the assessment suggests that extreme wildfires (e.g., 97.5th percentile) should be occurring under present conditions, in agreement with observations, and they could rise to unprecedented levels.



97.5th percentile

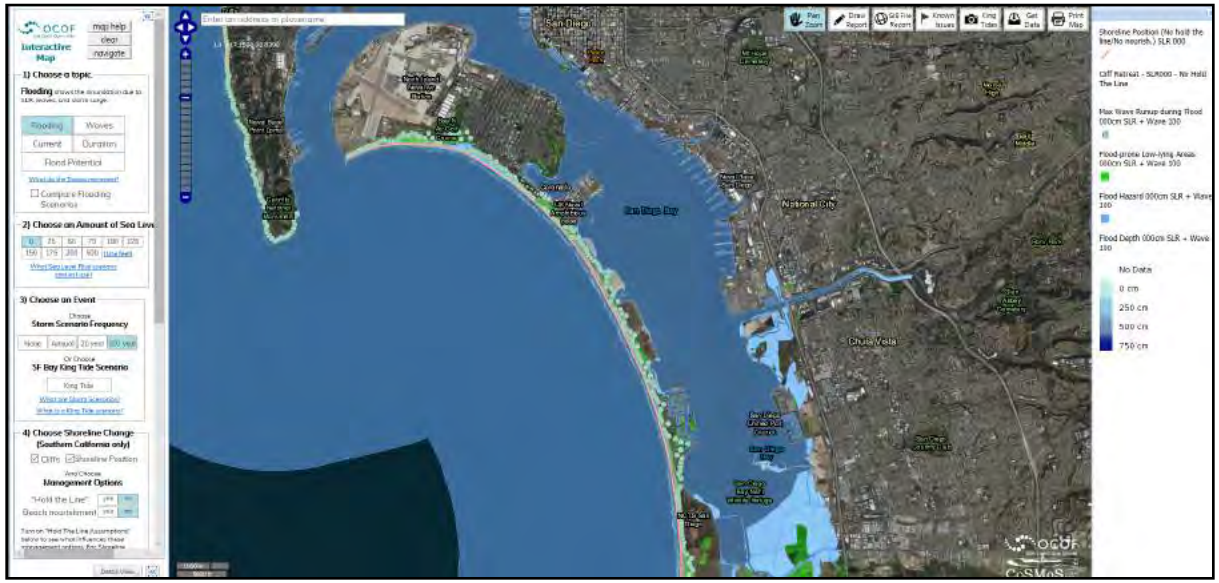
RCP4.5 vs 8.5 California Area Burned Quantities.

Source: Westerling, 2018

Costal Impact Scenarios

- The California Natural Resources Agency (CNRA) supported substantial refinements of the CoSMoS (Coastal Storm Modeling System) model by USGS for Southern California. USGS and their partners are extending the simulations with the new enhanced version of CoSMoS (version 3) to central and northern California.
- CoSMoS 3 is a sophisticated sea level rise, coastal storm and shoreline evolution model that considers wave action, movement of sand, cliff erosion, and other factors.
- The CEC supported UC Berkeley (Prof. Radke) to study the vulnerability of the natural gas and the petroleum systems. For this work Radke's group used a three dimensional hydrodynamic model with high level or geographical resolution calibrated to observed tide gauge data.

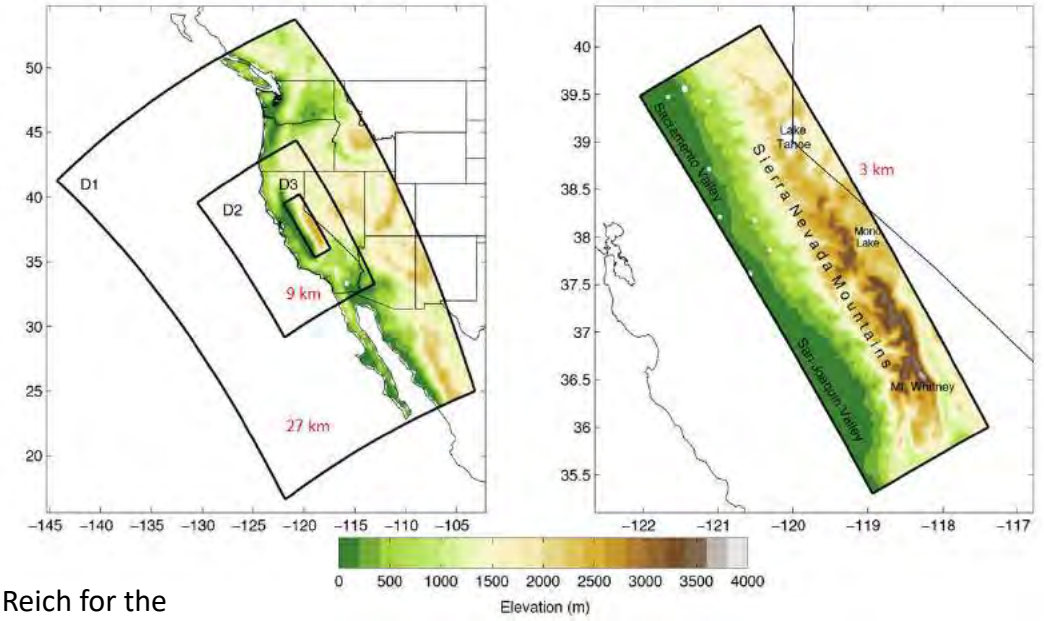
http://data.pointblue.org/apps/ocof/cms/ Accessed on 7/30/2018



CoSMoS 3

Additional Climate Scenarios from UCLA

- Prof. Alex Hall (UCLA) and his group are using a dynamic regional climate model known as the Weather Research and Forecasting (WRF) model.
- UCLA is applying new downscaled climate projections, under funding by the CEC, to estimate the vulnerability of the natural gas system in an on-going project that is not part of the Fourth Assessment.
- The CEC is providing funding to make some WRF modeling results available via Cal-Adapt.



Source: Presentation by Katharine Reich for the June 21, 2016 IEPR workshop

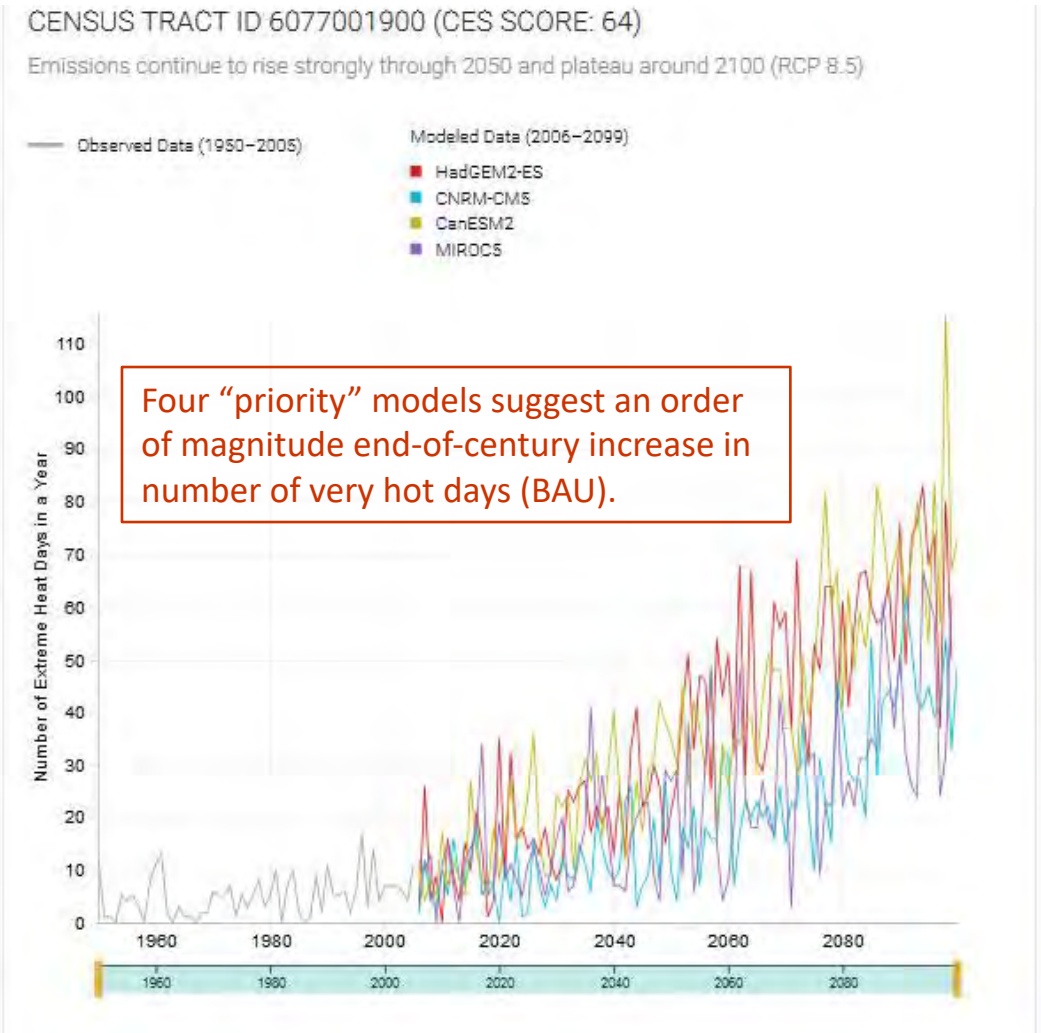
Data scenarios availability

LOCA/VIC data Sets (available in the public domain)

- Cal-Adapt aligns with a number of state guidance documents and presents only peer-reviewed data/information. The first version of Cal-Adapt was released in June 2011 and has been influential in educating the public and decision-makers about potential changes in our climate.
- Cal-Adapt provides access to the data throughout California, and provides value-added abilities to visualize and analyze the data.
- Cal-Adapt 2.0 was unveiled in 2018 and now includes the scenarios created for the Fourth Assessment.
- Further enhancements are taking place to be as useful as possible to the energy sector.
- The Strategic Growth Council (SGC) is partially supporting the addition of non-energy data sets and tools.

Cal-Adapt: one example

Projected annual number of extreme heat days in a Disadvantaged Community in Stockton



LOCA/VIC data Sets (cont.) (available in the public domain)

- Power users have other options to access data not only for California but also for outside California (e.g., WECC region).
  - Lawrence Livermore National Laboratory: Downscaled CMIP3 and CMIP5 Climate and Hydrology Projections (https://gdo-dcp.ucllnl.org/downscaled_cmip_projections/dcpInterface.html). This is the best and easiest to use site from this list.
  - NASA OpenNEX. The LOCA downscaling was done on NASA supercomputers, and the data is available from the NASA Earth Exchange (https://nex.nasa.gov/nex/static/htdocs/site/extra/opennex/).
  - US Geological Survey Geo Data Portal provides THREDDS access to the data (https://owi.usgs.gov/blog/LOCAdownscaling/)
  - Desert Research Institute (DRI) SCENIC (Southwest Climate and Environmental Information Collaborative https://wrcc.dri.edu/csc/scenic/). This site may be still under development.
- The raw data set for California in NetCDF format is about 14 Terabytes which currently can be easily stored in relatively inexpensive storage units (<$1,000) but requires expertise in handling NetCDF files. Fast access requires more expensive storage units.

Sea level, wildfire, and other scenarios

- Cal-Adapt provides access to coastal and wildfire data in California, and provides value-added abilities to visualize and analyze the data. Further enhancements are taking place to be as useful as possible to the energy sector. For sea level rise impacts a tool is being created to compare across different models (including CoSMoS).
- Cal-Adapt will include some basic access to the CoSMoS scenarios but more detailed information is available via the *Our Coast Our Future* (OCOF) website http://data.pointblue.org/apps/ocof/cms/
- USGS has created an outstanding analysis product known as HERA (Hazard Exposure Reporting and Analytics - https://www.usgs.gov/apps/hera/) that combines CoSMoS results with socio-economic and infrastructure data to show impacts in Google Earth and in tabular form.
- Additional visualizations and raw data from the coastal inundation projections created by Prof. Radke (UC Berkeley) are available from http://keystone.gisc.berkeley.edu

Questions

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Nuin-Tara Key

Resilience Program Manager

Governor's Office of Planning and Research

December 10, 2018

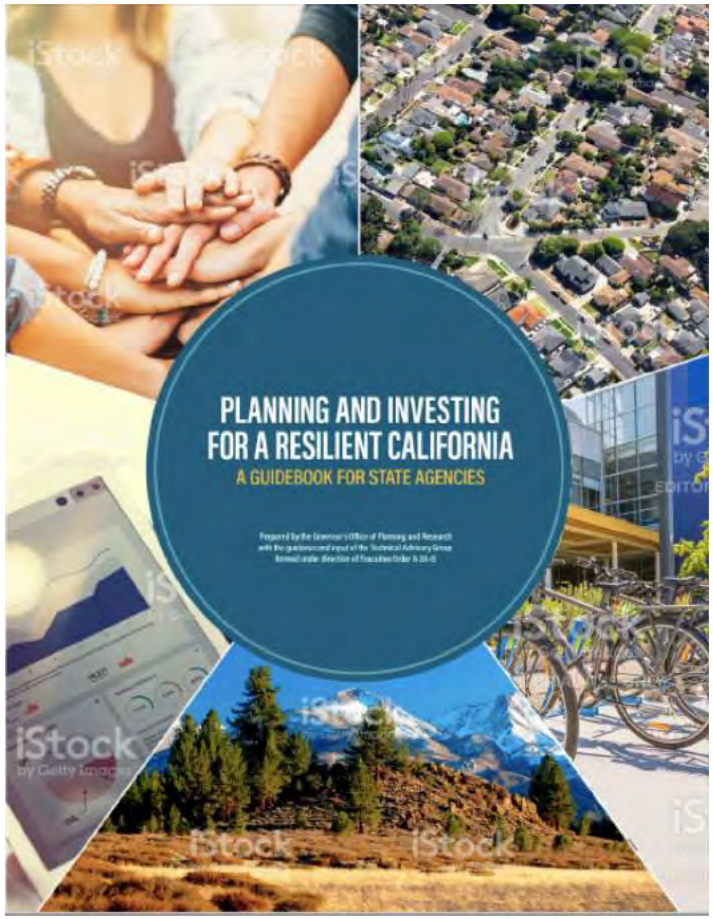
Climate adaptation in California

State policy landscape

EO B-30-15	climate considerations in all state investment and planning decisions, entities under Executive Branch
SB 379	Incorporate climate considerations in Safety element of General Plans
SB 246	Integrated Climate Adaptation and Resiliency Program (ICARP), OPR & Adaptation Planning Guide, CalOES
AB 1482	Safeguarding update every three years, CNRA
AB 2800	Climate-Safe Infrastructure Working Group, CNRA

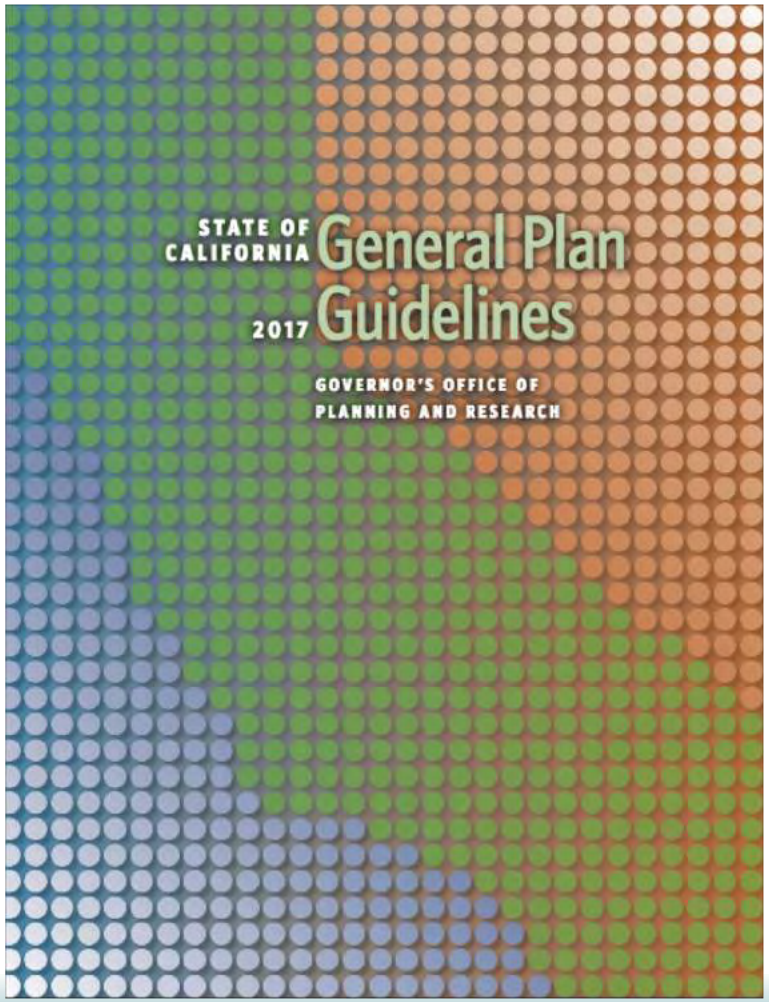
Additional bills recently signed (SB 901, SB 1035, multiple insurance, etc.)

EO B-30-15: State Agency Guidance



- Roughly 50 members
- Met from March 2016-January 2017
- Workgroups:
  - Scenarios
  - Community Development and Equity
  - Infrastructure
  - Metrics
- Product: Guidebook for State Agencies
  - What to plan for
  - How to plan differently
- Available online: http://opr.ca.gov/docs/20171117-Building_a_Resilient_CA.pdf

SB 379: Local Planning Requirements



- Every City and County in CA required to have a General Plan
- Long-term vision for future growth and development
- 2017 Update, first inclusion of climate adaptation
- Suite of tools
  - Data Mapping Tool
  - Cal-Adapt
  - Adaptation Planning Guide
- Available online: http://opr.ca.gov/planning/general-plan/guidelines.html

SB 246: Integrated Climate Adaptation and Resiliency Program (ICARP)

Purpose

Coordinate state, tribal, local, and regional activities with a focus on local implementation

Cross-cutting objectives

Advance equity and environmental justice

Support an integrated approach to climate change (adaptation and mitigation)

Programmatic elements

Adaptation Clearinghouse

Technical Advisory Council

RESOURCES: Adaptation Vision Framework

ICARP

Adaptation Vision and Principles…

All Californians thrive in the face of a changing climate…

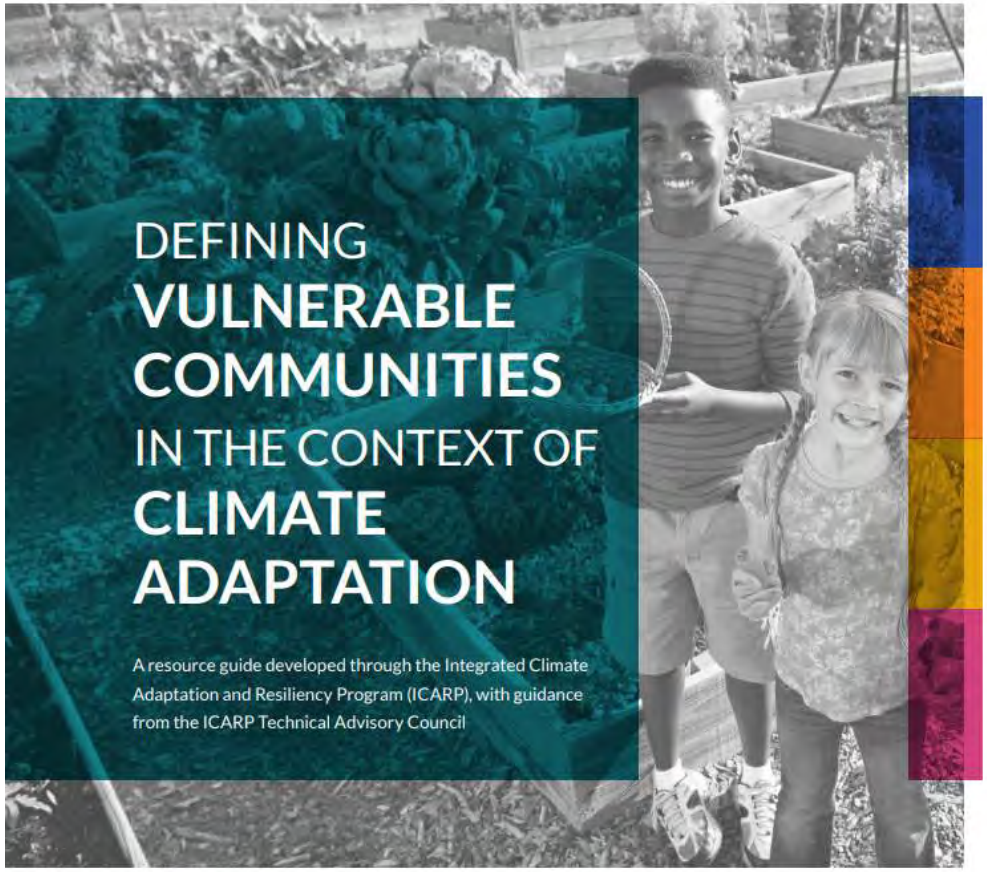
- **All people and communities** respond to changing average conditions, shocks, and stresses in a manner that minimizes risks to public health, safety, and economic disruption and maximizes equity and protection of the most vulnerable.
- **Natural systems** adjust and maintain functioning ecosystems in the face of change.
- **Infrastructure and built systems** withstand changing conditions and shocks, including changes in climate, while continuing to provide essential services.

ICARP Technical Advisory Council Vision Framework

http://opr.ca.gov/planning/icarp/tac/

RESOURCES: Vulnerability Assessments

ICARP

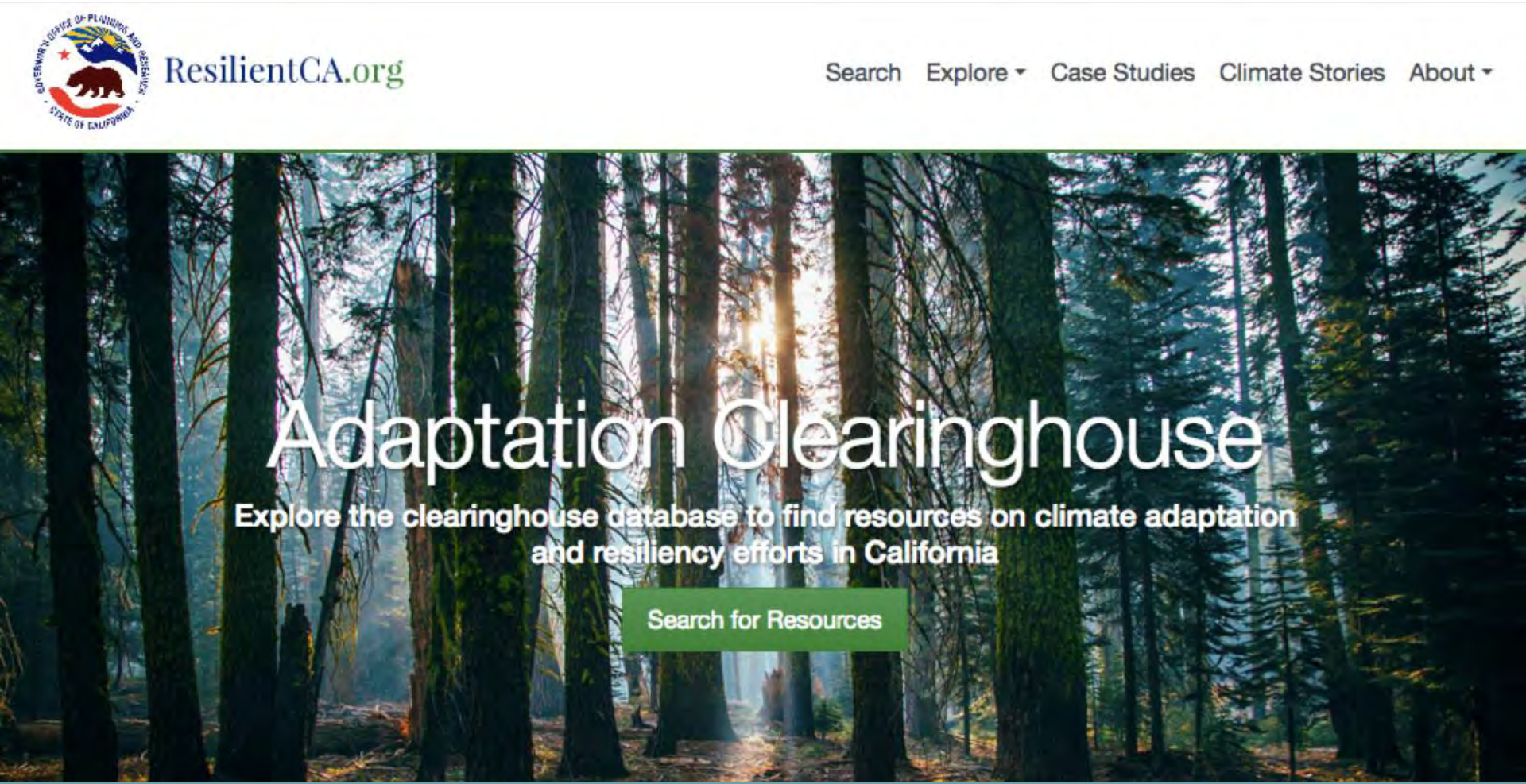


Resource Guide for Defining Vulnerable Communities

http://www.opr.ca.gov/planning/icarp/vulnerable-communities.html

RESOURCES: Adaptation Clearinghouse

ICARP



Climate adaptation and local implementation

Fourth California Climate Assessment Report

Implementation is taking place, but lags behind planning efforts…

Survey question on where jurisdiction is in adaptation process*

- Not begun = 10%
- Building understanding = 46%
- Planning = 29%
- Implementation = 15%

**Respondents, n = 230, self selected*

Moser, Susanne C., J.A. Ekstrom, J. Kim, S. Heitsch. 2018. **Adaptation Finance Challenges: Characteristic Patterns Facing CA Local Governments and Ways to Overcome Them**, California's Fourth Climate Change Assessment, California Natural Resources Agency. Publication number: CCCA4-CNRA-2018-007 http://www.climateassessment.ca.gov/techreports/governance.html

Climate adaptation and local implementation

Fourth California Climate Assessment Report

Agencies face multiple "financing" challenges…

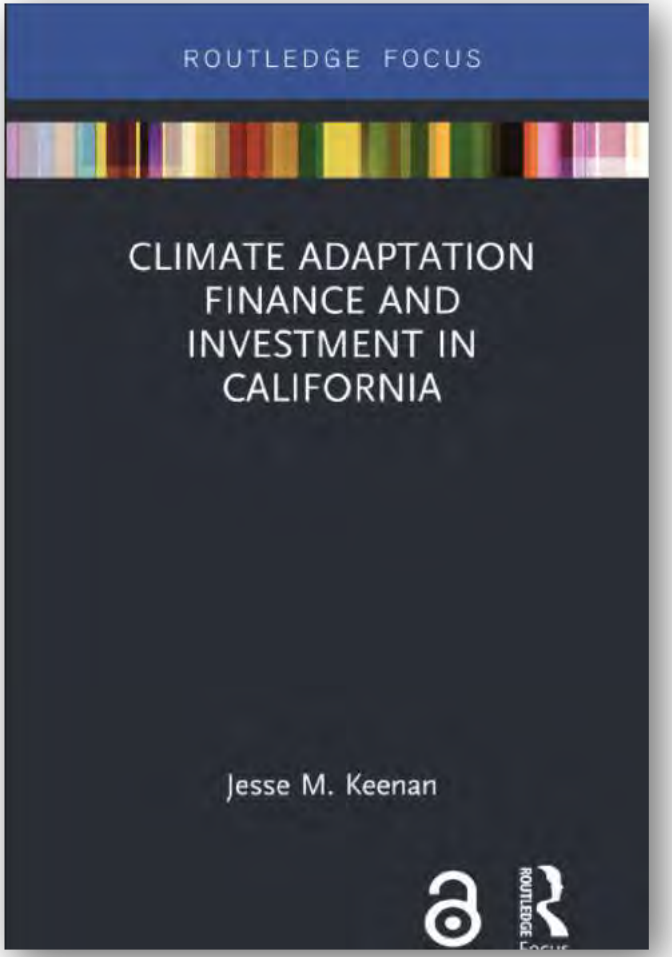
Survey question on perceived barriers to adaptation efforts – top four

- Lack of funding to implement
- Insufficient staff resources to analyze relevant information
- Current pressing issues are all consuming
- Lack of funding to prepare a plan

Moser, Susanne C., J.A. Ekstrom, J. Kim, S. Heitsch. 2018. **Adaptation Finance Challenges: Characteristic Patterns Facing CA Local Governments and Ways to Overcome Them**, California's Fourth Climate Change Assessment, California Natural Resources Agency. Publication number: CCCA4-CNRA-2018-007 http://www.climateassessment.ca.gov/techreports/governance.html

RESOURCE: Adaptation Finance Guide

ICARP



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https://resilientca.org/topics/investing-in-adaptation/

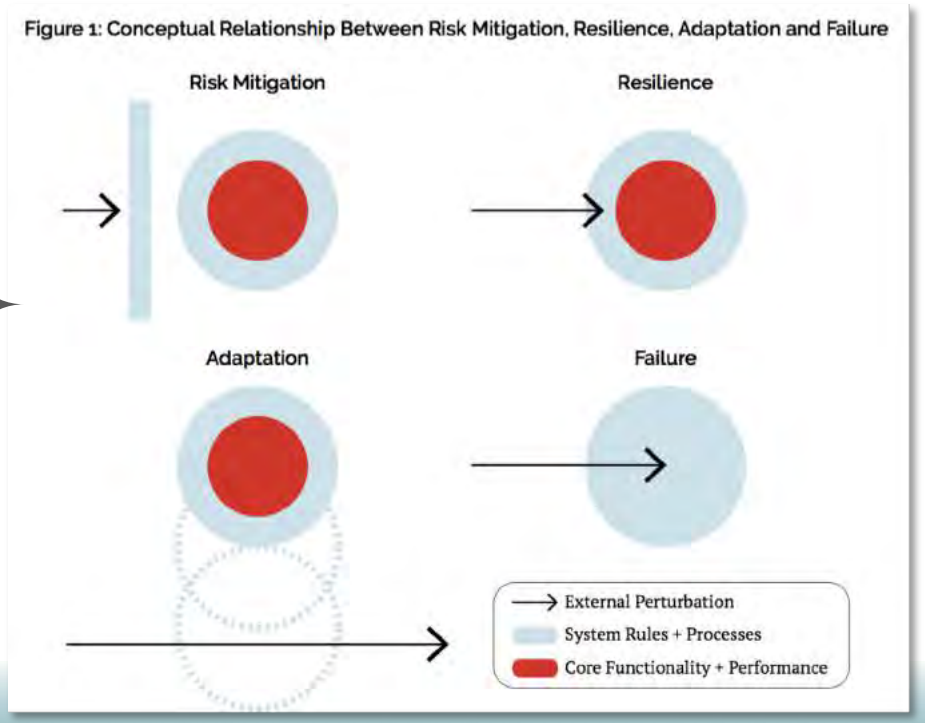
OPR Adaptation Clearinghouse - Investing in Adaptation Topic Page

RESOURCE: Adaptation Finance Guide

ICARP

- **Need revenue stream if going to rely on financing mechanisms other than grants**

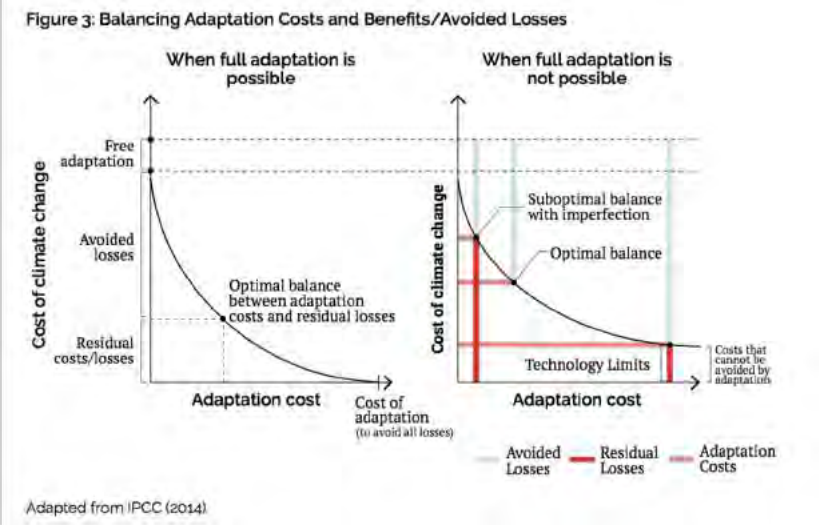
- **Chapter 1**: Need to mainstream definitions – what are we working towards?
  - ✓ Risk mitigation
  - ✓ Resilience
  - ✓ Adaptation



RESOURCE: Adaptation Finance Guide

ICARP

- **Chapter 2**: Need to incorporate climate projections and uncertainty into standard accounting and disclosure processes, especially in asset management



RESOURCE: Adaptation Finance Guide

ICARP

Funding sources covered

- Loans, Insurance & Incentives
- Taxes, Assessments, Charges & Fees
- Public Sector Grants, Loans, Insurance and Incentives

<u>Chapter 3</u>: survey of funding sources

- Local
- Public and private utilities
- State government
- Federal government
- Civic and private sectors
- Alternative funding models

RESOURCE: Adaptation Finance Guide

ICARP

Table 7: Example Framework for a Multi-criteria Assessment of Funding Options

		Economic Efficiency									Consequences of Actions/Inaction					
Risk	Treatment Option	Effectiveness	Cost	Funding Options	Time to Implement	Duration	Technical Feasibility	Human Capacity	Regulatory Impact	Community Acceptance	Benefit	Climate Change Impact	Social Impact	Environmental Impact	Co-Benefits	Secondary Risks	Residual Risk
1	A																
	B																
2	A																
	B																
	C																
	D																
3	A																
	B																

EXAMPLE

- **Chapter 4:** Standard assessment approaches to determining the right funding options

  Example: City and County of San Francisco, *Strategies for Funding the Seawall Resilience Project (2017)*

- **Chapter 5:** Ensuring investments in equitable outcomes

  Example: Strong Prosperous and Resilient Communities Challenge (SPARCC), *Capital Project Screen (2018)*

Table 9: SPARCC Capital Screening Evaluation Criteria (2018)

	Racial Equity	Health	Climate
Project measurably improves social determinants of health and would be expected to reduce racial disparities in health outcomes.	■	■	■
Project addresses other environmental determinants of health and would be expected to reduce racial disparities in preventable illness.	■	■	
Project responds to specific health needs of the community.		■	
Project is designed to impact racial equity outcomes identified by collaborative table or a community informed plan.	■		
Community is engaged in the design of the project and/or project is consistent with an existing community informed plan.	■		
Community is incorporated into the ownership, governance, and/or asset building aspects of the project.	■		
Project team has identified potential negative unintended racial equity outcomes and has developed strategy for mitigation.	■	■	■
Project features a resilient and/or sustainable design with attention to energy and water efficiency.			■
Project increases active or public transport options for residents and/or adds key neighborhood features and amenities.	■	■	■
Project strengthens community members' resiliency against impacts of climate change, emergencies, and natural disasters.	■	■	■
Project is informed by analysis of relevant data during and after development process in order to leverage project's impact.	■	■	■
Project demonstrates consistency with collaborative table's work plan and theory of change.	■	■	■

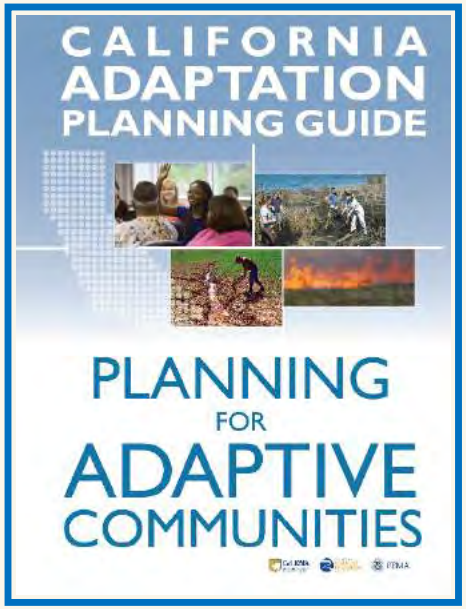
Cal OES

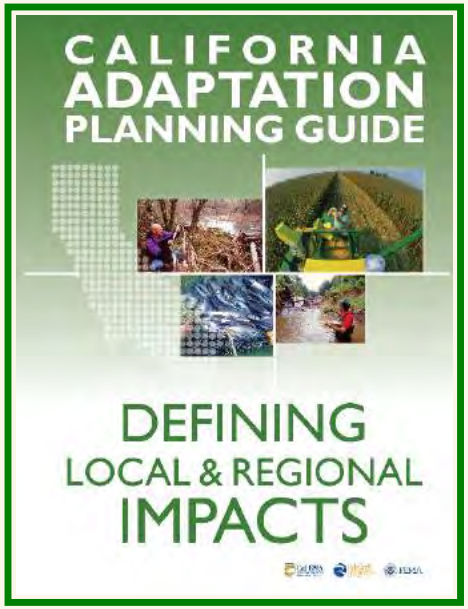
GOVERNOR'S OFFICE
OF EMERGENCY SERVICES

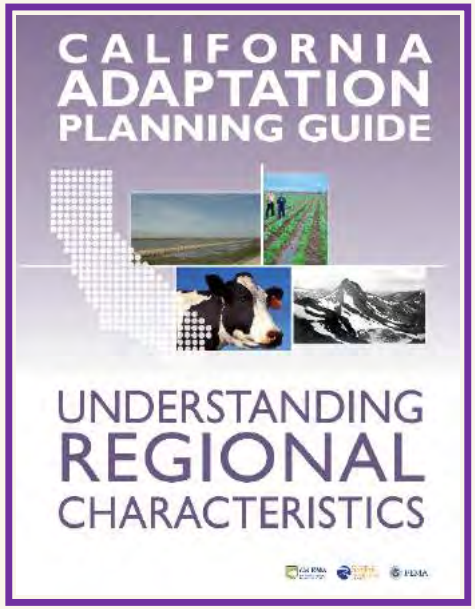
Adaptation Planning Guide Update

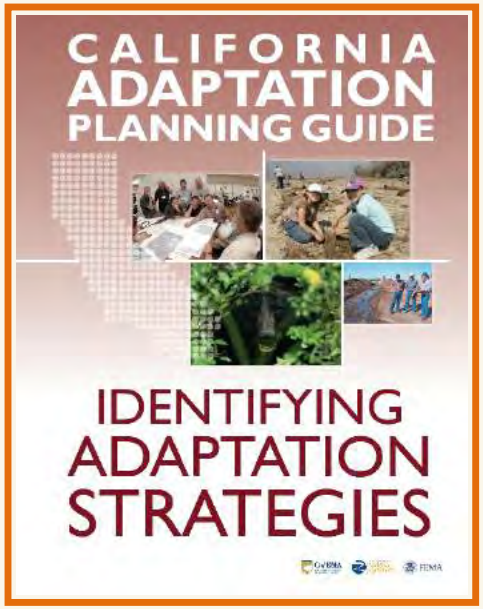
Adam Sutkus, Chief | Sarah Risher, Climate Fellow
Hazard Mitigation Planning Division

Adaptation Planning Guide (APG)









Purpose

- Equip local and regional governments with the latest adaptation resources and planning methodologies
- Incorporate findings from the 2018 Safeguarding California Plan
- Integrate with the Adaptation Clearinghouse
  - including potential alignment with federal 5-step process on US Climate Resilience Toolkit
  - Develop a web-based tool
- Streamline with California's Fourth Climate Change Assessment and other State climate documents
- Integrate with LHMP and other planning processes, which will ultimately lead to funding opportunities for implementation

Process/Timeline

Late 2018 Early 2019

- Collect public input
- Analyze feedback & compile list of needs
- Map out content-develop plan

Mid 2019

- Develop initial drafts
- Release 45-day public review draft
- Implement necessary changes

Late 2019

- Publish & promote finalized draft
- Development of a web application tool
- Build-out of online interface on Adaptation Clearinghouse

Stakeholder Input

- Seeking input from the government and community-based leaders in local and regional climate preparedness through:
  - Public workshops and webinars
  - APG update needs assessment survey on the Cal OES website

- Currently determining additional engagement channels to ensure end-users are included throughout the process

Contact

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www.caloes.ca.gov/cal-oes-divisions/hazard-mitigation/hazard-mitigation-planning/california-climate-adaptation

THANK YOU!

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Participant Discussions

1. What opportunities and resources can be leveraged to accelerate adaptation efforts in the Central Coast region?
2. What actions have you taken, or need to take, to increase staff capacity and improve coordination?

Networking Break

Next panel will begin promptly at 3:00 PM.

Accelerating Adaptation along the Central Coast

Monique Myers

California Sea Grant

Anna Olsen

Cachuma Resource Conservation District

Chris Read

City of San Luis Obispo

moderated by Nuin-Tara Key | Resilience Program Manager, OPR

Closing Remarks

Supervisor
Ryan Coonerty

Santa Cruz County

Local Government Commission
Leaders for Livable Communities

California Natural Resources Agency

California Water Boards
Central Coast - R3

Central Coast Climate Collaborative

University of California Santa Cruz

SoCalGas
A Sempra Energy utility