Santa Cruz and Monterey County SLR and Adaptation Planning Project

TAC Meeting I

Moss Landing Marine Labs
Monday January 12, 2015

Agenda

1. Introduction
2. Goals of Meeting
3. Project Partners
4. Project Scope
5. Related Studies
6. ESA Hazard Maps Methodology
7. SLR Scenario Selection
8. Impact Assessment Methodology
9. Discussion
10. Next Steps

Goals of TAC Meeting 1

1. Brief update on previous and parallel efforts
2. Review project deliverables and gather input
3. Review SLR scenario selection
4. Discuss vulnerability/impact methodology

Project Partners

- **Ocean Protection Council:** funder
- **CCWG/Moss Landing Marine Labs:** project management and coastal resource assessment
- **Coastal Conservation and Research:** contract administrator
- **Monterey County:** contract lead and policy guidance
- **Santa Cruz County**: policy guidance and project support
- **City of Capitola**: policy guidance and project support
- **Center for Ocean Solutions**: website, policy, and inter-county coordination
- **Natural Capital Project**: ecosystem services
- **ESA and Revell Coastal:** coastal impact modeling
- **TNC:** adaptation planning and policy

CCWG Central Coast Wetlands Group

Moss Landing Marine Laboratories

ESA

Revell Coastal

The Nature Conservancy Protecting nature. Preserving life.

Center for Ocean Solutions

Ocean Protection Council

Monterey County California 1850

The County of Santa Cruz 1850

City of Capitola Incorporated 1949

natural capital PROJECT

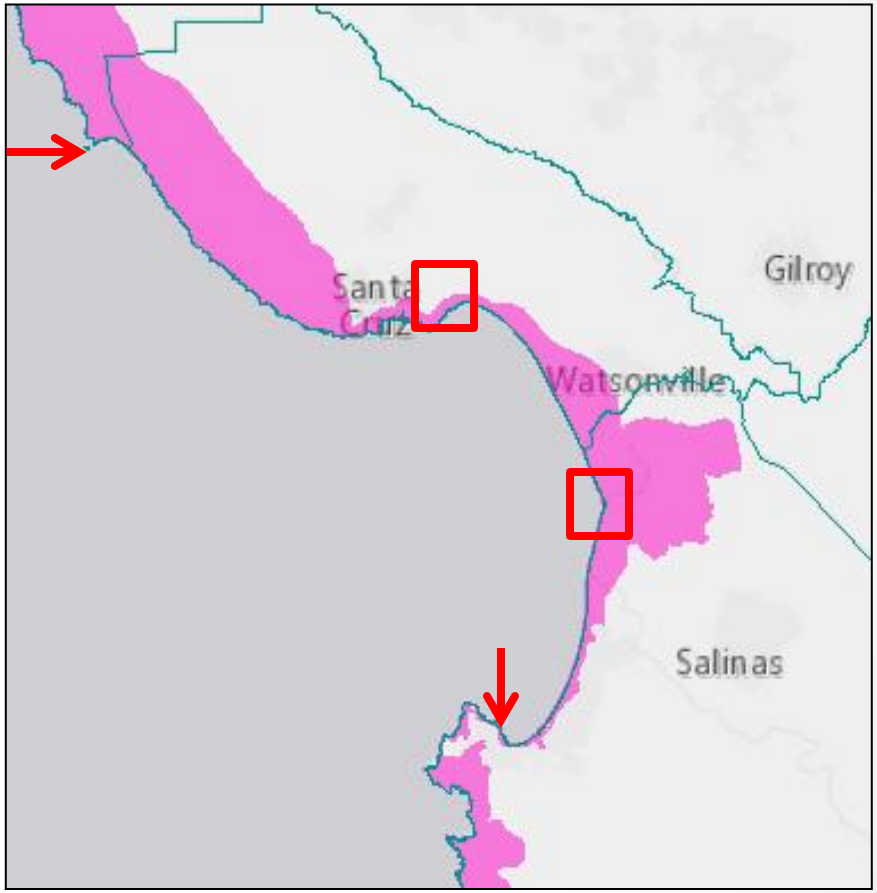
Scope of Work

Provide initial steps to applying Coastal Commission Guidance on assessing vulnerabilities and adaptation strategies to help inform municipalities and aid LCP updates.

Scope of Work

Project Area:

- Santa Cruz and Monterey County: Ano Nuevo to Wharf II
- LCP segments
- Focus areas at Moss Landing and Capitola



Scope of Work

Project Goals:

- Identify what critical coastal infrastructure will be compromised due to SLR for time horizons 2030, 2060, and 2100.
- Identify how fluvial processes will increase flooding risk to coastal communities in the face of rising seas.
- Define appropriate response strategies for these risks and discuss with regional partners the programmatic and policy options that can be adopted to address these risks to the region.

Scope of Work

Project Process and Products:

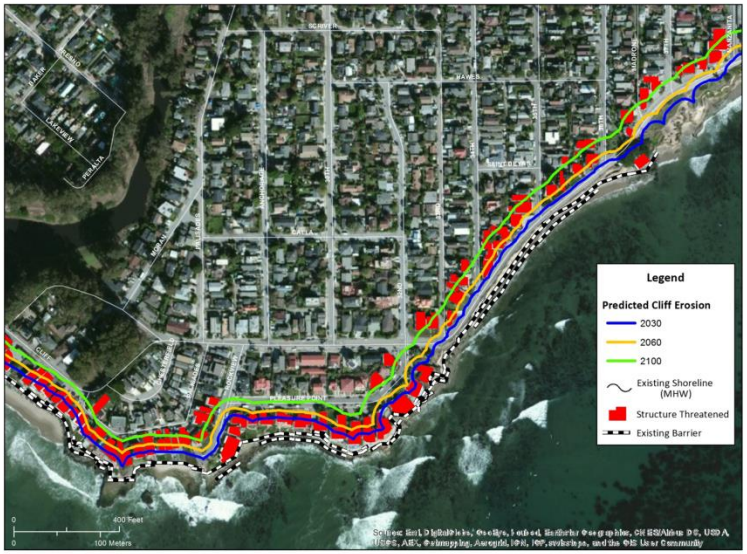
- Vulnerability Analysis for entire Monterey Bay (Ano Nuevo to Wharf II using ESA PWA hazard maps
  - Inventory of water control structures
  - Table of land use/infrastructure impacts
  - Report of vulnerable structures and land uses
  - Temporal risk maps
  - Evaluation of coastal protection structures

Evalations of Impacts		2030	2060	2100	2100
Scenario		Mid	Mid	Mid	High
Private Property	Residential				
	Multi Family				
	Commercial				
	Industrial				
	Visitor Serving				
	Municipal/ public				
	Agriculture				
Public Acccess	access points (stairs, trailheads)				
	parking				
	Latteral access ways				
	OTDs/Easments				
Seawalls at Risk	# / Miles				
	% for counties				
	% by jurisdiction				
	% by LCP segment				
Beaches at risk	#				
	%				
Bluffs at Risk	# parcels				
	Miles				
	%				
	% by jurisdiction				
Wetlands	#				
	Types				
	Adaptive Capacity				
water Infrastructure	Tide gates and storm drains				
	lift stations				
	Buildings				
	Pumps				
	Levees				
	Sea Walls				

Scope of Work

Project Process and Products:

- Fluvial impact report for Capitola and Moss Landing
- Santa Cruz and Monterey coastal vulnerability report
- Evaluation of protection and adaptation options
- Stakeholder policy discussion



Outcomes

- Vulnerability Assessment (quantified)
  - Coastal hazards, erosion, wave overtopping, inundation
  - Coastal confluence flooding hazards
- Expanded review of adaptation strategies and temporal impacts (primary and secondary)
  - Relative cost, effectiveness, life span and lead times
  - Expand "soft" land use policies
- Adaptation and Policy Evaluation
  - Policy links- other CA examples
  - cliff adaptation strategies

Related Studies

- Coastal Regional Sediment Management Plan (2008)
- Pacific Institute SLR Report (2009)
- Technical Evaluation of Erosion Mitigation Alternatives (2012)
- Sea Level Rise Modeling and Mapping (2014)
- Opportunistic Sand Placement Program (ongoing)

- *Adapt Monterey Bay (TNC led); Climate Ready Grant Funded*
- *Sonoma and Marin Counties SLR analysis (OPC)*

Adapt Monterey Bay

Analyzing the economic Impact of Climate Adaptation Strategies for Southern Monterey Bay

- Work with stakeholders to develop feasible alternative strategies for managing impacts of sea level rise on social, economic and ecological assets;
- Model the physical and economic impact of the strategies on the coastline under several potential future sea level rise scenarios at 2030, 2060, and 2100;
- Integrate the results of this analysis into a user-friendly, online decision-support tool that will provide access to coastal hazard scenarios and asset data in service of adaptation planning and project implementation; and
- Promote regional dialogue and collaboration in furtherance of updating Local Coastal Programs to manage the impacts of sea level rise and coastal hazards.

OPC Funded SLR Parallel Projects Approaches from Marin & Sonoma

Sonoma County

- Have not yet begun contracted work on LCP SLR grant
- Primary interest is in ensuring agreement with neighboring counties and presenting scenarios that are easy to understand

Marin County

- Initial approach based on 40 SLR scenarios from OCOF CoSMoS* analysis
- Through stakeholder engagement and local advice, they selected 6 scenarios for further planning and analysis

* Coastal Storm Modeling System

ESA Sea Level Rise Study: Monterey Bay Coastal Hazard Layers

Methods

Monterey Bay Sea Level Rise Study
Coastal Erosion and Flood Maps
For use in Impact Analysis in support of

Monterey Bay Sea Level Rise Adaptation and Policy Project

January 10th, 2015

Bob Battalio, P.E
David Revell, Ph.D.
James Gregory, P.E.

.

E. Vandebroek, 2012

ESA

ESA PWA

PWA
PHILIP WILLIAMS & ASSOCIATES, LTD
ENVIRONMENTAL HYDROLOGY

Introduction

- Hazard Maps already produced (Dave Revell will describe)

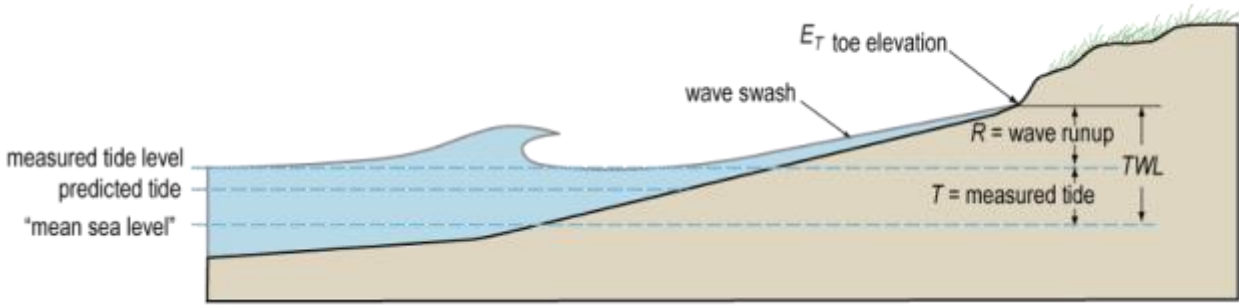
- This Study with MLML et al:
  - Refine maps to better represent coastal structures
  - Add river flooding (James Gregory will describe)
  - Apply to support assessment of asset vulnerability

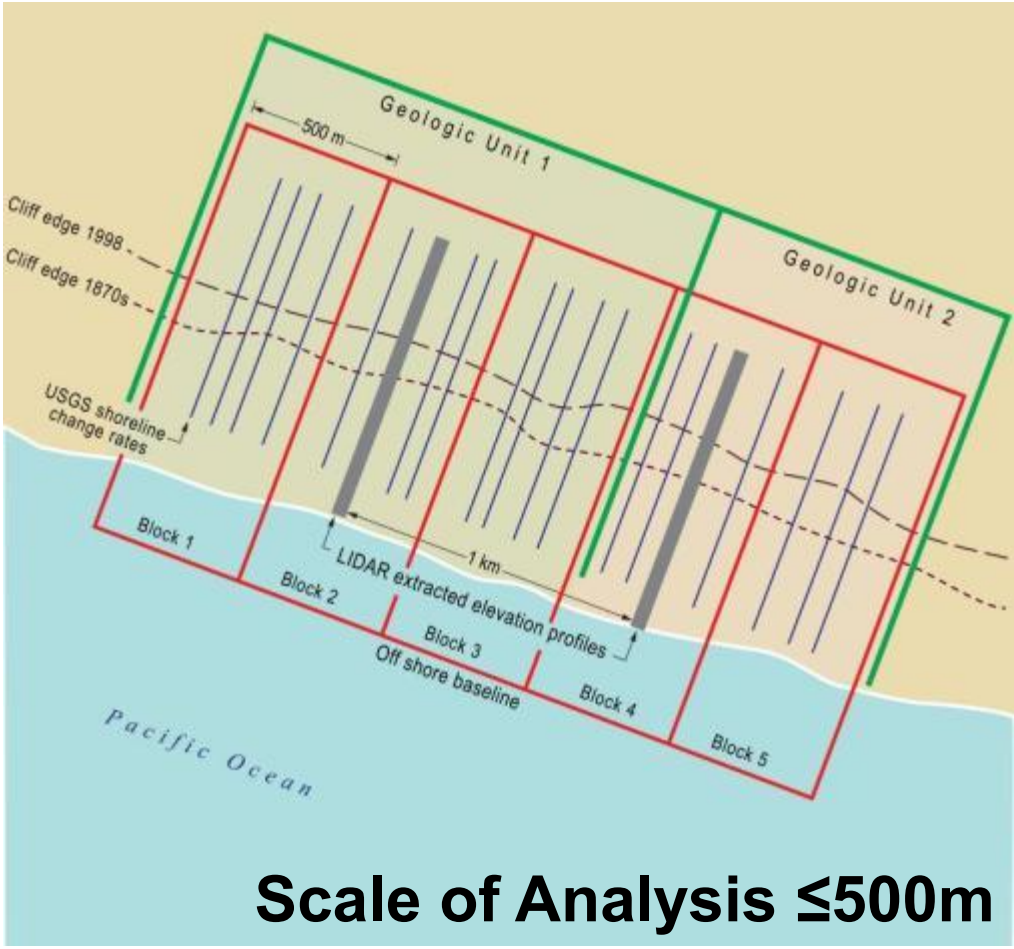
- Associated project underway
  - TNC southern Monterey Bay coastal adaptation measures

- Key ESA staff - contacts:
  - James Gregory – Project Manager, River hydraulics
  - David Revell – Technical Expert (Independent Contractor – aka Revell Coastal)
  - Bob Battalio – Coastal Engineer

Model Inputs

- Physical Forces
  - Offshore wave/ climate "scenarios"
  - Transformed nearshore waves
  - Tides
  - Total Water Levels
- Backshore Characterization
  - Geology
  - Geomorphology (slopes, heights)
  - Backshore type (cliff, dune, inlet, armored)
  - Historic erosion rates (short term, long term)
  - Coastal Armoring
  - Topography





Assumptions

- No inclusion of management strategies (e.g. armoring)
- No modeling of fluvial processes (coastal confluences)
- Surface hydraulic connections only
- No groundwater connection
- Equilibrium profile response
- Flooding based on historic observed event rather than a single “event” with a set return interval – 100yr
- Topography captured in LIDAR representative of existing conditions

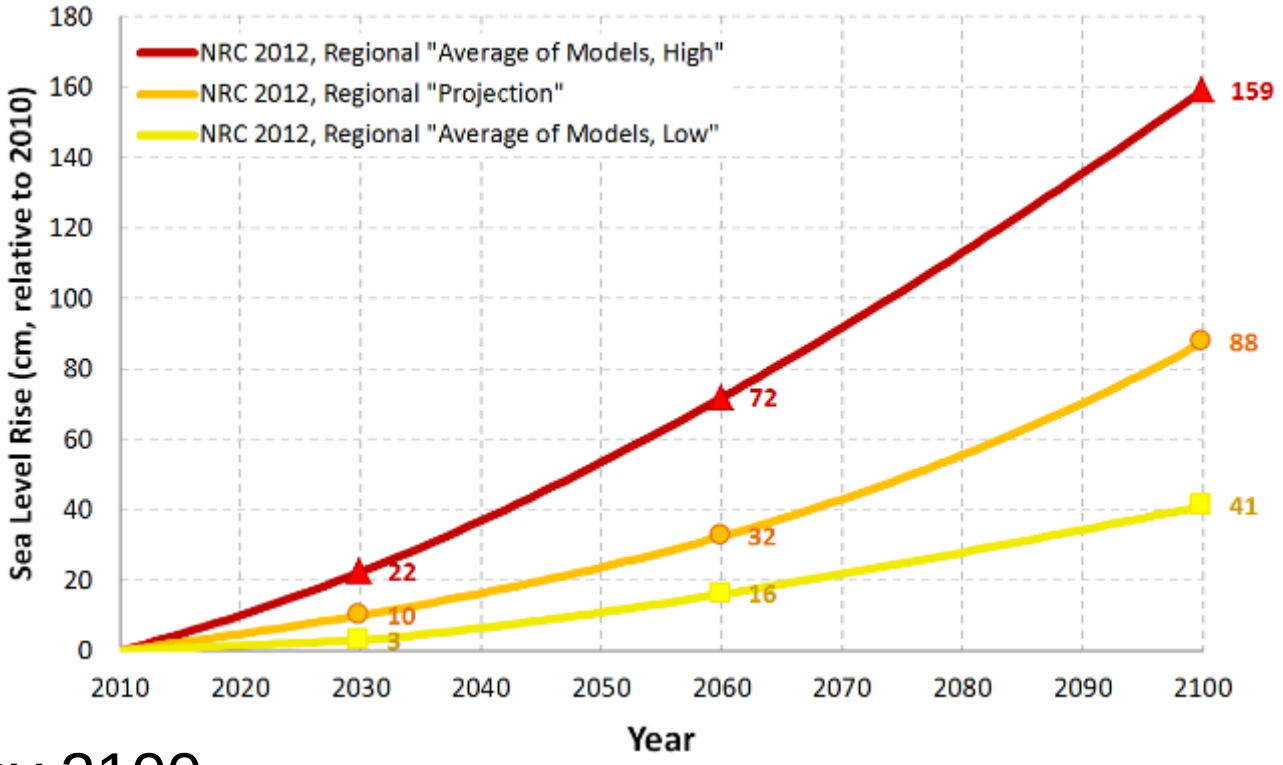
Scenarios

Planning Horizons:

- 2010, 2030, 2060, 2100

Sea Level Rise:

- Low: 0.41 meters by 2100
- Medium: 0.88 meters by 2100
- High: 1.59 meters by 2100

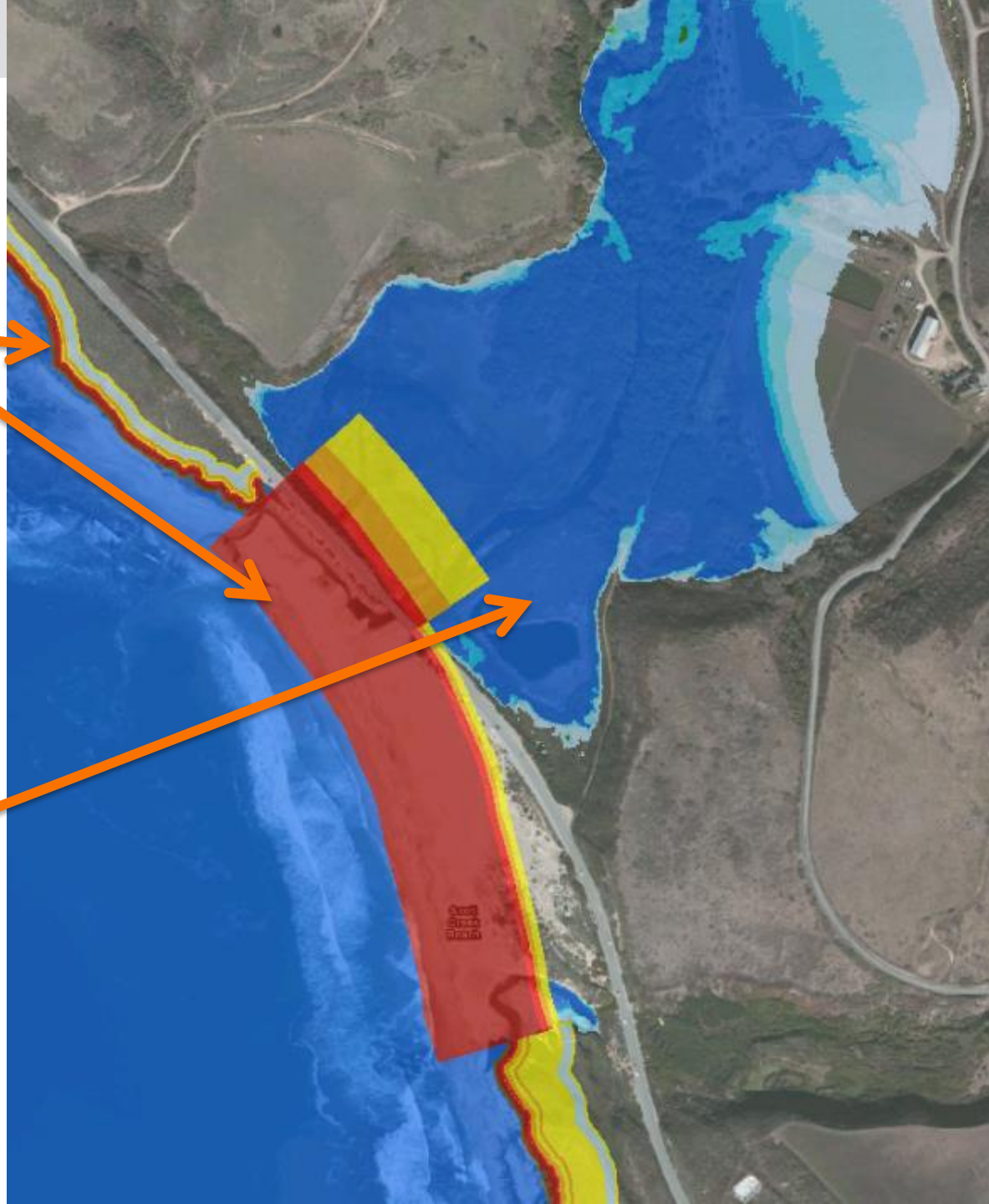


Model Outputs

1. Erosion Hazard Zones
   Future erosion increases hydraulic connection and risk of flooding

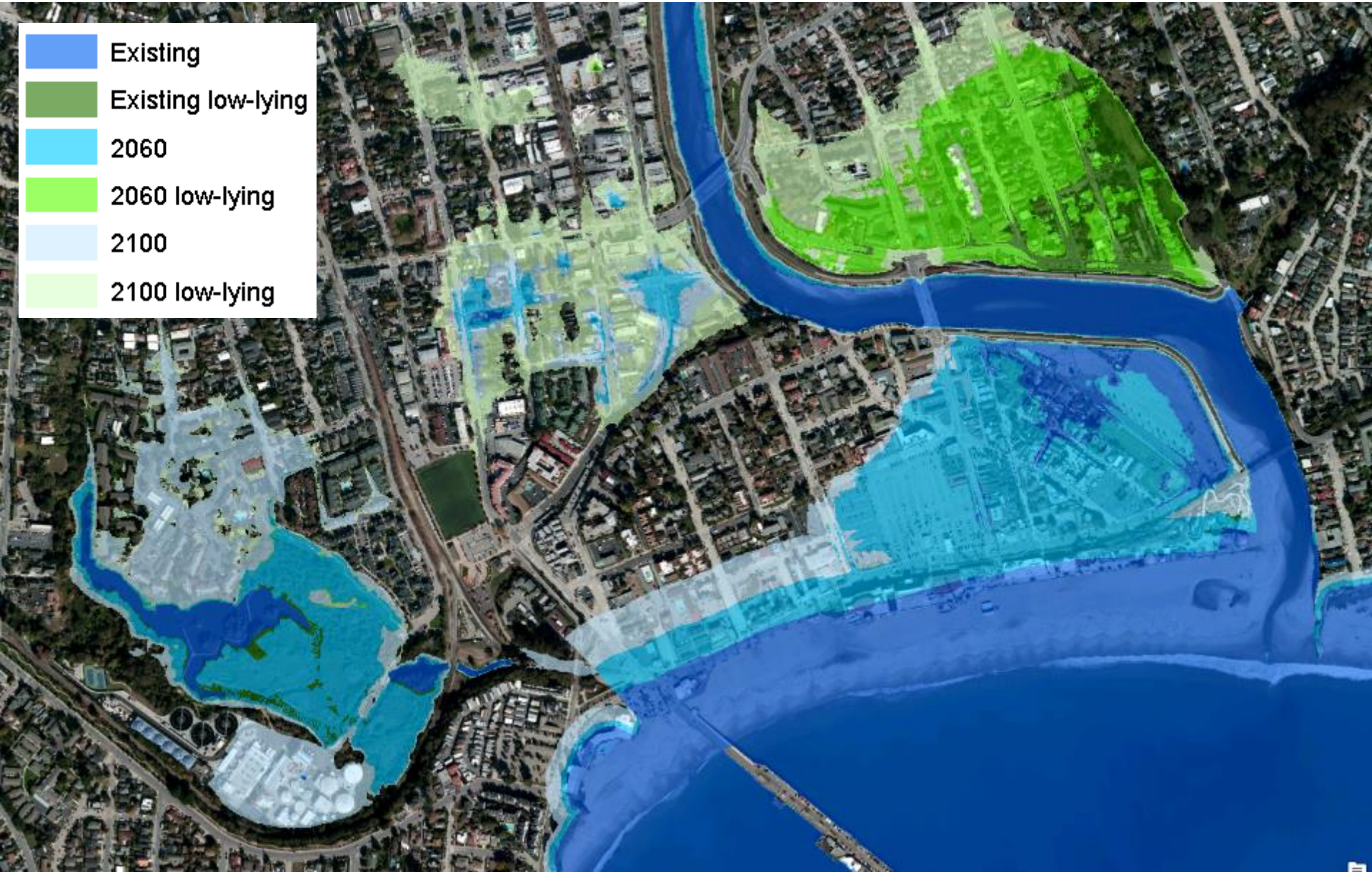
2. Coastal Flooding
   inundation during extreme coastal events (integrated with erosion)

3. Rising Tide Zones
   inundation during monthly extreme tides [not shown]

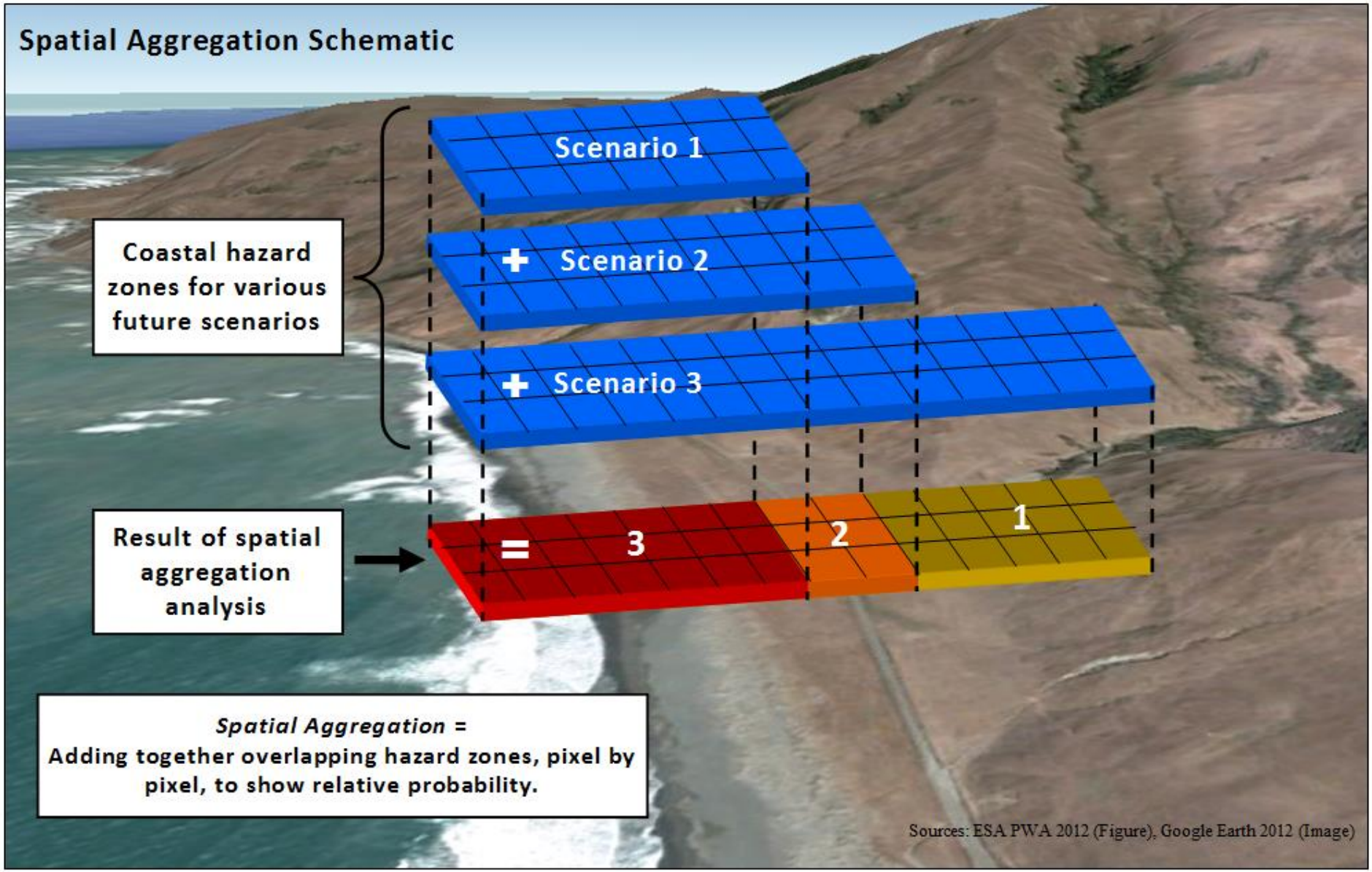


ESA PWA

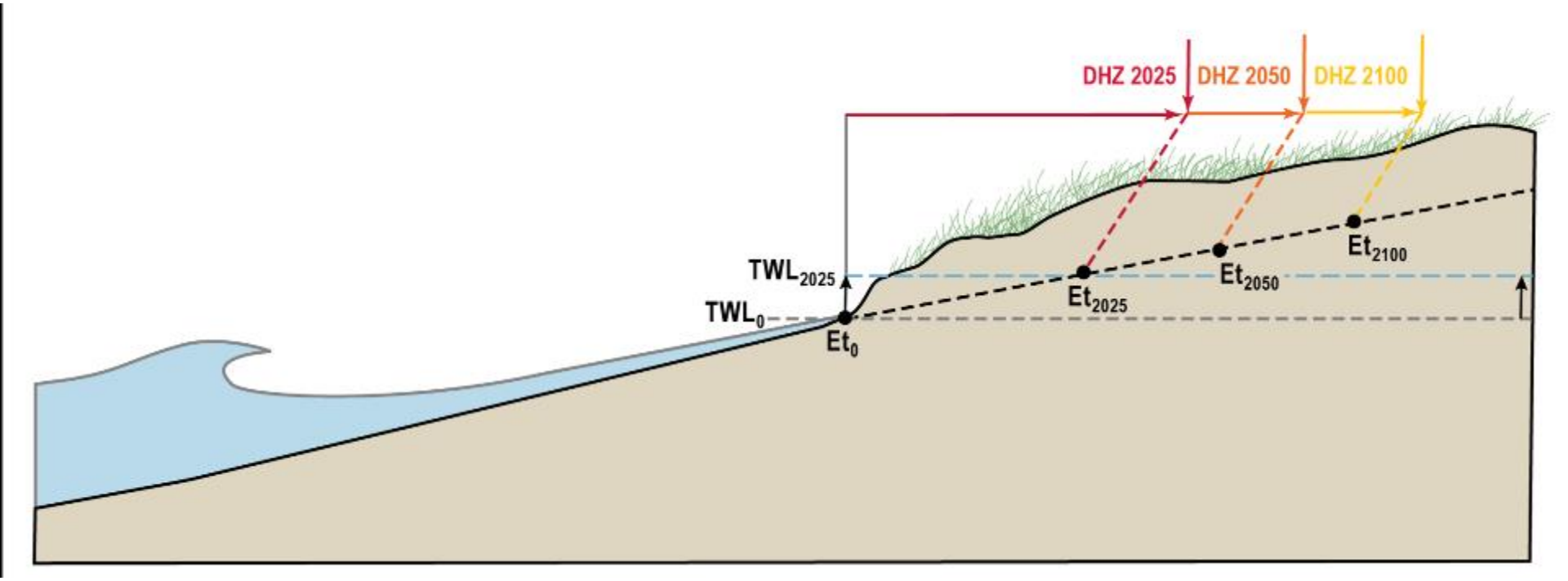
Example Flood Hazard Zones



Evaluating Uncertainty: *Spatial Aggregation*



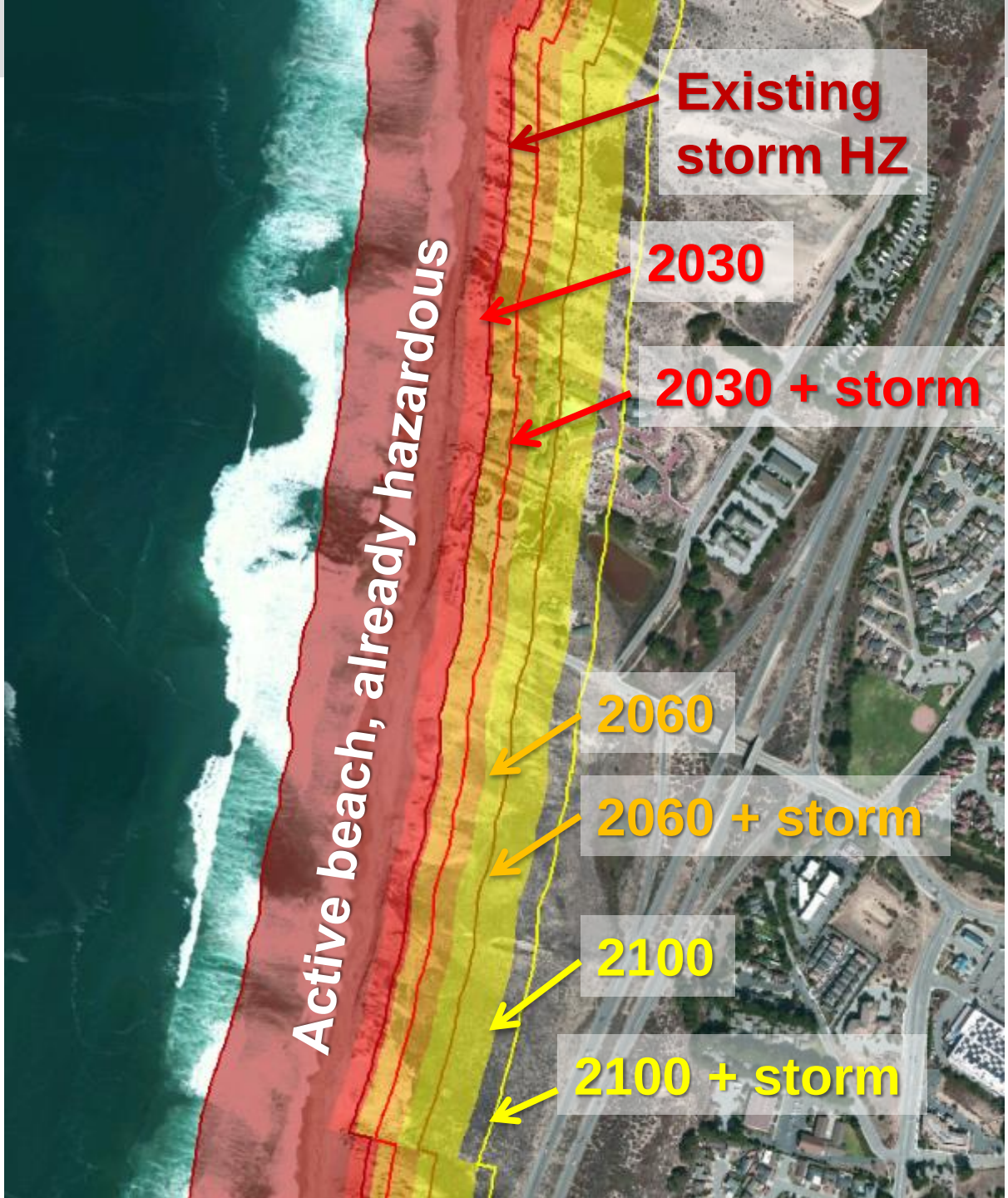
Dune Erosion Components



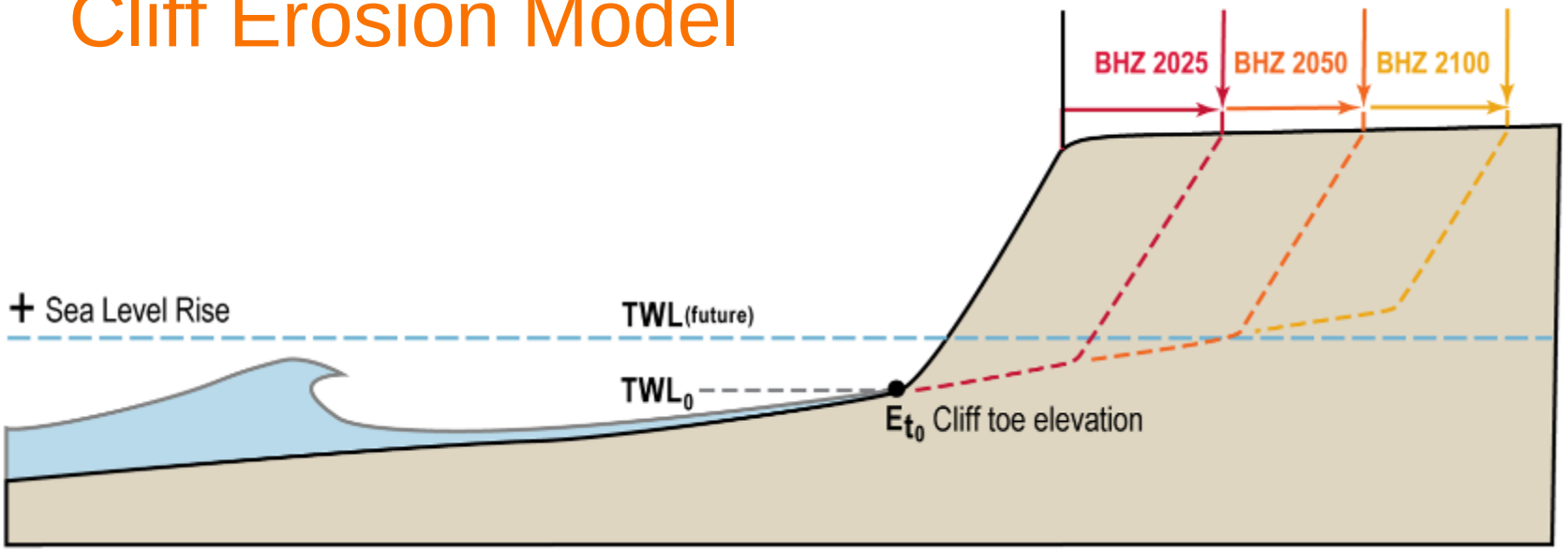
- 3 components –
  1. Changes in TWL from SLR combined with shoreface slope
  2. Historic shoreline trends (USGS, updated with 2005, 2009, 2010)
  3. Impact of a “100 year storm event”

ESA PWA

Example Dune Hazard Zones



Cliff Erosion Model



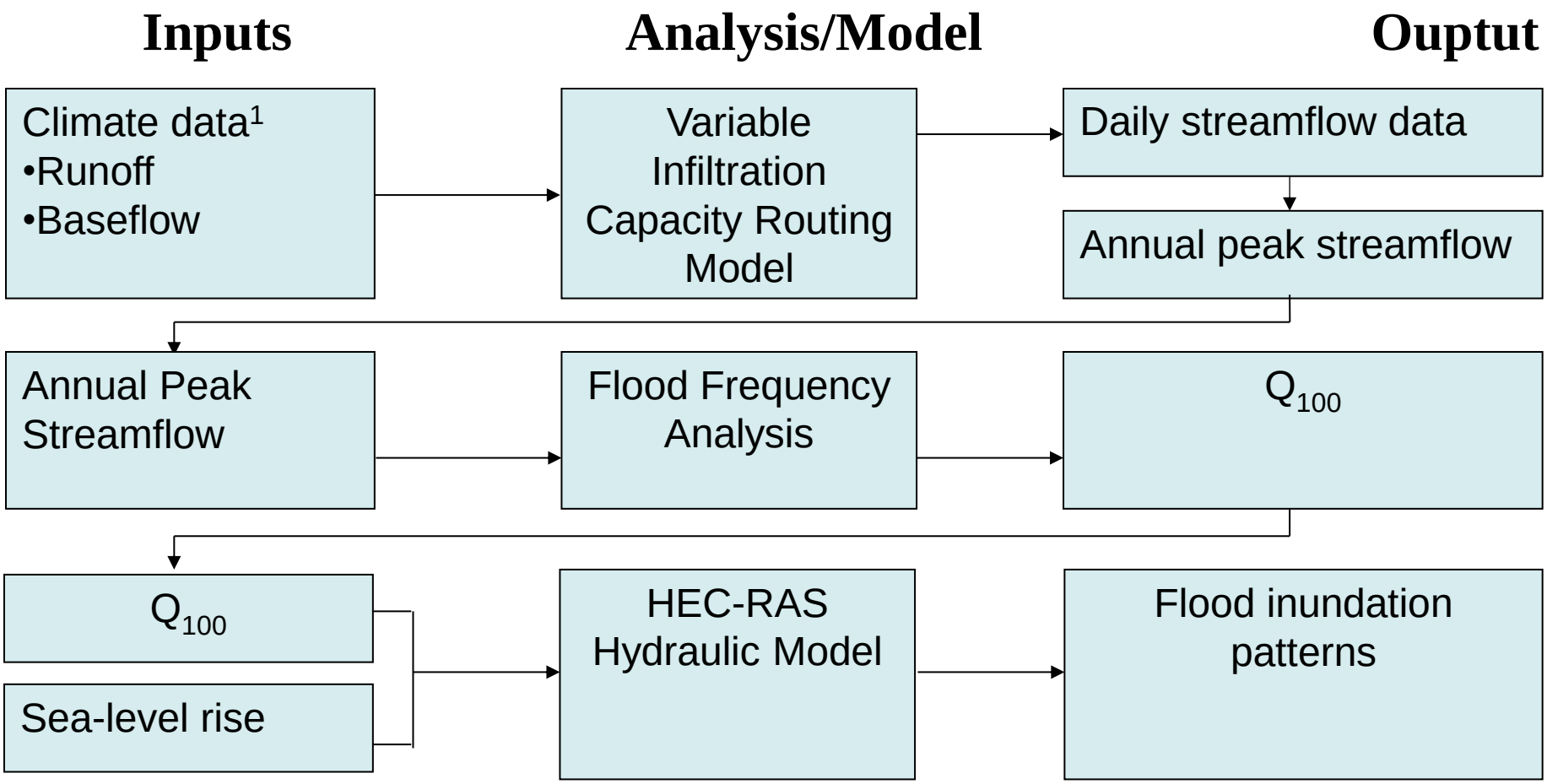
- Prorated acceleration of historic erosion rates based on increases in the duration of wave attack at various elevations
- Include geologic unit standard deviation x planning horizon to account for uncertainties in alongshore variability

ESA PWA

Example Cliff Hazard Zone

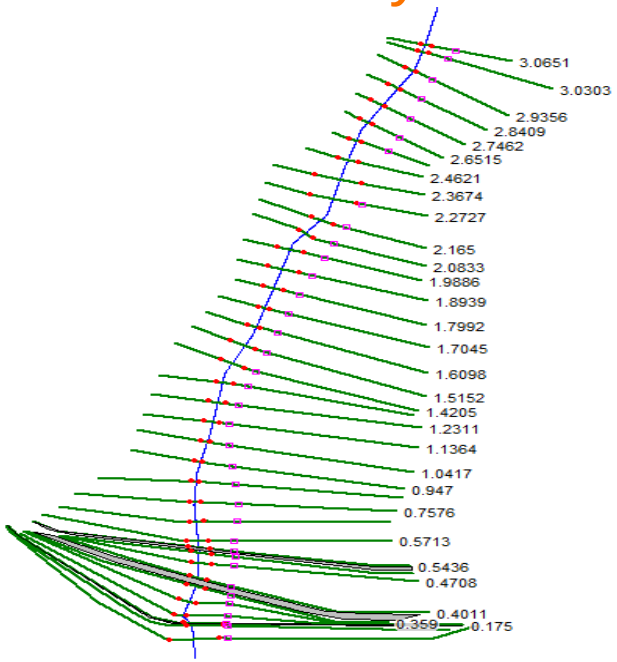
Fluvial Analysis

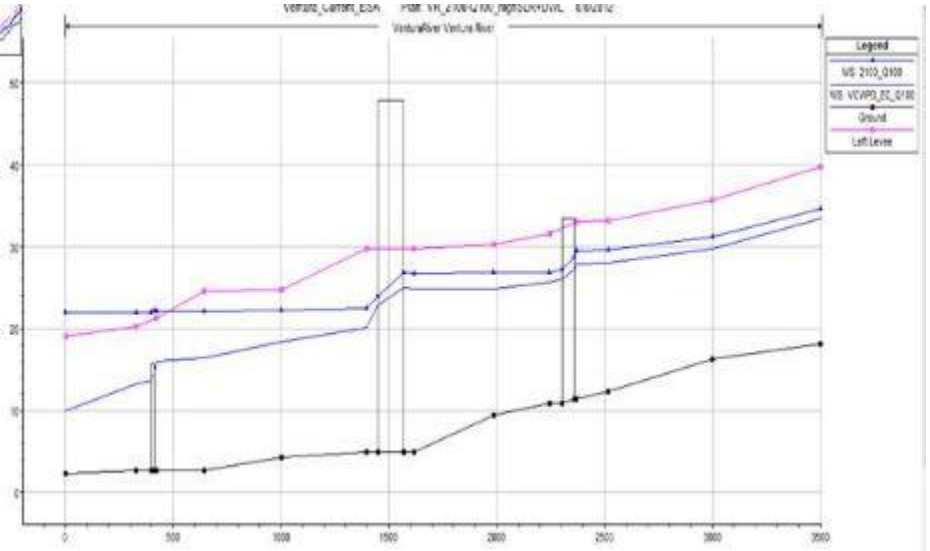
Hec -RAS models:
- **Soquel Creek**
- **Salinas River**



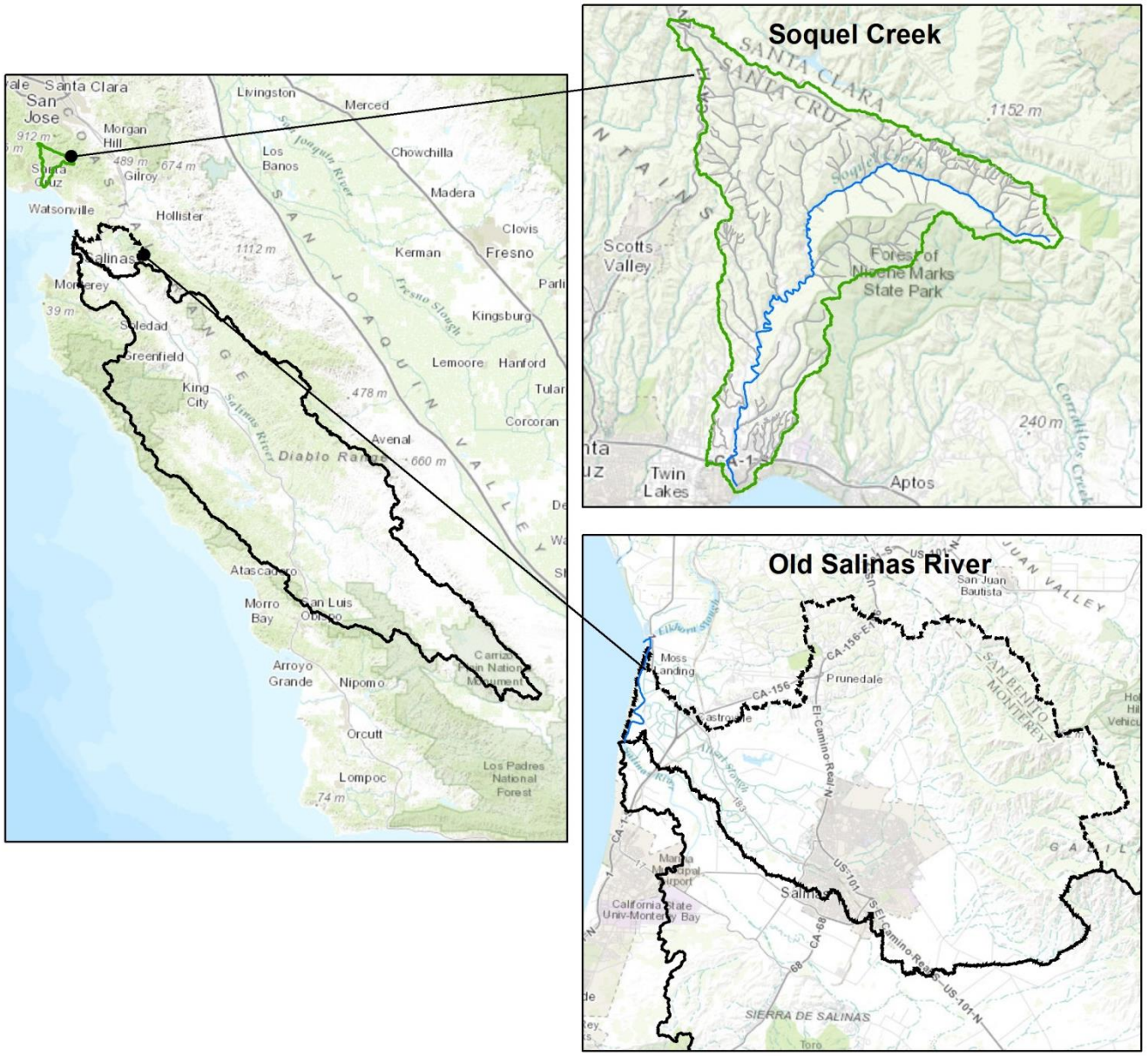
[1]Data produced by California Climate Change Center

Case Study: Ventura River Modeling



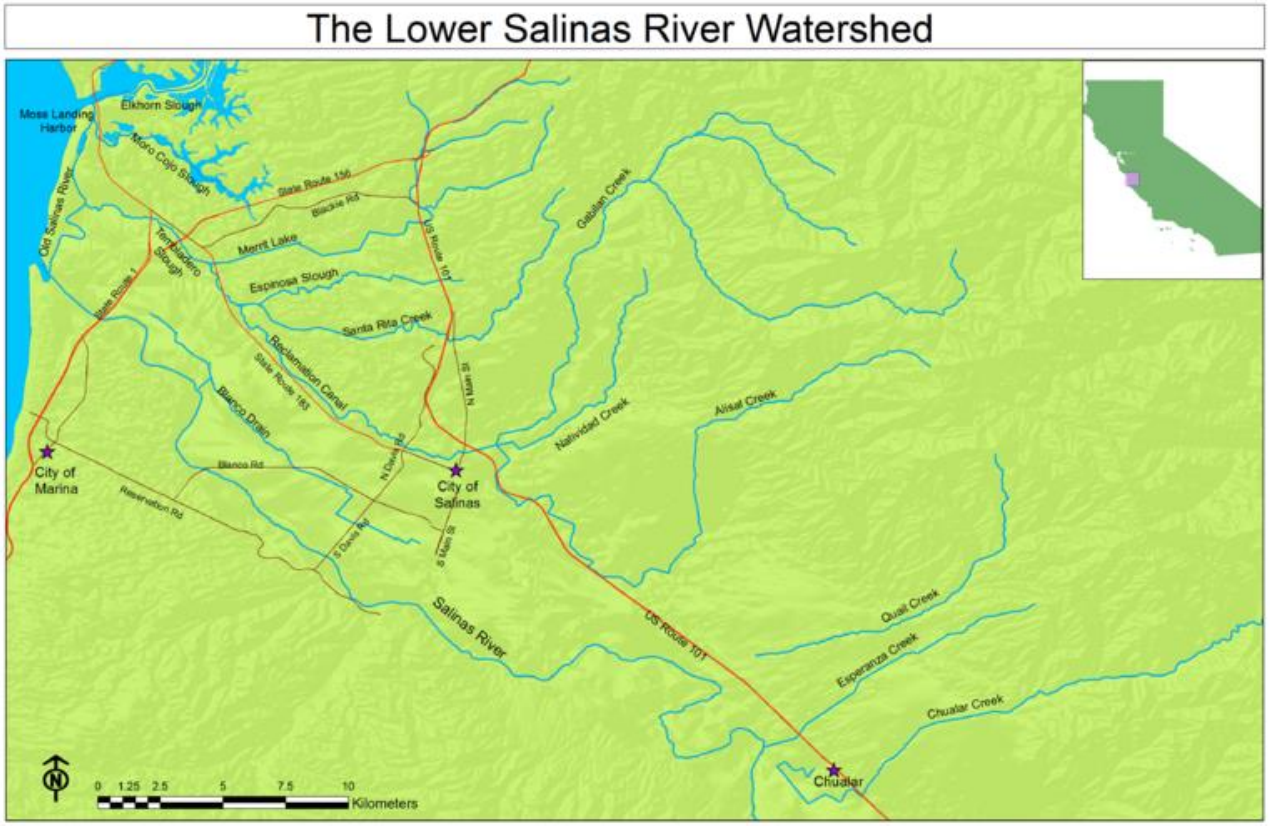


Soquel and Salinas Rivers

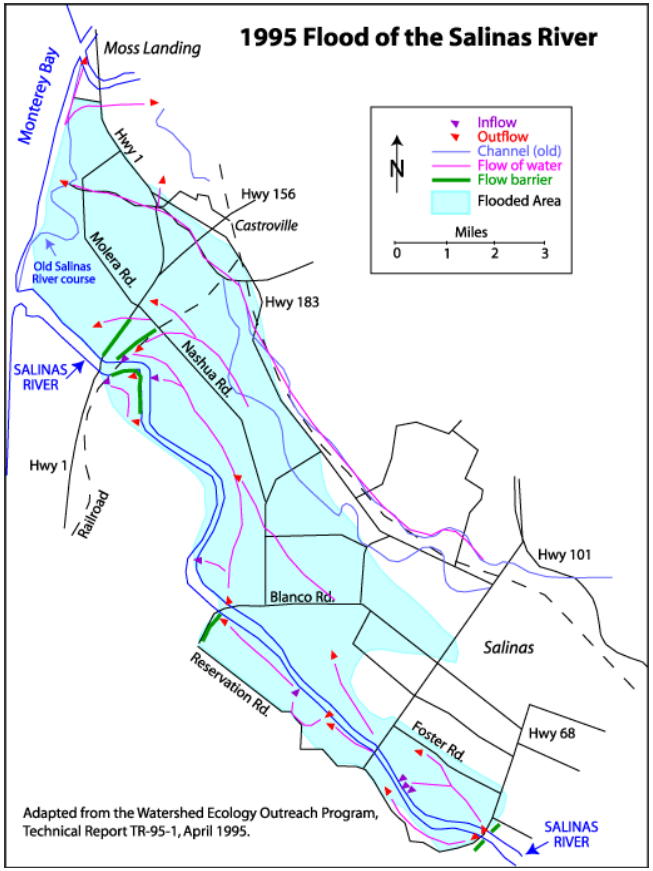


Lower Salinas River and salinas river drainage canal

http://ccows.csumb.edu/wiki/index.php/Lower_Salinas_River_Watershed

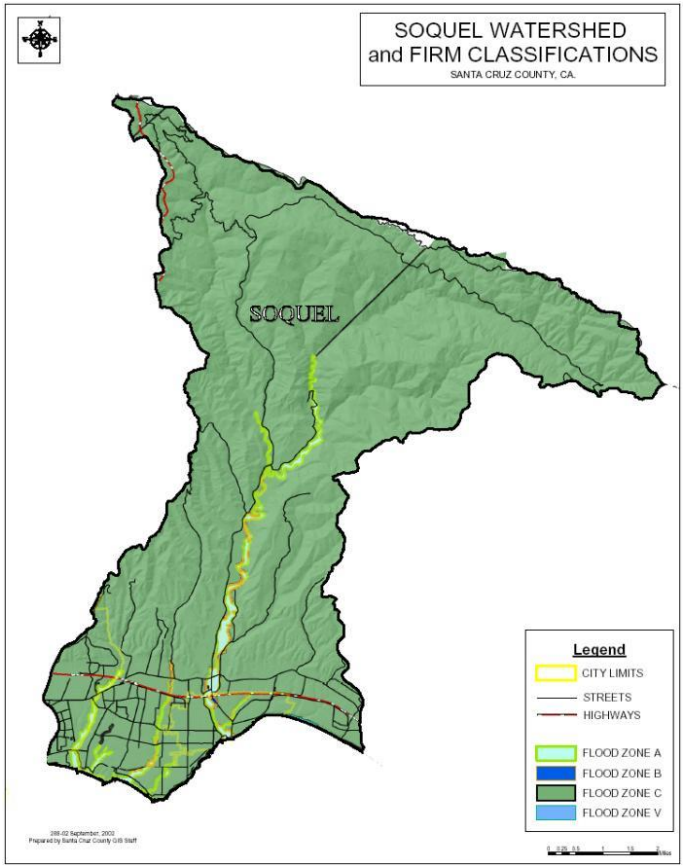


http://sanctuarysimon.org/monterey/sections/other/sporadic_flood.php



Soquel Creek Watershed

https://localwiki.org/santacruz/Soquel_Creek/_files/Soquel_Watershed.jpg/_info/



SLR Scenario Selection

State Guidance

State of California Sea-Level Rise Guidance Document

Developed by the Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT), with science support provided by the Ocean Protection Council's Science Advisory Team and the California Ocean Science Trust

March 2013 update

Background, Purpose, and Intended Use

This document provides guidance for incorporating sea-level rise (SLR) projections into planning and decision making for projects in California. This document was developed by the Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT) in response to Governor Schwarzenegger's Executive Order S-13-08, issued on November 14, 2008, which directed state agencies to plan for sea-level rise and coastal impacts. That executive order also requested the National Research Council (NRC) to issue a report on sea-level rise (SLR) to advise California on planning efforts.

The final report from the NRC, *Sea-Level Rise for the Coasts of California, Oregon, and Washington*[1], was released in June 2012. The *Sea-Level Rise Guidance Document* has been updated with the scientific findings of the 2012 NRC report. The intent of this guidance document is to inform and assist state agencies as they develop approaches for incorporating SLR into planning decisions with the most recent and best available science, as published in the 2012 NRC report. Specifically, this document provides information and recommendations to enhance consistency across agencies in their development of approaches to SLR. Because of their differing mandates and decision-making processes, state agencies will interpret and use this document in a flexible manner, taking into consideration risk tolerances, timeframes, economic considerations, adaptive capacities, legal requirements and other relevant factors. (Refer to Recommendation #2 below for a discussion of risk tolerance and adaptive capacity). Although the estimates of future SLR provided in this document are intended to enhance consistency across California state agencies, the document is not intended to prescribe that all state agencies use specific or identical estimates of SLR as part of their assessments or decisions.

SLR potentially will cause many harmful economic, ecological, physical and social impacts and incorporating SLR into agency decisions can help mitigate some of these potential impacts. For example, SLR will threaten water supplies, coastal development, and infrastructure, but early integration of projected SLR into project designs will lessen these potential impacts.

Summary of Guidance Development and Planned Future Updates

Staff from the CO-CAT member agencies worked collaboratively to develop the first version of this document, the *Interim Sea-Level Rise Guidance Document*[2] (2010), prior to the release of the NRC

[1] Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future (2012). http://www.nap.edu/catalog.php?record_id=13389

[2] Sea-Level Rise Interim Guidance Document (2010). http://opc.ca.gov/webmaster/ftp/pdf/agenda_items/20110311/12.SLR_Resolution/SLR-Guidance-Document.pdf

STATE OF CALIFORNIA—NATURAL RESOURCES AGENCY

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CALIFORNIA COASTAL COMMISSION DRAFT SEA-LEVEL RISE POLICY GUIDANCE

Public Review Draft Comment Period: October 14, 2013 - January 15, 2014


Sunset Beach, Photo by Mario Fernandez

Chula Vista, Photo by Lisa Cox


San Francisco, Photo by Mike Baird


Arcata, Photo by Humboldt Baykeeper

NRC 2012

Table 1. Sea-Level Rise Projections using 2000 as the Baseline

Time Period	North of Cape Mendocino[3]	South of Cape Mendocino
2000 - 2030	-4 to 23 cm (-0.13 to 0.75 ft)	4 to 30 cm (0.13 to 0.98 ft)
2000 – 2050	-3 to 48 cm (-0.1 to 1.57 ft)	12 to 61 cm (0.39 to 2.0 ft)
2000 – 2100	10 to 143 cm (0.3 to 4.69 ft)	42 to 167 cm (1.38 to 5.48 ft)

Comparison with parallel studies

- Marin County
- Sonoma County
- Adapt Monterey Bay Project (TNC)
- Local partners

Sea Level Rise Scenarios: Sonoma County

- Awaiting confirmed contract with Ocean Protection Council
- Analysis is focused on 2030, 2050, 2100 scenarios from NRC 2012 report.
- Obligation to look at "reasonable worst-case scenario"
- CoSMoS analysis expanding to coast in summer 2015

Overall, Sonoma would like to ensure agreement in scenario selection with neighboring counties in a representation that is easily understood by the public.

Sea Level Rise Scenarios: Marin County

40 different SLR scenarios

	No storm	Annual storm	20-year storm	100-year storm
0cm SLR	Baseline			
25cm SLR		*	*	
50cm SLR			*	
75cm SLR				
100cm SLR				*
125cm SLR				
150cm SLR				
175cm SLR				
200cm SLR				*
500cm SLR				

*** Marin County selected SLR scenarios**

Sea Level Rise Scenarios: Adapt Monterey Bay (TNC)

- Mid and high scenario for 2030, 2060, and 2100

Del Monte Beach, Monterey, Photo Credit: Dr. Philip King

The Nature Conservancy
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SLR Local Partner Input?

- Additional freeboard
- Update to FEMA flood maps
- Hazard Mitigation Plan Updates

(fl.stormsmart.org)

Monterey and Santa Cruz Scenarios and Impacts

Time horizon	Scenario	Rising tides	Coastal storm flood	Cliff Erosion				Dune Erosion			
				longterm		wstorm		longterm		wstorm	
				no change	stormier	no change	stormier	no change	stormier	no change	stormier
2030	Low										
	Mid										
	High										
2060	Low										
	Mid										
	High										
2100	Low (41cm)										
	Mid (88cm)										
	High (159cm)										

- **Erosion Projection**
  - **Longterm:** A continuation of historic erosion with additional erosion caused by sea level rise. Does not include potential impacts of a large storm
  - **Wstorm:** Includes long-term erosion and the potential erosion of a large storm event (e.g. 100-year storm)

- **Future erosion scenario**
  - **NoChange**: A continuation of existing wave climate
  - **Stormier:** Increased storminess (doubling of storm intensity in a decade)
  - ~~**Stopmining:** Stop sand mining (only applies to southern Monterey Bay)stormier~~

Process/Impact

Cliff Erosion

Dune erosion

Rising tides

Storm flood impacts

Cliff Erosion

- Cliffs- storms drive majority of the erosion impact

SLR scenarios play small role in cliff erosion rates

Larger storms = more erosion hazards

Rising Tides

Extreme SLR scenario predicts greater flooding after 2060

Coastal Storm flood

For Capitola - very little difference between years for scenario 3

For Capitola - very little difference between scenarios

Santa Cruz and Monterey Scenario Recommendations

Time horizon	Scenario	Rising tides	Coastal storm flood	Cliff Erosion				Dune Erosion			
				longterm		wstorm		longterm		wstorm	
				no change	stormier	no change	stormier	no change	stormier	no change	stormier
2030	Low										
	Mid	x	x				x			?	x
	High	?	?				?				?
2060	Low										
	Mid	x	x				x				x
	High	?	?				?				?
2100	Low (41cm)										
	Mid (88cm)	x	x				x				x
	High (159cm)	x	x				x				x

Precipitation assumptions for fluvial analysis?

- **A1, B1 (Cayan 2009)**
- **Plus or Minus 30%**
- **USGS 2013**

Impact Assessment Methodology

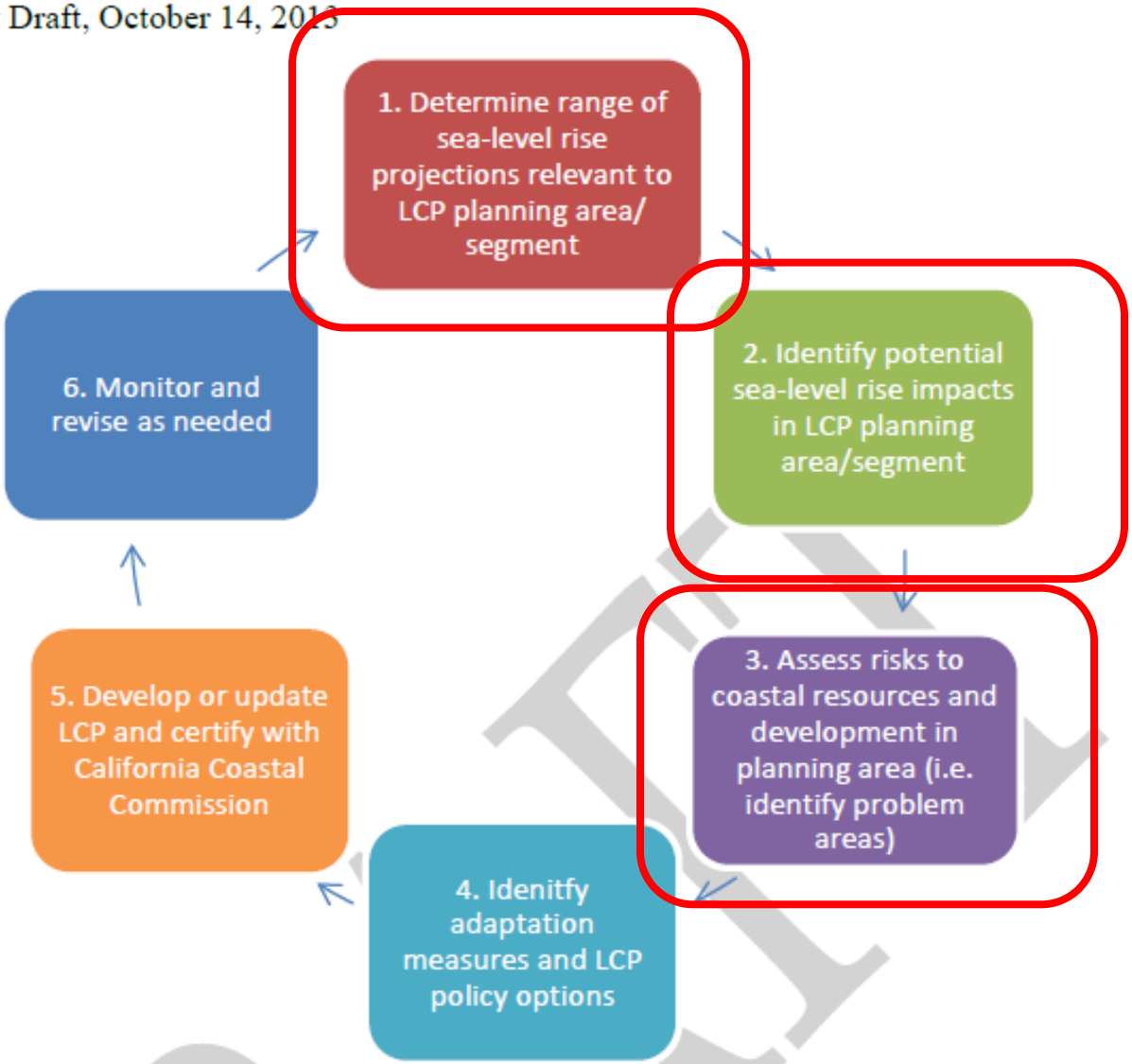


Figure 4. Sea-Level Rise Adaptation Planning Process for new and updated Local Coastal Programs

Impact Assessment Methodology

- **Step 1:** Vulnerability Assessment without coastal protection (all hazards)
- **Step 2:** Integrate coastal protection layer- assume structures protect for period of time
- **Step 3:** Project future coastal structure failure w/wo replacement (2030, 2060, 2100)
- **Step 4:** Assess relative risk level using aggregate hazard data layer (number of scenarios impacting)

Possible GIS Data Layers for Analyses

Infrastructure
- Roads/highways/bridges
- Utilities
- Water control structures
- Emergency service
- Schools
- Contaminated sites

Land Uses
- Parks
- Coastal Access
- Property boundaries /parcels
- Easements
- Beaches
- Wetlands
- Dunes
- Industry
- FEMA - Repetitive Loss Inventories

Coastal Structures
- Sea Walls
- Revetments
- Breakwaters/groins
- Levees

Resources
- Urban Development footprints
- LCP planning designations
- GP growth boundaries
- Redevelopment Zones
- River mouth habitats
- ESHA
- Prime Ag Land
- ASBS
- Cultural resources

Social Vulnerability
- Demographic overlays
- Disadvantaged community

Subset of GIS Data Layers Used for Example Analysis

Hazard Layers

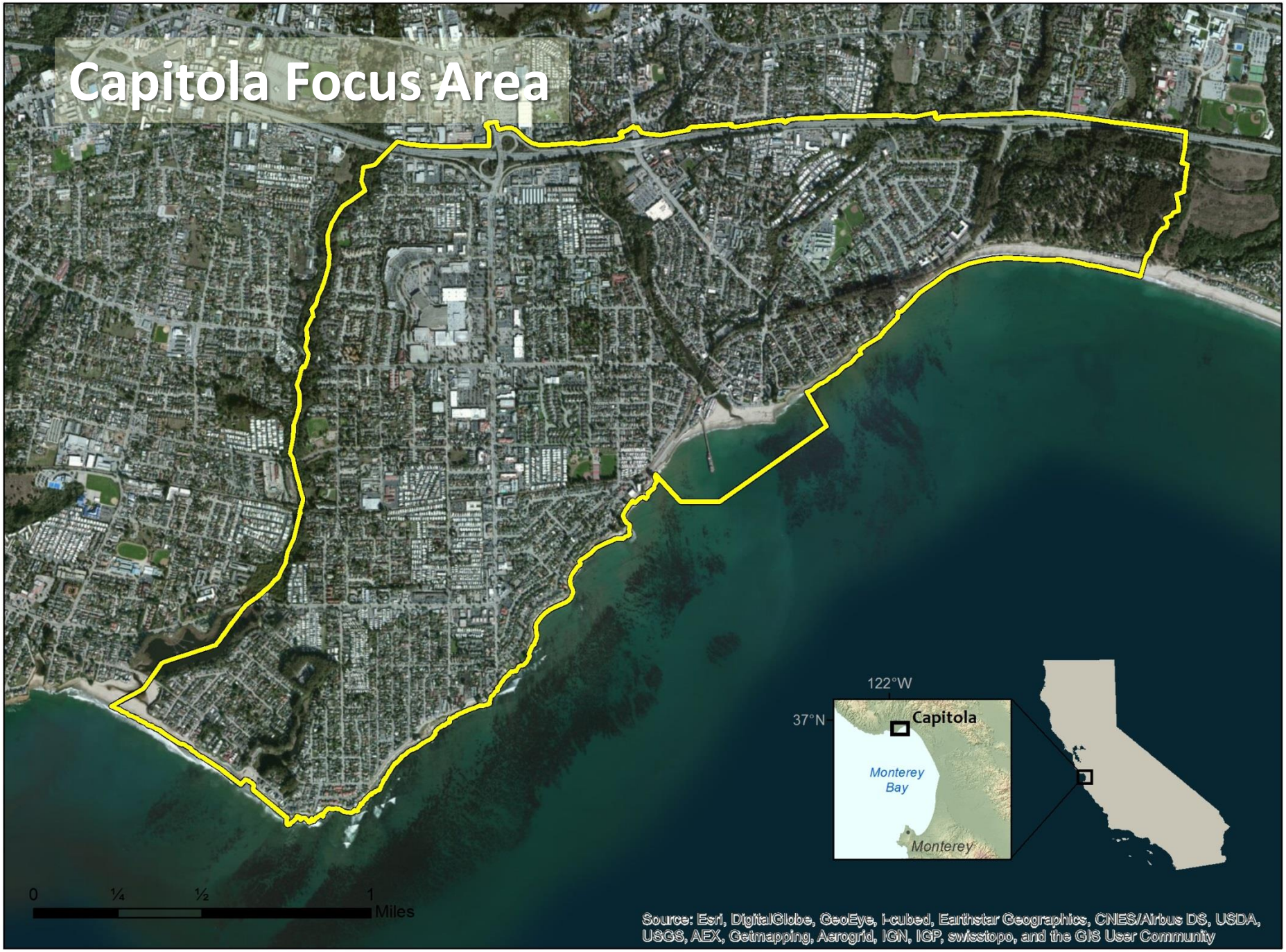
- Dune Erosion
- Cliff Erosion
- Rising Tides
- Coastal Storm Flooding

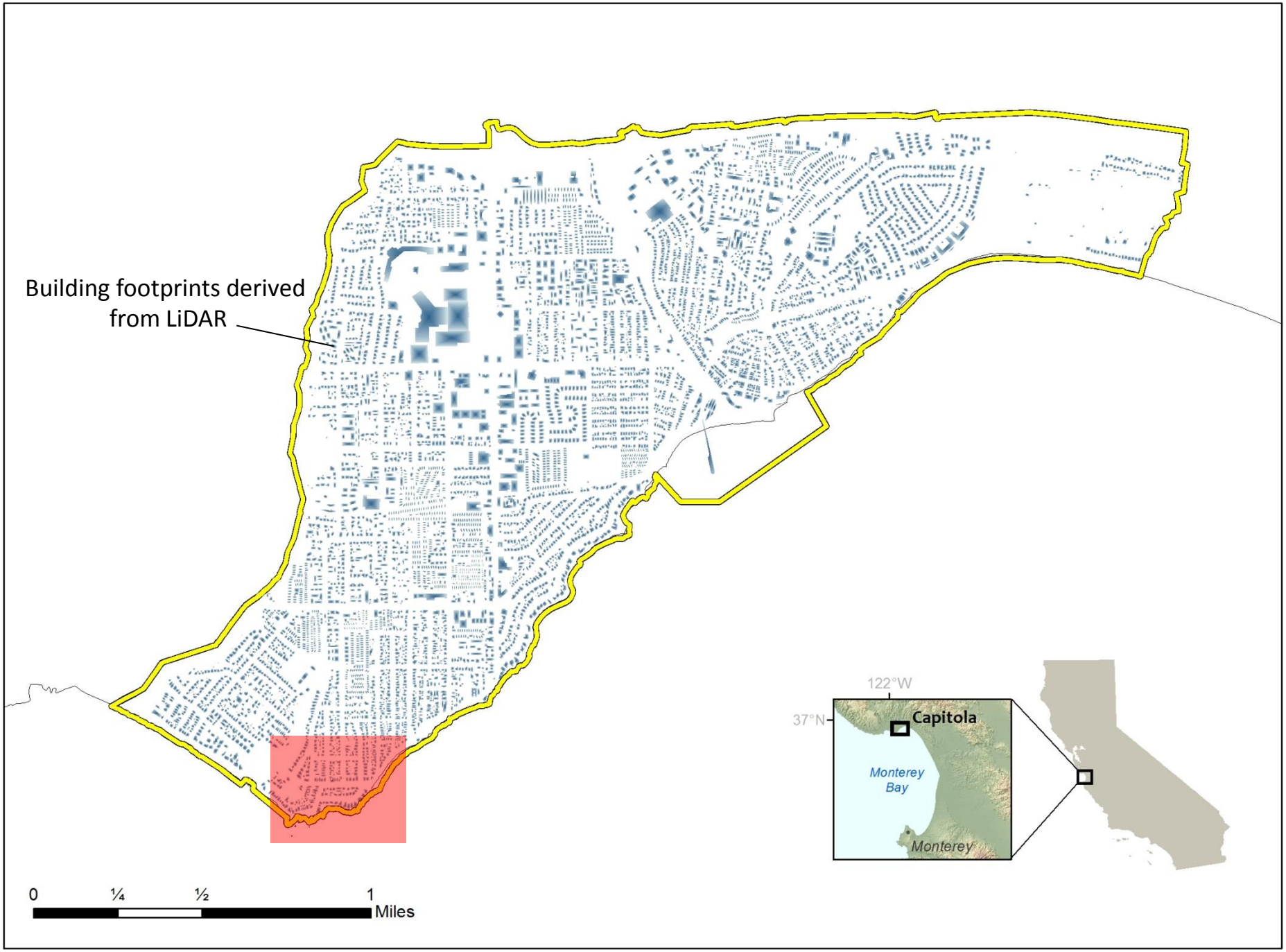
Land Use Layers

- Building Footprints
- Agricultural
- Coastal Protection Structures

Walk through of Analysis

- Goal: to identify and inventory potential land use threats given SLR hazard model results
- Focus Area: Capitola (cliff erosion, tides, storm flooding) and Moss Landing (rising tides)
- Base Layers subset: building footprints, agriculture lands
- Time Horizons: Existing condition, 2030, 2060, 2100
- Hydrologic connectivity (select all areas that are hydraulically disconnected or uncertain) are they connected or not by water control structures


Capitola Focus Area
122°W
37°N
Capitola
Monterey Bay
Monterey
0
¼
½
1
Miles
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Building footprints derived from LiDAR
122°W
37°N
Capitola
Monterey Bay
Monterey
0
¼
½
1
Miles


0
400 Feet
0
100 Meters
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


SCRIVER
HAWES
MADRONE
37TH
MANZANITA
FRESNO
BAKER
LAKEVIEW
PERALTA
ANCHORAGE
30TH
34TH
35TH
36TH
SAINT DEYNS
MORAN
PALISADES
CALLA
33RD
32ND
CLIFF
CHESTERFIELD
PALISADES
ROCKVIEW
PLEASURE POINT
Legend
Predicted Cliff Erosion
2030
2060
2100
Existing Shoreline (MHW)
Structure Threatened
0
400 Feet
0
100 Meters
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


SCRIVER
HAWES
MADRONE
37TH
MANZANITA
FRESNO
BAKER
LAKEVIEW
PERALTA
ANCHORAGE
30TH
34TH
35TH
36TH
SAINT DEYNS
MORAN
PALISADES
CALLA
33RD
32ND
CLIFF
CHESTERFIELD
PALISADES
ROCKVIEW
PLEASURE POINT
Legend
Predicted Cliff Erosion
2030
2060
2100
Existing Shoreline (MHW)
Structure Threatened
0
400 Feet
0
100 Meters
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


SCRIVER
HAWES
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37TH
MANZANITA
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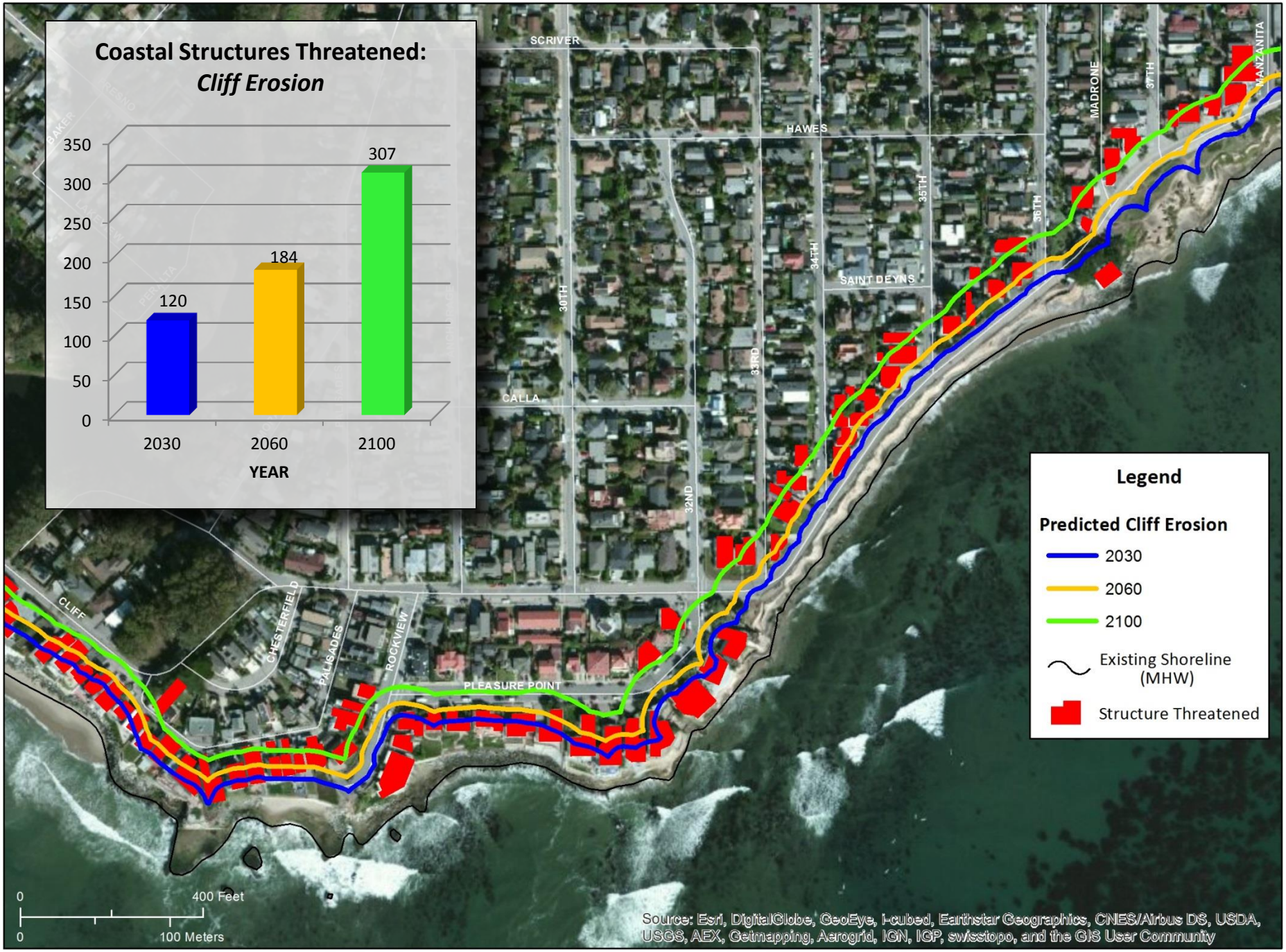
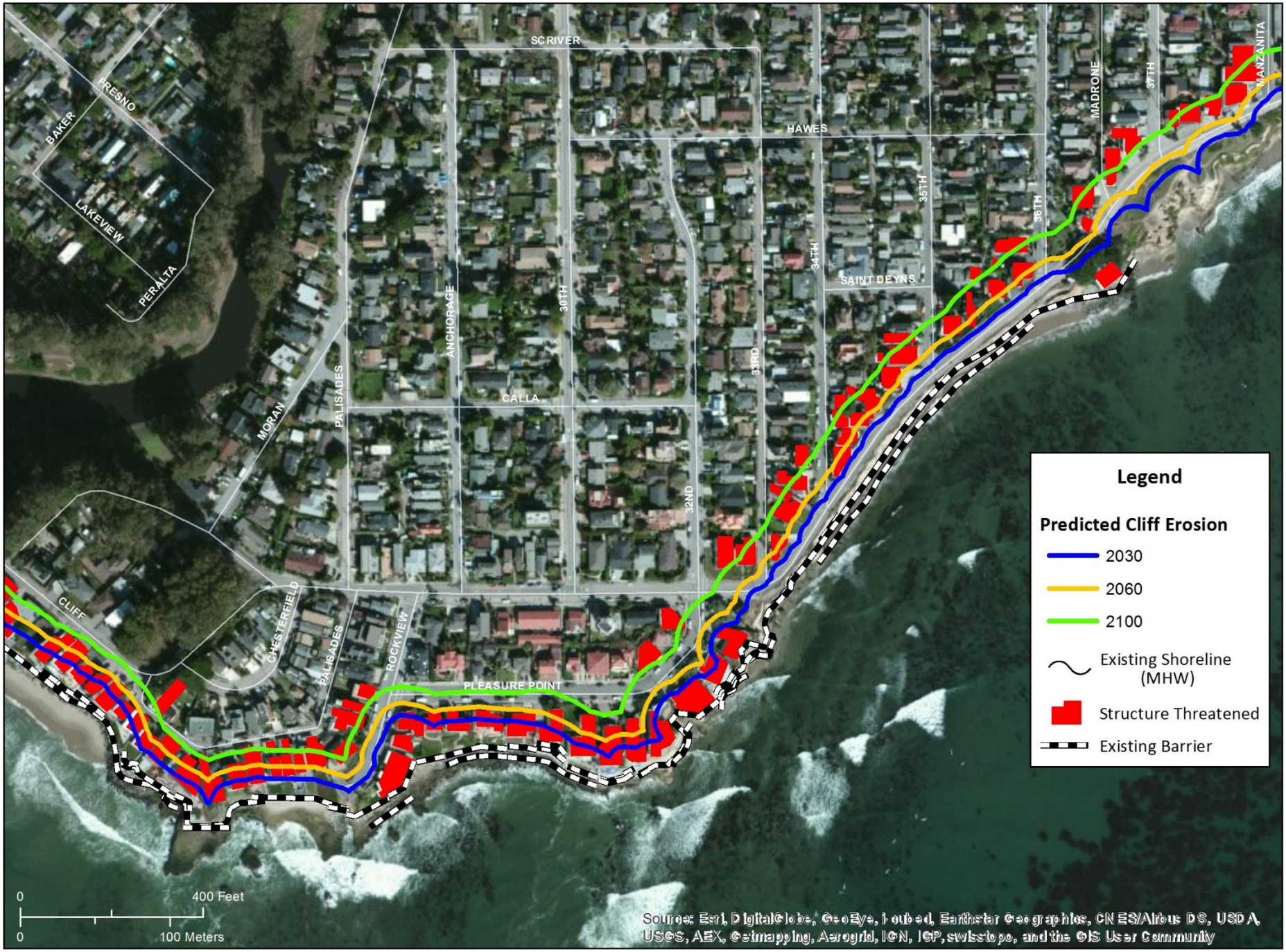
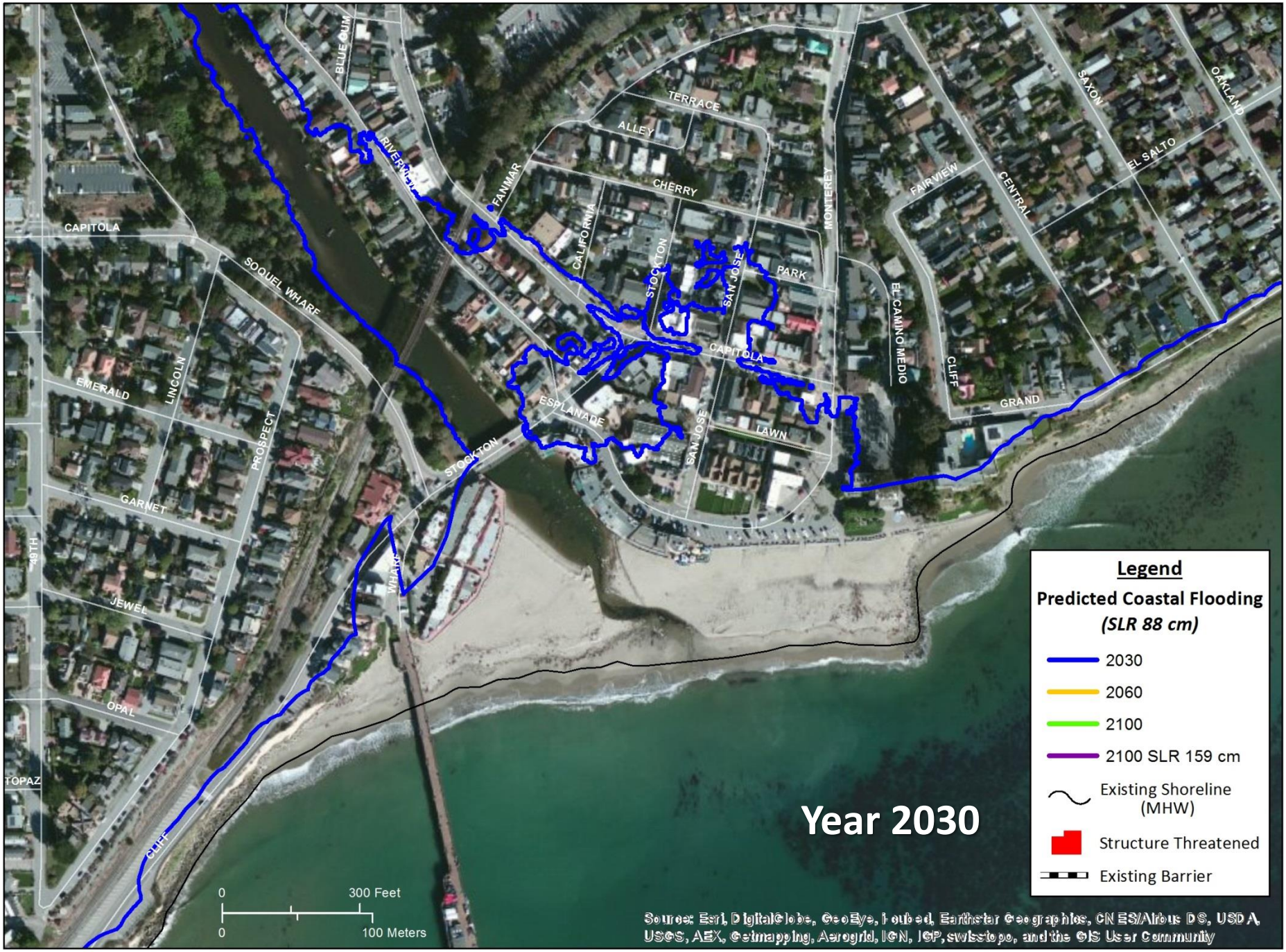
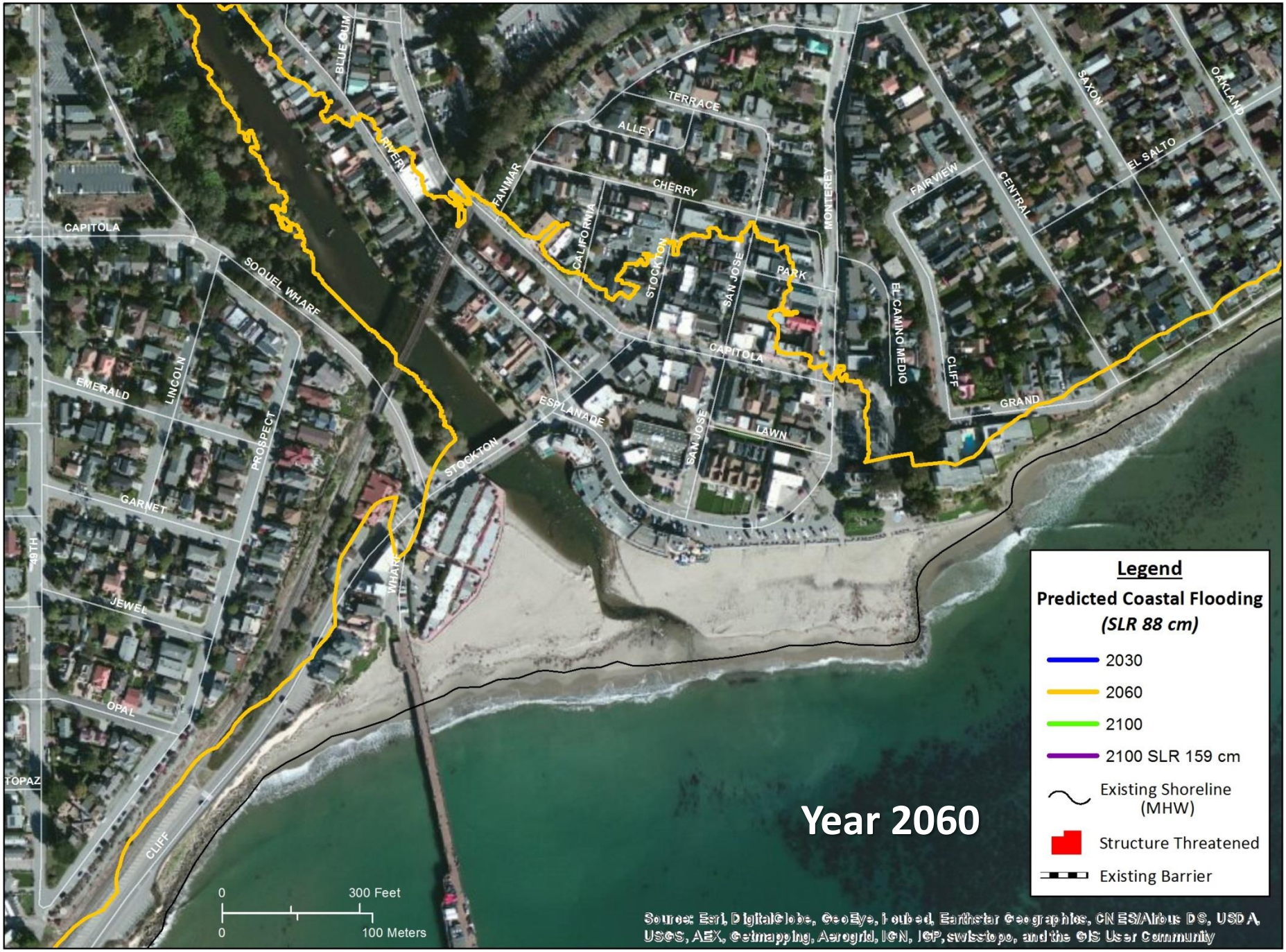
LAKEVIEW
PERALTA
ANCHORAGE
30TH
34TH
35TH
36TH
SAINT DEYNS
MORAN
PALISADES
CALLA
33RD
32ND
CLIFF
CHESTERFIELD
PALISADES
ROCKVIEW
PLEASURE POINT
Legend
Predicted Cliff Erosion
2030
2060
2100
Existing Shoreline (MHW)
Structure Threatened
0
400 Feet
0
100 Meters
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Coastal Structures Threatened:
Cliff Erosion
350
300
250
200
150
100
50
0
120
184
307
2030
2060
2100
YEAR
SCRIVER
HAWES
MADRONE
37TH
MANZANITA
35TH
36TH
34TH
SAINT DEYNS
30TH
33RD
CALLA
32ND
CLIFF
CHESTERFIELD
PALISADES
ROCKVIEW
PLEASURE POINT
Legend
Predicted Cliff Erosion
2030
2060
2100
Existing Shoreline (MHW)
Structure Threatened
0
400 Feet
0
100 Meters
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


SCRIVER
HAWES
MADRONE
37TH
MANZANITA
FRESNO
BAKER
LAKEVIEW
PERALTA
ANCHORAGE
30TH
34TH
35TH
36TH
SAINT DEYNS
MORAN
PALISADES
CALLA
33RD
32ND
CLIFF
CHESTERFIELD
PALISADES
ROCKVIEW
PLEASURE POINT
Legend
Predicted Cliff Erosion
2030
2060
2100
Existing Shoreline (MHW)
Structure Threatened
Existing Barrier
0
400 Feet
0
100 Meters
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

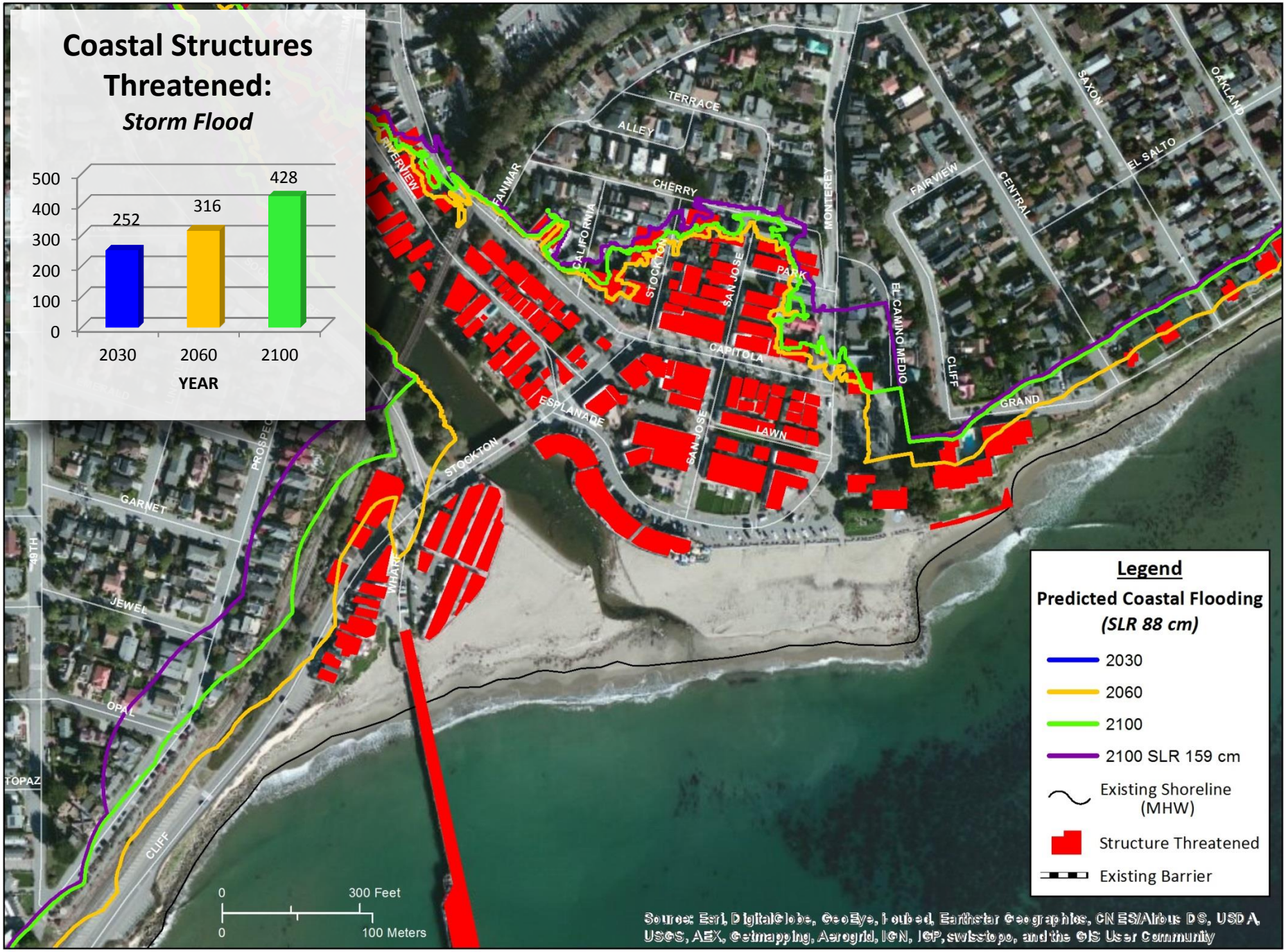

BLUFF
RIVER
TERRACE
ALLEY
CHERRY
FANMAR
CALIFORNIA
STOCKTON
SAN JOSE
PARK
MONTEREY
FAIRVIEW
CENTRAL
SAXON
EL SALTO
OAKLAND
CAPITOLA
SOQUEL WHARF
EL CAMINO MEDIO
CLIFF
GRAND
LAWN
ESPLANADE
EMERALD
LINCOLN
PROSPECT
GARNET
JEWEL
OPAL
TOPAZ
49TH
WHARF
0
300 Feet
0
100 Meters
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Legend
Predicted Coastal Flooding
(SLR 88 cm)
2030
2060
2100
2100 SLR 159 cm
Existing Shoreline (MHW)
Structure Threatened
Existing Barrier
Year 2030
0
300 Feet
0
100 Meters
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
CAPITOLA
SOQUEL WHARF
EMERALD
LINCOLN
PROSPECT
GARNET
JEWEL
OPAL
TOPAZ
49TH
CLIFF
STOCKTON
WHARF
ESPLANADE
SAN JOSE
LAWN
PARK
CAPITOLA
CHERRY
TERRACE
ALLEY
FANMAR
CALIFORNIA
STOCKTON
SAN JOSE
MONTEREY
EL CAMINO MEDIO
CLIFF
GRAND
FAIRVIEW
CENTRAL
EL SALTO
SAXON
OAKLAND
BLUE GUM


Year 2060
Legend
Predicted Coastal Flooding
(SLR 88 cm)
2030
2060
2100
2100 SLR 159 cm
Existing Shoreline (MHW)
Structure Threatened
Existing Barrier
0
300 Feet
0
100 Meters
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
CAPITOLA
SOQUEL WHARF
EMERALD
LINCOLN
PROSPECT
GARNET
JEWEL
OPAL
TOPAZ
49TH
CLIFF
STOCKTON
WHARF
ESPLANADE
SAN JOSE
LAWN
PARK
CALIFORNIA
STOCKTON
SAN JOSE
CAPITOLA
CHERRY
ALLEY
TERRACE
FANMAR
MONTEREY
EL CAMINO MEDIO
CLIFF
GRAND
FAIRVIEW
CENTRAL
EL SALTO
SAXON
OAKLAND
BLUE GUM
RIVER

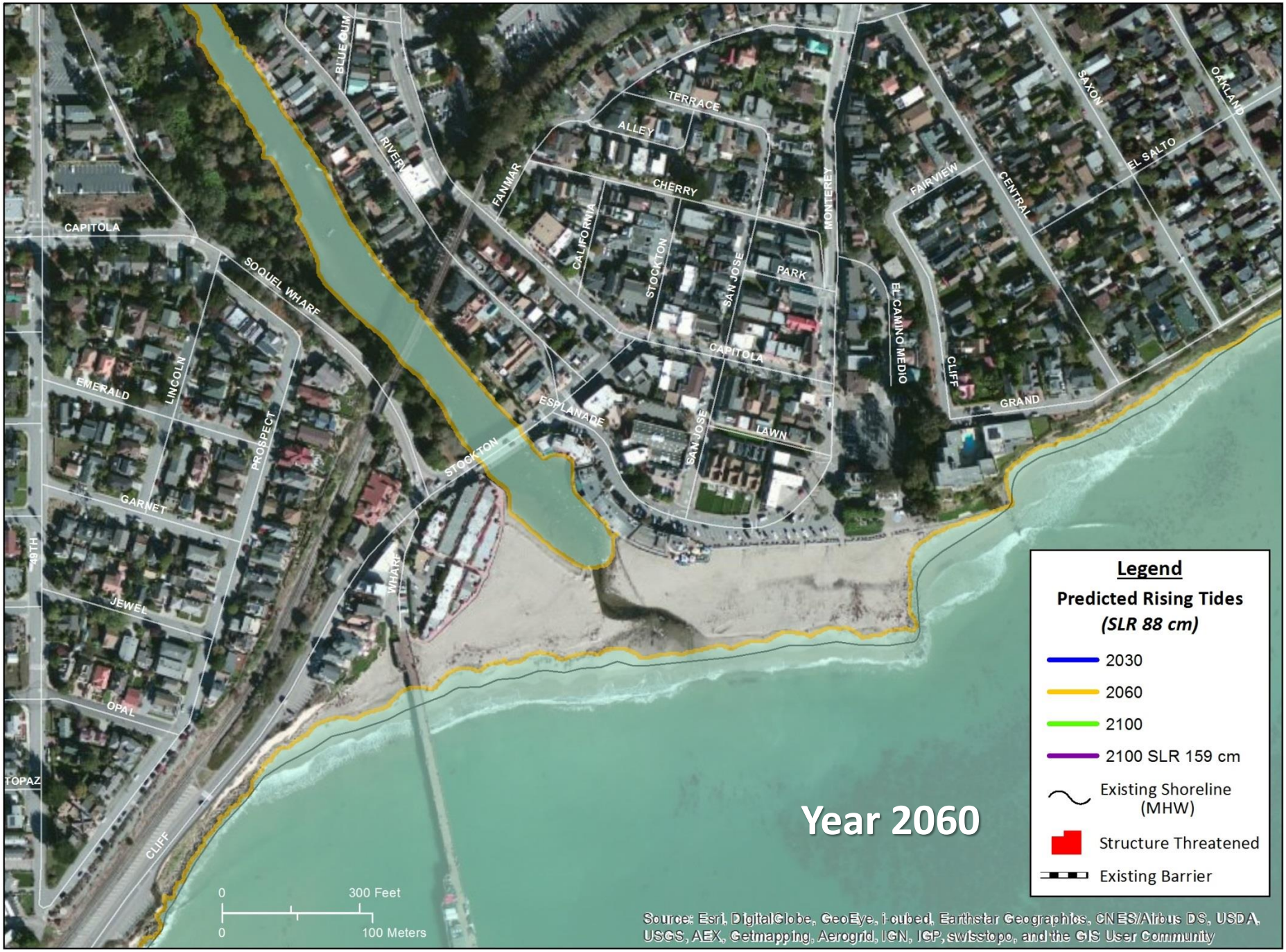

Year 2100
Legend
Predicted Coastal Flooding
(SLR 88 cm)
2030
2060
2100
2100 SLR 159 cm
Existing Shoreline (MHW)
Structure Threatened
Existing Barrier
0
300 Feet
0
100 Meters
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
CAPITOLA
SOQUEL WHARF
EMERALD
LINCOLN
PROSPECT
GARNET
JEWEL
OPAL
TOPAZ
49TH
CLIFF
STOCKTON
WHARF
ESPLANADE
SAN JOSE
LAWN
PARK
CALIFORNIA
STOCKTON
SAN JOSE
CAPITOLA
CHERRY
ALLEY
TERRACE
RIVER
BLUE GUM
FANMAR
MONTEREY
EL CAMINO MEDIO
CLIFF
GRAND
FAIRVIEW
CENTRAL
EL SALTO
SAXON
OAKLAND


BLUFF
RIVER
TERRACE
ALLEY
FANMAR
CHERRY
CALIFORNIA
STOCKTON
SAN JOSE
PARK
MONTEREY
FAIRVIEW
CENTRAL
SAXON
EL SALTO
OAKLAND
CAPITOLA
SOQUEL WHARF
EL CAMINO MEDIO
CLIFF
GRAND
EMERALD
LINCOLN
PROSPECT
ESPLANADE
LAWN
GARNET
49TH
WHARF
JEWEL
OPAL
TOPAZ
0
300 Feet
0
100 Meters
Legend
Predicted Coastal Flooding
(SLR 88 cm)
2030
2060
2100
2100 SLR 159 cm
Existing Shoreline (MHW)
Structure Threatened
Existing Barrier
Year 2100
SLR 159 cm
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

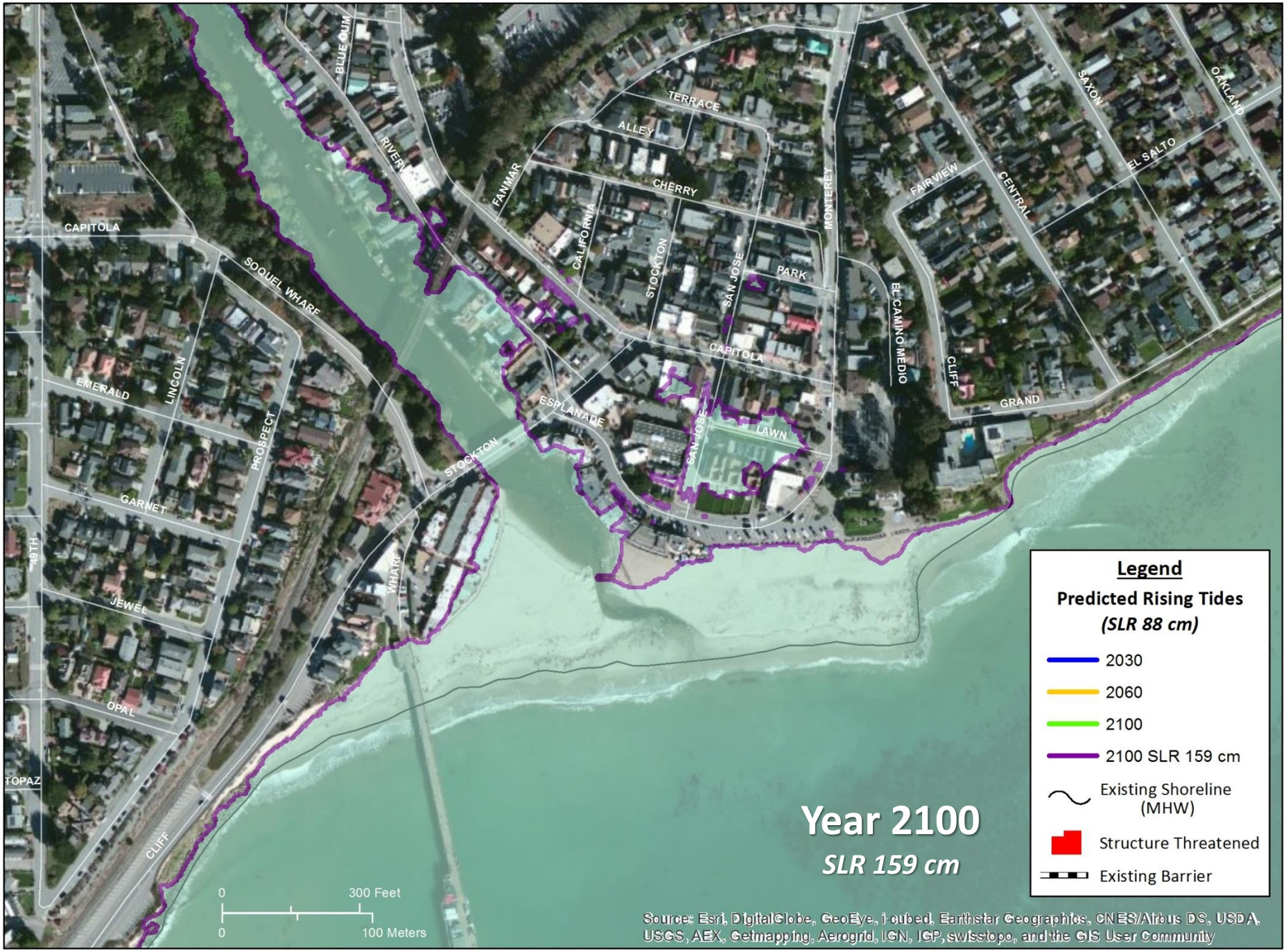

Coastal Structures Threatened:
Storm Flood
500
400
300
200
100
0
252
316
428
2030
2060
2100
YEAR
TERRACE
ALLEY
CHERRY
FANMAR
CALIFORNIA
STOCKTON
SAN JOSE
PARK
MONTEREY
FAIRVIEW
CENTRAL
EL SALTO
SAXON
OAKLAND
EL CAMINO MEDIO
CLIFF
GRAND
CAPITOLA
ESPLANADE
LAWN
WHARF
GARNET
JEWEL
OPAL
TOPAZ
49TH
PROSPECT
0
300 Feet
0
100 Meters
Legend
Predicted Coastal Flooding
(SLR 88 cm)
2030
2060
2100
2100 SLR 159 cm
Existing Shoreline (MHW)
Structure Threatened
Existing Barrier
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

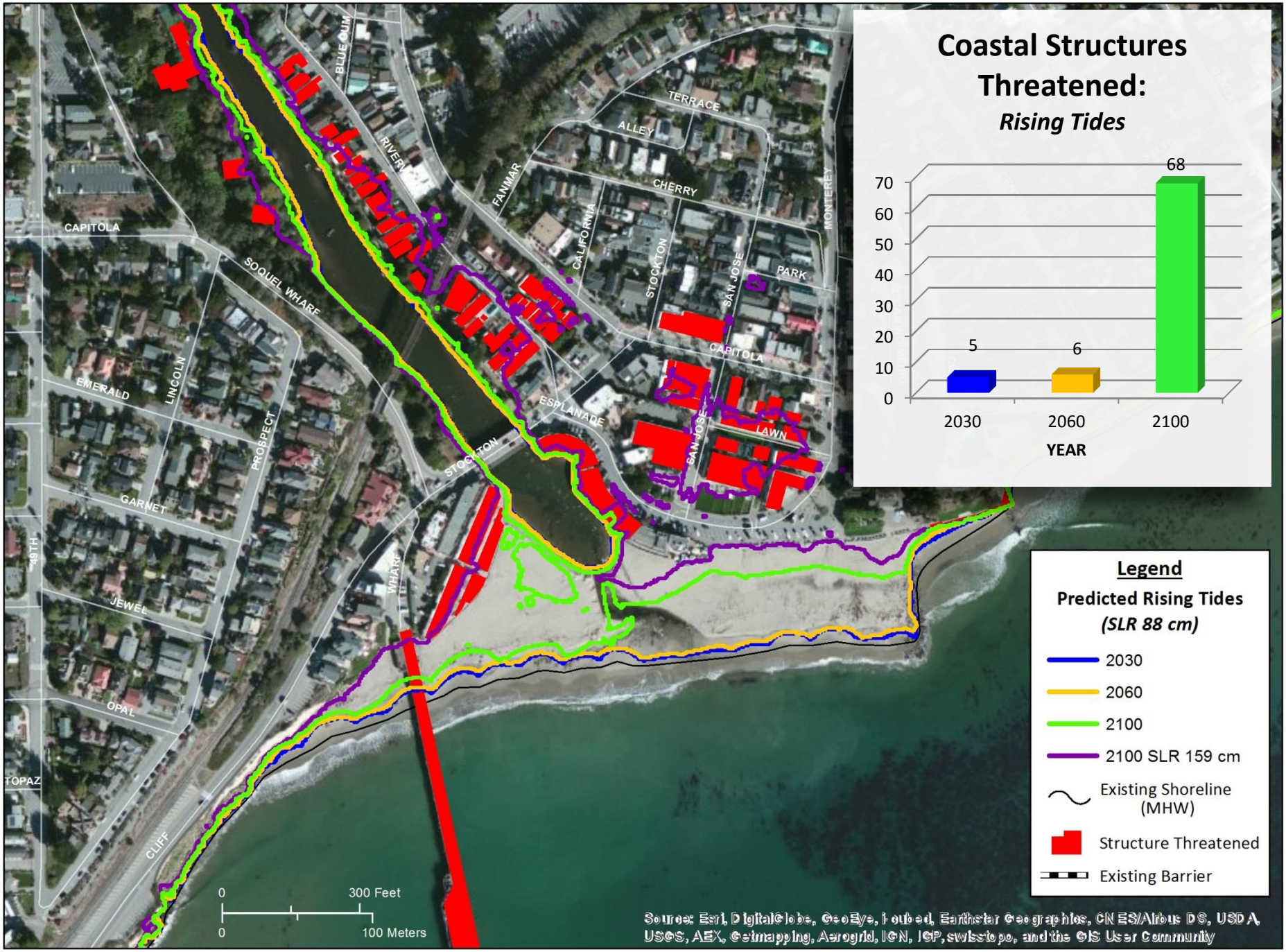

Legend
Predicted Coastal Flooding
(SLR 88 cm)
2030
2060
2100
2100 SLR 159 cm
Existing Shoreline (MHW)
Structure Threatened
Existing Barrier
0
300 Feet
0
100 Meters
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
CAPITOLA
SOQUEL WHARF
EMERALD
LINCOLN
PROSPECT
GARNET
JEWEL
OPAL
TOPAZ
CLIFF
49TH
BLUE GUM
RIVERVIEW
TERRACE
ALLEY
CHERRY
FANMAR
CALIFORNIA
STOCKTON
SAN JOSE
PARK
MONTEREY
FAIRVIEW
CENTRAL
EL SALTO
SAXON
OAKLAND
EL CAMINO MEDIO
CLIFF
GRAND
ESPLANADE
LAWN
WHARF


Legend
Predicted Rising Tides
(SLR 88 cm)
2030
2060
2100
2100 SLR 159 cm
Existing Shoreline (MHW)
Structure Threatened
Existing Barrier
Year 2030
0
300 Feet
0
100 Meters
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
CAPITOLA
SOQUEL WHARF
EMERALD
LINCOLN
PROSPECT
GARNET
JEWEL
OPAL
TOPAZ
CLIFF
49TH
BLUFF
RIVER
TERRACE
ALLEY
CHERRY
FANMAR
CALIFORNIA
STOCKTON
SAN JOSE
PARK
MONTEREY
ESPLANADE
LAWN
EL CAMINO MEDIO
FAIRVIEW
CENTRAL
SAXON
EL SALTO
OAKLAND
GRAND
WHARF


Legend
Predicted Rising Tides
(SLR 88 cm)
2030
2060
2100
2100 SLR 159 cm
Existing Shoreline (MHW)
Structure Threatened
Existing Barrier
Year 2060
0
300 Feet
0
100 Meters
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
CAPITOLA
SOQUEL WHARF
EMERALD
LINCOLN
PROSPECT
GARNET
JEWEL
OPAL
TOPAZ
CLIFF
49TH
WHARF
STOCKTON
ESPLANADE
BLUE GUM
RIVER
TERRACE
ALLEY
CHERRY
FANMAR
CALIFORNIA
STOCKTON
SAN JOSE
PARK
MONTEREY
EL CAMINO MEDIO
CAPITOLA
SAN JOSE
LAWN
CLIFF
GRAND
FAIRVIEW
CENTRAL
EL SALTO
SAXON
OAKLAND


Year 2100
Legend
Predicted Rising Tides
(SLR 88 cm)
2030
2060
2100
2100 SLR 159 cm
Existing Shoreline (MHW)
Structure Threatened
Existing Barrier
0
300 Feet
0
100 Meters
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
CAPITOLA
SOQUEL WHARF
EMERALD
LINCOLN
PROSPECT
GARNET
JEWEL
OPAL
TOPAZ
CLIFF
49TH
STOCKTON
WHARF
ESPLANADE
BLUFF
RIVER
TERRACE
ALLEY
CHERRY
FANMAR
CALIFORNIA
STOCKTON
SAN JOSE
PARK
MONTEREY
EL CAMINO MEDIO
LAWN
FAIRVIEW
CENTRAL
SAXON
EL SALTO
OAKLAND
GRAND


BLUE GUM
RIVER
TERRACE
ALLEY
CHERRY
FANMAR
CALIFORNIA
STOCKTON
SAN JOSE
PARK
MONTEREY
FAIRVIEW
CENTRAL
SAXON
EL SALTO
OAKLAND
CAPITOLA
SOQUEL WHARF
EL CAMINO MEDIO
CLIFF
GRAND
EMERALD
LINCOLN
PROSPECT
ESPLANADE
LAWN
GARNET
49TH
WHARF
JEWEL
OPAL
TOPAZ
0
300 Feet
0
100 Meters
Year 2100
SLR 159 cm
Legend
Predicted Rising Tides
(SLR 88 cm)
2030
2060
2100
2100 SLR 159 cm
Existing Shoreline
(MHW)
Structure Threatened
Existing Barrier
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Coastal Structures Threatened:
Rising Tides
70
60
50
40
30
20
10
0
5
6
68
2030
2060
2100
YEAR
Legend
Predicted Rising Tides
(SLR 88 cm)
2030
2060
2100
2100 SLR 159 cm
Existing Shoreline (MHW)
Structure Threatened
Existing Barrier
0
300 Feet
0
100 Meters
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
CAPITOLA
SOQUEL WHARF
EMERALD
LINCOLN
PROSPECT
GARNET
JEWEL
OPAL
TOPAZ
CLIFF
49TH
BLUFF
RIVER
TERRACE
ALLEY
CHERRY
FANMAR
CALIFORNIA
STOCKTON
SAN JOSE
PARK
MONTEREY
ESPLANADE
LAWN
WHARF

Moss Landing Focus Area

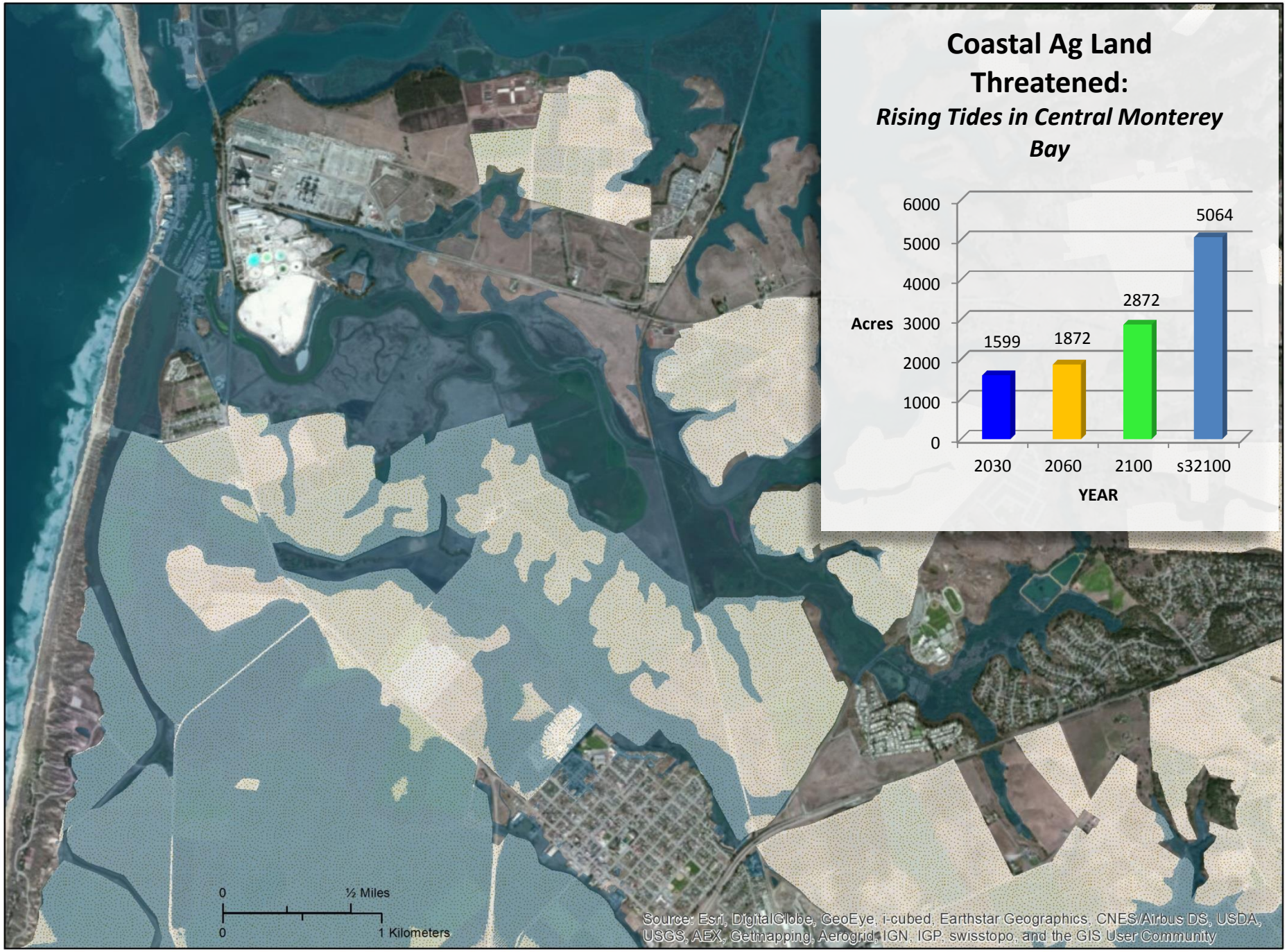

Agricultural Land
0
½ Miles
0
1 Kilometers
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Rising Tides:
Year 2030
0
½ Miles
0
1 Kilometers
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Rising Tides:
Year 2060
0
½ Miles
0
1 Kilometers
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Rising Tides:
Year 2100
0
½ Miles
0
1 Kilometers
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Rising Tides:
Year 2100
SLR 159 cm
0
½ Miles
0
1 Kilometers
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Coastal Ag Land Threatened:
Rising Tides in Central Monterey Bay
6000
5000
4000
3000
2000
1000
0
Acres
1599
1872
2872
5064
2030
2060
2100
s32100
YEAR
0
½ Miles
0
1 Kilometers
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Questions for Discussion:

- Proposed SLR Scenario selection (agree?)
- How can vulnerability reports best aid counties and coastal commission?
- How is it most useful to break down these analyses?(county, LCP, city, etc.)
- How do we determine threshold of vulnerability?
- How do we determine when coastal protection structures fail?
- If we assume protection structures fail, do we then assume they are replaced?

Next Steps

- TAC Review of Draft Methodology Document
- Next TAC meeting: Summer?
  - Risk and adaptive capacity
  - Adaptation responses

Risk and Adaptive Capacity

Risk= Consequence x Likelihood
Consequence= Impacts x Adaptive Capacity

- **Impact:**
  - Temporary event
  - Replacement
  - Total Loss
- **Adaptive Capacity**
  - Based on current coastal protection
  - Adaptive design
- **Likelihood**
  - #of scenarios and time horizons

Adaptation Response Evaluation

Coastal Vulnerability Process	Response Option	Longevity	Cost	Secondary Consequences	Legal hurdles
Coastal Storm Flooding	Wall (protect)				
	Sand barriers				
	Raise house (adapt)				
Bluff/sandy shore Erosion	Wall (protect)				
	Sand barriers				
Cliff erosion	Wall (protect)				
	Sand barriers				
Tidal flooding	Wall (protect)				
	Sand barriers				
Wave impact	Wall (protect)				
	Sand barriers