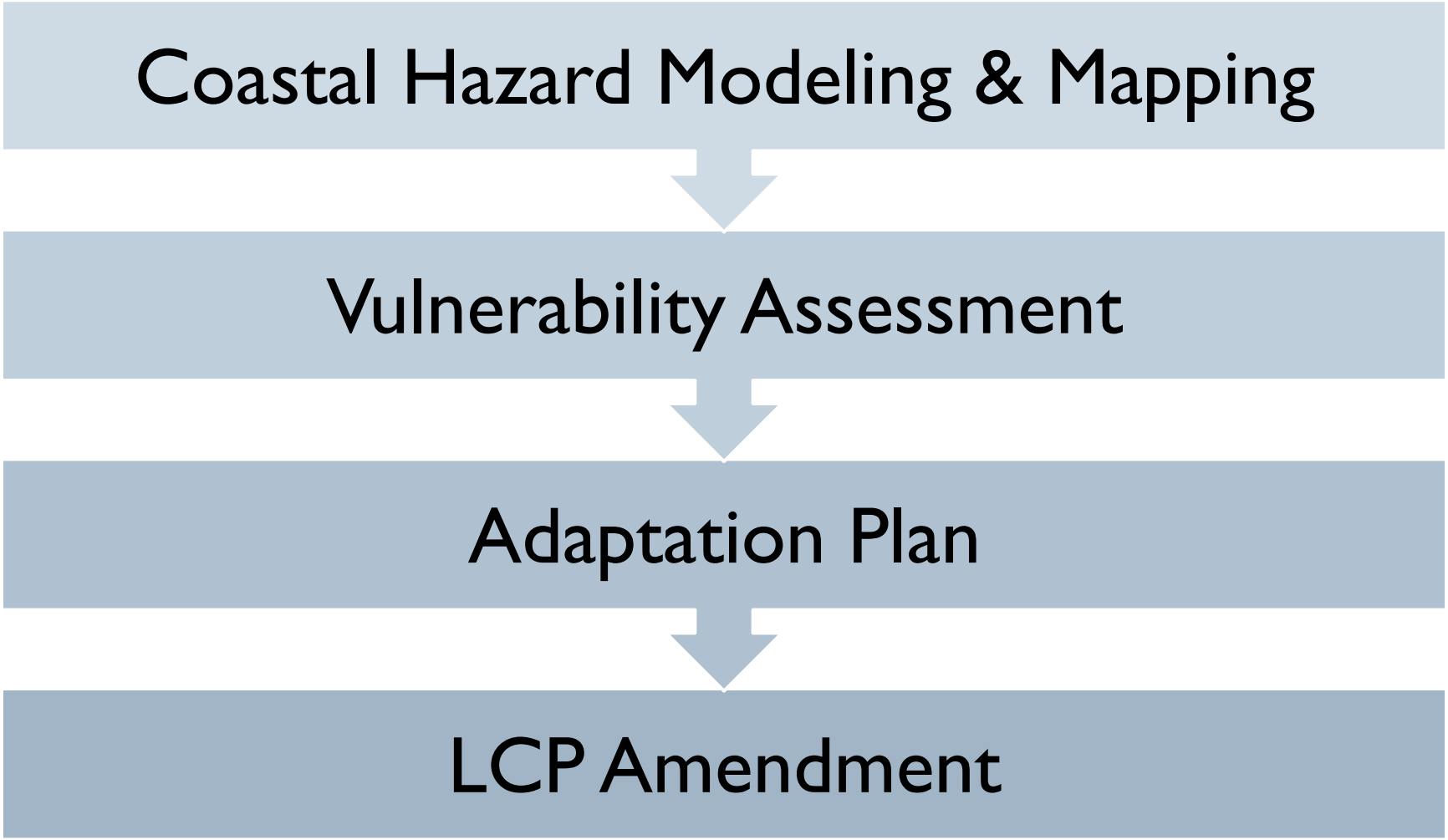
Santa Barbara County Coastal Resiliency Project



Phase 1 Project Background

- Funded by the Coastal Conservancy's Climate Ready Grant Program
- Project Initiated:
  July 2014
- Proposed Completion:
  December 2015

Photo David Revell

Phase 1 Scope of Work

- Task 1 – Project Kick Off Meeting
- Task 2 – Stakeholder Meetings
- Task 3 – Develop Regional Resource Databases
- Task 4 – Model Coastal Hazards with Climate Scenarios
- Task 5 – Develop Policy & Planning Tool Database
- Task 6 – Analyze Social, Economic & Ecological Conditions
- Task 7 – Prepare a Coastal Hazard Vulnerability Assessment

Coastal Hazard Modeling & Mapping

- Working with ESA and Revell Coastal
- Based on The Nature Conservancy's *Building Coastal Resilience for Disaster Risk Reduction and Climate Adaptation* project.

Santa Barbara County Coastal Resiliency Project - Phase 1

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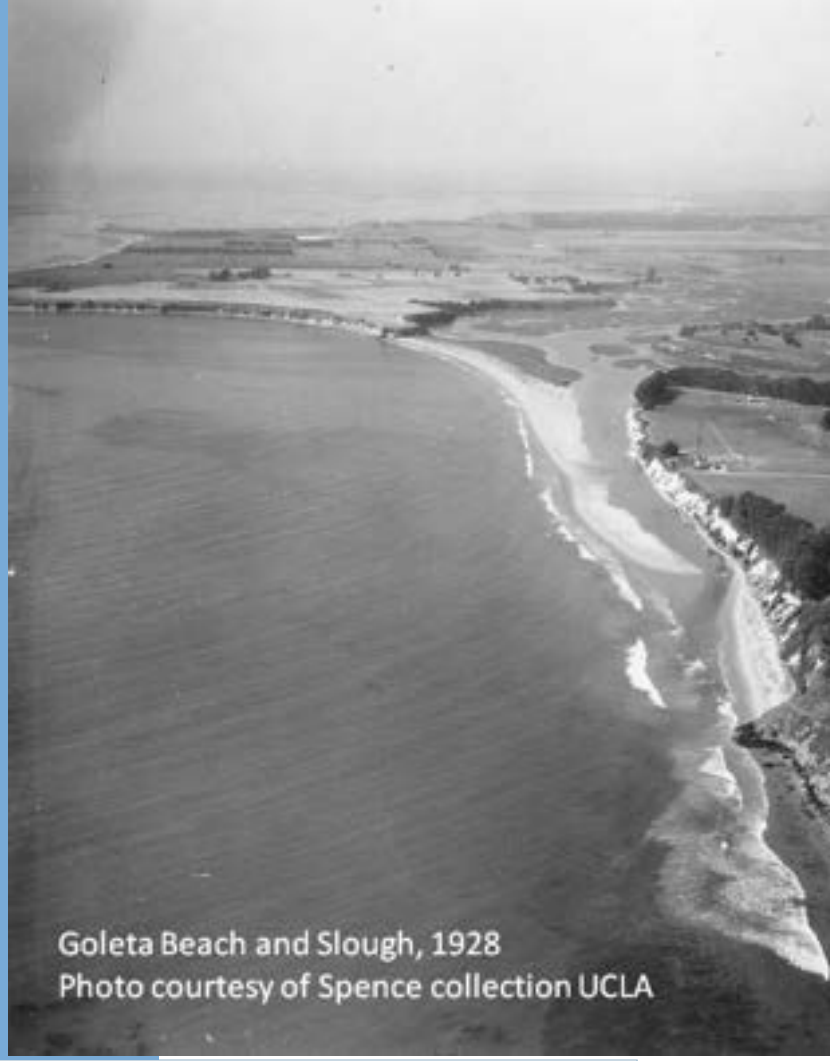


Goleta Beach and Slough, 1928
Photo courtesy of Spence collection UCLA

ESA

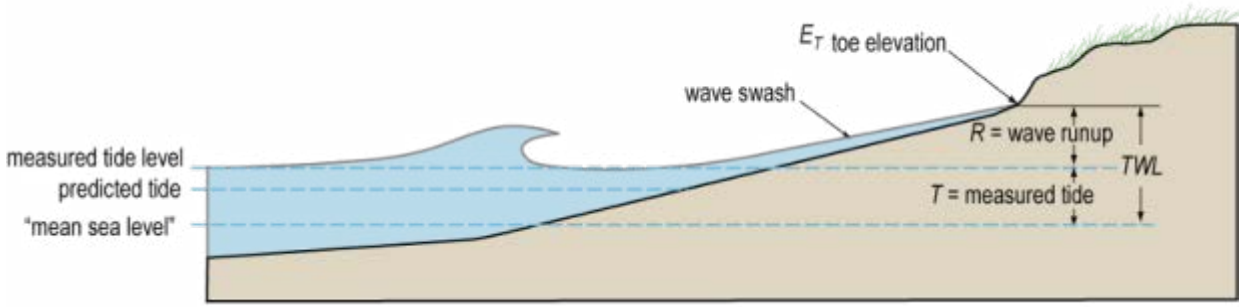
State of California Coastal Conservancy

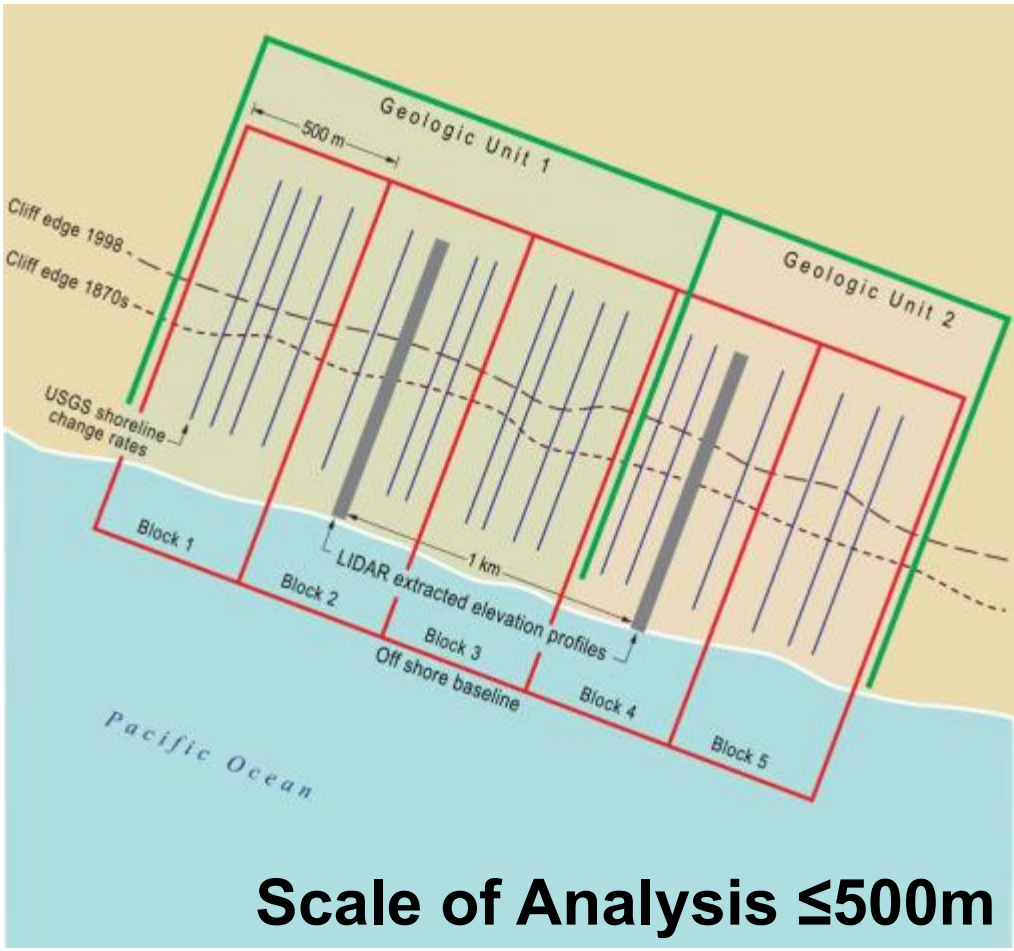
The Nature Conservancy
Protecting nature. Preserving life.

Revell Coastal

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





ESA PWA

Outputs

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

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

3. Wave Velocity
   zone of wave momentum (similar to FEMA V-Zone)

1. Rising Tides
   inundation during monthly extreme tides [not shown]

Selected Conditions

Planning Horizons

Sea Level Rise

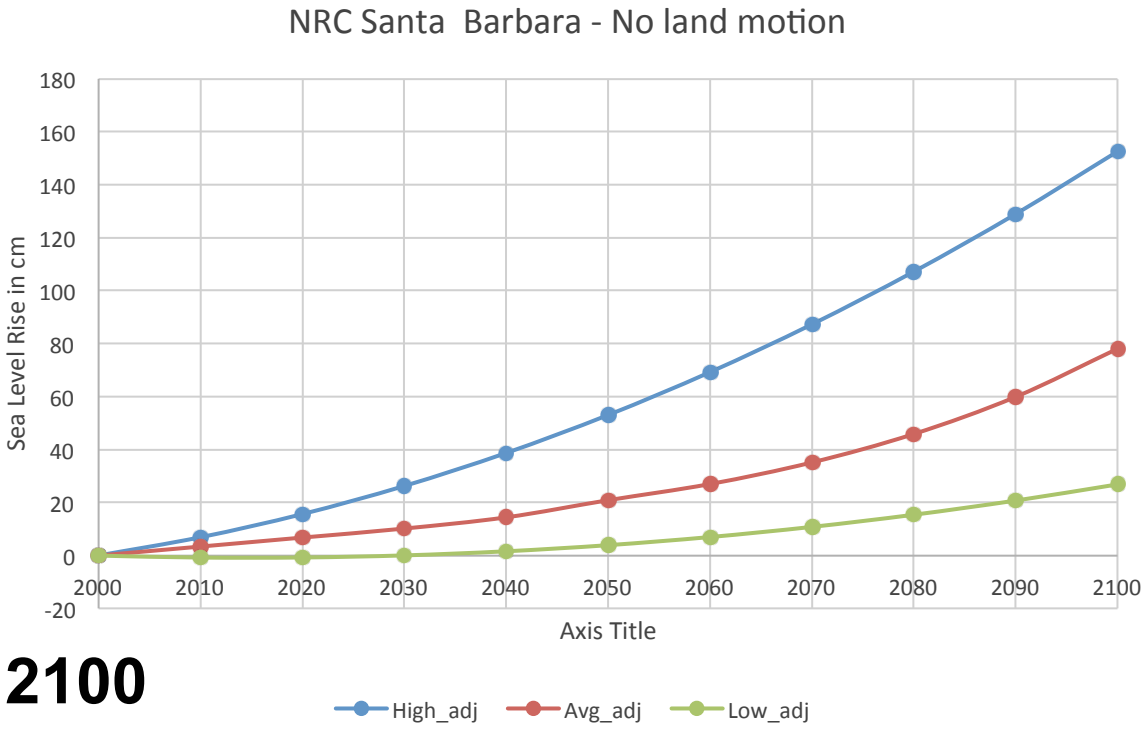
Lagoon Management

Coastal Armoring

Sediment Management

Photo Courtesy Dr. Mark Morey

Scenarios



Planning Horizons:

- 2010, 2030, 2060, 2100

Sea Level Rise:

- **High: 1.52 meters by 2100**
- Medium: 0.78 meters by 2100
- Low: 0.27 meters by 2100

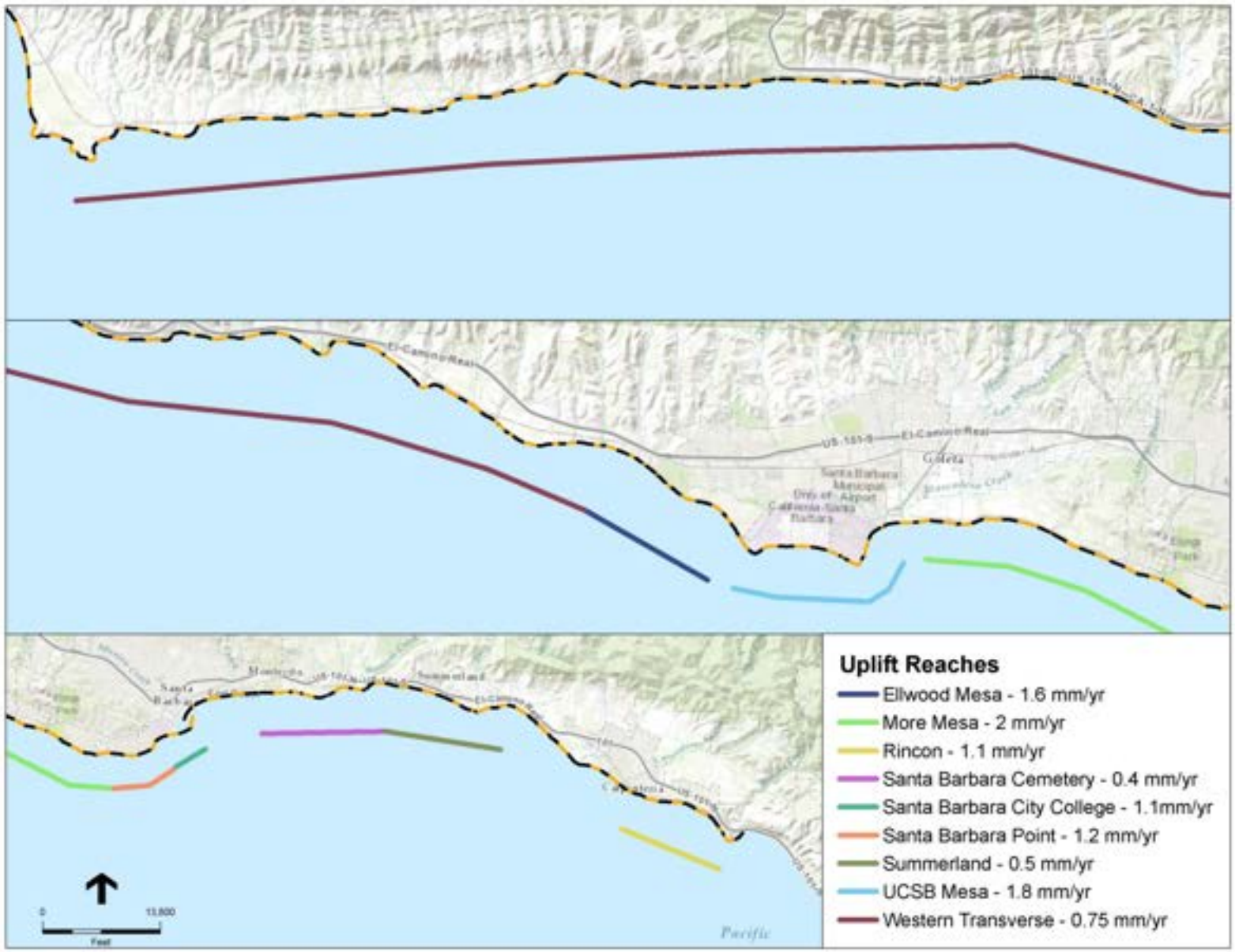
Waves:

- **Existing wave data repeated**
- COSMOS 3.0 RCP 4.5
- COSMOS 3.0 RCP 8.5

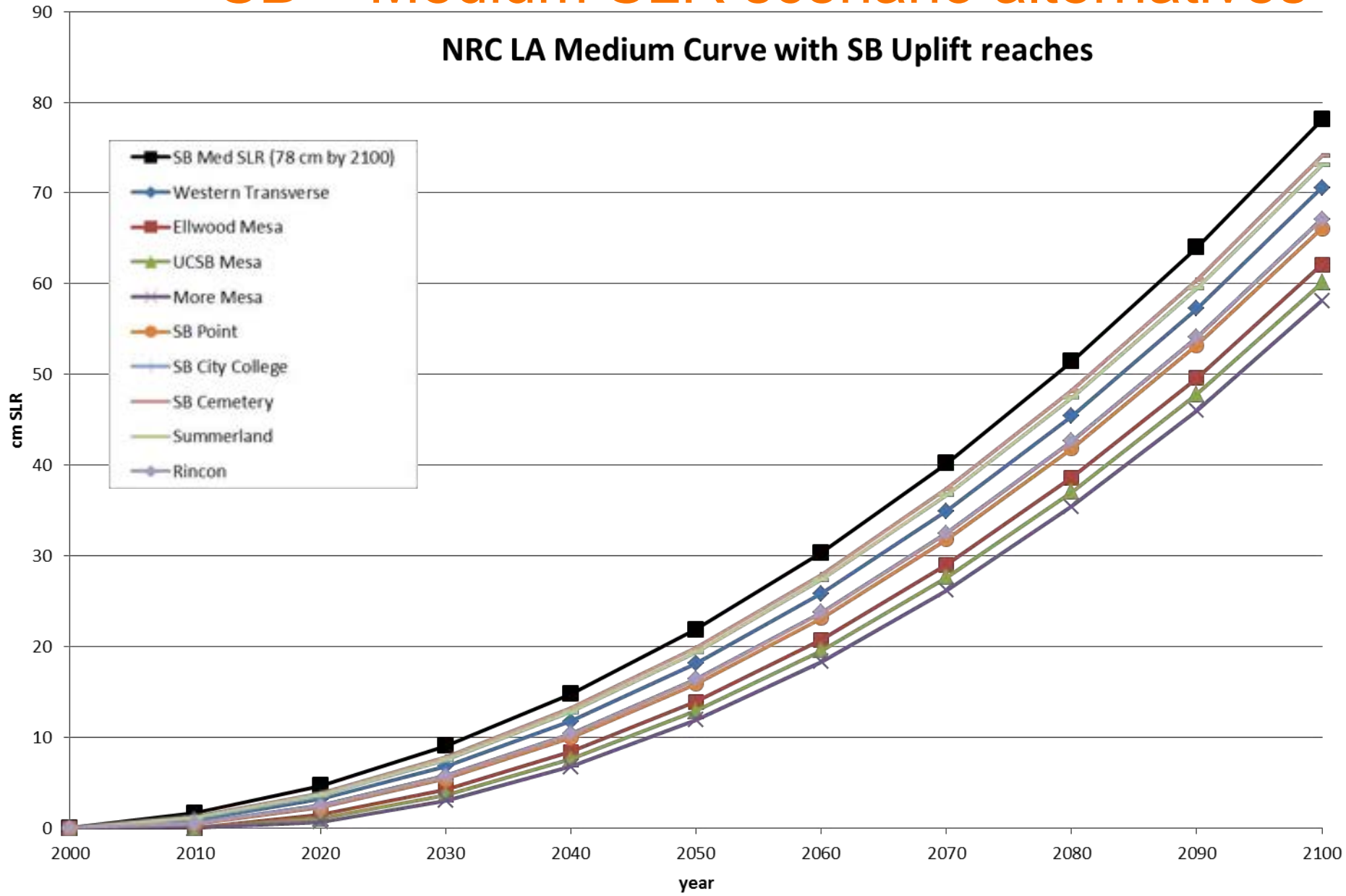
Vertical Land Motion:

Removed South of Cape Mendocino subsidence rates from NRC 2012 report

9 uplift regions in Santa Barbara



SB – Medium SLR scenario alternatives



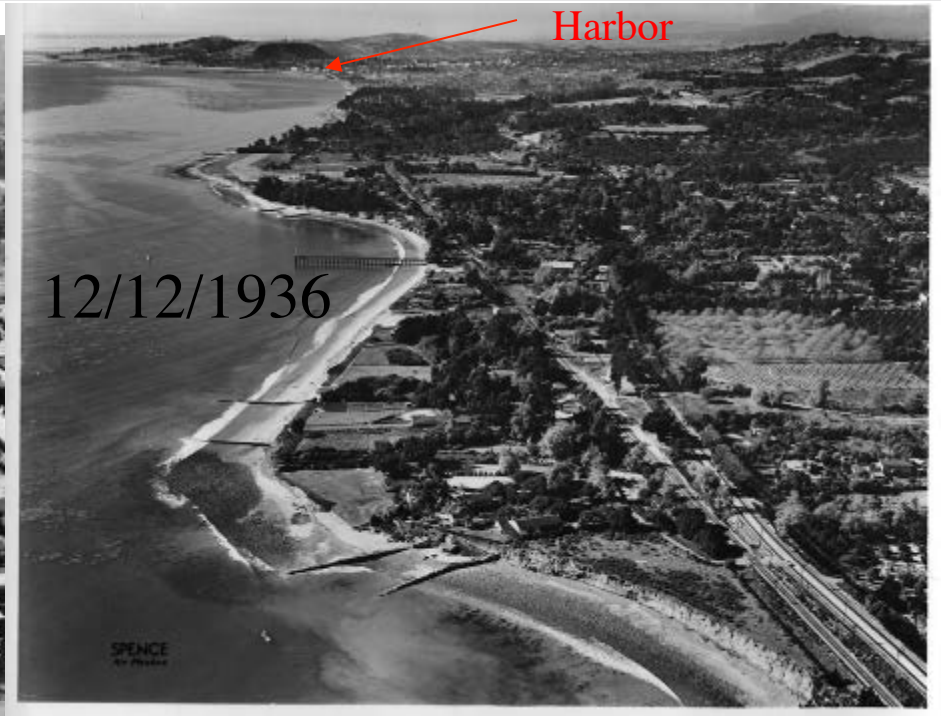
Coastal Armoring

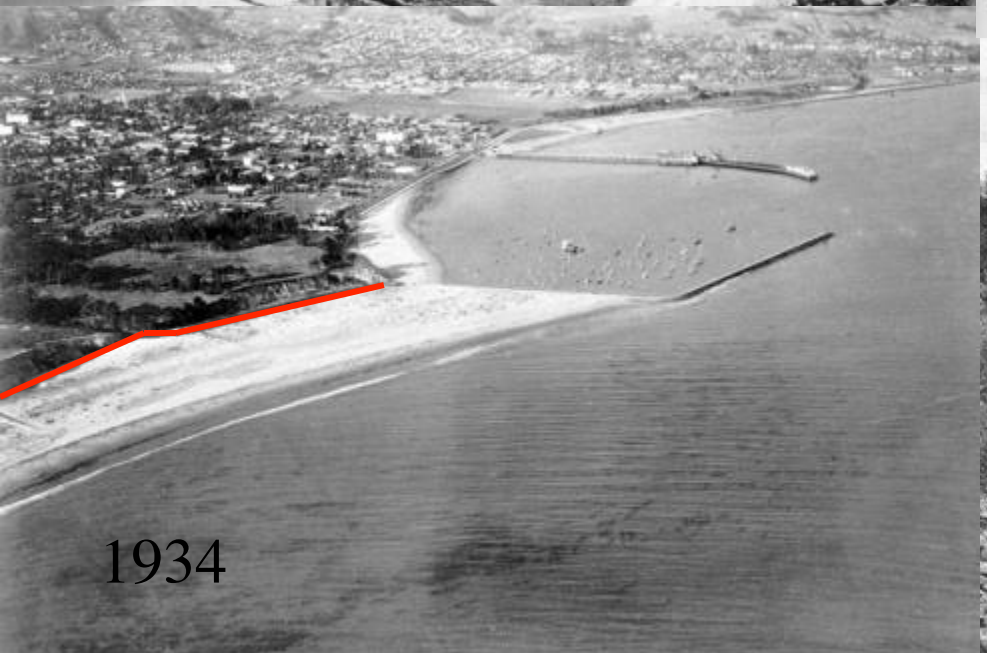
Photo www.californiacoastline.org

Photo City of Goleta

Photo David Revell

Sediment – Harbor Management

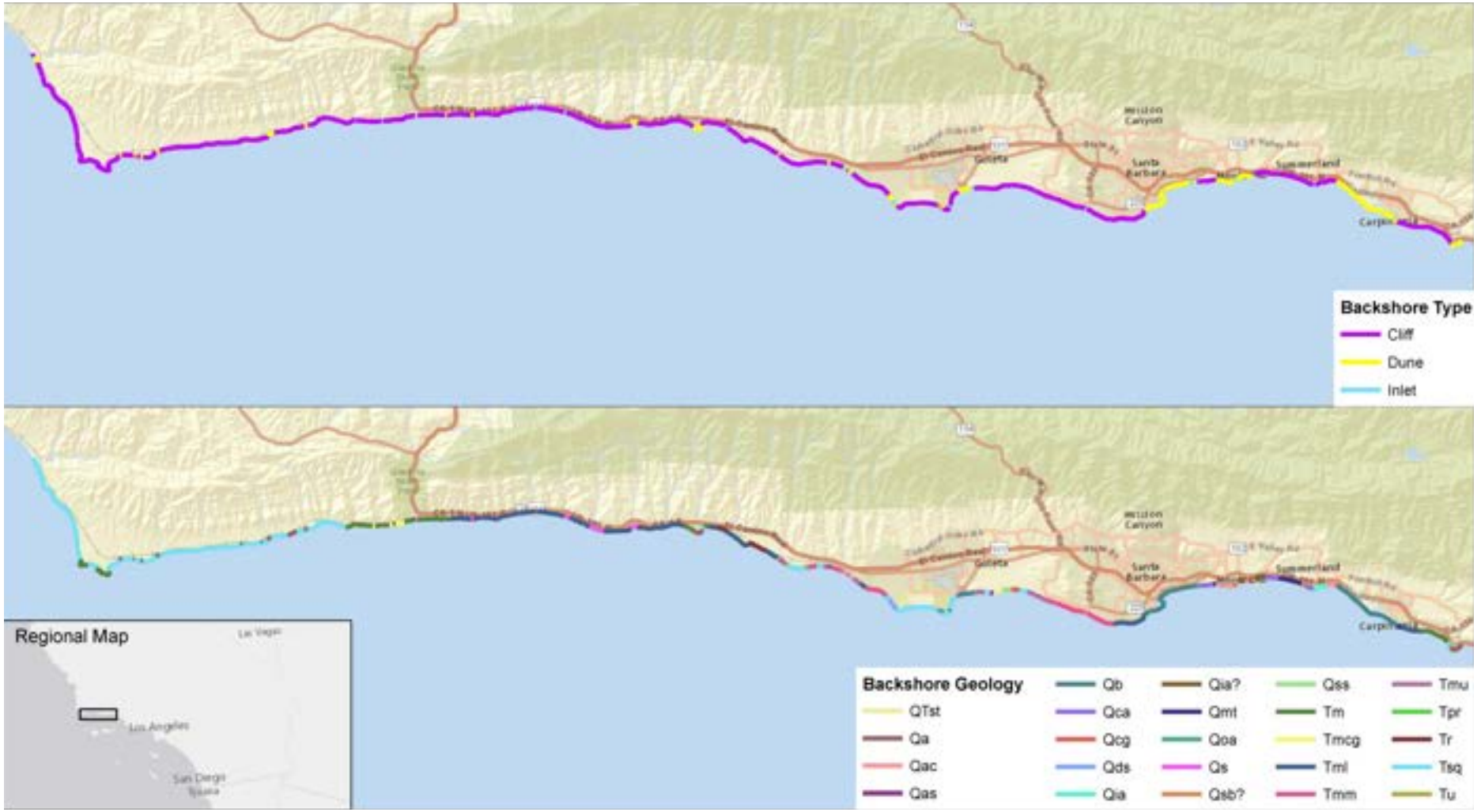




Selected conditions

- Geology (USGS, Steve Campbell, Ed Keller, Larry Gurrolla)
- Shoreline armoring (Coastal Commission)
- Erosion Rates (USGS, Revell PhD, LiDAR)
- No inclusion of management strategies (e.g. armoring)***
  - Erosion allowed despite armoring
  - Historic erosion rates at armoring replaced with geologic rates
- Topography from 2009 LIDAR

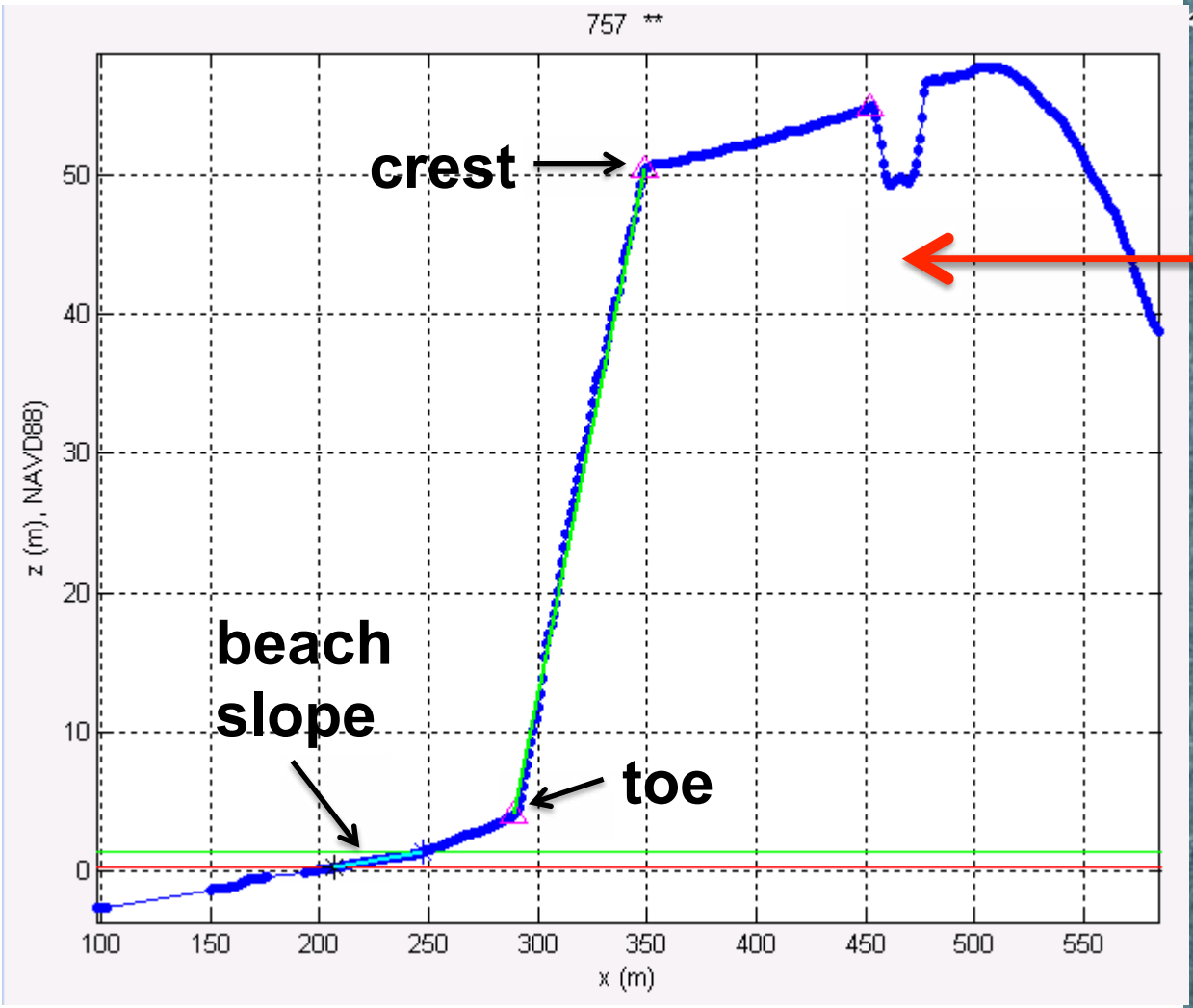
Backshore Characterization

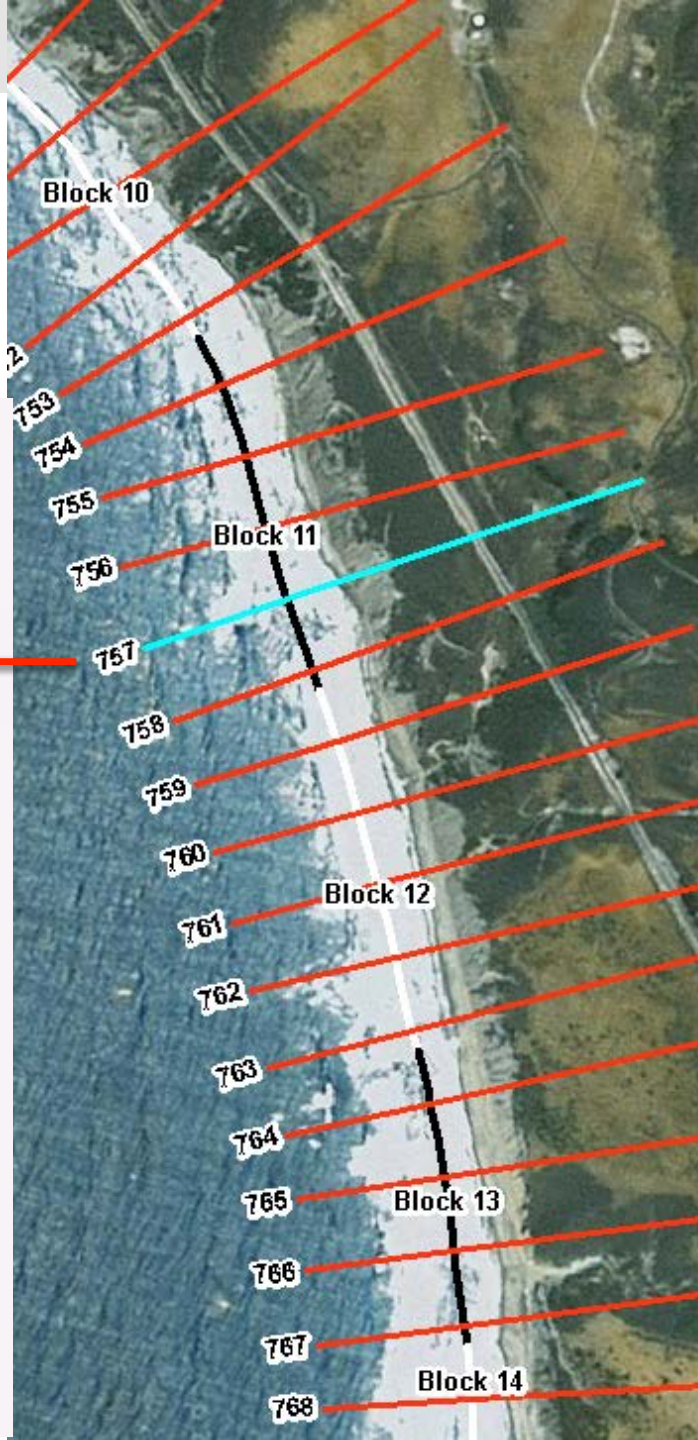


Profile Analysis

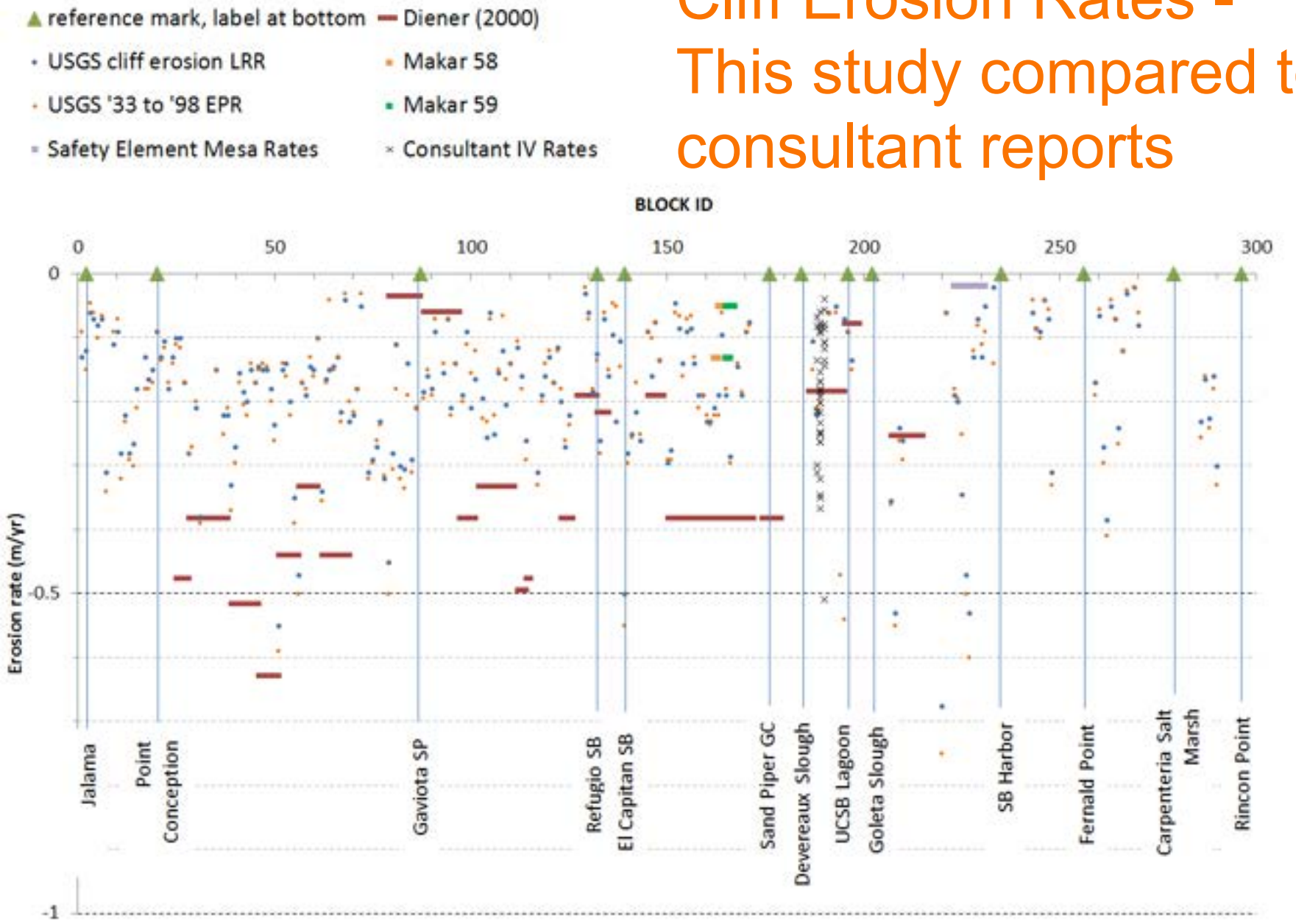
~1100 profiles

4-5 per block

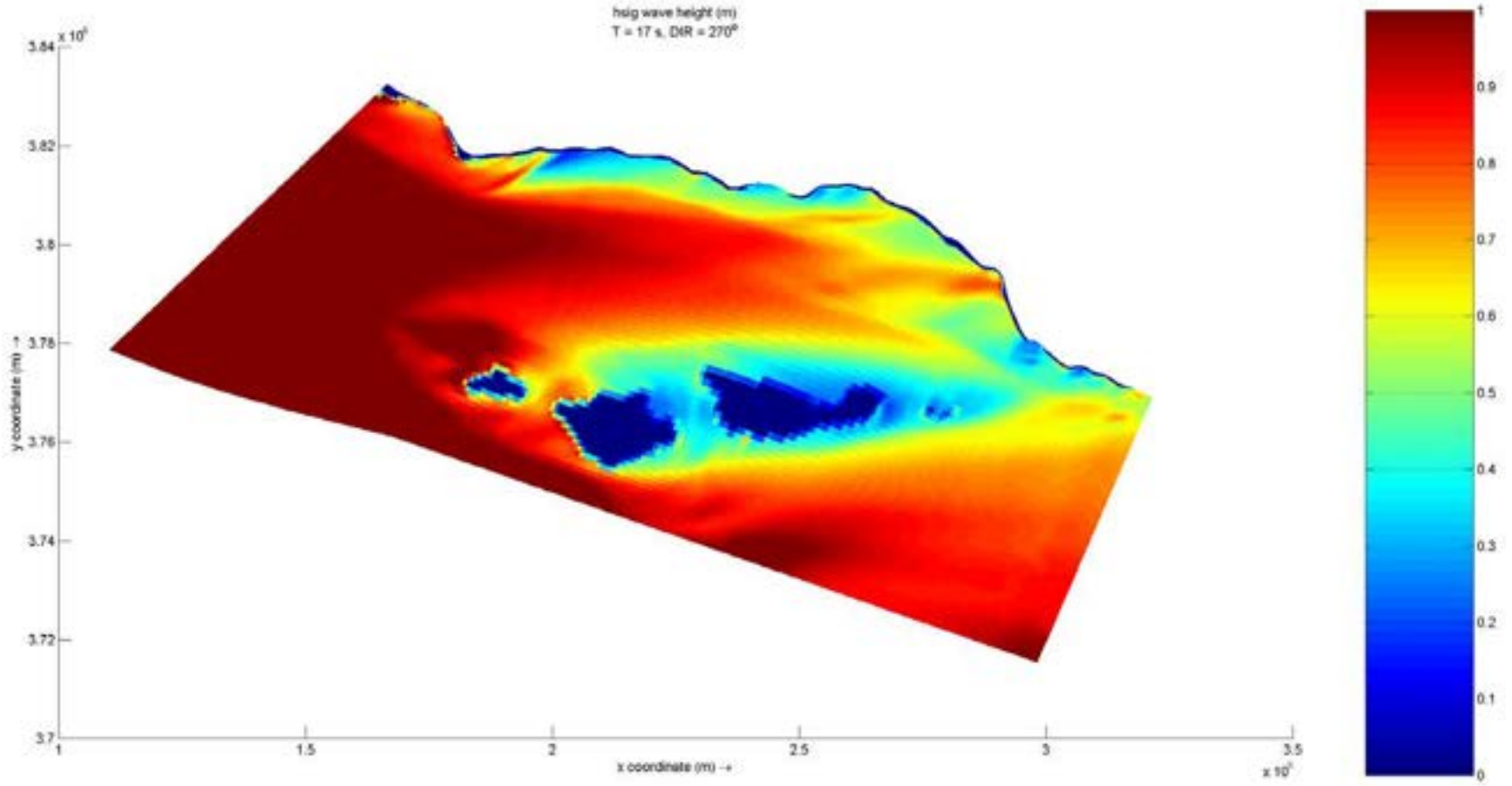




Cliff Erosion Rates - This study compared to consultant reports



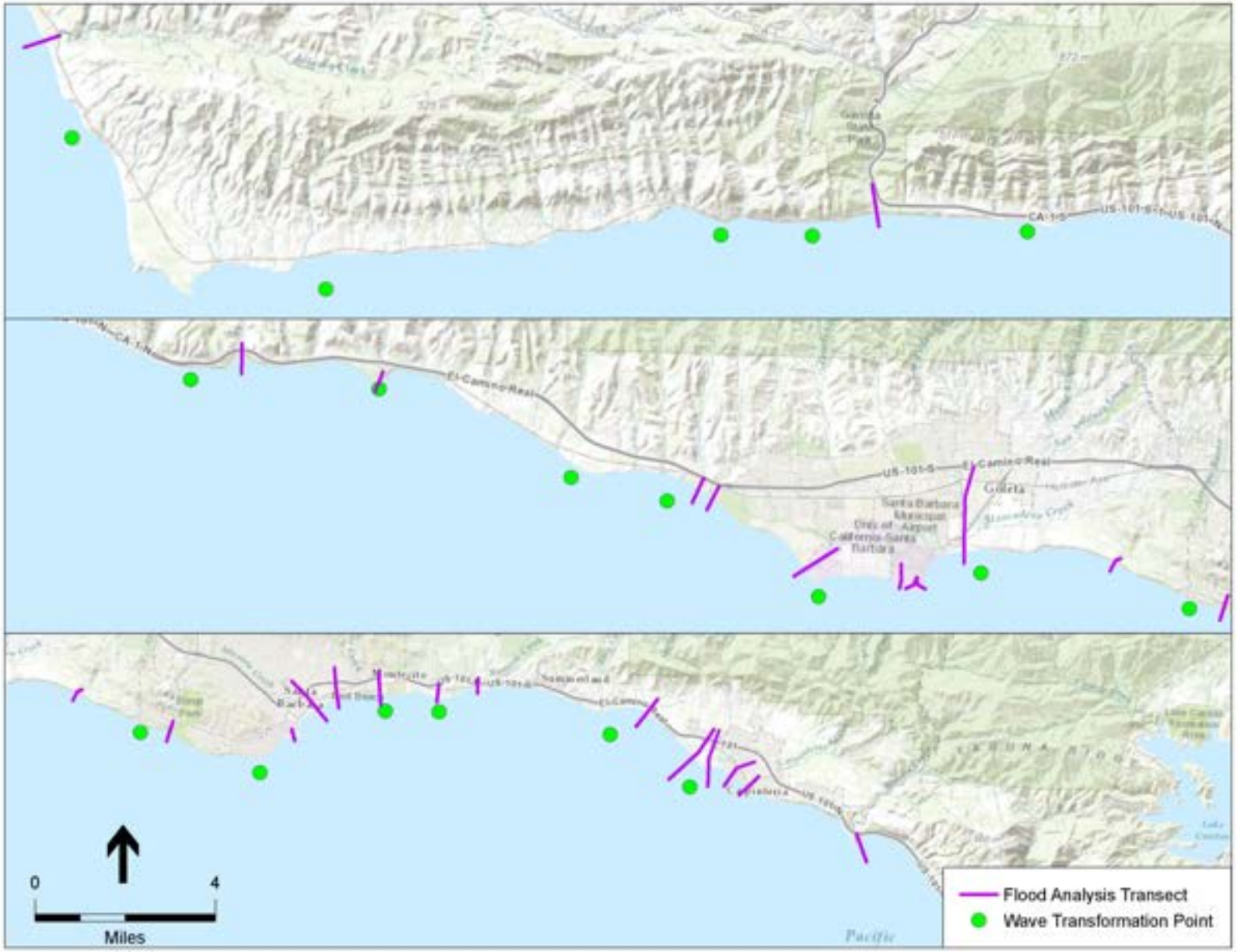
Wave Transformation Models



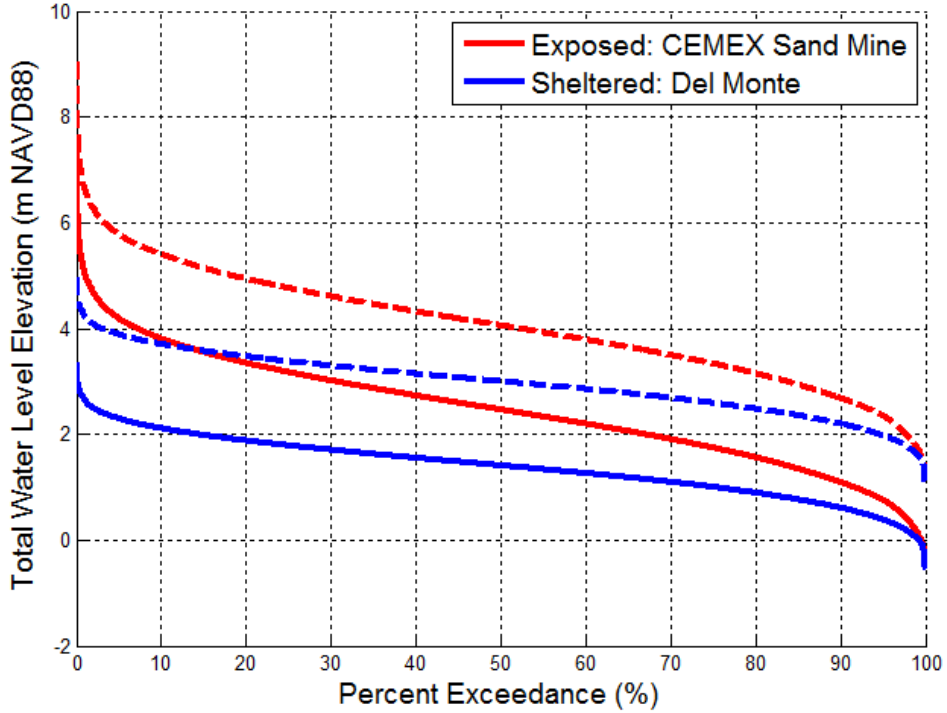
Transformations using Grids from USGS from COSMOS 3.0

- Southern California Grid
- Santa Barbara Grid (extended)

Wave Transformation Points & Flood Profiles



Total Water Levels

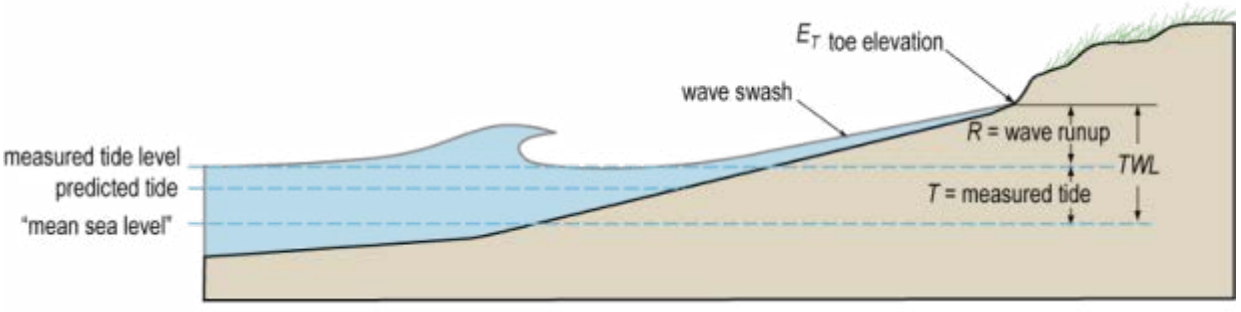


- Combined SLR and Wave Run-up
- Generate exceedance curves for each block using individual slopes and toe elevations

Total Water Level

- Wave Data:
  - Coincident hourly wave and water level time series, 1996-2013
  - Deepwater Waves from Harvest Platform buoy, with gaps filled from Diablo Canyon buoy (located near Point Conception)
  - Waves transformed to shore using refraction modeling
- Tides:

  Water levels from tide gage at Santa Barbara (Station 9411340)



- Runup methods
  - Stockdon for all profiles – drives erosion
  - Composite slope for low backshores – drives flooding

Coastal Erosion Hazards Analysis

Coastal Erosion Hazards Concepts

Total Water Levels

- Sea Level Rise
- Tides
- Wave Run-up
- Storm Surge
- El Niños

Exceeds

Elevation of the dune toe

Causes

Erosion Response based on:

- Backshore Type
- Geology
- Shoreline Change
- Geomorphology

Results

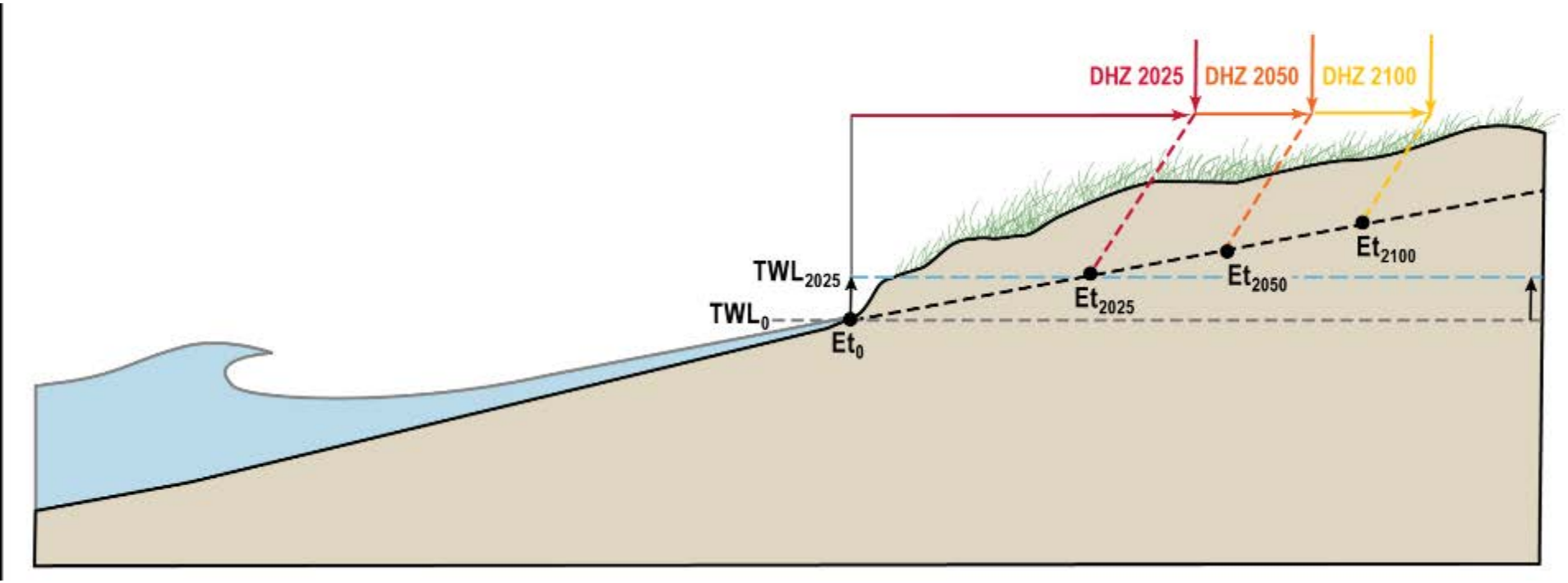
- Accelerated Erosion
- Inland Migration of Shore
- Loss of Upland

Climate Change

- Sea Level Rise
- Wave Climate

Revell et al 2011

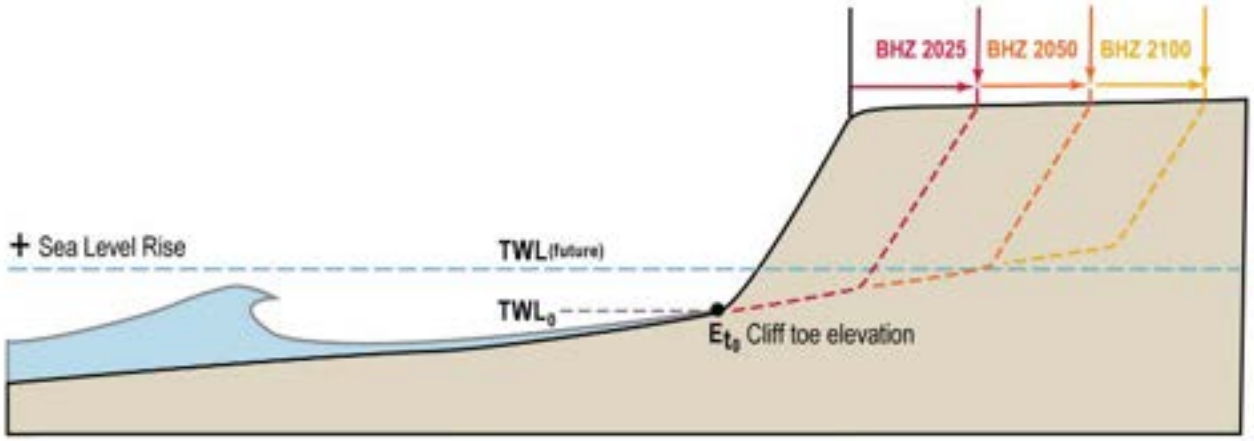
Dune Erosion Components



- 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”

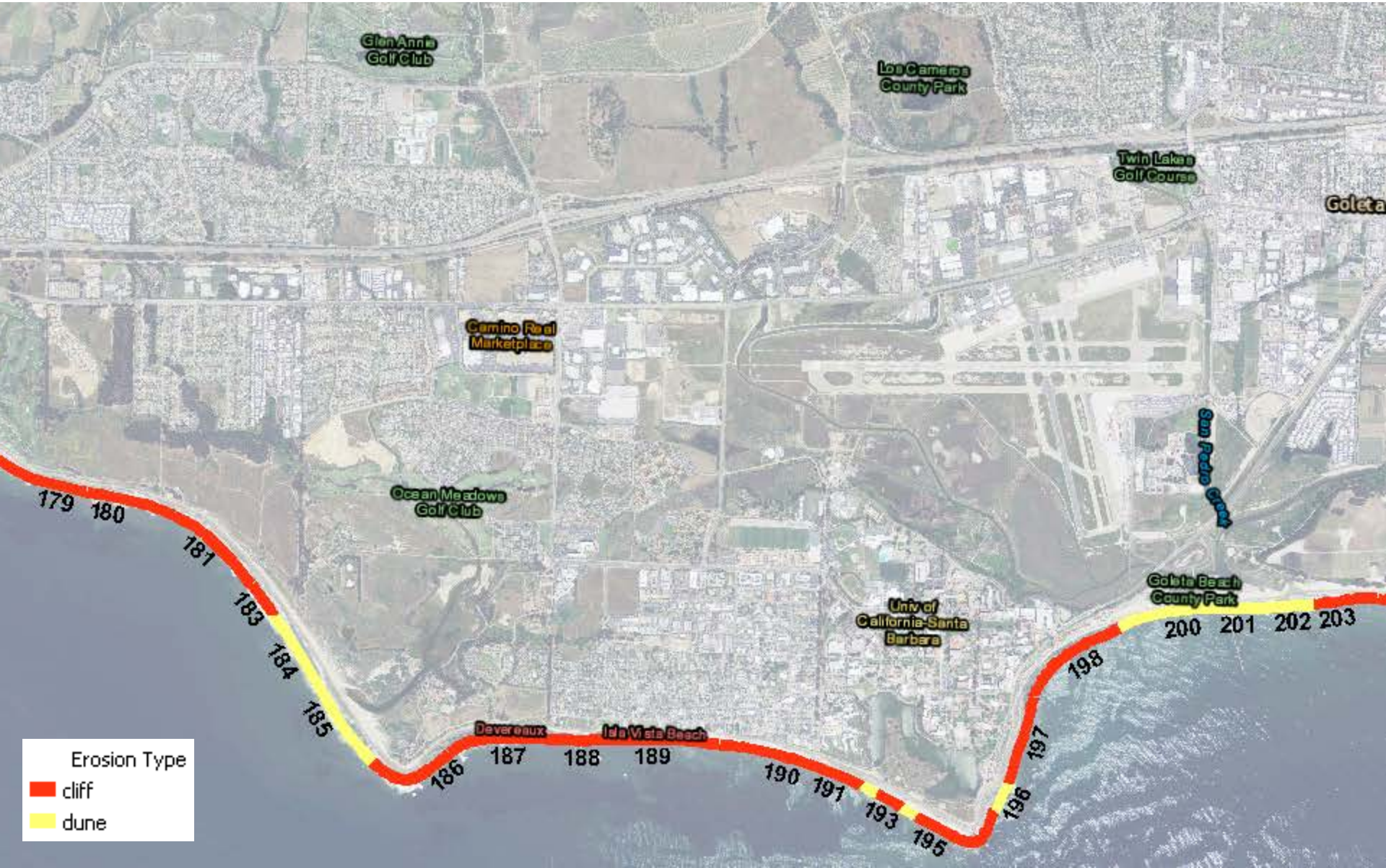

Goleta Beach

Cliff Erosion Model



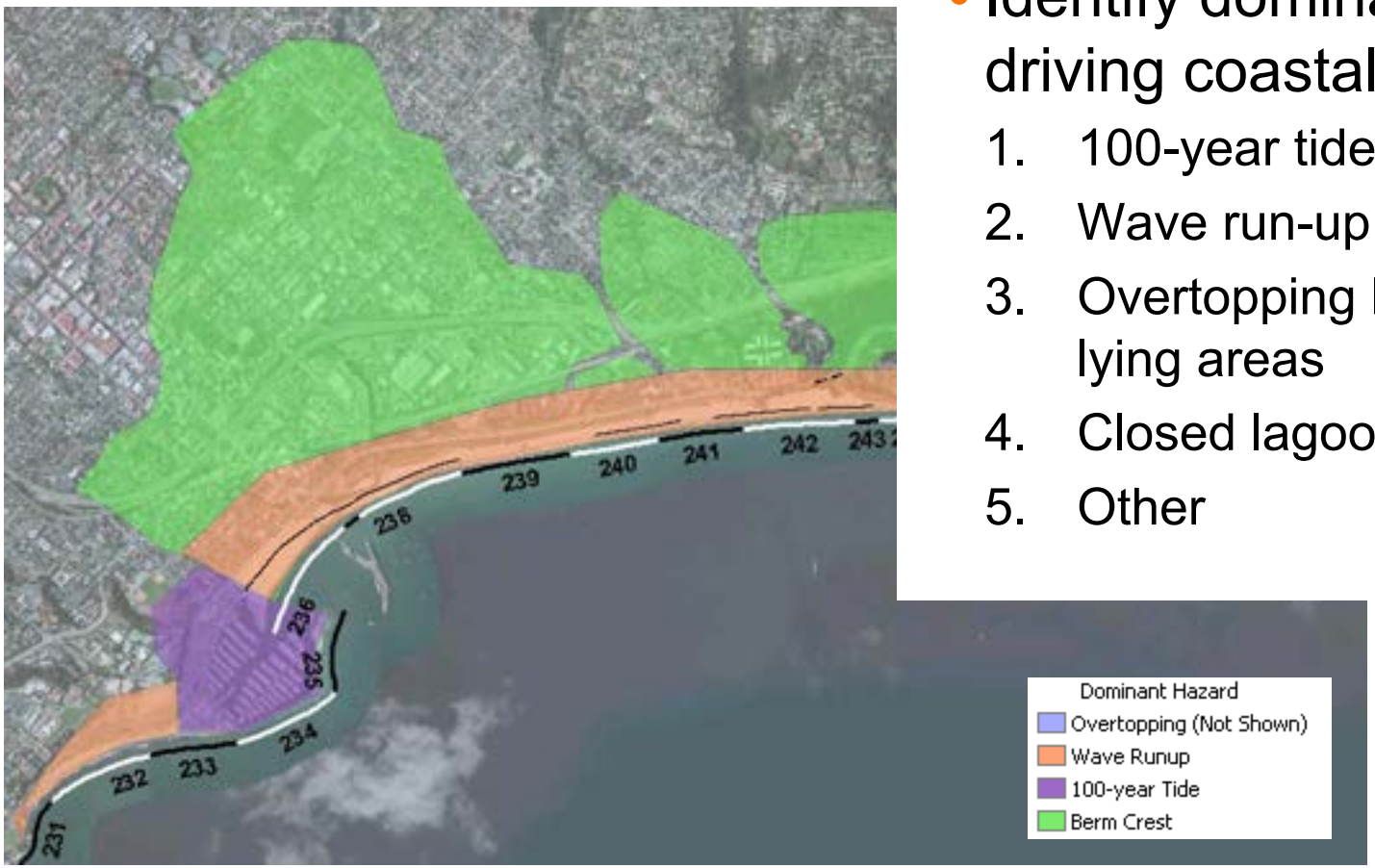
- Prorated acceleration of historic erosion rates based on increases in the duration of wave attack at various elevations
- Include geologic unit standard deviation x planning horizon or geomorphic failure widths to account for uncertainties in alongshore variability

Erosion Mapping



Flood Mapping Approach

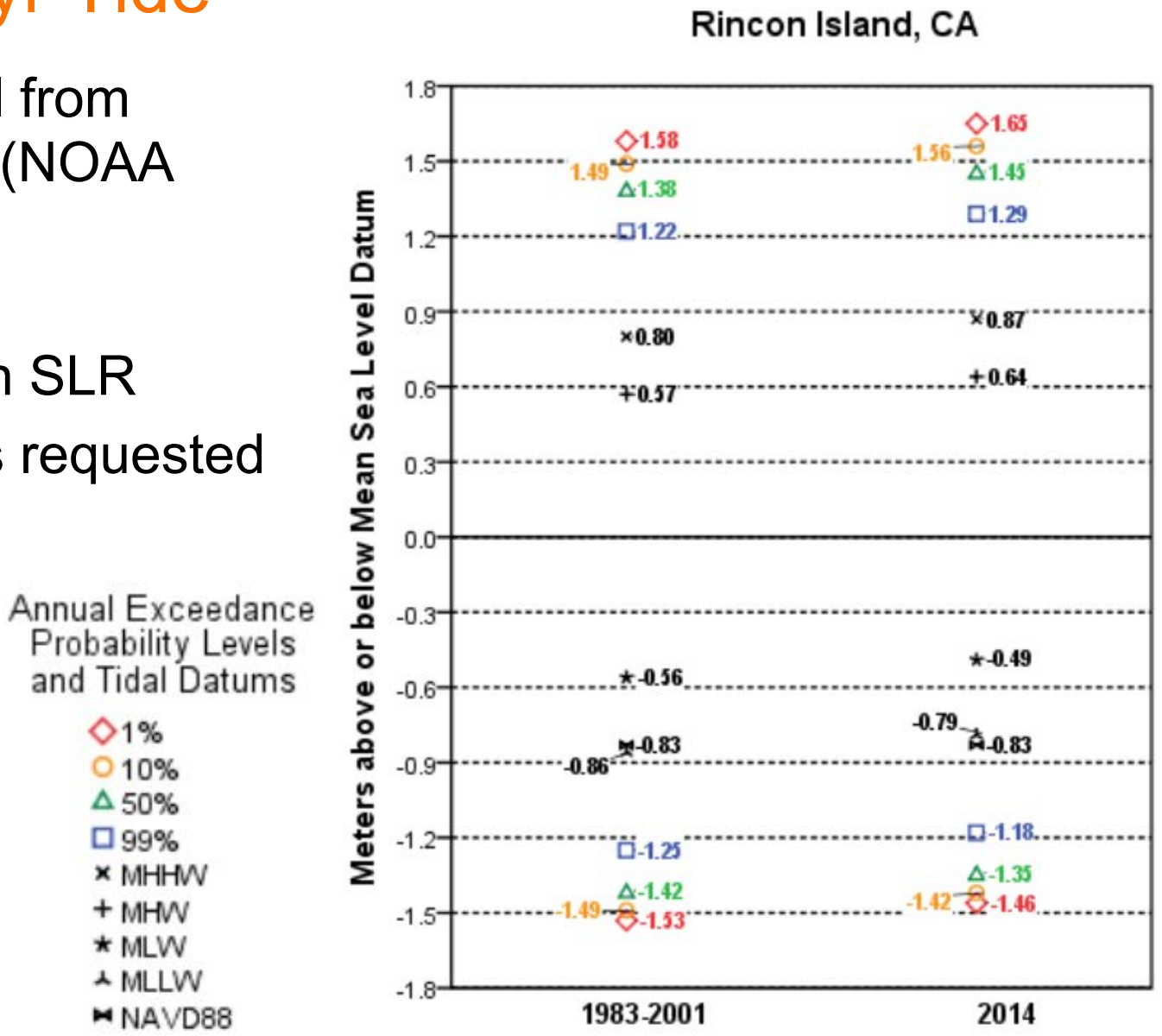
Downtown Santa Barbara



- Divide coast into regions based on geomorphology
- Identify dominant process driving coastal flooding:
  1. 100-year tide
  2. Wave run-up on cliffs
  3. Overtopping by waves into low-lying areas
  4. Closed lagoon water levels
  5. Other

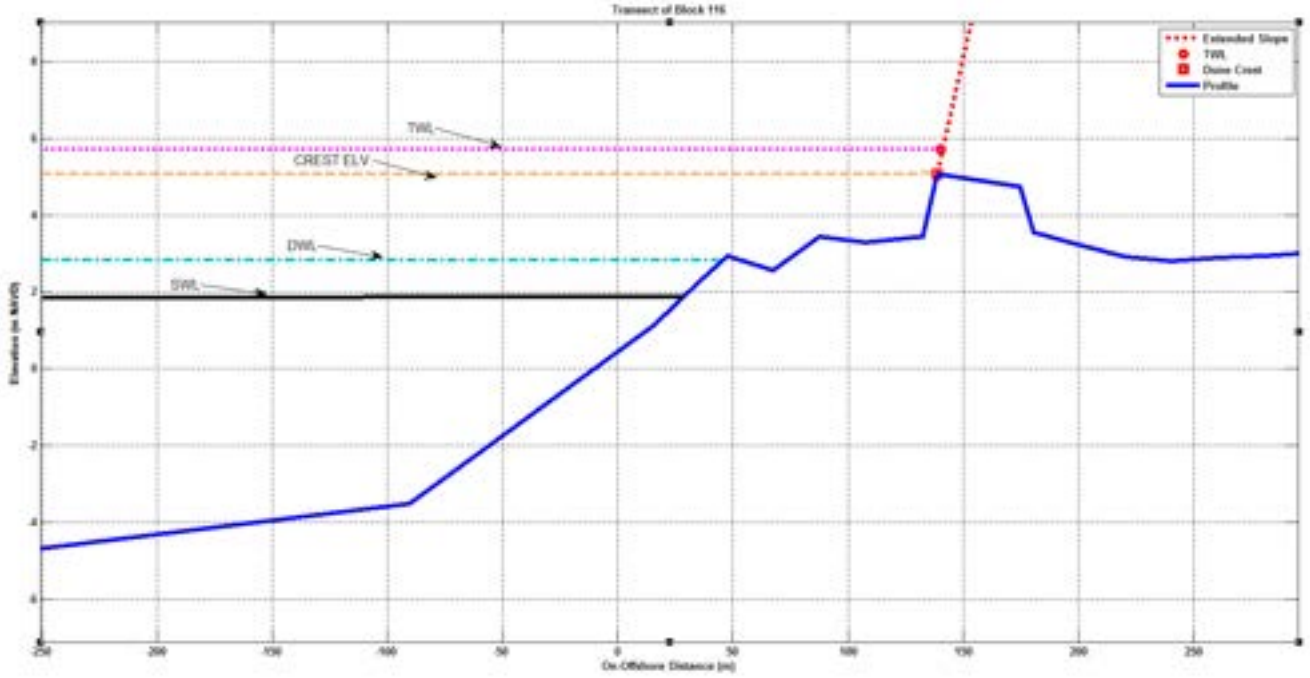
1. 100-yr Tide

- 100-yr water level from Rincon tide gage (NOAA 2013)
  - 2.99 m NAVD88
- Assume rises with SLR
- Adding EMHW as requested



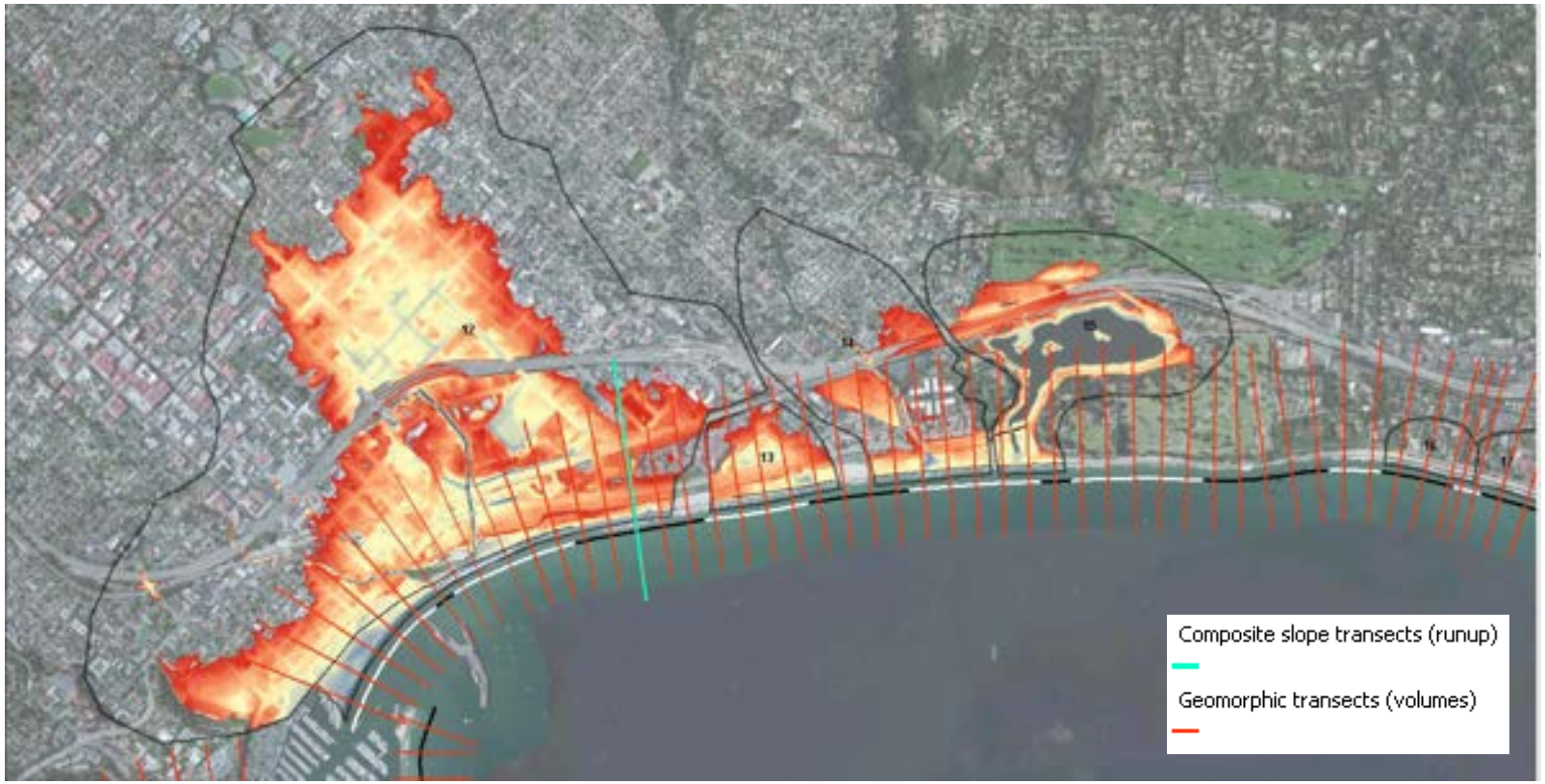
2. Wave Run-up

- Wave run-up analysis using full-length representative profiles
- Identified the event in a 17-year (1996 – 2013) wave time series that caused the highest run-up on each profile.
- Runup represented by
  1. Potential elevation at backshore
  2. Potential inland extent of wave action



3. Overtopping

- Delineate flood basins based on topography
- Estimate overtopping **volume** at 100 m spacing alongshore
- Map flood elevation over existing topography

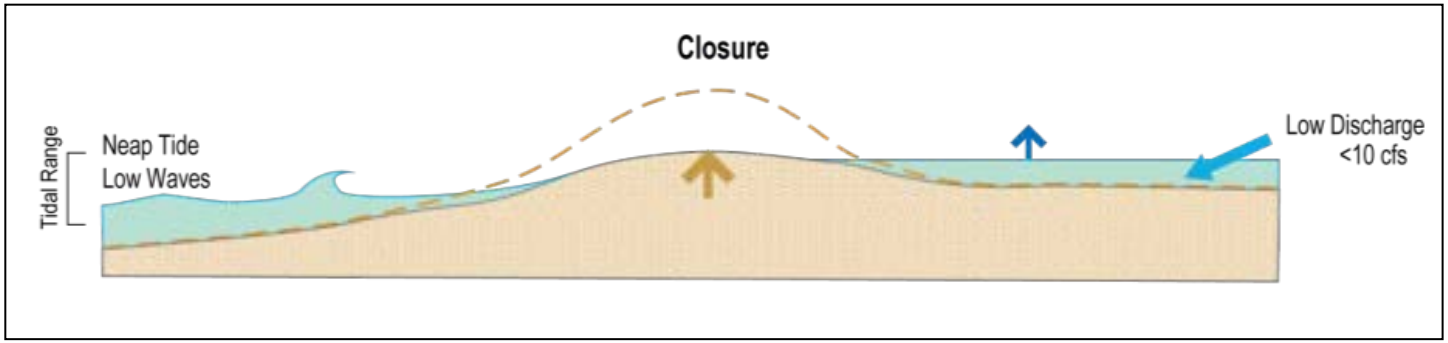


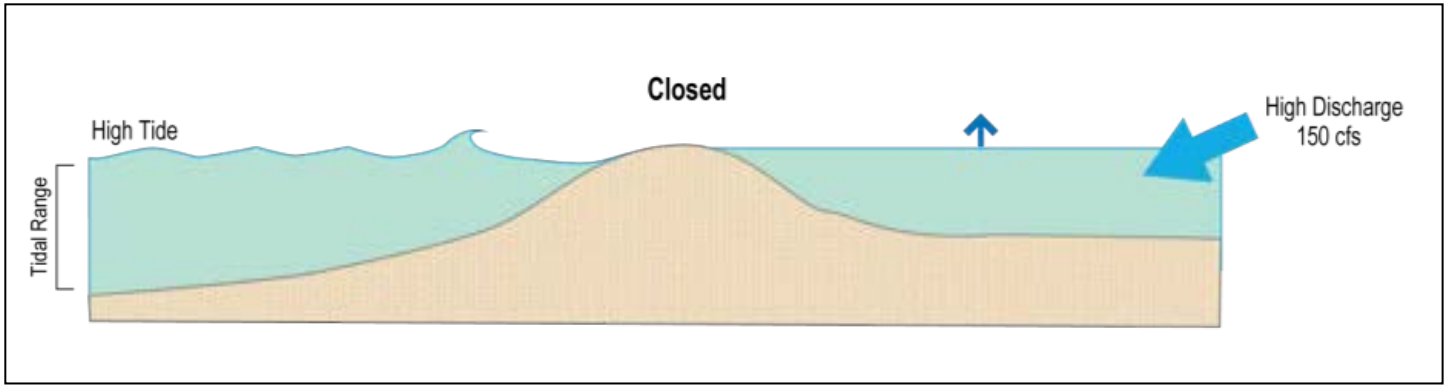
Cabrillo Blvd

Figure 10. Palm Park, on Cabrillo Boulevard, was strewn with debris, including a picnic table that was carried in by waves that had overtopped East Beach in March 1983 (*Santa Barbara News-Press*).

4. Closed Lagoon Water Levels

- Highest water levels observed during lagoon closures
- Water levels related to beach berm elevation
- Geomorphic interpretation of maximum beach berm crest
- Assume beach berm elevation grows with SLR





Lagoons Closed
(except for Carpinteria Salt Marsh)

Pre Breach 7am April 1, 2014

Photo: A. Bermond

Lagoons Open

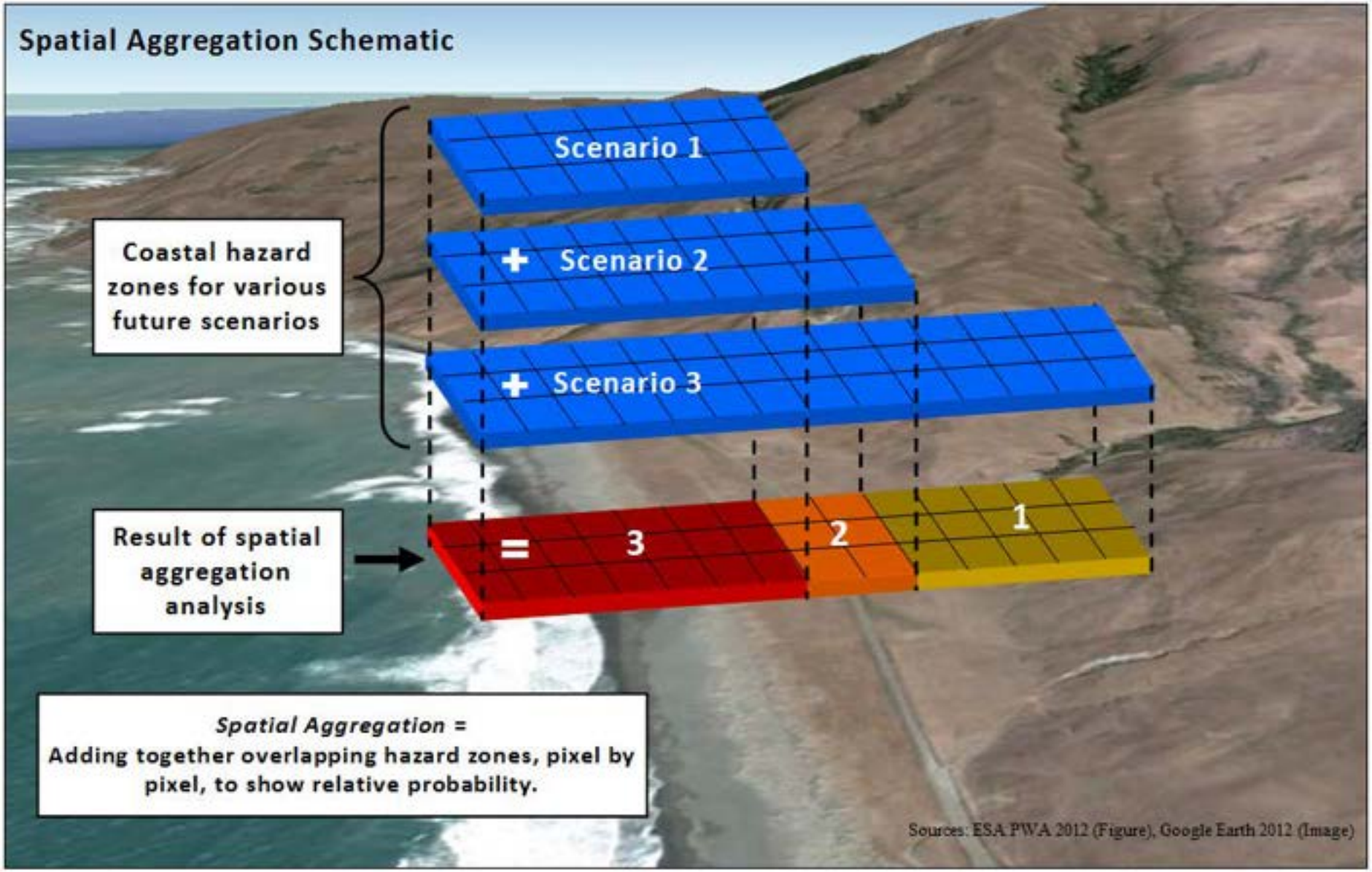
Post Breach 5:45pm – April 1, 2014

Photo: A. Bermond

ESA PWA

Mapping Flood Hazard Zones

Evaluating Uncertainty: *Spatial Aggregation*



Proposed Next Steps

- South Coast Vulnerability Assessment
  - Summer 2015 through Fall 2015
- North County Modeling & Mapping
  - Proposed Fall 2015 through Winter 2017
- LCP Amendment
  - Proposed Fall 2015 through Winter 2017
- Adaptation Plan (unfunded)