Rising Oceans and Coastal Hazards

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Smart Growth and Hazards Resilience: Helping Coastal Communities Stay Safe, Sustainable, and Above the Water

February 4, 2012

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Sea Level Changes

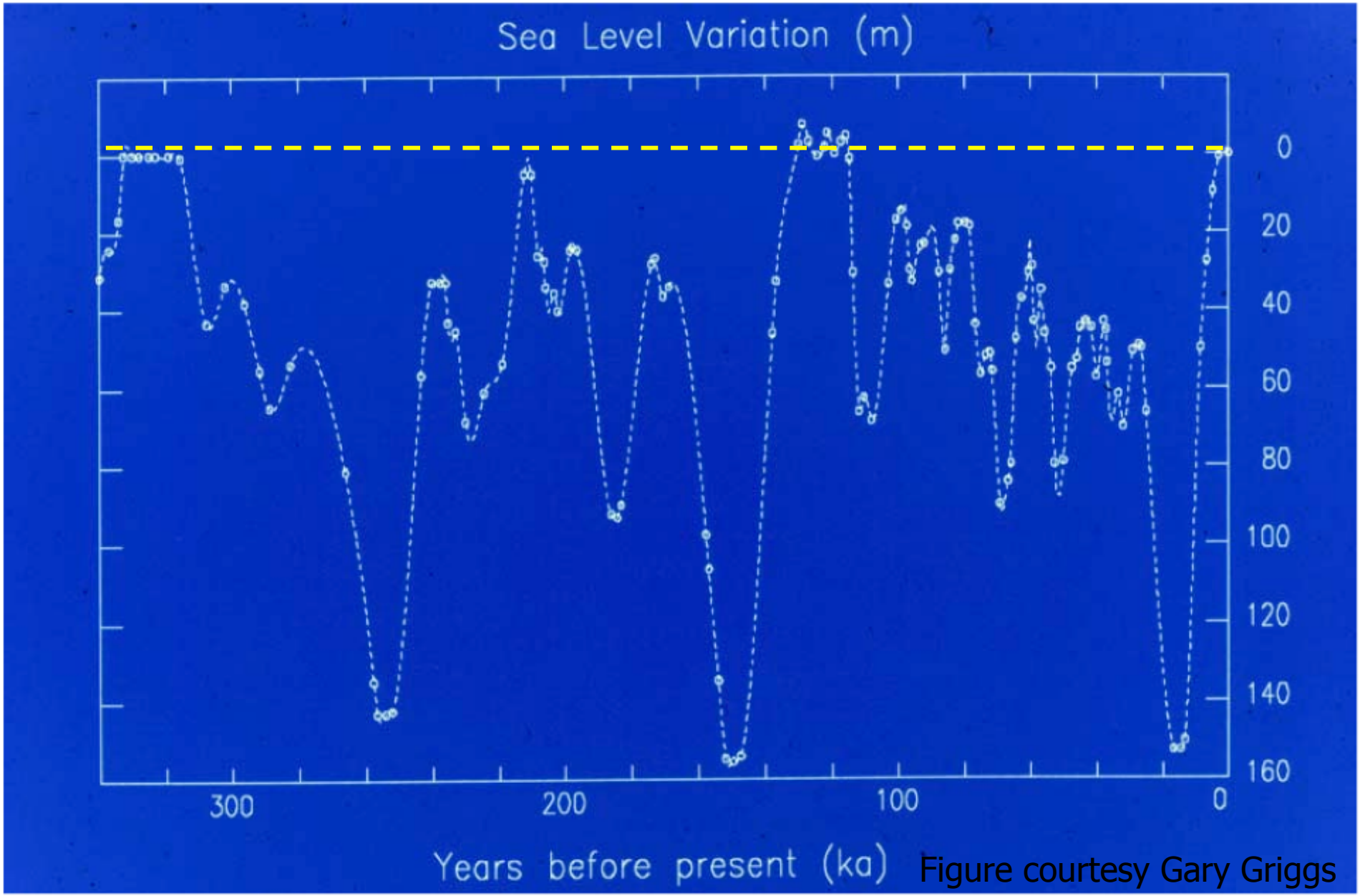
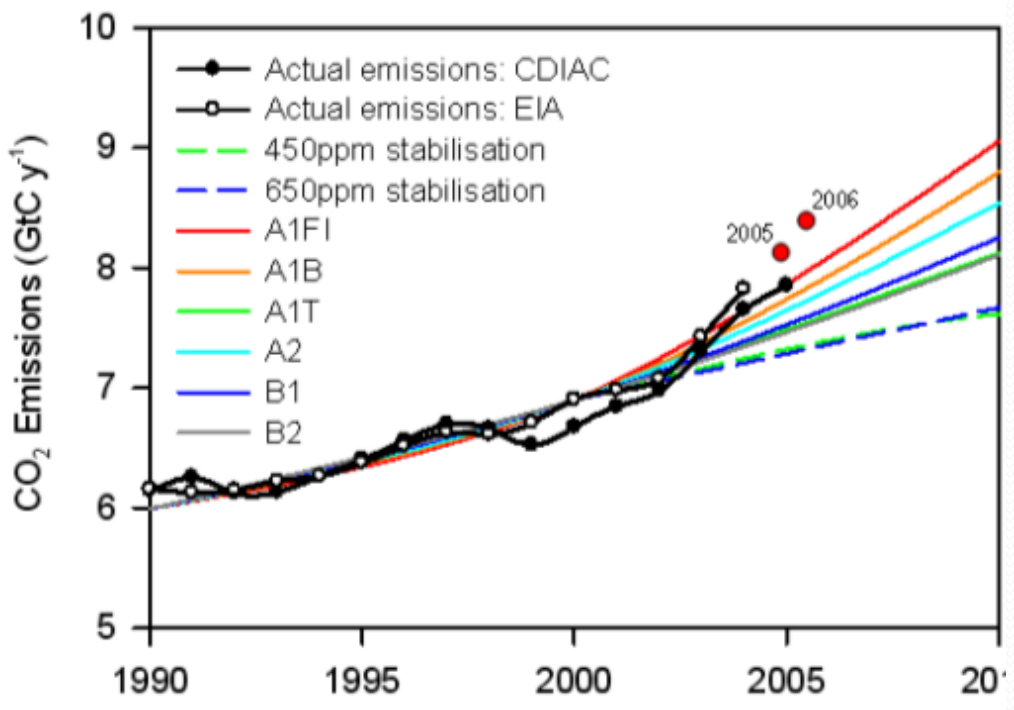


Figure courtesy Gary Griggs

Sea level rise

- Driven by GHGs
  - Modeled vs measured
- Several components
  - Thermal Expansion
  - Ice Melting
  - IPCC 2007 estimates of 0.59m did not include Ice Melt



Raupach et al., PNAS, 2007

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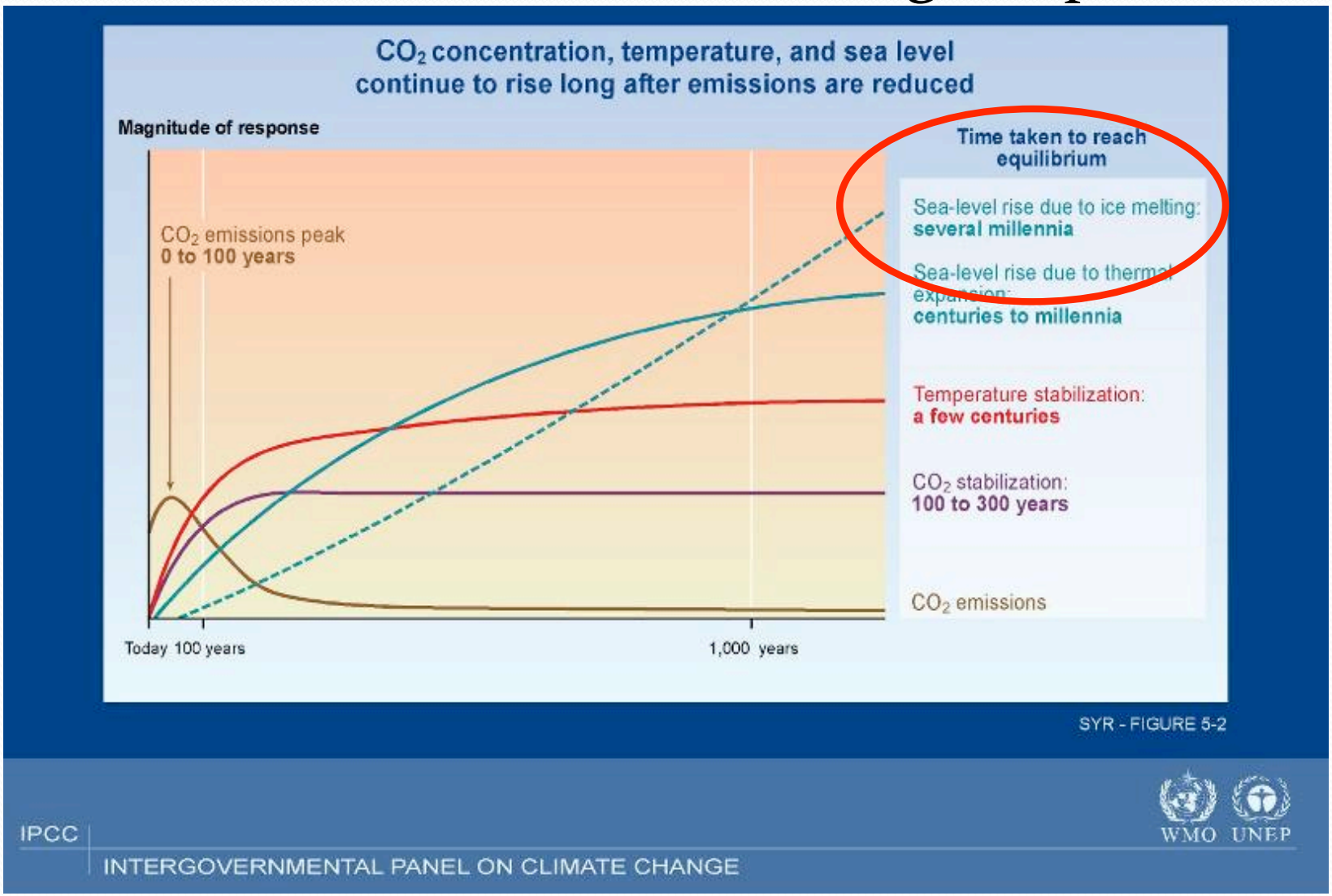
Time Scales of Climate Change Impacts



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2500 SCIENTISTS SAY WE'VE CAUSED GLOBAL WARMING
I'D LIKE A SECOND OPINION
THAVES


I DON'T BELIEVE IN

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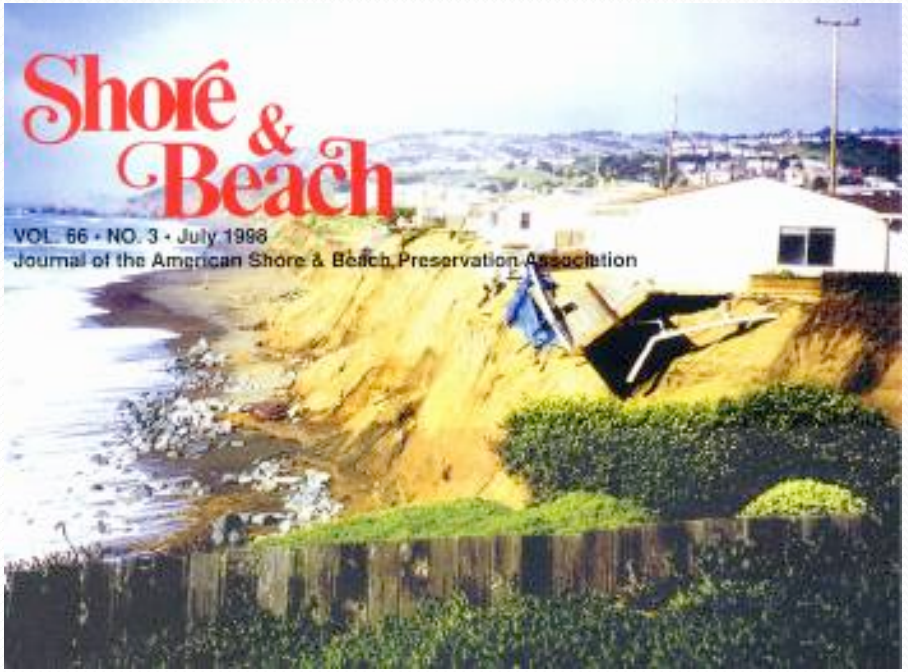
Evaluating Coastal Hazards As A Result Of Sea Level Rise Along The California Coast: Technical Work for the Pacific Institute



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General Approach - Vulnerability

- Adopt updated CA Energy Commission scenarios
  - Downscaled GCM for CA (Cayan et al 2009)
  - Scenarios A2 (1.4m), B1 (1.0m) sea level rise
- Map flood and erosion hazards for CA coast.
- Quantify populations and infrastructure at risk.
- Offer policy guidance and recommendations.

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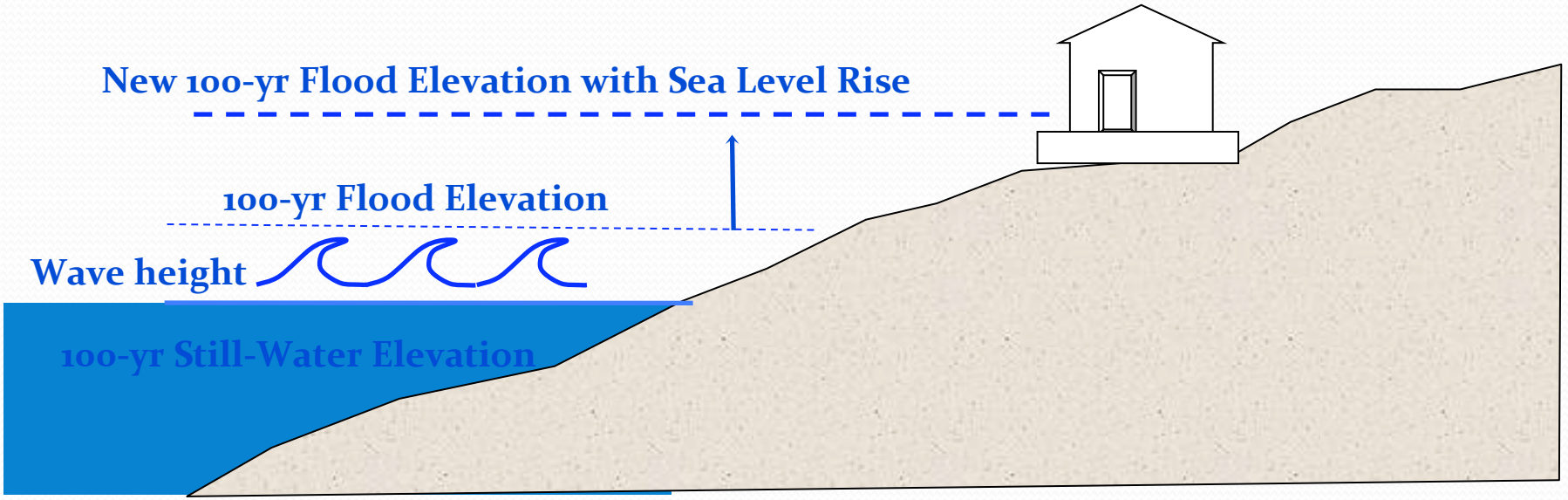
Risk - Mapping Flood Hazards



- Review all existing FEMA Flood Insurance Studies
- Extract Coastal Base Flood Elevations into GIS
- Add Sea level rise scenarios to BFE elevations
- Map inundation using terrain datasets

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Risk - Mapping Erosion Hazards

Total Water Levels

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

Exceeds

Elevation of the Toe of Cliff or Dune

Causes

Erosion Response

- Backshore Type
- Geology
- Failure Mechanism
- Shoreline Change

Climate Change

- Sea Level Rise
- Wave Climate

Shore Change

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

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Hazard Maps

WA

Backshore Types

- Dune/Inlet
- Cliff/ Bluff
- Landslide
- Armored

GIS data:

Shoreline Inventory, Geology, Armoring, Landslides, LIDAR, Bathymetry, Sandy Shoreline change rates, Cliff Erosion rates.

Non GIS references:

Griggs et al 2005 Living with the Changing California Coast
California Coastal Records Project

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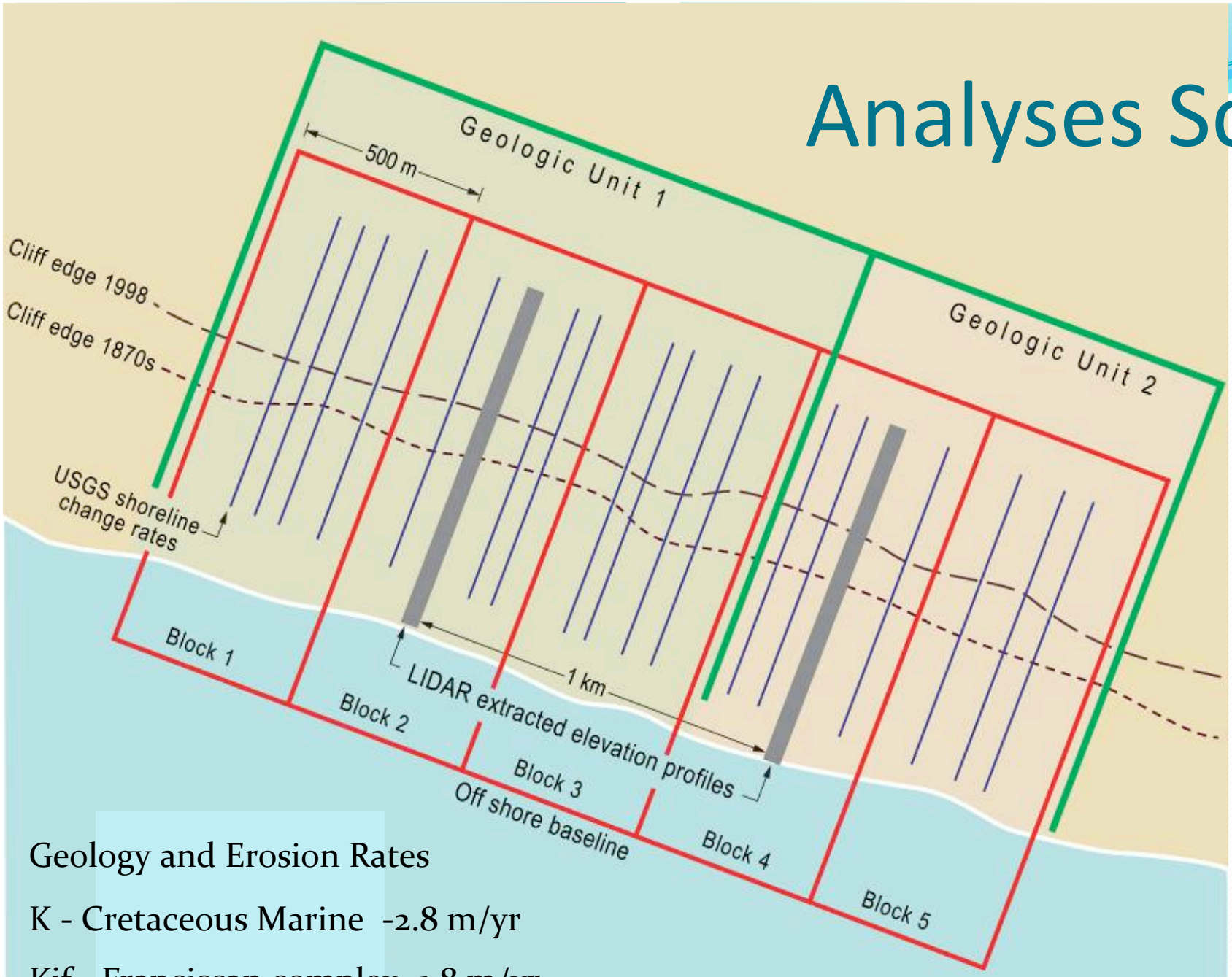
Analyses Scale



Geology and Erosion Rates

K - Cretaceous Marine -2.8 m/yr

Kjf - Franciscan complex -1.8 m/yr

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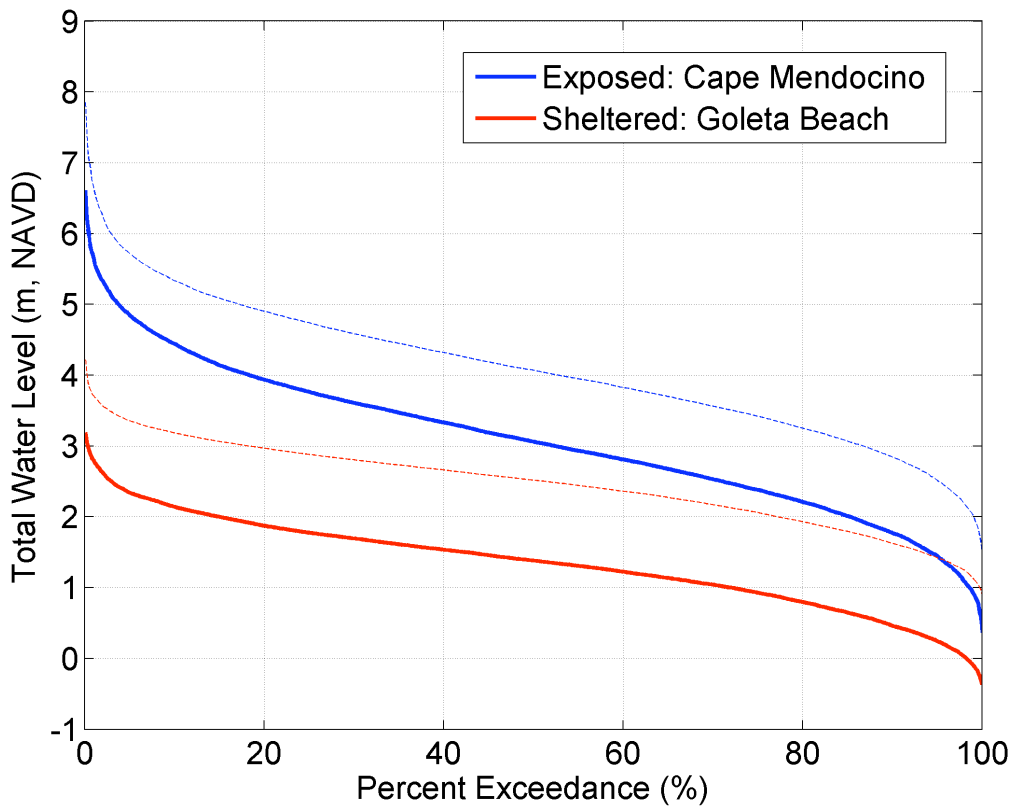
Total Water Levels



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

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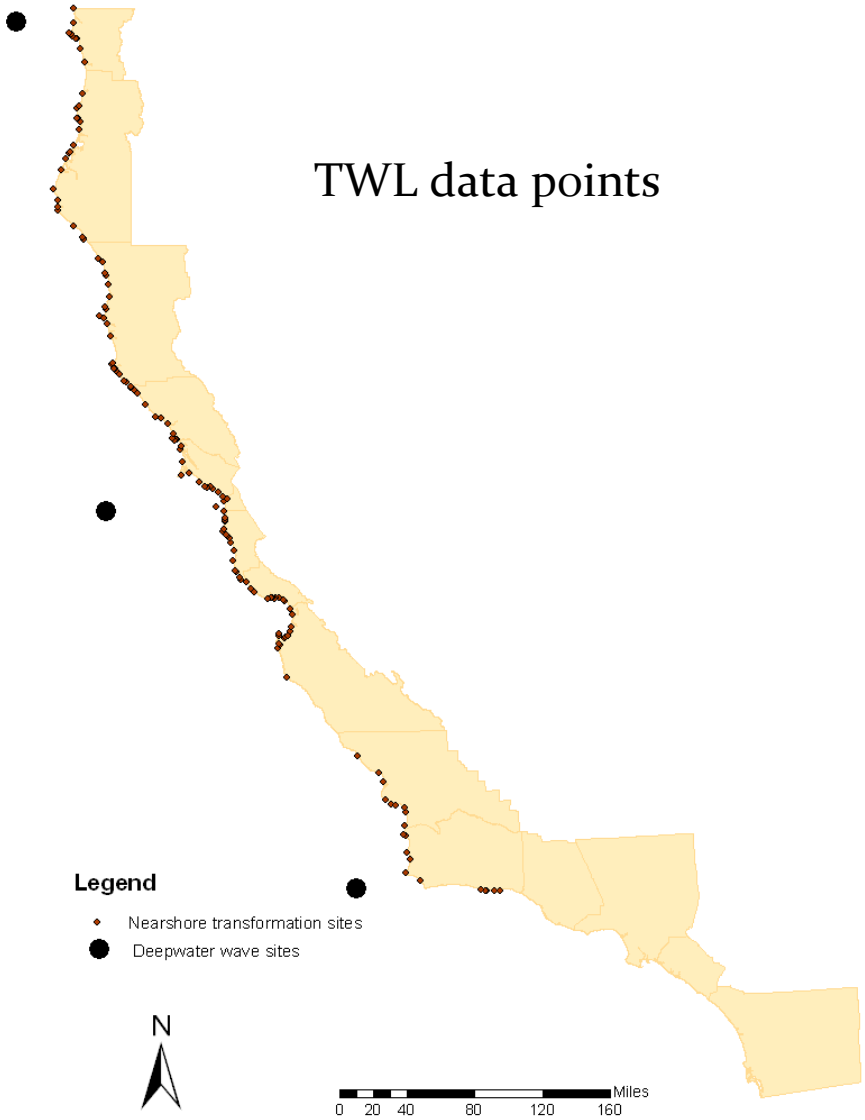
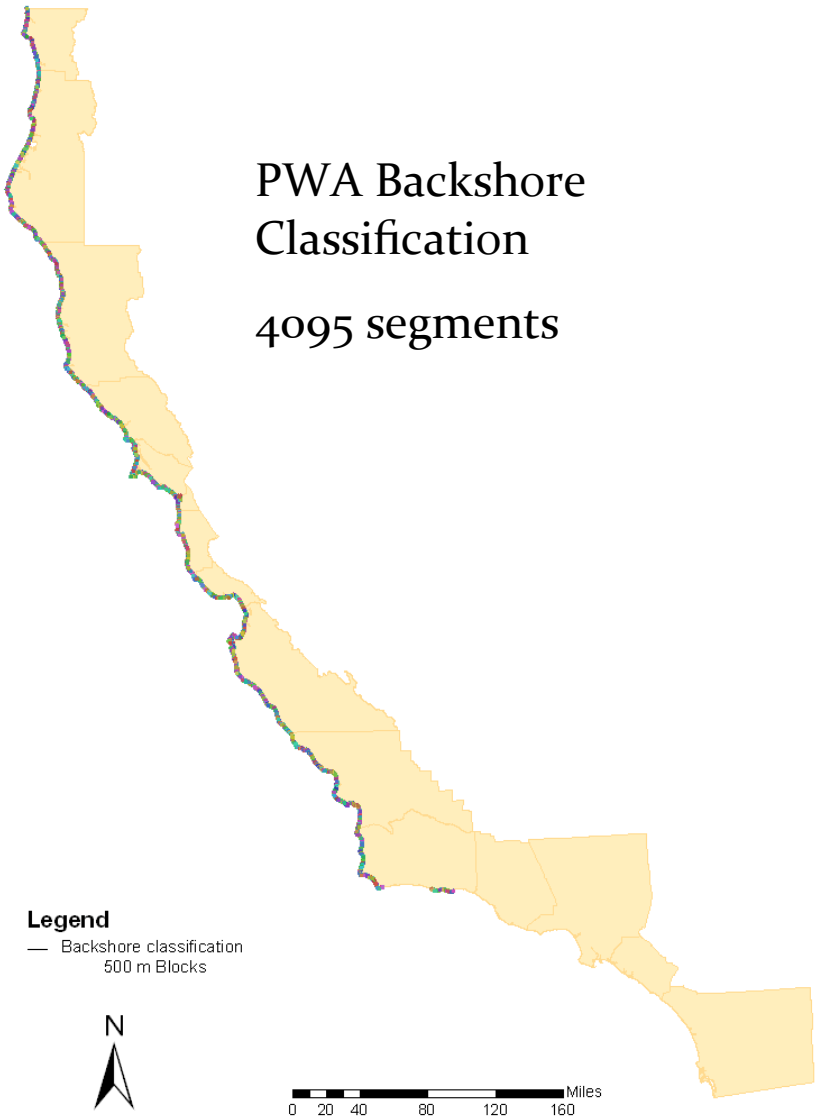
TWL data points

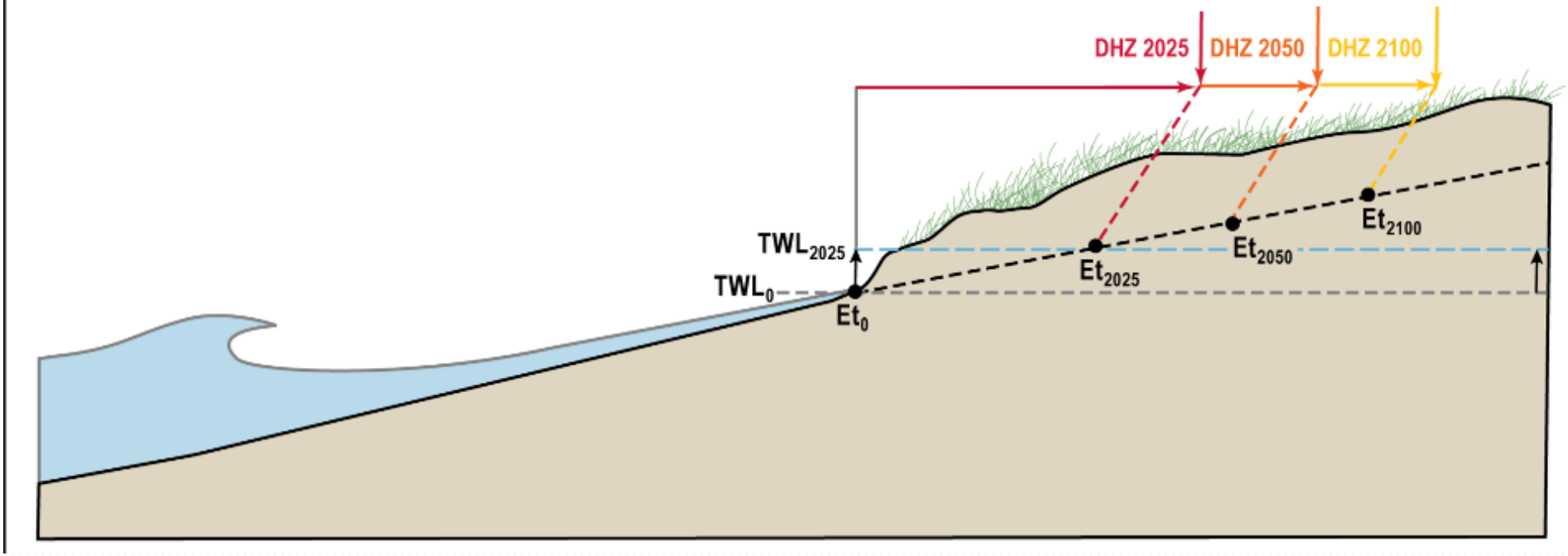


PWA Backshore Classification

4095 segments



Dune Erosion Model



- 3 components –
  - Changes in TWL from SLR combined with shoreface slope
  - Historic shoreline trends (USGS)
  - Impact of a "100 year storm event"

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Dune Hazard Zones

Air Photo from 2005

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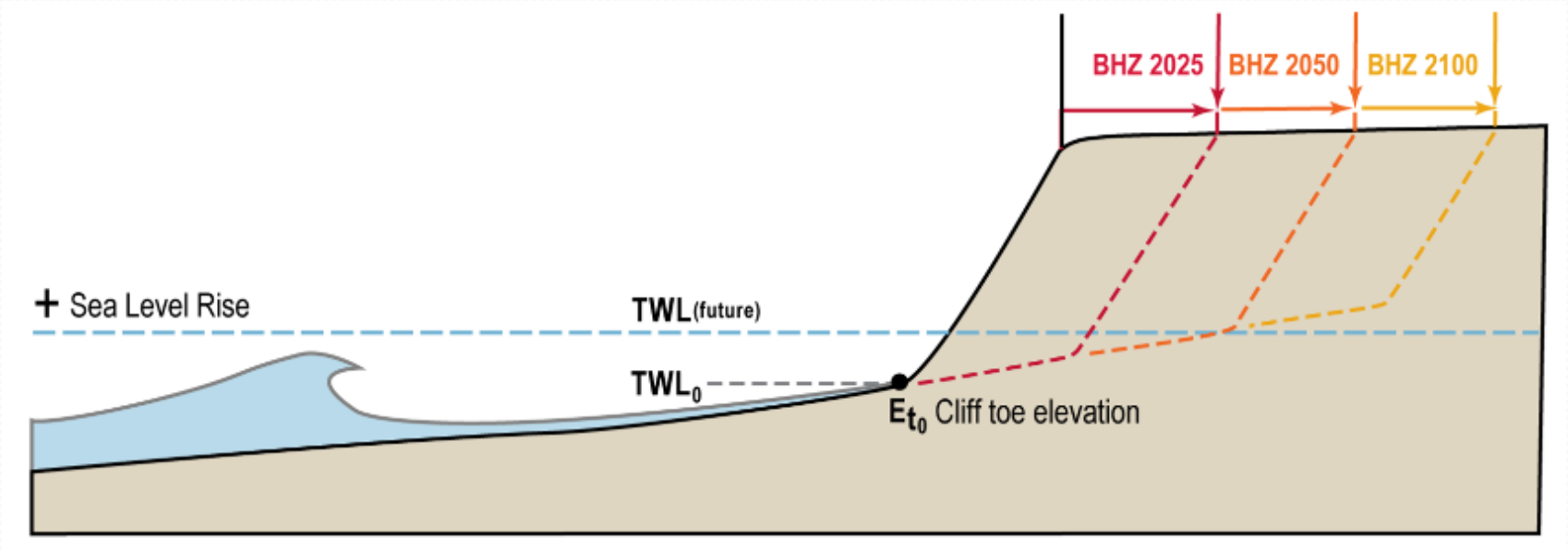
Cliff Erosion Model



- Acceleration of historic erosion rates (Rh)
- Prorated based on % increase in TWL exceeding the elevation of the toe of the beach/cliff junction
- Include geologic unit standard deviation x planning horizon to account for alongshore variability

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California State Guidance

Year		Average of Models	Range of Models
2030		7 in (18 cm)	5-8 in (13-21 cm)
2050		14 in (36 cm)	10-17 in (26-43 cm)
2070	Low	23 in (59 cm)	17-27 in (43-70 cm)
	Medium	24 in (62 cm)	18-29 in (46-74 cm)
	High	27 in (69 cm)	20-32 in (51-81 cm)
2100	Low	40 in (101 cm)	31-50 in (78-128 cm)
	Medium	47 in (121 cm)	37-60 in (95-152 cm)
	High	55 in (140 cm)	43-69 in (110-176 cm)

2 current pilot projects

- Coastal Resilience project in Ventura County
- Monterey Bay regional SLR coastal hazard assessment

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Infrastructure at Risk

At Risk by 1.4m SLR

- Roads: 3,500 miles*
- Highways: 400 miles*
- Railroads: 300 miles*
- Schools: 139
- Hospitals: 55
- Police/Fire Stations: 34
- Power Plants: 30
- Wastewater Plants: 28
  - * Did not include So.Cal erosion

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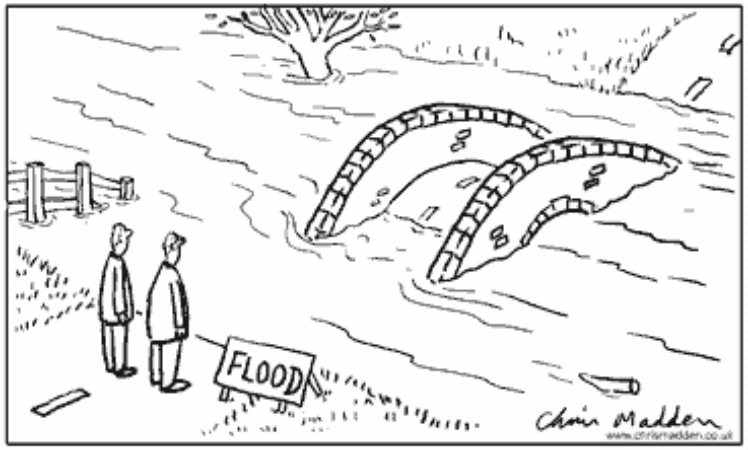
GLOBAL FORECASTING INSTITUTE
According to this report, climate change may cause serious flooding!
Well, we'll cross that bridge when we come to it.


FLOOD
Chris Madden


Photos courtesy G.Griggs

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Case

There is an inherent conflict between the static property boundaries and the dynamic shoreline….

We need to continue to evolve our thinking to incorporate future changes.

Policy and Management Recommendations # 1

1. **Integrate future sea level rise and accelerating erosion into coastal policies.**
2. **Limit scales of development in areas at risk from SLR – setbacks, size of development, uses.**
3. **Preserve adjacent uplands to keep options open.**
4. **Maintain historic ecological linkages between oceans, beaches, dunes, and wetlands.**
5. **Cost-benefit analyses should explicitly evaluate the social, recreational and environmental tradeoffs of adaptation strategies. Multiple time horizons…**

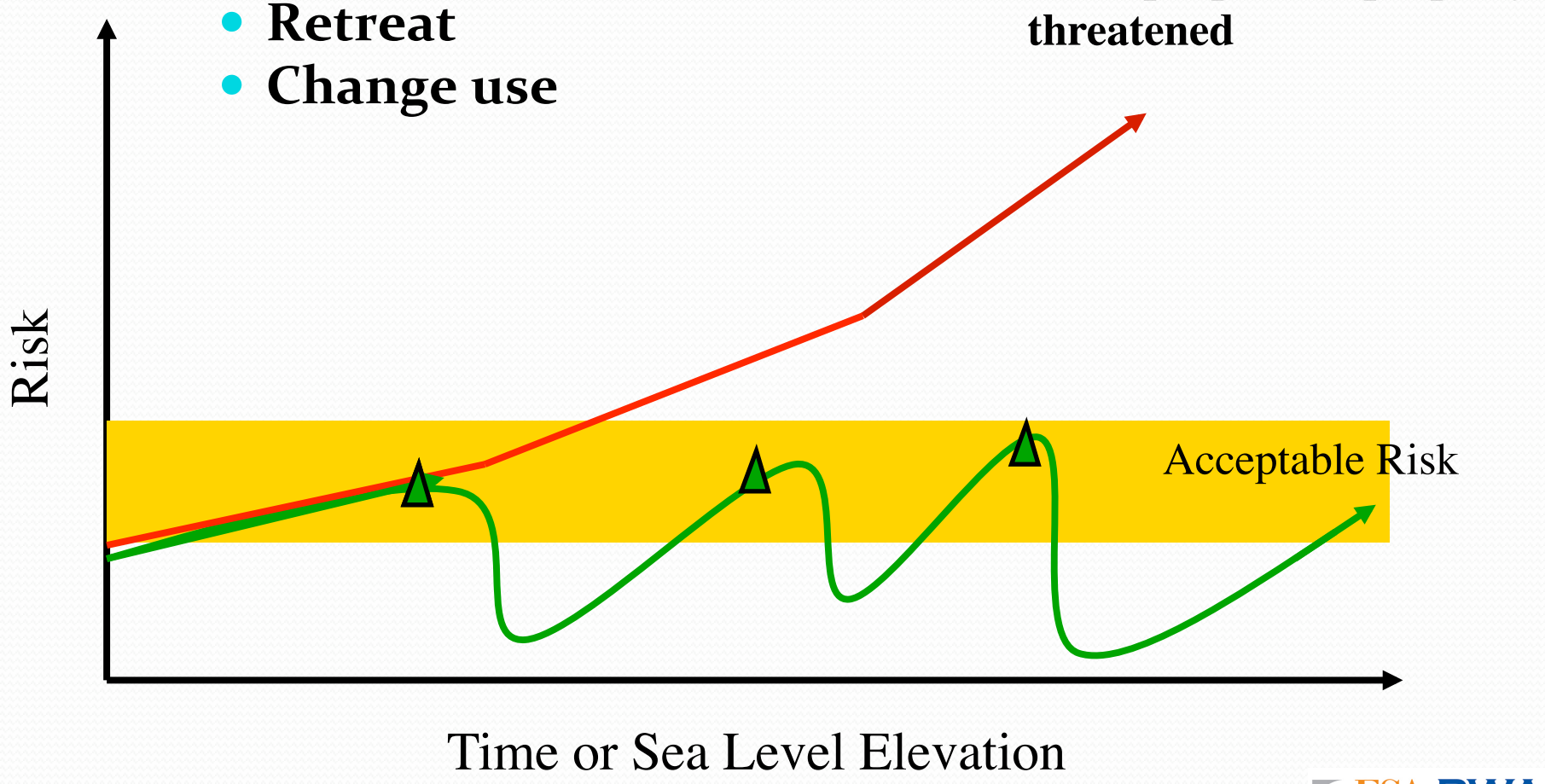
Policy and Management Recommendations # dos

6. Adopt policies to avoid future erosion hazards- e.g. managed retreat, rolling easements, transfer dev.
7. Have future seawalls bonded to have upfront costs for removal, maintenance at end of structure life/ nuisance
8. Review flood insurance programs in light of SLR
9. Conduct local vulnerability assessment of future erosion and flooding hazards
10. Communicate results with the planning jurisdictions and policy decisions makers…

Adaptation

Choices

- Hold the line
- Retreat
- Change use



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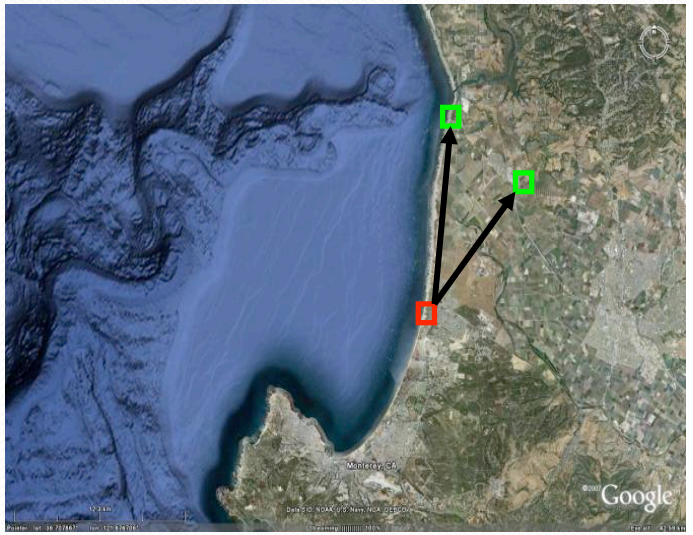
Land Use Planning Tools

- Rolling easements
- Managed Retreat
- Transfer of development credit
- Conservation Easements
- Present use tax
- Fee Simple Acquisition
- Structural or Habitat Adaptation
- Setbacks for Bluff top Development
- Setbacks + Elevation for Beach Level Development



Generally issues are: high upfront costs, long implementation timelines, limited application, or put off the problem until a later date

Non Structural

- Sand Mining cessation
- SCOUP/ Opportunistic Sand
- Beach Dewatering
  - Active Pumping
  - Passive – PEMs
  - Desalination wells
- Beach Nourishment

General approach is: increase natural sand supply, accelerate natural accretion processes, or augment sand volumes

Structural Tools

- Revetments
- Seawalls
- Perched Beaches
- Groins
- Breakwaters
- Artificial Reefs/ Submergent Breakwaters/ Low Crested Structures

Photo courtesy G.Griggs

*$**3.6** million sand mitigation fee for lost recreational beach over the life of the seawall*

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Regulatory Risk Analysis

HYPOTHETICAL LAND USE TOOL	HYPOTHETICAL PROPERTY TYPE		
	Undeveloped property with proposed development	**Developed property with "no future armoring" permit condition in place**	**Residential development *predating* the Coastal Act**
Transfer of development rights (TDR) credits	No Development Allowed; Partial Diminution in Property Value —1	N/A, although TDRs can be used in combination with easements and setbacks to reduce regulatory risk.	N/A, although TDRs can be used in combination with easements and setbacks to reduce regulatory risk.
Lateral conservation easement condition to CDP	Exactions or Dedications—2	Exactions or Dedications—3	Exactions or Dedications—4
Rolling easement ("no future armoring") condition to CDP	Exactions or Dedication —5	N/A, although TDRs can be used in combination with easements and setbacks to reduce regulatory risk.	Exactions or Dedication —6
Rolling easement regulation	Partial Diminution in Property Value—7	Partial Diminution in Property Value—8	Partial Diminution in Property Value—9
Setback condition to CDP	Exactions or Dedications—10	Exactions or Dedications—11	Exactions or Dedications—12
Setback regulation	Denial of All Economically Beneficial Use; Partial Diminution in Property Value—13	Denial of All Economically Beneficial Use; Partial Diminution in Property Value—14	Denial of All Economically Beneficial Use; Partial Diminution in Property Value—15

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