Adapting to a Rising Sea Level

October 12, 2016

City of Carlsbad

How Is Carlsbad Planning for Sea Level Rise?

Latest Project Update

- Stakeholder Outreach Meetings
- Survey Questionnaires
- Initial Development of Adaptation Strategies
- Initial Development of LCP/Zoning Updates
- Continued Coordination with Coastal Commission

Stakeholder Outreach

- Buena Vista Lagoon Foundation
- Batiquitos Lagoon Foundation
- Encina Waste Water
- Buena Sanitation/City of Vista
- North County Assoc. of Realtors
- Sierra Club
- North County Transit District
- Leucadia Waste Water
- Carlsbad City Departments
- SDG&E
- California State Parks
- Poseidon Resources Corp.
- Surfrider Foundation
- Agua Hedionda Lagoon Foundation

Residential Outreach

- Survey Questionnaires
- 207 Respondents
  - 60% near a lagoon
  - 30% North Carlsbad
  - 15% Terramar
- 15% of respondents have had past coastal damage
- At risk, 55% properties with bluffs or slopes

What is Vulnerable?

- Beaches
- State Parks
- Buildings
- Critical Infrastructure
- Transportation
- Environmentally Sensitive Lands

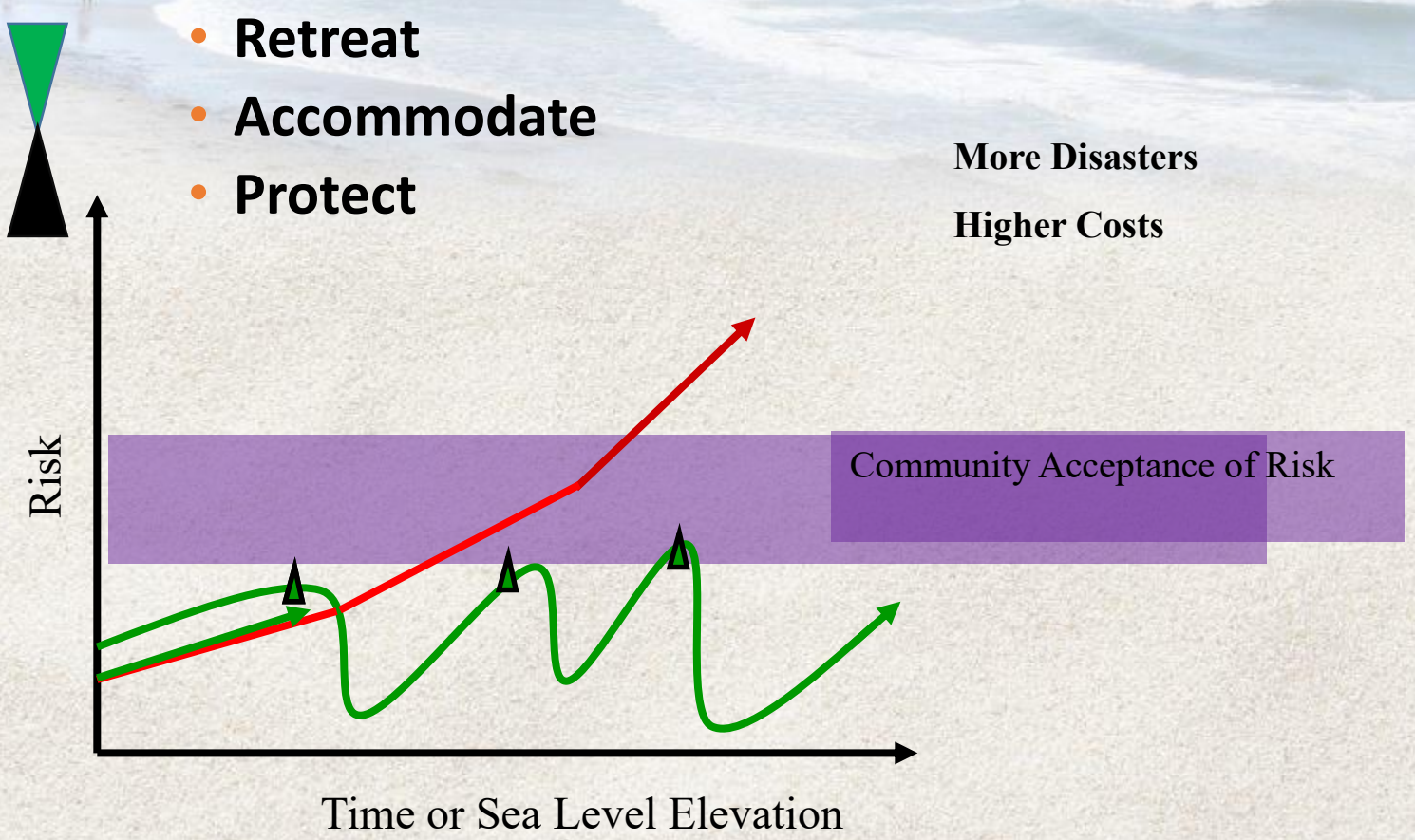
Adaptation Strategies

What is Adaptation?

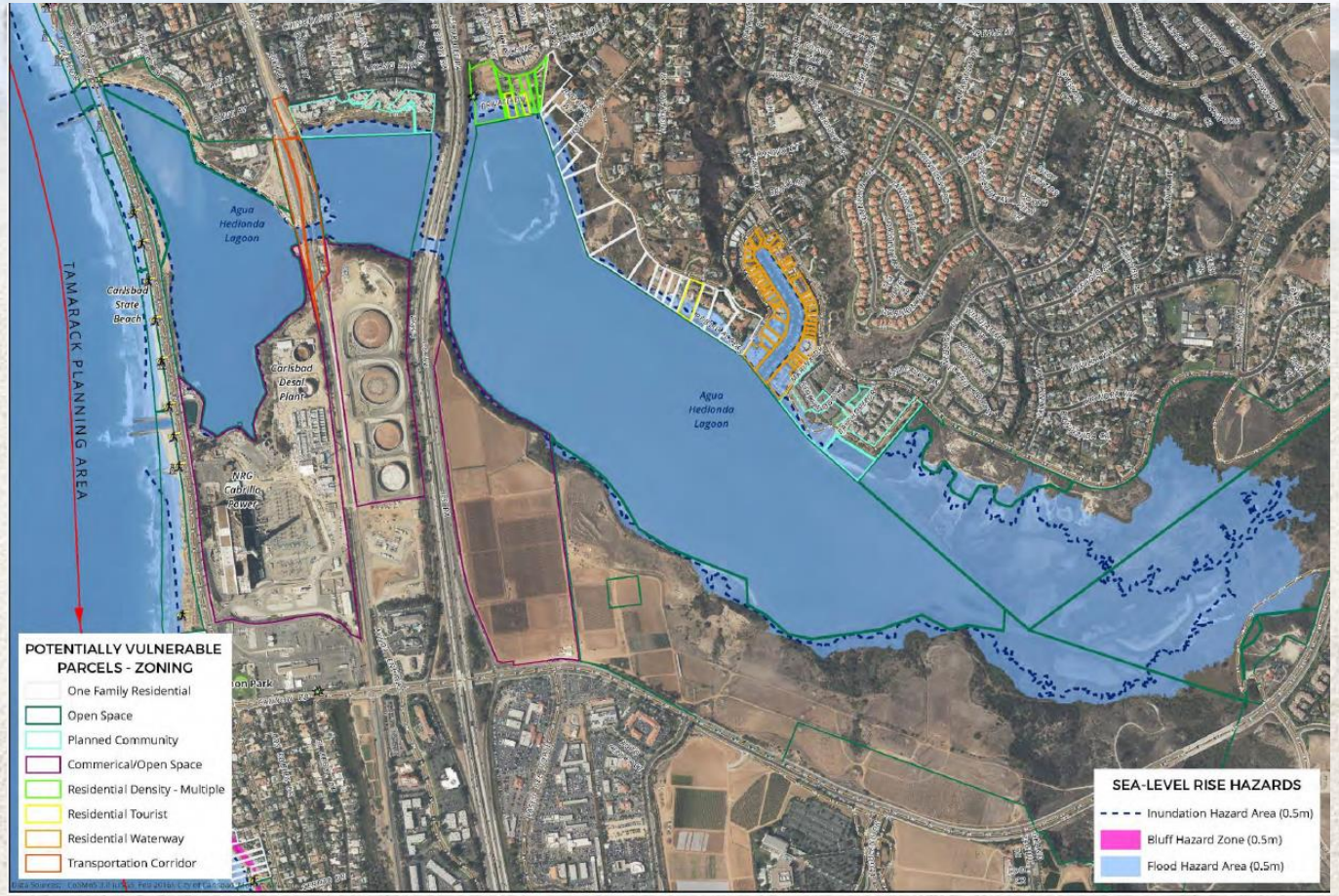
- **Do Nothing**
- **Retreat**
- **Accommodate**
- **Protect**

More Disasters

Higher Costs



Vulnerability Maps



Modeling assumes no adaptation strategies

Adaptation

- Project vs Policy Approaches

Do Nothing

Retreat

- Fee Simple Acquisition
- Realignment / Phased relocation
- Rolling Easements / Conservation Easements
- Hybrid – Purchase with lease back option

Source: California Coastal Records Project

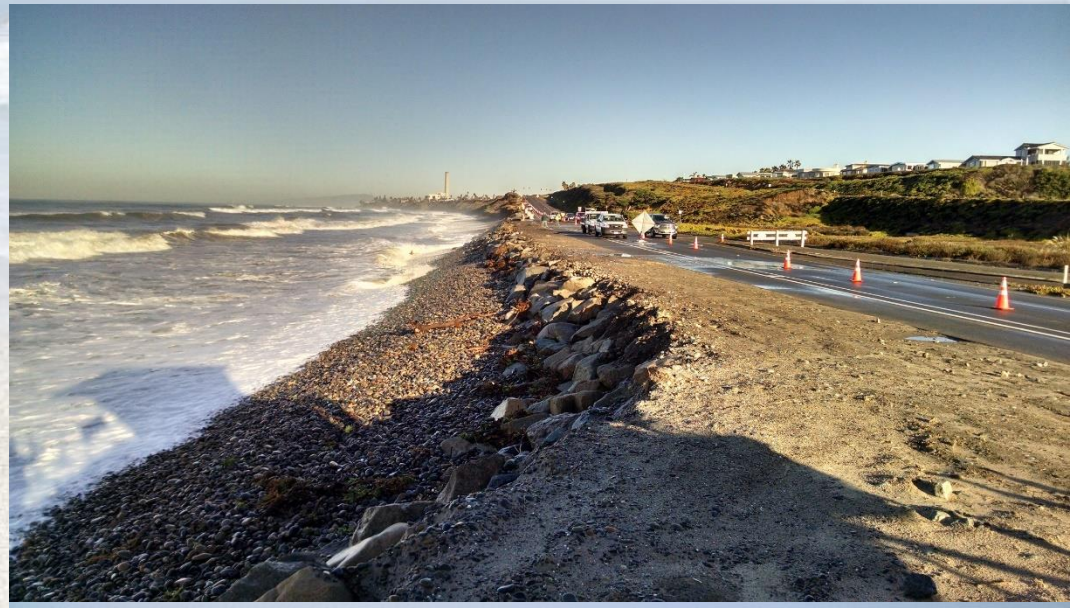
Accommodate

- Elevate
- Setbacks
- Moveable Foundations
- Building standards

Protect

- Green
  - Sediment Management
  - Beach Nourishment
  - Cobble Nourishment
- Gray
  - Seawalls and Revetments
  - Breakwaters
  - Jetties
  - Artificial Reefs
  - Perched Beaches

Photos City of Carlsbad



Opposing Viewpoints on Adaptation

What if…?

How much
does it cost?

Beach front homeowners ask what will my house be worth in 30 years?

Beach communities ask what will my beach look like in 30 years?

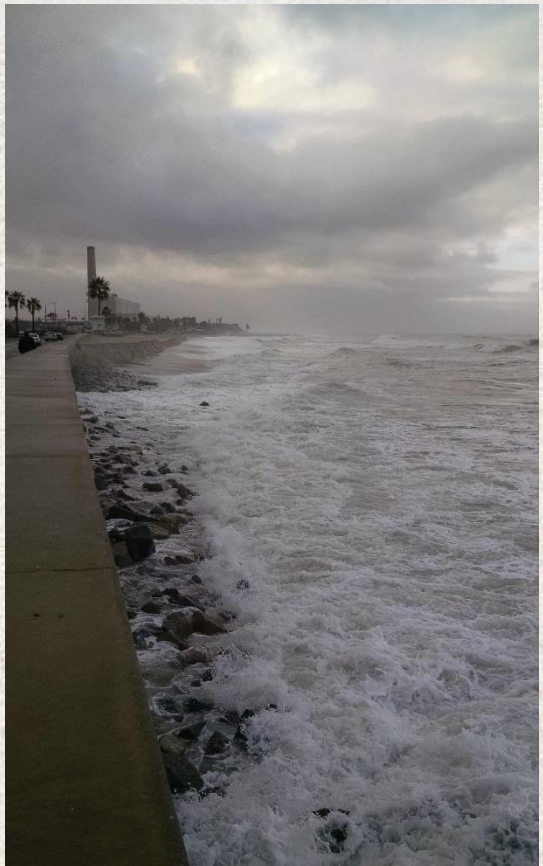
Can’t we make everyone happy?

Adaptation Strategies - Projects

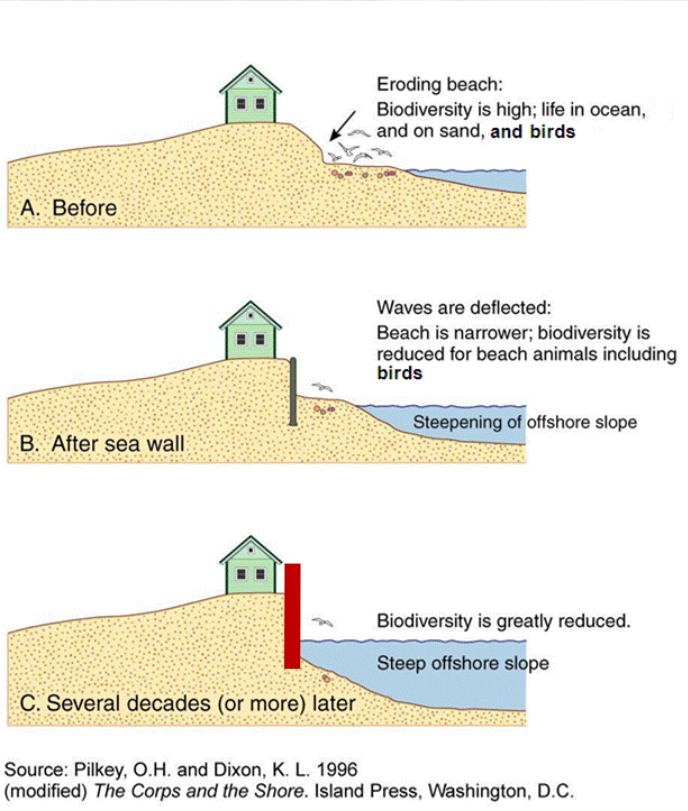
1. Fee Simple Acquisition
2. Conservation Easements
3. Transfer of Development
4. Rolling Easements
5. Managed Retreat
6. Structural or Habitat Adaption
7. Setback Development
8. Controlling Surface Run-off
9. Controlling Groundwater
10. Beach Nourishment
11. Harbor By-Passing
12. Back-Passing
13. Subaerial Placement
14. Artificial Seaweed
15. Geotextile Core
16. Nearshore Placement
17. Offshore Sand Deposits
18. Added Coarser Sand than Native
19. Opportunistic Sand
20. Canyon Interception
21. Inter-littoral Cell Transfers
22. Berms/Beach Scraping
23. Perched Beaches
24. Groins
25. Breakwaters
26. Dune Nourishment
27. Delta Enhancement
28. Headland Enhancement
29. Geotextile Groins
30. Branch Box Breakwaters
31. Floating Breakwaters
32. Submerged Breakwaters
33. Dune Restoration
34. Beach Dewatering
35. Seawalls
36. Revetments
37. Gabions
38. Cobble Nourishment
39. Dynamic Revetments
40. Geotextile Revetment
41. Floating Reefs
42. Rubber Dams
43. Sand Fencing
44. Soil Nail Walls
45. Perched Beaches

Secondary Impacts

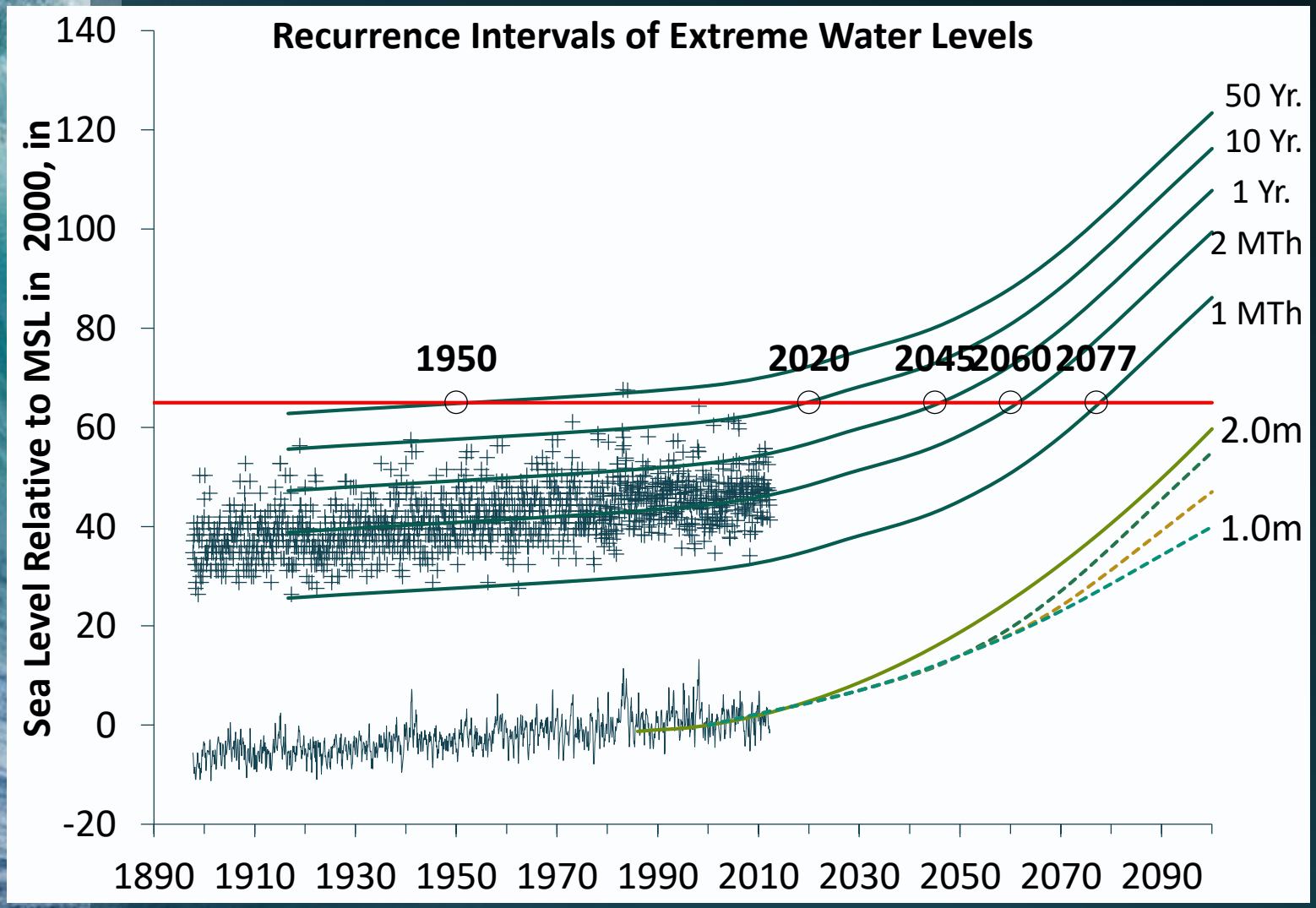
- Construction Costs
- Escalating Maintenance Costs
- Ecology
- Recreation
- Views
- Aesthetics



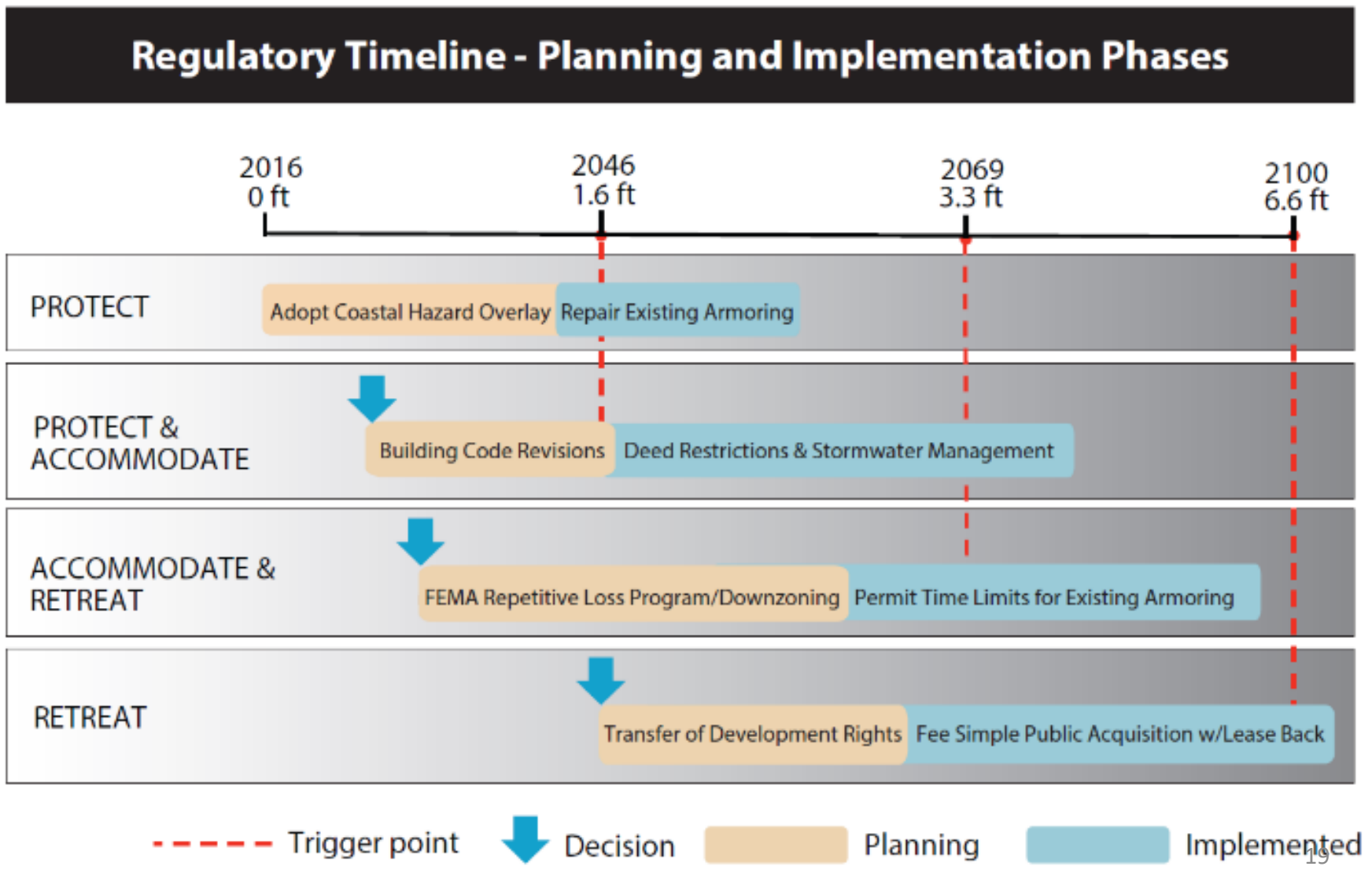
- Seawalls destroy beaches and views



Source: Pilkey, O.H. and Dixon, K. L. 1996 (modified) *The Corps and the Shore*. Island Press, Washington, D.C.


Recurrence Intervals of Extreme Water Levels
Sea Level Relative to MSL in 2000, in
140
120
100
80
60
40
20
0
-20
1890
1910
1930
1950
1970
1990
2010
2030
2050
2070
2090
1950
2020
2045
2060
2077
50 Yr.
10 Yr.
1 Yr.
2 MTh
1 MTh
2.0m
1.0m

Policy - Implementation Times



Shoreline Type – Estuaries and Beaches

- Setting – Sandy Beach, “Dunes”, and Low Lying Estuaries

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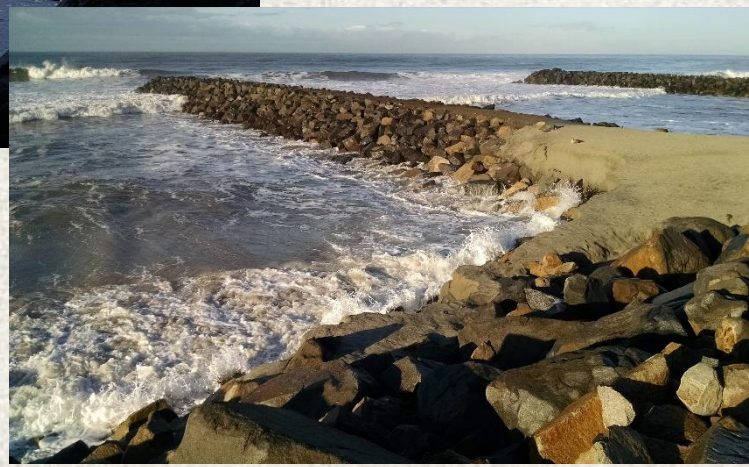


- Physical Processes
  - Wave Flooding
  - Coastal Erosion
  - Stormwater confluence
  - Eventually Tidal Inundation
- Key Vulnerabilities –
  - North Beach/Buena Vista, Aqua Hedionda, Batiquitos Lagoons

Adaptation Options – Estuaries and Beaches

- Adaptation
- Retreat (purchase or easements)
- Nourishment
- Groins with nourishment
- Sand Retention
- Armoring
- Elevate
- Dune or wetland restoration

- Secondary Impacts
- Eventual loss of property
- Impacts to sensitive species
- Habitat changes, lateral access
- Eventual loss of beach, aesthetics
- Aesthetics, retrofit is expensive

Shoreline Reach – Bluffs

- Setting – Bluff backed, narrow beaches, armor backed
- Physical Processes
  - Wave Velocity
  - Coastal Flooding
  - Erosion of Bluffs
  - Acceleration of Bluff erosion
- Vulnerabilities
  - Visitor Serving State Parks and Accommodation
  - Beach Access
  - Recreation

Photo City of Carlsbad

Adaptation Options – Bluffs

- Adaptation Strategies

- Retreat
- Armoring (recurved seawall)
- Soil Nail Wall
- Elevation
- Setbacks

- Secondary Impacts

- Loss and damages to development
- Loss of beaches, access, habitats, aesthetics
- Viewsheds
- Put off for future generations

Adaptation Options - Policy

- Goal reduce City wide vulnerabilities and liabilities
- Utilizing zoning regulations to support strategies
  - Hazard overlays
  - Site specific report
  - Real estate disclosures for hazards
  - Repetitive loss strategy
  - Revised setback standards that account for accelerated erosion
- Monitoring
  - Effectiveness of strategies
  - Triggers

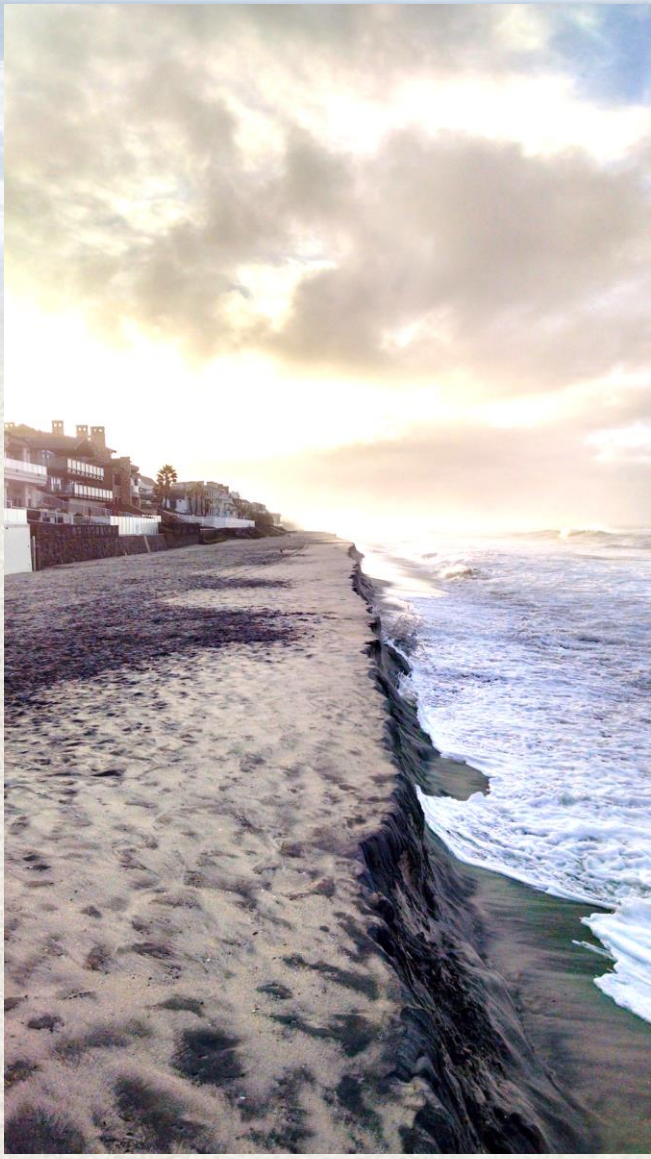


Photo City of Carlsbad

Adaptation Options - Projects

- Continue with regional sand nourishment/ bypassing
- Construct winter berm/dunes
- Landward relocation of public assets
- Manage existing revetments
- Rolling easements along bluff edge
- Fee Simple Acquisition
- Limit redevelopment/repairs to non conforming structures in at risk locations

Triggers

- **By sea level rise elevation** – trigger planning stages, study requirements
- **By time** – specify that by 2025 some long range study identifying appropriate strategies must be complete (e.g. wastewater or transportation) planning.
- **By exposure** – how frequently does Highway 101 get exposed to wave action? Once a decade currently, have to do something different if once a month
- **By damages** – structures need to be removed when it is damaged by 50% or has multiple damage claims

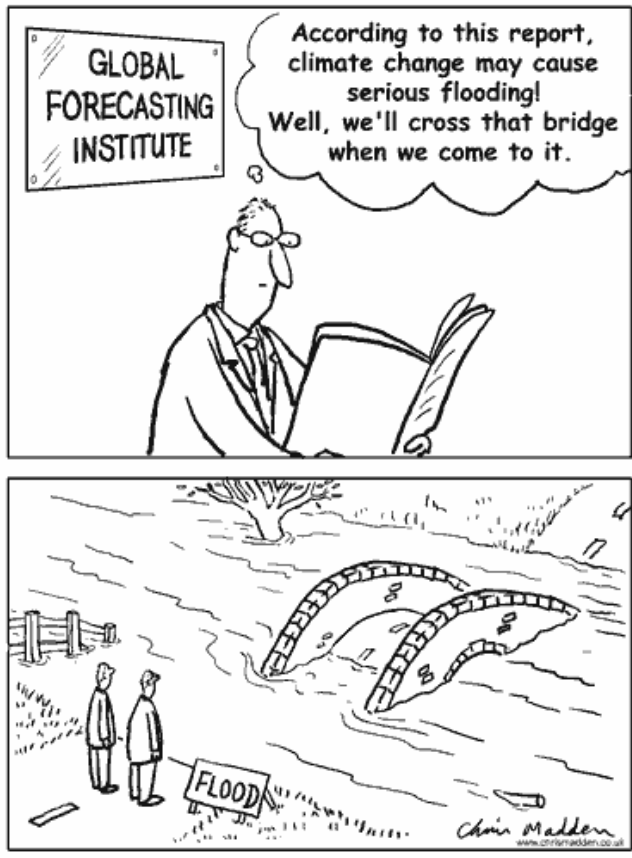
Implementation

- Variety of different mechanisms
- Tied to triggers
- Regional Sediment Management Plans
- Capital Improvement Plan
- Local Hazard Mitigation Plans
- Park Master Plans
- Shoreline Management Plans
- Local Coastal Program

Photo City of Carlsbad

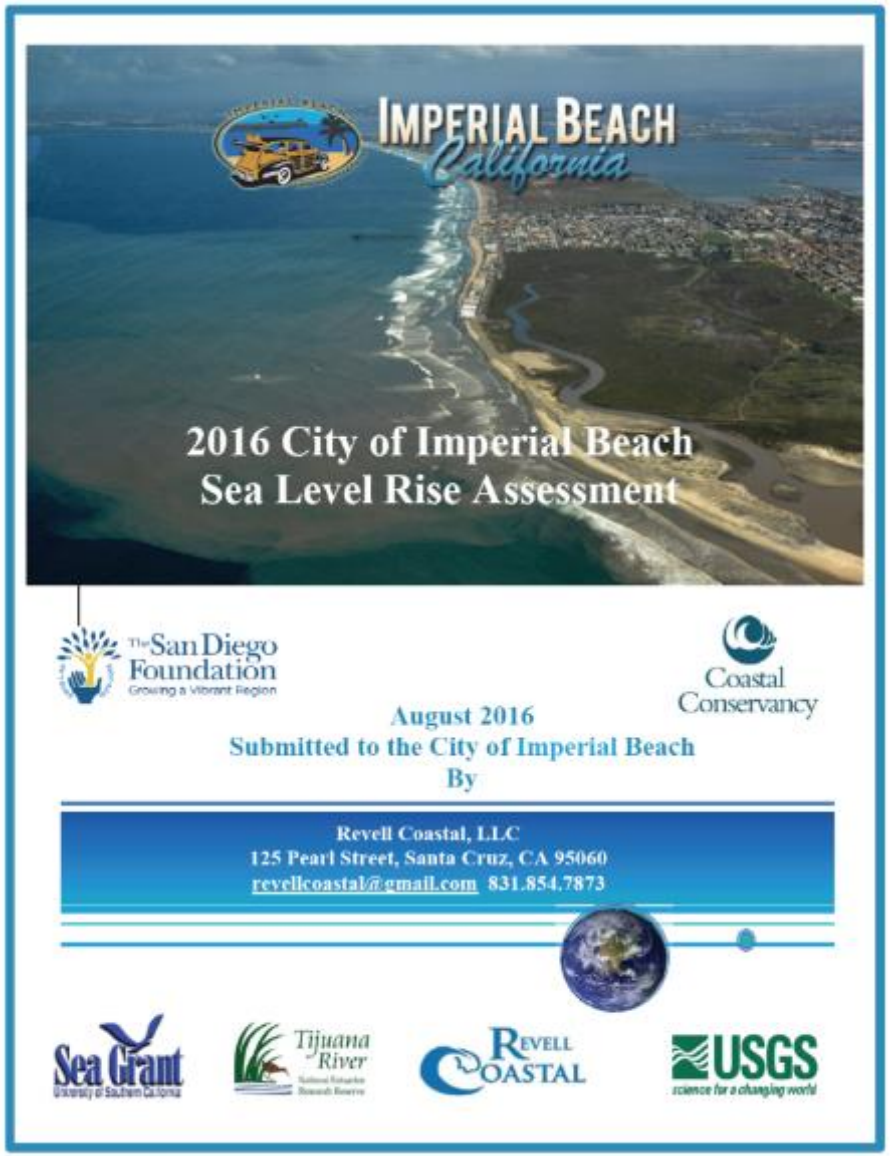
Financial vehicles

- Transient Occupancy tax (dedicated %)
- Infrastructure rate payer increases
- Sales Tax increase
- Coastal Hazard Abatement Districts (CHAD)
- Local Hazard Mitigation Projects (FEMA)
- Fees – Sand mitigation, recreational loss fee, placement loss of beach (rent)
- Green Infrastructure Bonds



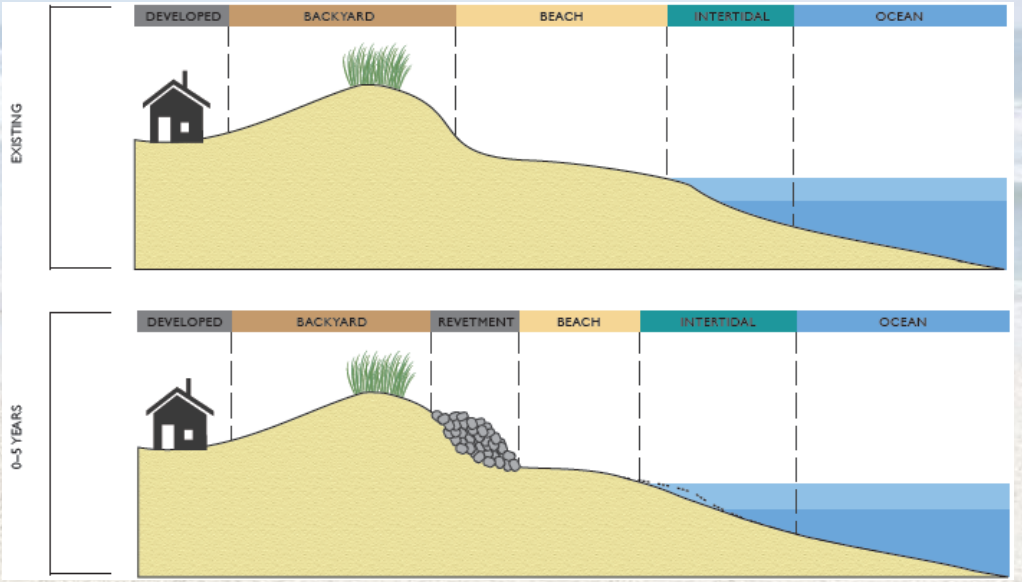
The City can't adapt to climate change alone… the County, SANDAG, the Cities of Encinitas and Oceanside, San Diego Gas and Electric, NRG, San Diego Climate Collaborative, Caltrans must all be partners.

Imperial Beach Case Study



Methods

For each Adaptation Strategy:



- Beach Width vs Upland – Physical modeling

(assumes erosion caused by accelerated erosion rates, not direct storm impacts)

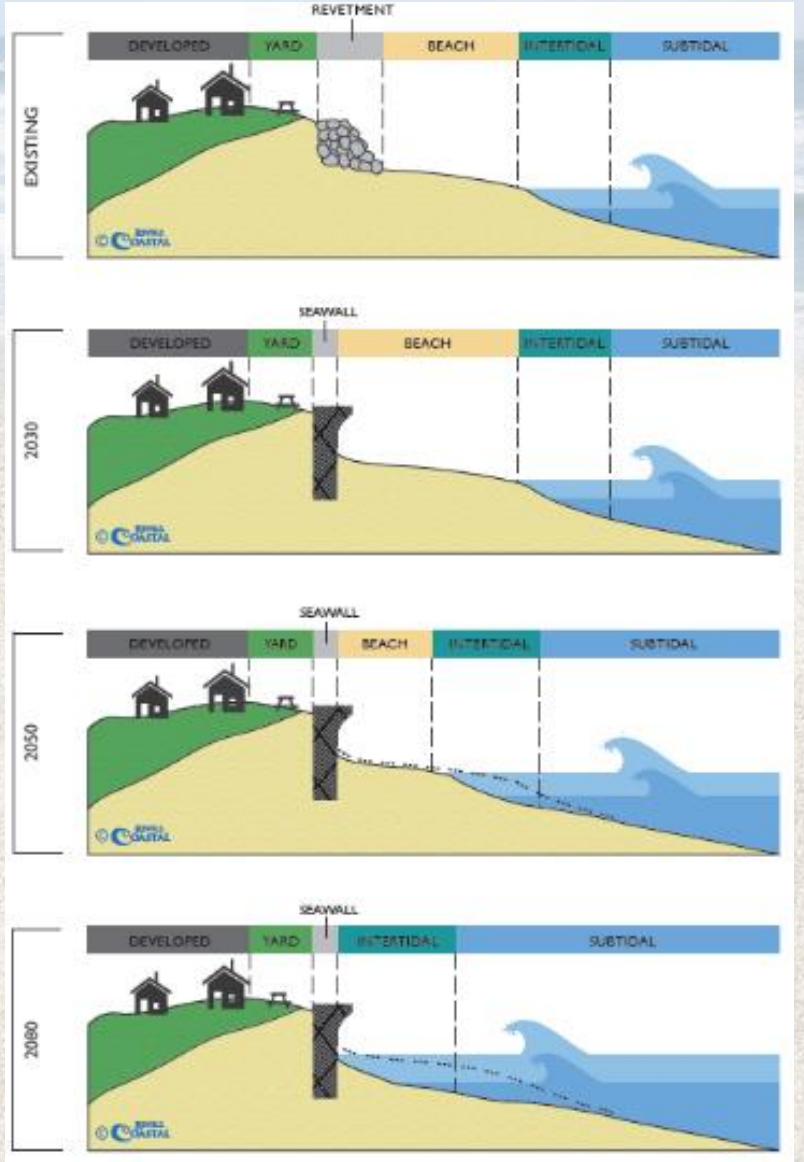
- Physical and Economics over multiple horizons
- Recreation and habitat valuation
- Narrow versus wide beach

Coastal Armoring

- Key findings:

- **Dry sand beaches disappear between 2050 - 2075**
- **Only damp sand beaches by 2035 - 2065**

***Not directly including storm impacts which could speed up impacts



Beach Changes

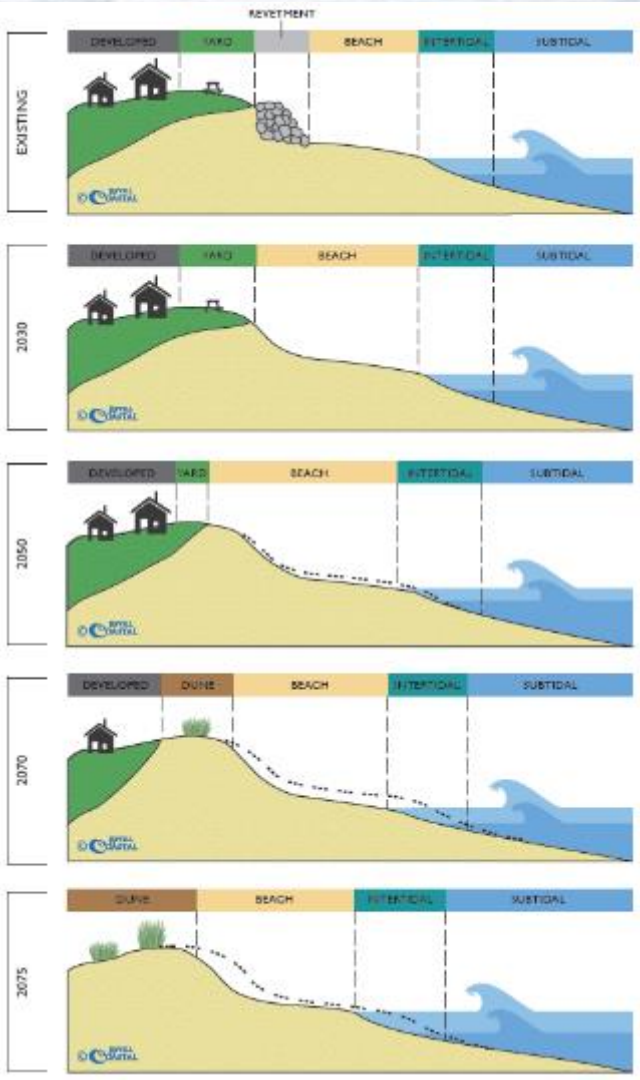
- Loss of sand from the beach
- Exposure of revetments and seawalls
- Difficult and unsafe beach access

Managed Retreat

- Allow Erosion
- Variety of implementation options
- Structure, armoring removed when damaged Infrastructure removed when damages occur, restoration of dune

Key findings:

- Beach is maintained
- Development eroded up to 3 parcels inland

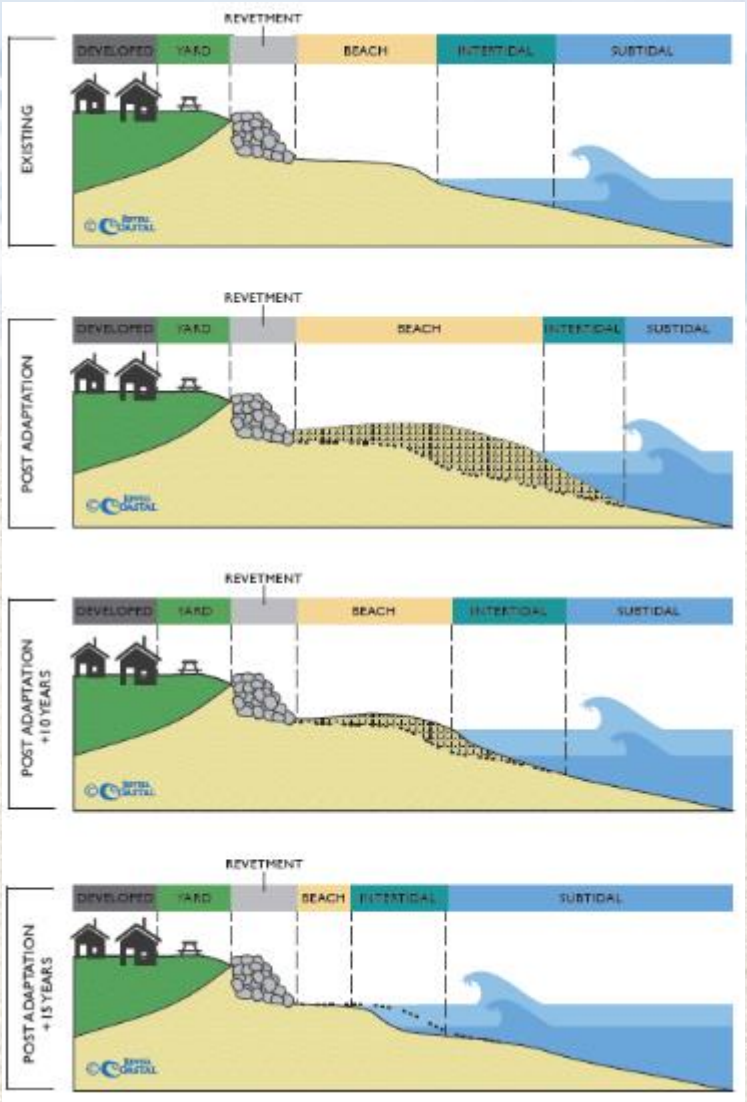


“Business-as-usual” sand nourishment

- Description: Continue to nourish beach and maintain armoring

Key finding:

- Nourishment required 9 to 11 times by 2100 to maintain beach width
- Nourishment cycle goes from ~15 years to 5 years
- Upland remains protected



Net Benefits Through 2100 (2.0 m)

	Groins	Retreat	Nourish	Dunes	Armor
2047 (0.5 m)	$217,100,000	$187,900,000	$158,500,000	$194,000,000	$219,100,000
2069 (1.0 m)	$349,100,000	$352,200,000	$219,300,000	$239,600,000	$333,500,000
2100 (2.0 m)	$420,000,000	$566,500,000	$212,100,000	$183,700,000	$327,100,000

Summary of IB Adaptation Findings

- Armoring leads to loss of beach recreation and ecological value
- Dunes/Nourishment is poor choice long term
  - Due to increasing costs and shorter construction cycles over time.
- Short term, armoring and groins about even in Net benefits
- Medium term, managed retreat and groins have similar Net benefits
- Over the long run managed retreat has highest Net benefits
  - Pubic benefits of recreation and ecological value as well as avoided construction costs offset losses to infrastructure and private property
  - Hybrid public acquisition with lease back breakeven within 30 years

Next steps: How can we use this information?

- Stakeholder Outreach
- Develop Adaptation Strategies for each planning area
- Finalize Sea Level Rise Vulnerability Study
- Perform Update to Local Coastal Program
- Future Workshops
  - Planning Commission
  - Coastal Commission

Stay Involved!

- Visit City Website for Continued Updates:
  www.carlsbadca.gov/planning

- Email: planning@carlsbadca.gov