Sea Level Rise Vulnerability and Adaptation Workshop

Dr. David Revell, Dr. Juliette Hart, Danielle Boudreau, Jim Nakagawa, Dr. Phil King, Jeff Giliem

May 11, 2016

Revell Coastal
Surf. Sand. Sustainability.

Sea Grant
University of Southern California

Tijuana River
National Estuarine Research Reserve

Imperial Beach
California

http://dornsife.usc.edu/uscseagrant/ib-slr/

Acknowledgements

Steering Committee

City of Imperial Beach

- Jim Nakagawa
- Hank Levien
- Chris Helmer
- Russell Mercer

Regional Stakeholders

- Port of San Diego
- Navy
- TRNERR

Tidelands Advisory Committee

- Joe Ellis (coastal engineer)

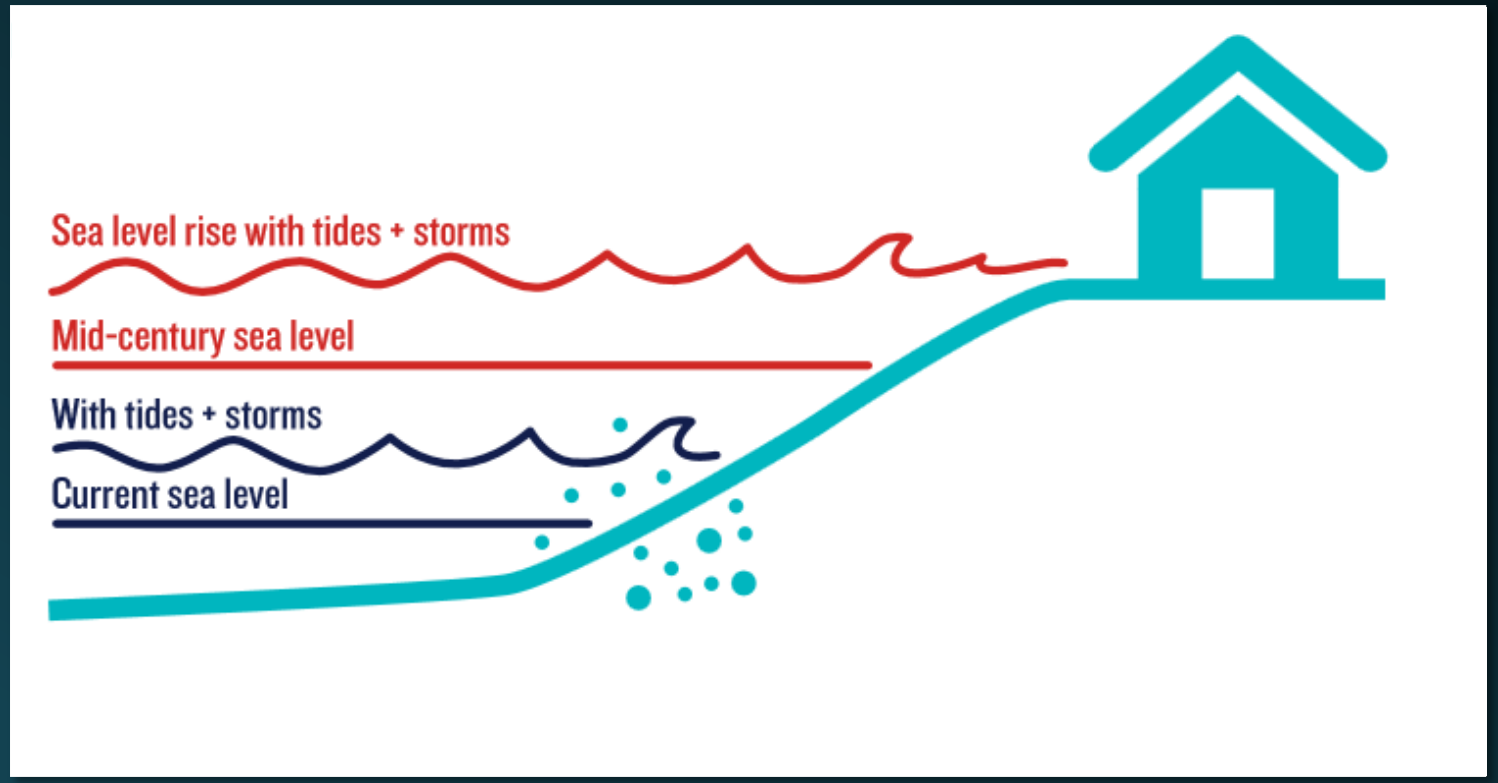
City Council Member

- Councilman Ed Spriggs

Funders

Presentation Outline

- Background
- Regional Efforts
- IB Sea Level Rise Study
- Coastal Hazards
- Vulnerability Assessment
- Adaptation Strategies
- Future Work
- Discussion



San Diego, 2050 Is Calling. How Will We Answer? (2014)
The San Diego Foundation; Climate Education Partners..

Workshop Questions

1. What do you value about IB today that you want to maintain into the future?
2. What adaptation strategies align with your vision of your community?
   - Preferences? Others?
3. How should we pay for adapting to coastal flooding and erosion?
4. How should we communicate these findings To the community?

Definitions

- Flooding vs. Inundation vs. erosion vs. nuisance flooding
- Mitigation vs Adaptation
- Hazards, Vulnerability, Adaptation

Erosion

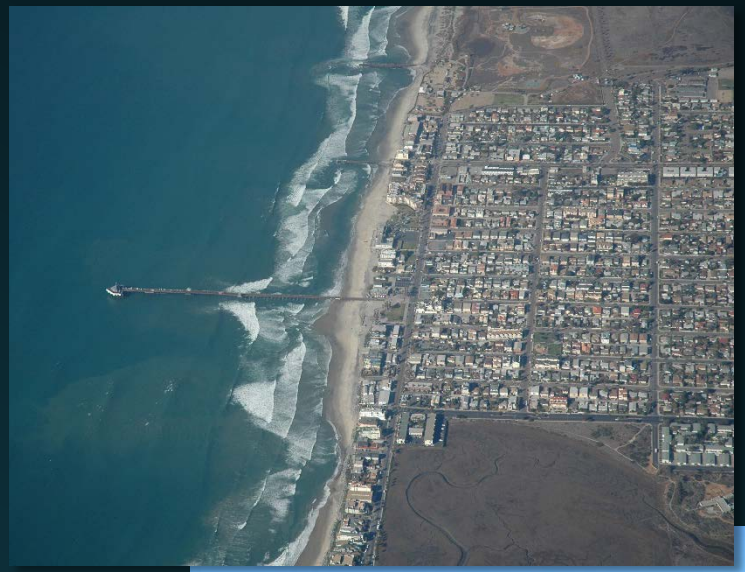
Flooding

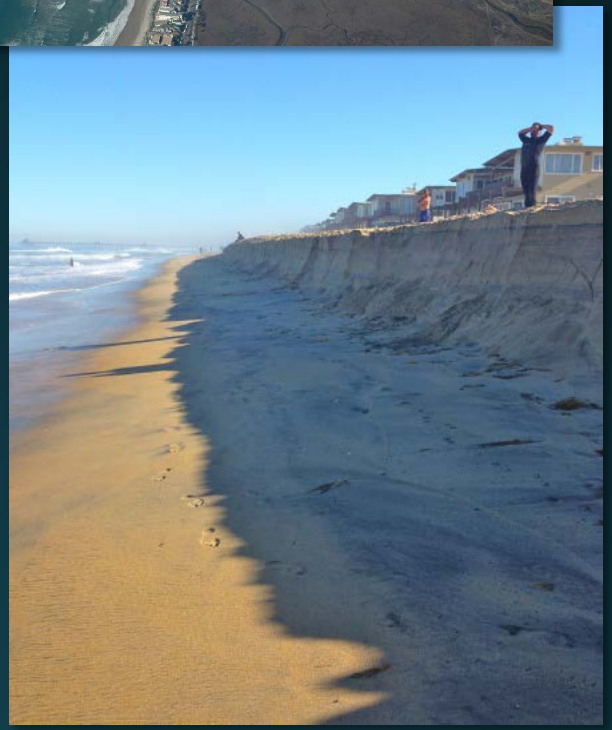
Inundation

Nuisance Flooding

Project Goals

- Identify Imperial Beach-specific coastal vulnerabilities from sea level rise and coastal hazards
- Identify range of adaptation strategies
- Recommend strategies that are politically digestible and economically feasible



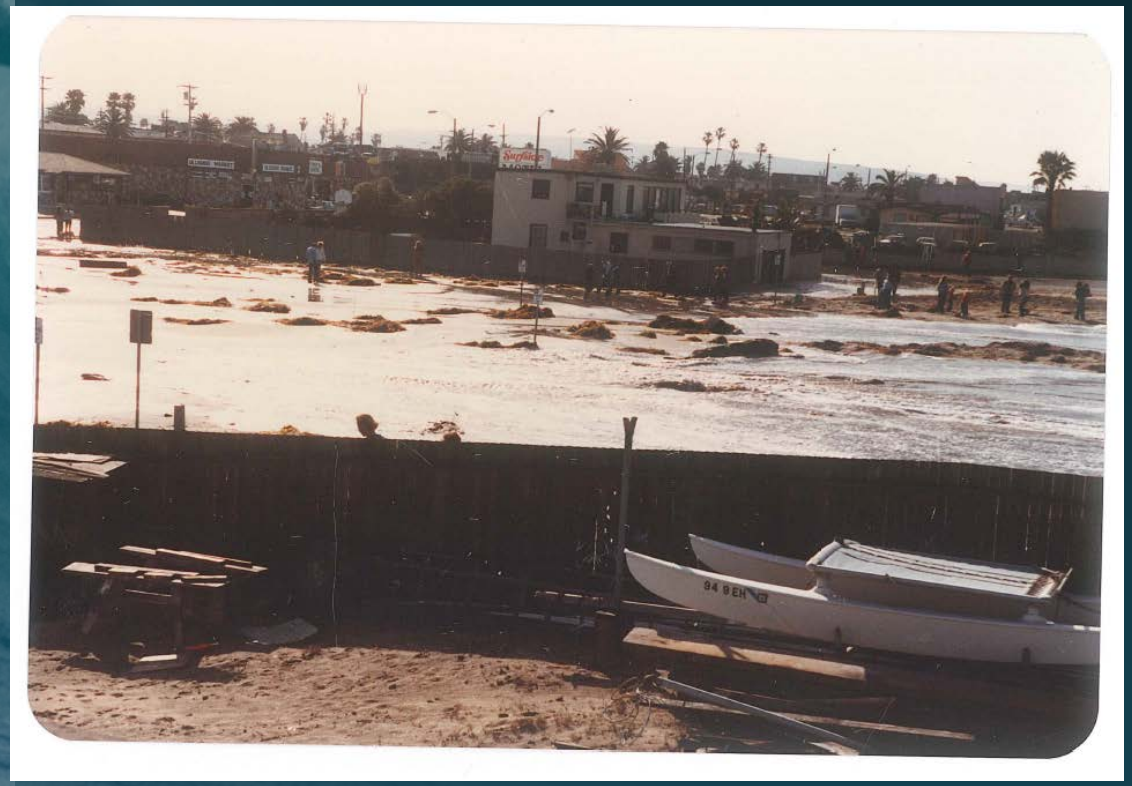


Identifying Existing Hazards

- “Today’s storm is tomorrow’s high tide”
- What we experience today are good indicators of what we will experience more frequently in the future
- Understanding existing vulnerabilities help prioritize adaptation strategies

January 1983 El Niño

January 1983 El Niño



The San Diego Union/Humberto Ramirez

A winter rainstorm flooded portions of Imperial Beach, making the day interesting for residents at 11th and Ebony. Mark Arched uses a surf board, Andrew Dedrick snorkles and Don LaBoole jumps off the roof of a house.

2010 Erosion Event

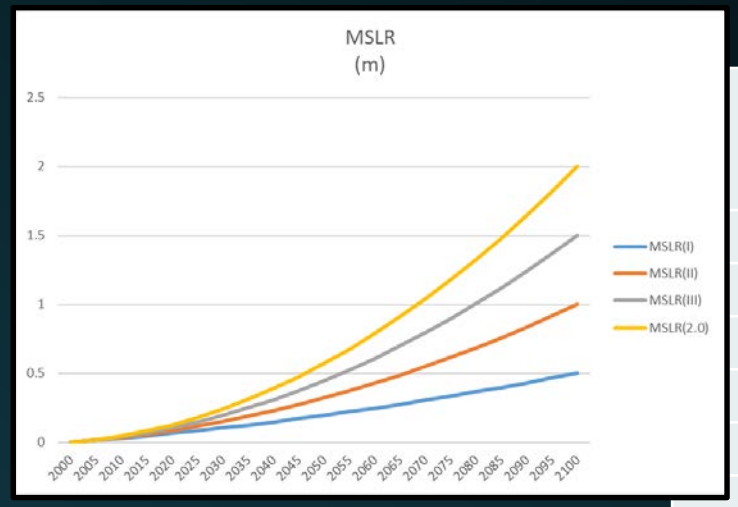
Beach Changes

- Loss of sand from the beach
- Exposure of revetments and seawalls
- Remnant cobbles remain

Sea Level Rise Impacts in San Diego

- Accelerated erosion rates
- Increase frequency and depth of coastal flooding & inundation
- Saltwater intrusion into coastal aquifers
- Beach loss
- Dangerous navigation conditions
- Beach/shore safety compromised
- Costly damages

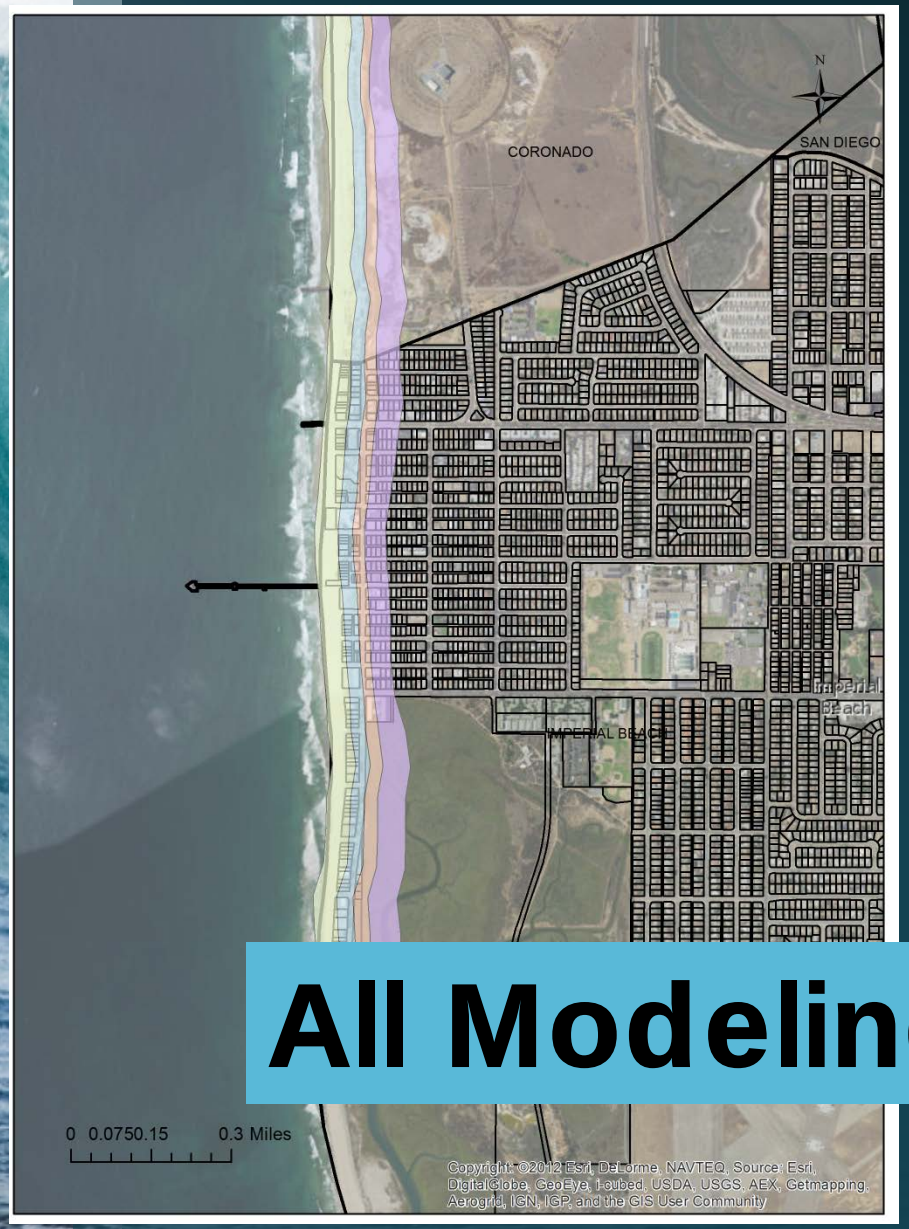
Sea level Rise and Erosion



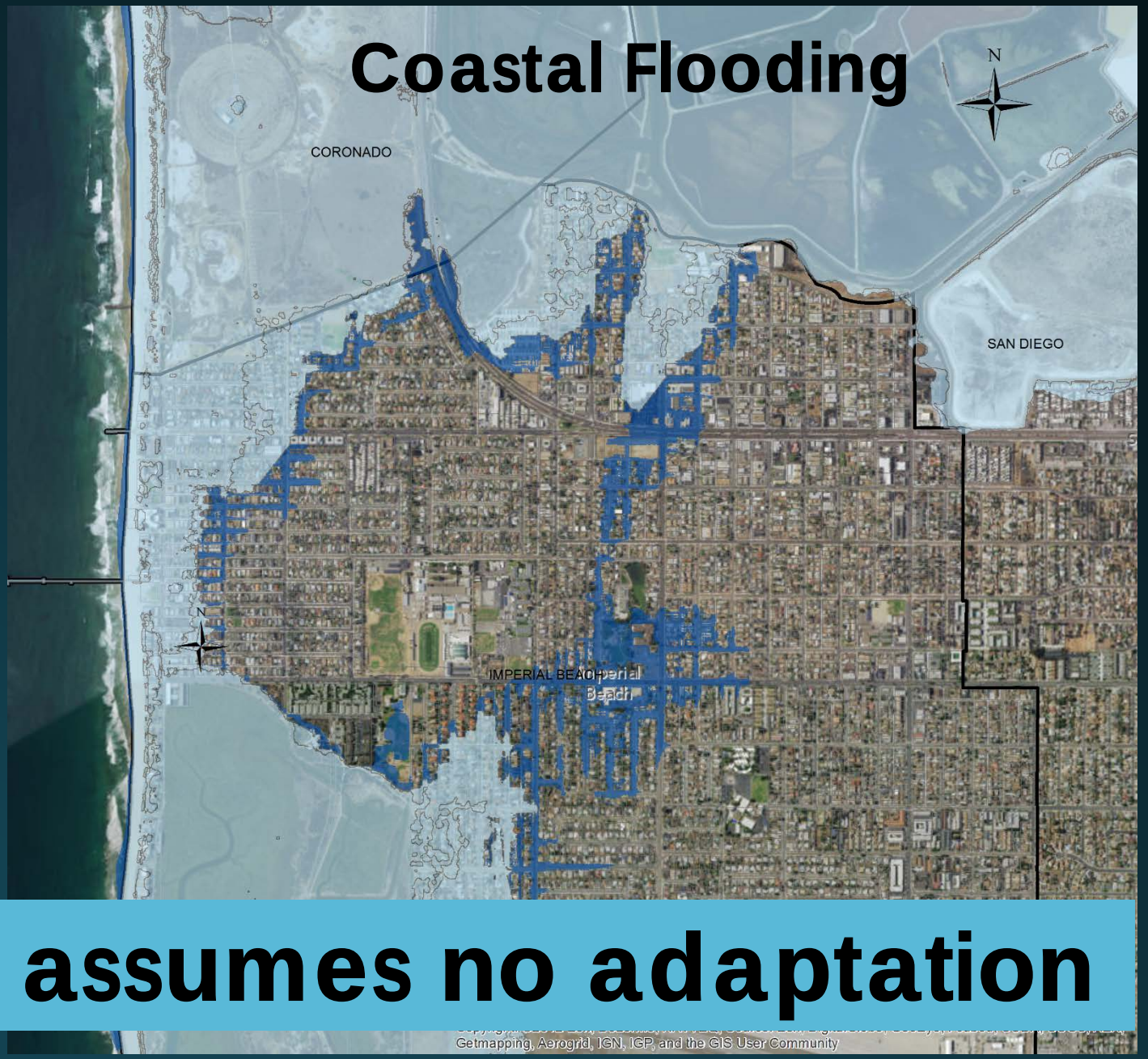
- Sea Level Rise estimates vary widely
- Plan for the worst and hope for the best
- Study examines up to 6.5 feet by 2100
- Future erosion rates calculated based on existing erosion rates and escalated 6.5 foot SLR curve.
- **7.8 inches/year to 6.2 feet/ Year**
- Do not account for storms erosion events

	Erosion Rates (ft/yr)
Year	MSLR(2.0)
2000	0.62
2005	0.62
2010	0.92
2015	1.21
2020	1.50
2025	1.79
2030	2.09
2035	2.38
2040	2.67
2045	2.97
2050	3.26
2055	3.55
2060	3.84
2065	4.14
2070	4.43
2075	4.72
2080	5.02
2085	5.31
2090	5.60
2095	5.89
2100	6.19

Coastal Erosion



Coastal Flooding



All Modeling assumes no adaptation

Modeling done separately by USGS and DoD - SPAWAR

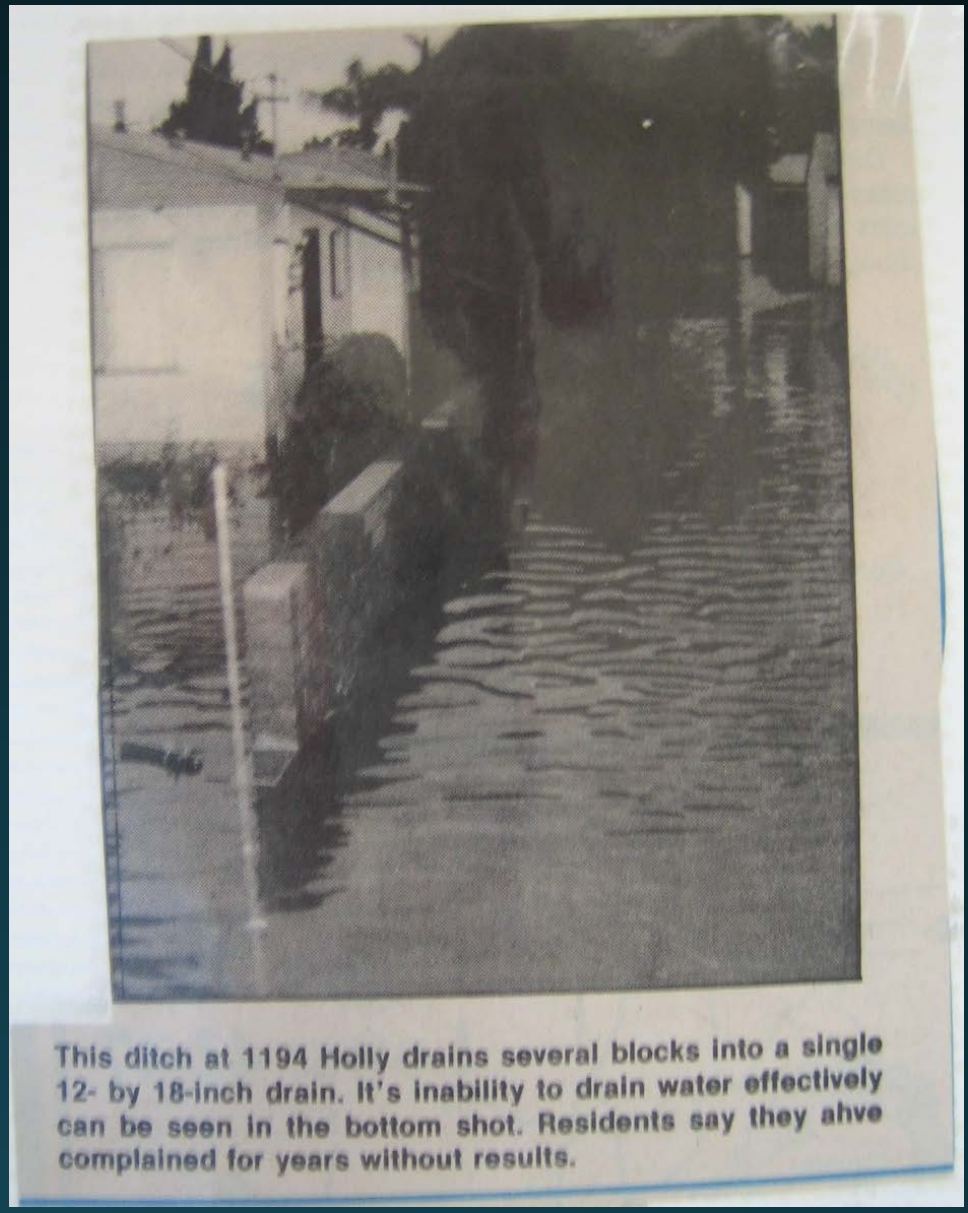
Nuisance Flooding

Caused by:

- rainfall
- wave overtopping
- high tide

South San Diego residents found taking a boat to this 7-11 store off Palm Avenue much easier than driving Tuesday. Almost five inches of rain was dumped on the South Bay causing widespread flooding, electrical problems and traffic congestion.

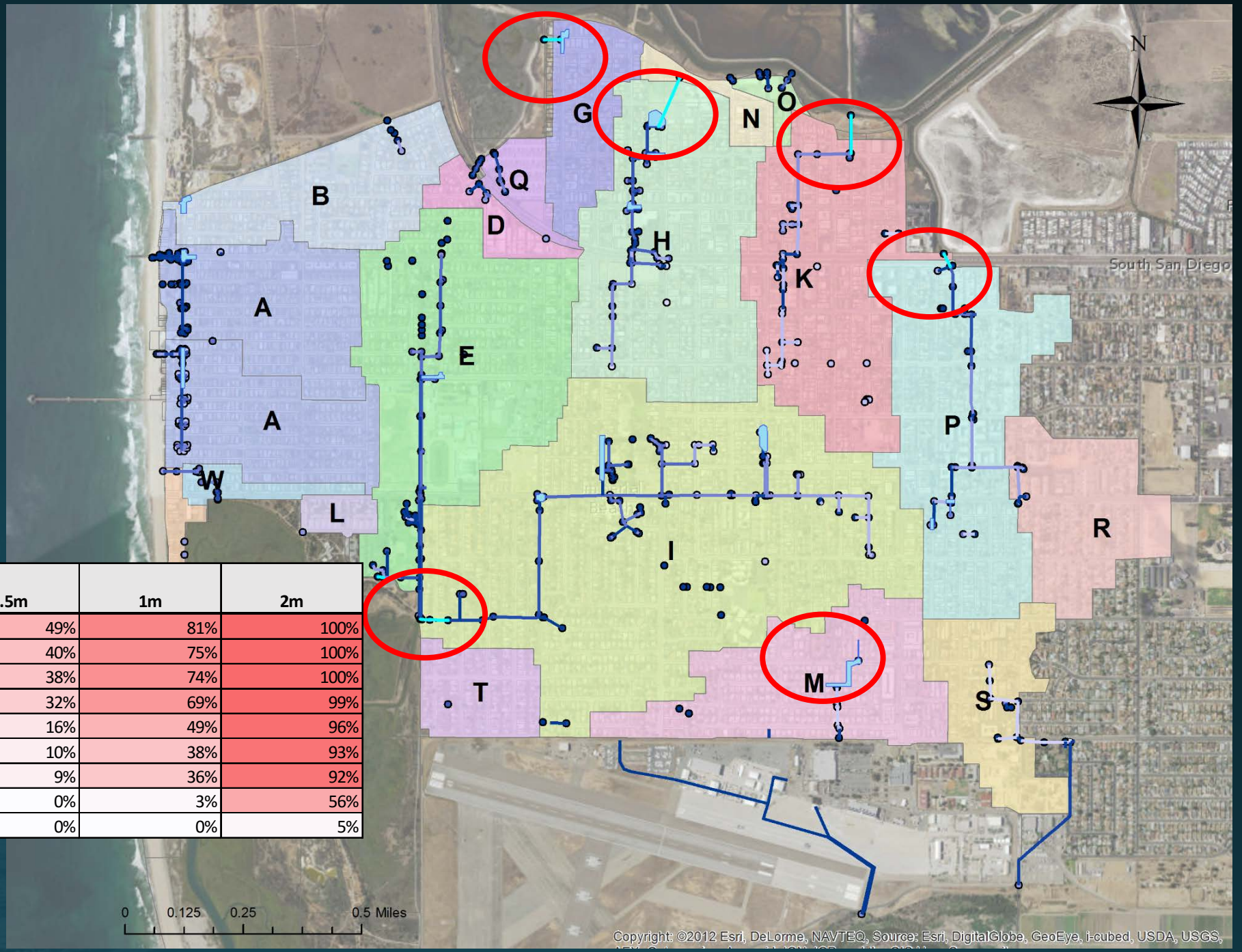
Staff photo by Paul Longworth



This ditch at 1194 Holly drains several blocks into a single 12- by 18-inch drain. It's inability to drain water effectively can be seen in the bottom shot. Residents say they ahve complained for years without results.

Future Nuisance Flooding

Drainage Basin	Elevation top of Pipe - (ft NAVD)	Baseline	0.5m	1m	2m
I	4.3	18%	49%	81%	100%
G	4.7	12%	40%	75%	100%
I	4.8	11%	38%	74%	100%
I	5.1	8%	32%	69%	99%
H	6	2%	16%	49%	96%
I	6.5	1%	10%	38%	93%
K	6.6	0%	9%	36%	92%
K - P	9	0%	0%	3%	56%
E	12.1	0%	0%	0%	5%

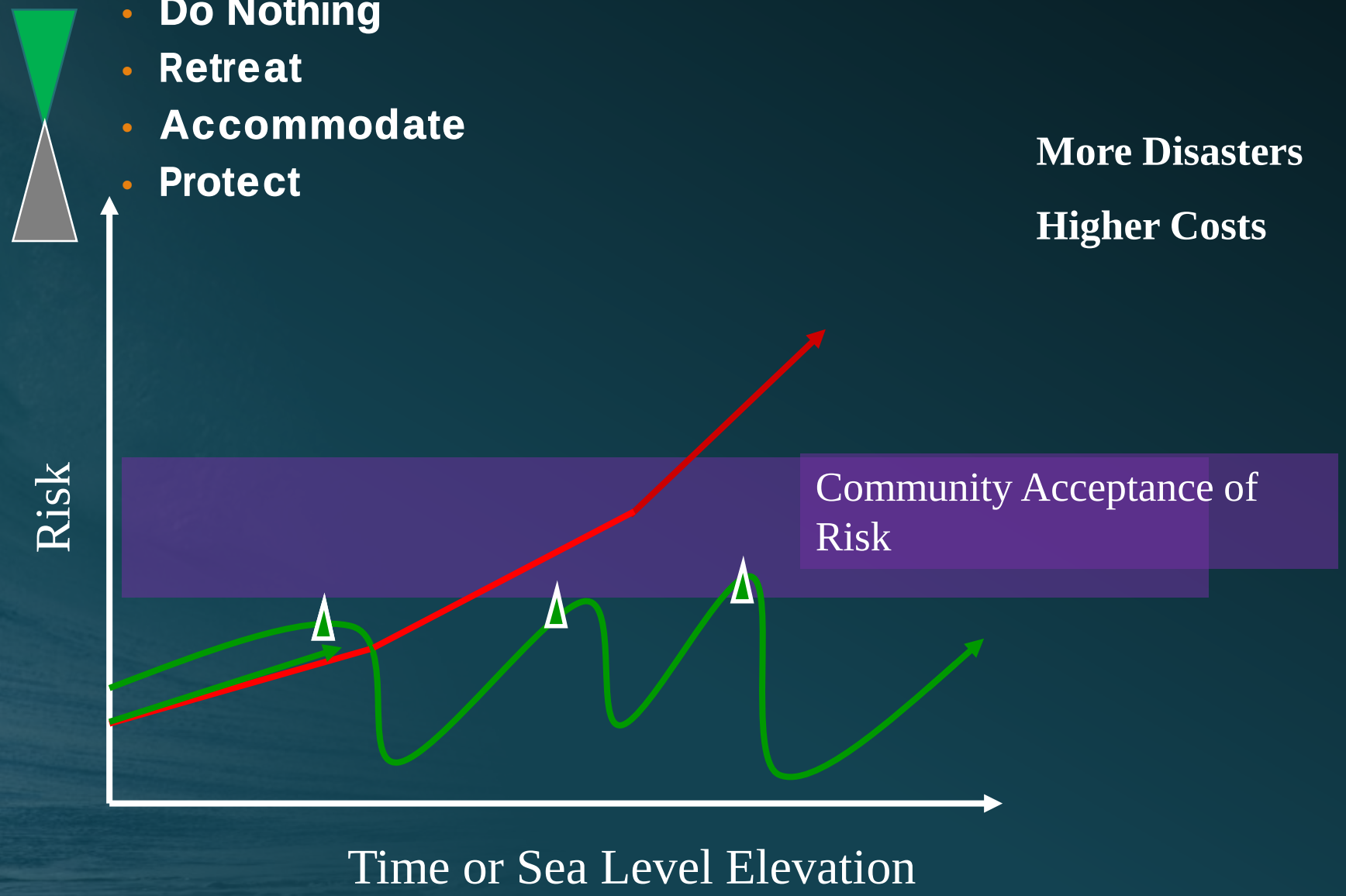


What is Adaptation?

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

More Disasters

Higher Costs



Pop Quiz Question 1

- What do you value about IB today that you want to maintain into the future?

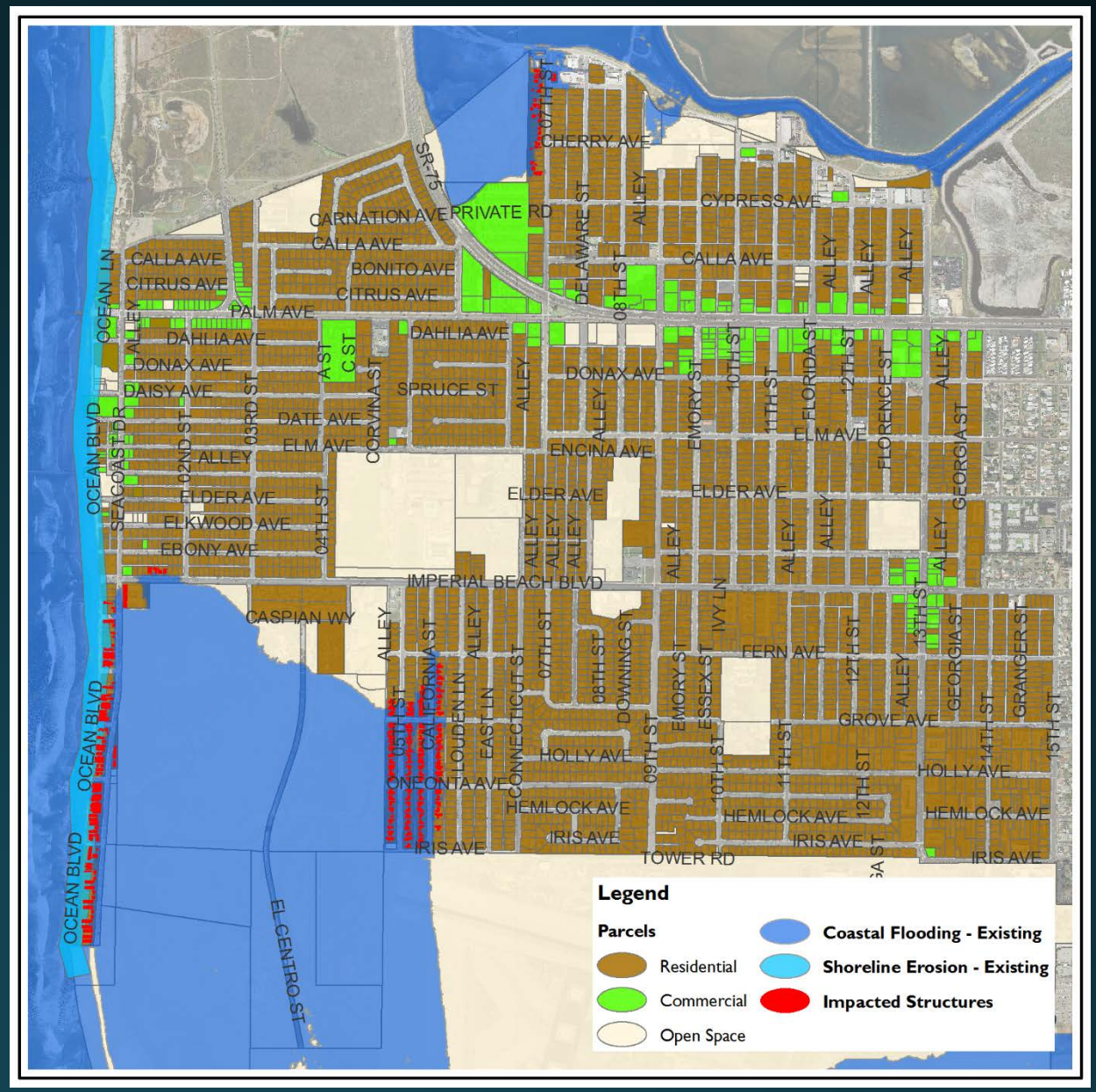
Vulnerability Assessment Sectors

- **Land Use**
- Beaches and Public Access
- **Roads**
- Public Transportation
- Wastewater
- Water Supply
- Stormwater
- Schools and Parks
- Hazardous Materials
- Social Vulnerability

Photo C. Helmer

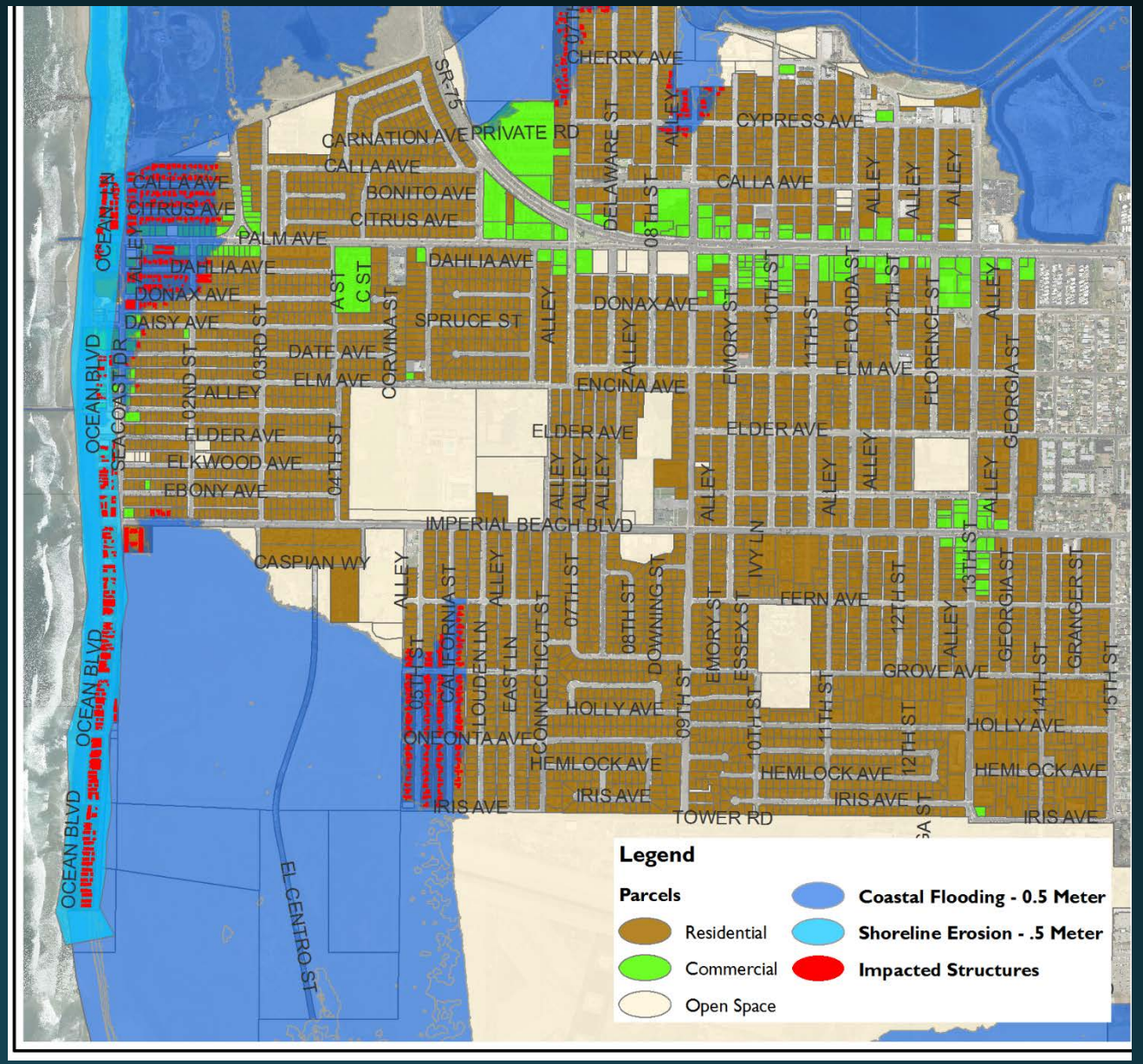
Land Use – Existing Conditions

- Number of parcels in existing Hazard Zones vs total
  - Total = 5955
  - Nuisance = 77 (74 residential, 3 public (school)
  - Coastal Flooding = 1082
    - 55 Open Space
    - 940 Residential
    - 87 Commercial
  - Coastal Erosion = 383
    - 9 Open Space
    - 351 Residential
    - 23 Commercial



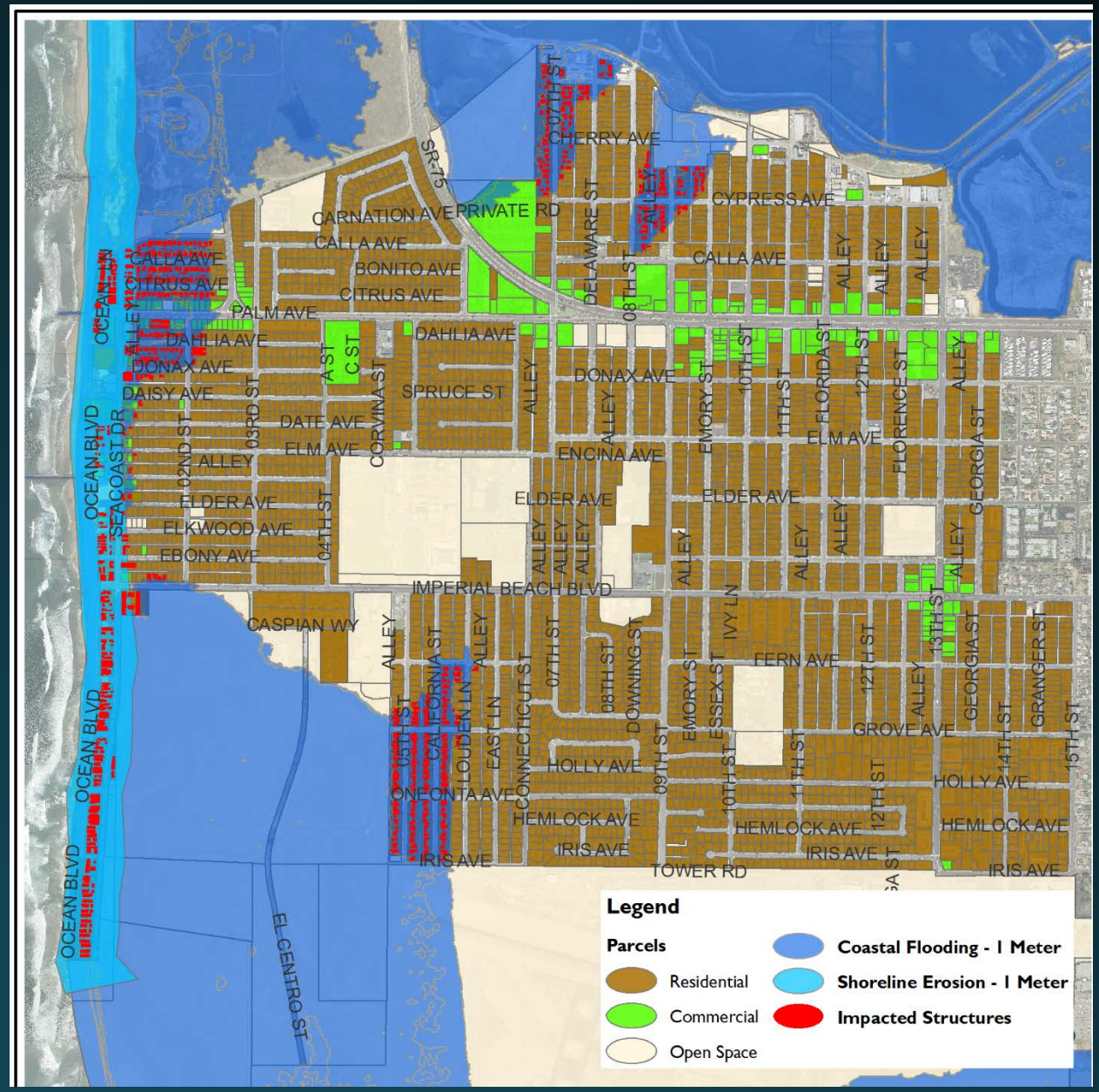
Commercial vs Residential 0.5 meters

- Number of parcels in existing Hazard Zones vs total
  - Total = 5955
  - Nuisance = 77 (74 residential, 3 public (school)
  - Coastal Flooding = 1352
    - 62 Open Space
    - 1195 Residential
    - 95 Commercial
  - Coastal Erosion = 430
    - 16 Open Space
    - 379 Residential
    - 35 Commercial



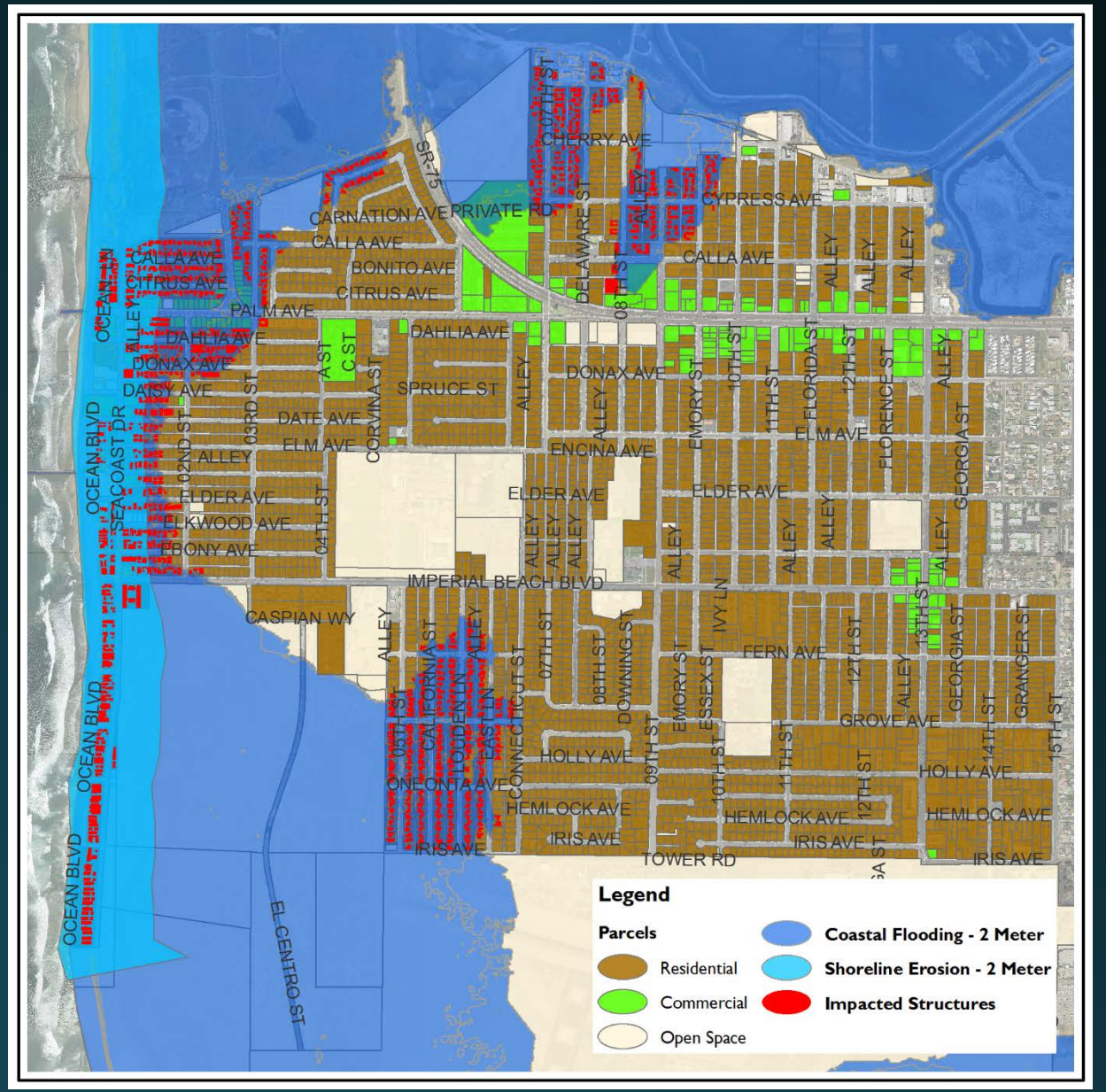
Commercial vs Residential 1.0 meters

- Number of parcels in existing Hazard Zones vs total
  - Total = 5955
  - Nuisance = 77 (74 residential, 3 public (school)
  - Coastal Flooding = 1573
    - 65 Open Space
    - 1409 Residential
    - 99 Commercial
  - Coastal Erosion = 544
    - 24 Open Space
    - 476 Residential
    - 44 Commercial



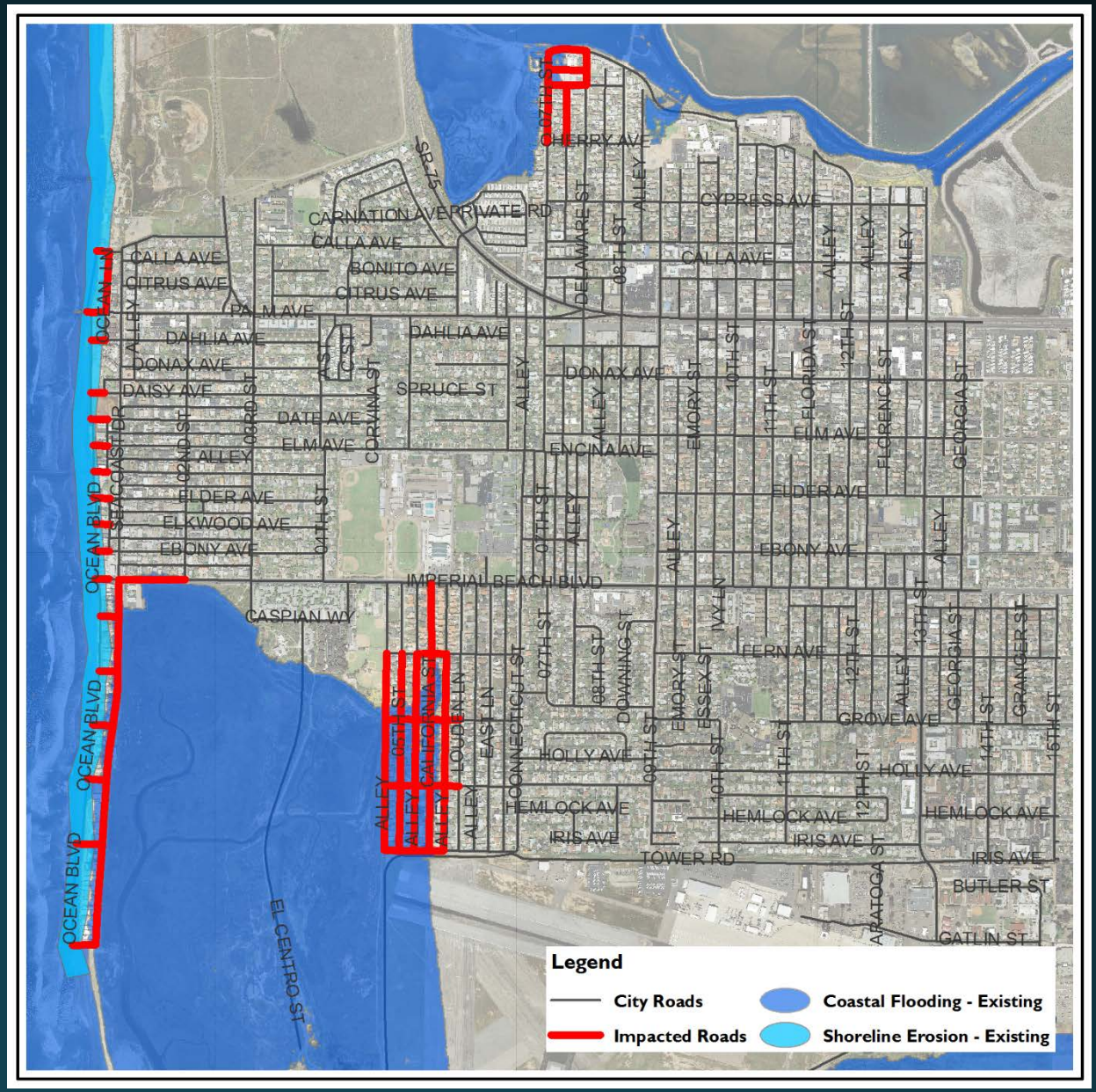
Commercial vs Residential 2100 – 2.0 meters

- Number of parcels in existing Hazard Zones vs total
  - Total = 5955
  - Nuisance = 77 (74 residential, 3 public (school)
  - Coastal Flooding = 2373
    - 73 Open Space
    - 2190 Residential
    - 110 Commercial
  - Coastal Erosion = 683
    - 27 Open Space
    - 594 Residential
    - 62 Commercial
  - **All Coastal Hazards = ~30% of all parcels**



Road 2015 - Existing

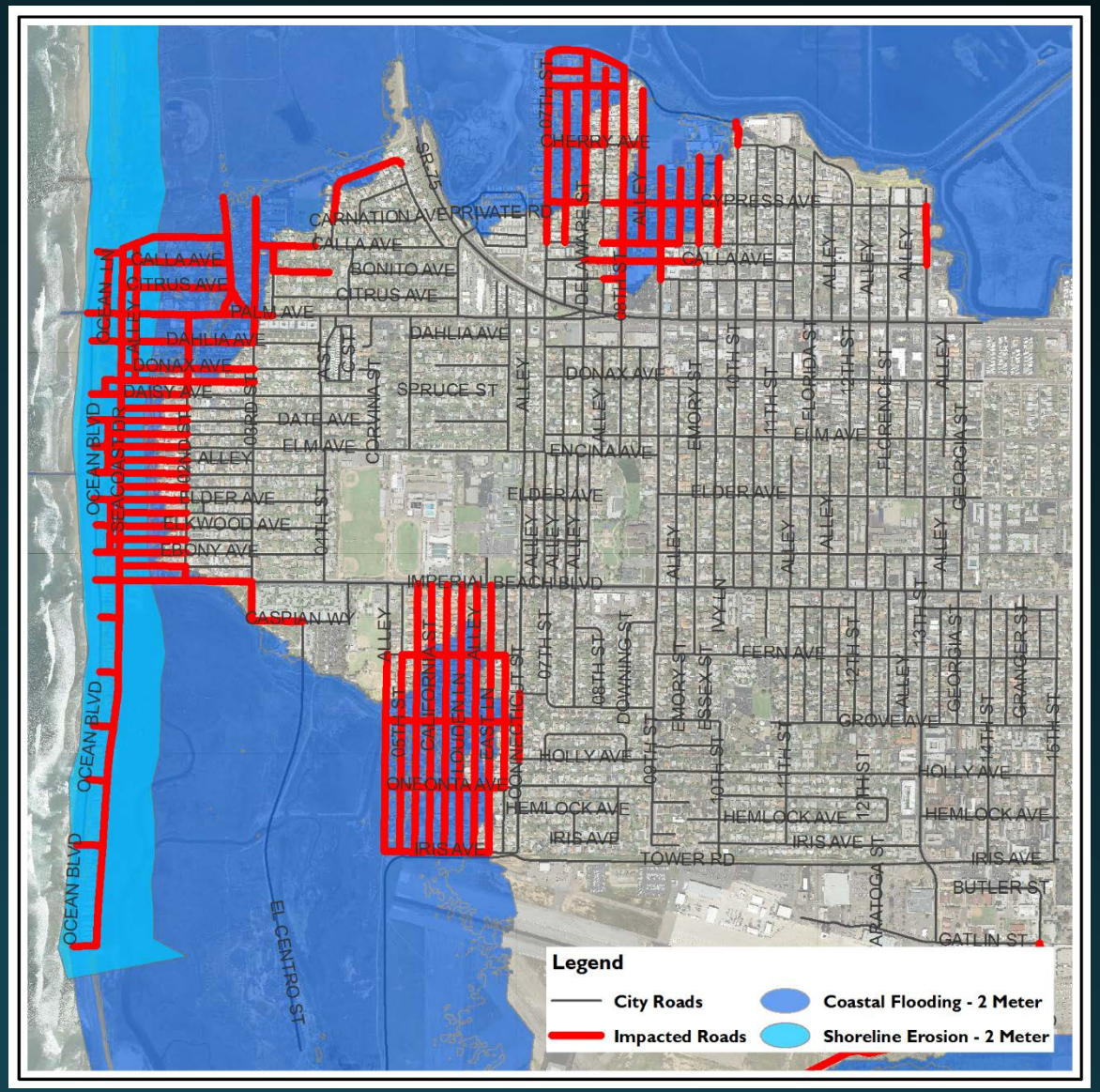
- # Miles of Road
- Total = 73.1 miles
- Nuisance = 2,989 feet
- Coastal Erosion = 1.7 miles
- Coastal Flooding = 13.7 miles



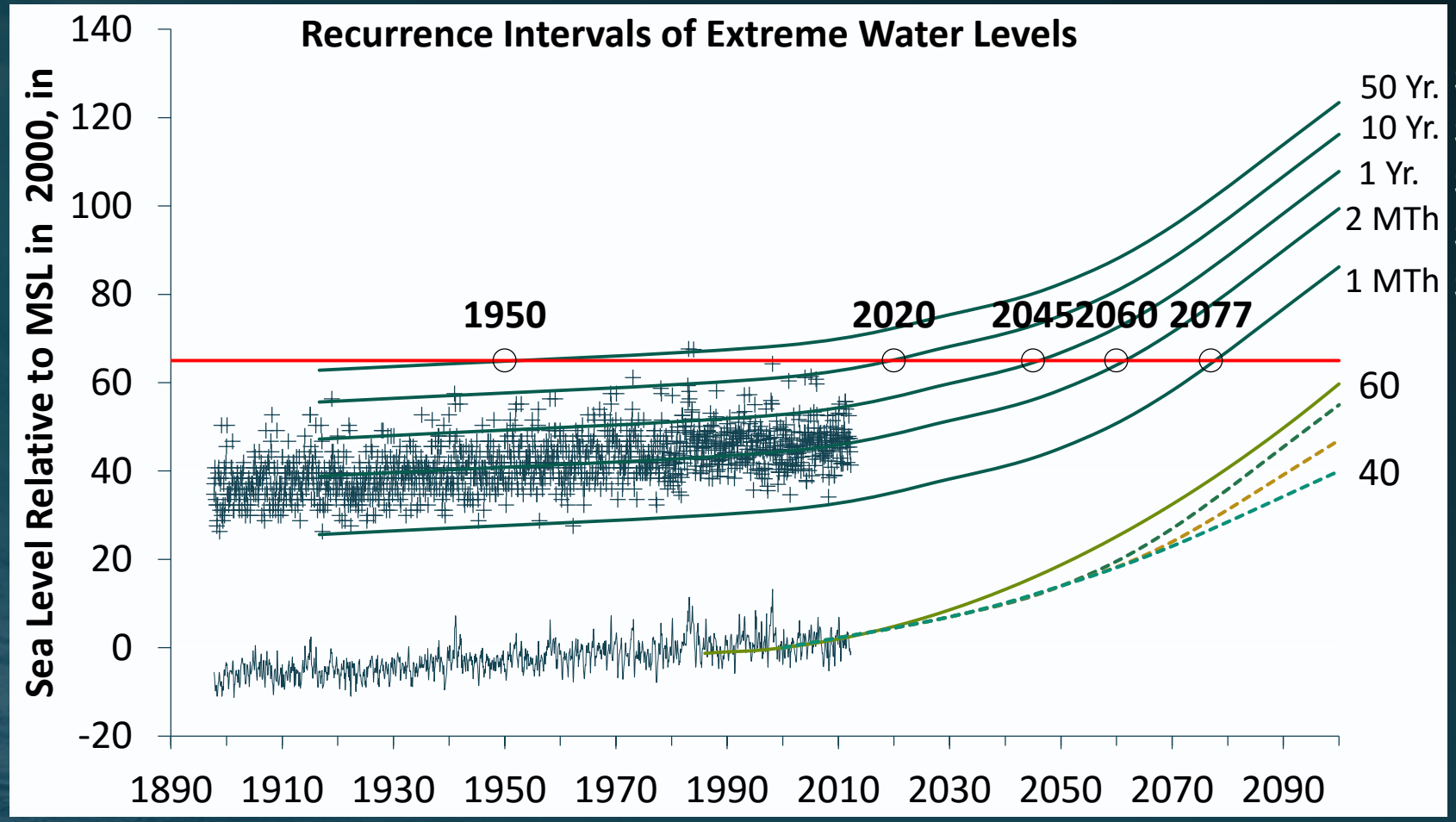
Road 2100 – 2.0 meters

- # Miles of Road
- Total = 73.1 miles

- Coastal Erosion = 5.4 miles
- Coastal Flooding = 29.6 miles
- **(40%)**



Increasing Vulnerabilities and Costs



Cost / year

$10K - $90K

$50K - $450K

$500K - $4.5M

$3M - $27M

$6M - $54M

Adaptation


THIS IS THE SOLUTION WE'VE DEVISED FOR DEALING WITH THE FLOODING CAUSED BY CLIMATE CHANGE.
Chris Madden

Do Nothing - Allow Natural Erosion

Retreat

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

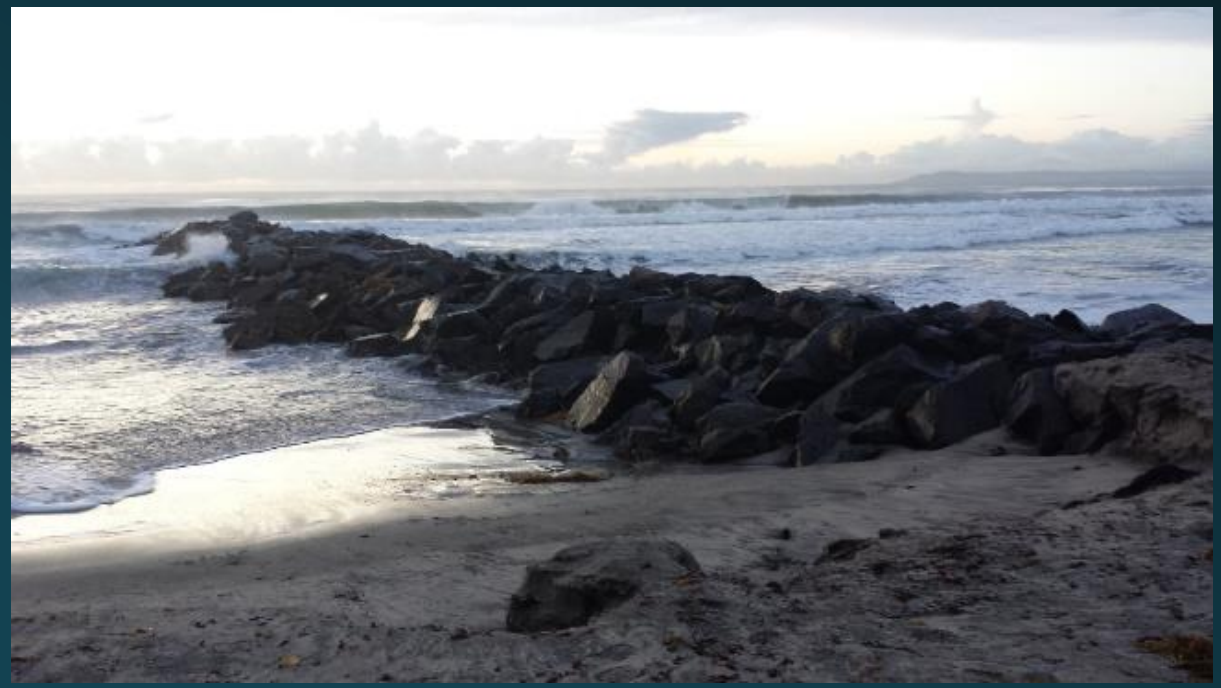
Source: California Coastal Records Project

Accommodate

- Elevate
- Setbacks
- Moveable Foundations

Protect

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



Opposing Viewpoints on Adaptation

What if…?

How much does it cost?

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

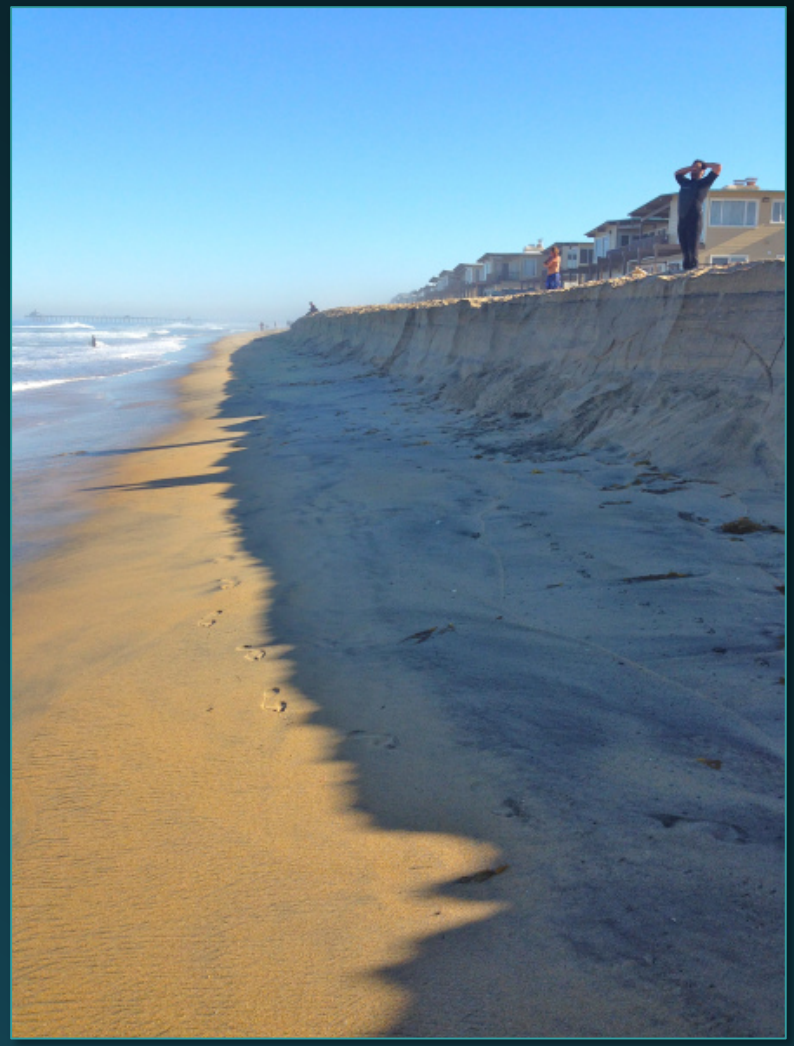
Beach communities ask what will my beach look like in 30 years?

Pop Quiz Question 2

- What adaptation strategies align with your vision of your community?
  - Preferences?
  - Others?

Adaptation Challenges

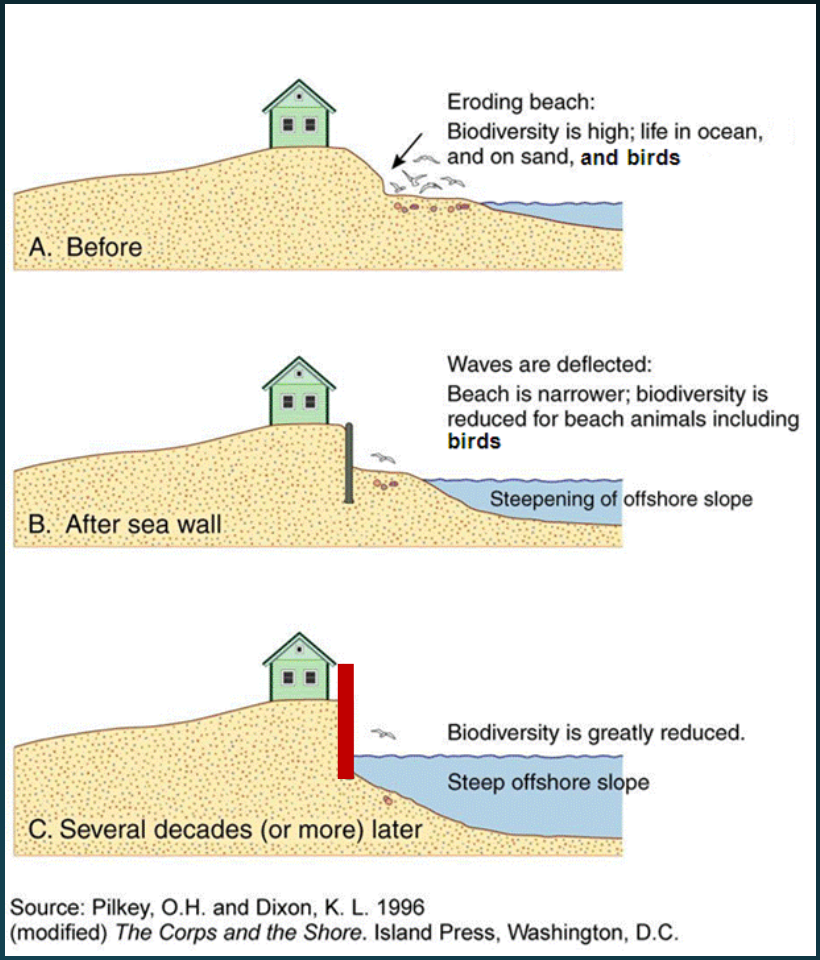
- Public vs Private perspectives
- Typically sector focus
- Varying level of detail from vulnerability
- Modeling of human management decisions
- Changing policies
- Lack of comprehensive or regional strategy
- Needs evaluation of Maladaptation



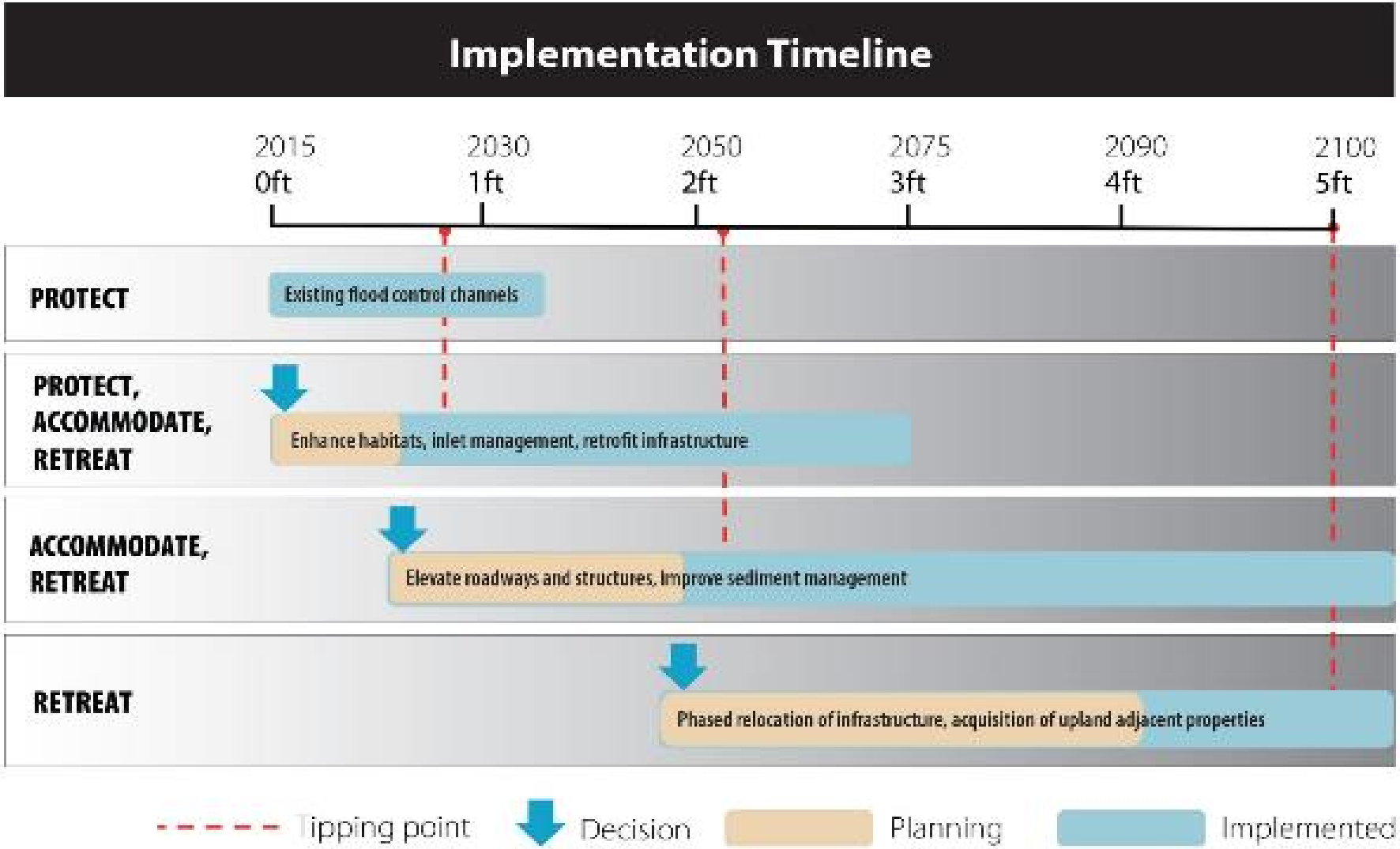
Secondary Impacts

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

Seawalls destroy beaches and views



Implementation Times



Adaptation Strategies

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

1. Nearshore Placement
2. Offshore Sand Deposits
3. Added Courser Sand than Native
4. Opportunistic Sand
5. Canyon Interception
6. Inter-littoral Cell Transfers
7. Berms/Beach Scraping
8. Perched Beaches
9. Groins
10. Breakwaters
11. Dune Nourishment
12. Delta Enhancement
13. Headland Enhancement
14. Geotextile Groins

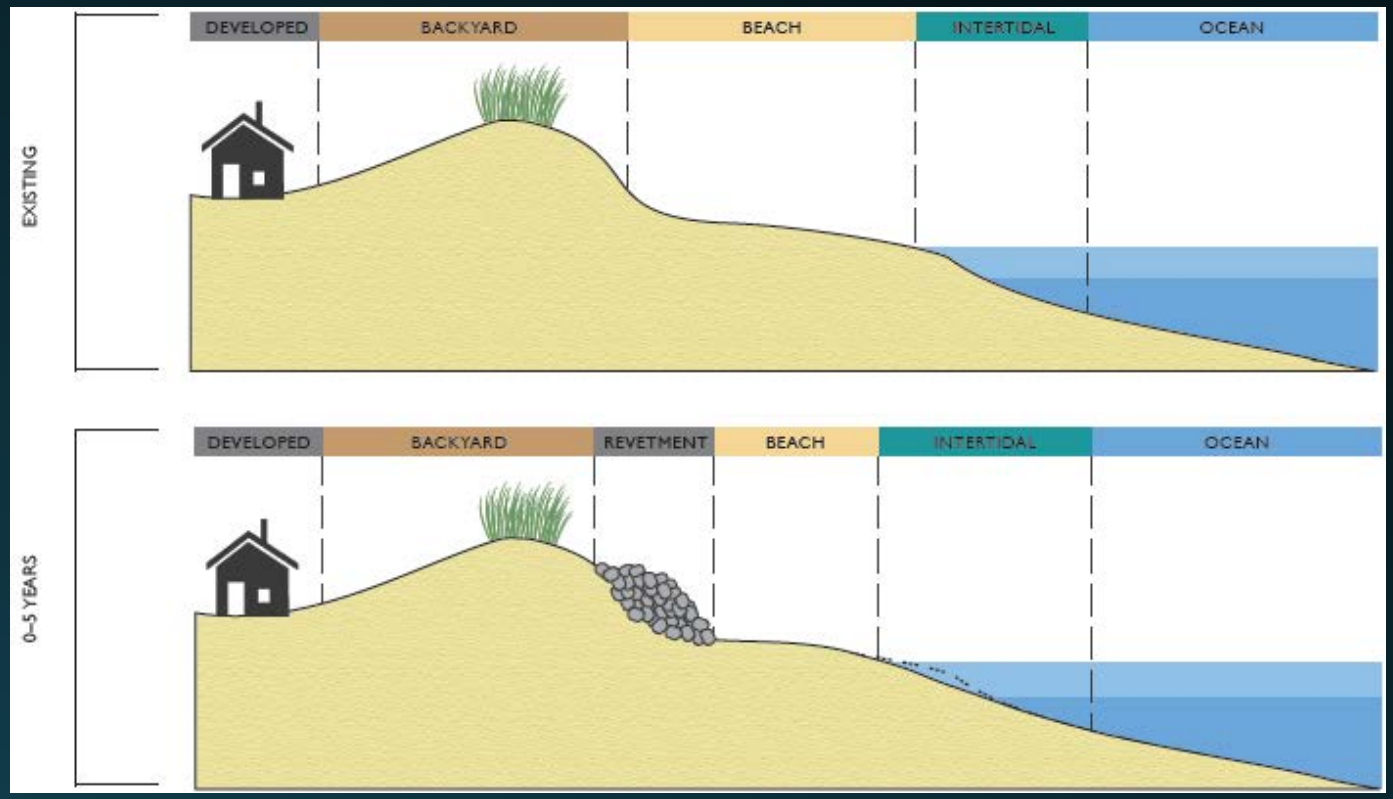
1. Branch Box Breakwaters
2. Floating Breakwaters
3. Submerged Breakwaters
4. Dune Restoration
5. Beach Dewatering
6. Seawalls
7. Revetments
8. Gabions
9. Cobble Nourishment
10. Dynamic Revetments
11. Geotextile Revetment
12. Floating Reefs
13. Rubber Dams
14. Sand Fencing

Adaptation Strategies

1. Coastal armoring of the entire IB coastline
2. “Business-as-usual” sand nourishment
3. Hybrid dune and cobble approach (living shoreline)
4. Extension and completion of 5 groins w/associated sand nourishment
5. Public acquisition with lease back option (hybrid managed retreat)

Adaptation scheme applied to urbanized portion of City down to South end of Seacoast Drive.

Methods

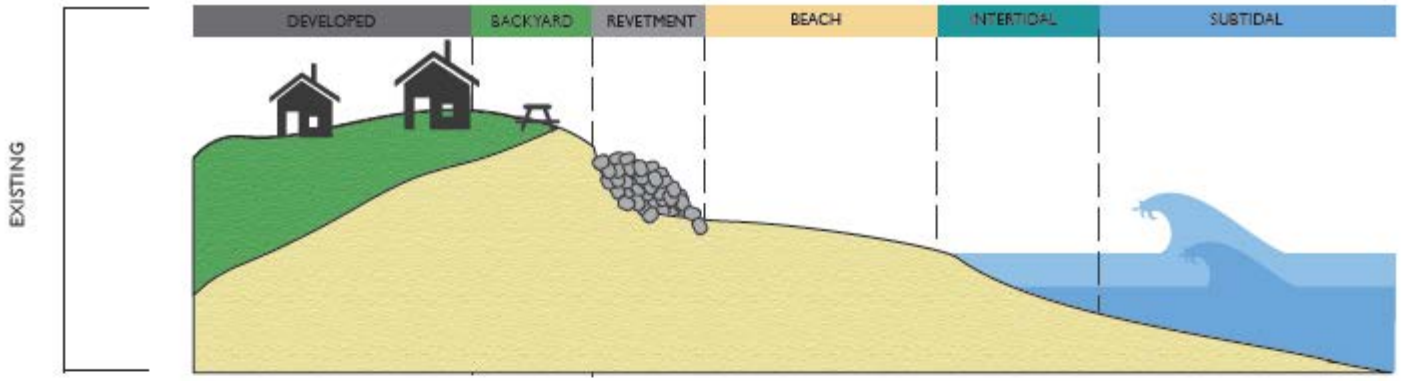


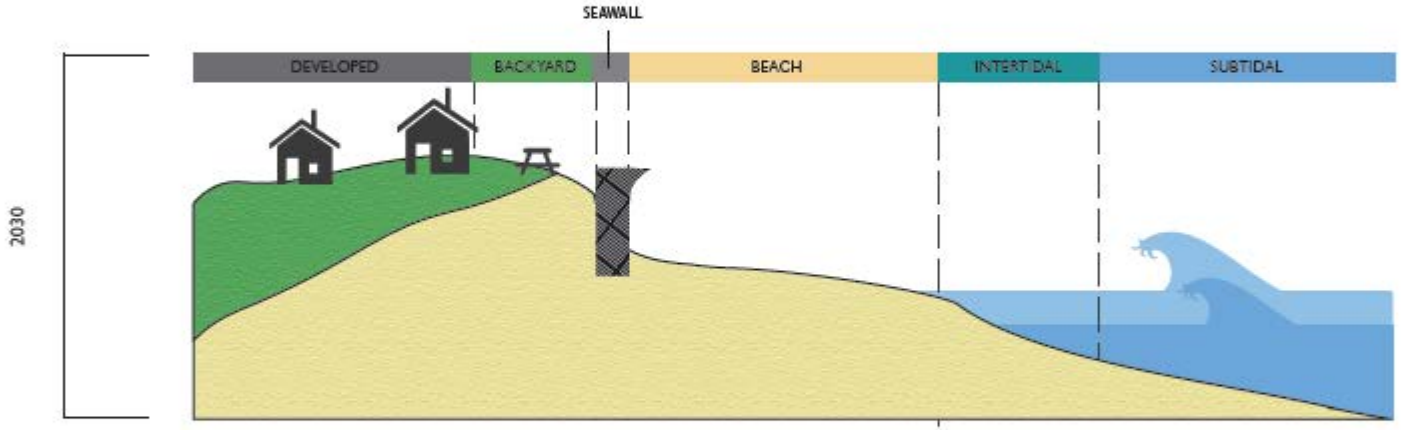
For each Adaptation strategy:

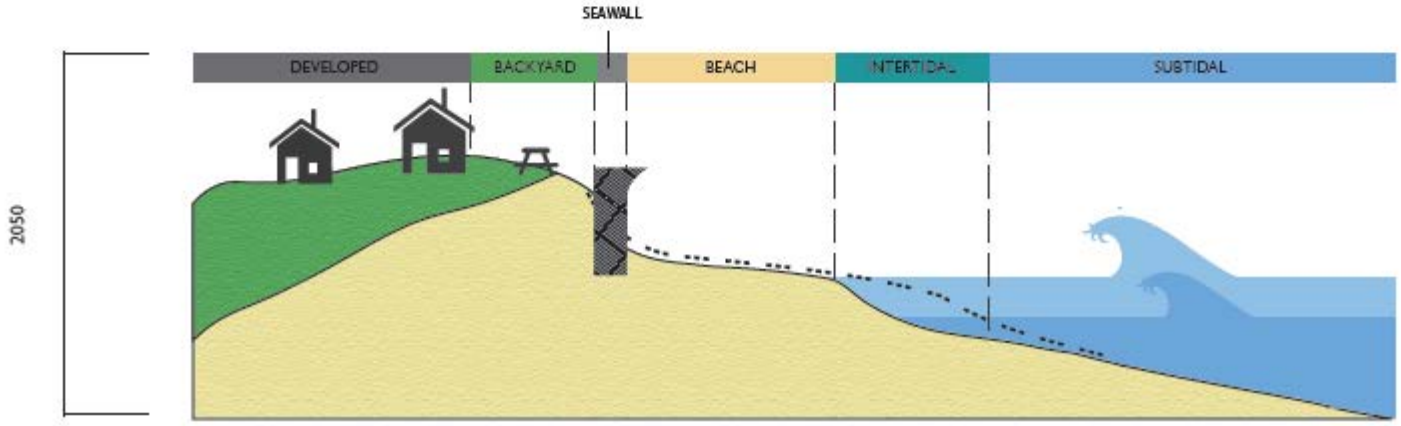
- Beach Width vs Upland
- Physical and Economics over multiple horizons
- Recreation and habitat zones
- Narrow versus wide beach

Coastal Armoring

- Key findings:
- Beaches disappear between 2050 - 2075
- Damp sand beaches by 2035 - 2065







Managed Retreat – Public Acquisition

- Hybrid- fee simple acquisition with lease back
- Public purchase of property
- Development of lease agreement
- Structure, armoring removed when damaged Infrastructure removed when damages occur, restoration of dune

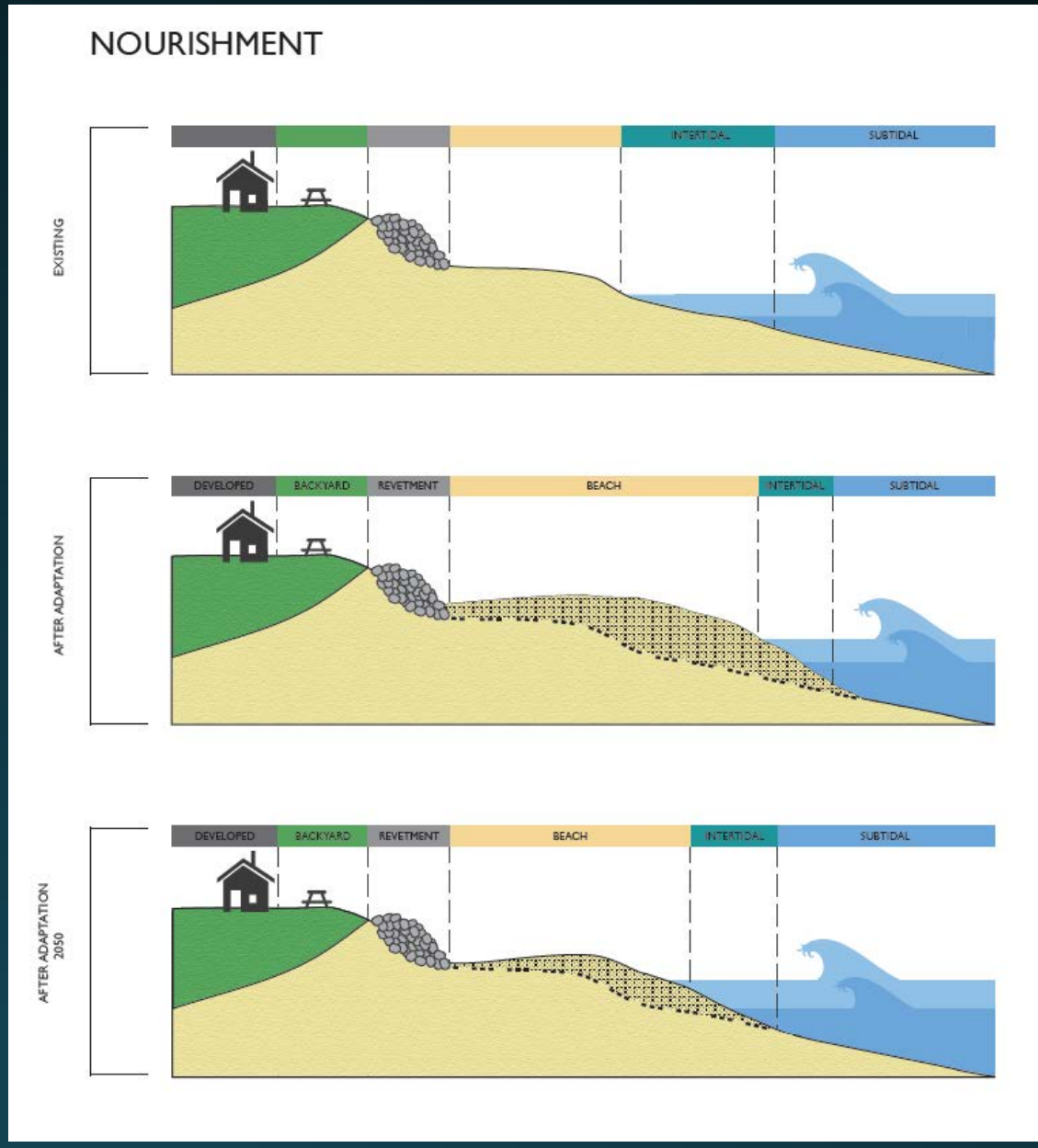
Key findings:

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

“Business-as-usual” sand nourishment

- Continue to nourish beach and maintain existing armoring

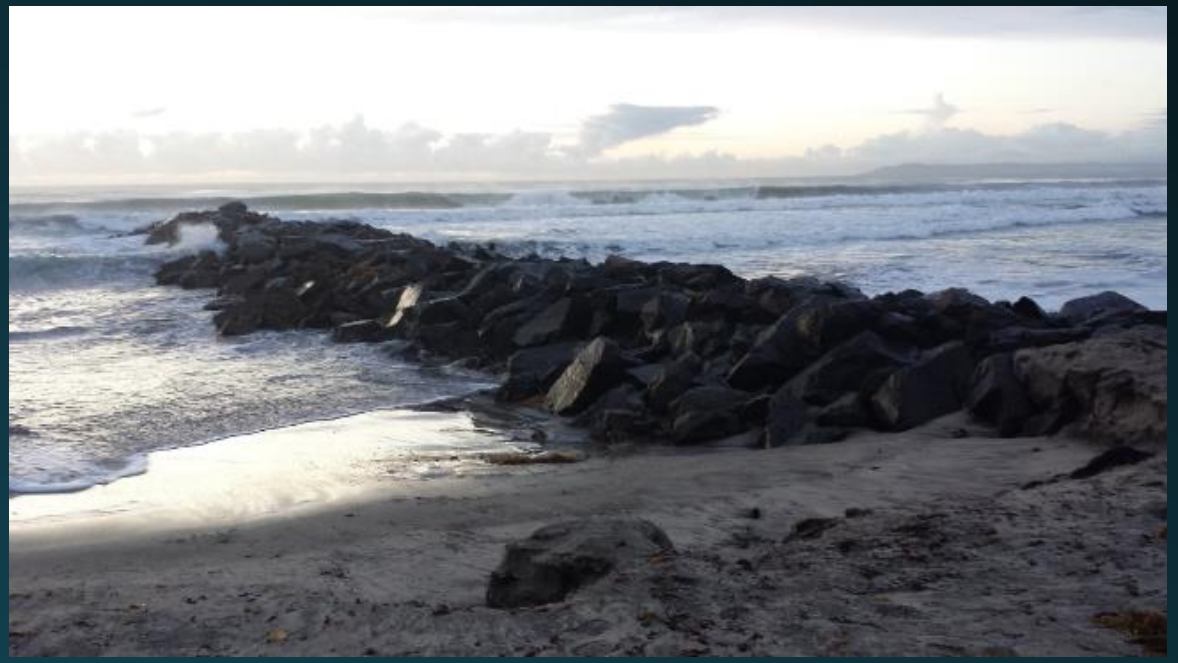
Key findings:
Nourishment required 7 to 14 times by 2100 to maintain beach width



Sand Retention with Groins

Complete original Army Corp of Engineers project

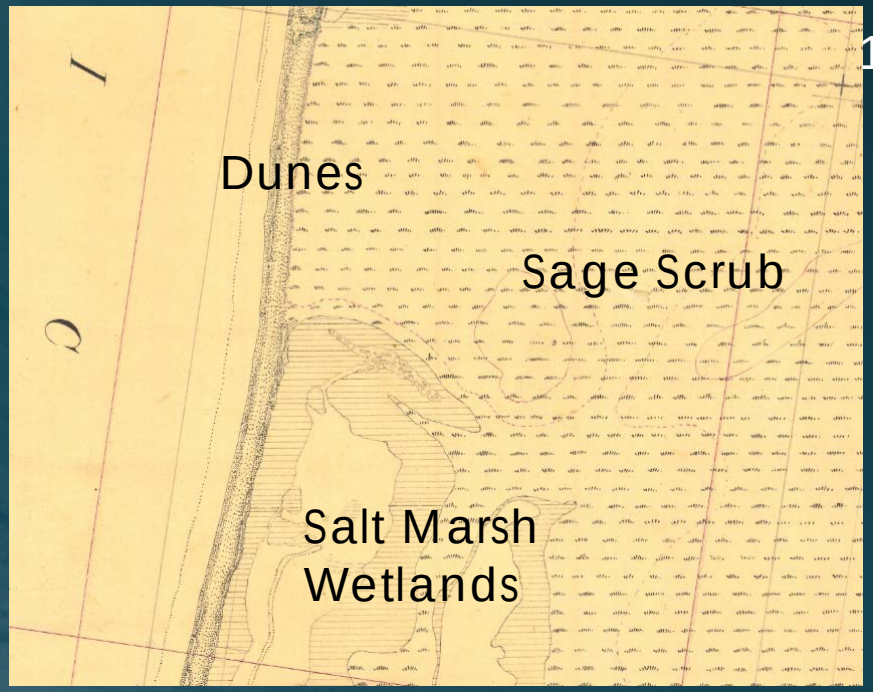
- 5 groins
- Increase length
- Nourish

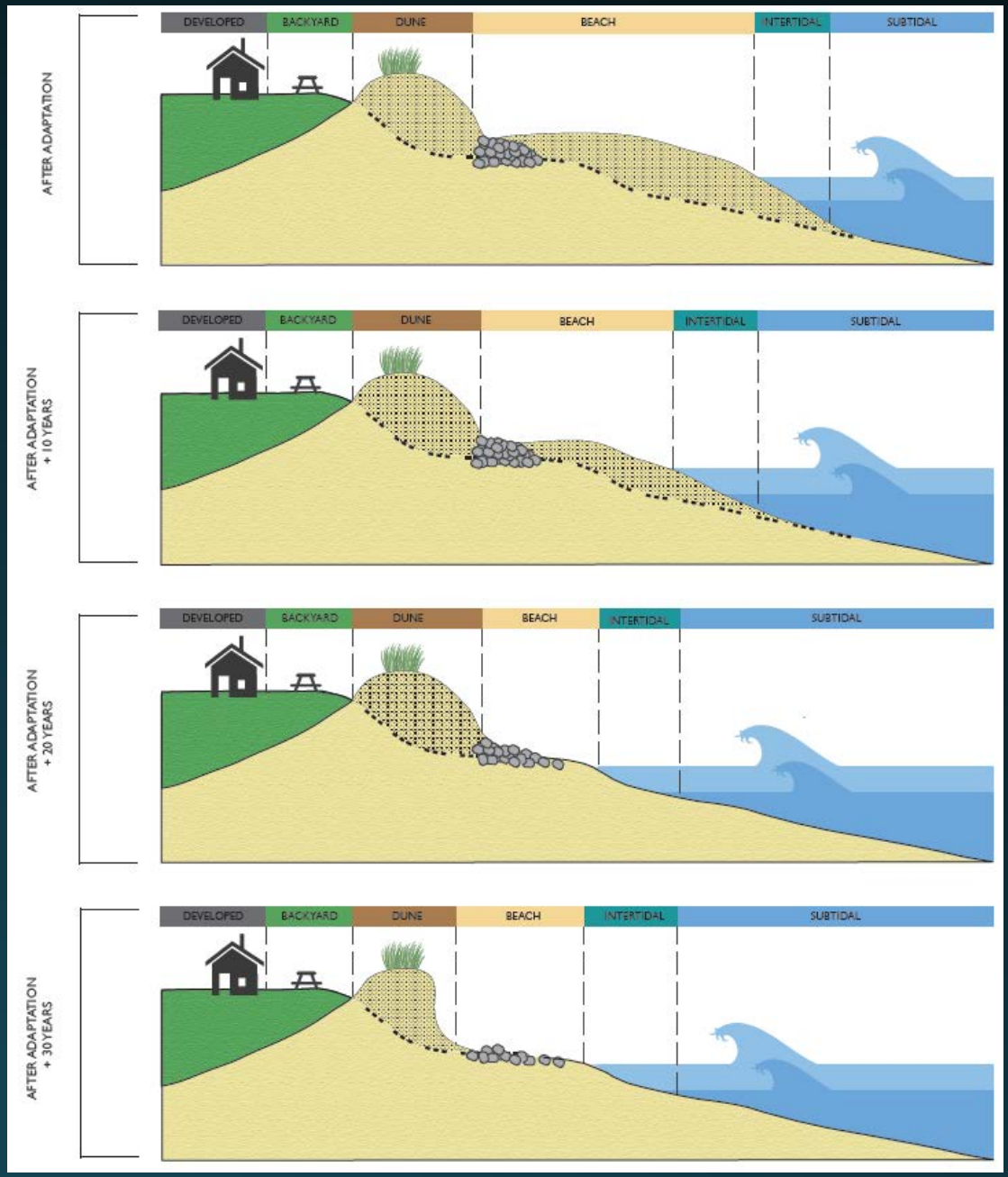


Key Findings:
Groins retain sand longer so nourishment cycles only 5 to 10 times by 2100

Natural hybrid dune

- Beach Nourishment
- Cobble Nourishment
- Removal of revetment
- Dune restoration





Key finding: Reconstruction cycles 4 to 7 times by 2100

Types of Costs:

1. The costs of adaptation implementation and construction (e.g., seawalls, nourishment)

2. The losses and damages to public property and assets (e.g., beach erosion, ecological losses)

3. The losses and damages to private property and assets (e.g., flood losses, erosion losses)

Types of Benefits/Impacts:

1. Recreational value
2. Ecological value
3. Prevention of erosion and flood losses

Economic/Fiscal Impacts

1. Increased local spending
2. Increased tax revenue

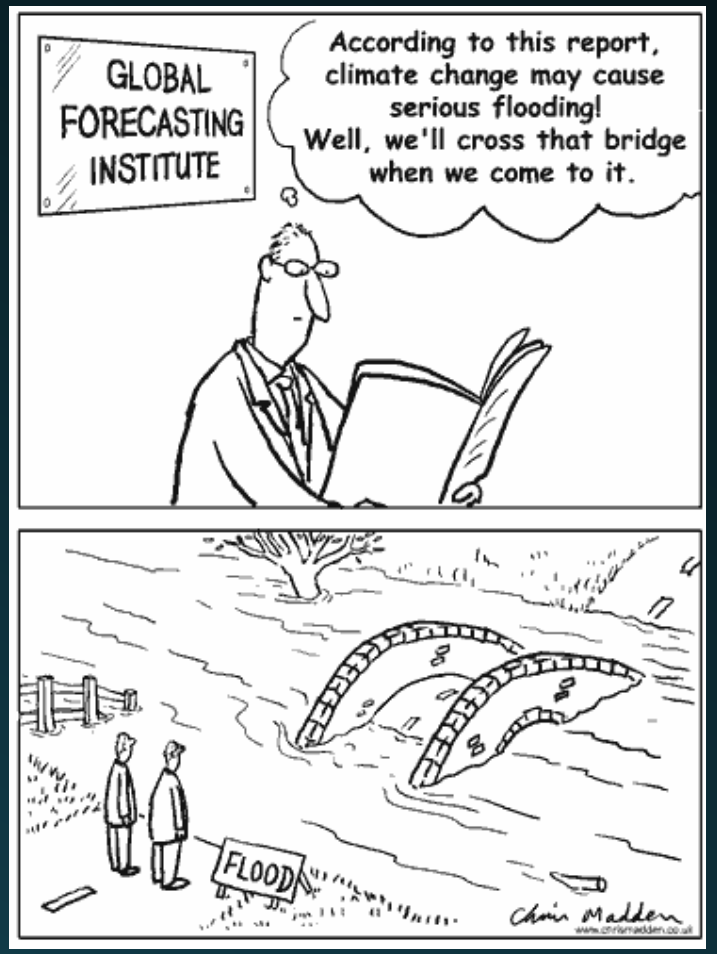
- Benefits strongly correlate with a wide, beach
- Strategies that preserve wide beaches produce largest benefits

Implementation

- Variety of different mechanisms
- Capital Improvement Plan
- Local Hazard Mitigation Plans
- Park Master Plans
- Shoreline Management Plans
- Local Coastal Program

Financial vehicles

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



Pop Quiz Question 3

- How should we pay for adapting to coastal flooding and erosion?

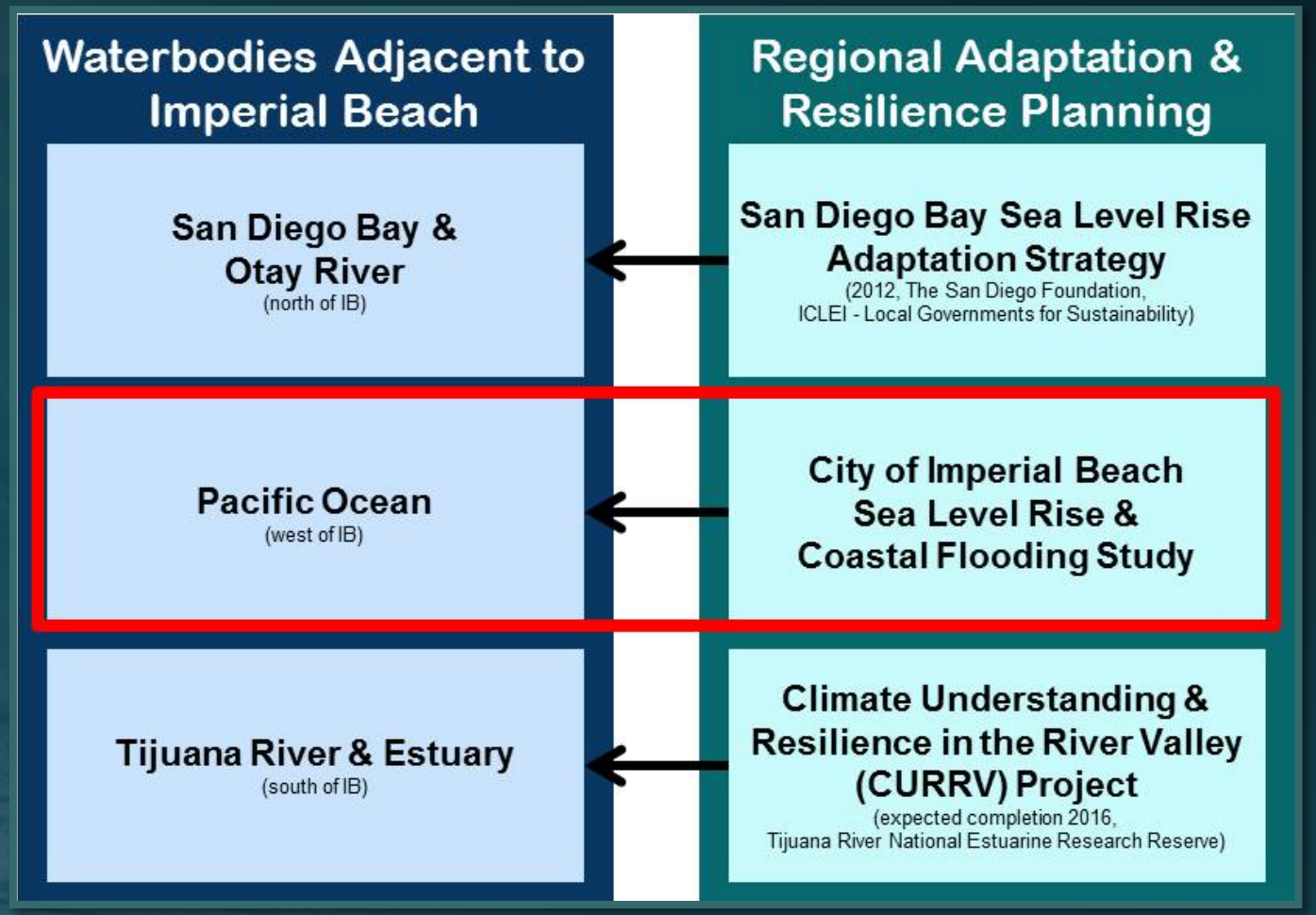
Future Work

- Economic Analyses
- Report Writing
- Steering Committee 6/14/2016
- Final City Council presentation 6/15/2016
- Final Report and Recommendations 6/30/2016
- Policy Work?

Pop Quiz Question 4

- How should we communicate these findings To the community?

Climate Adaptation in Imperial Beach



Revell Coastal
Surf. Sand. Sustainability.

Sea Grant
University of Southern California

Tijuana River
National Estuarine Research Reserve

Coastal Conservancy

The City can't adapt to climate change alone… the County, SANDAG, the Port, City of Coronado, and the Navy must be partners.

Workshop Discussion Questions

1. What do you value about IB today that you want to maintain into the future?
2. What adaptation strategies align with your vision of your community?
   - Preferences? Others?
3. How should we pay for adapting to coastal flooding and erosion?
4. How should we communicate these findings To the community?