Adaptation Pathways: Navigating an Uncertain Future

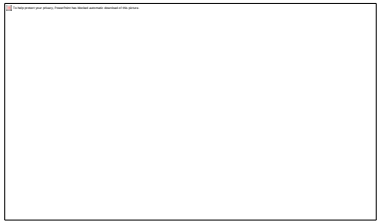
Beyond the Vulnerability Assessment

David Revell, PhD

Principal – Coastal Resilience

February 14, 2023

PICHTR – Beyond Hazard and Vulnerability Planning



Opposing Viewpoints on Adaptation

What if...?

How much does it cost?

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

Beach communities ask what beach and surf spots will be in 30 years?

Politicians ask how can I make everyone happy?

integral

Adaptation Approaches

Do Nothing

Accommodate

Hybrid

Protect

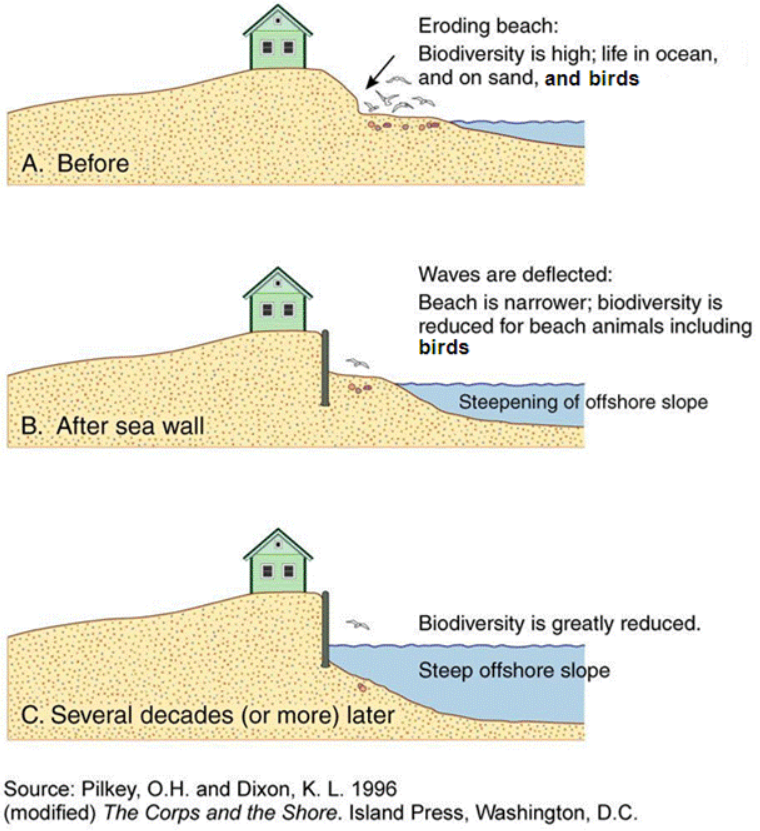
Managed Retreat

Project vs. Policy Approaches

Green vs Grey (Nature Based vs Engineered)

Secondary Impacts

- Construction/ Maintenance Costs
- Protection holds the line and causes a loss of beach – burying or drowning
- Recreation – beach, surf, fishing
- Views and aesthetics
- Displacement of under represented communities
- Access to low cost recreation
- Loss of tourism related revenues
- Ecology



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

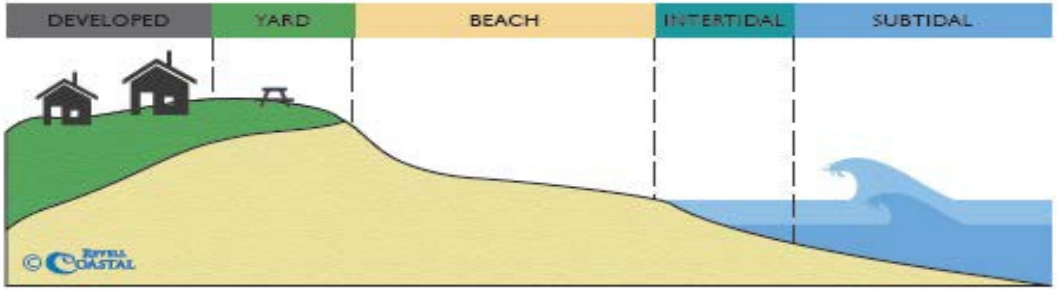
Example: Seawalls destroy beaches and views

Adaptation Challenges

- Current erosion mitigation is implemented in an emergency
- Lack of community vision - Planned response not emergency reaction
- Public vs Private interests
- Adaptation is local, but solutions need regional perspectives
- Limited dollars
- Uncertainty
- When do we change from one adaptation strategy to the next?

integral

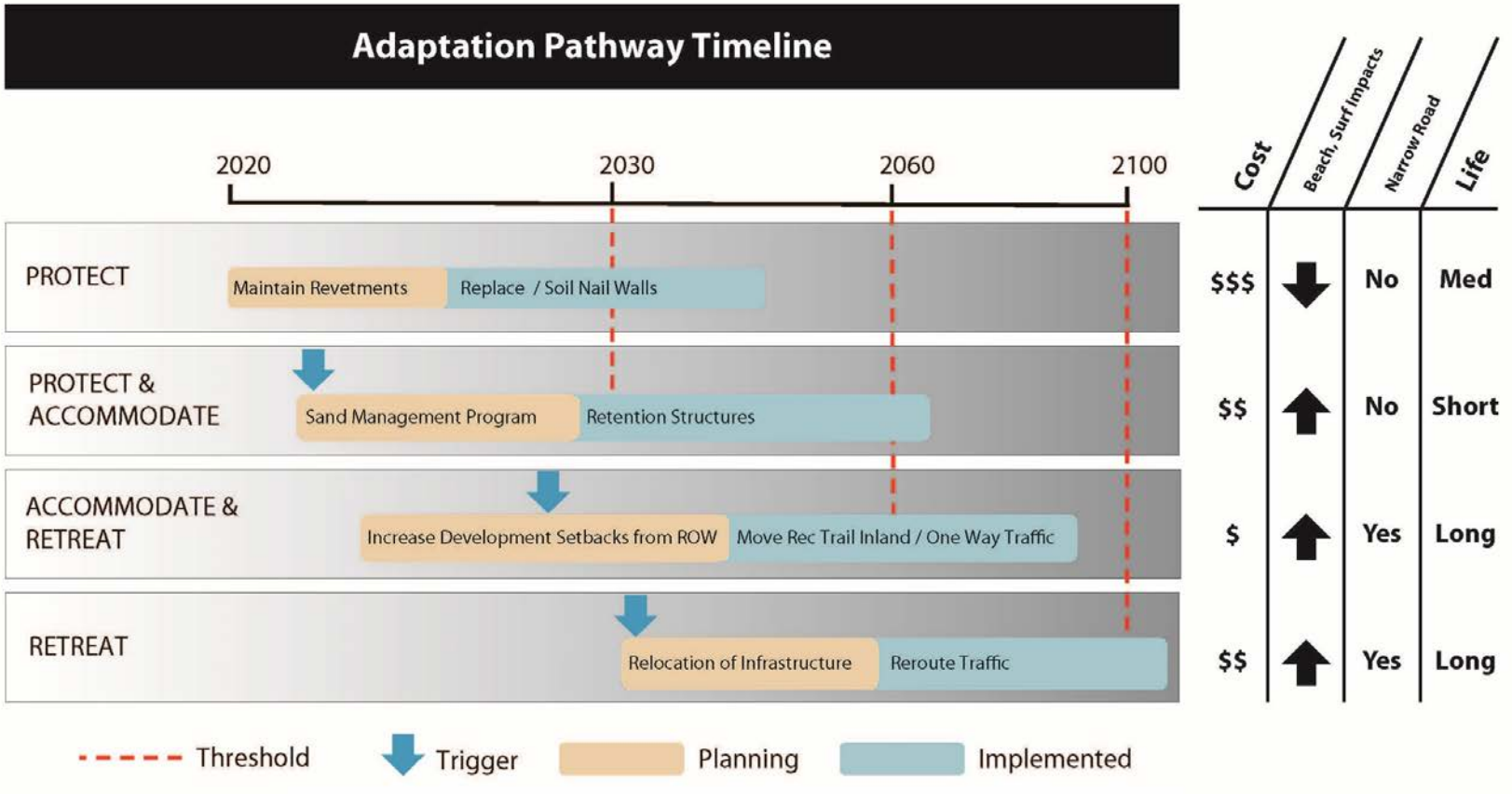
What needs to be considered



- Developed – Private and Public Infrastructure
- Recreation – Beach, Intertidal, and Subtidal
- Ecosystem Services – Flora & Fauna, Water Quality, Mental Health (Replacement Cost)
- Economics – Costs, Revenues and Fiscal Impacts (Net Benefits)

integral

Adaptation Pathway – Addresses Uncertainty



Triggers - Requires Monitoring

- By sea level rise
- By time
- By exposure
- By distance
- **By damages**
- **By cost**
- By number of incidences

West Cliff triggers, triggered 2023

Short term – disrupts traffic or Rec Trail

Two Mid Term

-Erosion within 5 feet of Rec trail

-Beach Width

Long Term

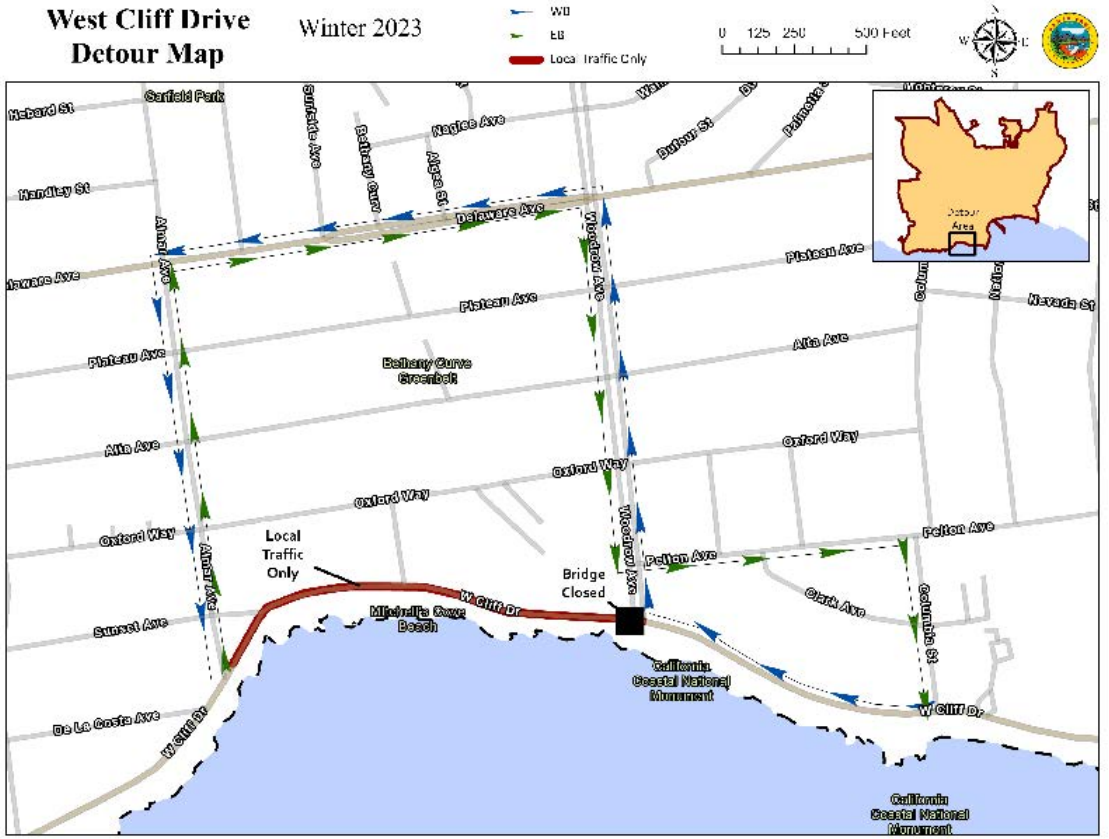
-City spends over $500k over 5 years – current FEMA estimate $15M, FHWA $15M+

integral

Trigger Example on West Cliff

Trigger:

One Way Road Segment
Closed Road Segment



West Cliff Drive Planning vs Reaction

- Recreation Focused Actions – enhancing surf and beach recreation along with Recreational Trail showed highest benefit and probability of success
- Business as usual costs the most in the long term
- Managed Retreat and Protection Focused better if started before 9 inches of SLR
- Community reaction is to repair and not adapt
- Invest now or Pay more later?

Unmanaged Retreat

- State Policy - Protect beaches
- No new seawalls
- No emergency sand bags
- No plan for acquisition
- No options for homeowners
- Need transparency

integral consulting inc.

Managing Retreat – aka Move

- Getting out of the way gracefully – set expectations
- Repetitive loss
- Buy outs
- Land use decisions
- Transfer of development
- Hybrid approaches
- Educate contractors and buyers
- Monitor physical changes
- Real Estate Disclosures

integral

Closing Thoughts

- Impacts of climate change are uncertain – storms and sea level rise
- We need a phased approach and a pathway to adapt
- Direction depends on a strong community vision for 5, 10, 50 years. NOW
- Develop equitable funding methods to create the vision
- Value nature- beaches, surf breaks, turtles and monk seals
- Study natures adaptation resources – Sandshed/ sediment
- Identify triggers when current management needs to change

Native Hawaiians respected the mana of the ocean and historically built simple elevated houses that were rebuild inland when destroyed, not the same now.

integral

Resources and Contact

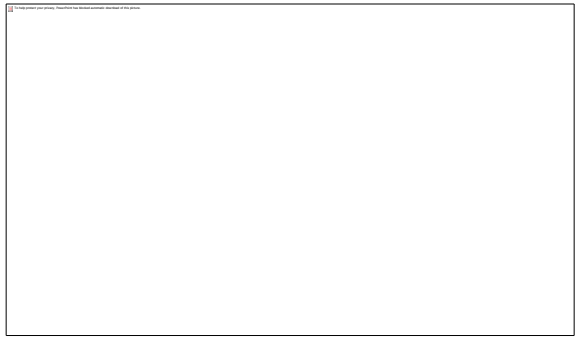
Revell et al 2021. A Holistic Framework for Evaluating Adaptation Approaches to Coastal Hazards and Sea Level Rise: A Case Study from Imperial Beach, California ***Water* 2021**, *13*(9), 1324; https://doi.org/10.3390/w13091324.

Special Issue Adaptation to Coastal Climate Change and Sea-Level Rise

Resilient Coast Santa Cruz
https://www.cityofsantacruz.com/government/city-departments/city-manager/climate-action-program/west-cliff-drive-adaptation-and-management-plan

David Revell
drevell@integral-corp.com

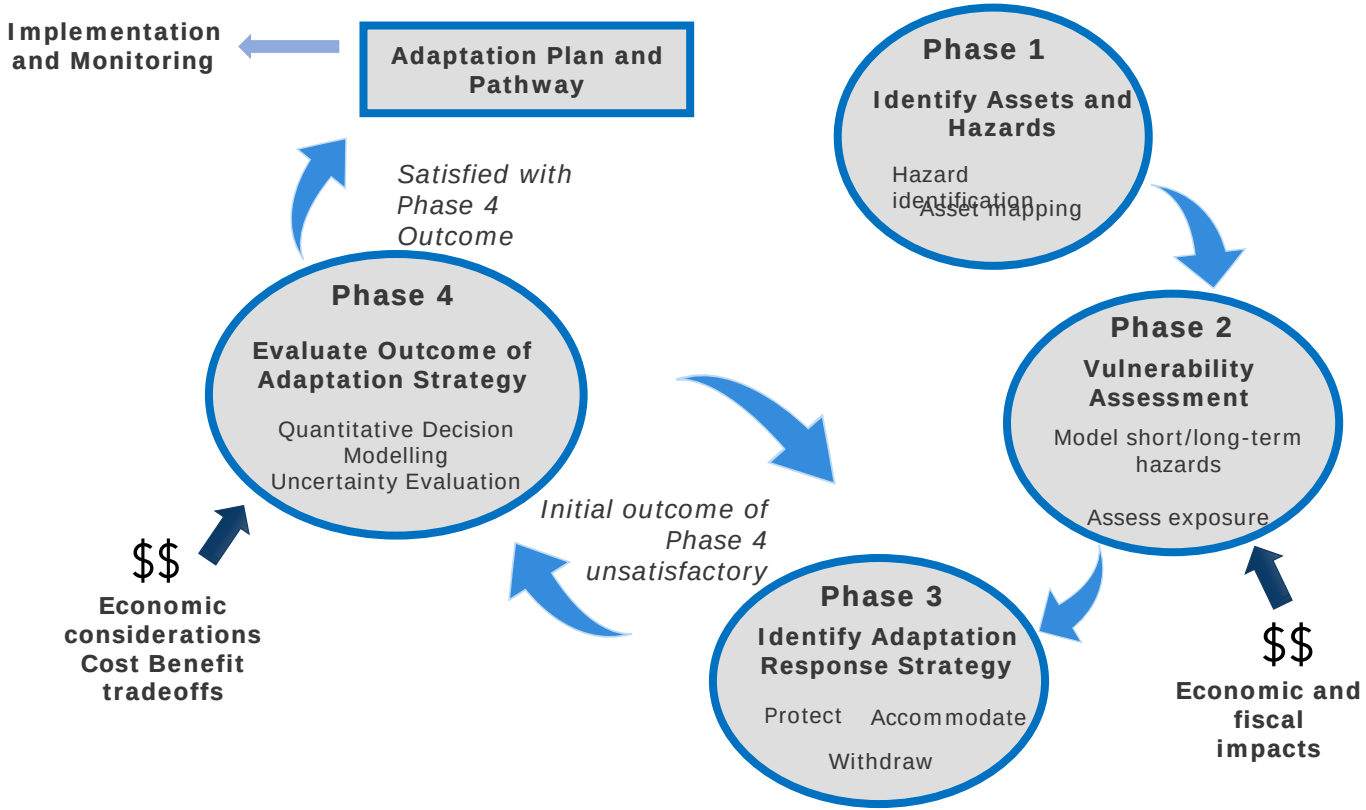
integral



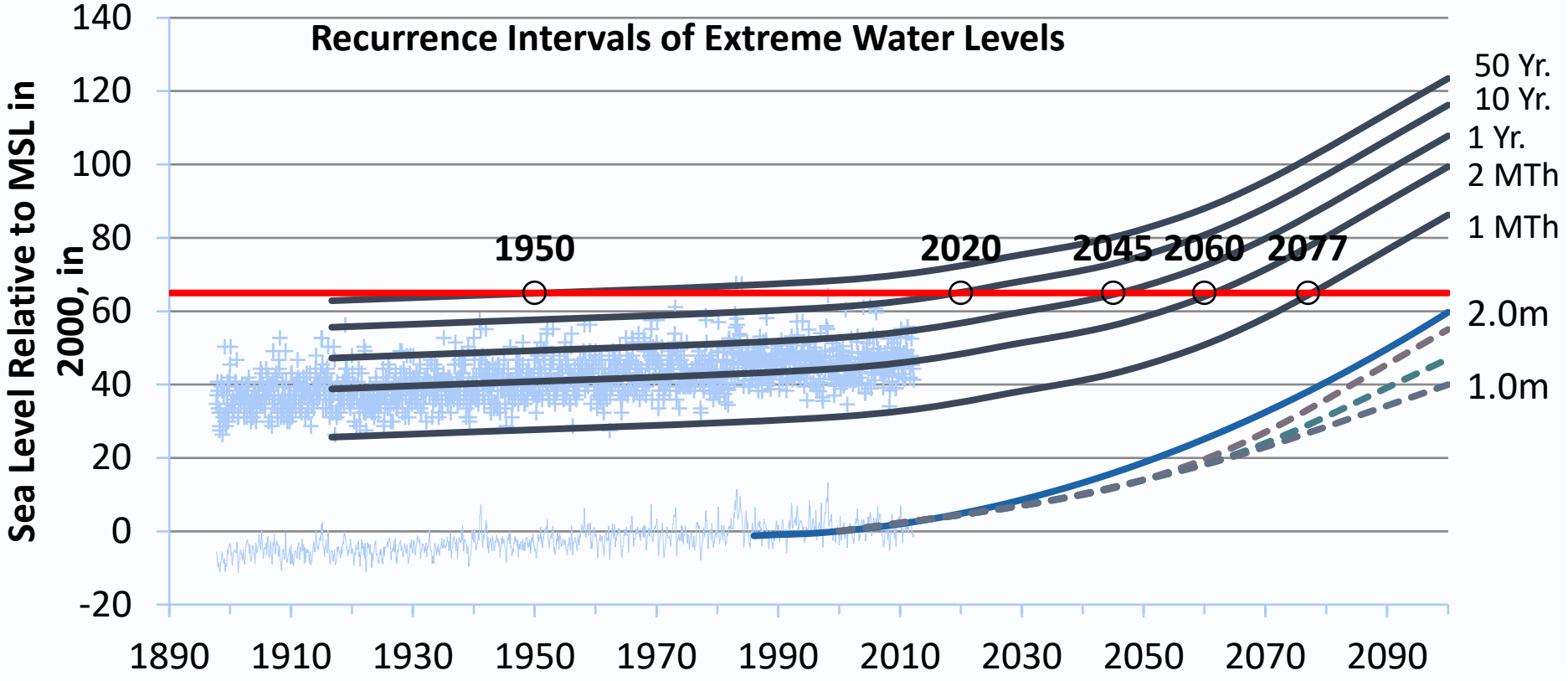
Backup slides

Coastal ADAPT

Scientific and model-based decision support framework for sea-level rise and coastal hazard adaptation planning



Increasing Vulnerabilities and Costs

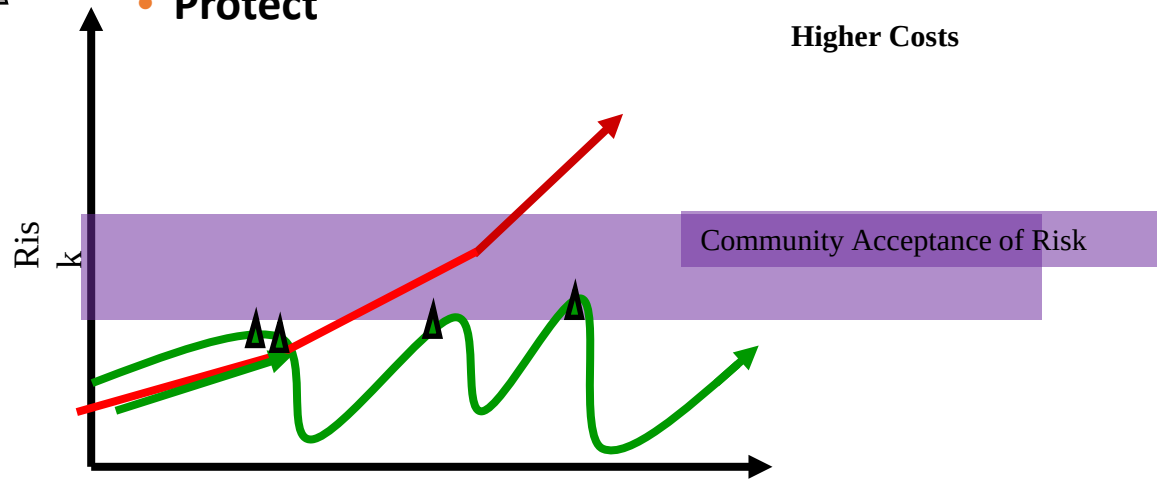


ADAPTATION

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

More Disasters

Higher Costs



Santa Cruz - West Cliff Drive

Adaptation Strategies Considered

- Emergency Armoring (BAU)
- Coastal Recreation and Sand Backpass
- Protection Focused
- Managed Retreat

Methodology

- Change in beach width and recreational use tied to reduced time within tide windows.
- Monte Carlo: Probability based on 10,000 iterations of SLR and adaptation timing to identify positive net present value compared to BAU

Costs

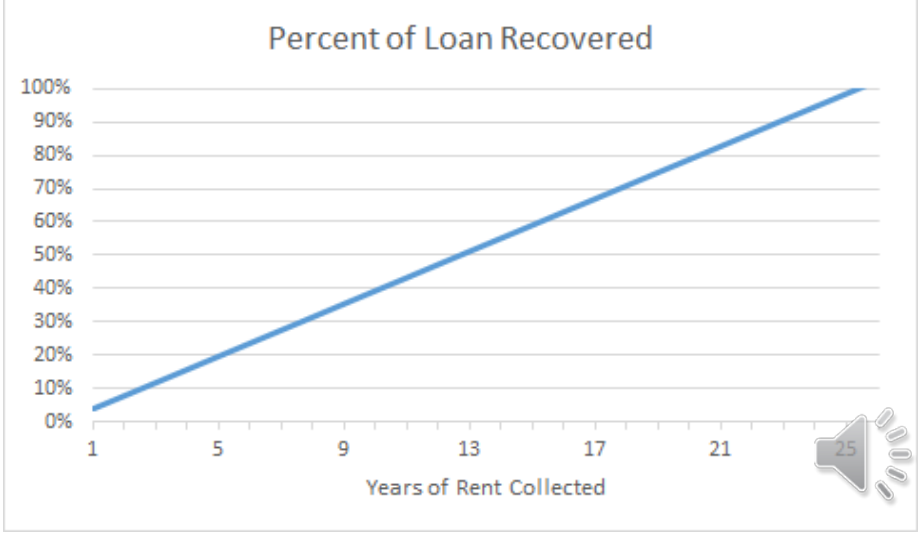
- Implementation and maintenance
- Lost recreation values

Benefits (compared to BAU)

- Gains in recreation value
- Avoided costs and damages

Policy Approach – Fee Simple Acquisition with a Lease Back option

- Initial work showed with Property Tax Exemption, and current rental and interest rates, the City could recover its investment in about 30 years
- Options:
  - Exempt Property Tax
  - Transfer of Development Rights
  - Public Subsidy
  - NGO Acquisition
  - Short term Vacation Rental



Rio Del Mar – Living Shoreline

- https://www.integral-corp.com/videos/integral-nature-based-living-shoreline-solutions/
- Survived a 50year wave event

Potential Damages

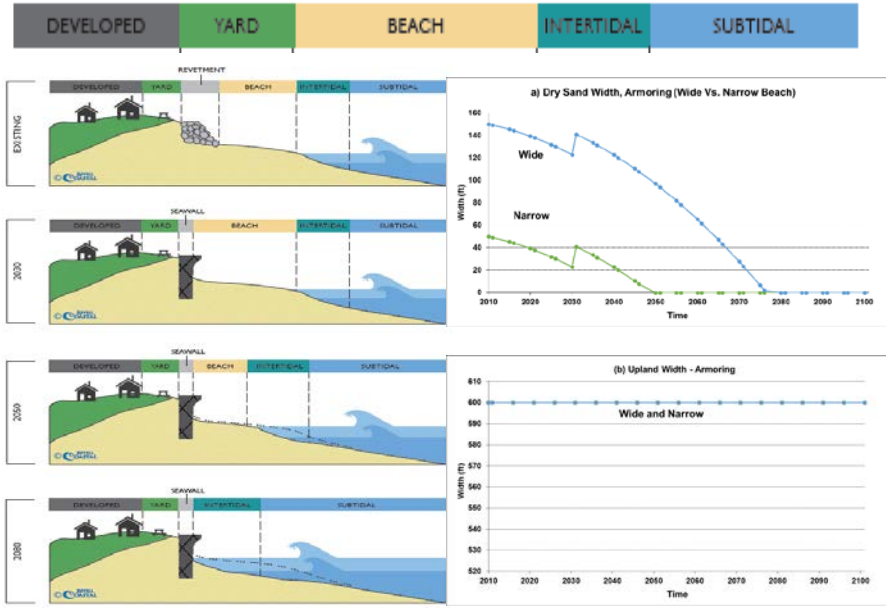
Vulnerability Assessment

- Evaluates the impacts of each type of hazard (e.g. erosion, flooding, inundation)
- Assesses impacts to each resource sector over time (e.g. infrastructure, habitat, land uses, recreation, homes)
- Identifies thresholds in either time or rise in sea level

Imperial Beach

Adaptation Strategies Considered

- Armoring from revetment to seawall
- Managed Retreat
- Expanded Groins
- Nourishment
- Living Shoreline Dune / Cobble Restoration



(A) (B)

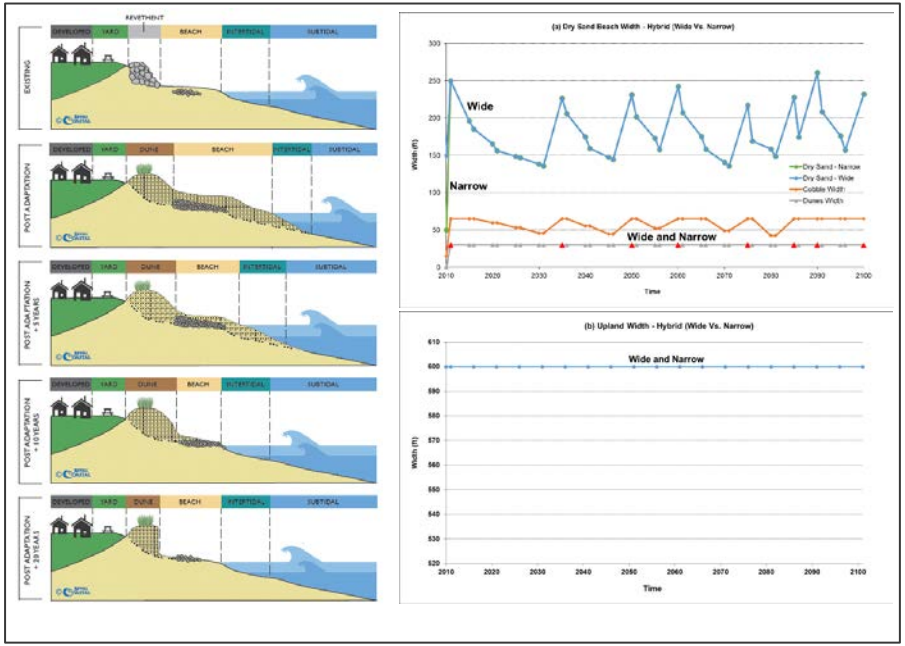
Methodology

- Beach Width vs Upland
- Changes in Beach Width tied to Economics over time
- Recreation and habitat valuation (Net Benefits)
- Narrow vs wide beach as a sensitivity analysis
- Hybrid managed retreat approach of buy out/lease back

Upland protected
Dry sand beaches disappear 2050 - 2075
Only damp sand beaches by 2035 - 2065

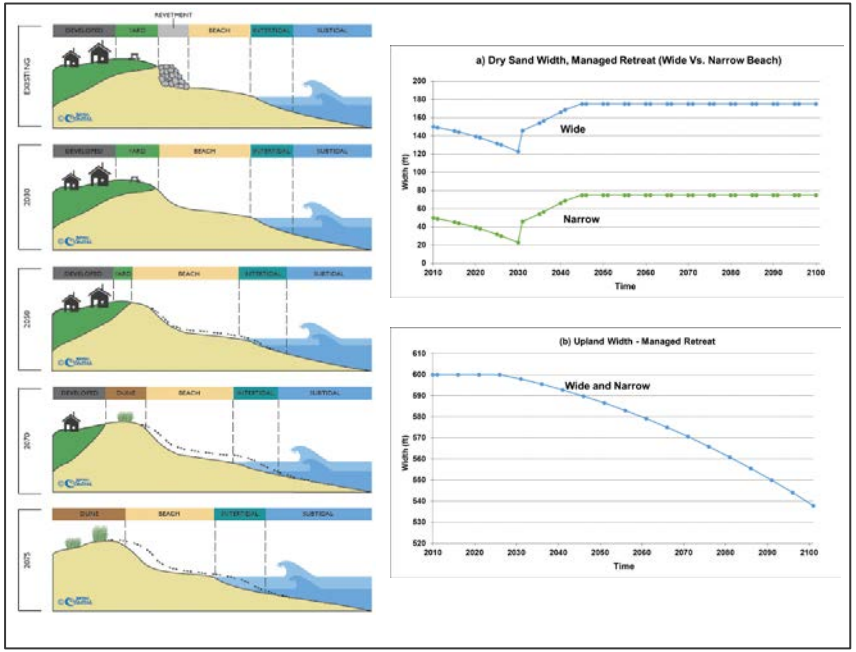
Adaptation Comparisons

Living Shoreline



8 Reconstruction cycles by 2100

Managed Retreat



Beach is maintained
Development eroded up to 3 parcels inland