



Collaboration: Sea-level Marin Adaptation Response Team (C-SMART)



Community Development Agency
3501 Civic Center Drive, Suite 308
San Rafael, CA 94903
415 473 6269 T / 415 473 7880 F
marinslr.org

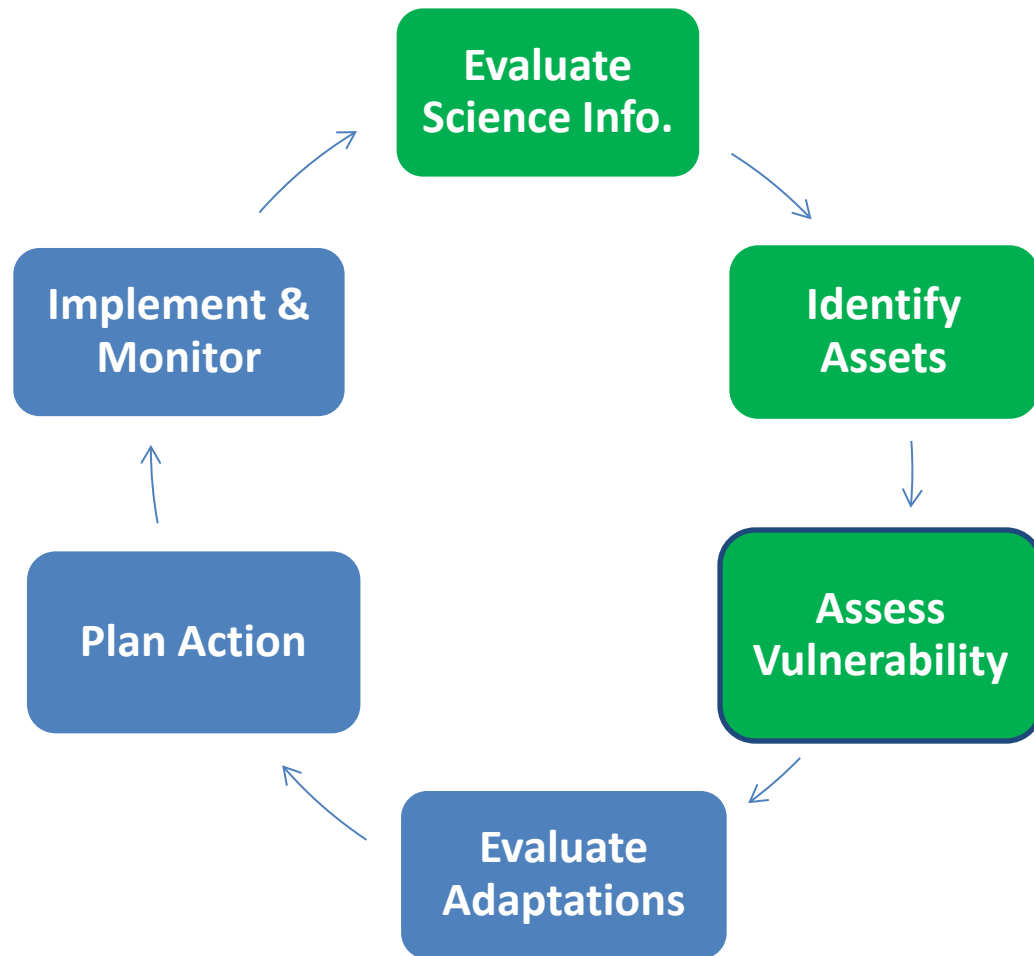
Workshop #3 – Adaptation Strategies
Point Reyes Station
May 30, 2015



Overview

- Update on C-SMART
- Adaptation Options
- Game of Floods
- Individual Workbooks
- Next Steps

Sea Level Rise Adaptation Process



Wharf Road, Bolinas 1982 El Nino flood.
Photo courtesy of Bolinas Museum





Stinson Beach winter storm of 1997



Stinson Beach parking lot

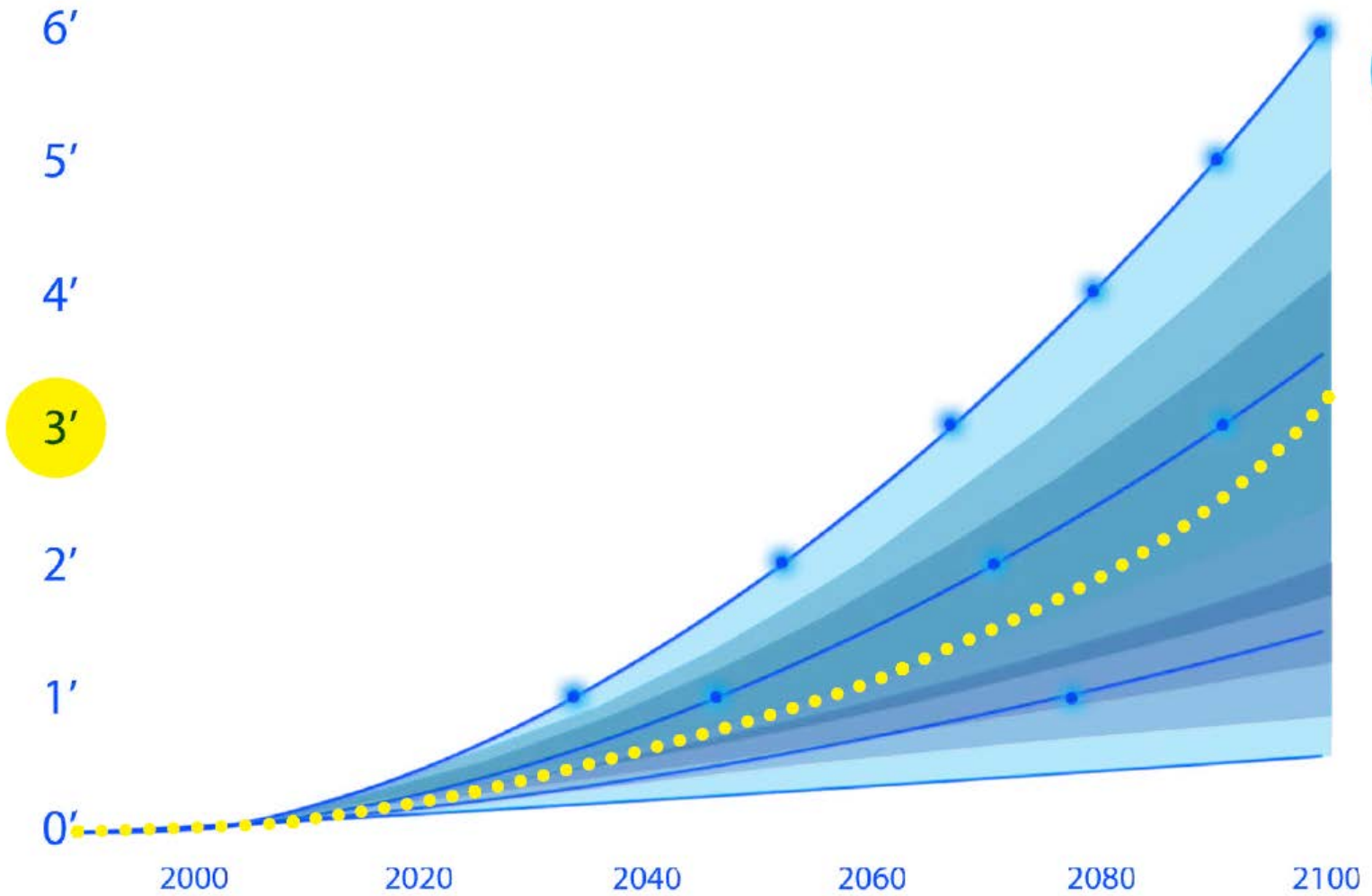
Marin County DPW



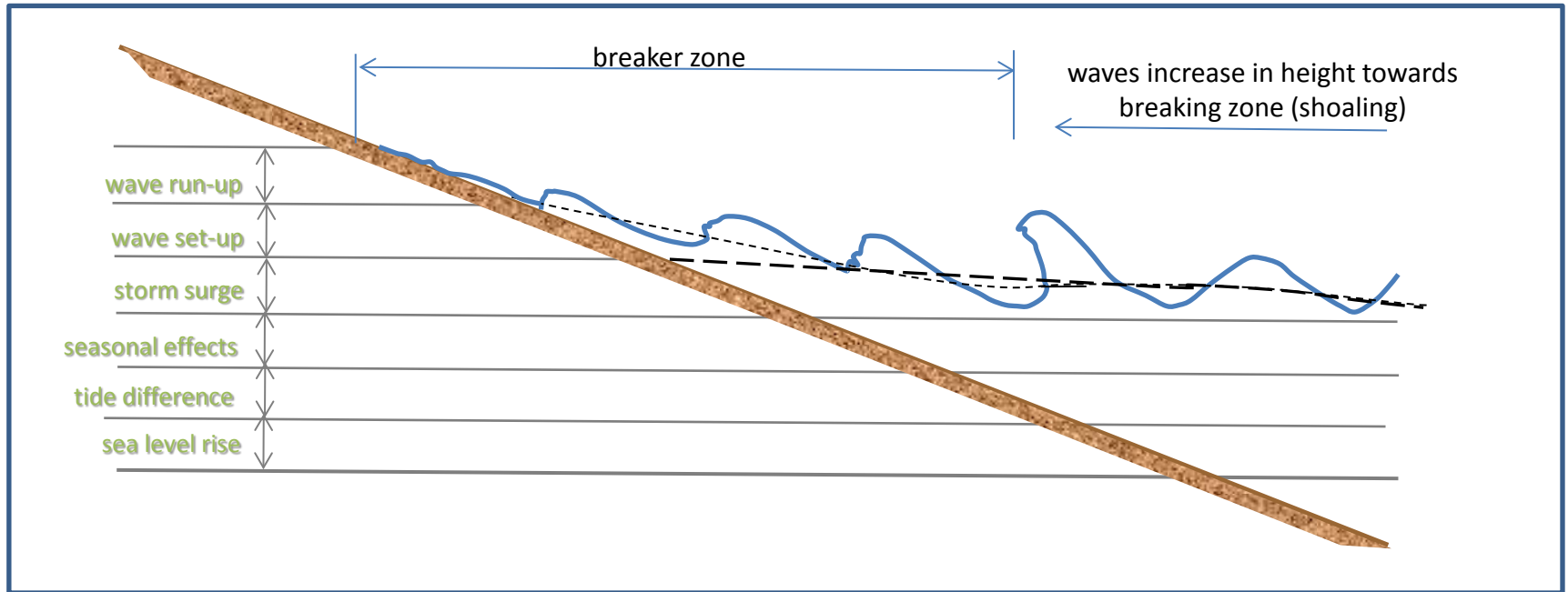
Beach access at King Tide

Rappaport

Potential Future Sea Level Rise



Components of Coastal Water Levels



Stinson Beach
50 cm SLR



Asset Mapping & Inventory

Mapping people; livelihoods; infrastructure, environmental, and economic, social, & cultural assets



Hospital



Parking



School Site



Water



Grocery



Fire Station



Library



Restaurant



Roadway



Public Well



Post Office



Historic Church



Boat Launch



Beach



Home



Ranch



Mammal Habitat



Marina



Evacuation Route



Agriculture



Seabird Colony



Gas Station



Storm Shelter



Sheriff



Aquaculture



Sewage Lift Station



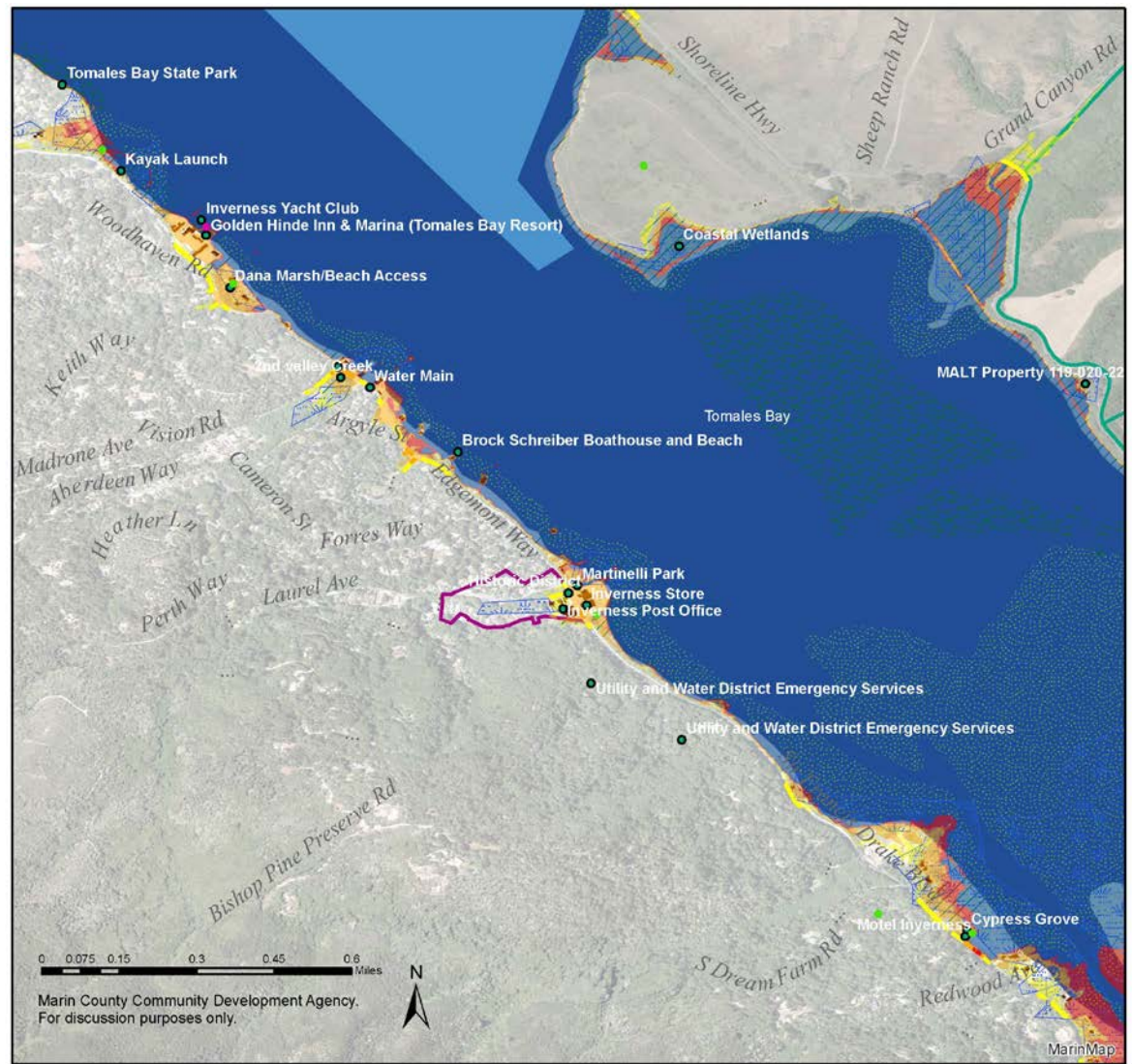
Electrical Sub-Station

- Hotels/Motels
- Trails

- Elderly/mobility limited facilities

- Harbors and marinas
- Archeological sites

Inverness Exposed Assets



Marin County Community Development Agency.
For discussion purposes only.

- Seabird Colonies
- Mammal Haul Out
- Surfgrass
- Eelgrass
- Coastal Marsh

- Parcels
- Buildings
- Agricultural Parcels
- Aquaculture
- Park Parcels
- Historic District
- Dike
- Bulk head
- Inlet/Outlet Pipes

- berm
- bluff wall
- jetty
- revetment (rock)
- seawall
- seawall (cement)
- seawall (soldier pile)
- seawall (timber)

- mid bluff wall
- revetment
- seawall
- upper bluff wall
- Access Points
- Ports
- Marinas
- Boat Launches

Sea Level Rise Scenarios

- 10" SLR + Annual Storm
- 10" SLR + 20 year Storm
- 20" SLR + 20 year Storm
- 40" SLR + 20 year Storm
- 80" SLR + 100 year Storm

Exposed Roads

- 10" + Annual storm
- 10" + 20-year storm
- 20" + 20-year storm
- 20" + 100-year storm
- 80" + 100-year storm

Fall 2014 Public Workshops



Stinson Beach, October 2014

Marin County CDA



Tam High SLR Adaptation Game



Adaptation Measures

1. PROTECT

Revetment/Seawall
 \$\$\$ | EEE | ●

Tide Gate
 \$\$\$\$\$\$ | EEE | ●

Traditional Levee
 \$\$\$\$ | EEE | ●

Wall & Pump Station
 \$\$\$ | EEE | ○

Hard Engineering

Horizontal Levee
 \$\$\$\$\$\$ | E | ●

Wetland/shoreline vegetation
 \$\$\$\$ | E | ●

Artificial Reef
 \$\$ | EE | ●

Beach Maintenance
 \$\$\$ | EE | ○

Soft Engineering

2. ACCOMMODATE

Elevate Buildings
 \$\$\$ | EE | ●

Floodable Buildings
 \$\$\$\$\$\$ | EEE | ●

Elevate/New Road
 \$\$\$\$\$\$ | EEE | ●

Accommodate Water

3. RETREAT

Retreat
 \$\$\$\$ | E | ●

Post-storm prohibitions
 \$ | EE | ●

Move here
 \$\$\$ | EEE | ●

Stricter land use zoning
 \$ | EE | ●

Managed Retreat

Famous adaptors throughout history...

Dutch Boy built protection



Moses implemented phased managed retreat

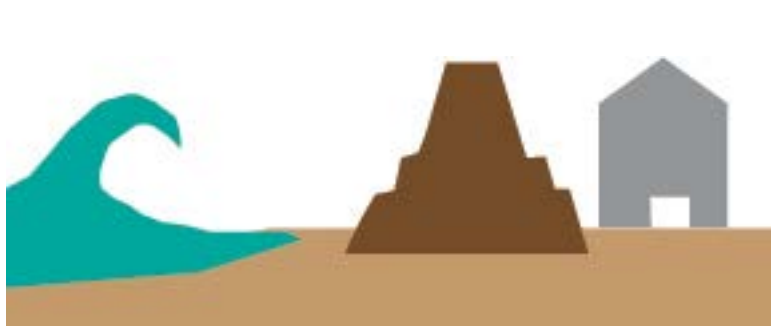


Noah went for accommodation
(floodable structures)

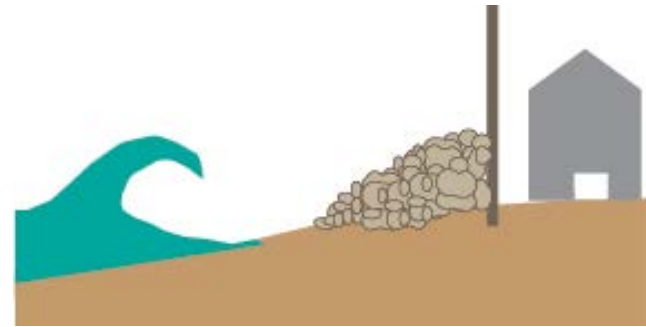


1. PROTECT

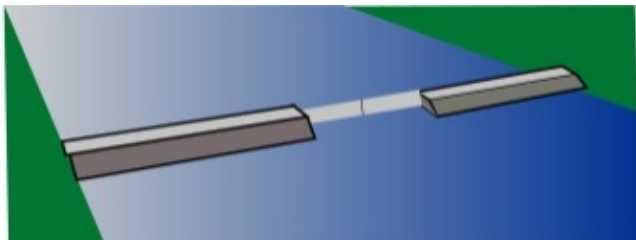
Hard (Traditional) Engineering



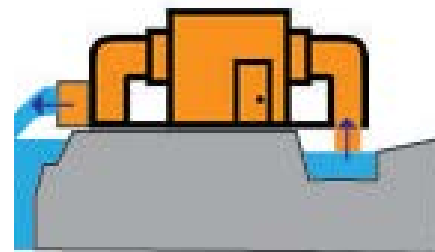
Traditional levee



Seawall/Revetment



Tidal gate



Flood wall & Pump station



Seawall

Pros: Limited ROW required
Cons: Cost, Impacts



Bulkhead seawall in Seadrift neighborhood

Westhoff



Failed "razor dike,"
New Orleans (2005)



Levee

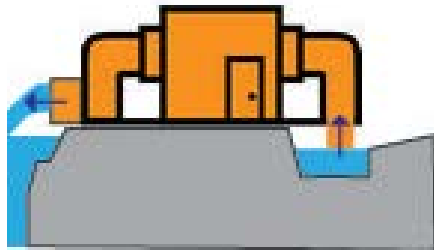


Pros: Stability if maintained,
Cost lower than wall

Cons: Large ROW required

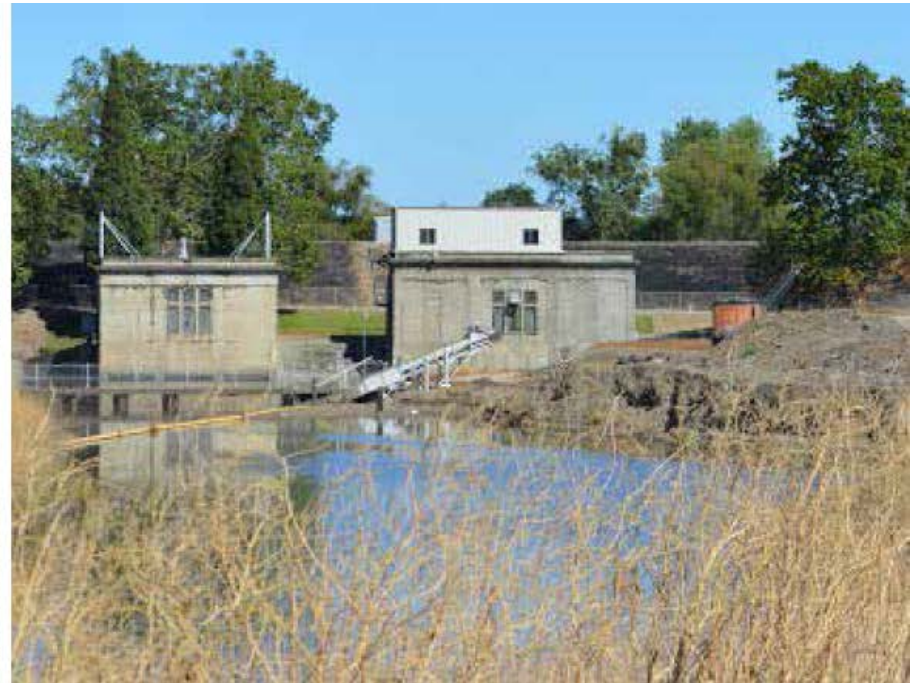


Flood wall & Pump station

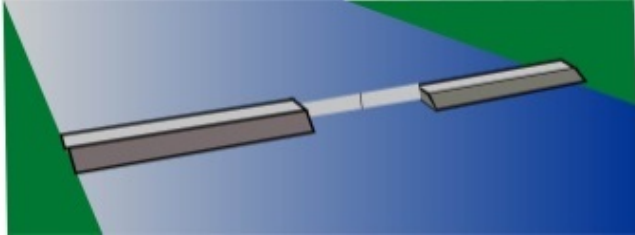


Pros: Lower ROW than levees

Cons: Capital and maintenance costs

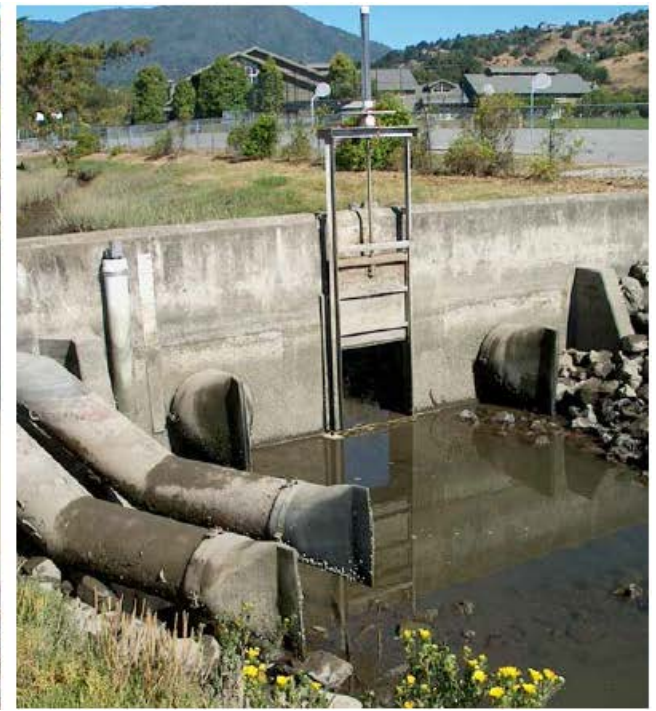


Tidal gate



Pros: Temp solution to tidal riverine flooding

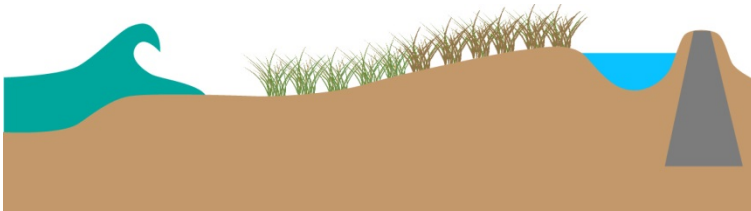
Cons: Cost, limited effectiveness over time





1. PROTECT

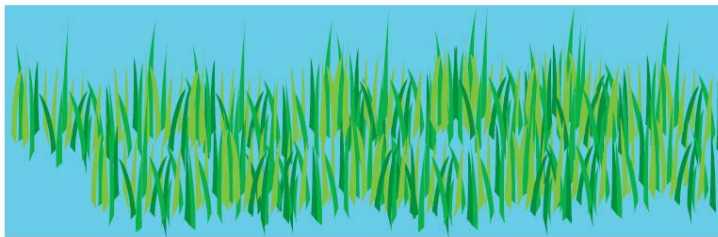
Soft (Nature-based) Engineering



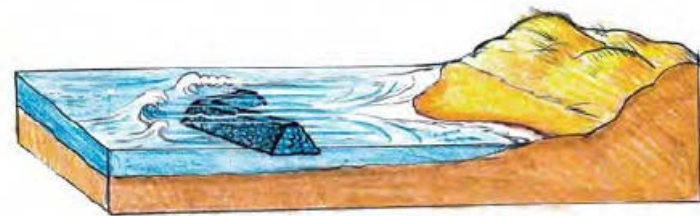
Horizontal levee



Dune restoration & Beach maintenance

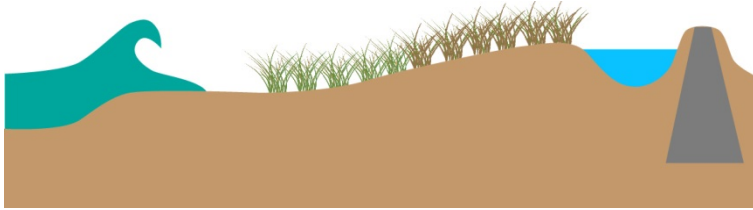


Wetland/ shoreline vegetation



Offshore structure

Horizontal levee

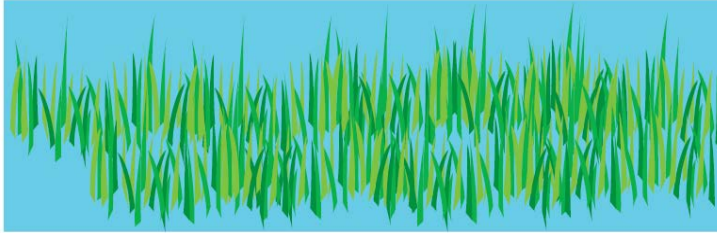


Pros: Uses landscape to attenuate waves, provides habitat

Cons: Cost for earthwork, larger ROW



Wetland/ shoreline vegetation



Pros: Habitat improvement and flood reduction

Cons: Large ROW required



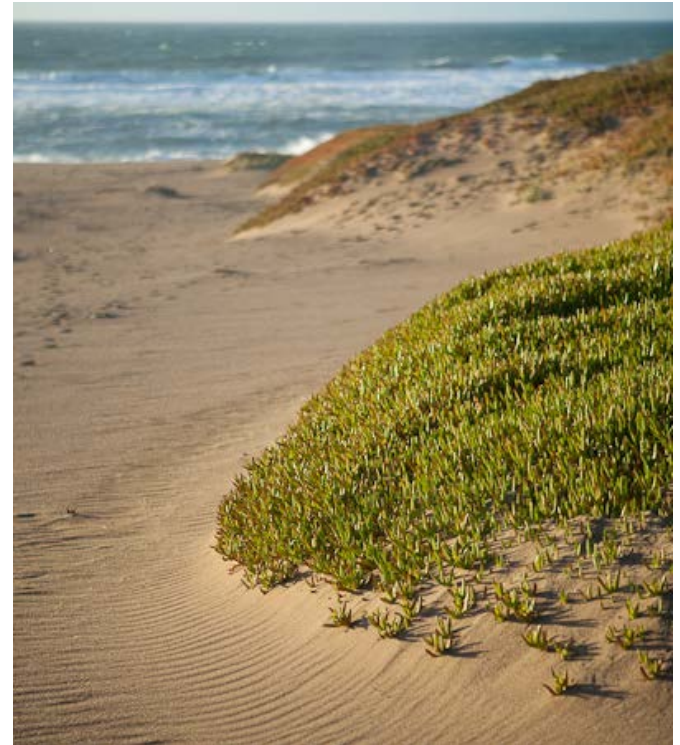
Giacomini Wetland Restoration, 2008

Dune Restoration & Beach Maintenance



Pros: Recreation and flood reduction benefits

Cons: Costs for replenishment





Building the “Zandmotor” using a side-caster, in addition to slurry pipes : 2011



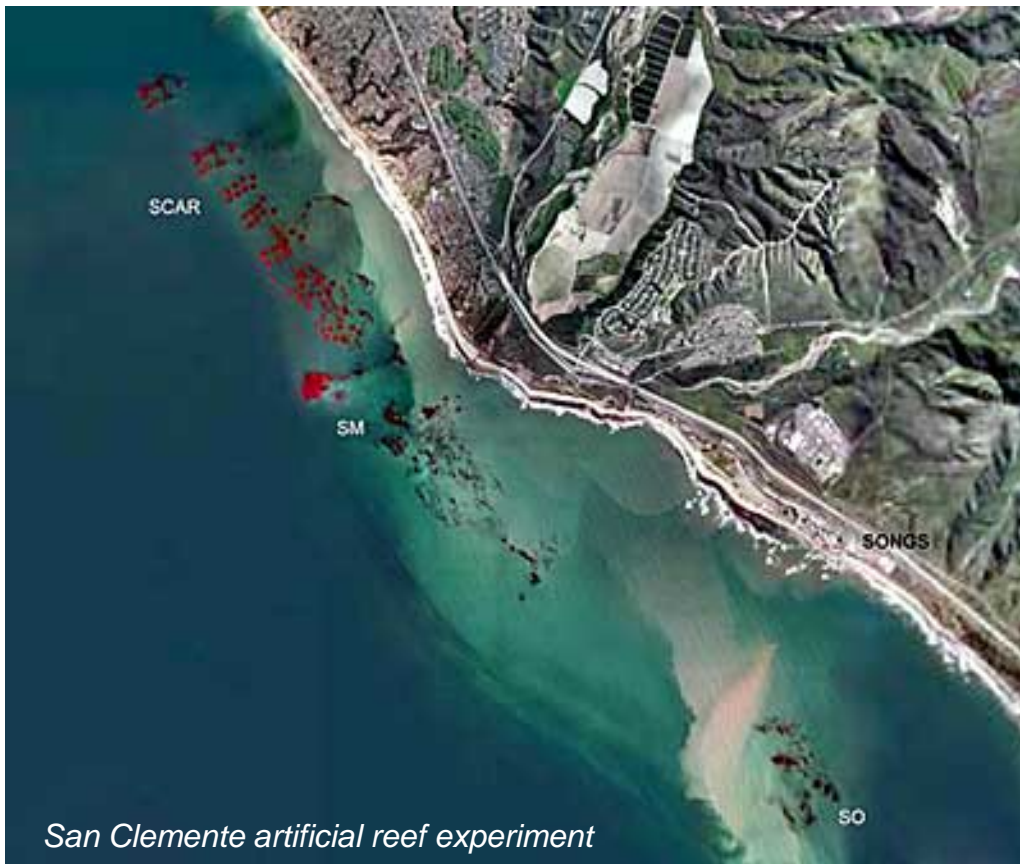
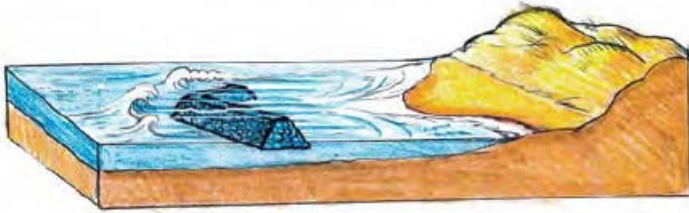
Rotterdam, The Netherlands

The “sand engine,” hard at work widening beaches/dunes to the north and south.

Offshore structures

Pros: Reduces waves impacts – more when structure is higher

Cons: Costs to construct, maintain and limited effectiveness for SLR



2. ACCOMMODATE



New floodable
development



Elevate buildings



New/elevate road



Elevate buildings

Pros: Effective for storm flooding

Cons: Costs, not effective for permanent tidal flooding





Floodable development

Pros: Potential solution that generates revenue

Cons: Impacts from more development – higher density to pay for costs



New/elevate road

Pros: Protects roads when designed correctly

Cons: Very high cost, ROW



New/elevate road

Pros: Protects roads when designed correctly

Cons: Very high cost, ROW





3. RETREAT



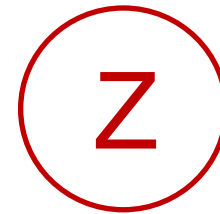
Retreat



Rebuild here



Post-storm prohibitions



Stricter land use zoning

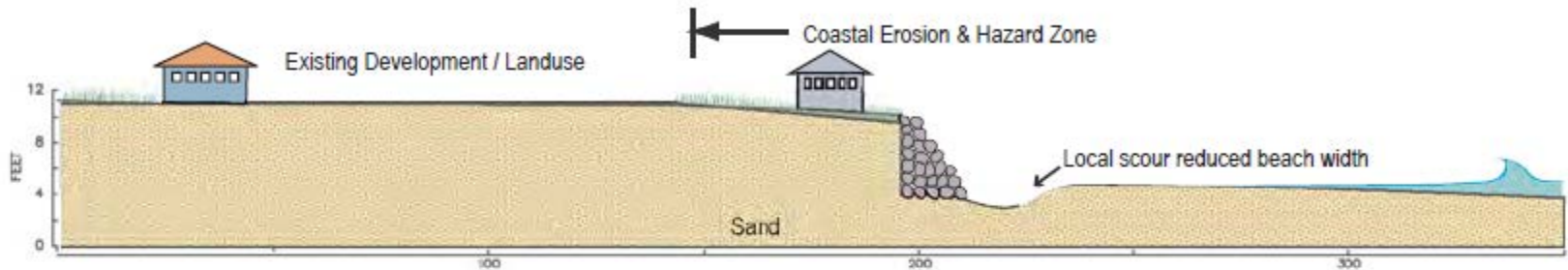


Managed Retreat

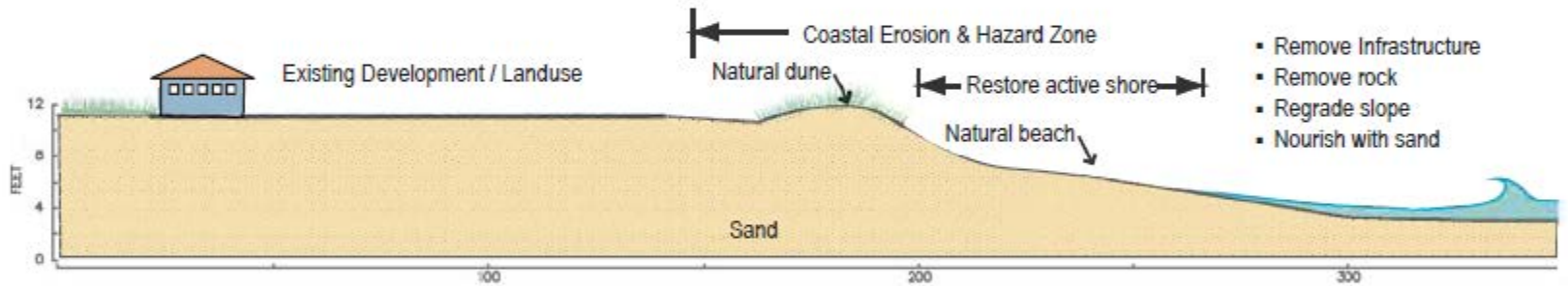
Pros: Lower costs if no buyout

Cons: Costs for buy-out and community impacts, new infrastructure

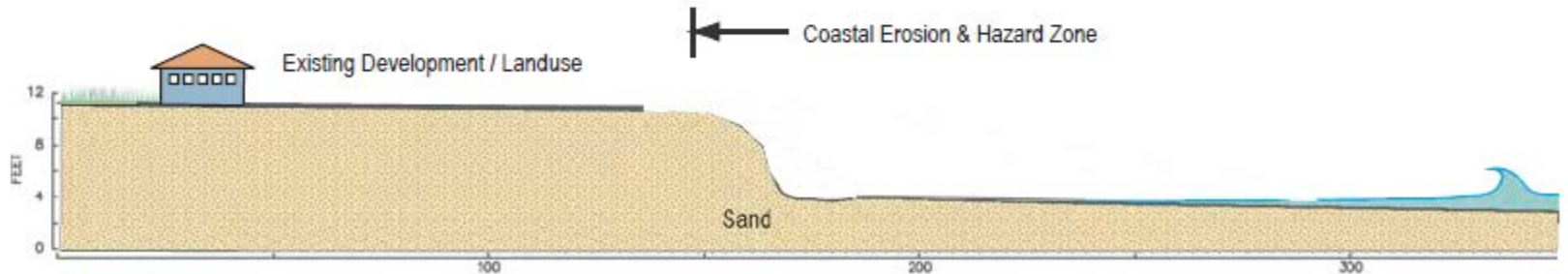
Current



Post



Eroded



Post Storm Restrictions and Stricter Land Use Zoning



- No or restricted rebuilding after storms?
- Rolling easements
- Extra technical studies
- Use of stricter codes (FEMA V)



Costs \$\$\$

Real World – costs are messy and depend on many factors

+ planning & engineering








+ permitting

+ maintenance & repair

Game World – costs are simpler one-time costs and given to you per unit (i.e. mile or # of buildings)

Game of Floods of Martin Island

Adaptation Game Piece Reference Sheet

Name	Piece	Units	Cost (\$)	Env. Impact EEE or EE or E	Flood Protection Short, med, or long-term	Uses and Notes
Hard (Traditional) Engineering						
Traditional Levee		Mile	\$\$\$\$	EEE	med	Protects against temporary flooding, storm surge and some sea level rise. <ul style="list-style-type: none"> • Can increase wave run-up and overtopping. • In high wave energy environment on coast, need to armor levee slope.
Seawall/Revetment		Mile	\$\$\$	EEE	med	Protects against erosion. <ul style="list-style-type: none"> • Can increase wave run-up and overtopping. • Increase erosion in adjacent areas.
Tidal Gate		Feet	\$\$\$\$\$	EEE	med	Protects against temporary flooding, storm surge and some sea level rise. <ul style="list-style-type: none"> • High environmental impacts to hydrology. • Viable in sheltered estuaries and lagoons.
Flood wall & pump station		Mile	\$\$\$	EEE	short	Protects against temporary flooding, storm surge and some sea level rise. <ul style="list-style-type: none"> • Can increase wave run-up and overtopping. • Require electricity and maintenance.
Soft Engineering						
"Horizontal" Levee		Mile	\$\$\$\$	E	med/long	Protects against temporary flooding, storm surge, some sea level rise, and wave impacts. <ul style="list-style-type: none"> • Viable in sheltered estuaries and lagoons.
Wetland/shoreline vegetation		Acre	\$\$\$	E	short-med	Protects against temporary flooding, storm surge, and wave impacts. <ul style="list-style-type: none"> • Viable in sheltered estuaries and lagoons.
Dune Restoration and Beach Maintenance (nourishment & groins)		Mile	\$\$\$	EE	short/med	Protects against temporary flooding and storm surge. <ul style="list-style-type: none"> • Even nourished beaches can erode and expose infrastructure to wave damage.

THE GAME OF FLOODS

Marin Island

START

Sea levels are rising worldwide as warming oceans expand and melt glaciers and ice sheets. Stronger storms coupled with rising seas can significantly damage—even destroy—property, infrastructure, public facilities, natural habitats, and other resources we depend on. We need to take action now to reduce our vulnerability to sea level rise. Adaptation Plan shows the strategies game pieces.

1. People and property needs the sea level rise scenario about.
2. Roles, also to the sea level rise. The highest of sea level rise, if it occurs, the tide players must re-roll. Players take turns in clockwise order.

3. In turn, each player selects an asset to accommodate, defend, or retreat from. No need to duplicate assets. Use the worksheet provided to record your choice, costs, and pros and cons.
4. Next, in turn, each player places and stakes about their preferred adaptation strategies or around the island. Conflicting strategies are allowed.
5. Consider the following factors to inform the proposal: (1) cost/benefit, (2) Private property impacts, (3) Environmental impacts, (4) Equity/Social Justice concerns, (5) Others. Use your worksheet to take notes.

Sea Level Rise 2050 Scenario Key

RED AREA = Permanent Sea Level Rise Flooding
ORANGE AREA = Temporary Sea Level Rise Flooding
YELLOW AREA = Temporary 100 Year Storm Flooding



- Evacuation Route
- Marina
- Mammal Habitat
- Ranch
- Grocery
- School Site
- Parking
- Hospital
- Storm Shelter
- Gas Station
- Seabird Colony
- Agriculture
- Public Well
- Library
- Fire Station
- Electrical Sub Station
- Sewage Lift Station
- Aquaculture
- Sheep
- Home
- Historic Church
- Post Office

LEGEND

Managed Retreat

- Retreat
- Post-storm prohibitions
- Move here
- Stricter land use zoning

Accommodate Water

- Elevate Buildings
- Floodable Buildings
- Elevate/New Road

Hard Engineering

- Revetment/Seawall
- Traditional Levee
- Tide Gate
- Wall & Pump Station

Soft Engineering

- Horizontal Levee
- Wetland/shoreline vegetation
- Offshore Structure
- Beach Maintenance

GAME PIECES

Next Steps

- Host a Game Night!
- Publish Vulnerability Assessment
- Next workshops in Fall 2015
- Draft Adaptation Plan and Local Coastal Program (LCP) Amendment



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