Moving from Planning to Implementation
Bridging Coastal Climate Science, Law, Policy, and Spatial Modeling

Eric Hartge
Research Development Manager

Stanford Center for Ocean Solutions

April 19, 2018
Jesse Reiblich, Lisa Wedding, Gregg Verutes, Jessica Williams, Cole Sito, Sierra Killian, Monica Moritsch
Adaptation Planning in California

What have we heard from coastal managers?

Common Themes from Engagement Meetings

- Where are we most exposed to climate hazards?
- Where are people? Habitats? Infrastructure?
- What options are available along our coastline?
- How do I determine what is feasible, appropriate, or suitable?
- What policy or legal factors limit or enable my options?
<table>
<thead>
<tr>
<th>Spatially Relevant</th>
<th>Non-Spatially Relevant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geomorphologic Features</td>
<td>Cultural Attachment</td>
</tr>
<tr>
<td>Land Use / Zoning</td>
<td>“Not in my back yard”</td>
</tr>
<tr>
<td>Coastal Exposure</td>
<td>Avoiding “Takings” Claims</td>
</tr>
<tr>
<td>Habitat Presence</td>
<td>Cost</td>
</tr>
<tr>
<td>Protective Role of Habitat</td>
<td>Political Will</td>
</tr>
<tr>
<td>Population Density</td>
<td>Community Vision &amp; Values</td>
</tr>
</tbody>
</table>

**Spatially Filtering**

What spatial features enable my strategy of interest?

- Geomorphologic Features
- Land Use or Zoning Category
- Habitat Presence
- Protective Role of Habitat
- Population Density
- Exposure/Hazard Mapping

---

Potential Location for Dune Restoration Project
Connecting Strategies to Spatial Filters

How can we “code” these connections?

Initial Statement

Dune restoration strategies are effective where dunes are present; zoning types are residential, agricultural, parks/open space/public, or uncategorized; and geomorphology includes lowlands.

Coded Selections

<table>
<thead>
<tr>
<th>Habitats</th>
<th>Zoning</th>
<th>Geomorphology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dunes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wetlands</td>
<td>Residential</td>
<td></td>
</tr>
<tr>
<td>Eelgrass</td>
<td>Agricultural</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Comm/Ind</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Park/Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Uncat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blufftop</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Beachfront</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Estuary</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hard Coast</td>
<td></td>
</tr>
</tbody>
</table>

Habitats: Dunes, Wetlands, Eelgrass
Zoning: Residential, Agricultural, Parks/Open Space/Public, Uncat
Geomorphology: Lowlands

Structure Query Language (SQL) Statement

```
Selection = (dune=1) AND (resident = 1 OR ag = 1 OR park_open = 1 OR uncat = 1) AND (beachfront= 1 OR Estuary = 1)
```
Visualizing in Online Viewer

**HABITATS**
- Explore: Zoom map to each county
- Obtain summary of science and policy considerations
- Visualize at-risk locations and comparisons to other coastal CA counties

**EXPOSURE**
- Hazard: Map scenarios of coastal exposure with InVEST
- Show exposure drivers within user-defined AOI

**ZONING**
- Zoning: Map land cover and zoning by county
- View aerial photos from the Coastal Records Project

**STRATEGIES**
- Strategies: Map suitable locations for each of four categories
- Click dot symbols to access legal guidance and links to additional online resources
### Adaptation Strategies

#### What options are possible in coastal California?

<table>
<thead>
<tr>
<th>Legal or Regulatory</th>
<th>Engineered</th>
<th>Financial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overlay Zones</td>
<td>Beach Nourishment, Restoration</td>
<td>Catastrophe Bonds</td>
</tr>
<tr>
<td>Downzoning</td>
<td>Cliff Stabilization</td>
<td>Transfer of Development Rights</td>
</tr>
<tr>
<td>Development Moratoria</td>
<td>Seawalls</td>
<td>Buyouts/Buybacks/Leasebacks</td>
</tr>
<tr>
<td>Prohibit Seawalls</td>
<td>Breakwaters</td>
<td>Special Assessment for Vuln. Properties</td>
</tr>
<tr>
<td>No Build Areas</td>
<td>Jetties, Groins</td>
<td>Conservation Easements</td>
</tr>
<tr>
<td>Setback Requirements</td>
<td>Tide Gates</td>
<td>Land banking</td>
</tr>
<tr>
<td>Flood Hazard Regulations</td>
<td>Revetments and Riprap</td>
<td>Geologic Hazard Abatement Districts</td>
</tr>
<tr>
<td>Rolling Easements</td>
<td>Elevating Structures</td>
<td>Amendments to the National Flood</td>
</tr>
<tr>
<td>Zoning Regulations</td>
<td>Dune Restoration</td>
<td>Insurance Program</td>
</tr>
<tr>
<td>Redevelopment Restrictions</td>
<td>Wetland Restoration</td>
<td></td>
</tr>
<tr>
<td>Density Limits</td>
<td>Managed Retreat and Relocation</td>
<td></td>
</tr>
<tr>
<td>Time Horizons</td>
<td>Living Shorelines</td>
<td></td>
</tr>
<tr>
<td>Triggering Event Language</td>
<td>Inaction (decision not to act)</td>
<td></td>
</tr>
</tbody>
</table>

*NON-EXHAUSTIVE LIST*
**Adaptation Strategies**

*What options are possible in coastal California?*

### Legal or Regulatory
- Overlay Zones
- Downzoning
- Development Moratoria
- **Prohibit Seawalls**
- No Build Areas
- **Setback Requirements**
- Flood Hazard Regulations
- Rolling Easements
- Zoning Regulations
- Redevelopment Restrictions
- Density Limits
- Time Horizons
- Triggering Event Language

### Engineered
- Beach Nourishment, Restoration
- Cliff Stabilization
- Seawalls
- Breakwaters
- Jetties, Groins
- Tide Gates
- Revetments and Riprap
- Elevating Structures
- **Dune Restoration**
- Wetland Restoration
- Managed Retreat and Relocation
- Living Shorelines
- **Inaction (decision not to act)**

### Financial
- Catastrophe Bonds
- Transfer of Development Rights
- Buyouts/Buybacks/Leasebacks
- Special Assessment for Vuln. Properties
- **Conservation Easements**
- Land Banking
- Geologic Hazard Abatement Districts
- Amendments to the National Flood Insurance Program

**Spatially Distilled Selection of Feasible Options**
## Policy Brief List of Strategies

### Engineered
- Beach Nourishment / Restoration
- Dune Restoration
- Elevation of Structures
- Living Shorelines
- Riprap
- Seawalls
- Wetland Restoration

### Financial
- Buyout Programs
- Conservation Easements
- Geologic Hazard Abatement Districts
- Transfer of Development Rights

### Legal & Regulatory
- Development Moratoria
- Overlay Zones
- Redevelopment Restrictions
- “Trigger” Language

### Additional Topics
- Public Trust Doctrine
- Coastal Adaptation and Takings Law
Distilled Policy Analysis

What information will help inform my decision?

- Strategy Description
- Tradeoffs
- Legal Considerations
- Examples in California or Beyond