Harnessing the power of nature to adapt to sea level rise in SF Bay

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Sierra Club
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How did we get here?

- Issue 1: History matters
- Issue 2: Lands below sea level
- Issue 3: History of inequality
- Issue 4: Water from all sides
- Issue 5: Many cooks in the kitchen
Issue 1: History matters

We built on top of the Baylands and in floodplains and now these areas are sinking and flooding.
Tidal wetlands
Ca 1800
1952

Low-level fill development

High-level fill development

Development History
Tidal wetlands
Ca 2010
Issue 2: Lands below sea level

Some areas are severly subsided and protected by fragile levees.
The Bay’s polder problem
Redlining in the Bay Area forced the historically marginalized to live in the lowest lying areas that flood the most regularly.
Issue 4: Water from all sides

Sea level rise is only one part of the problem.

Increased precipitation from atmospheric river events and rising groundwater are not fully incorporated into flood models.
Different jurisdictions have generally pursued shoreline planning separately, yet this approach does not confer the greatest value or benefits.

A regional approach is needed.
Sea level rise will not stop at city boundaries.
What is nature-based adaptation?

Actions that **harness biodiversity and ecosystem services to reduce vulnerability and build resilience** to climate change.

Range from fully natural → Hybrid (natural + engineered)
Local sea level rise adaptation planning

- Challenge of transitioning from vulnerability assessments to adaptation solutions
- Lots of interest in nature-based options, where are they appropriate?
- Challenge of “go-it-alone” land use decisions
- **Goal**: Develop a framework process and set of tools to support the transition from vulnerability assessment to adaptation strategies at a useful scale
**STEP 1**
Plan using nature’s boundaries (instead of traditional boundaries)

**STEP 2**
Identify adaptation measures that could work well in a given place (and use nature as much as you can)

**STEP 3**
Use when bringing stakeholders together to envision a resilient future
Defining geomorphic units

1. Headlands & small valleys
   - Watershed size: small
   - Slope: steep
   - Bayland width: narrow
   - Distance to deep water: small

2. Alluvial fans & plains
   - Watershed size: intermediate
   - Slope: moderate
   - Bayland width: intermediate
   - Distance to deep water: intermediate

3. Wide alluvial valleys
   - Watershed size: large
   - Slope: gradual
   - Bayland width: wide
   - Distance to deep water: large
Nature’s Boundaries

Operational Landscape Units
Areas with shared geophysical and land use characteristics suited for a particular suite of nature-based measures

- Connected hydrologically (tie to watersheds)
- Land potentially inundated by SLR under H++ scenario (OPC 2017)
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<th>Regulatory, financial, policy tools</th>
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Living shorelines: oyster reefs

Coastal storm-surge approach: tidal marsh & horizontal levee
Arambaru beach enhancement project
Peter Baye, Roger Leventhal
Marsh restoration

Methods:

- Identify areas currently at the right elevation to potentially support tidal marshes using $z^*$ (\(^\sim\)MSL and \(^\sim\)HAT)
- Assess width of marsh needed to knock 100-year waves down to \(^\sim\)1 ft (0.3 m)
Migration space

Identify areas that are above tidal range now, but will be within tidal range in the future (areas where wetlands could migrate)

- **Protected**
- **Unprotected**
Nearshore reefs

Submerged aquatic vegetation (eelgrass)

Beaches

Tidal marshes

Polder management

Ecotone levees

Migration space preparation
Suitability of nature-based measures

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<td>Some suitability</td>
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<td>High suitability</td>
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1. Richardson
2. Corte Madera
3. San Rafael
4. Gallinas
5. Novato
6. Petaluma
7. Napa - Sonoma
8. Carquinez North
9. Suisun Slough
10. Montezuma Slough
11. Bay Point
12. Walnut
13. Carquinez South
14. Pinole
15. Wildcat
16. Point Richmond
17. East Bay Crescent
18. San Leandro
19. San Lorenzo
20. Alameda Creek
21. Mcevoy
22. Santa Clara Valley
23. Stevens
24. San Francisco
25. Belmont - Redwood
26. San Mateo
27. Colma - San Bruno
28. Yosemite - Visitacion
29. Mission - Islais
30. Golden Gate
Adaptation measures

Nature-based measures
- Oyster reef creation
- Submerged vegetation restoration
- Mudflat augmentation
- Beach creation (sand, cobble, shell)
- Marsh restoration (various)
- Polder management
- Horizontal levee creation
- Migration zone preparation
- Creek to bay connections
- Green stormwater infrastructure

Regulatory, financial, policy tools
- Zoning and overlay zones
- Setbacks, buffers, and clustering
- Building codes and building retrofits
- Rebuilding and development restrictions
- Conservation easements
- Tax incentives and special assessments
- Geologic Hazard Abatement District
- Transfer of Development Rights
- Buyouts
The result: a spatially-explicit framework to guide adaptation efforts
Easements, buyouts in open/protected areas
Not intensifying development, elevating roads, buildings, re-zoning

**Oyster reefs**

**Horizontal Levees**

**Beaches**

**Eelgrass**

**Creek connections**

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Not intensifying development, elevating roads, buildings, re-zoning
Measures to strategies

1. Mudflat Augmentation
2. Vegetated Marsh
3. Creek-to-Bayland Reconnection
4. Migration Space Preparation

Agriculture
Upland
Mudflat
Subtidal
Adaptation pathways

Conceptual phasing of measures triggered by sea-level rise, rather than a chronological timeline (adapted from Goals Project 2015).
How can this be used?

• As a toolkit to bring together stakeholders around a given shoreline unit
• A resource to assist environmental review and permitting
• Guidance for developers and project applicants
• Local, regional planners, and communities creating adaptation plans and policies
• Guidance for policy changes within regional agencies
City and Regional Goals Clash as Newark Pushes Ahead With Low-Density Housing in A Bayshore Flood Zone

by Mukta Patil
March 9, 2021

Florence LaRiviere has fought to protect marshes in the Bay Area for decades. In the 1960s, she joined a small group of residents to push for the creation of what would become the Don Edwards San Francisco Bay Area National Wildlife Refuge, a now-30,000-acre haven along the shores of the South Bay that provides habitat for migratory birds and several special...
Migration space example

Identify areas that are above tidal range now, but will be within tidal range in the future (areas where wetlands could migrate)

- Protected
- Unprotected
We need a regional approach
We also need more housing
But not housing that will be flooded
Need for sediment

- USACE dredges navigation channels yearly
- Cheaper to take the material off shore
- We need to reuse the sediment in a smart way, collaboratively if we want to design with nature for climate resilience

San Francisco Bay: Protection from costly disasters is being thrown away, scientists say

Sea level rise threatens billions in flood damage, but dredged mud to raise shoreline isn’t being used
Engineering With Nature at USACE

- “Run to where the ball is going to be”: Where will landscape features create the most value in the future?
- Size it right: nature-based features are scalable, affordable, and innovative.
- Solutions are place-based: Local knowledge and systems thinking.
Shallow water placement pilot

- Beneficial reuse of dredged materials
- Using natural transport processes to move material onshore
- Creates resilience for mudflats and marshes
- Innovative, cost-effective
- Needs modeling, monitoring to quantify impacts and benefits
We can adapt to sea level rise if we:

- Add more tools to our toolbox
- Speed up
- Design with nature
- Empower and center communities
- Work together
THANK YOU

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