
http://tribune.com.pk


More powerful storms
Sea level rise
Habitat modifications
T. Turner/National Geographic

WE HAVE A CHOICE TO MAKE

QUESTIONS AND DECISION CONTEXT

Climate adaptation and coastal resilience

- Where and to what extent do existing habitats reduce risk of people and infrastructure to coastal hazards now and in the future?

Habitat restoration on public and private lands

- Where will investments in restoration of habitats be most effective for increasing coastal resilience and the delivery of other coastal and marine ecosystem services?

Corporate risk

- How much habitat needs to be restored to reduce damages to facilities from a category 3 hurricane?

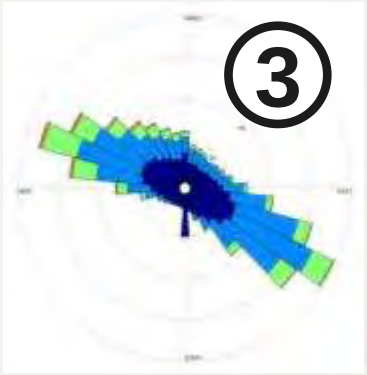
OUTLINE
INCREASING COMPLEXITY

1. Hazard index & social metrics US
2. Modeling green & grey Puget Sound
3. Coastal defense & stakeholders Texas
4. Adaptation & co-benefits Belize

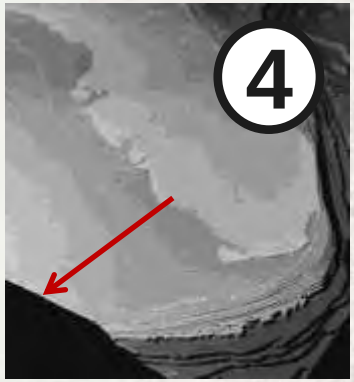
COASTAL HAZARD INDEX

GEOMORPHOLOGY

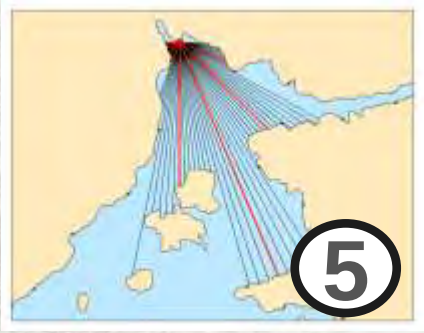
HABITATS



WAVE RISK



SURGE POTENTIAL

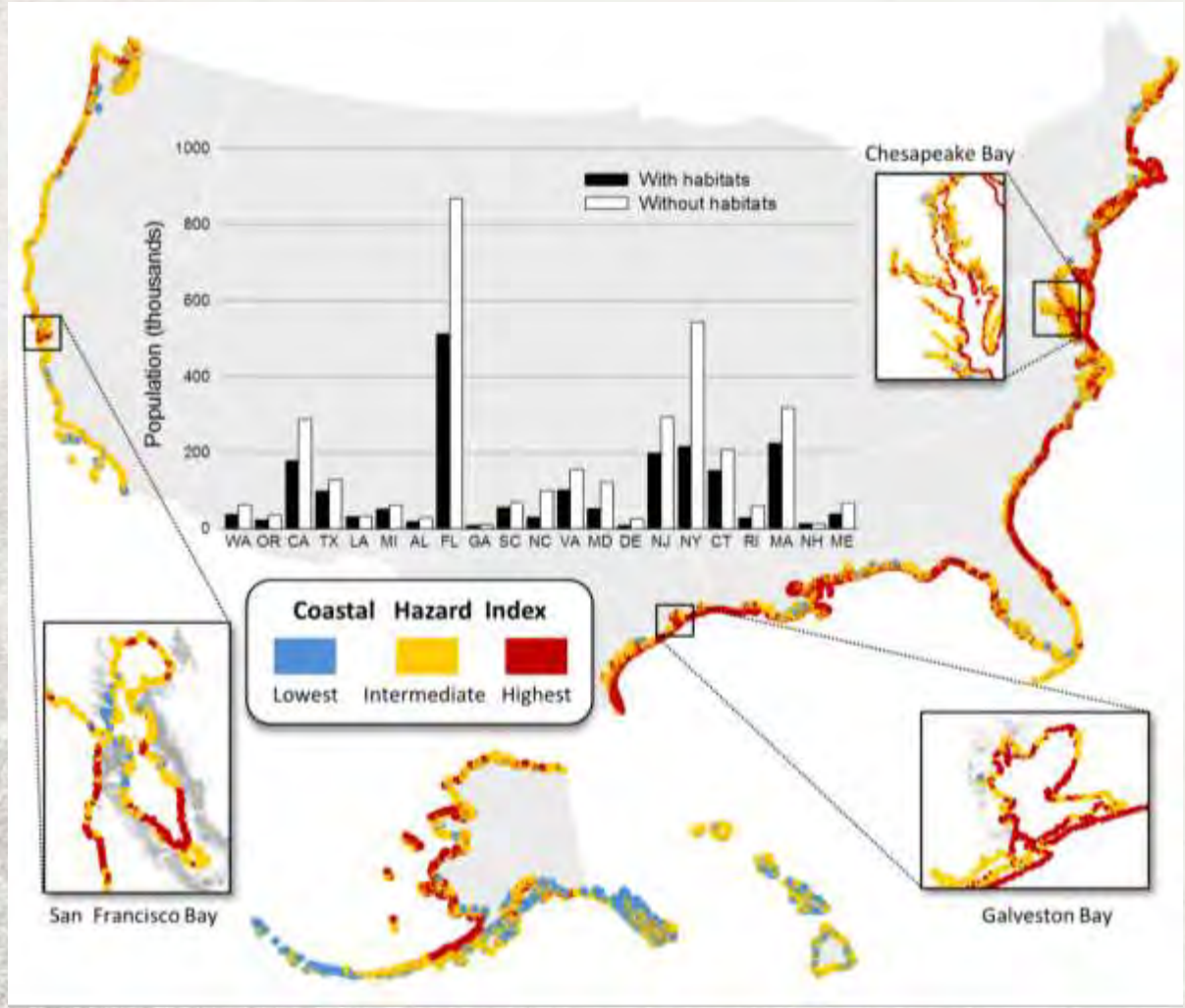


WAVE EXPOSURE

RELIEF

SEA-LEVEL RISE

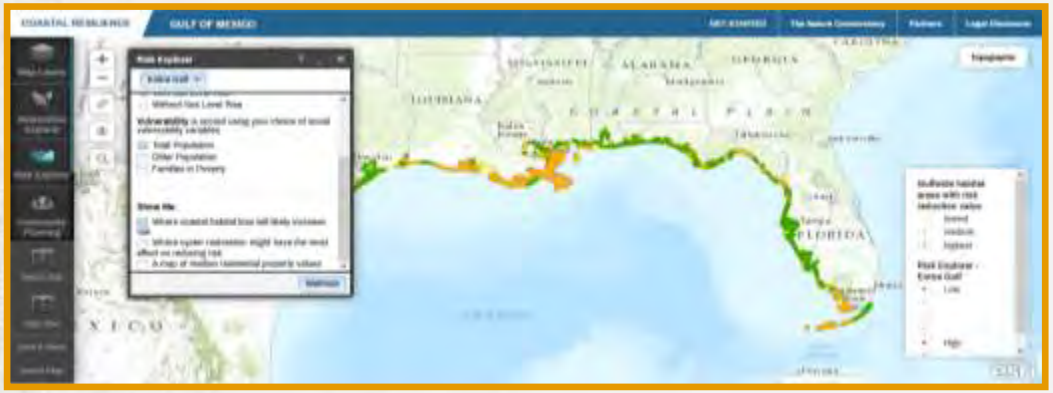
Coastal habitats shield people & property

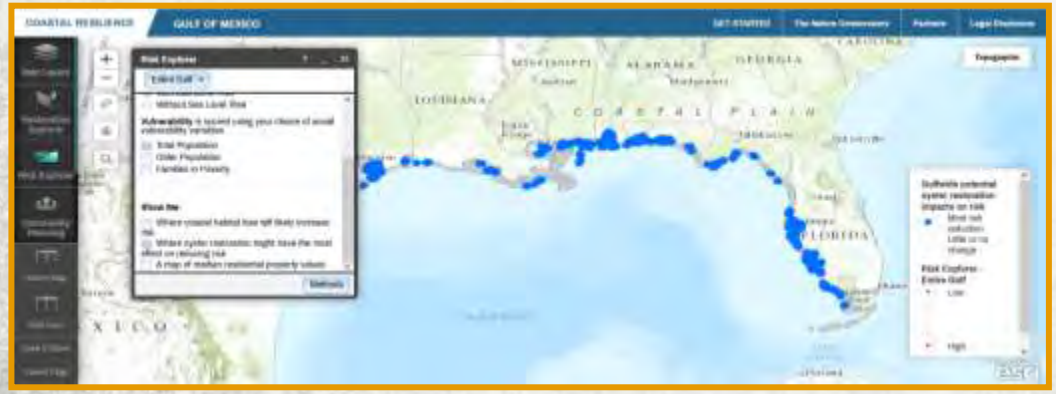


- US Census Bureau
- Zillow Home Value Index
- A2 sea-level rise scenario

Arkema et al. 2013. Nature Climate Change

INFORMING HABITAT RESTORATION
AT REGIONAL AND LOCAL SCALES





The Nature Conservancy
Protecting nature. Preserving life.™

Resource Investment Optimization System

INFORMING INVESTMENTS IN HABITAT RESTORATION

E.g., Distribution of funds from RESTORE ACT

Which projects should we fund to increase coastal resilience and delivery of other coastal and marine ecosystem services?

Coastal defense

Fisheries

Tourism

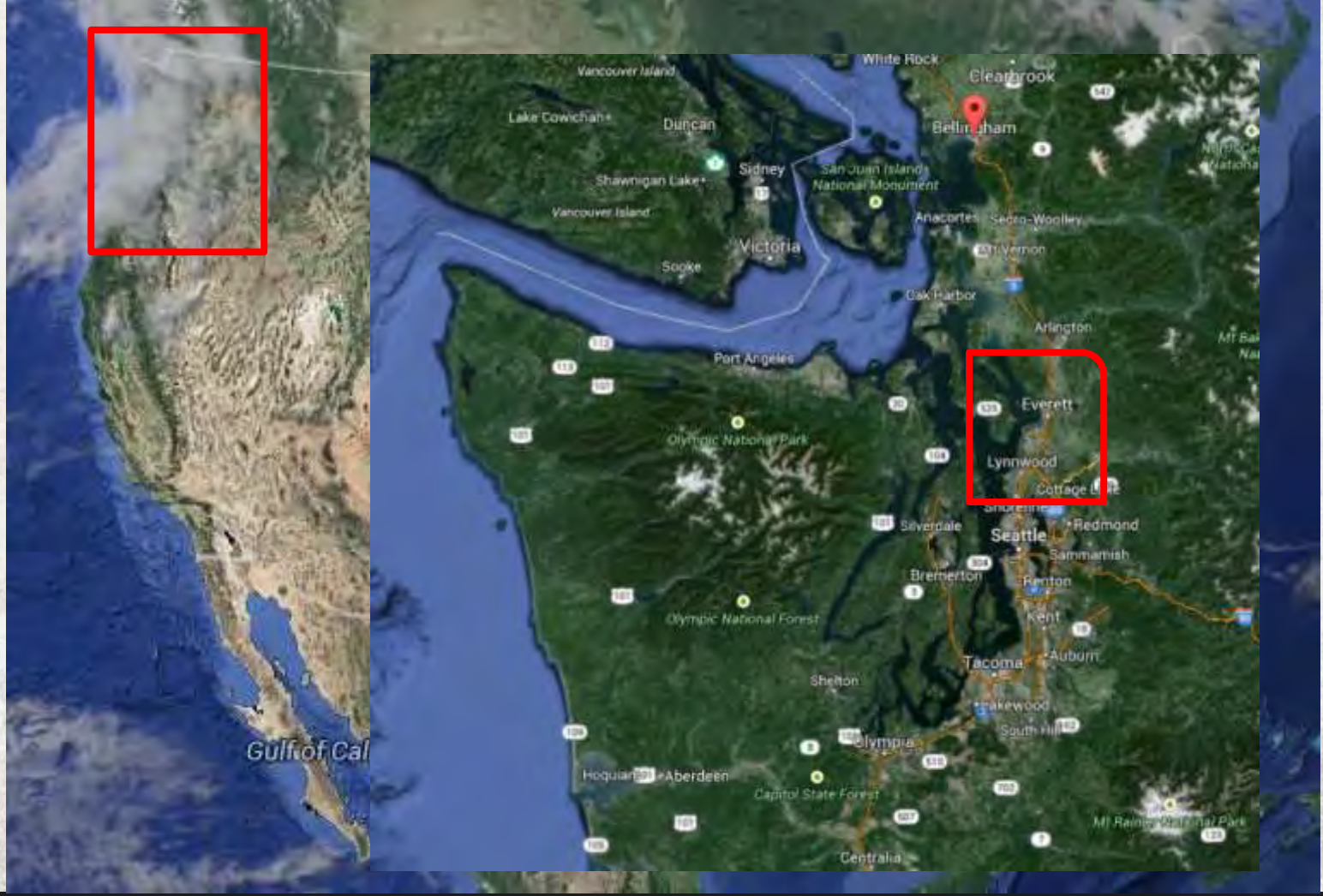
OUTLINE
INCREASING COMPLEXITY

COASTAL PROTECTION

TNC

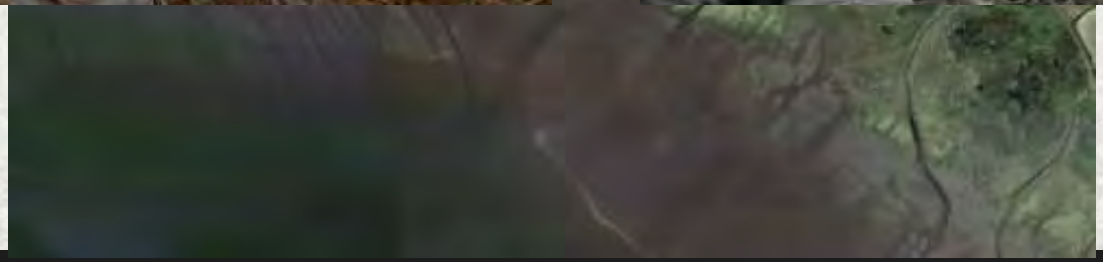
Coastal Defense

Coastal Defense quantifies how natural habitats (oyster reefs, tidal marshes, seagrass ...) protect coastal areas by reducing wave-induced erosion and inundation. It uses standard engineering techniques to help you estimate how and where to restore or conserve critical habitat, and increase the resilience of your coastal community and infrastructure.


Vancouver Island
Lake Cowichan
Duncan
Sidney
Shawnigan Lake
Vancouver Island
Victoria
Sooke
White Rock
Clearbrook
Bellingham
San Juan Islands National Monument
Anacortes
Sedro-Woolley
Mt Vernon
Oak Harbor
Arlington
Port Angeles
Olympic National Park
Everett
Lynnwood
Cottage Lake
Silverdale
Seattle
Redmond
Sammamish
Bremerton
Renton
Olympic National Forest
Kent
Tacoma
Auburn
Shelton
Lakewood
South Hill
Olympia
Hoquiam
Aberdeen
Capitol State Forest
Mt Rainier National Park
Centralia
Gulf of Cal


R. Fuller


R. Fuller



COASTAL PROTECTION

Combination of green and traditional infrastructure can reduce the impacts of coastal hazards.

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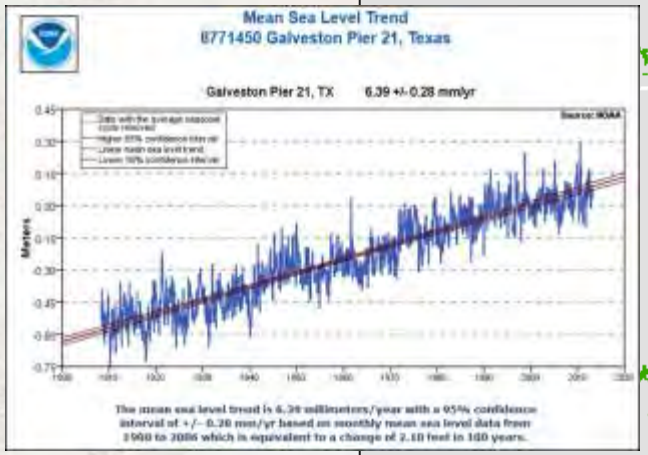
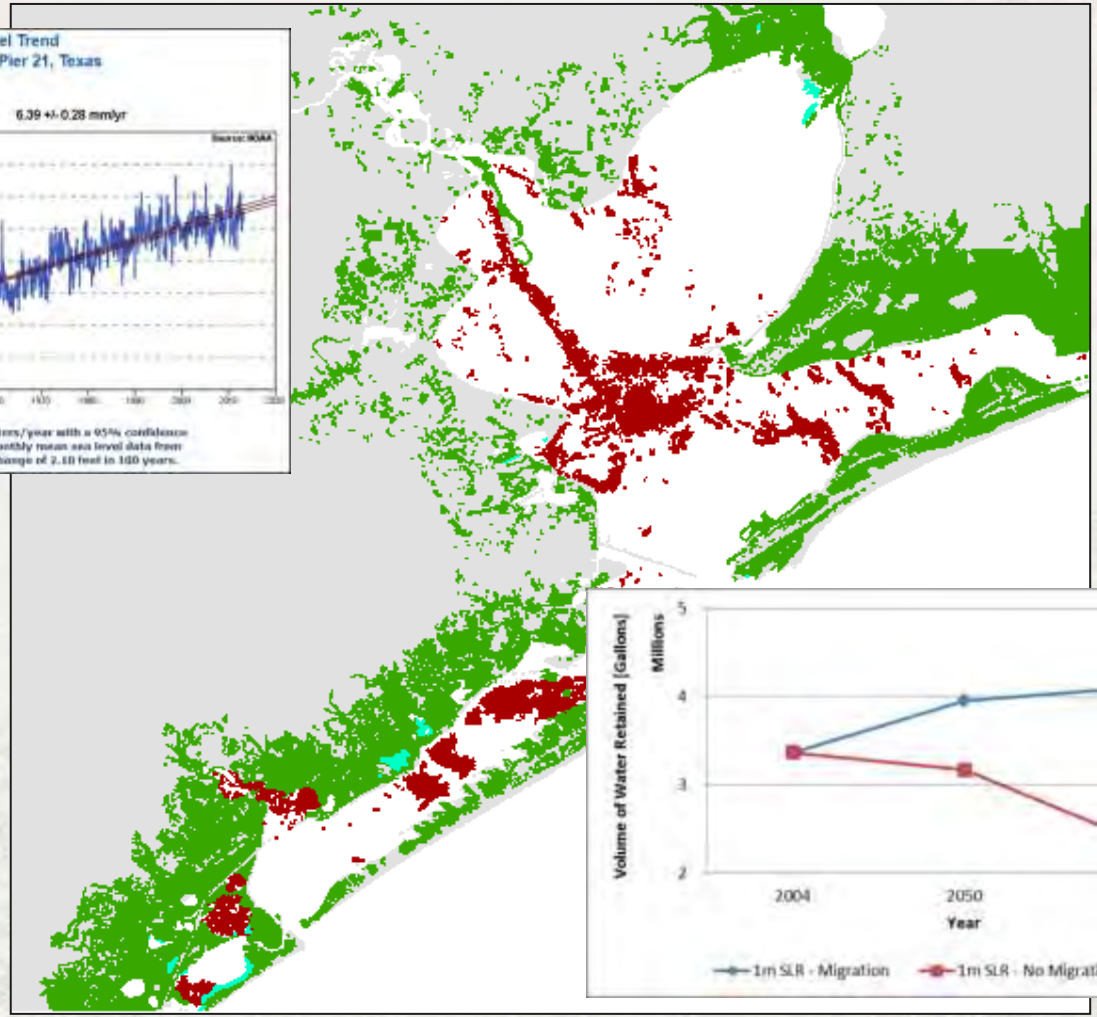
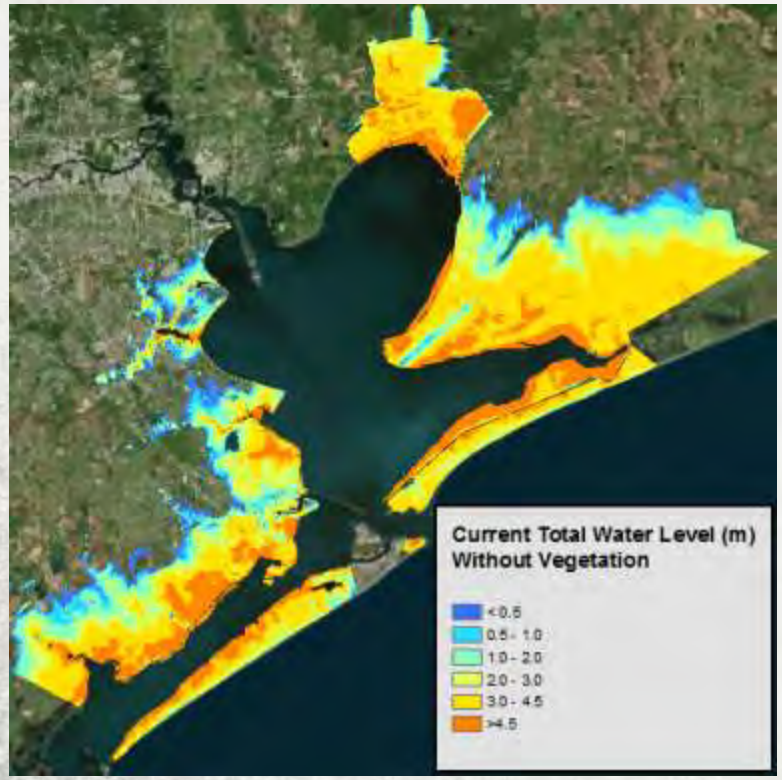

Mean Sea Level Trend
8771450 Galveston Pier 21, Texas
Galveston Pier 21, TX 6.39 +/- 0.28 mm/yr
Meters
The mean sea level trend is 6.39 millimeters/year with a 95% confidence interval of +/- 0.28 mm/yr based on monthly mean sea level data from 1900 to 2006 which is equivalent to a change of 2.10 feet in 100 years.



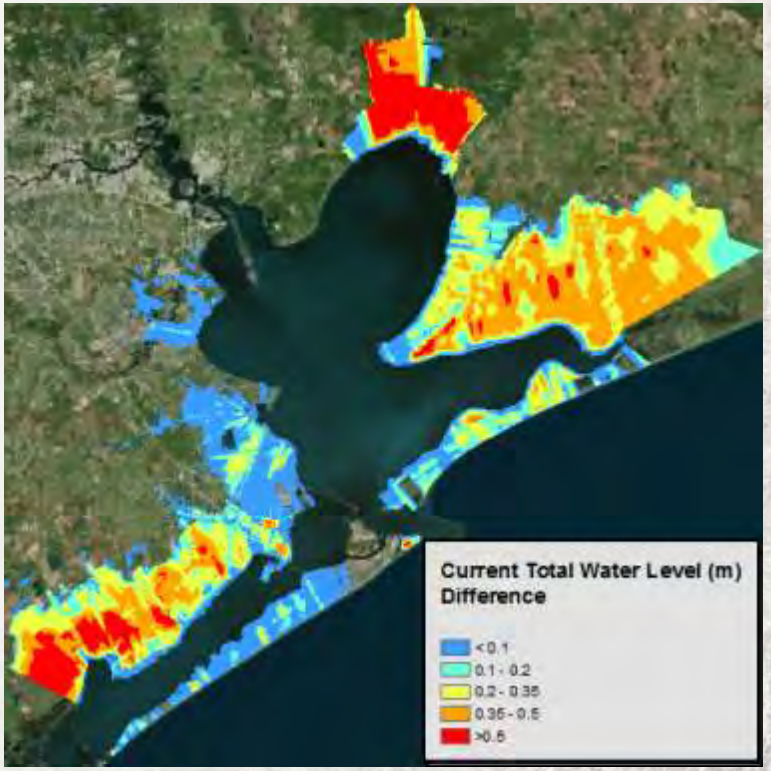
Volume of Water Retained (Gallons)
Millions
5
4
3
2
2004
2050
2100
Year
1m SLR - Migration
1m SLR - No Migration

MARSHES PROTECT PEOPLE

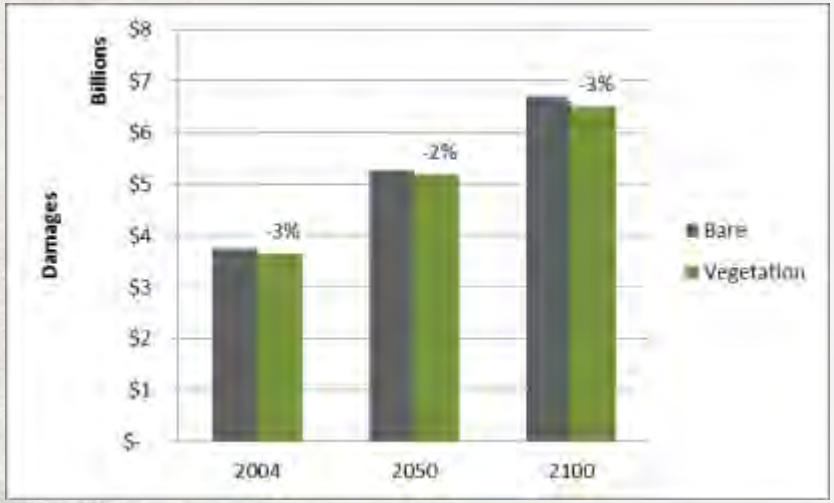
Marsh Absent

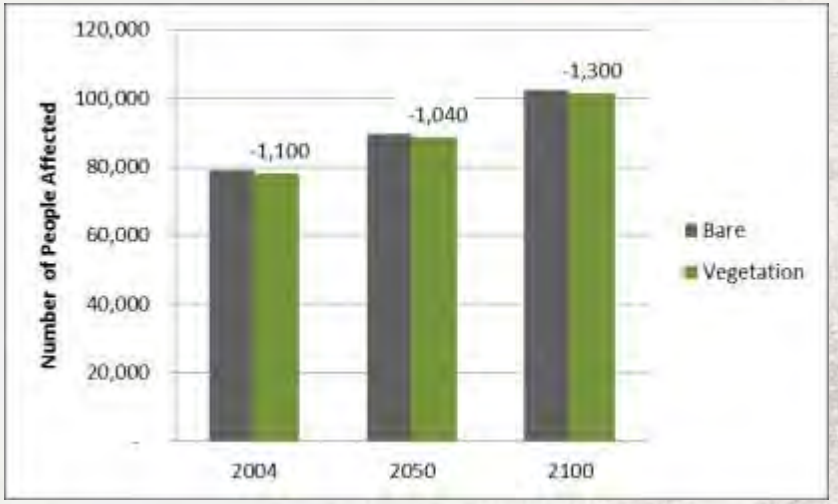


Marsh Present



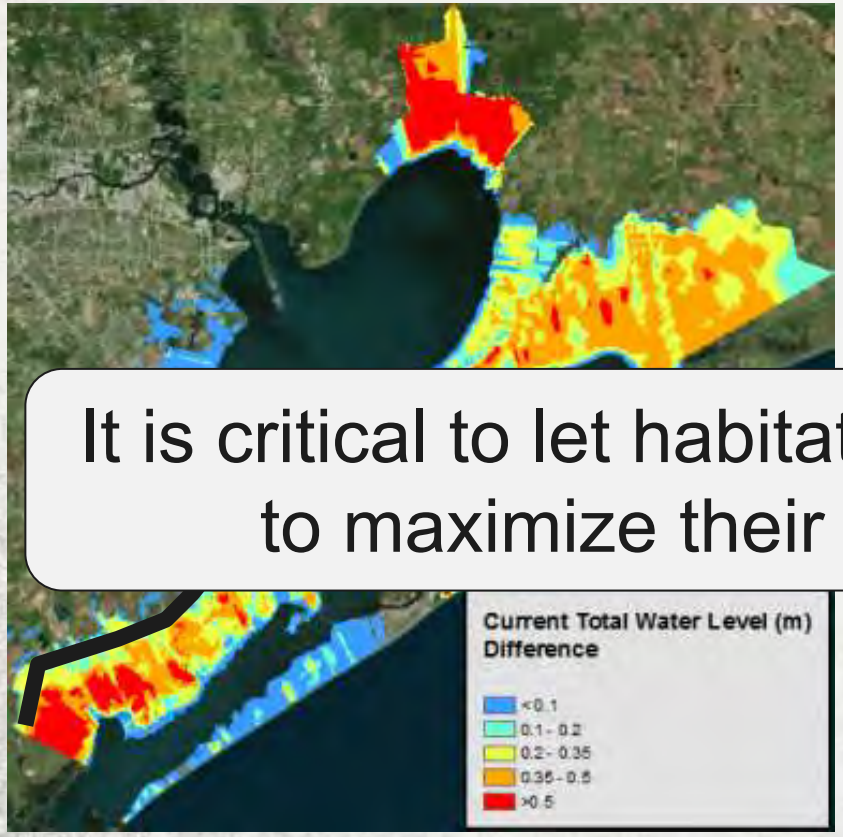
THE RELEVANT METRICS





- **Damages will increase as sea level rises**
- **Wetlands reduce damages by ~3-6%**
- **Wetlands protect ~1,000 people**

COASTAL PROTECTION & ADAPTATION

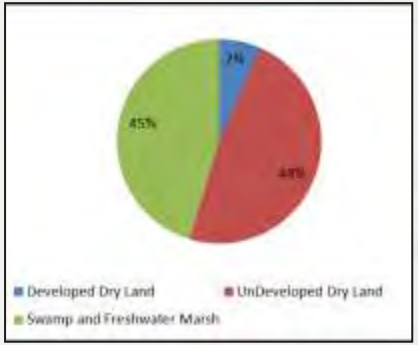


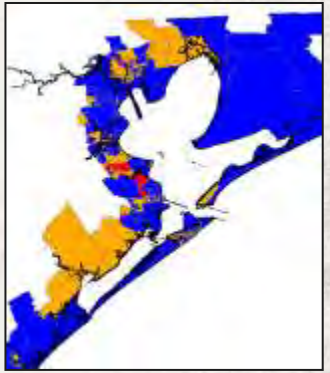
It is critical to let habitats adapt to new stressors to maximize their protective services.

WHO ARE THE STAKEHOLDERS?
i.e.
TRADEOFFS

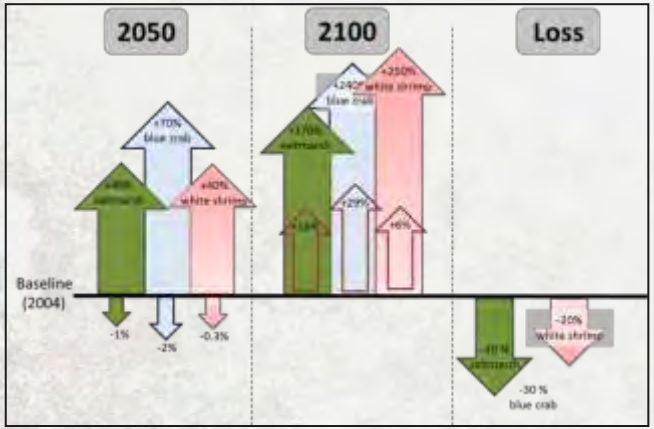
TRADEOFFS

Whose land becomes marsh?

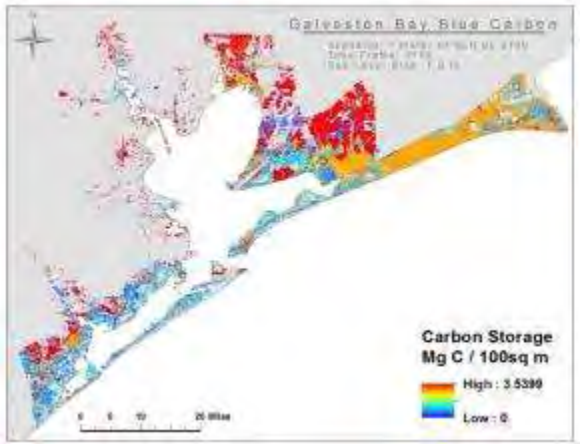




Fisheries and marsh?



Blue Carbon



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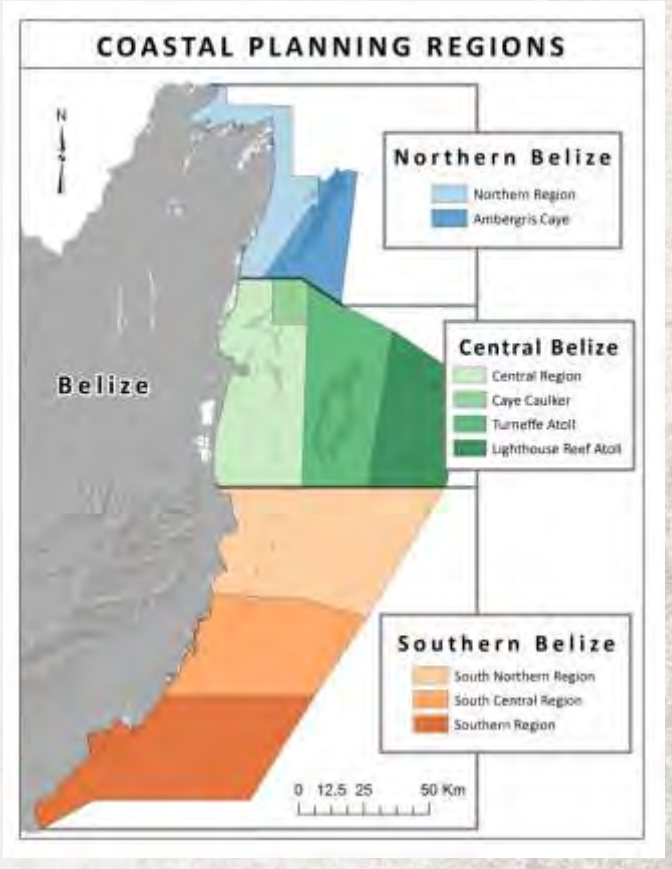
BELIZE
COASTAL ZONE MANAGEMENT

Stakeholder engagement

Science

InVEST

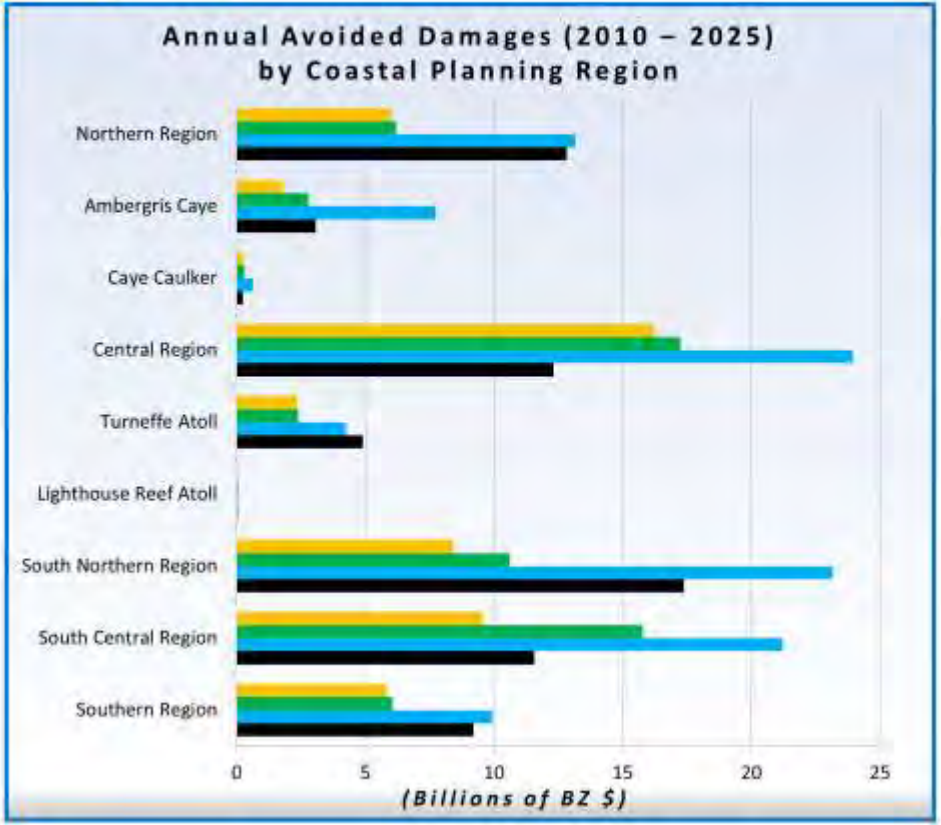
integrated valuation of environmental services and tradeoffs



natural capital PROJECT

WWF

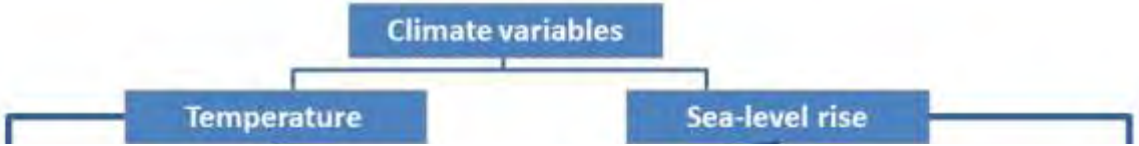
COASTAL PROTECTION



INFORMED MANAGEMENT

A suite of services

Climate change



A suite of services


Lobster catch & revenue


Carbon & sequestration

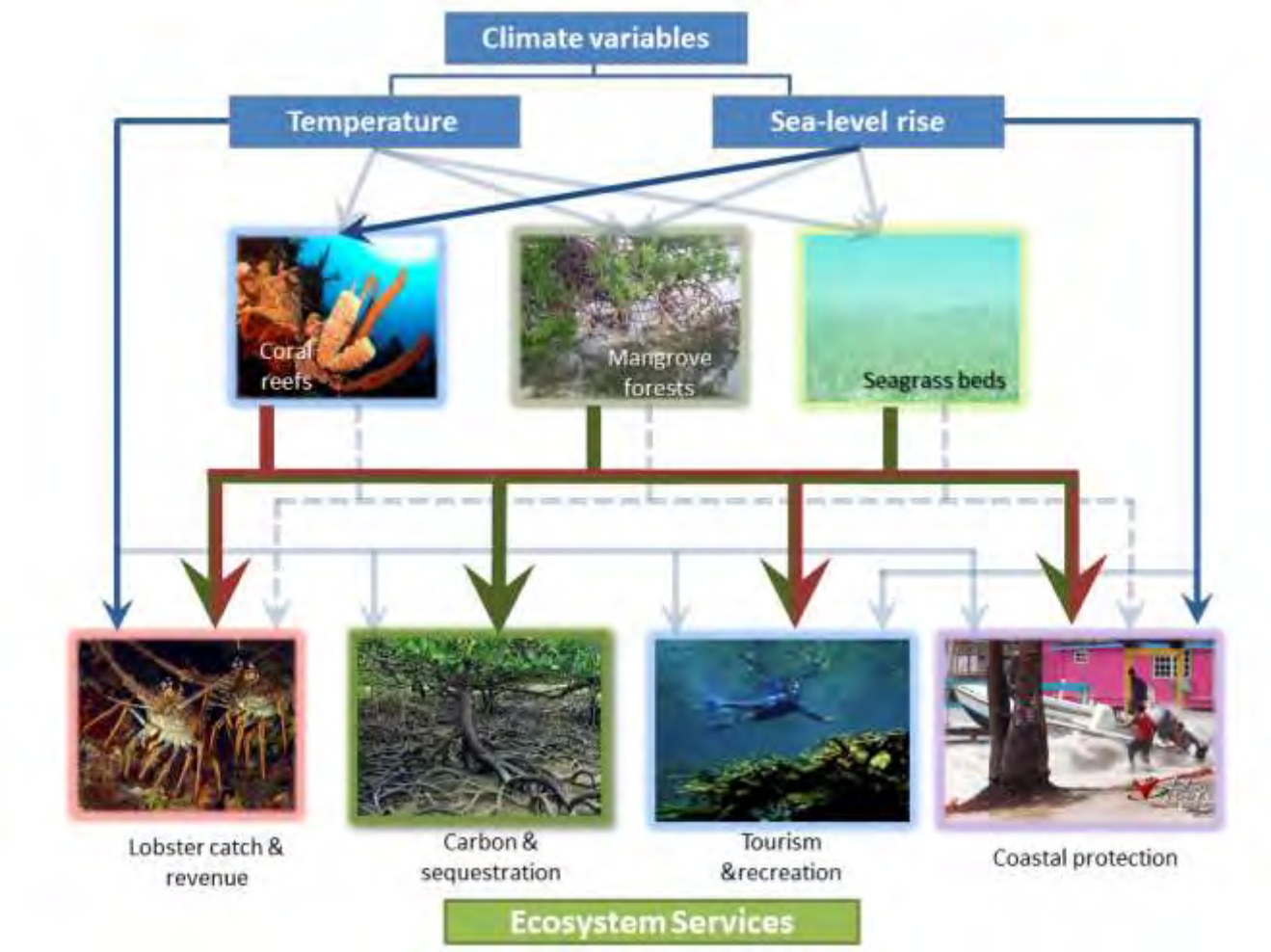

Tourism &recreation


Coastal protection

Ecosystem Services

Climate change

A suite of services



CLIMATE ADAPTATION
COSTS & BENEFITS OF ALTERNATIVES

IDB

natural capital PROJECT

WWF

Green

Grey

ADAPTATION SCENARIOS

Integrated

- Protection of coastal forests & coral reefs
- Restoration of mangroves
- Strategic construction of sea walls

Reactive

- Sea wall construction
- Some protection of coastal forest

COMPARISON OF CLIMATE ADAPTATION SCENARIOS

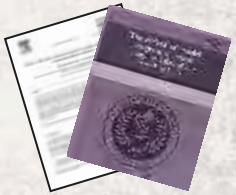
Global mitigation	No Action	Adaptation Scenarios Integrated	Reactive
NPV of total benefits	$0.790	$1.300	$0.650
NPV Lobster fishing	$0.008	$0.009	$0.006
NPV Tourism & recreation	$0.782	$1.273	$0.702
NPV Carbon storage & sequestration	-	$0.013	-$0.061
NPV of total implementation costs	-$0.005	-$0.015	-$0.191
NPV of erosion damages from sea level rise and storms	-$2.517	-$2.556	-$2.005
Total NPV of all benefits, costs and damages	-$1.731	-$1.275	-$1.550
NPV compared to No Action scenario	-	$0.456 billion	$0.181 billion

TAKE HOME MESSAGES

- Biophysical and social factors influence where and to what extent ecosystems help to reduce the numbers and demographics of people at risk from hazards.
- Green infrastructure can be combined with traditional infrastructure schemes to reduce the impacts of coastal hazards.
- Critical to let habitats adapt to new stressors to maximize their protective capabilities.
- Accounting for influence of climate and adaptation strategies on a full suite of services suggests that a scenario that emphasizes green strategies and minimizes use of grey strategies results in less overall costs.

OPPORTUNITIES TO ADVANCE SCIENCE AND PRACTICE

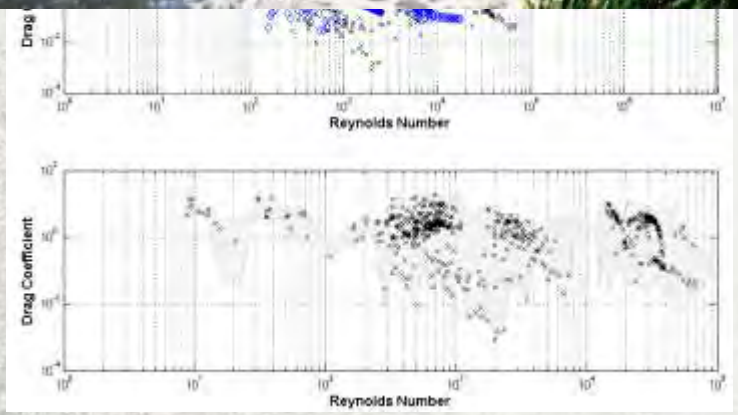
1. Build evidence base - What is the evidence that investments in green infrastructure lower disaster risk and damages?



2. Advance natural science - How do multiple habitat types operate together to reduce risk from disasters, now and given habitat specific responses to climate change?

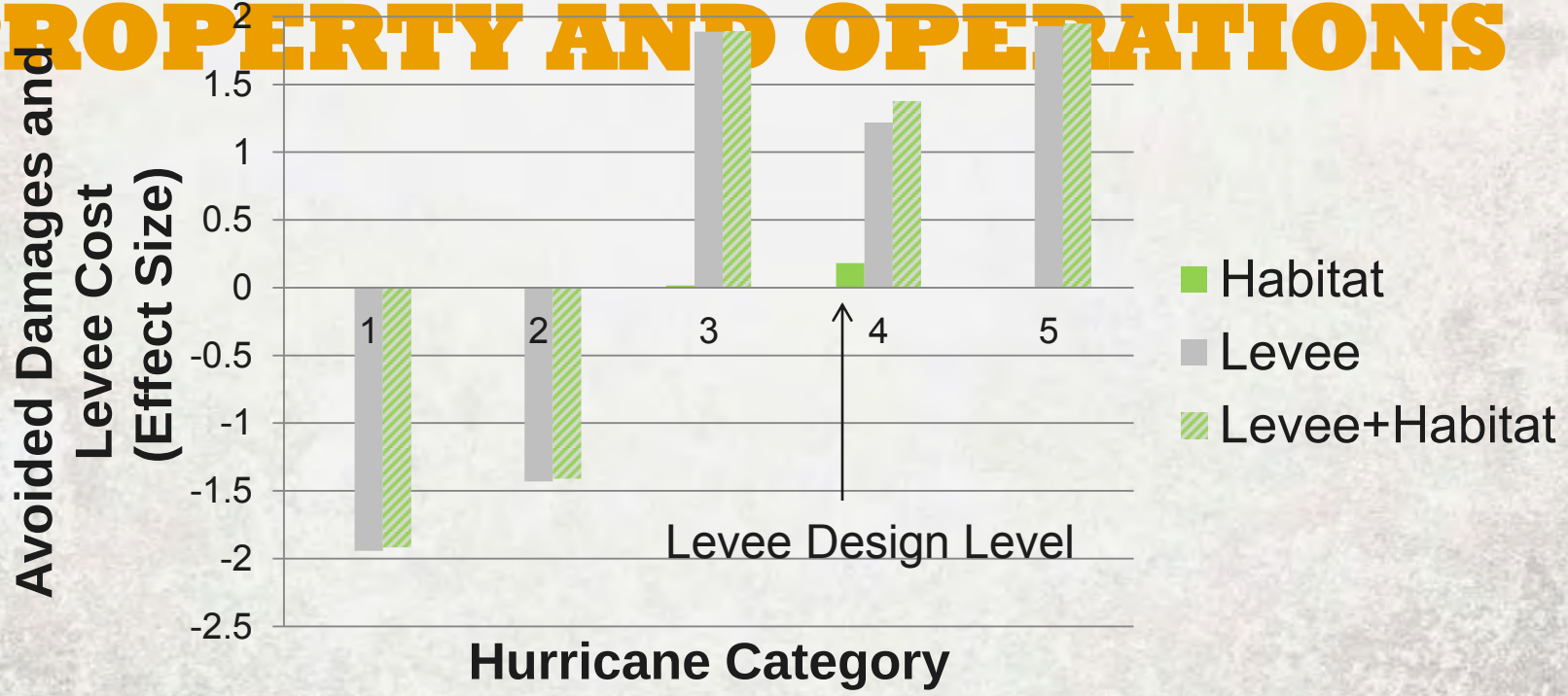
3. Advance social science - How does variation in perceptions of risk influence the effectiveness of incorporating habitats into coastal defense planning?

THANKS!

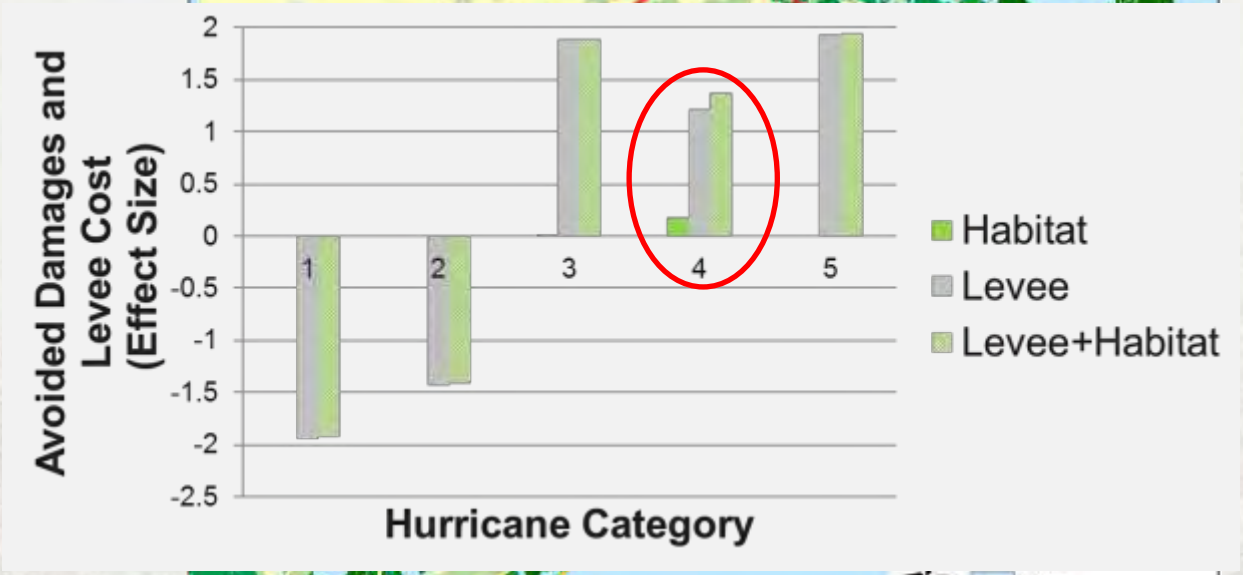

Drag
Reynolds Number
Drag Coefficient
Reynolds Number


The effect of model seagrass on wave runup: A laboratory investigation

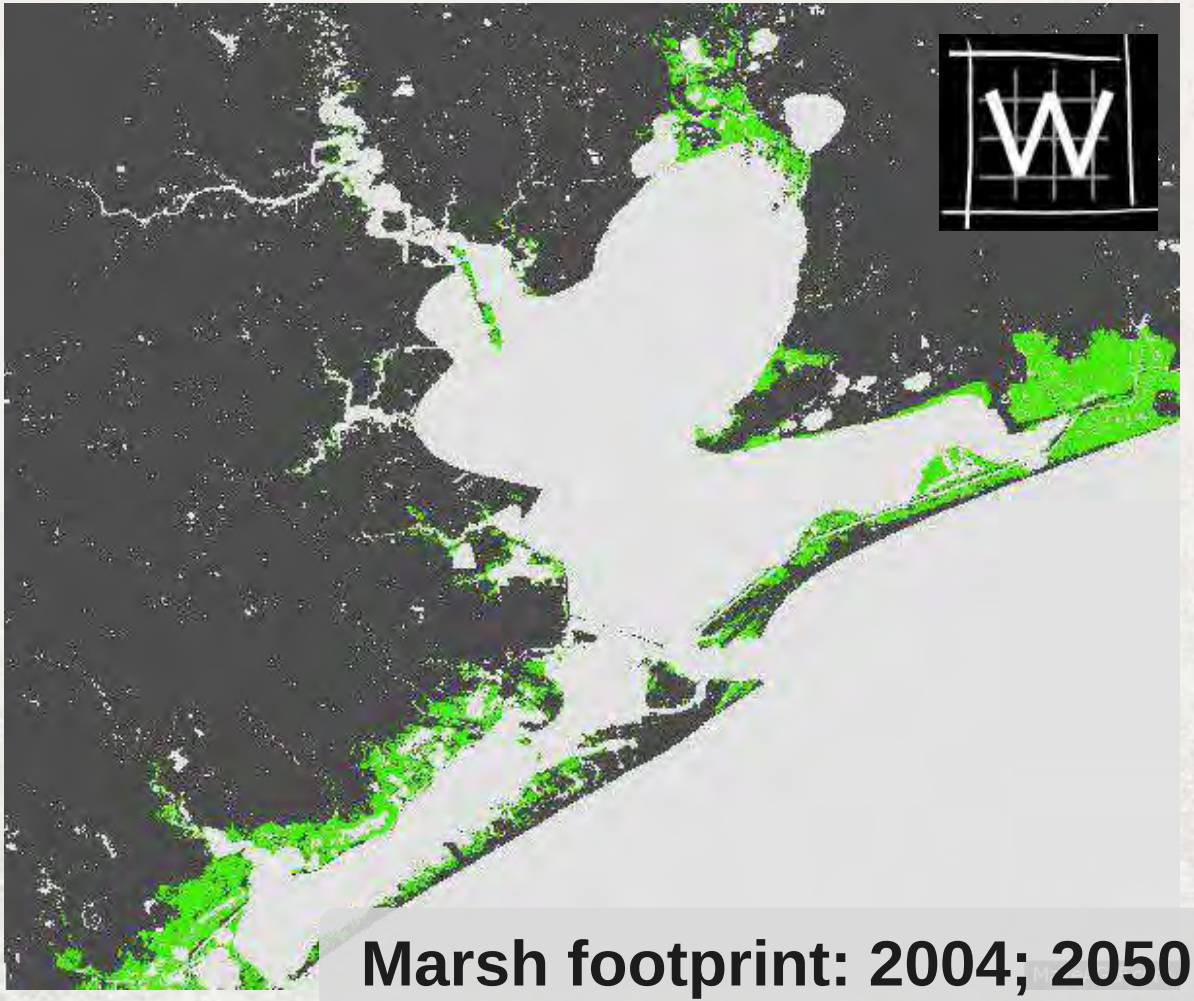
FREEPORT MARSHES AND LEVEES PROTECT BUSINESS PROPERTY AND OPERATIONS



The Dow Chemical Company, Freeport, TX



I WANT MY MARSHES!!



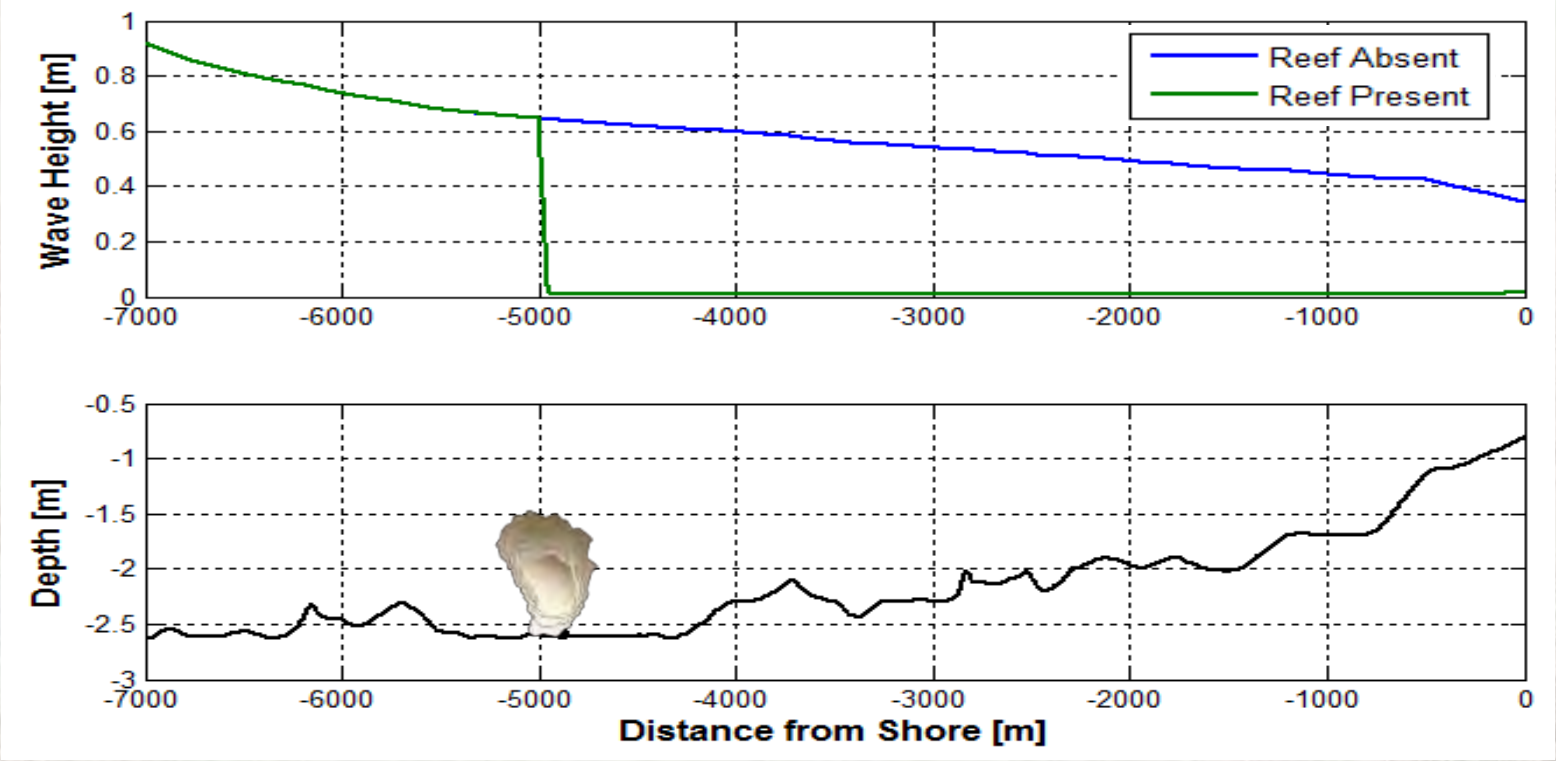
Marsh footprint: 2004; 2050; 2100

Protecting Marsh Now and in the Future

Can marshes can help reduce the size and impact of hard coastal protection structures?

Green/Grey and Green&Grey Options

OYSTERS TO THE RESCUE



Putting InVEST into Practice: Disaster risk reduction by coastal habitats

Your team has been tasked by state and county governments in the US to assess where investments in habitat conservation and restoration will be most effective for reducing risk of coastal communities and properties to sea-level rise and storms. Use results from the InVEST Coastal vulnerability model to answer the questions below. You do not need to run the InVEST model. Rather, use the Risk Explorer and Restoration Explorer Apps in Coastal Resilience 2.0 (developed in collaboration with The Nature Conservancy) to explore habitat and sea-level rise scenarios, visual results and communicate your findings.

http://coastalresilience.org/tools/apps

Background

Extreme weather, sea-level rise and degraded coastal ecosystems are placing people and property at greater risk of damages from coastal hazards. Marine and coastal habitats work as buffers from storms and floods, reducing the need and investment costs in riprap, levees, bulkheads, and other types of'hard' shore protection. Coastal habitats include oyster reefs, coral reefs, marshes, dunes, seagrass, and kelp forests. They habitats all play different roles in reducing risk from coastal hazards as well as providing many other auxillary benefits, such as carbon sequestration, opportunities for recreation and nursery habitat for fisheries. The Natural Capital Project is working with The Nature Conservancy and other partners to determine where to prioritize habitat conservation and restoration for hazard risk reduction and the sustained benefit of a suite of ecosystem services.

Tasks

1. **United States Risk Explorer App** – determine where existing habitats are most important for reducing exposure to coastal hazards and risk to poor families, people over 65 and coastal property. http://maps.coastalresilience.org/us/#

2. **Gulf of Mexico Restoration Explorer and Coastal Defense Apps** – determine where oyster restoration will be most effective for reducing exposure to coastal hazards and risk to poor families, people over 65 and coastal property. http://maps.coastalresilience.org/gulfmex/#

Seagrass

Coral reefs

Dunes

Coastal forests

Emergent marsh

Oyster reefs

Questions / Discussion

1. On the scale of the whole United States, which regions (Northeast, Southeast, Gulf Coast and West Coast) are most exposed to coastal hazards? (hint: this is just biophysical exposure and does not include social vulnerability).
2. Zoom into the northeast states. Identify an area at high risk when vulnerability is measured with total population, but at lower risk when vulnerability is measured with poor families. Take a screen shot of the area.
3. On the scale of the whole United States, where is the risk reduction provided by coastal habitats greatest? Take a few screen shots to communicate your findings.
4. Moving to the Gulf, name a region with the highest older population at risk from coastal hazards.
5. Where would oyster restoration in the Gulf lead to the greatest risk reduction? Take a few screen shots to communicate your findings.
6. Where in Mobile Bay, AL, would oyster restoration lead to the greatest risk reduction? Take a screenshot to communicate your findings.
7. Open an incognito or private window in your browser, then go to http://dev.maps.coastalresilience.org/gulfmex. In the region that you identified in the step above, what type of oyster reef configuration would reduce wave height and energy by more than 90%?

Task 3 – *read the following and continue the activity in plenary*

Protect the hotel and save the tourists! Touristy Enterprise is building a resort in a wonderful coastal region, where sea turtles, mermaids and rare seabirds abound.

The main hotel of the resort will be built near a mangrove forest, and the hotel bar and play area will be built near a sandy beach. Less than 1 km away from the beach, there is a reef, with 100% live coral cover. The lagoon fronting the reef is covered with live seagrass, which supports important fisheries.

The hotel is protected against surge by a small 1 m wall. It can only be accessed via the mangrove area. Architects have found that it's best to remove as many trees as possible to facilitate access and movement.

The resort is really popular with very fancy tourists who enjoy sunbathing on their beach towels and play volley-ball. However, the currents in the area are such that if the beach erodes during a storm, the sand never comes back to the beach. So it's important to minimize beach erosion during storms.

Finally, the region is experiencing accelerated sea-level rise. Observations at a near tide gage indicate that mean sea level will increase by 1 m in 50 years.

What is the minimum width of mangrove forest that maximizes access to the hotel, while minimizing coastal erosion and maintain the structural integrity of the hotel complex?