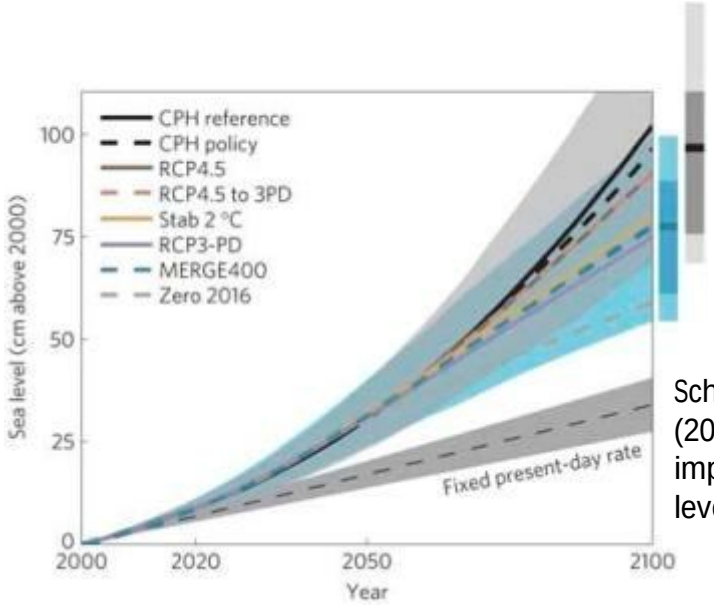
Nature based coastal defence: an NGO perspective

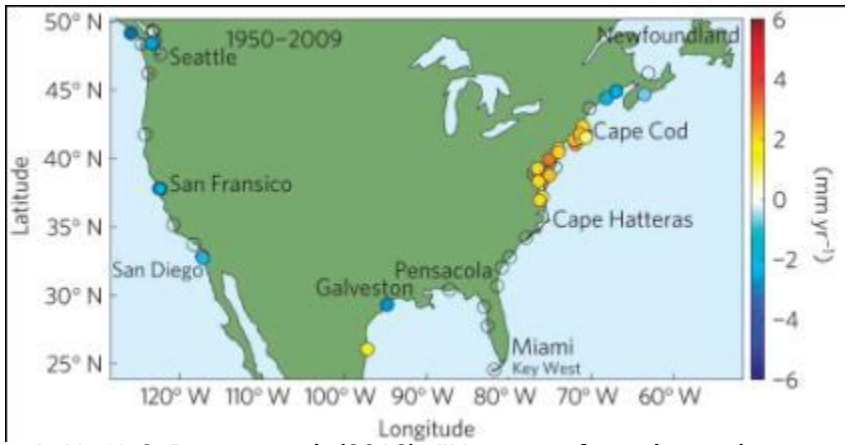
Mark Spalding

The Nature Conservancy
Protecting nature. Preserving life.™

The issues: growing risks?



Schaeffer, M., W. Hare, et al. (2012). "Long-term sea-level rise implied by 1.5°C and 2°C warming levels." Nature Clim. Change.

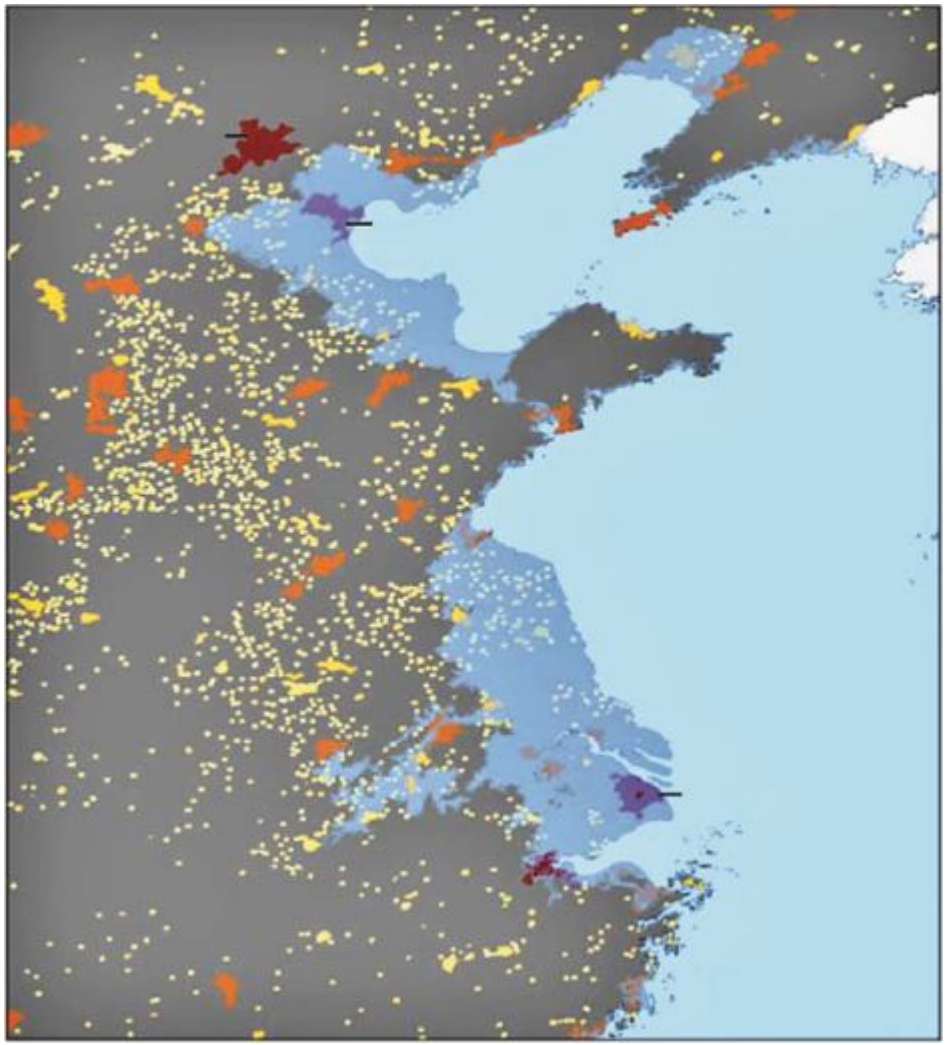


Sallenger, A. H., K. S. Doran, et al. (2012). "Hotspot of accelerated sea-level rise on the Atlantic coast of North America." Nature Clim. Change

Terra and Aqua/MODIS – 2012/240, 08/27/2012, 02:40 UTC. Typhoons Tembin (15W) and Bolaven (16W) in the Philippine Sea

The issues: growing vulnerability

(coastal migration, infrastructure development, land claim)



Urban extents by population size, 2000

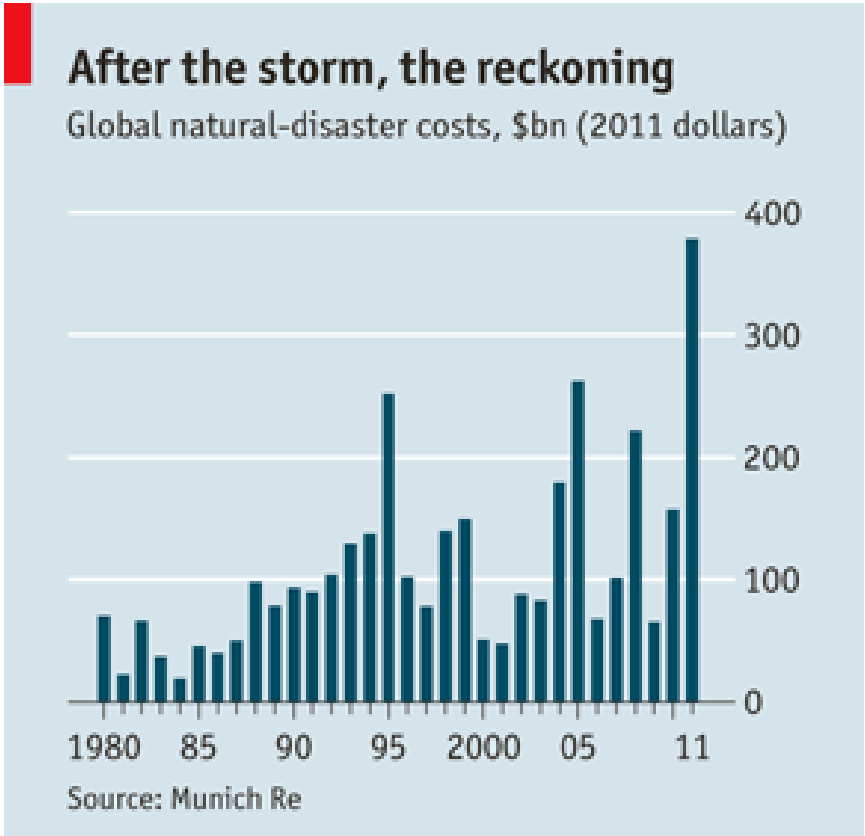
5K-100K | 100K-500K | 500K-1M | 1-5M | 5M+

Low Elevation Coastal Zone (LECZ)

NOTE: LECZ layer has been made semi-transparent to show the underlying layers. Thus the blue colour is not uniform.

McGranahan et al 2007. Environment and Urbanization, v. 19, no. 1, p. 17-37.

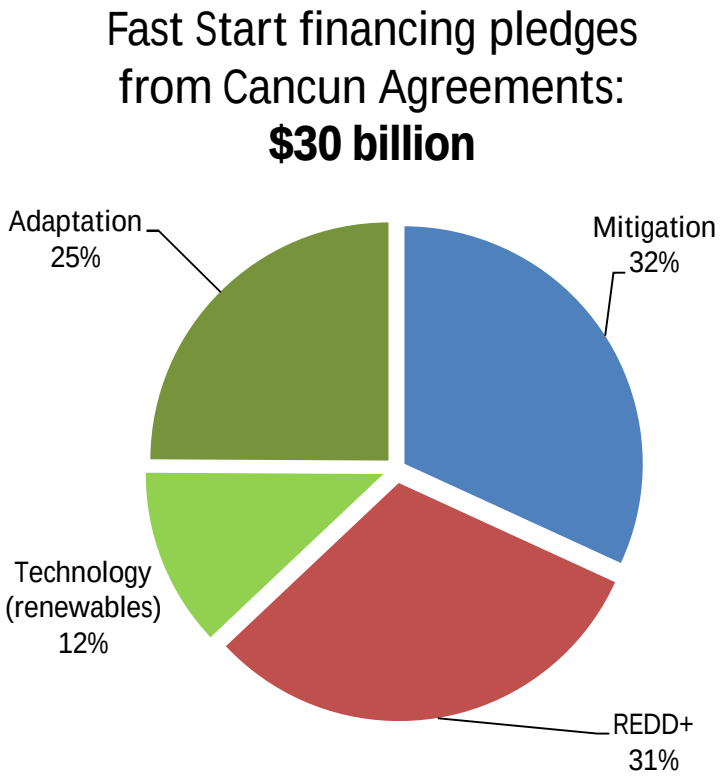
The issues: Growing costs engineering, insurance



...and the responses

- Increasing coastal defence
- Adaptation funds

Mobile Bay, Alabama. Graph from Douglass & Pickel (1999)



NGO interest

- Concern at the loss of natural systems
- Aware that ecosystems can play a role in coastal defence, but that this may be being overlooked
- Want to emphasise the additional ecosystem benefits

NGO involvement

- Action on the ground
- Planning tools/Decision support
- Science - building the case
- Policy - making the case

Action on the ground: mangroves

Photos: Shigeyuki Baba and Mami Kainuma

Action on the ground: coral reefs

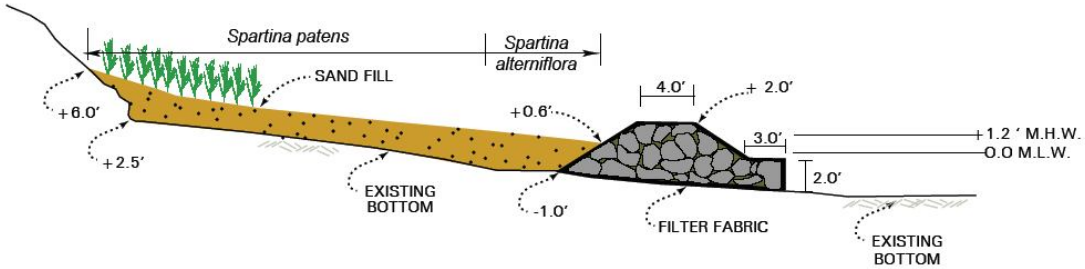
St Vincent Grenadines

Marriott, Grand Cayman

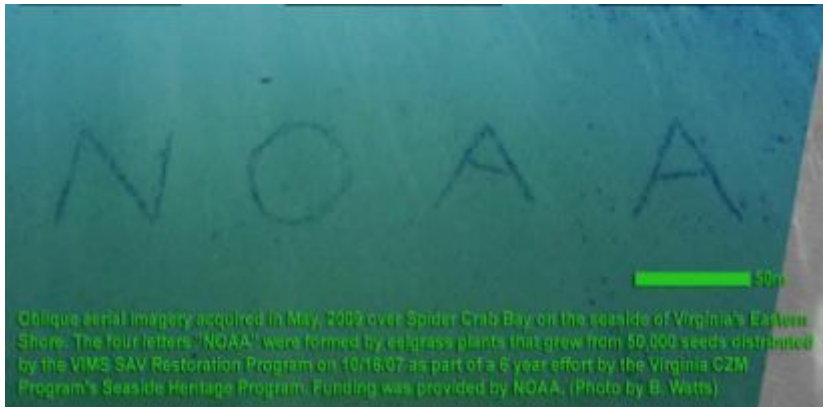
Photos: TNC

Action on the ground: seagrasses and saltmarshes

Mark Godfrey/TNC



Living Shorelines graphic: Jefferson Patterson Park project, Maryland

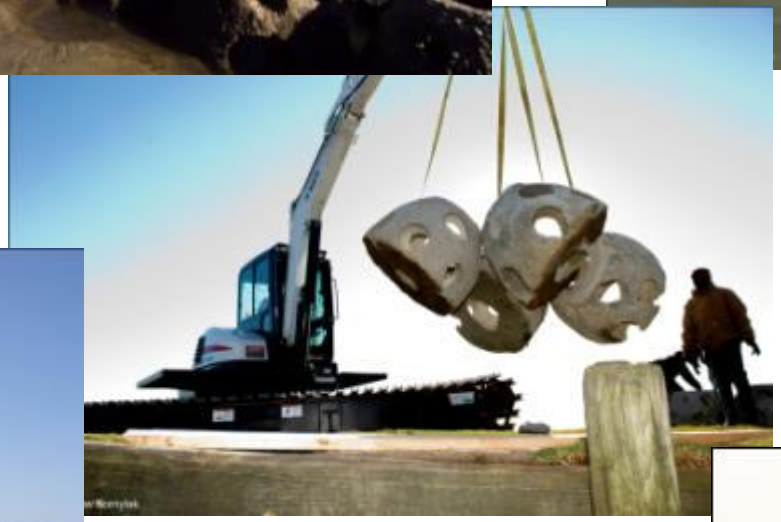


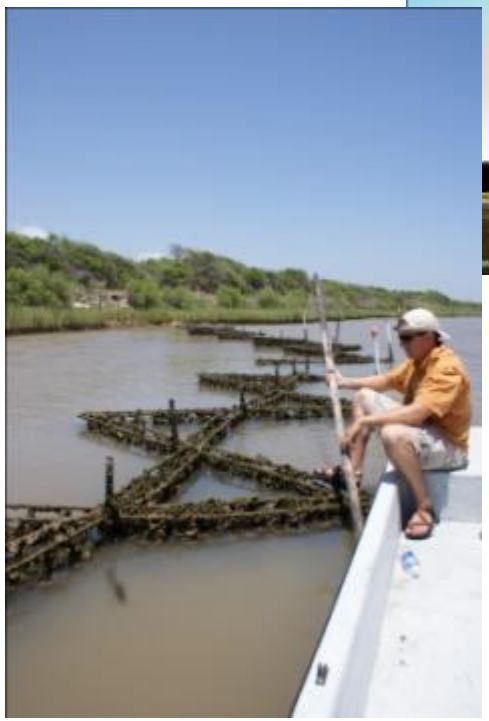
Oblique aerial imagery acquired in May, 2002 over Spider Crab Bay on the seaside of Virginia's Eastern Shore. The four letters "NOAA" were formed by eelgrass plants that grew from 50,000 seeds distributed by the VIMS SAV Restoration Program on 10/16/07 as part of a 6 year effort by the Virginia CZM Program's Seaside Heritage Program. Funding was provided by NOAA. (Photo by B. Watts)

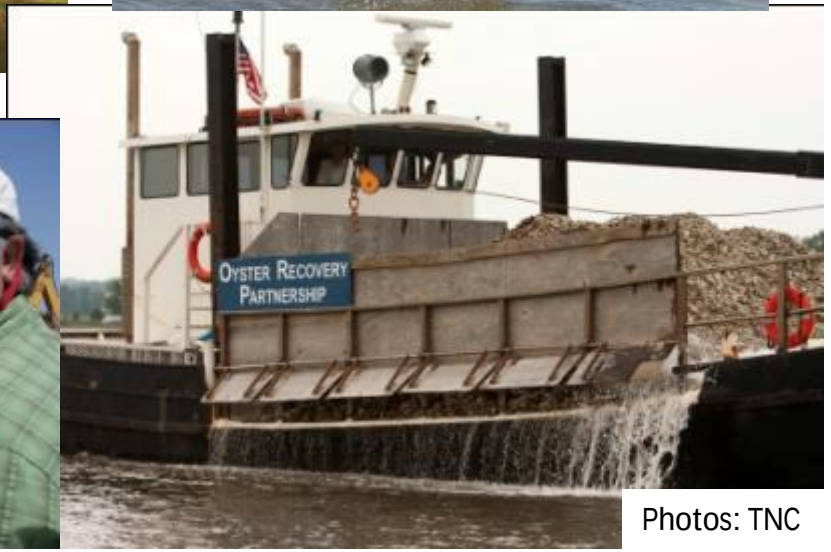
Shoreline Design LLC

Action on the ground: oyster reefs

Erika Nortemann/TNC







Photos: TNC

Federal efforts

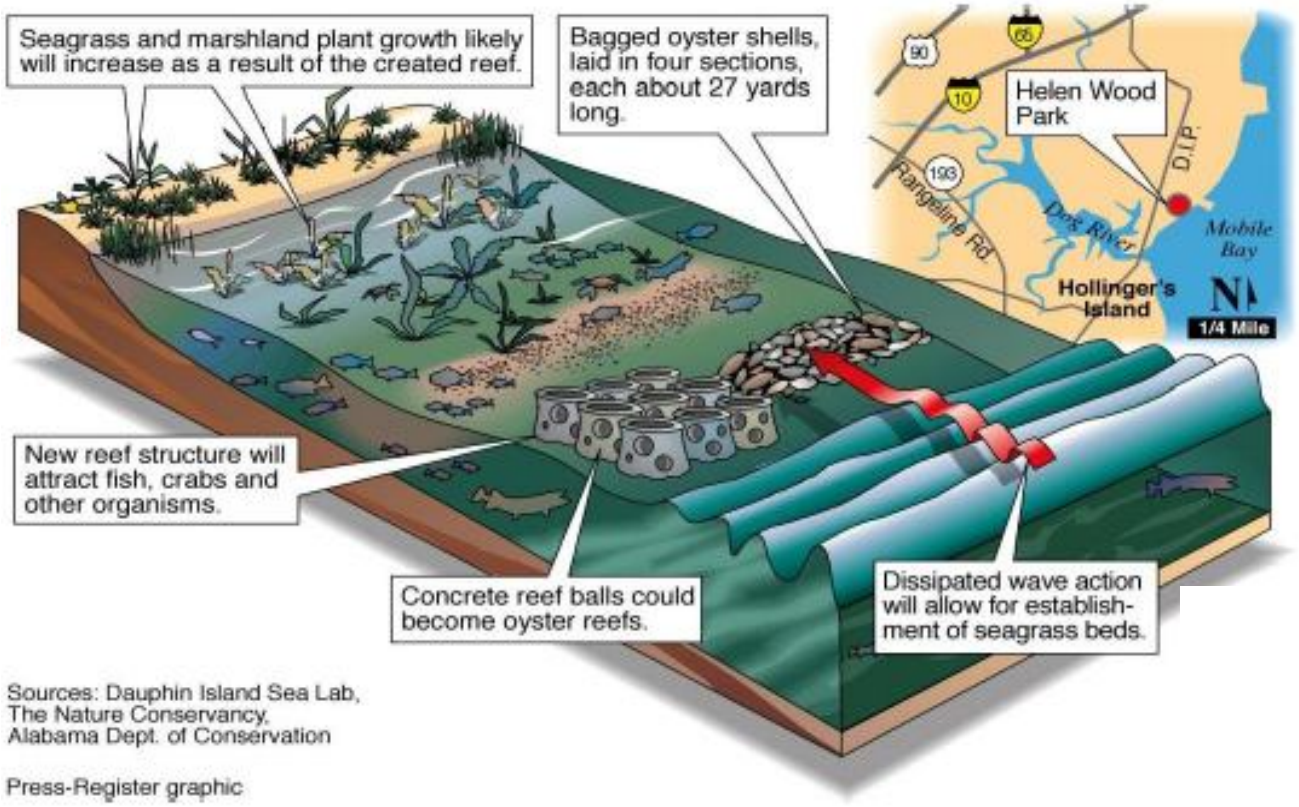
NOAA Restoration Center – 2009-2011 only

	#projects	Hectares	NOAA funding	Total funding
Community-based Restoration Program (CRP)	201	127.9	$ 9,602,929	$ 27,914,609
American Recovery and Reinvestment Act (ARRA)	6		$ 18,066,812	$ 18,066,812
Damage Assessment, Remediation, and Restoration Program	13	20.6	$ -	$ 5,908,868
Appropriations	166	682.7	$ 1,220,853	$ 1,804,974
Emergency Support	4	459.7	$ 9,000,000	$ 9,006,876
Total	**391**	**1404.7**	**$ 28,848,782**	**$ 53,660,327**

US Army Corps of Engineers - Chesapeake

State	Period	Hectares	Cost
Maryland	1996-2011	182	$6,726,000
Virginia	2000-2011	162	$12,800,000
Total USACE Chesapeake		**344**	**$19,526,000**

Oyster reefs as coastal defence



Sources: Dauphin Island Sea Lab, The Nature Conservancy, Alabama Dept. of Conservation

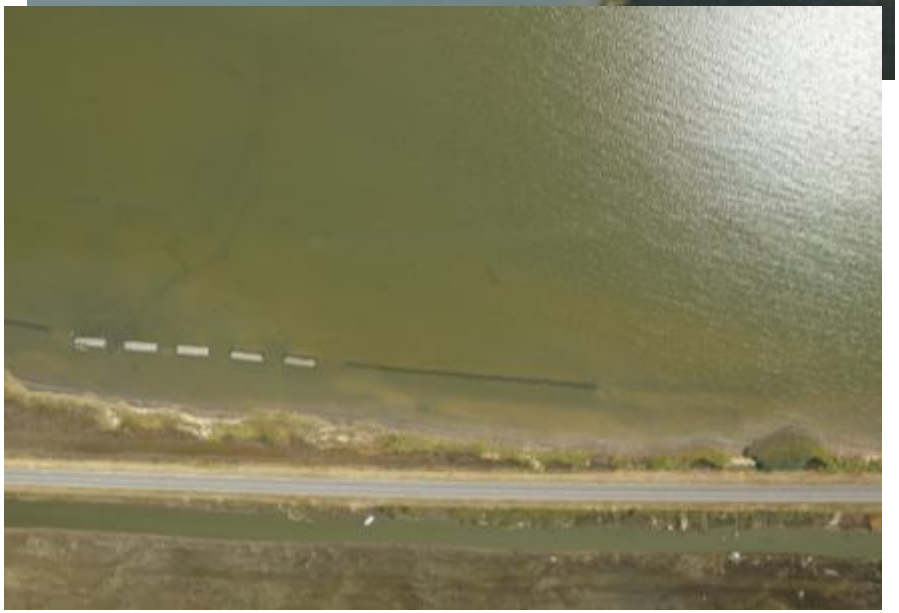
Press-Register graphic

4 m

0.8 m

4.7

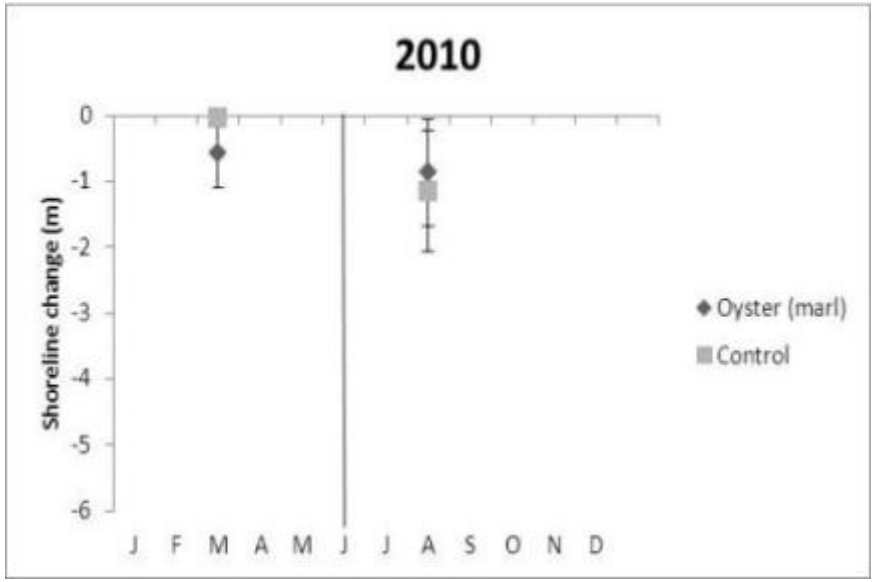
Oyster reefs as coastal defence

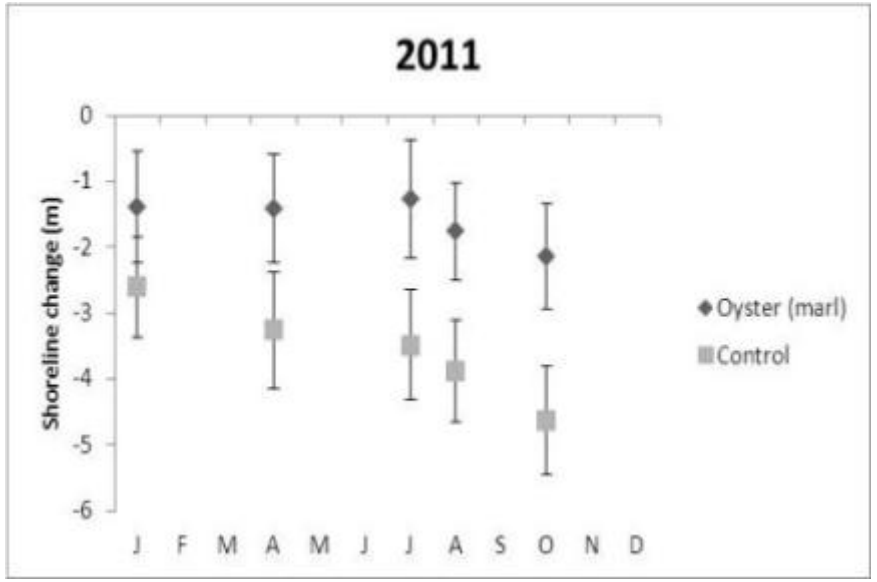


Photos: TNC

Oyster reefs as coastal defence

Photos: TNC

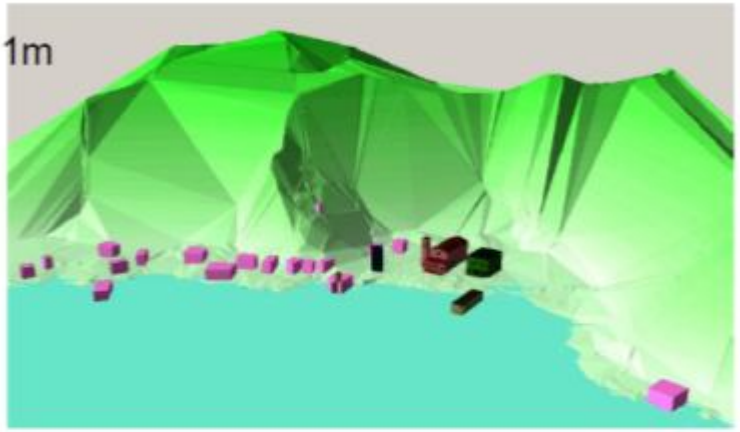


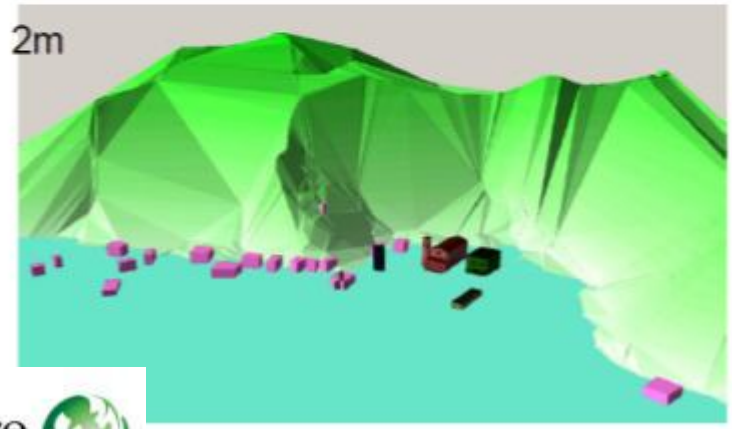


TNC unpublished data

Planning tools and decision support:

Participatory 3D modelling, Choiseul, Solomons (AusAID)





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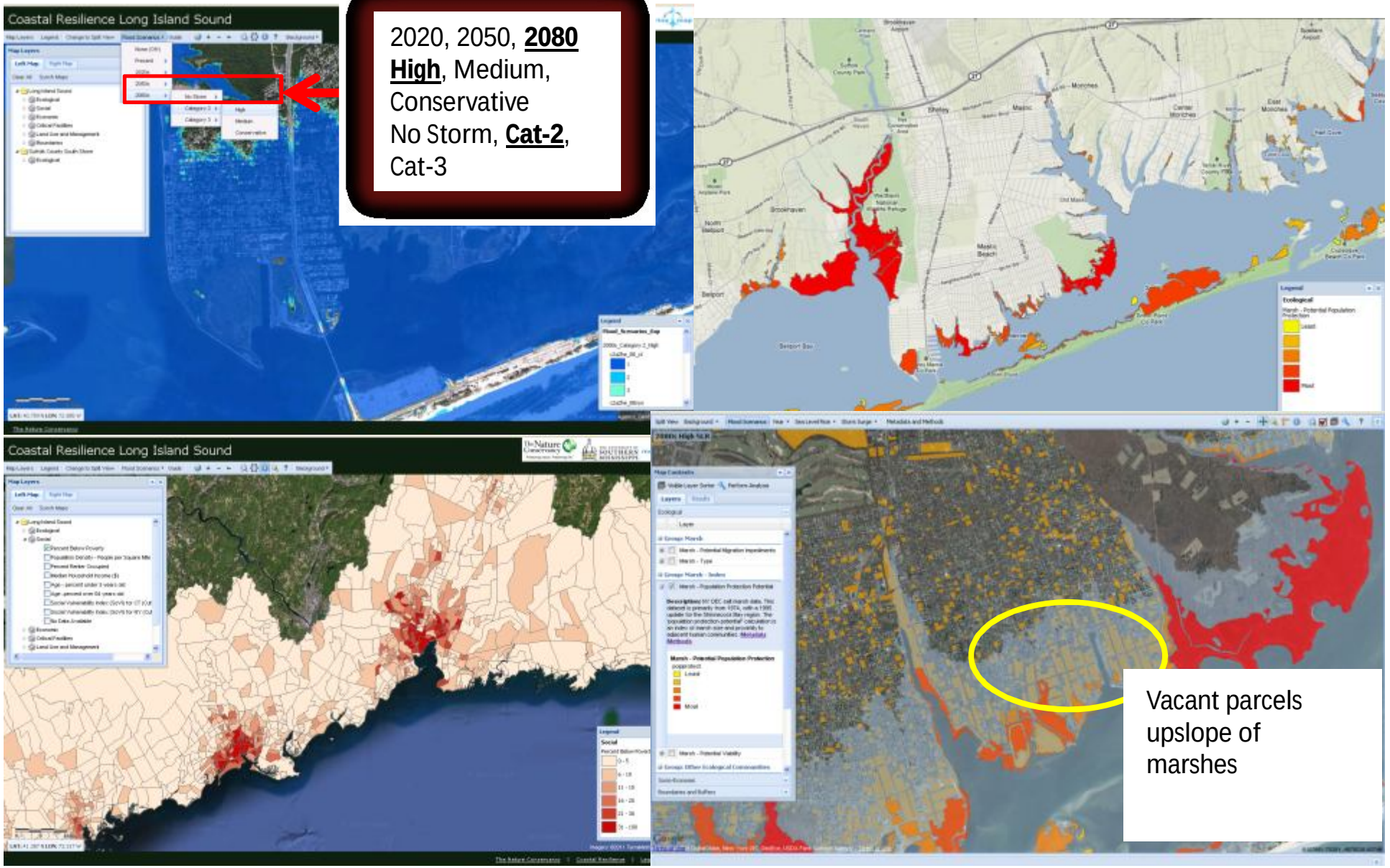
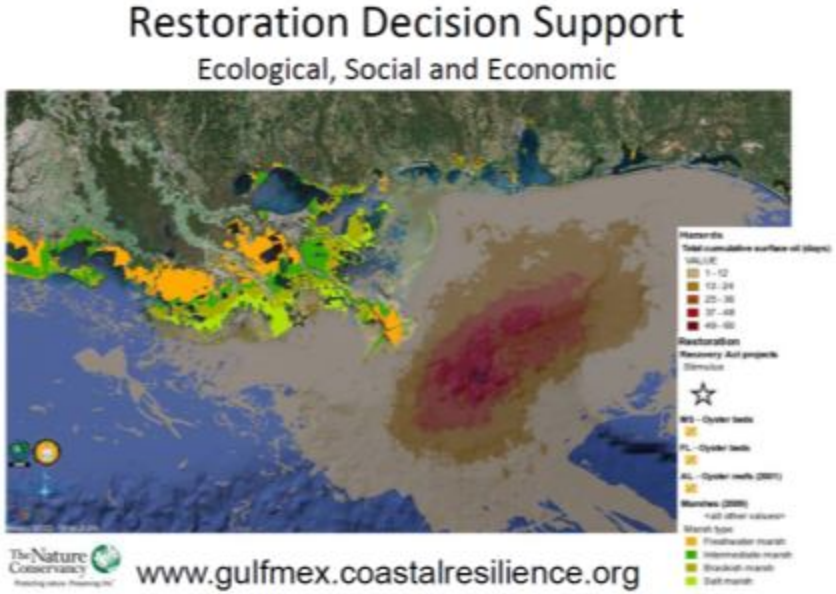
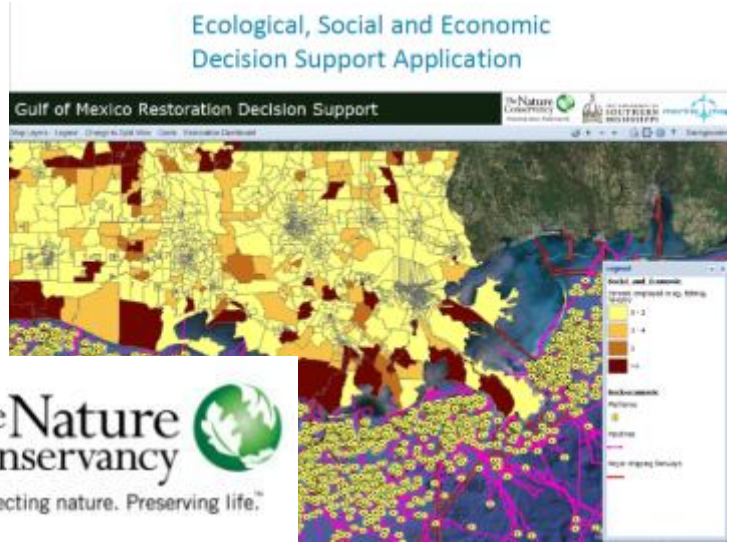
Planning tools and decision support:

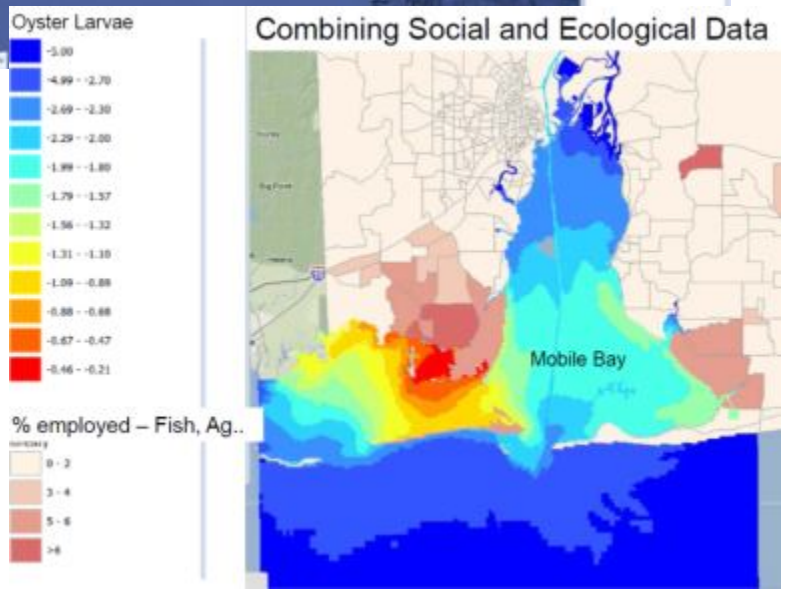
sea-level rise and storm surge scenarios



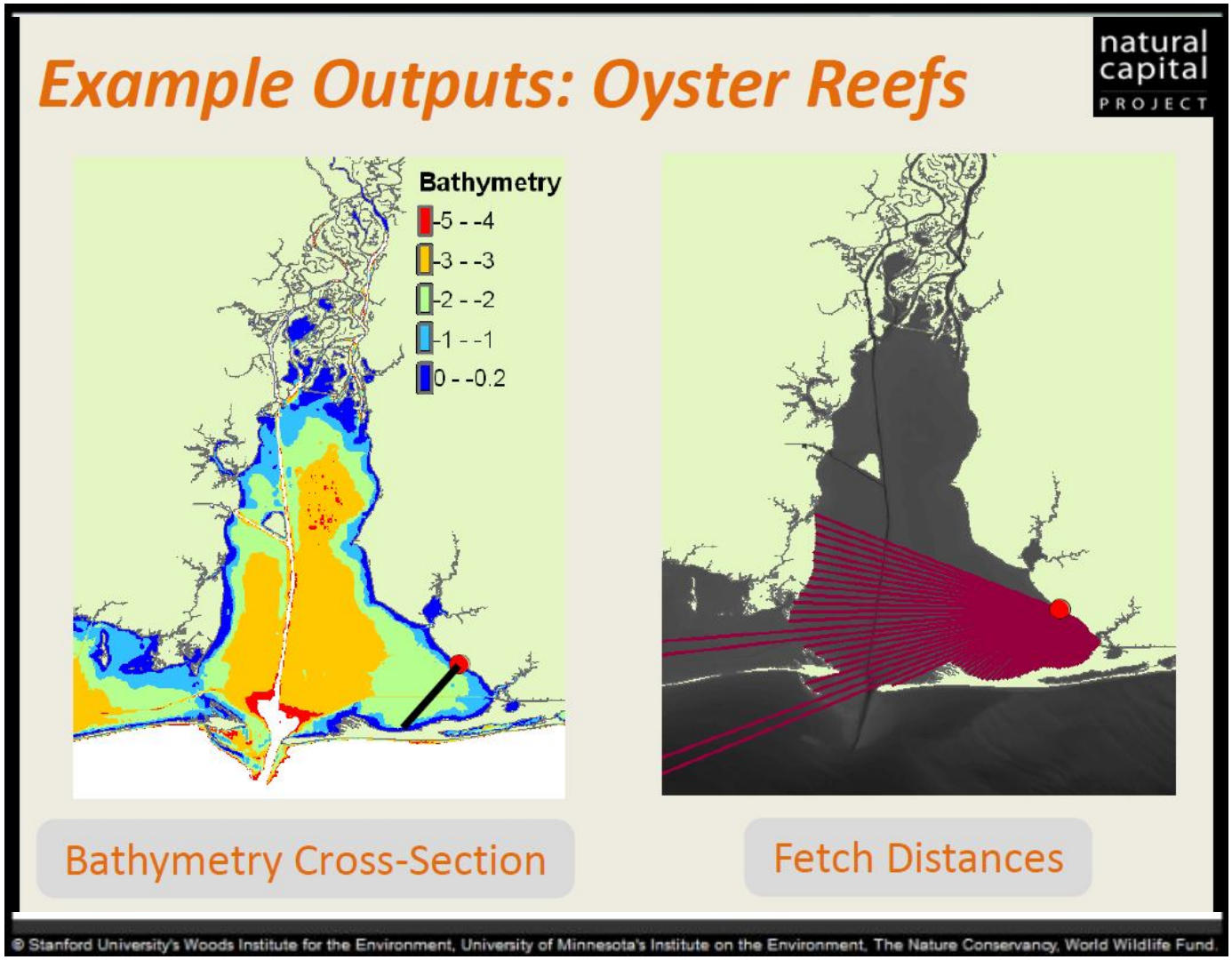
Planning tools and decision support:
Gulf of Mexico



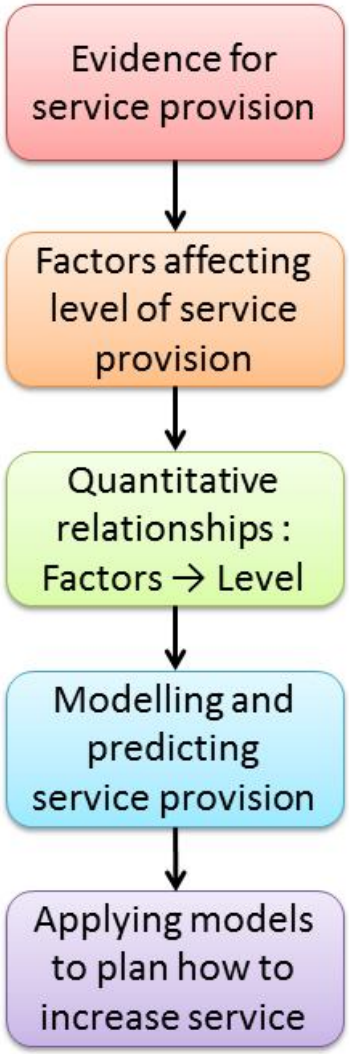




Planning tools and decision support:
Building numerical models



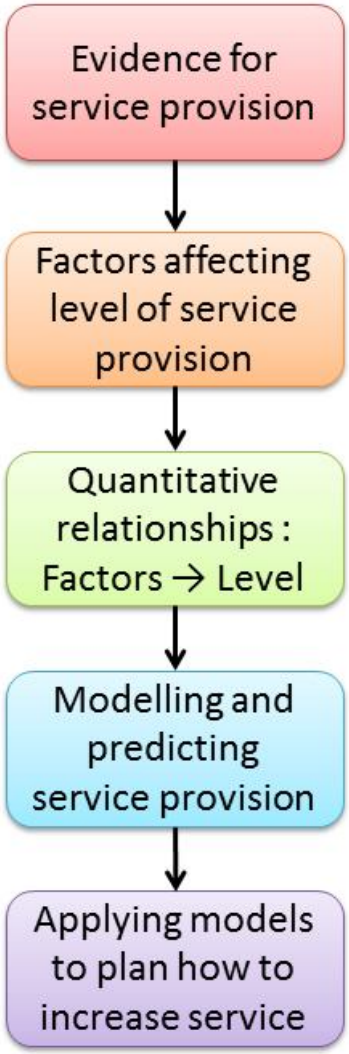
Science - building the case

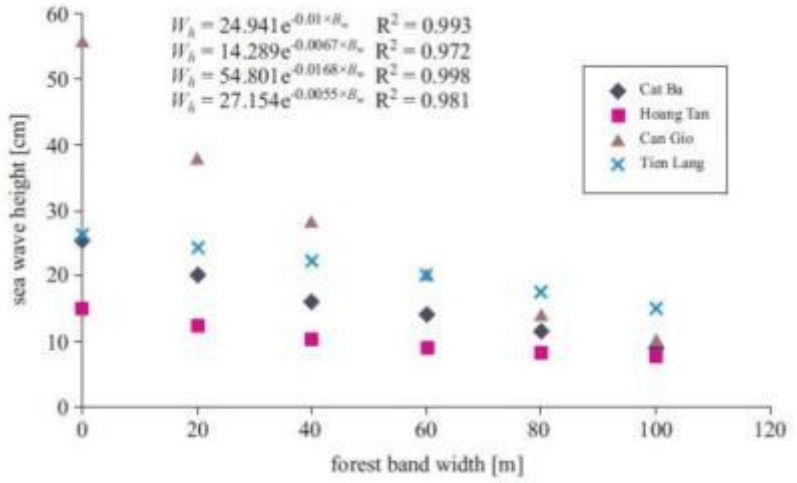


Location	Species	Wate attenuation / transmission	Source
Cocoa Creek, Australia	*Rhizophora stylosa*	Wave transmission factor 0 to 0.7	Brinkman *et al.* 1997
Iriomote Island, Japan	*Bruguiera* sp.	Wave transmission factor 0.2 to 0.8	Brinkman *et al.* 1997
Tong King Delta, Vietnam	*Kandelia candel*	Waves attenuated 20% per 100m	Mazda *et al.* 1997
Vinh Quang coast, northern Vietnam	*Sonneratia* sp.	45% / 100m when water 0.2m deep, 26% per 100m when water 0.6m deep	Mazda *et al.* 2006 ***(typhoon conditions)***
Red River Delta, Vietnam	*Kandelia candel*	0.002 to 0.011/m	Quartel *et al.* 2007
Nang Hai, Can Gio Mangrove Forest, Vietnam	*Avicenia* sp. and *Rhizophora* sp.	50-70% in first 20m (coinciding with 2m scarp)	Vo-Luong & Massel 2006, 2008
Red River Delta and Can Gio forest, Vietnam	as above	mean 0.0043/m over 80m of forest	Bao, 2011

All studies reviewed show that mangroves are capable of reducing wave energy and height).

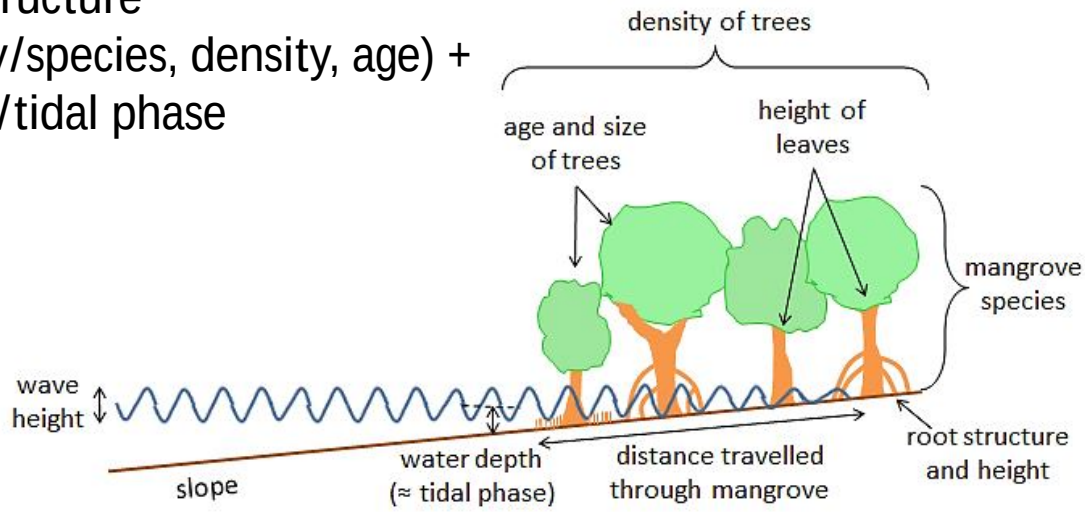
Science - building the case



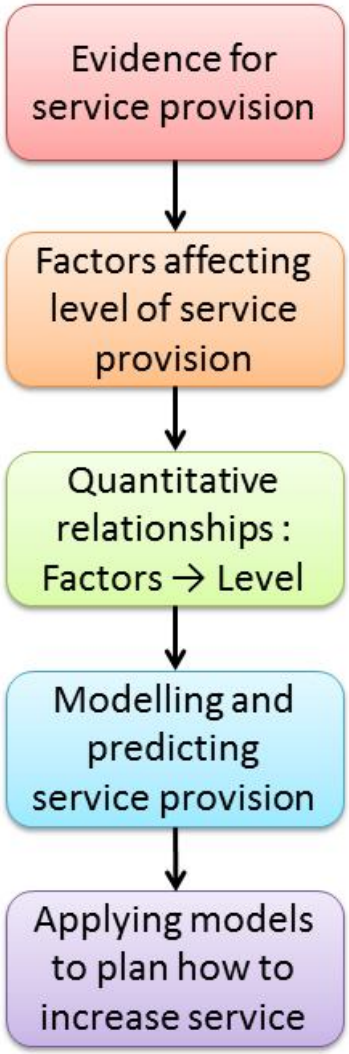


(from Bao, 2011)

a) Distance travelled through mangrove
b) Mangrove structure (morphology/species, density, age) + water depth/tidal phase
c) Wave height
d) Topography



Science - building the case



Three models:

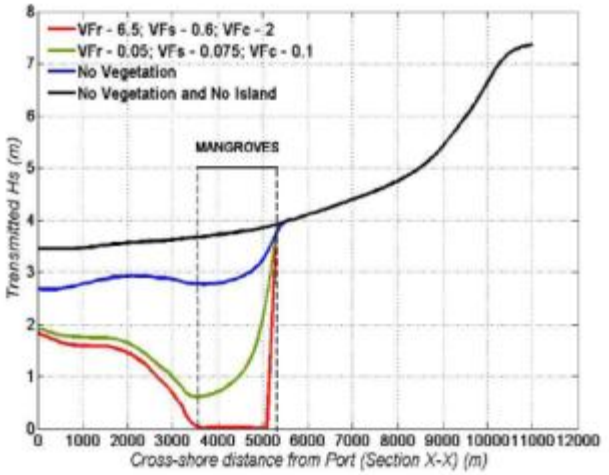
i. WAPROMAN (Vo-Luong and Massel, 2008)

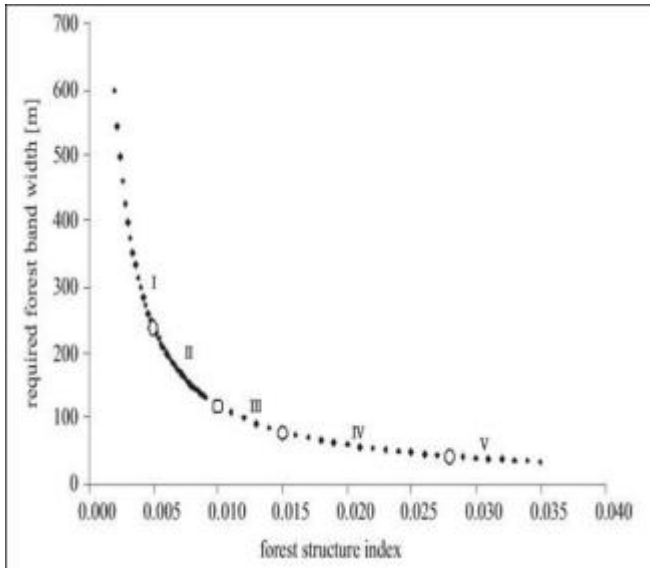
ii. SWAN model (Suzuki *et al*., 2011)

Used to estimate wave attenuation behind a mangrove island Dhamra Port, Orissa and to make case for expansion of mangroves

iii. Regression model based on forest structure data (Bao, 2011)

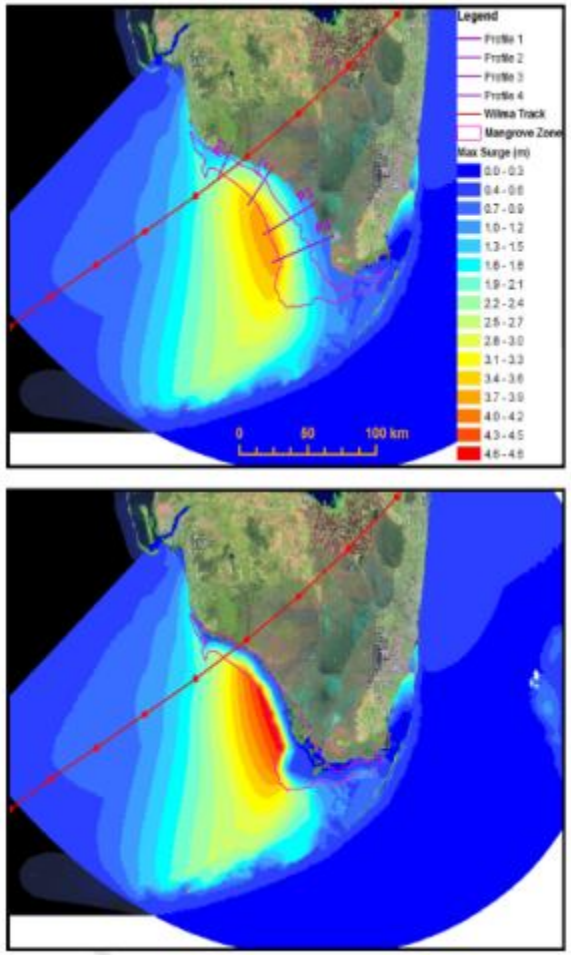
Used to to work out the required band width of mangrove forests of different vegetation structure to reduce 3m waves to 0.3m for Vietnamese coasts





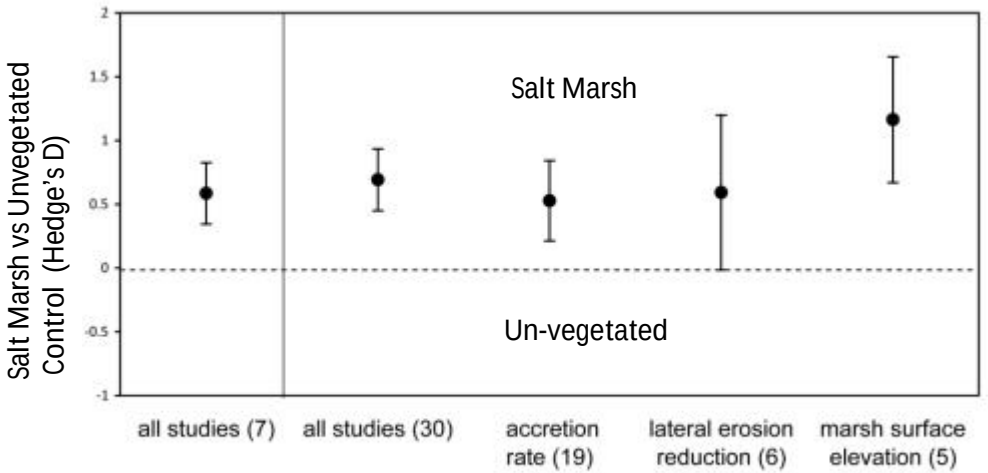
Science - building the case

Storm surge reduction in Florida

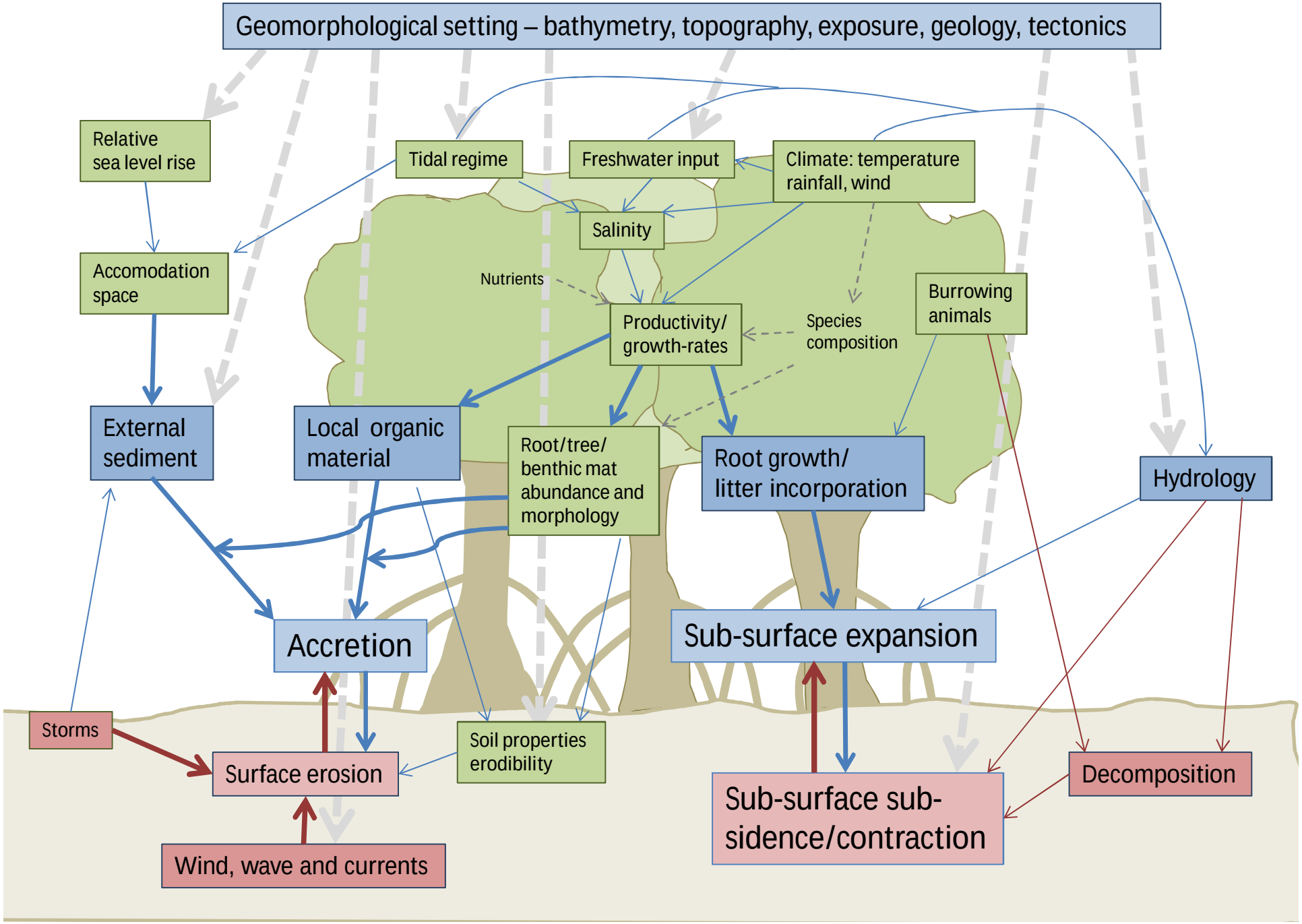


Zhang *et al*., 2012

Ferrario et al.. In rev



Shepard et al. 2011. PloS One 6: e27374


Geomorphological setting – bathymetry, topography, exposure, geology, tectonics
Relative sea level rise
Tidal regime
Freshwater input
Climate: temperature rainfall, wind
Salinity
Accomodation space
Nutrients
Burrowing animals
Productivity/ growth-rates
Species composition
External sediment
Local organic material
Root/tree/ benthic mat abundance and morphology
Root growth/ litter incorporation
Hydrology
Accretion
Sub-surface expansion
Storms
Soil properties erodibility
Surface erosion
Decomposition
Sub-surface sub-sidence/contraction
Wind, wave and currents

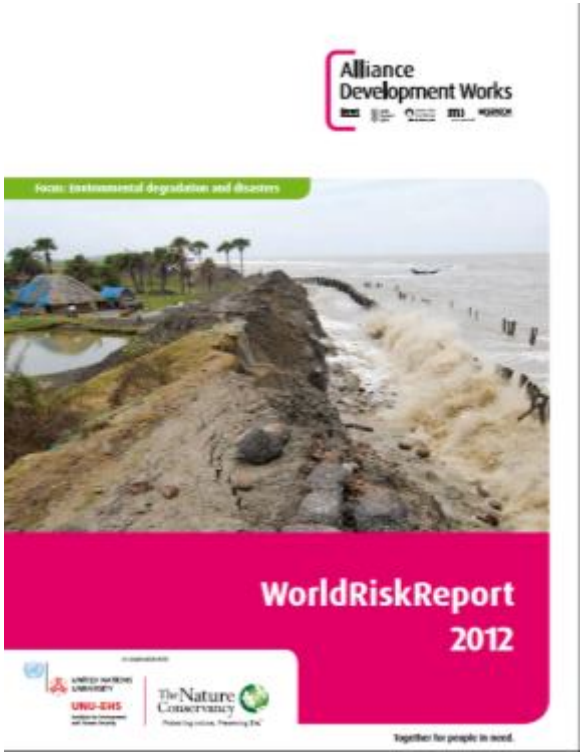
Building the economic case

5.8km of restored oyster reefs, Alabama, USA:

- **Fisheries:**
  - 3100 kg/year of additional fish and crab total economic output of $39,000/year.
- **Coastal erosion:**
  - 51-90% reduction in wave height and 76-99% reduction in wave energy at the shore.
- **Nitrogen abatement:**
  - 130-1890kg of nitrogen per year removed from Bay waters.
- **Economic impacts from reef construction itself**:
  - $8.4 million in local output, $2.8 million in earnings and 88 jobs created.

Kroeger, 2012 and in press

Communication and outreach



Shifting the needle

- Policy
  - PEDRR
  - World Bank
  - CBD/UNFCCC/IUCN
- Partnerships
  - NOAA, Restoration Center
  - US Army Corps, SAGE – hybrid engineering
  - Mangrove Capital Project (Wetlands Int, Deltares, Wageningen)
- Leverage


Thank you
Mark Spalding