



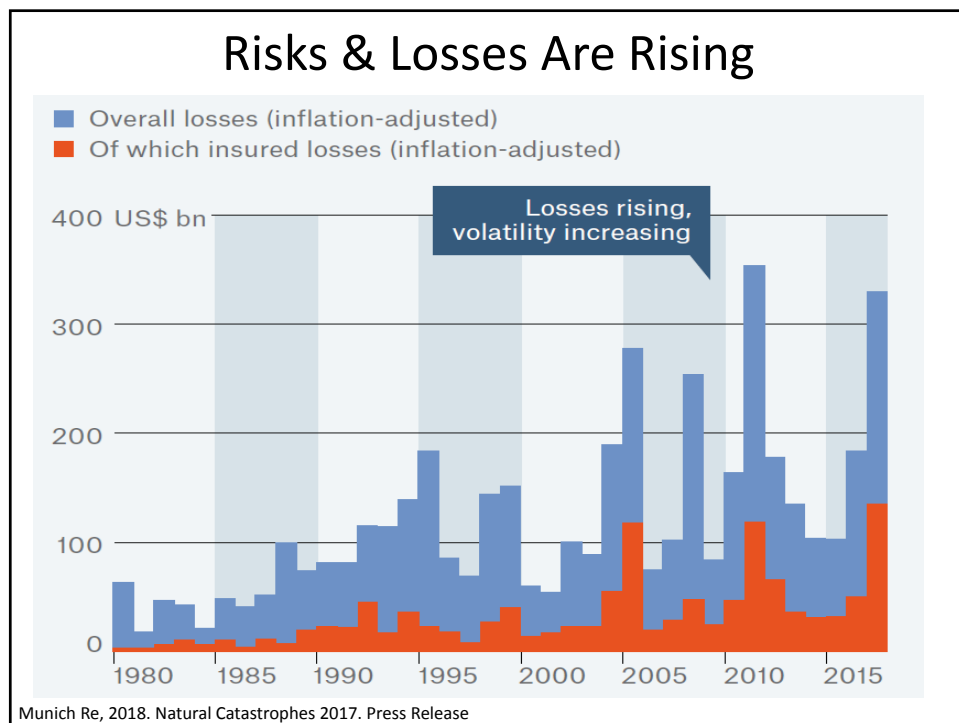
The Ecology, Economics and Engineering of Natural Coastal Defenses

Michael W. Beck
 Borja Reguero, Siddharth Narayan
 Iñigo Losada, Pelayo Menéndez, Curt Storlazzi

The Nature Conservancy

IH cantabria
 INSTITUTO DE HIDRÁULICA AMBIENTAL

**UNIVERSITY OF CALIFORNIA
 SANTA CRUZ**

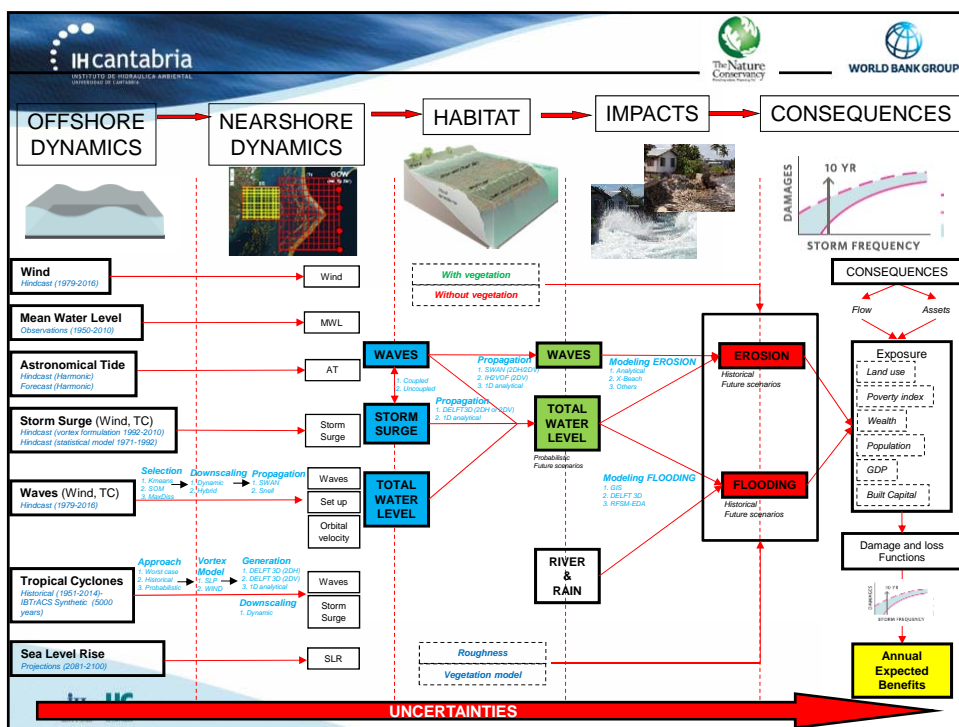
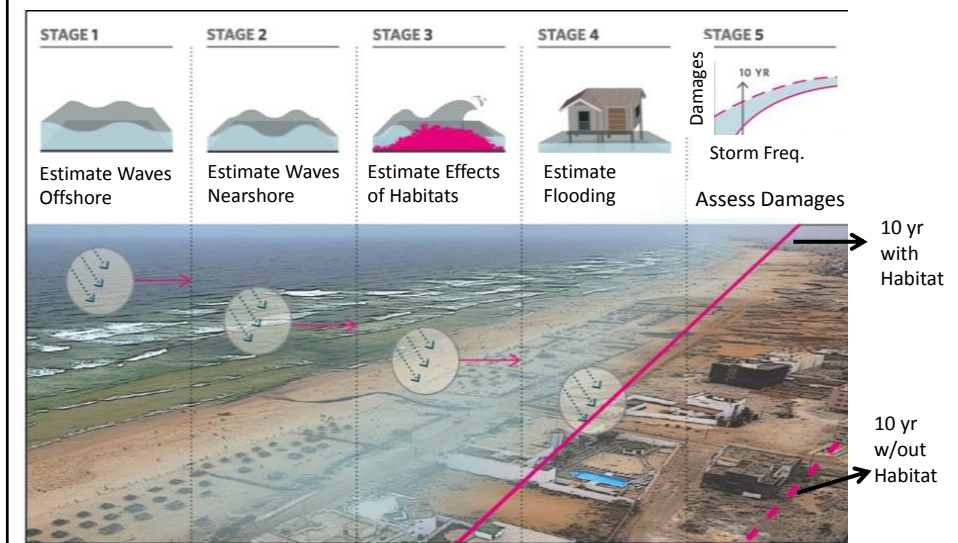


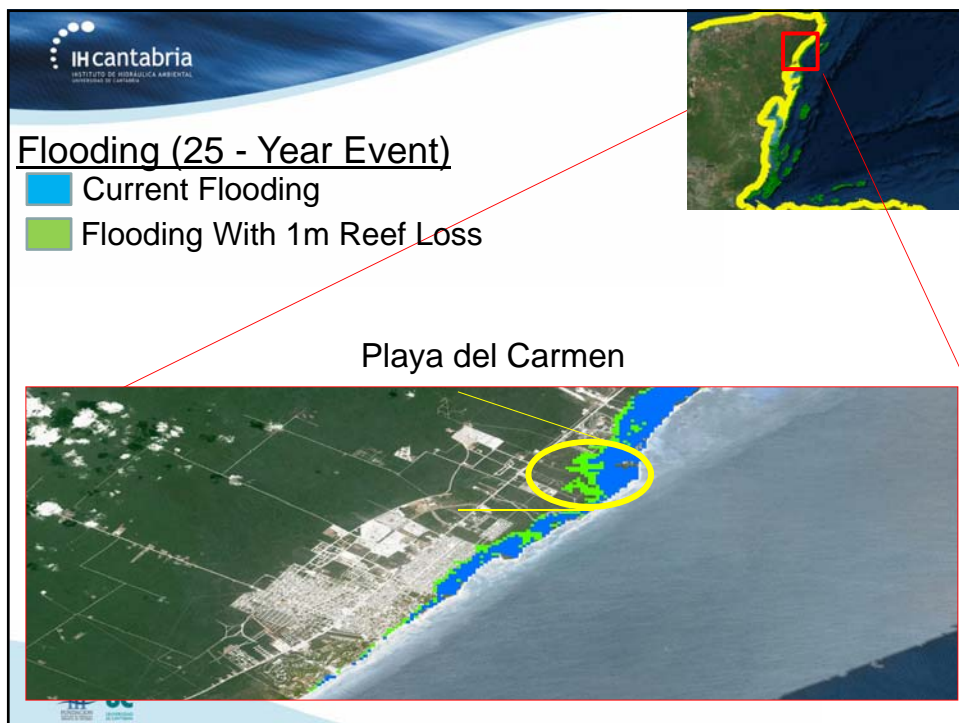
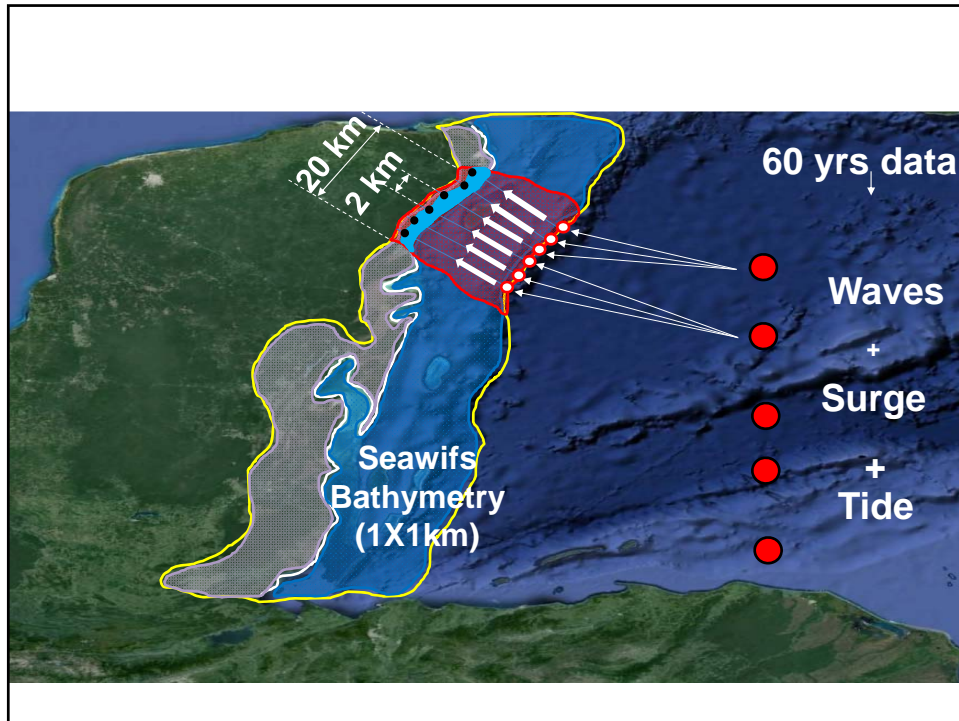
Guidelines for Valuing Coastal Protection Services from Mangroves and Reefs

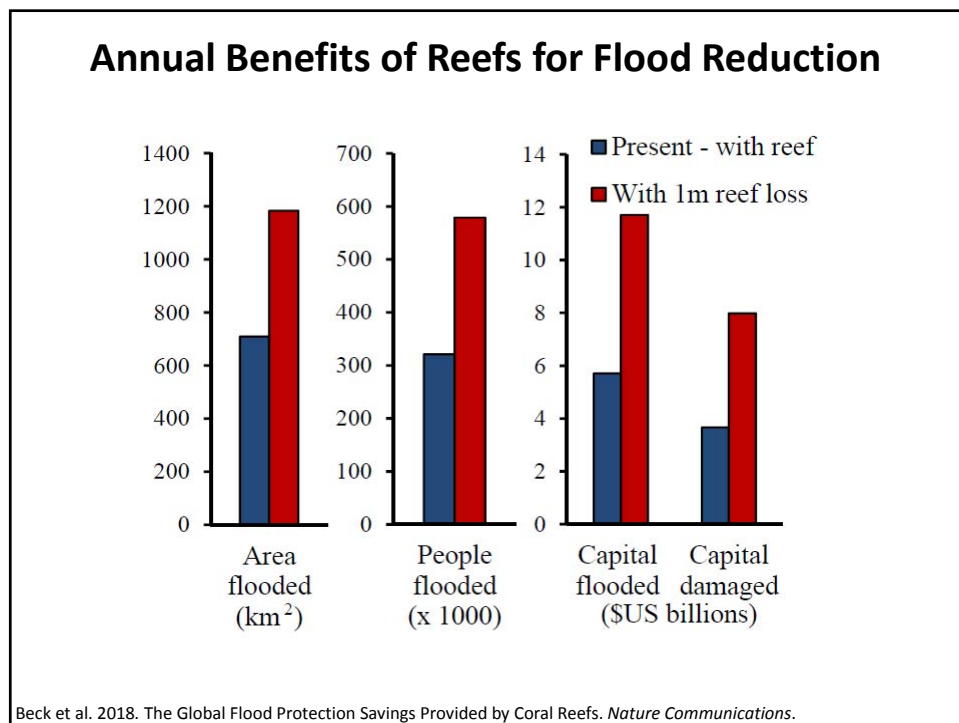
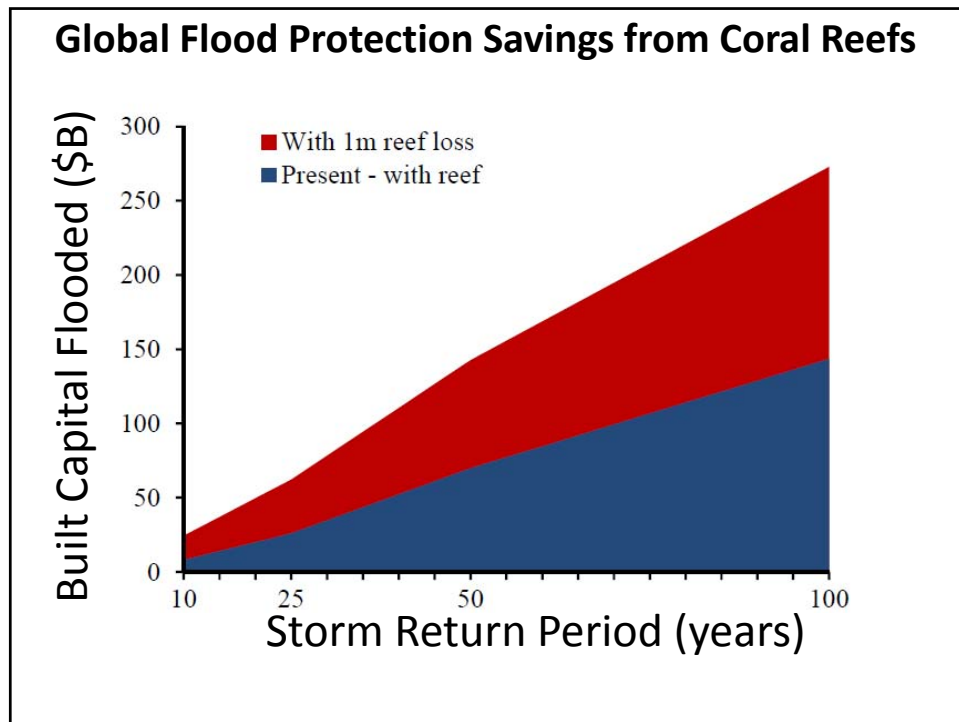
M W. Beck & G-M Lange (eds)

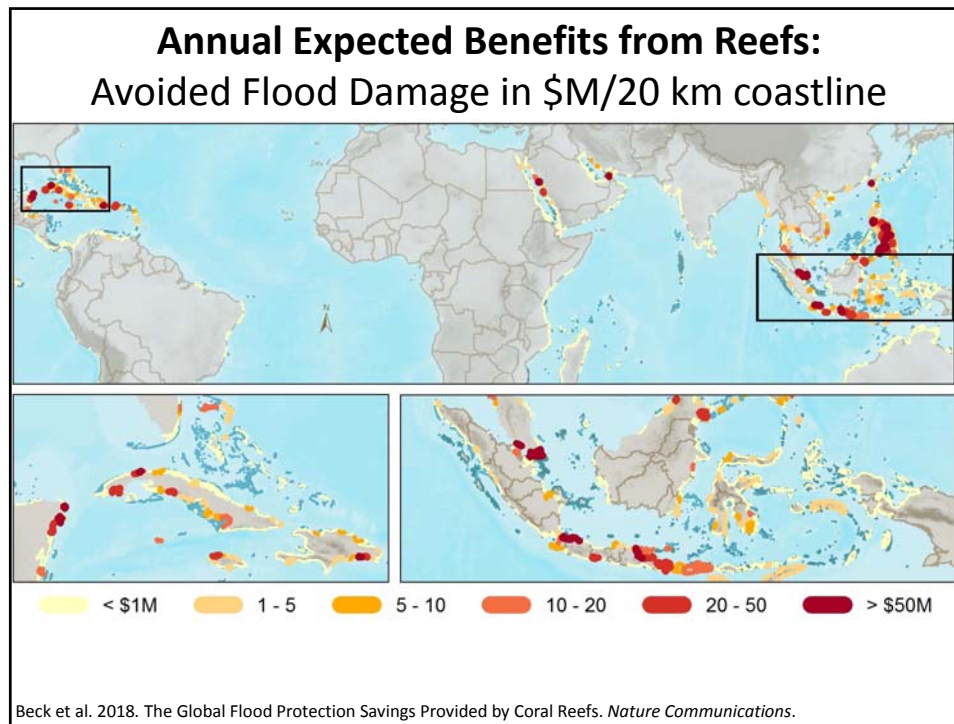


Recommended Approach: Expected Damage Function





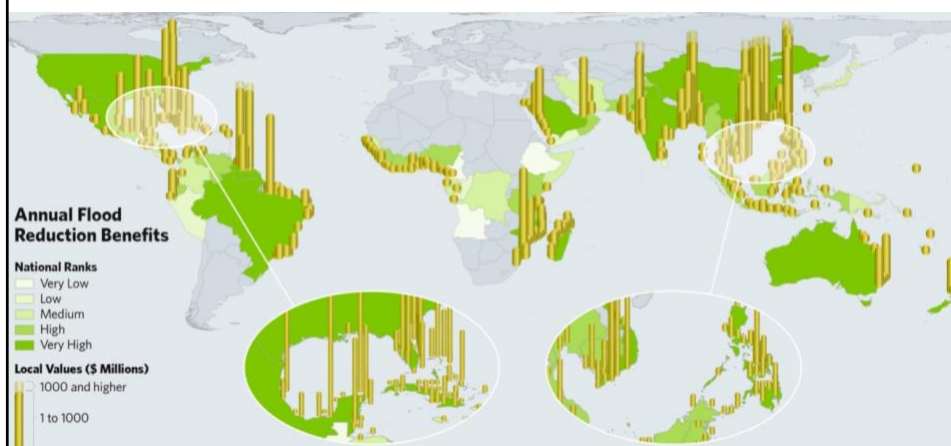




Annual Expected Benefits of Reefs for Flood Protection

Annual Averted Damages (\$Millions)			Annual Averted Damages/GDP	
1	Indonesia	639	Cayman Islands	0.98
2	Philippines	590	Belize	0.37
3	Malaysia	452	Grenada	0.30
4	Mexico	452	Cuba	0.25
5	Cuba	401	Bahamas	0.16
6	Saudi Arabia	138	Jamaica	0.14
7	Dominican Republic	96	Philippines	0.13
8	United States	94	Antigua and Barbuda	0.13
9	Taiwan	61	Dominican Republic	0.11
10	Jamaica	46	Malaysia	0.09
11	Vietnam	42	Seychelles	0.06
12	Myanmar	33	Turks and Caicos	0.06
13	Thailand	32	Guadeloupe	0.05
14	Bahamas	14	Indonesia	0.04
15	Belize	9	Solomon Islands	0.04

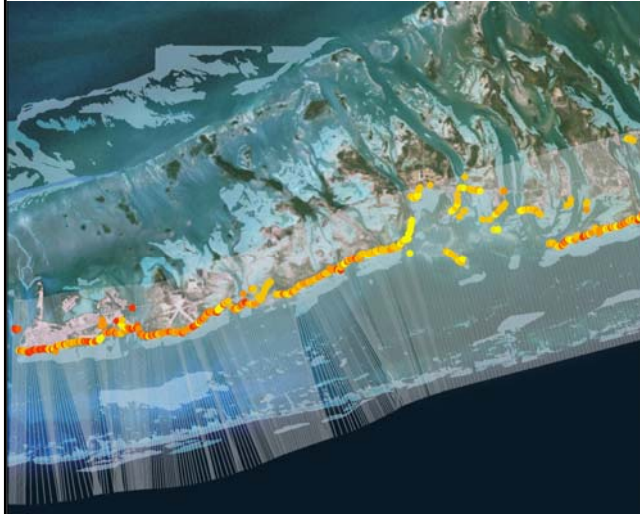
Annual Flood Reduction Benefits from Mangroves



Countries Where Mangroves Provide Greatest Annual Flood Reduction Benefits

People Protected (millions)		Property Protected (US \$ Billions)		Property Protected per GDP
Vietnam	8.1	China	19	Guyana
India	3.3	United States	13	Belize
Bangladesh	1.3	India	9	Bahamas
China	0.8	Mexico	9	Suriname
Philippines	0.7	Vietnam	7	Mozambique
Brazil	0.4	Guyana	7	Vietnam
Nigeria	0.4	Mozambique	2	Guinea-Bissau
Indonesia	0.3	Saudi Arabia	2	Madagascar
Mozambique	0.3	Bangladesh	2	Benin
Mexico	0.3	Bahamas	2	Sierra Leone

Benefits of Coral Reefs for Risk Reduction (1in100yr flood)



Flood Reduction (%)

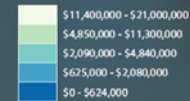


Benefits of Coral Reefs for Risk Reduction

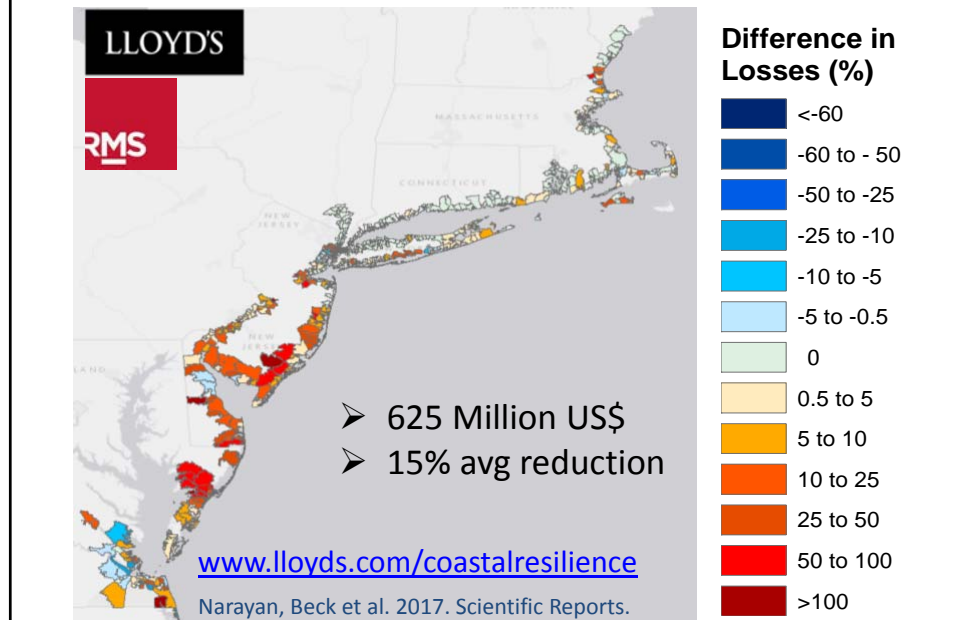
Informing FEMA & Puerto Rico Recovery Efforts


Averted Damages by Reefs - 100 Year Storm - Zone 3

\$122,000,000 Total Damages Averted



Effects of Marshes on Sandy Flood Damages








Swiss Re

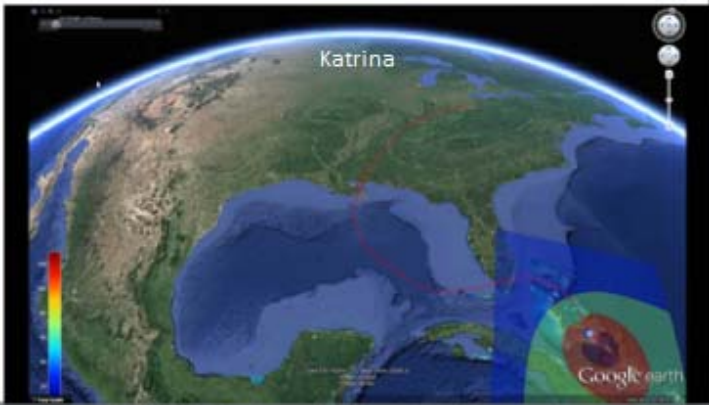
The Nature Conservancy
Protecting nature. Preserving life.

Economics of Climate Adaptation

Aims

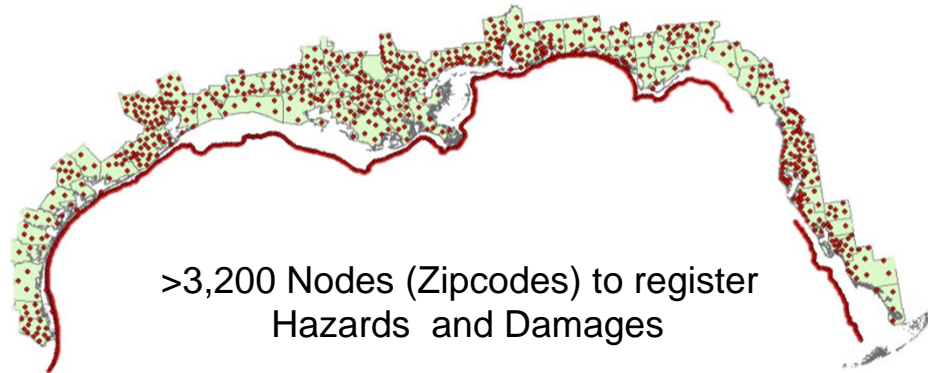
- Work with world's 2nd largest re-insurer
- Public cost effectiveness model that includes nature
- Identify where nature-based defenses are cost effective



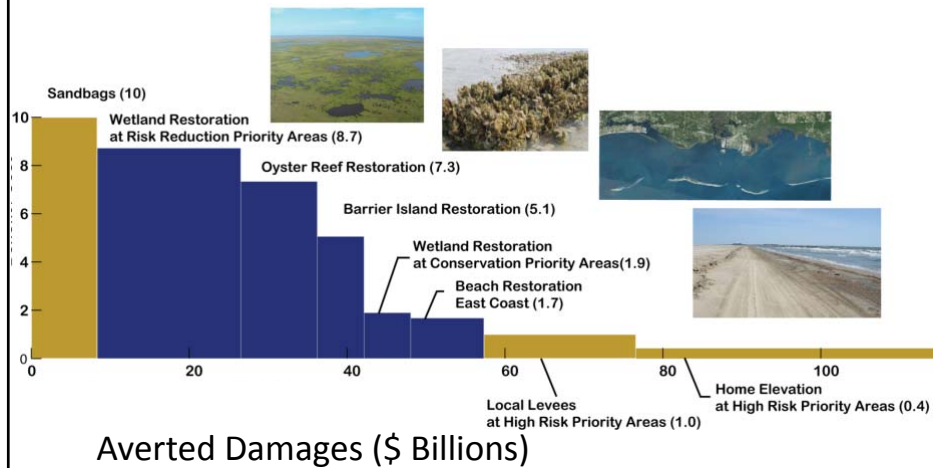
ETH zürich

The regional domain: The Gulf Coast of US



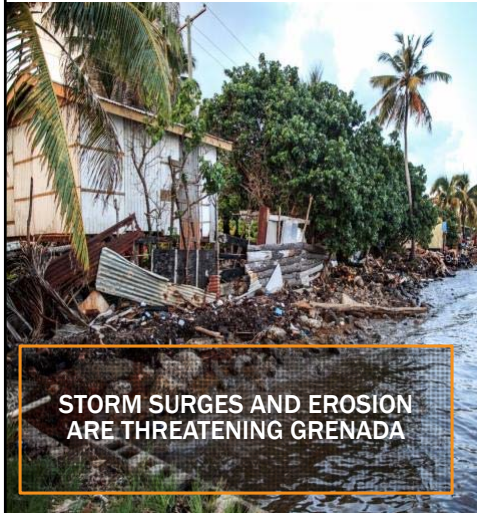
Economics of Coastal Adaptation

Benefit to Cost ratio



Reguero, Beck et al (2018). PLOS ONE

Global to Local Connection
PILOT PROJECT: GRENVILLE BAY, GRENADA



**REEF RESILIENCE & INSURANCE FUND
IN QUINTANA ROO, MEXICO**

The Nature
Conservancy 
Protecting nature. Preserving life.

 **Swiss Re**



Implications and Opportunities

- **Include Nature in Industry Risk Models**
- **Private incentives-** Insurance, Resilience Bonds
- **Public incentives-** Pre- and Post- disaster spending (special purpose tax districts, FOPREDEN)
- **Prioritizing Natural Infrastructure in Policy** (Philippines Greening Program, US ACoE)



SUMMARY

- Wetlands and reefs reduce flood risks
- We can rigorously value these benefits to:
 - Inform adaptation & development planning
 - Support Natural Infrastructure Projects



