Coastal infrastructure resilience to extreme events: Geoscience in planning, design, and construction

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BUILDING THE MODERN WORLD:
Geoscience that Underlies Our Economic Prosperity
Geoscience and the U.S. Economy Briefing Series Webinar

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Maritime Transportation Infrastructure
Critical, complex, constrained

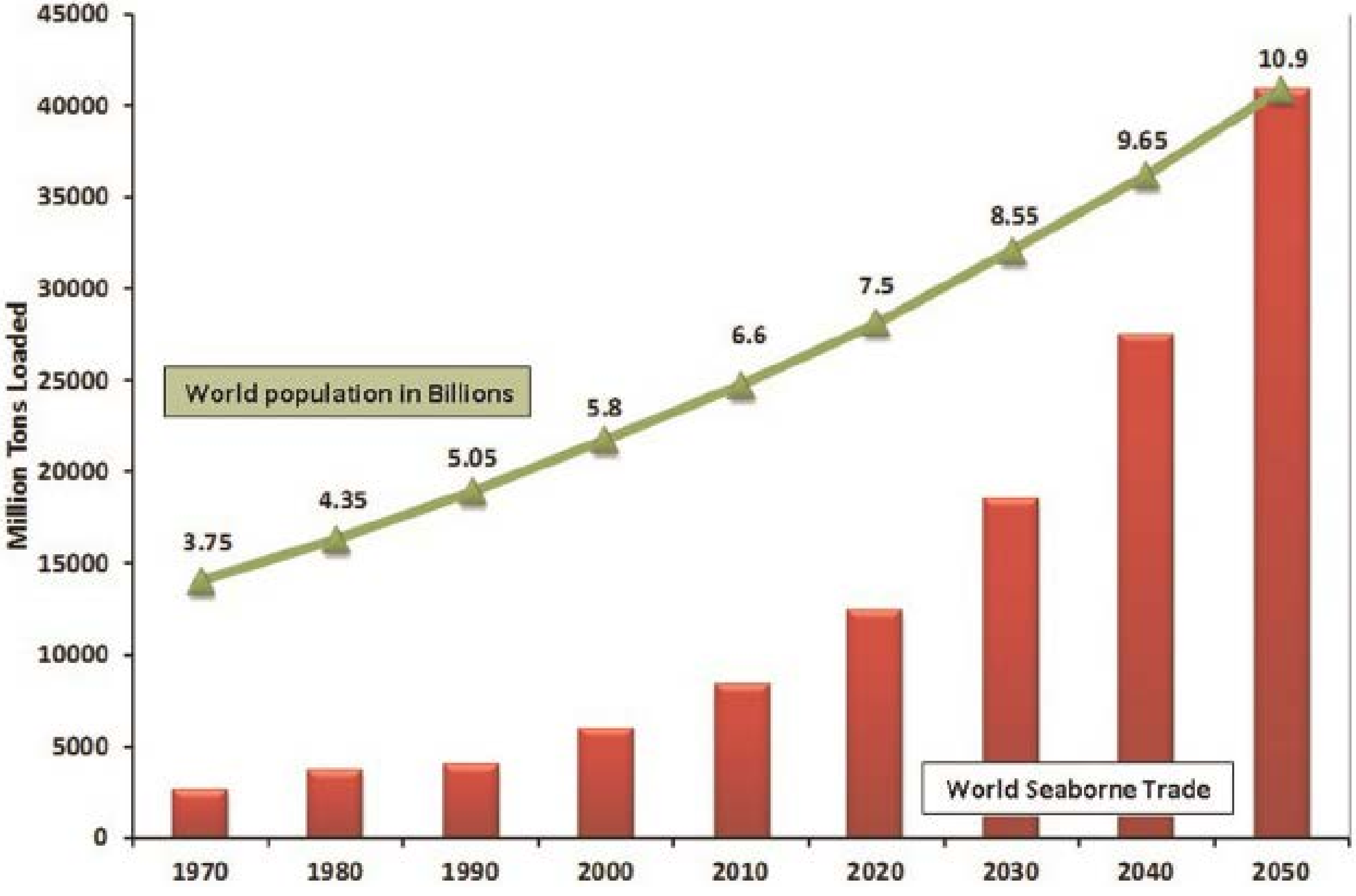
Critical – 23M U.S. jobs; 99% volume of U.S. overseas trade[1]

Complex – Multiple stakeholders across space and time

Constrained - Dependent on specific and environmentally-sensitive locations

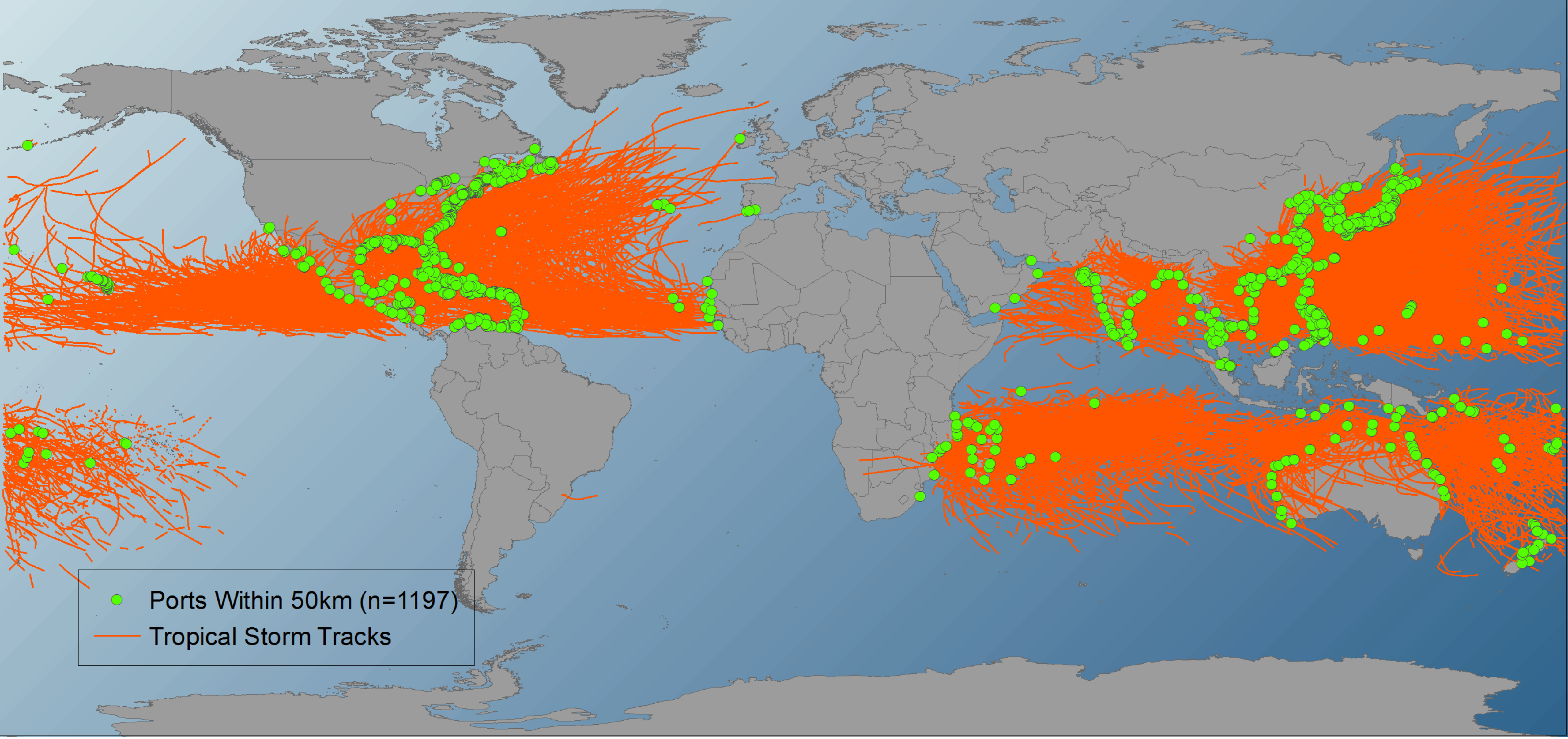
1. MARAD. 2016. "Marine Transportation System (MTS)." Maritime Administration. https://www.marad.dot.gov/ports/marine-transportation-system-mts/.

Global population & shipping projections



Elgohary, et al. 2014

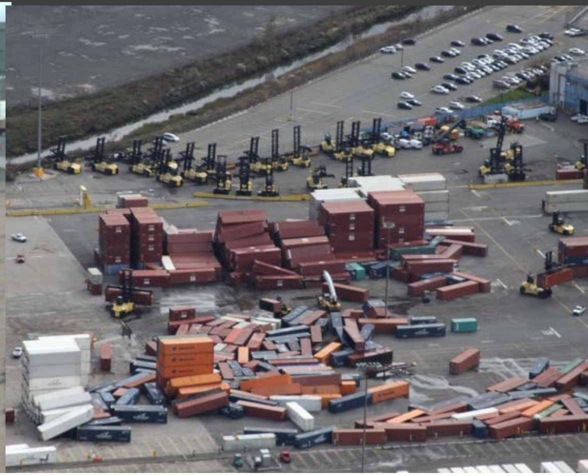
Ports Within 50km of Tropical Storm Tracks 1960-2010



Becker, A., et al. (*2013*)

Long term challenges





Doubling of Cat 4 and 5 tropical storms

Sea levels to rise 0.75 – 1.9 meters by 2100

Inland flooding

Hurricane Sandy photos courtesy Mary Lee Clanton, Port of NYNJ

(Bender et al. 2010; Grinsted et al. 2013; Rahmstorf 2010; Emanuel 2013; IPCC 2012; Tebaldi et al. 2012)

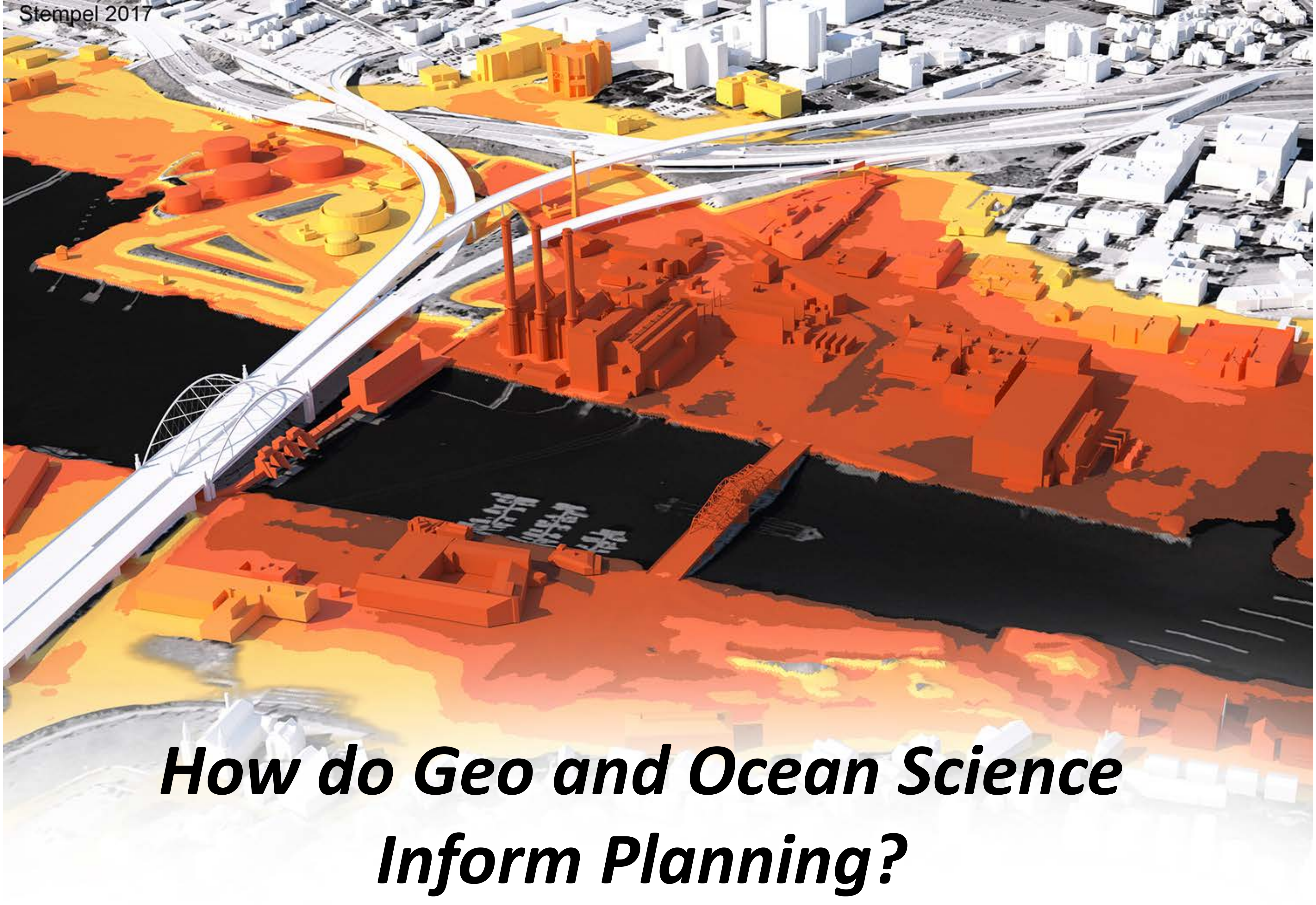
Long term challenges

1-in-100 year storm event of today

1-in-3 year storm event of 2100

Hurricane Sandy photos courtesy Mary Lee Clanton, Port of NYNJ

(Bender et al. 2010; Grinsted et al. 2013; Rahmstorf 2010; Emanuel 2013; IPCC 2012; Tebaldi et al. 2012)

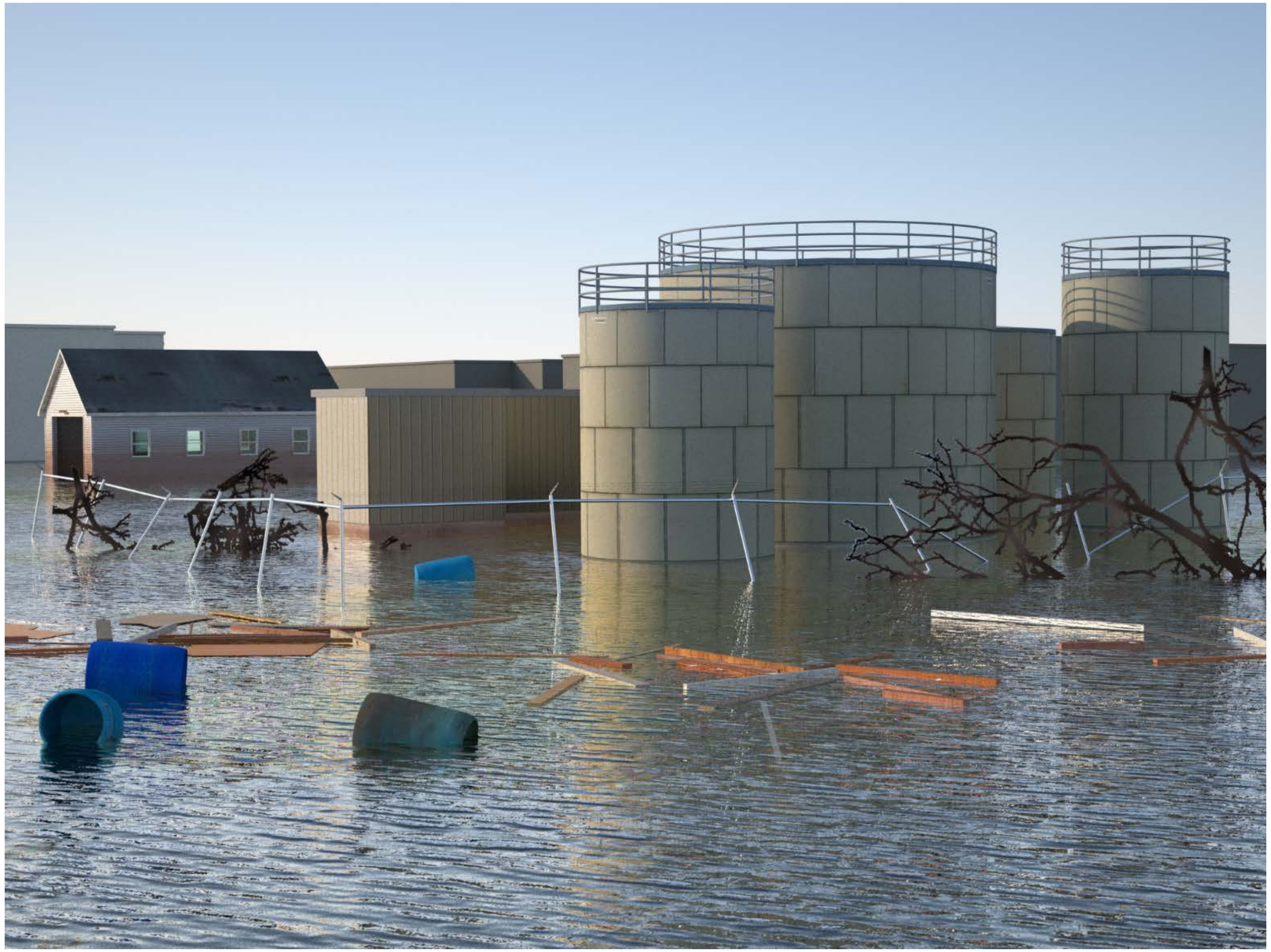


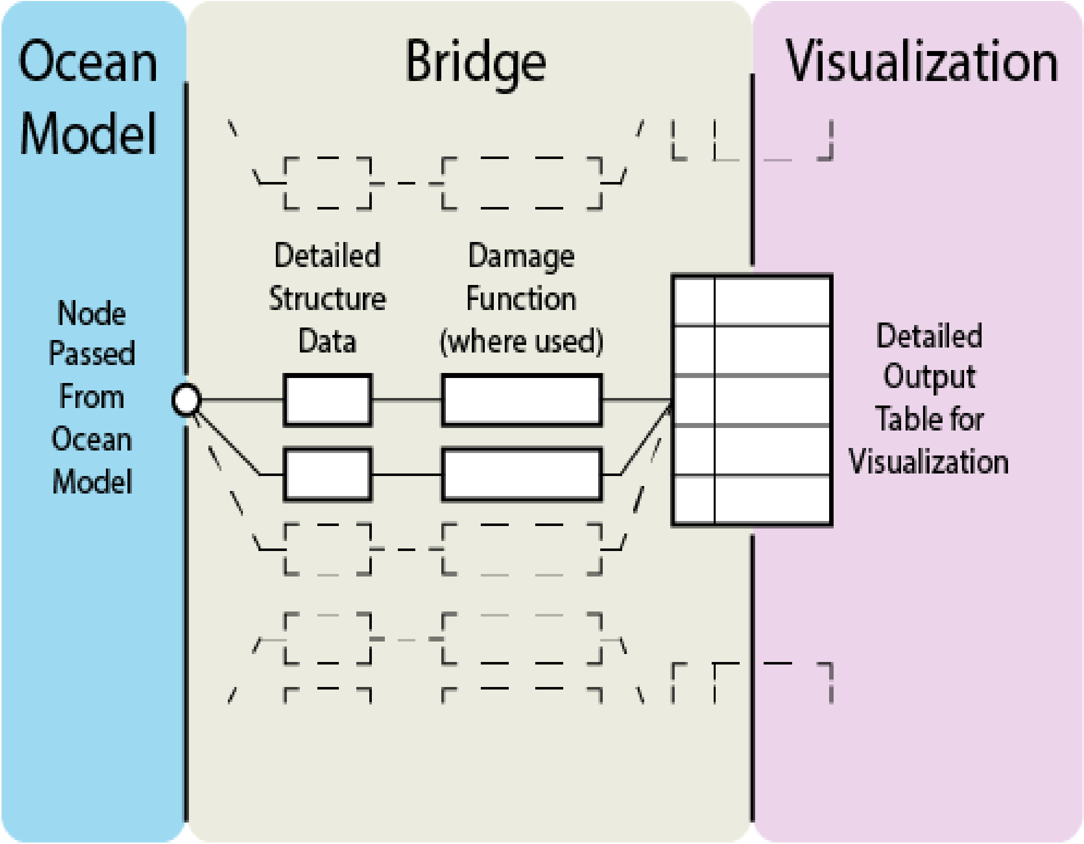
How do Geo and Ocean Science Inform Planning?

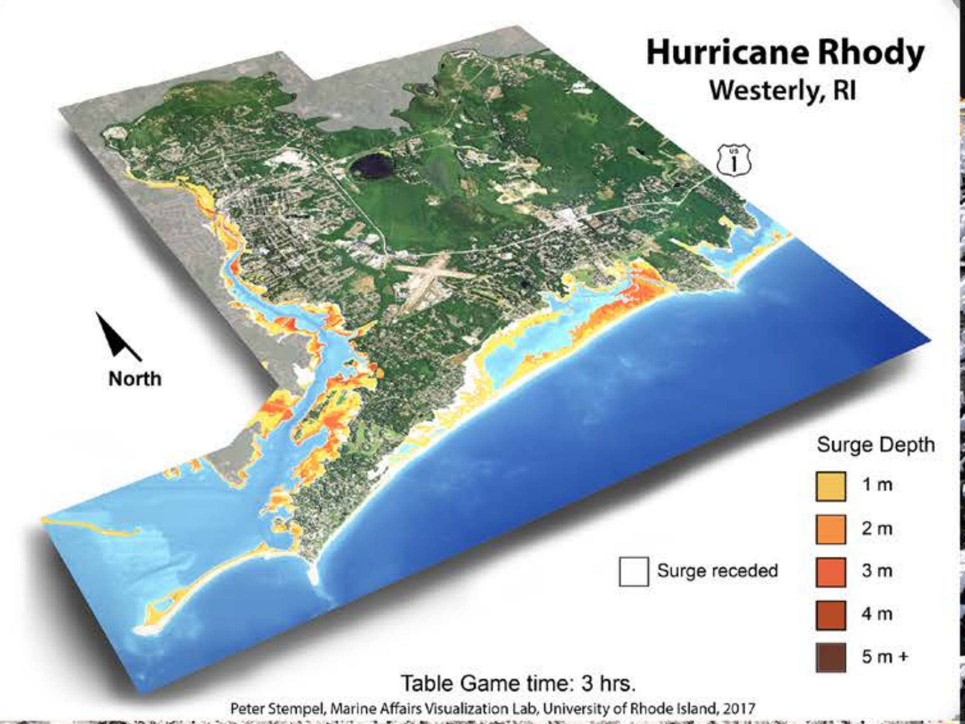
How do we understand the risks?

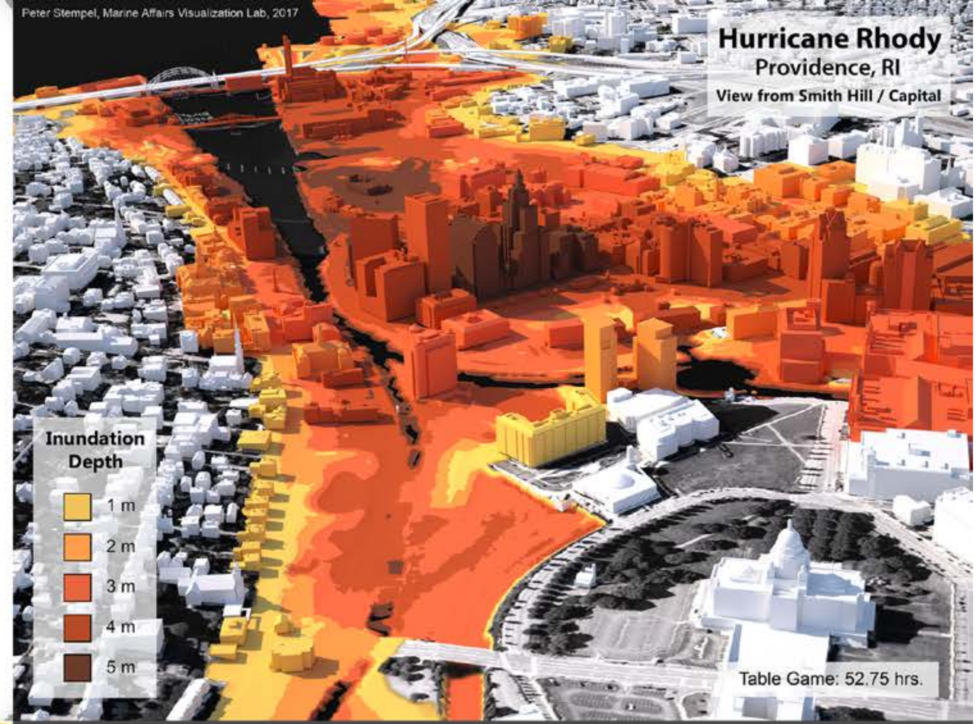
Connecting hydrodynamic, wind, and hydrologic modeling to cities and towns

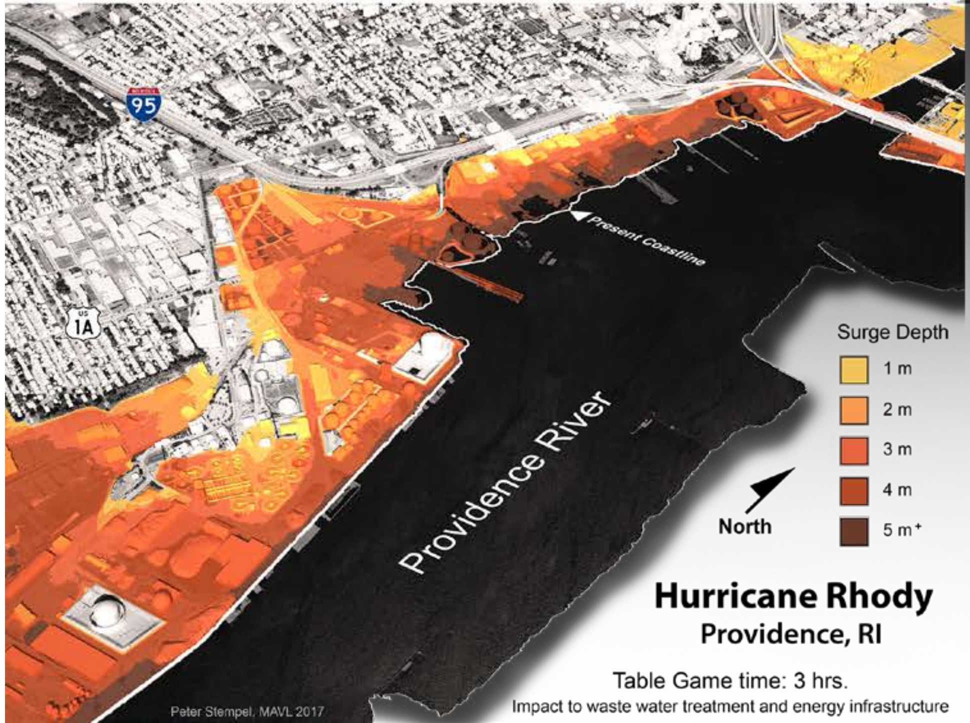
- Scenario-based planning and real time forecasting of storm damage
- Engaging and recognizable representations of complex phenomena





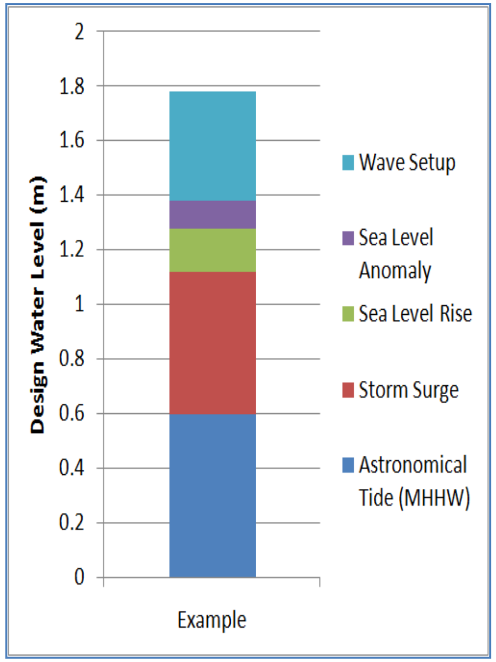






Engaging and recognizable representations of phenomena that are difficult to comprehend

Construction and design - How high, how strong?



- Mean sea level
- Tide amplitude
- Thermal expansion
- Climate change (GSLR)
- Storm surge (including wave set-up)
- Wave run-up (dynamic component)

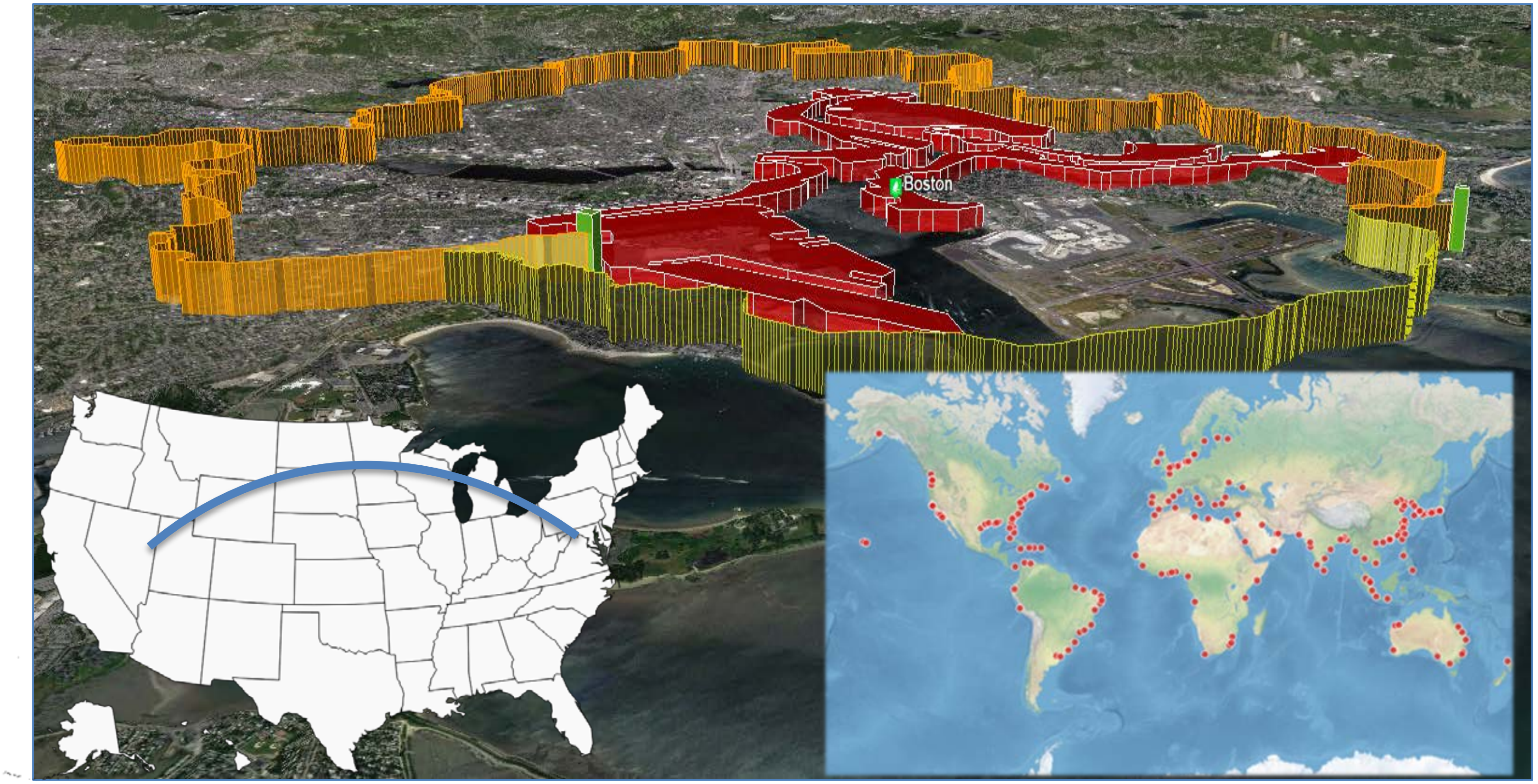
Protect

Elevate

Design for submersion

Photo from Alabama State Port Authority

Resource requirements on a local and global scale?



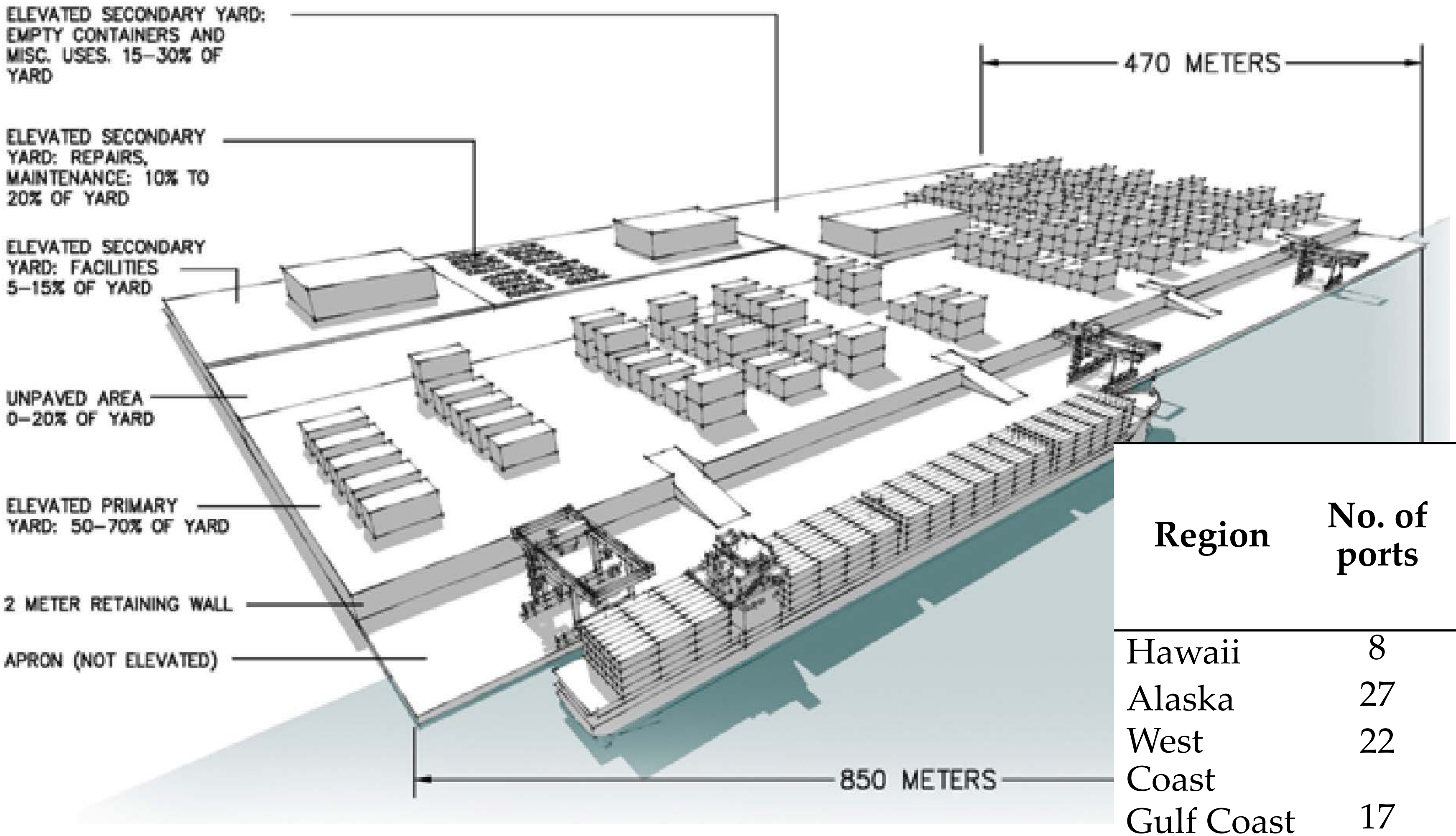
Materials to protect 221 of world's 3500+ seaports:

- 2,600km of structure *(D.C. to Vegas)*
- 143M cubic meters of concrete *(52 Hoover Dams)*
- 308M cubic meters of sand and stone *(approx. vol. of Great Wall of China)*

Becker et al, 2016

Cost to elevate 100 U.S. coastal ports' infrastructure by 2 meters

= $64B - $85B



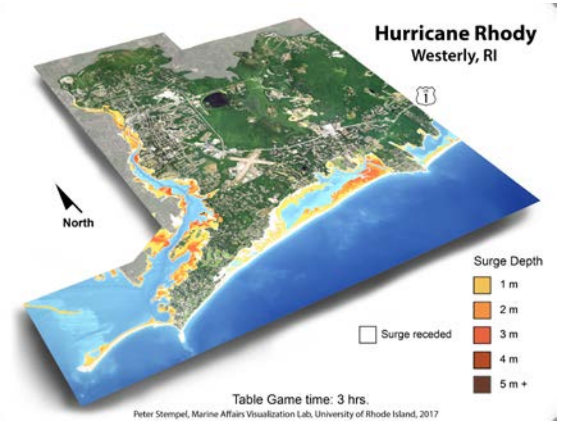
Region	No. of ports	Area (km²)	Total Cost *(Millions)* to elevate 2 meters & retrofit *Lower bound*		*Upper bound*
Hawaii	8	5.7	$958	-	$1,274
Alaska	27	5.9	$992	-	$1,319
West Coast	22	110.0	$18,495	-	$24,591
Gulf Coast	17	129.5	$21,771	-	$28,946
East Coast	26	129.1	$21,714	-	$28,870
Total	**100**	**380.1**	**$63,930**	**-**	**$84,999**

Coastal infrastructure resilience to extreme events: Geoscience in planning, design, and construction

- Understand context & risks (locally, nationally, *and* globally)
- Engage stakeholders
- Find consensus
- Design wisely for future conditions

Protect/enhance quality of life for this and future generations

Questions?



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