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

Complex – Multiple stakeholders across space and time

Constrained - Dependent on specific and environmentally-sensitive locations

Global population & shipping projections

Elgohary, et al. 2014
Ports Within 50km of Tropical Storm Tracks 1960-2010

- Green dots represent ports within 50km (n=1197)
- Orange lines represent tropical storm tracks

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

Restoration - Current Status:

- HUD EA – Restoration
- 60-acre fill will be completed on March 27, 2011
- 24-acre dredging schedule to advertise March 2011 – ON HOLD
- 24-acre fill to be scheduled to begin in April 2011
- 25 feet elevation is scheduled to start Fall 2011

Permanent tenant facilities:
- Upgrades to roads, rail, and utilities on the Port
- Equipment upgrades
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

<table>
<thead>
<tr>
<th>Region</th>
<th>No. of ports</th>
<th>Area (km²)</th>
<th>Total Cost (Millions) to elevate 2 meters &amp; retrofit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lower bound</td>
</tr>
<tr>
<td>Hawaii</td>
<td>8</td>
<td>5.7</td>
<td>$958</td>
</tr>
<tr>
<td>Alaska</td>
<td>27</td>
<td>5.9</td>
<td>$992</td>
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<td>West Coast</td>
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<td>Gulf Coast</td>
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<tr>
<td>East Coast</td>
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<tr>
<td>Total</td>
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<td>380.1</td>
<td>$63,930</td>
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</tbody>
</table>
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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