

NATIONAL RESEARCH COUNCIL  
OF THE NATIONAL ACADEMIES

# REDUCING COASTAL RISK

ON THE EAST AND GULF COASTS



**National Research Council**

Committee on U.S. Army Corps of  
Engineers Water Resources Science,  
Engineering, and Planning:  
Coastal Risk Reduction

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# Statement of Task

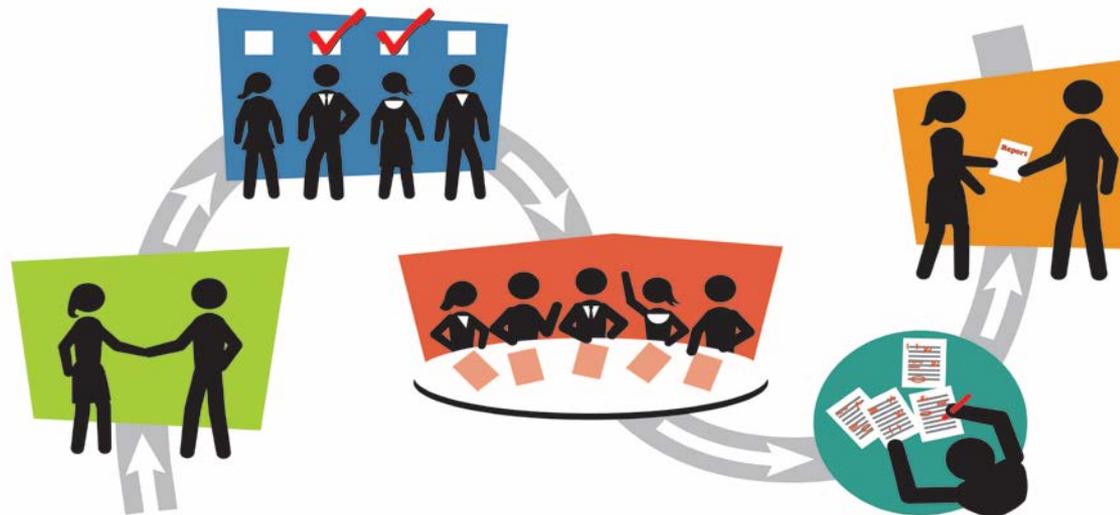
## **Focus on reducing flood risks from storms along the East and Gulf Coasts:**

1. To what extent have coastal risk-reduction strategies proven effective (life safety, economic return)?
2. What are the regional and national implications of expanded coastal risk reduction?
3. How might risk-related principles contribute to project design standards and increase community preparedness?
4. What general principles might be used to guide future U.S. investments in coastal risk reduction?

Sponsored by USACE, as the 3<sup>rd</sup> phase of a 5-year study to provide advice on a range of scientific, engineering, and water resources planning issues

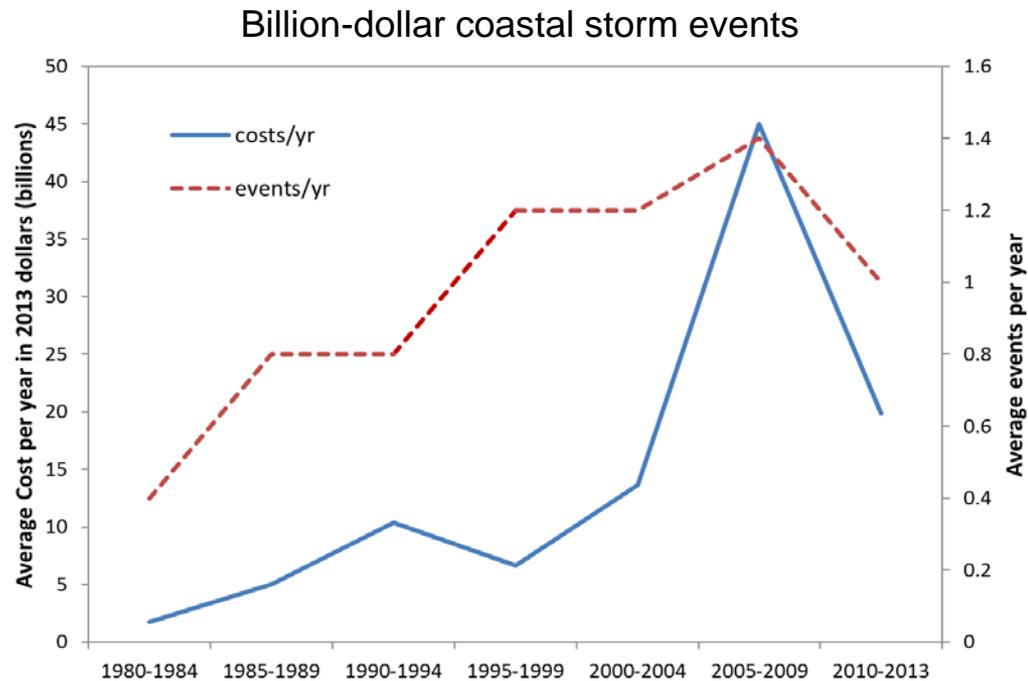
# Study Process

- 14 month study
- 5 in-person meetings (DC; Mobile, AL; Newark, NJ)
- Briefings from federal and state agencies, Congressional staff, community managers, private sector, academia
- Peer-reviewed consensus report



# Study Context

- Tropical storms and floods comprise ~50% of all natural disaster losses in the U.S.
- Extensive and growing loss from natural disasters
  - increase of people and property in harm's way
  - sea level rise is exacerbating problem
  - additional challenges due to climate change
- Increasing % of damages covered by federal aid



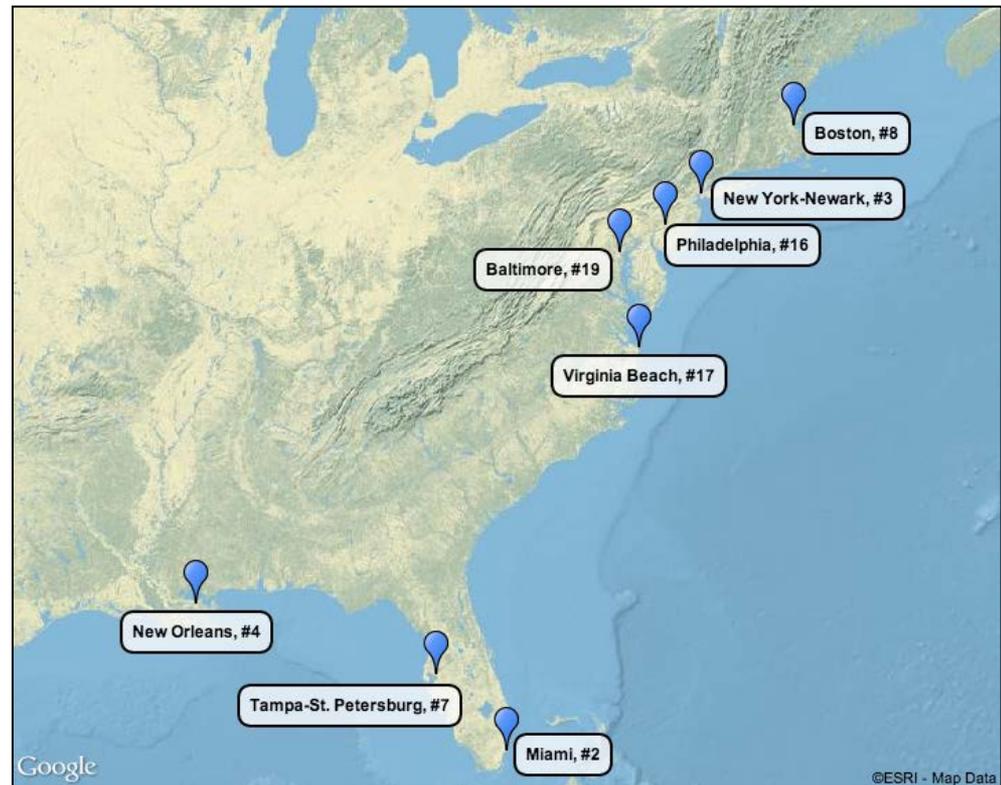
Data source: NOAA

# Study Context

- 8 U.S. cities in global top 20 of estimated average annual losses from coastal storm flooding
- Hurricanes Sandy and Katrina highlighted the nation's vulnerability



Image source: NASA



# Landscape for Coastal Risk Management

- **No central leadership or unified vision:** Responsibilities spread over federal, state, and local govt
  - FEMA, USACE, HUD, NOAA, USGS; state, local governments
  - Each driven by different objectives, authorities
  - No coordinating body with singular focus on coastal risk

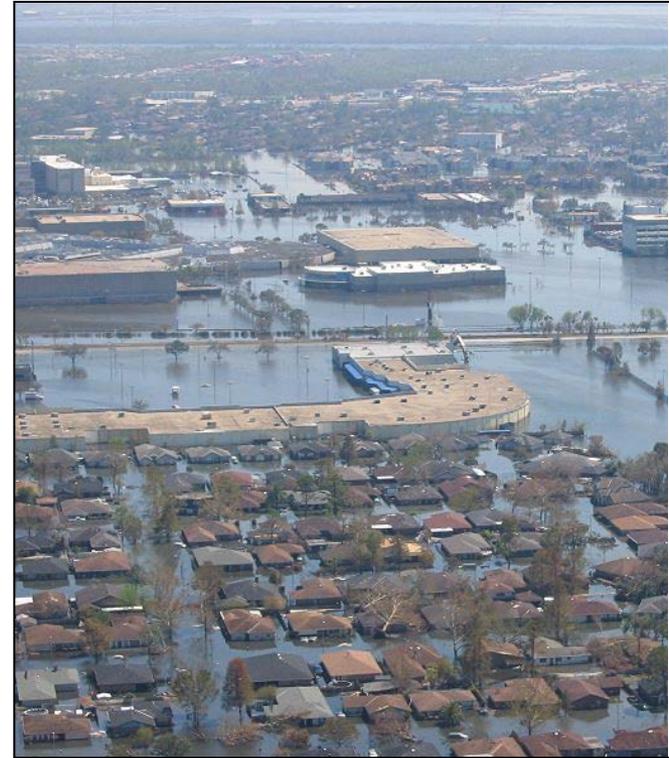
- **Lack of alignment of risk, reward, resources, and responsibility** leads to inefficiencies and **inappropriate incentives** that increase the nation's exposure to risk



Image source: NOAA

# Landscape for Coastal Risk Management

- The vast majority of funding for coastal risk-related issues is **provided only after a disaster occurs**
  - Bulk of funding for response and recovery
  - Small fraction for mitigation
  - Risk reduction efforts tend to be local, not regional
- **Few comprehensive regional evaluations of coastal risk have been performed**



*Image source: NOAA*

# Risk Reduction Strategies

RISK = probability of hazard x consequences



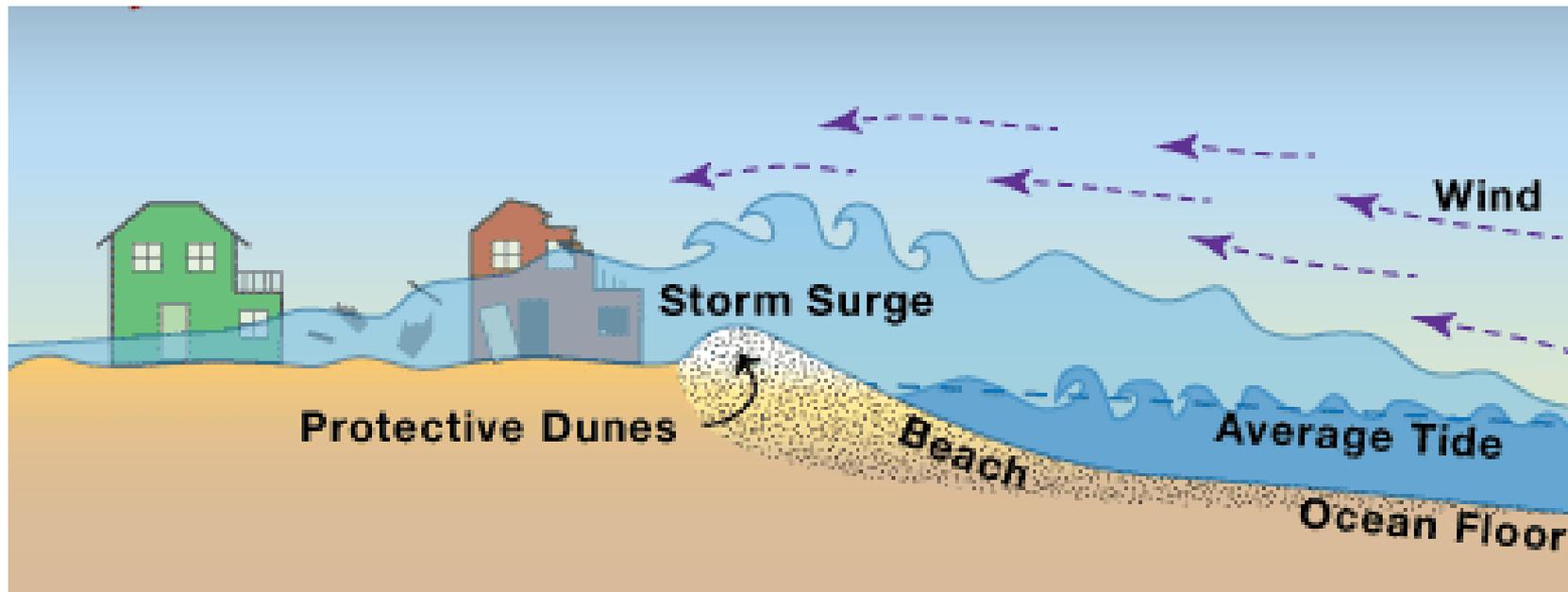
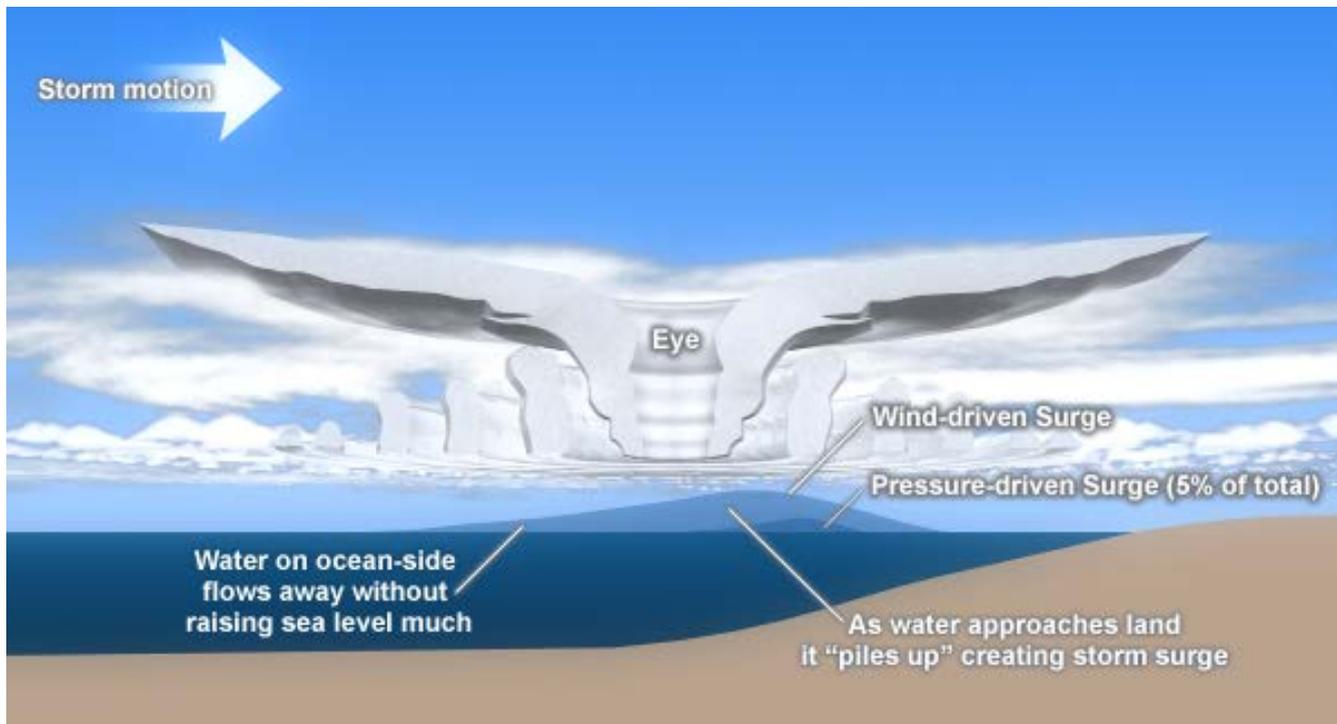
- Reduce the hazard (flooding, wave attack):
  - Hard structures (seawalls, surge barriers)
  - Nature-based strategies
    - Beach nourishment and dune building
    - Saltmarsh, seagrass, reefs, conservation and restoration



- Reduce the consequences of a storm
  - Building elevation and flood proofing
  - Non-structural (e.g., Land-use planning, preparedness, buyouts)
- **Optimal approaches will be site-specific, may involve multiple strategies**



Image sources: N. Aquino, FEMA, committee



# Strategies to Reduce the Hazard: Beach Nourishment and Dune Building

- Reduce damage from waves and surge
- Effectiveness linked to dune height and beach width
- Natural dunes/beaches tend to be too low or dynamic for infrastructure protection
- Back-bay flooding remains an issue



# Strategies to Reduce the Hazard: Beach Nourishment and Dune Building

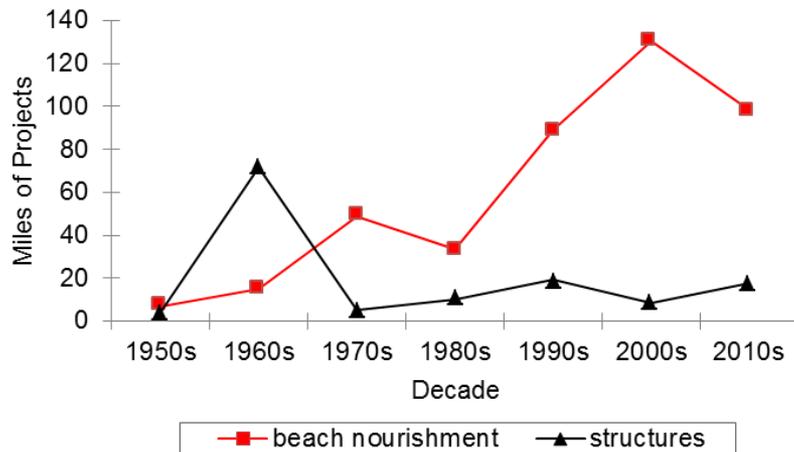


Image source: NOAA

- Reliable cost-benefit data lacking
- Short-term environmental impacts significant
  - Mortality of infauna
  - Impacts to borrow area
- Long-term impacts unknown
- **Can be designed to reduce short-term impacts and increase ecological value**

# Strategies to Reduce the Hazard: Other Nature-Based Approaches

Salt marsh, seagrass, mangroves, coral or oyster reefs, etc.

- **Provides substantial ecological benefits and some level of coastal risk reduction**
  - Stabilizes sediment
  - Much more effective to reduce wave energy than surge
  - May require large expanses of habitat
  - Some capacity to adapt to sea level rise
  - Conservation vs. restoration



*Image sources: NOAA*

# Strategies to Reduce the Hazard: Salt Marshes

- Among the most threatened ecosystems
- Key benefits: wave attenuation, shoreline stabilization
  - Factors: marsh width, vegetation height, stiffness, density
- Much more effective on wind waves than storm surge
- More effective on fast moving storms
  - During Hurricane Rita, surge increased over 25 mi salt marsh



# Strategies to Reduce the Hazard: Oyster and Coral Reefs

- Key benefits: May dampen wave energies, reduce shoreline erosion
  - Dependent on reef geometry
  - Even narrow reefs can be effective
- More effective on wind waves than storm surge
- Little quantitative information on effectiveness
  - Could compare to low-crested breakwater



*Image sources: USGS*

*Image sources: NOAA*

# Strategies to Reduce the Hazard: Mangroves

- Some modeling, limited field data
- Key benefit: Reduces wind wave energies
- Some reduction in storm surge
  - 3 to 32 inches/mi reported
  - Greatest effect at seaward edge
- May reduce extent of flooding

*Image sources: USGS*

# Strategies to Reduce the Hazard: Hard Structures

- **Hard structures are likely to become increasingly important in densely populated urban areas**
- **Adverse environmental impacts exist, designs can lessen these impacts**
- **Look for ways to couple hard structures and nature-based strategies**



Image sources: Wikipedia, USGCRP, NOAA

# Strategies to Reduce the Consequences of a Storm

- Includes hazard zoning, building elevation, land purchase, and setbacks
- **High documented benefit-cost ratios (5:1 to 8:1)**
- Given less attention by the federal government
- Mostly viewed as difficult to implement by states

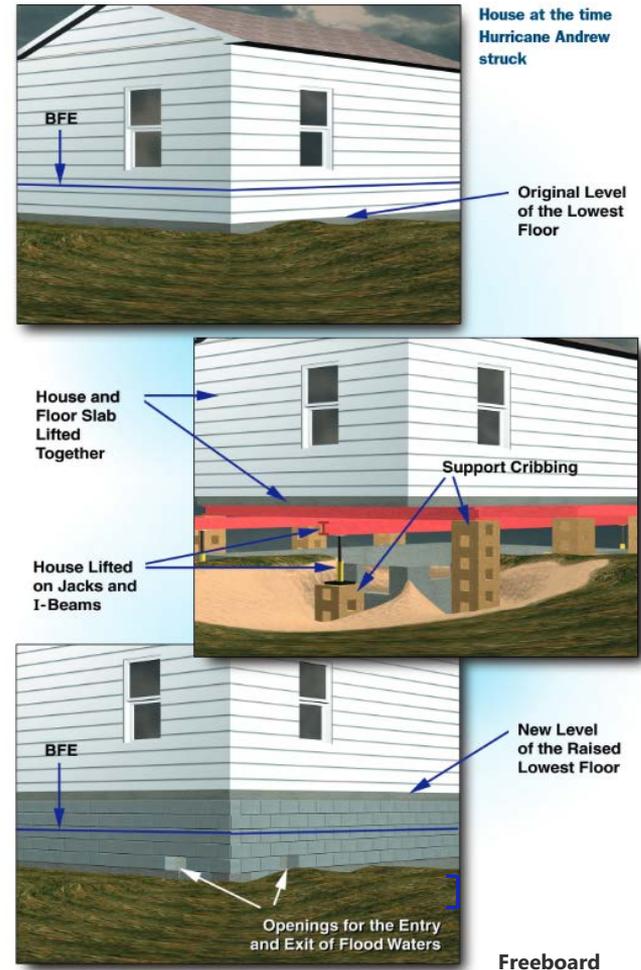
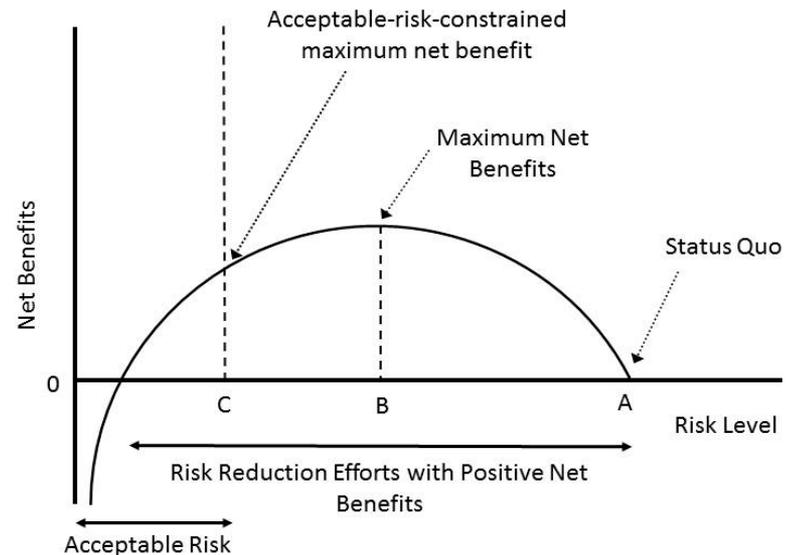


Image source: FEMA

# Guiding Investments in Risk Reduction

Two basic approaches for evaluating investments:

- 1) Risk-standard
- 2) Benefit-cost



- **Benefit-cost analysis constrained by acceptable risk and social and environmental dimensions** provides a reasonable framework
  - Constraints could include mass casualties, or individual risk
  - Costs/benefits that are difficult to measure can also be constraints
- There is **no basis to justify a default 1-percent annual chance (100-year) design level** for coastal risk.

# Guiding Investments in Risk Reduction

- Capacity to consider life-safety, environmental, social costs and benefits is limited in USACE current decision framework.
  - National Economic Development (NED) given priority
  - Social and environmental benefits rarely influence decision making
- ***Principles and Requirements for Federal Investments in Water Resources (CEQ, 2013)*** provide an effective framework to account for these other costs and benefits.
  - Improvement upon current planning framework

# Guiding Investments in Risk Reduction

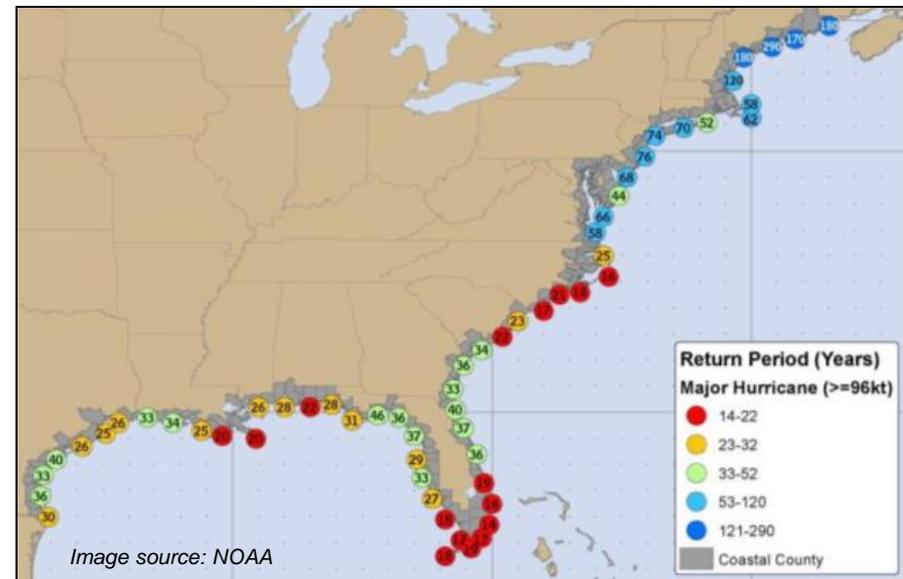
- **CEQ should expedite efforts to complete accompanying guidelines required to implement the *P&R*.**
- **Until then, there are steps USACE could take to improve consideration of multiple benefits and costs.**
  - More quantitative assessment of other costs and benefits, besides NED



Image source: Mass.gov

# Vision Toward Coastal Risk Reduction

- A **national vision for coastal risk management** is needed.
  - Long-term vision, recognition of multiple benefits
  - Federal leadership, extensive collaboration with states to establish objectives and metrics
- The federal government should work with states to develop a **national coastal risk assessment**
  - Assess economic, life-safety, social, and environmental costs and benefits under various hazard and risk management scenarios



# Vision Toward Coastal Risk Reduction

- **Stronger incentives are needed** to improve pre-disaster risk mitigation efforts at the local level
  - Better align risk, rewards, responsibilities
- The USACE should **seize opportunities within its existing authorities** to strengthen coastal risk reduction
  - Evaluate incentives (e.g., cost-share) for sound planning
  - Develop modeling tools
  - Reevaluate 50-yr planning horizon



*Image source: Wikipedia*

# Summary

- ***Coastal risk is increasing***
- Past investments have largely been ***reactive rather than proactive***
- ***Full array of risk reduction strategies*** should be considered
- ***Benefit-cost analysis*** (constrained by ***acceptable risk***, social/environmental considerations) is an appropriate decision framework for investments
- A ***national vision*** for coastal risk management is needed
- Federal government, states should develop a ***national coastal risk assessment***
- ***Stronger incentives*** needed to better align risks, rewards, and responsibilities

# More resources:

- Full report at [www.nap.edu](http://www.nap.edu)
- Additional resources:
  - 4 page “[Report in Brief](#)”
  - Key issues [slide show](#)
  - [Video](#)

