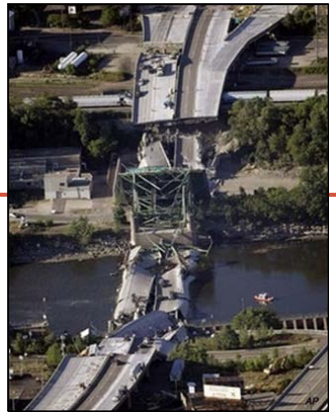
FREIGHT TRANSPORTATION ADAPTATION TO CLIMATE CHANGE: CURRENT NEEDS



TRB Annual Meeting

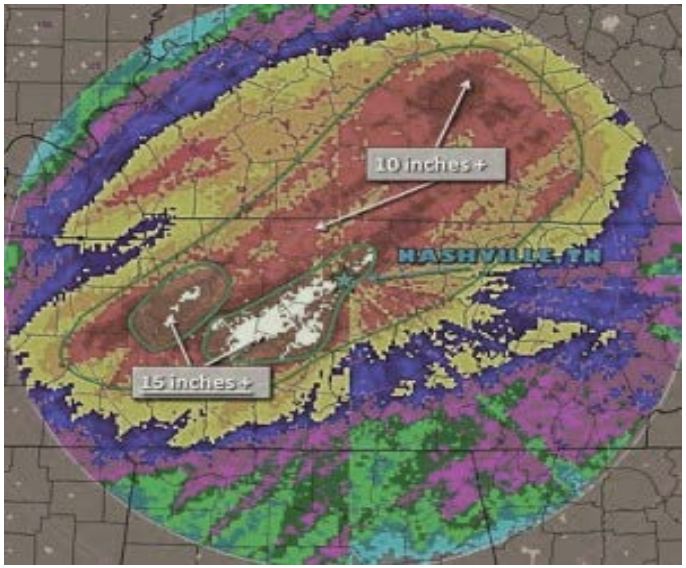
January 22-26, 2012

Janey Camp and Mark Abkowitz
Vanderbilt University

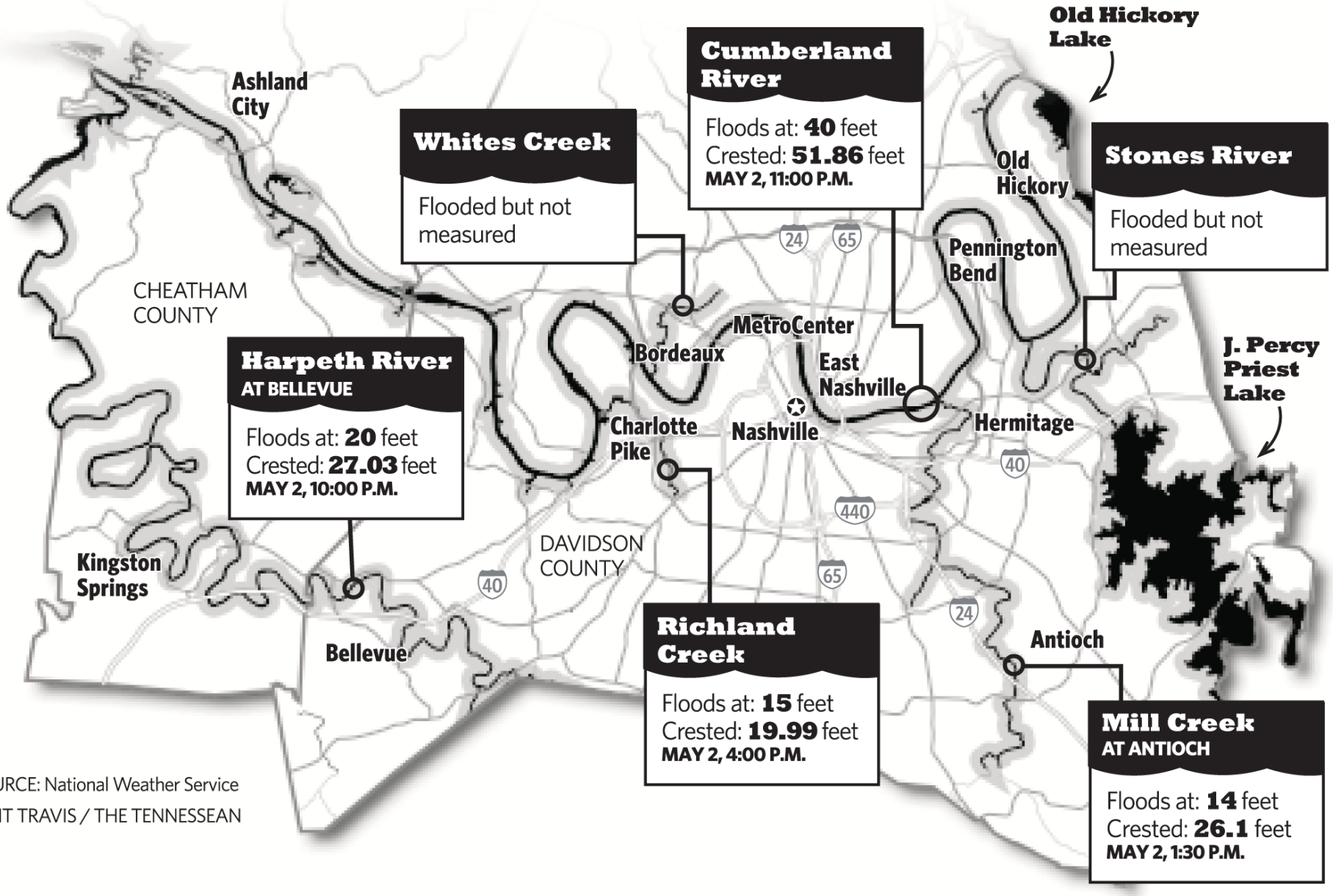
NASHVILLE FLOOD 2010: AN EXAMPLE OF POTENTIAL FOR CLIMATE CHANGE IMPACTS AND ADAPTATION

The Flood of 2010

- May 2-3, 2010
- Two to 4 inches of rain forecasted for the Nashville area
- Rainfall exceeded 17 inches, 13 inches of rain fell in 36 hours
  - The highest amount in more than 140 years of recorded history
  - More than doubled the 2-day rainfall record from 1979
- Mounting pressure behind critical dams resulted in release of headwaters which caused additional flooding



HOW RECORD RAINFALL AFFECTED THE CUMBERLAND



SOURCE: National Weather Service

KENT TRAVIS / THE TENNESSEAN

The Impacts

- An estimated $2 billion in damages to private property
- Resulted in 11 fatalities
- Thousands of claims filed with FEMA
  - 20,189 Individual Assistance applications
    (12,903 approved = ~$87 million)
  - 768 Public Assistance projects
    (cost = > $53 million)
- Historic buildings damaged
- Economic centers shut down
- Months of cleanup
  - Tons of debris and waste (some toxic) to manage
  - Public parks used for household waste staging areas

The Historic Ryman Auditorium

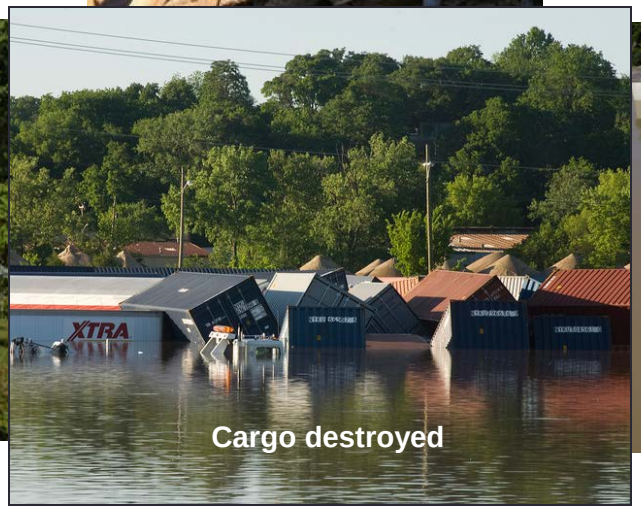
Transportation System Impacts

Road closures everywhere

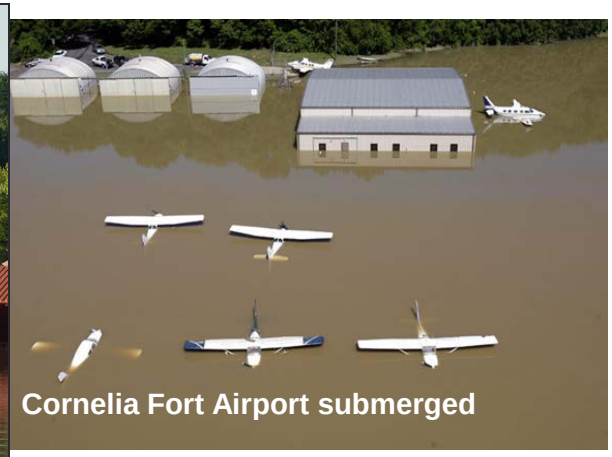
Debris from the floodwaters at Old Hickory Dam had collected on the back side of the dam by Friday.
SAMUEL M. SIMPKINS / THE TENNESSEAN

A portable School floating along Interstate-24

A house moved off of its foundation onto a street.



Cargo destroyed


Cornelia Fort Airport submerged

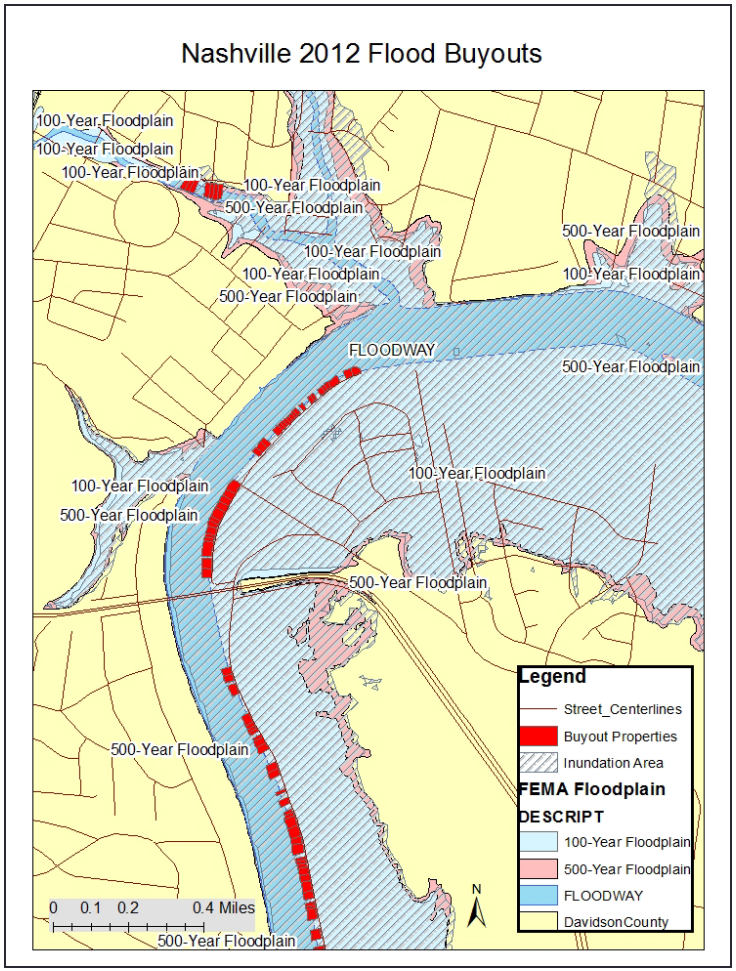
Freight Transportation System Impacts

- Roadways and rail lines severely damaged and destroyed
  - Alternate (possibly longer) routes had to be used
  - Increased fuel and transport costs (man hours) for same O-D
- Suppliers and customers looked for alternate modes of transport avoiding the Middle TN area
  - Lost business and loss of customers
- Fleet and cargo loss for some
- Waterway navigation slowed or halted for days until flood waters receded
- Repairs for some infrastructure took months – some still in need of repair

The Recovery

- Required “all hands on deck” approach
- Community pulled together to respond, restore, and recover
  - Over 330,000 volunteer hours (HandsOn Nashville and other groups organized volunteer activities)
  - Fundraisers to help rebuild
- Government agencies worked to restore public facilities
  - Metro Water Services worked around the clock to restore water service
  - Metro Public Works handled many roadway repairs
- Small Business Administration (SBA) provided loans to businesses and individuals for rebuilding
- FEMA Claims offices set up to help individuals file claims for assistance

Response and Adaptation Efforts



- Established Flood Recovery Office
  - http://www.nashvillerecovery.com/
  - Developing a Unified Flood Preparedness Program
- Hazard Mitigation Home Buyout Program, We Are Home, and other programs
  - Prevent future flooding losses for citizens
  - Create floodplain buffers for river system
- Building code and permit changes
  - New permit limits on reconstruction/new construction in flood plain
- Redrawing flood maps under current development conditions
- Converting Cornelia Fort Airport and other areas to parks and greenspace
- Embarking on major storm sewer rehabilitation project
- Metro Transit Authority relocating administration and maintenance facilities out of flood plain

THE CASE FOR FREIGHT TRANSPORTATION ADAPTATION

Current Infrastructure Challenges

- America's infrastructure is deteriorating as seen in ASCE Infrastructure Report Cards
  - New "Failure to Act" reports considering economic impacts of doing nothing (www.asce.org/failuretoact)
- What will happen with climate change?
  - Must consider both chronic and episodic changes
  - Uncertainty abounds as to the timing and magnitude of these effects
- New research interest in the potential impacts of climate change on infrastructure at Vanderbilt University
  - What infrastructure systems are most at risk?
  - How can we use risk analysis techniques to consider the potential impacts and prioritize adaptation strategies?

TABLE A ★ 2009 *Report Card for America's Infrastructure*

Aviation	D
Bridges	C
Dams	D
Drinking Water	D-
Energy	D+
Hazardous Waste	D
Inland Waterways	D-
Levees	D-
Public Parks and Recreation	C-
Rail	C-
Roads	D-
Schools	D
Solid Waste	C+
Transit	D
Wastewater	D-

AMERICA'S INFRASTRUCTURE G.P.A.	D
ESTIMATED 5 YEAR INVESTMENT NEED	$2.2 TRILLION

NOTES Each category was evaluated on the basis of capacity, condition, funding, future need, operation and maintenance, public safety and resilience

A = Exceptional
B = Good
C = Mediocre
D = Poor
F = Failing

Freight Transportation Infrastructure

- The U.S. Transportation Infrastructure System
  - 3.9 million miles of public roads
  - 600,000 bridges
  - 25,000 miles of commercially navigable waterways
  - 257 locks
  - 300+ ports and harbors
  - 120,000 miles of major railroads
  - 522 commercial service airports

- Transportation infrastructure is arguably an appropriate initial step at understanding climate change impacts and challenges
  - Provides the mobility lifeline for every community
  - Financial, environmental and social implications
  - A major contributor to greenhouse gas emissions
  - Most of the major transportation infrastructure in the country is nearing the end of its design life

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AMERICA'S INFRASTRUCTURE G.P.A. **D**

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= component of transportation infrastructure

Climate Change and Freight Transportation: When and How to Adapt?

- Summit on June 2-3, 2011 at Vanderbilt University, Nashville, TN
- Stakeholder representatives:
  - Modal carriers
  - Government officials at state and federal levels
  - Insurance industry
  - Climate change scientists and climate change impact experts
  - Researchers with a focus in transportation and/or climate science
- Combined plenary and breakout sessions to address key issues

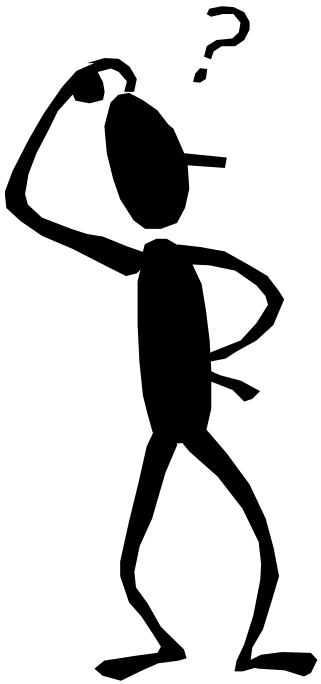
Summit Sponsors

Vanderbilt Center for Transportation Research (VECTOR)

Vanderbilt Institute for Energy and Environment (VIEE)

University of Memphis Center for Intermodal Freight Transportation Studies (CIFTS)

Fundamental Summit Questions



- At what climate change thresholds will freight transportation adaptation be necessary?
- What types of adaptation strategies would be most responsive to societal needs under these circumstances?
- What must be done **now** to plan and prepare for the expected changes?
- What information and research gaps need to be filled over the next five years to move this process forward?

Potential Adaptation Strategies

- Maintenance and operations
  - Have stock of sand bags, portable pumps
  - Maintain temporary flood gates
  - Clean drainage systems
  - Reposition rolling stock
- Capital investments
  - Install new flood barriers
  - Elevate or move at-risk infrastructure above projected flood levels
  - Design and invest in new assets with “quick restoration” capability
- Regulatory actions
  - Modify existing building codes and design standards

House raised to adapt to sea level rise and coastal flooding in Virginia.

Challenges to Adaptation Planning

- Adaptation planning constraints
  (in order of importance)
  - Current needs take precedence over future possibilities
  - Inability to relate the science to impacts/bottom lines
  - Limited funding (or funding is focused on mitigation not adaptation)
  - Lack of trust in the science/scientists
  - Too much uncertainty

- Areas that have begun adaptation planning or strategy implementation have common characteristics
  - Strong proactive leadership
  - Communities recently experienced natural disaster that prompted public awareness

These were critical factors in Nashville's adaptation decisions

Recommended Actions for Next Five Years

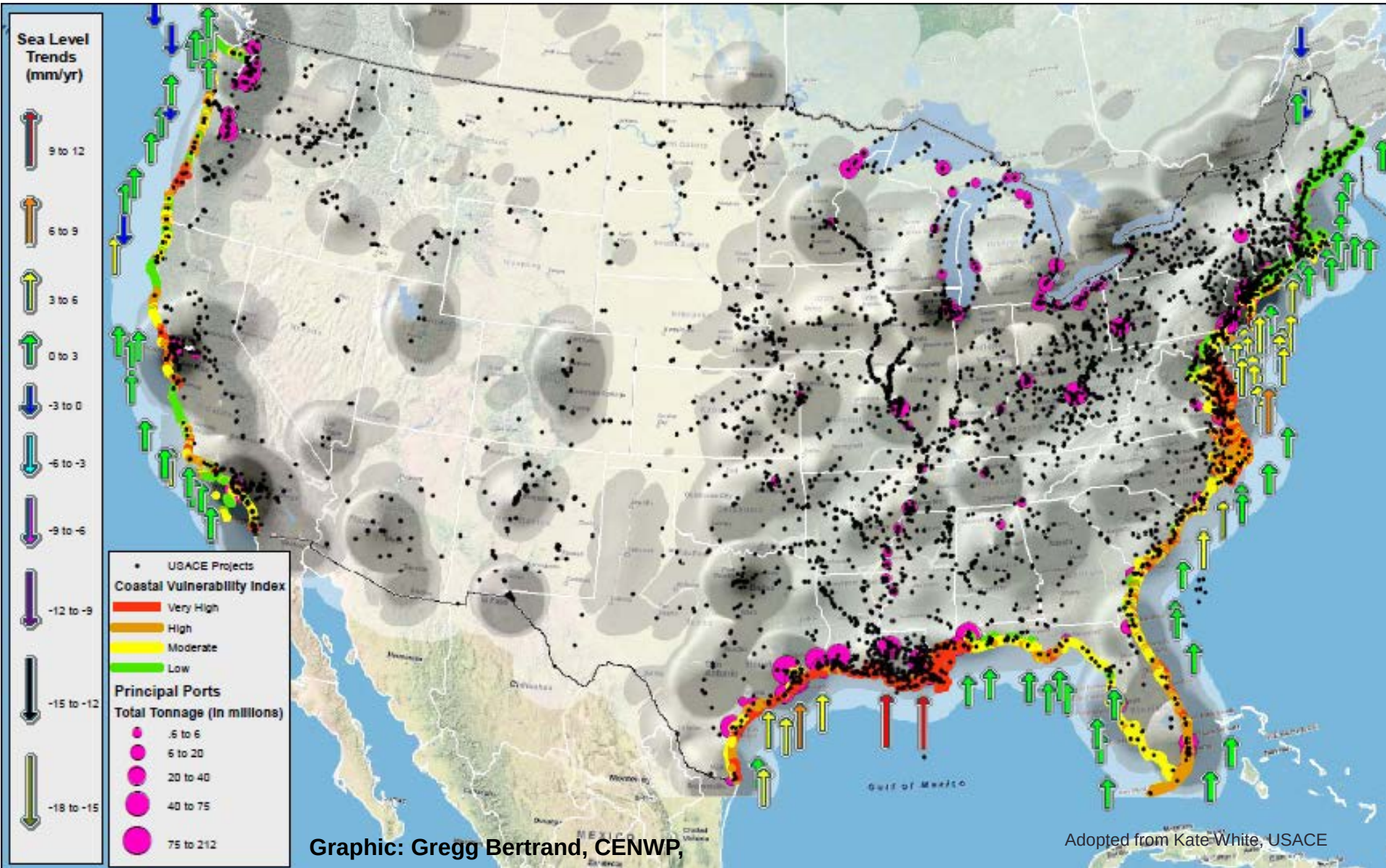
- Improve communication among stakeholders
  - Expand discussions beyond persons at the summit
  - Recognition of the interconnectedness of infrastructure sectors
  - Involve public and private stakeholders at the local, regional and national level
- Develop better tools/models for performing risk assessments
  - More robust local and regional climate impact modeling
  - A standardized approach to create a means for establishing priorities and make wise use of available resources
  - Assess the cost of impacts to key infrastructure components
- Define climate change problems in understandable terms to assist decision makers
- Prioritize critical (non-redundant) infrastructure as first step to risk assessment

Infrastructure Adaptation – Risk Assessment Process

- Define climate change variables and projections (possibly using a portfolio approach bounded by extremes)
- Develop infrastructure inventory
- Analyze risk to infrastructure
  - Vulnerability
  - Resilience potential
- Prioritize infrastructure according to risk
- Develop adaptation strategies for infrastructure at risk

Changing Sea Level: ID Critical Infrastructure

Observed sea-level trends (NOAA), Coastal Vulnerability Index (USGS), USACE Projects, and Port Tonnage on map of Population Density (Census)



Graphic: Gregg Bertrand, CENWP,

Adopted from Kate White, USACE

Summary

- Events such as the Nashville 2010 Flood can be used as examples of “what if” scenarios for potential impacts
- Taking action now can help prevent future catastrophes
- Limitations to adaptation planning include:
  - Uncertainty in the timing and magnitude of climate change
  - Insufficient knowledge of potential impacts to critical systems
  - Competition with mitigation efforts and current financial demands
  - Lack of leadership
- Adaptation management needs:
  - An integrated approach involving infrastructure risk management and climate science
  - Better organization capacity and stakeholder communication
  - More robust local and regional climate impact modeling
  - A standardized method for climate change risk assessment
  - Creative solutions for adaptation strategies in today’s tough economic climate

Thank You!

Janey Camp, PhD, PE (janey.camp@vanderbilt.edu)

Mark Abkowitz, PhD (mark.abkowitz@vanderbilt.edu)

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