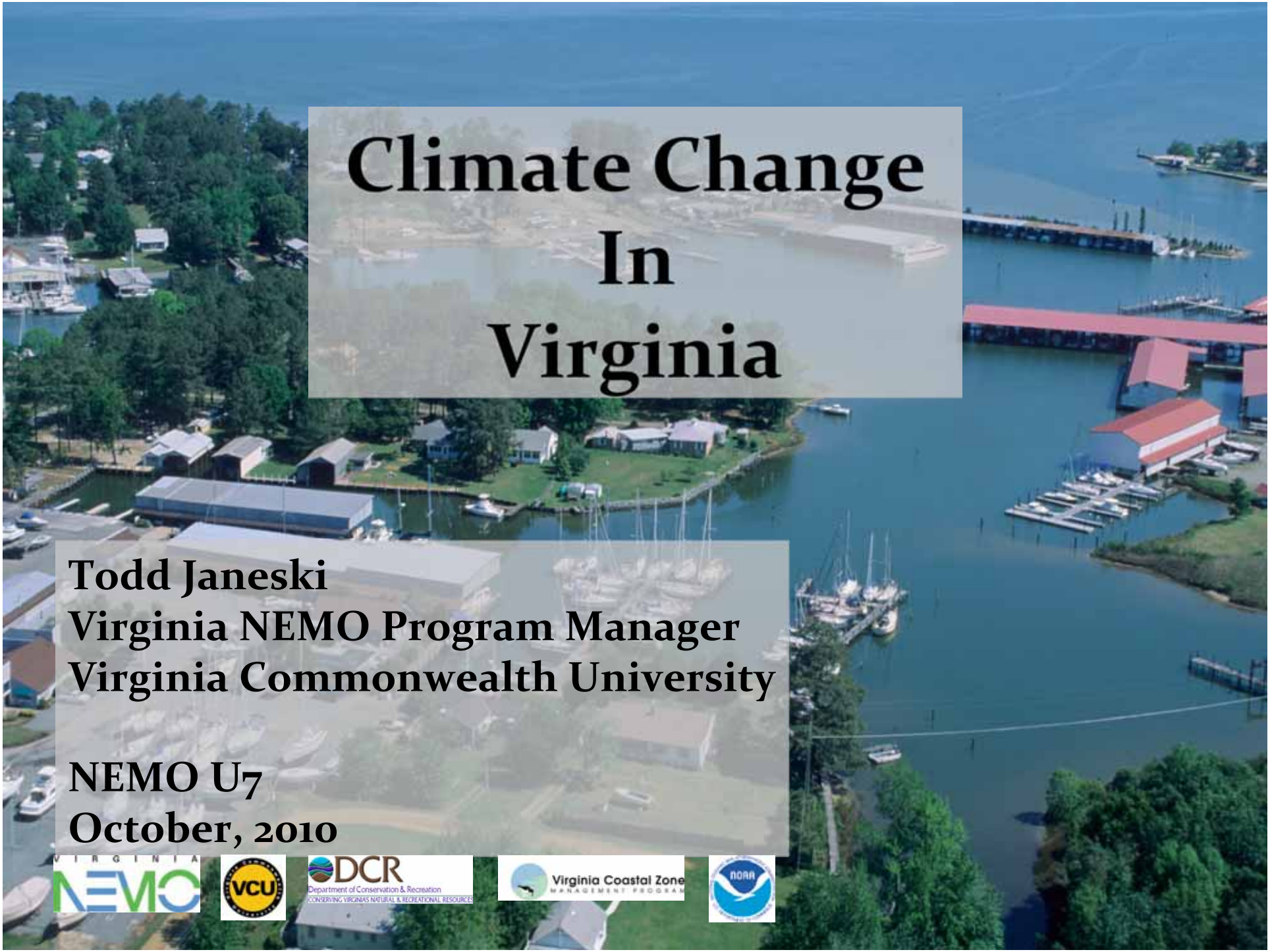

Climate Change
In
Virginia
Todd Janeski
Virginia NEMO Program Manager
Virginia Commonwealth University
NEMO U7
October, 2010
VIRGINIA
NEMO
VCU
DCR
Department of Conservation & Recreation
CONSERVING VIRGINIA'S NATURAL & RECREATIONAL RESOURCES
Virginia Coastal Zone
MANAGEMENT PROGRAM
NOAA

VNEMO Climate Change Projects

- Shrinking ice caps expose hundreds of secret arctic lairs
- Twice the number are being revealed than in the previous **three decades**
- August 2009 found 44 mad scientist laboratories, three highly classified military compounds and seven reanimated and very confused cavemen

Source: *the Onion*, 2009

VNEMO Climate Change Projects

Sea-level Rise and Coastal Change: The Future of Coasts and Low-lying Regions Under Climate Change

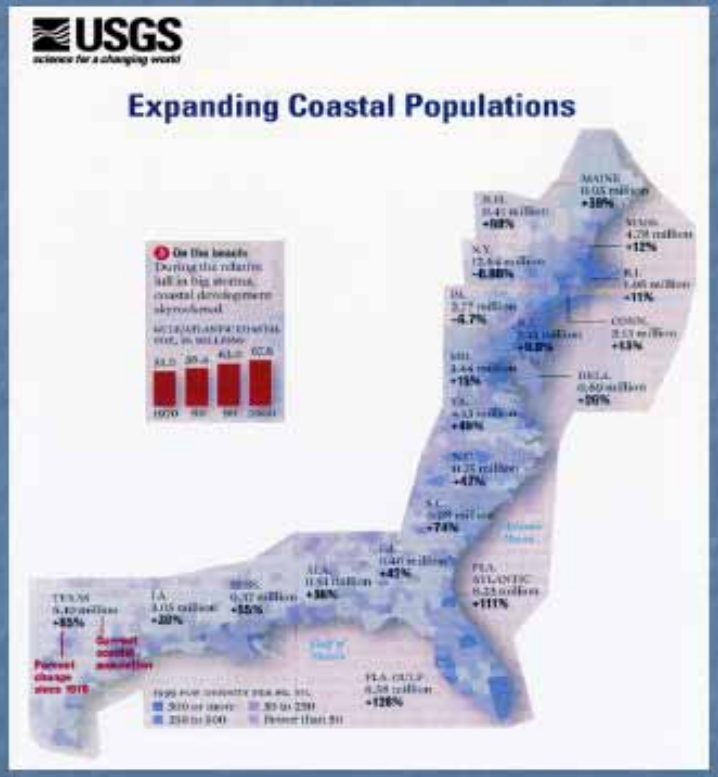
Chesapeake Watershed Forum 2009
Plan for Climate Change in the Watershed
8 October 2009

S. Jeffress Williams
Senior Coastal-Marine Geologist
U.S. Geological Survey
Woods Hole Science Center
Woods Hole, MA

VNEMO Climate Change Projects

USGS

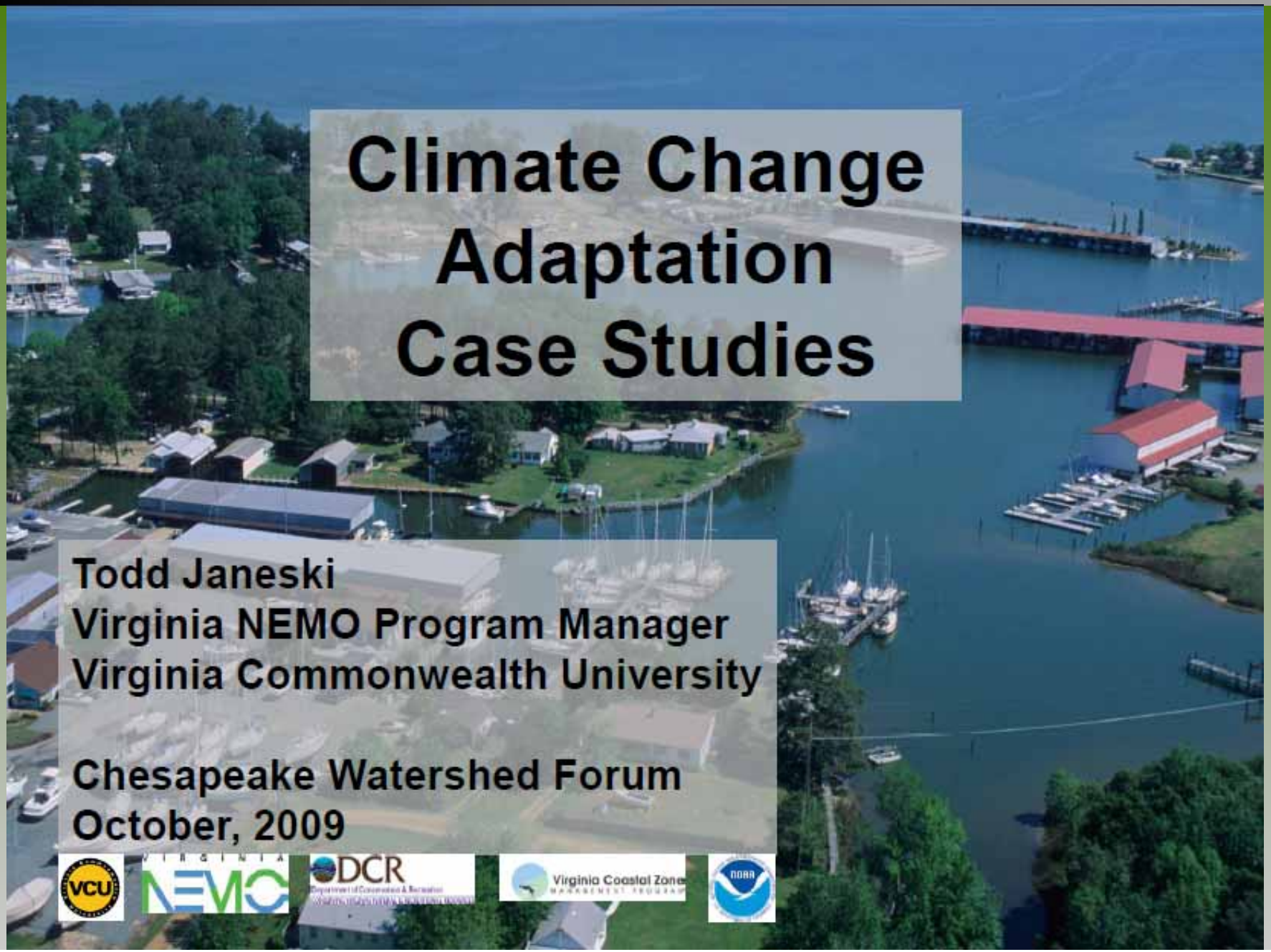
America's Coastal Crisis – Coastal population and development are increasingly vulnerable to coastal hazards



- Erosion affects all 30 coastal states
- 60-80% of coast is eroding
- erosion caused by complex processes

- Coastal populations have doubled
- ~50% live along coasts
- Infrastructure about $9 trillion

VNEMO Climate Change Projects



VNEMO Climate Change Projects

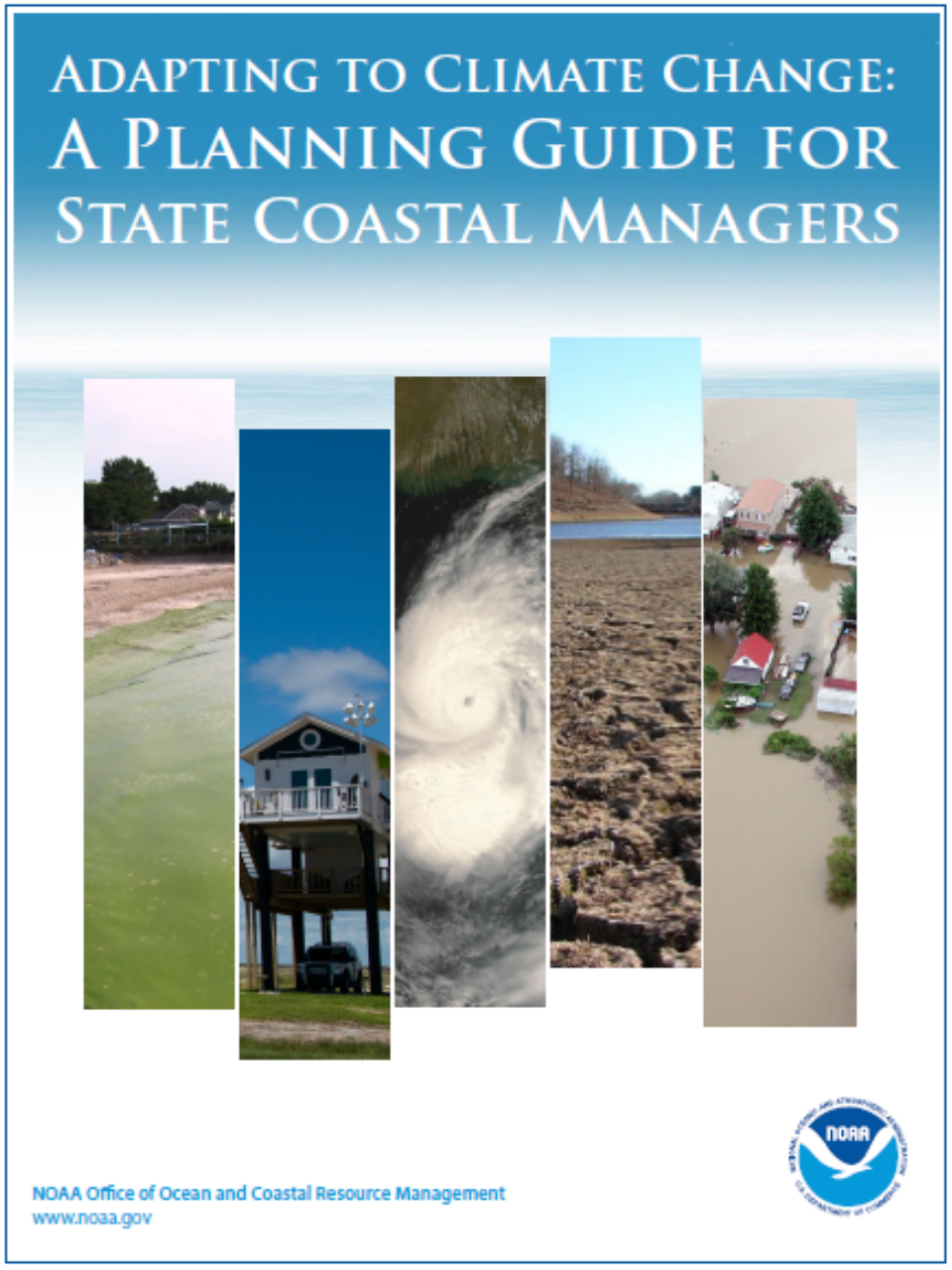
VNEMO Climate Change Projects

Maryland Case Studies
Climate Change Adaptation Planning

Photo: Jane Thomas, IAN Image Library

Gwen Shaughnessy
Maryland Department of Natural Resources
Chesapeake & Coastal Program

VNEMO Climate Change Projects



Roadmap for Adapting to Coastal Risks

Special Condensed Offering for
Chesapeake Watershed Forum
October 9, 2009

NOAA Coastal Services Center
LINKING PEOPLE, INFORMATION, AND TECHNOLOGY

VNEMO Climate Change Projects

MARYLAND
Smart, Green & Growing

BUILDING *COAST-SMART* COMMUNITIES

An Interactive Summit

MARYLAND DEPARTMENT OF NATURAL RESOURCES

MIT - USGS Science Impact Collaborative

What is adaptation?

Definition – ***Adaptation*** is any action or strategy that reduces vulnerability to the impacts of climate change. The main goal of adaptation strategies is to improve local community ***resilience***, or the ability of a community to bounce back quickly from climate impacts

What is adaptation

NOAA Adapting to Climate Change: A Planning Guide for State Coastal Managers

> The *Intergovernmental Panel on Climate Change* (IPCC): adaptation is the "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2007).

Successful adaptation needs

- Strong political leadership, i.e., a “champion”
- Institutional organization and coordination
- Active stakeholder involvement, including cross-cutting advisory groups
- Education and outreach program, citizen engagement
- Appropriate, scale relevant climate change information
- Decision making tools, including consideration of barriers and challenges to adaptation approaches
- Funding for implementation of adaptation planning and actions
- Research into future impacts
- A continuous adaptive management approach

Implement Adaptation Policies and Techniques

Dealing with Climate Change

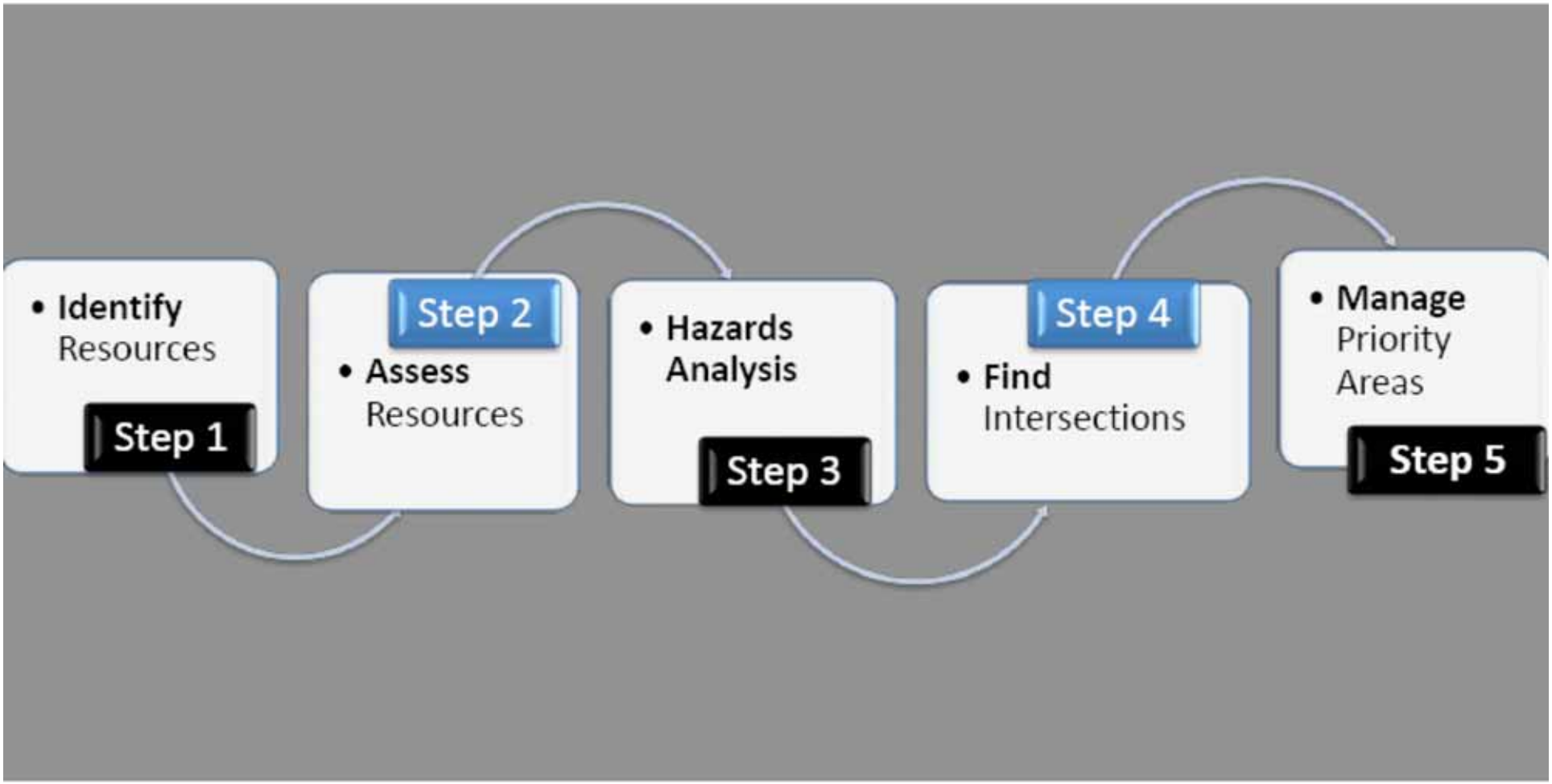
Make your community more **climate resilient**

- ***Protect resources/systems*** from climate change impacts
- ***Accommodate or adapt*** to expected changes
- ***Abandon or retreat*** when accommodation and protection are not feasible

Accommodate or adapt to expected changes

- Link growth planning to adaptation planning
- Elevate vulnerable structures
- Make revisions to building codes
- Add new technology or features to older public utilities
- Acquire migration areas

Vulnerability & Risk Assessment



What impacts necessitate adaptation?

What impacts necessitate adaptation?

What impacts necessitate adaptation?

What impacts necessitate adaptation?

What impacts necessitate adaptation?

What impacts necessitate adaptation?

What natural and built infrastructure is at risk?

What natural and built infrastructure is at risk?

What natural and built infrastructure is at risk?

What natural and built infrastructure is at risk?

What natural and built infrastructure is at risk?

What natural and built infrastructure is at risk?

What natural and built infrastructure is at risk?

What natural and built infrastructure is at risk?

What natural and built infrastructure is at risk?

Case Study: Keene, NH

Threats: Flooding, water supply

Responses:
•Incorporated climate change considerations into comprehensive plan

Case Study: Los Angeles, CA

Threats: Sea Level Rise, hurricanes, storm surge, saltwater intrusion, flooding, temp extremes, drought, stormwater, precipitation extremes

Responses:

- Established new position: Climate Adaptation Division Director within Environmental Affairs Department
- Million Trees LA Program
- Procurement planning checklist to incorporate climate/ sustainability considerations

Case Study: Seattle, WA

Threats: Sea Level Rise, storm surges, changing water regimes

Response:

- Water reclamation and distribution technology added to WWTP
- Increased property taxes to fund flood control
- New major bridge with longer spans to avoid flooding impacts
- Replacement of 57 small span bridges to accommodate floodwaters and debris
- Pooled resources and partnership with the University
- Enhanced and expanded GIS capabilities to assess vulnerabilities
- Water reclamation and distribution system being built

Case Study: Boston, MA

Threats: Sea Level Rise, hurricanes, storm surge, saltwater intrusion, flooding, temperature/ precipitation extremes, drought, stormwater

Responses:

•Integrated adaptation plan that will both outline actions to reduce risks from likely climate impacts and coordinate

•Planning for all new construction and major renovations of municipal facilities will evaluate the risks posed by climate change through 2050 and “describe potential steps to avoid, minimize or mitigate those risks.”

•Climate change impacts are considered for large private projects through reviews conducted by the Boston Redevelopment Authority

•Major private development projects subject to review by BDC for potential CC impacts

•Mayor’s initiatives focusing on adaptation

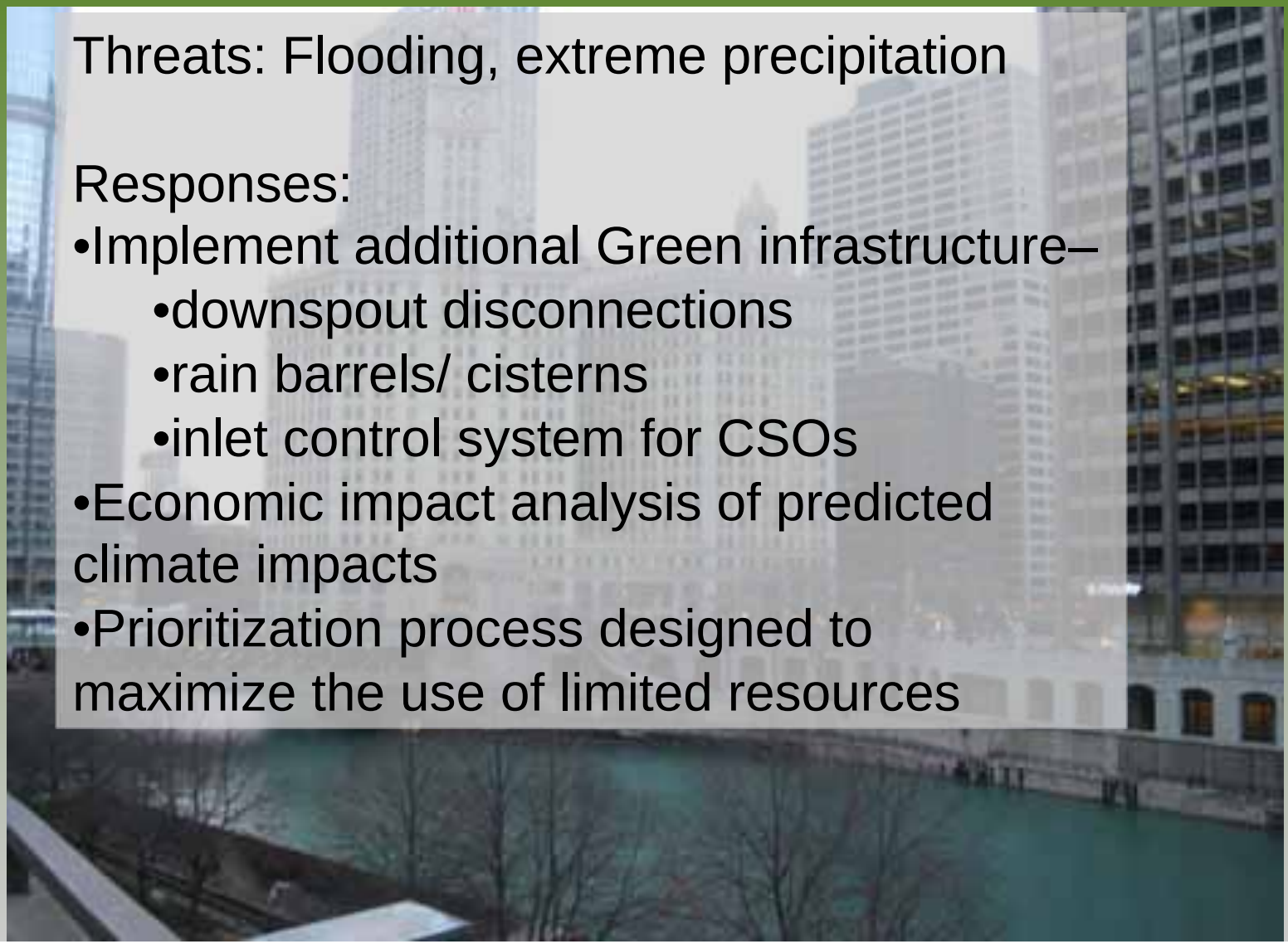
Case Study: Milwaukee, WI

Threats: Flooding, extreme precipitation

Responses:

- Watershed management and green infrastructure to improve water quality and flood storage--
  - Tunnel for stormwater storage
  - Analysis of future stormwater
  - Infrastructure investments
  - Green infrastructure

Case Study: Chicago, Il

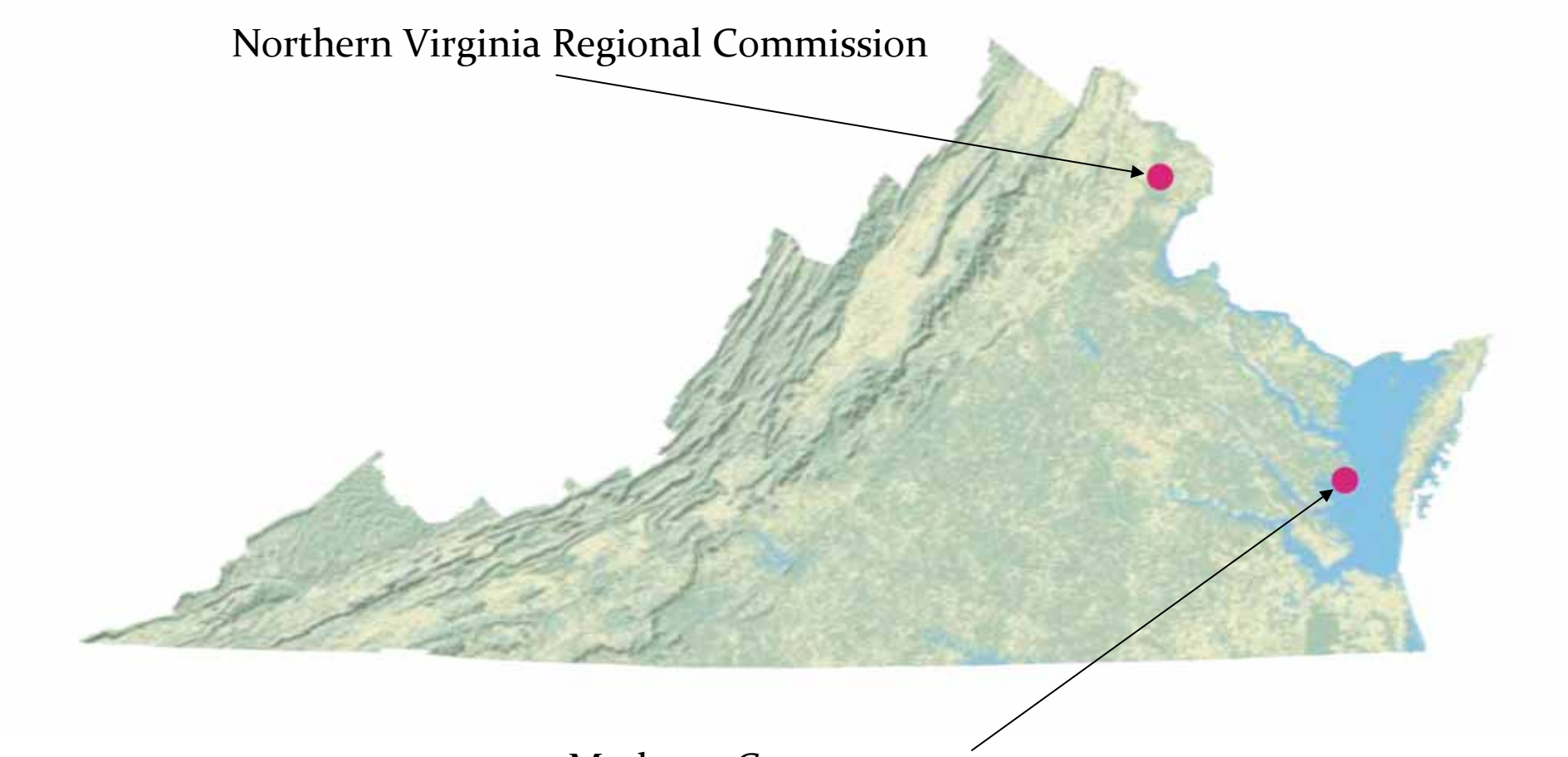


Threats: Flooding, extreme precipitation

Responses:

- Implement additional Green infrastructure–
  - downspout disconnections
  - rain barrels/ cisterns
  - inlet control system for CSOs
- Economic impact analysis of predicted climate impacts
- Prioritization process designed to maximize the use of limited resources

VNEMO Climate Change Projects



VNEMO Northern Virginia Communities

Sustainable Shorelines and Community Management

Partner: Northern Virginia Regional Commission

- Gather Data
- Assess Vulnerability
  - Storm Surge
  - Flooding
- Develop Strategies
  - Protect
  - Accommodate
  - Retreat
- Improve Resilience

VNEMO Northern Virginia Communities

Phase I
Oct 08 – Sep 09

- Workgroup Establishment;
- Broad Vulnerability Analysis;
- Policy Review

Phase II
Oct 09 – Sep 10

- Assessment Refinement;
  - Economic Analysis
- Strategy Development
  - Best Practices
  - Community Awareness

Phase III
Oct 10 – Sep 11+

- Strategy Refinement;
- Implementation Framework
- Outreach, as appropriate

VNEMO Northern Virginia Communities

Stakeholder Workgroup

- Identify key targeted planning areas
- Provide data and information
- Shape the strategy and recommendations

Arlington County

City of Alexandria

Fairfax County

Prince William County

Town of Quantico

Town of Occoquan

George Mason University

Virginia Tech

NPS – Center for Urban Ecology

NPS – GW Memorial Parkway

Fort Belvoir

Quantico Marine Corps Base

VA DCR – Mason Neck

USFWS – Mason Neck Refuge

VA Dept of Transportation

nvrc Northern Virginia Regional Commission

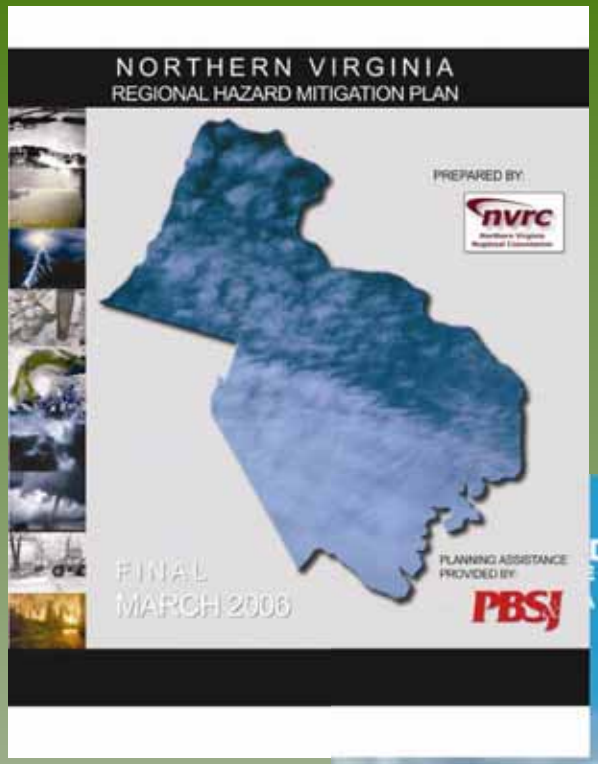
End Goals

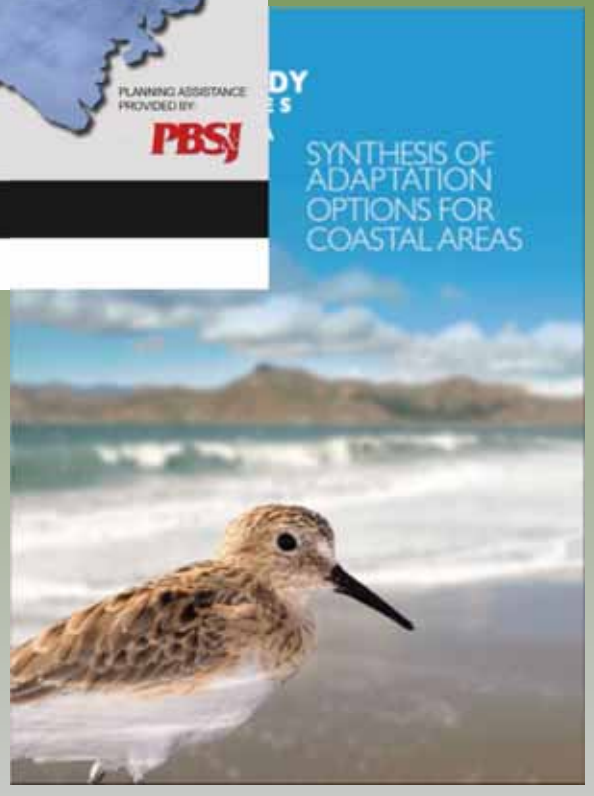
- Maps showing areas at risk of inundation from SLR and Storm Surge in the region.
- Quantification of specific elements vulnerable for both the built and natural environments.
  - Building, roadways, parks, tidal wetlands, critical infrastructure, wells, septic fields, etc…
  - Economic value/Ecosystem services
- Strategies to improve resilience of communities & structures located in areas at risk.

VNEMO Northern Virginia Communities

Current Efforts

- Regional Hazard Mitigation Plan update
- VIMS Shoreline Situation Report update
- Economic Evaluation
- Survey of Waterfront Property Owners
- Analysis of adaptation options and applicability to NoVA





nvrc
Northern Virginia Regional Commission

VNEMO Northern Virginia Communities

Historic Storm Surge

Absolute Water Level (recorded at NOAA Tides & Current Gages)			Corrected for relative sea-level rise to 2003	Corrected for relative sea-level rise at 2100, using average accelerated rate
Event	Date	Elevation (feet)	Elevation (feet)	Elevation (feet)
Hurricane Isabel	Sept. 2003	7.19	7.19	10.99
Hurricane	Aug. 1933	6.99	7.71	11.52

* Isabel was downgraded to a tropical storm as it moved through the Chesapeake Bay region – however the storm surge we experienced was that of a Category 2 Hurricane.

Adapted from: *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region*. US Climate Change Science Program, January 2009.

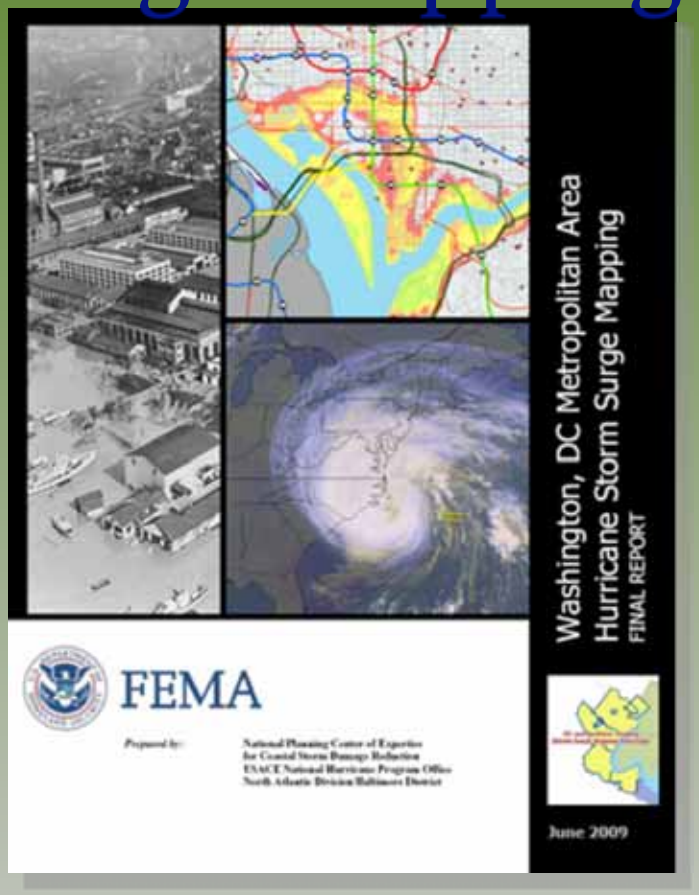
VNEMO Climate Change Projects

Northern Virginia Regional Commission

Washington DC Metropolitan Area Hurricane Storm Surge Mapping

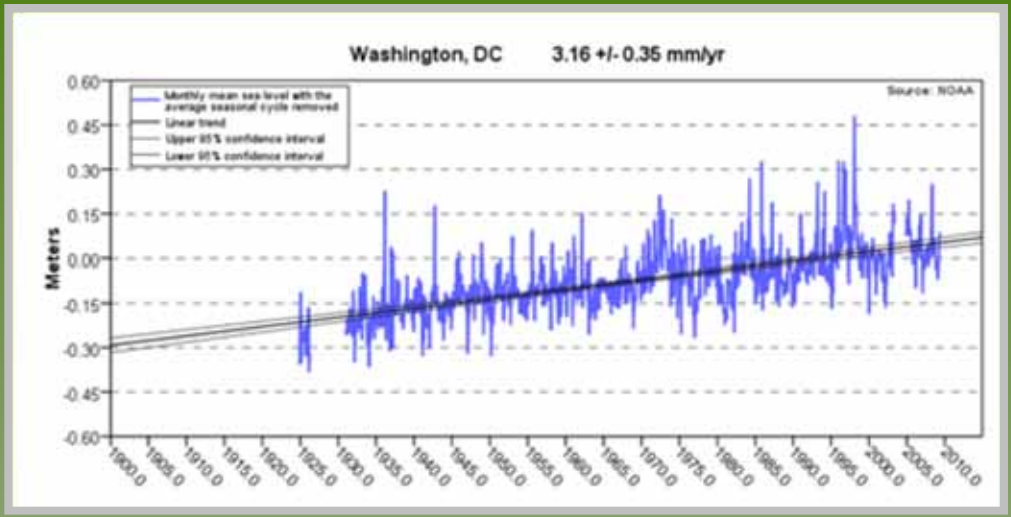
- Hazards Analysis
  - Probable worst-case (peak) storm surge from category 1 – 4 hurricanes*
  - Used NOAA's Sea, Lakes, and Overland Surges from Hurricanes (SLOSH) Model
  - Worst-Case combinations of direction, forward speed, landfall point, and astronomical tide

*Due to their extremely low chance of occurrence, category 5 hurricanes were not analyzed.



VNEMO Northern Virginia Communities

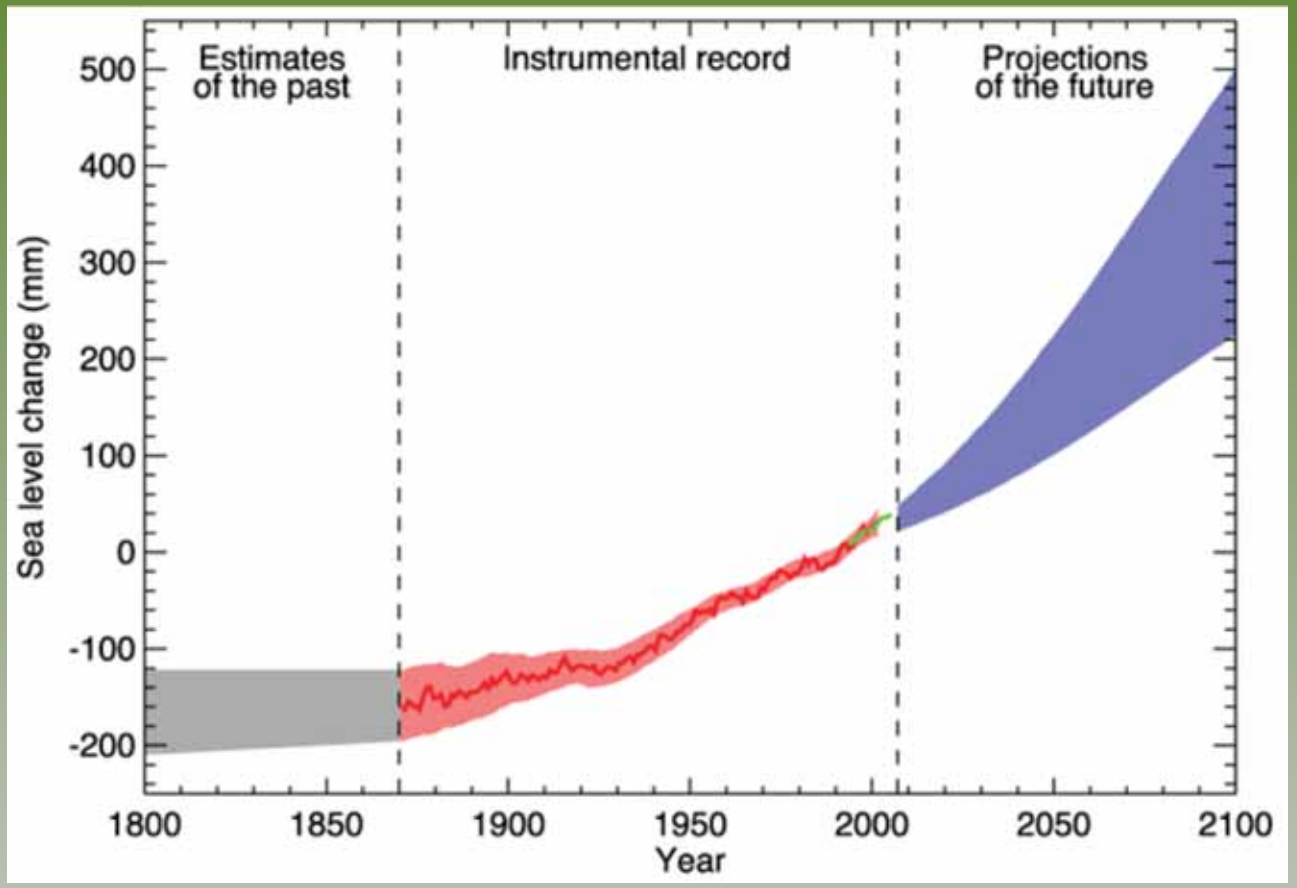
SLR Scenarios



Scenario	Definition	Relative Sea Level Rise Rate
Steady State	Observed historic trend at Washington, D.C. gage. *(NOAA Tides and Currents, Station 8594900)*	3.2 mm/year (1 foot by 2100)
Average Accelerated	Average projected sea level rise rate for the Chesapeake Bay region. *(IPCC, 2007; STAC, 2008; and GCCC, 2008)*	11.6 mm/year (1.9 feet by 2050; 3.8 feet by 2100)
Worst Case	Highest projected rate for the mid-Atlantic and Chesapeake Bay regions. *(STAC, 2008; and GCCC, 2008)*	16 mm/year (2.6 feet by 2050; 5.2 feet by 2100)

VNEMO Northern Virginia Communities

Future Global Sea Level Rise Projections to 2100



100 mm = ~ 4 inches
Medium growth emissions scenario
Source: IPCC 2007 - http://www.epa.gov/climatechange/science/futureslc_fig1.html

Uncertainties lie with the magnitude and speed of changes in the future.

If the West Antarctic Ice Sheet and the Greenland Ice Sheet were to melt, there would be a global increase in sea level rise of at least 13 meters.

(IPCC 2007, NRC 2002).

VNEMO Northern Virginia Communities

Areas at Risk: SLR

- Sea Level Rise = Hot Spots (i.e. the lowest lying areas in the region

Hot Spots for Sea Level Rise	
Arlington	• National Airport • Four Mile Run
Alexandria	• Four Mile Run • Dangerfield Island • Old Town • Jones Point
Fairfax County	• Huntington • Belle Haven/New Alexandria • Dyke Marsh • Tidal Embayments • Hallowing Point
Prince William County	• Occoquan NWR • Tidal Embayments • Town of Quantico • Occoquan River

VNEMO Northern Virginia Communities

City of Alexandria

MHW <= 1ft

Old Town - City of Alexandria

nvrc
Northern Virginia Regional Commission

VNEMO Northern Virginia Communities

City of Alexandria

MHHW <= 2ft

Old Town - City of Alexandria

nvrc
Northern Virginia Regional Commission

VNEMO Northern Virginia Communities

City of Alexandria MHHW+ 1FT SLR

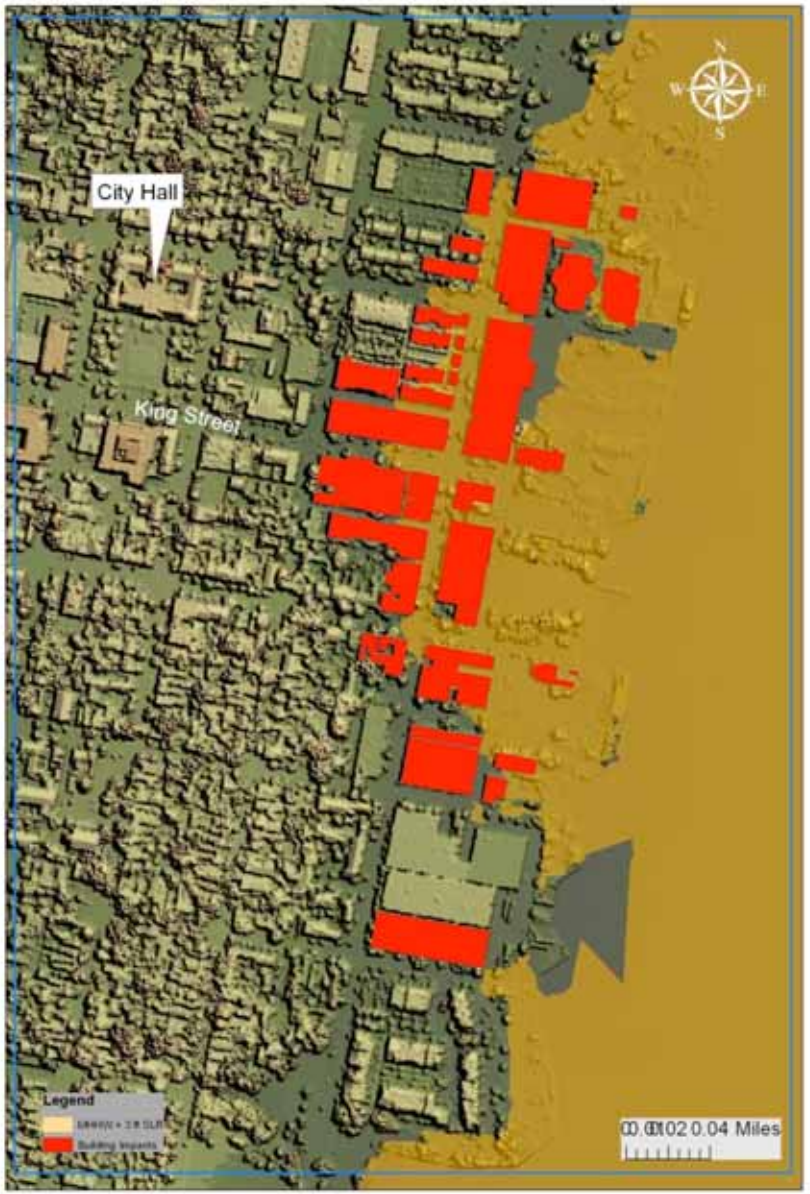
Old Town - City of Alexandria

nvrc
Northern Virginia Regional Commission

VNEMO Northern Virginia Communities

City of Alexandria MHHW+ 3FT SLR

Old Town - City of Alexandria



nvrc
Northern Virginia Regional Commission

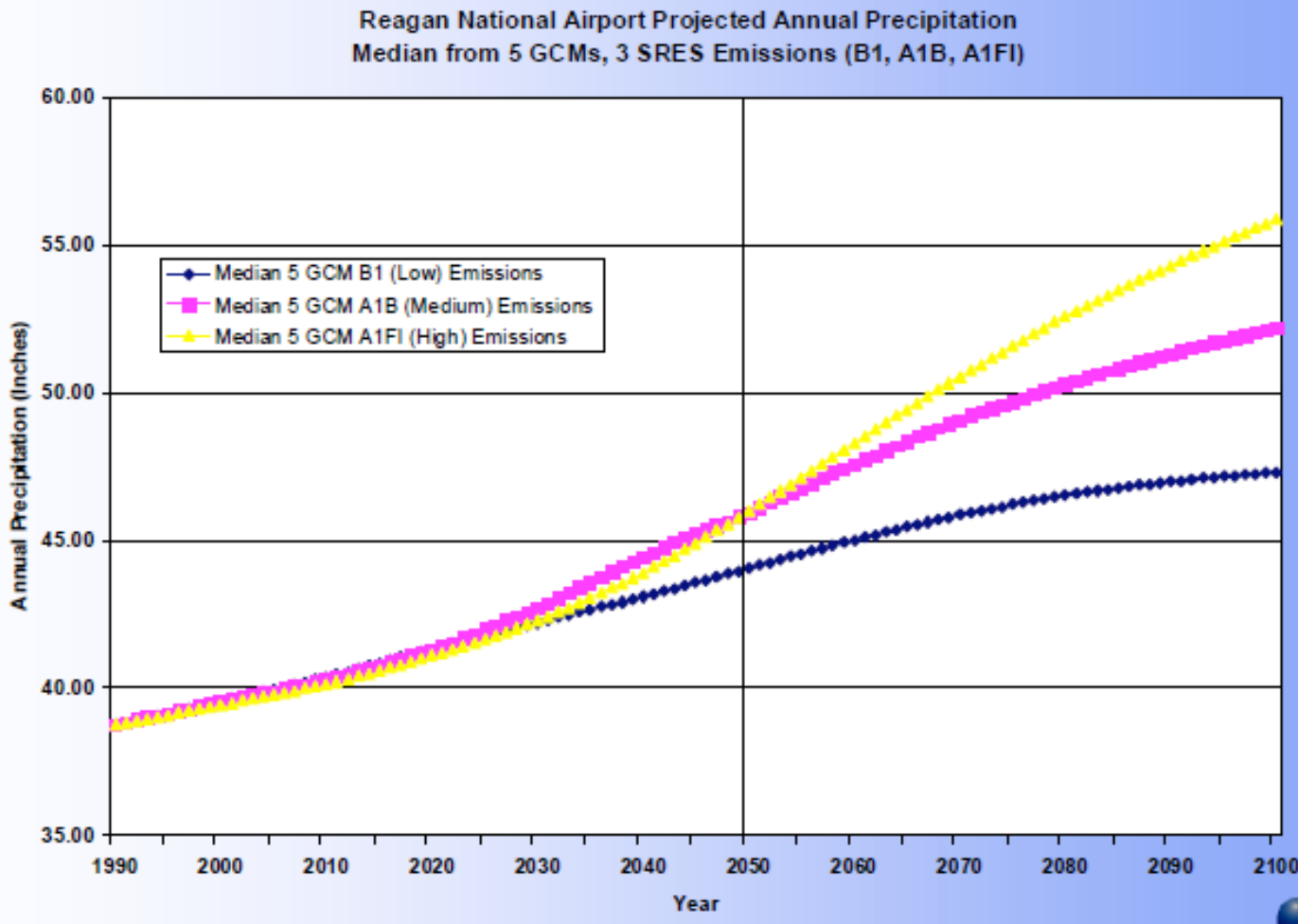
VNEMO Northern Virginia Communities

City of Alexandria MHHW+ 5FT SLR

Old Town - City of Alexandria

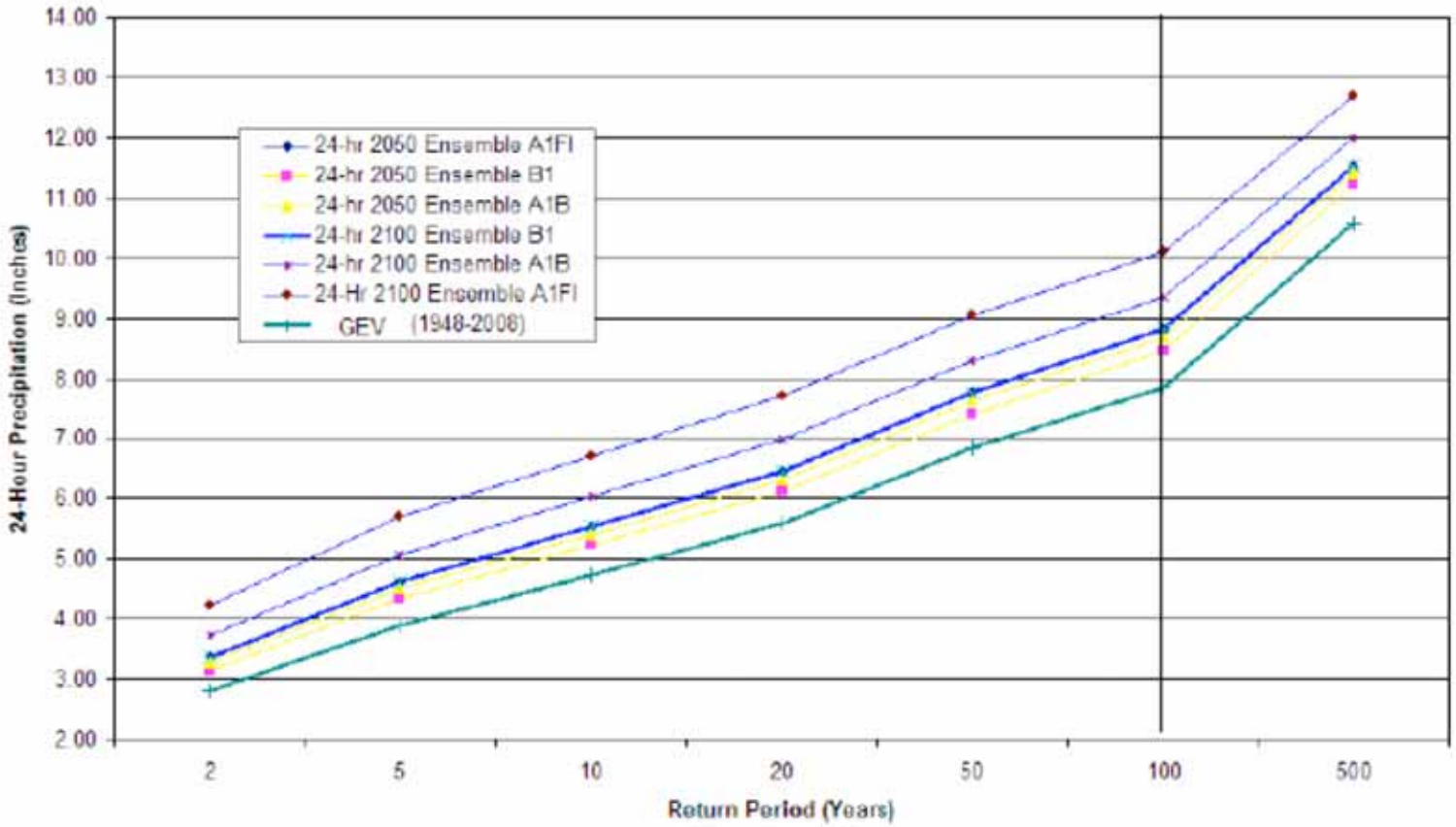
nvrc
Northern Virginia Regional Commission

Projected Annual Precipitation Reagan National Airport, DC

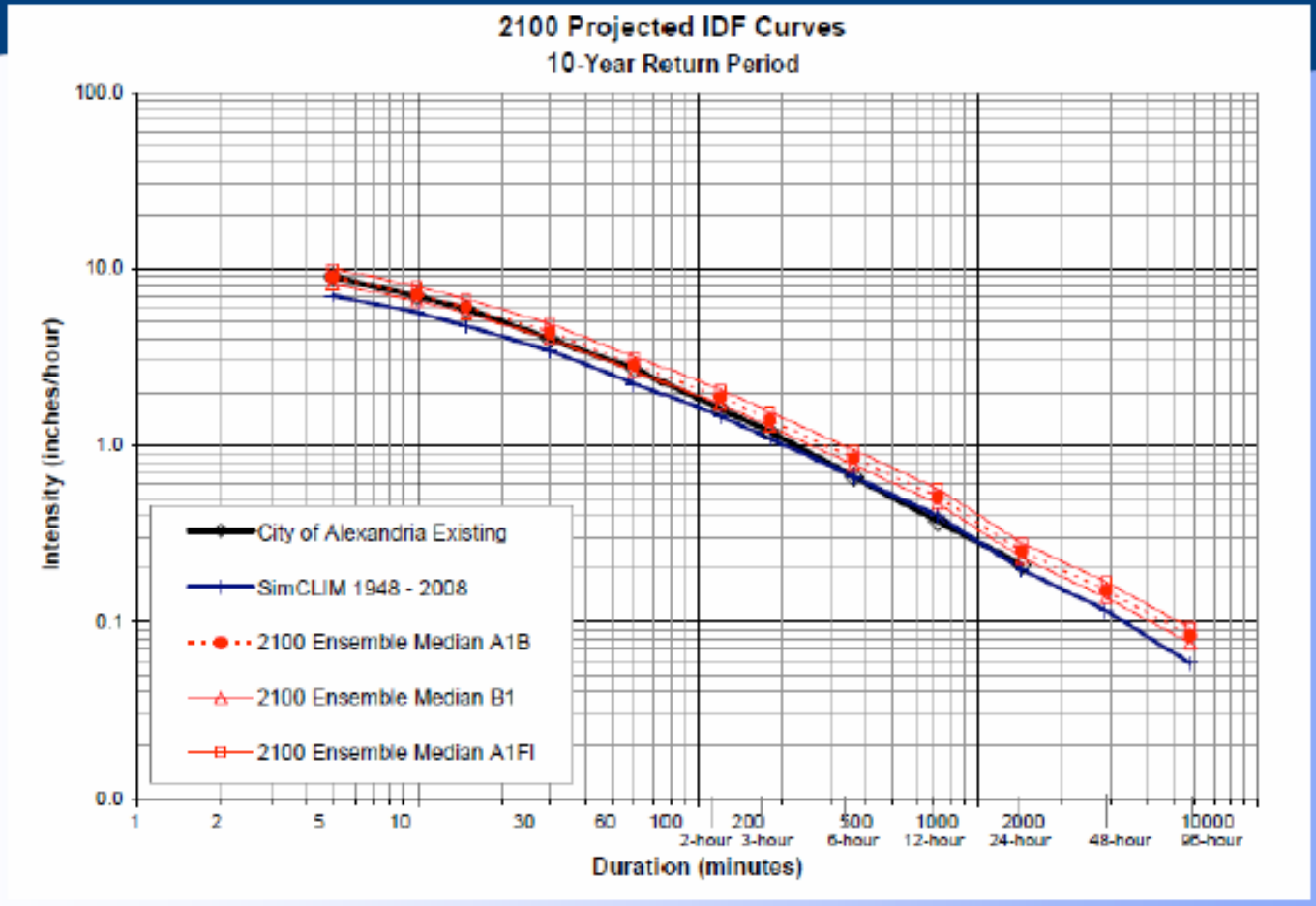


CH2MHILL

Projected Changes in Precipitation Intensity, Duration, Frequency, Reagan National AP, DC



10-year IDF Projections in 2100 Reagan National Airport



- ~1 to 11 percent greater than the existing Alexandria intensities for durations of 5 to 60 minutes
- ~17 to 29 percent greater for durations of 2 to 24 hours

CH2MHILL

Middle Peninsula Virginia

Mathews County, VA

Mathews County, Virginia

VNEMO Middle Peninsula

Local government's role in Climate Change:

Any county may adopt such measures as it deems expedient to secure and promote the **health, safety and general welfare** of its inhabitants which are **not inconsistent with the general laws of the Commonwealth**

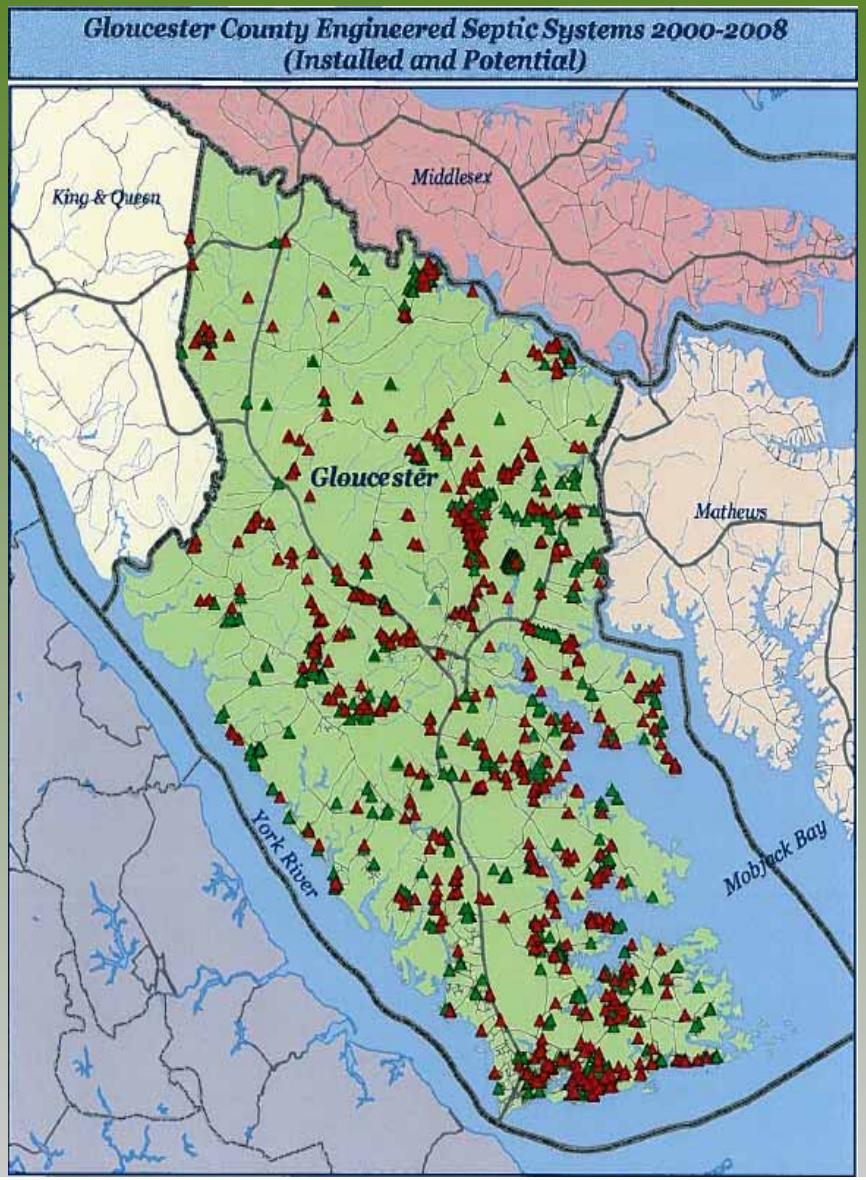
VNEMO Middle Peninsula

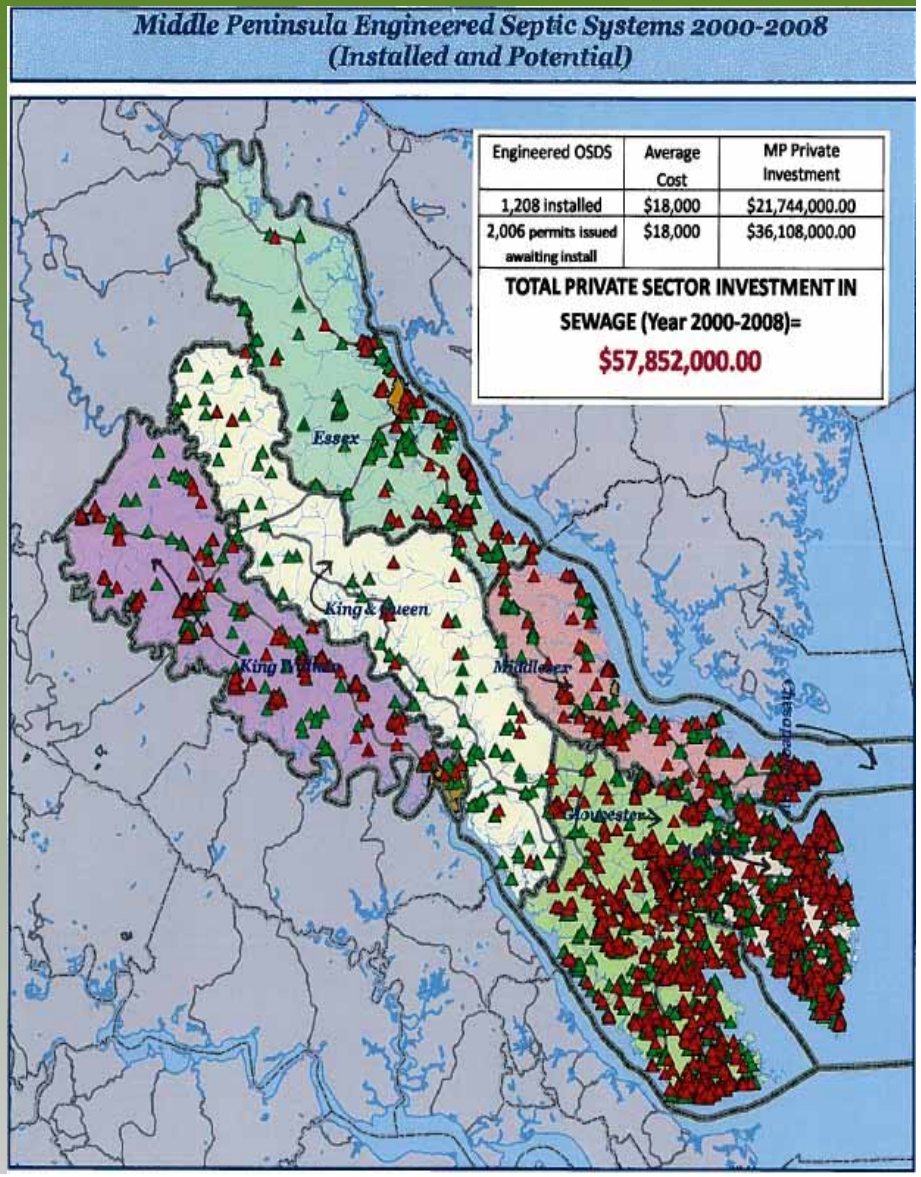
1. However, some committee members disagreed that global warming should be taken into consideration, saying the **concept was "based on spurious data"**
2. ...said that planners **"should be aware of" the issue, but that it "shouldn't drive the development process**."
3. When pointed out that, even if the **concept of sea level rise** were left out of the document, **"we still should be discouraging people from building there** (in the lower part of the county)". "...**I don't agree with that statement!"**
4. "Waterfront in Mathews County is our economic base," he said. "Nothing else comes close. **You have to be aware of possible sea level rise, but don't use a hammer to discourage someone from coming in and building a nice home."**
5. However, residents in some areas of the county have complained about sand build-up and other problems and **want to know why they were allowed to build there in the first place**.

Mathews on the move: loss of tax base

VNEMO Middle Peninsula

Private Sector Infrastructure is at risk





VAC §15.2-1200
General Power of Counties

Any county may adopt such measures as it deems expedient to secure and promote the **health, safety and general welfare** of its inhabitants …..

VNEMO Middle Peninsula

Changes in Climate will affect the local ecology

- ***Temperatures*** **in Virginia are estimated to increase 3°F increase during winter, spring and summer and increase 4°F in the fall (EPA, 2009)**

  Ask a duck hunter or bird watcher.....migrations have shifted or are delayed

- ***Precipitation*** **in Virginia will increase by 20% by 2100 (EPA, 2009)**

  Erosion, sedimentation and flooding concerns

- ***Storms*** **will intensify and are anticipated to be more frequent**

  How will flooding impact the health, safety and welfare of constituents and how will local governments provide public services to these areas?

VNEMO Middle Peninsula

Local Sea Level Rise

- National Wildlife Federation
  - **11.2** inch increase by 2050 and **27.2** inch increase by 2100
- Chesapeake Bay Foundation
  - **5.6** inch increase by 2050 and **12.5** inch increase by 2100
- Virginia Institute of Marine Science
  - 6.5 inch increase by 2050 and 14.3 inch increase by 2100
- Chesapeake Bay Program
  - 27.6 inches – 62.99 inch rise by 2100

VNEMO Middle Peninsula

We should not allow attention-grabbing headlines to mislead us into believing that *if* the effects of global warming are mitigated by natural changes or reducing man's potential contribution to global warming, coastal areas will remain high and dry. Other forces are in play and perhaps should get more attention than global warming.

Ed Merz
Hayes

The term Global Warming had been changed to Climate Change since world temperatures have been going down, not up. But, by whatever name, the theory is that the fate of the world depends on us humans and we must scale back our standard of living somewhere near the Stone Age or else the world will not be habitable.

But, we humans are not capable of destroying—or saving—the planet. The climate is controlled by God and the earth will be destroyed by God on His time schedule regardless of anything we do or don't do.

No surprise

It certainly comes as no surprise that the liberal Democrats in Congress would reject the recent exposure of e-mails sent by climatologists that suggest they are covering up the real numbers on global warming. My only response to their reaction would be to quote James Madison from "The Federalist Papers," Letter 10, when he said, "Enlightened statesmen will not always be at the helm."

It is insane that they have no qualms about committing our country to spending $147 trillion on the environment over the next several years, but they are concerned about the effect the troop surge in Afghanistan will have on the deficit. We need to send a very strong message to Congress over the next two election cycles. Every incumbent must be thrown out. Let's start over with a totally new Congress by 2012.

Larry Fritz
Poquoson

VNEMO Middle Peninsula

New Point Comfort Lighthouse
Mathews, VA

1885

TODAY

shoreline has moved ½ mile

Therefore, how does this impact the local tax base?

VNEMO Middle Peninsula

- Raise ½ mile of road 10 inches= **$320,000**
  (no permits and environmental cost)

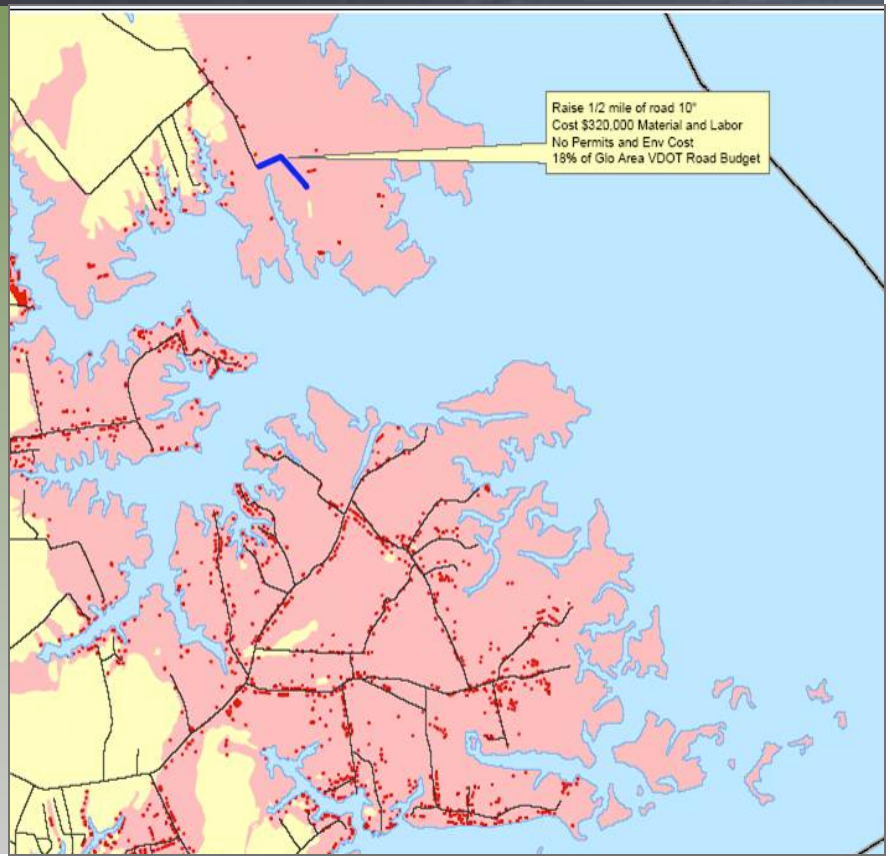
- **18%** of Gloucester Area VDOT Secondary Road Budget

Putting it into perspective:

$320,000 = ½ mile of road

$640,000 = 1 mile of road

$32,409,600 = 50.64 miles of road (amount of road in snapshot to the right)



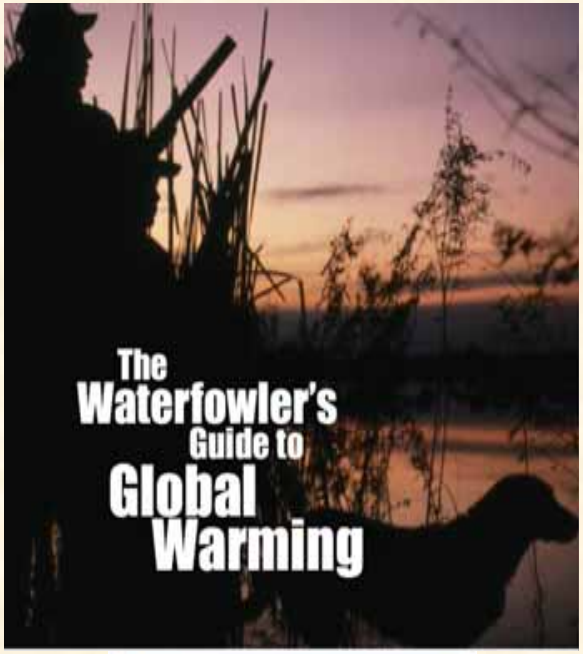
Cost of Public Safety

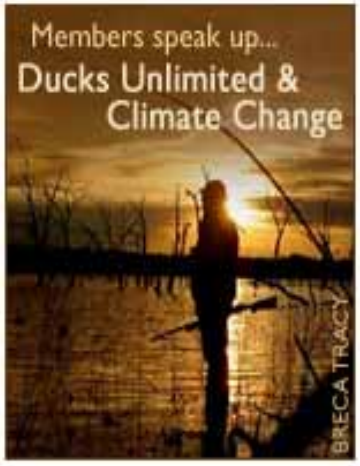
VNEMO Middle Peninsula

Repetitively Flooded Infrastructure

www.wetlandswatch.org

Global Warming Jeopardizes Cherished Outdoor Traditions in the Chesapeake Bay Region





The Major Investments in Chesapeake Bay Restoration Could Be Lost Due to Global Warming

THE CHESAPEAKE BAY AND GLOBAL WARMING

A PARADISE LOST FOR HUNTERS, ANGLERS, AND OUTDOOR ENTHUSIASTS?

NATIONAL WILDLIFE FEDERATION

VNEMO Middle Peninsula

Year 1: Assessment and Vulnerability

Part I

Create a Climate Change Advisory Stakeholder Committee to identify the critical anthropogenic and ecological impacts of climate change and sea level rise

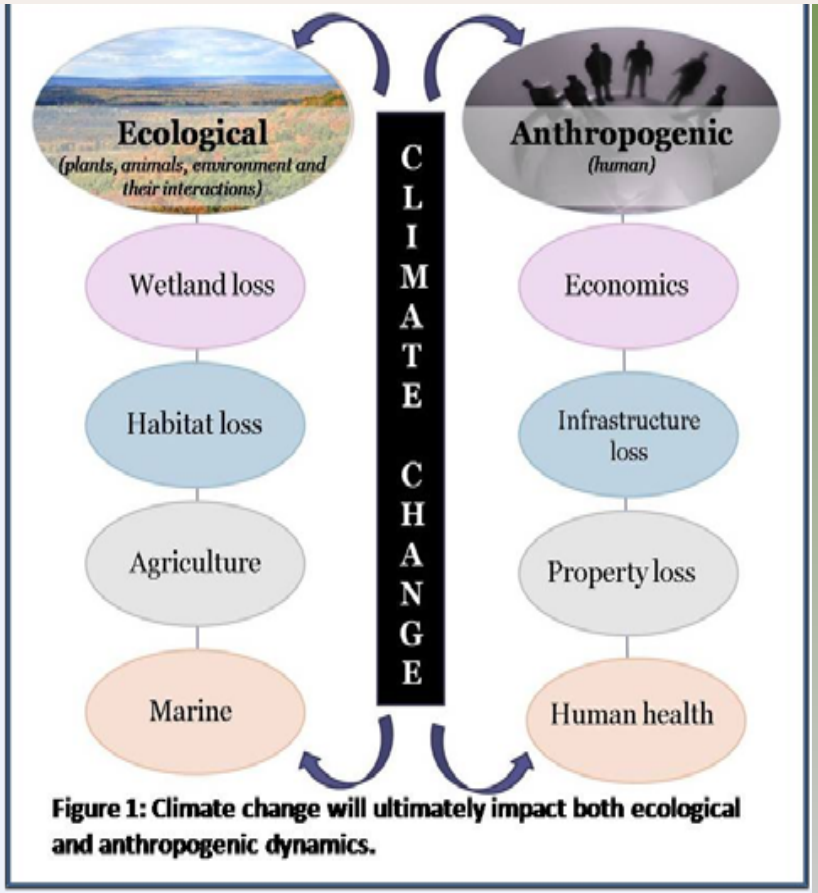


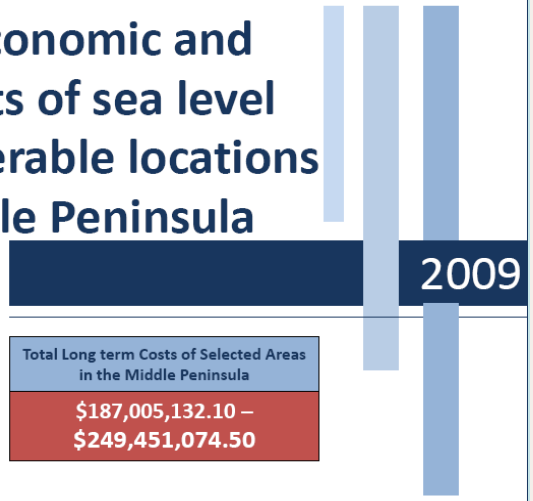
Figure 1: Climate change will ultimately impact both ecological and anthropogenic dynamics.

Part II

Mapped and assessed the critical anthropogenic and ecological impacts as identified by the stakeholder group

Assessing the economic and ecological impacts of sea level rise for select vulnerable locations within the Middle Peninsula

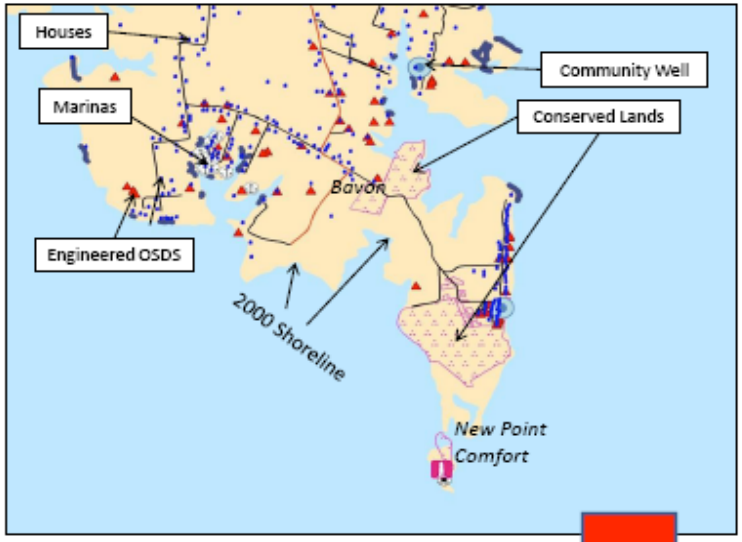
With well over 1,000 miles of linear shoreline, the Middle Peninsula is under direct threat from accelerated climate change. Specifically, sea level rise will impact coastal communities and infrastructure, as well as the region's natural resources.



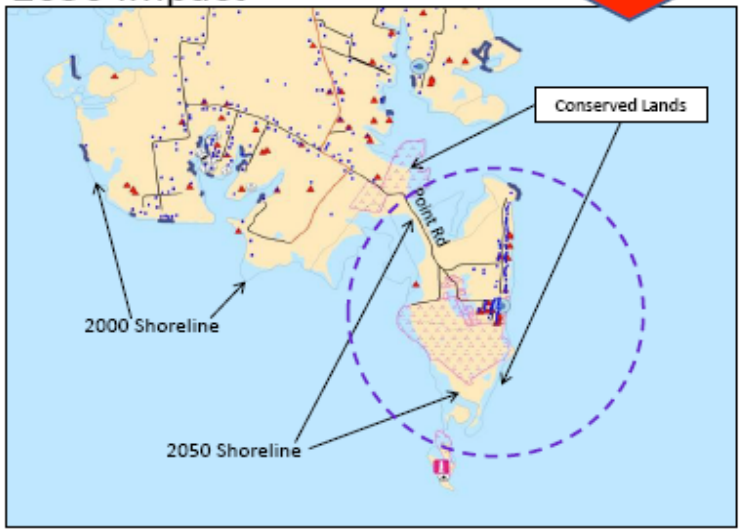
VNEMO Middle Peninsula

A

2000 Current



2050 Impact



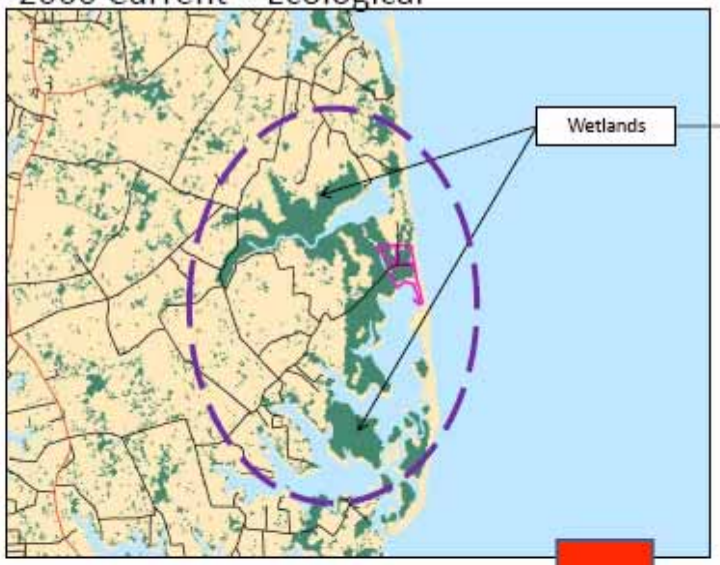
New Point Comfort: If Point Road floods consider the amount of infrastructure impacted

Infrastructure	Amount of Structures Impacted	Average Cost	Total Cost
Houses	72	$228,669 Estimated median house or condo value in 2007 (City-Data.com)	$16,464,168
Engineered OSDS	20	$18,000 (MPPDC Regional Estimate)	$360,000
Conventional OSDS	52	$4,000 (MPPDC Regional Estimate)	$208,000
Community Well (with 41 connections)	1	$40,000 (MPPDC Regional Estimate)	$40,000
Private Wells	31	$3,000 (MPPDC Regional Estimate)	$93,000
Shoreline Harding	658.122 ft of riprap	$60/foot (University of Minnesota)	$39,487.37
VDOT Road Segments	1,250.67 ft	Short term: $149 /sq ft Long term: $745/sq ft Additional right away acquisition and when raised 10 inches (VDOT Estimate)	Short term: $186,349.83 Long term: $931,749.15
TOTAL			**Short term:$17,391,005.20 Long term: $18,136,404.52**

- How will residents get to their house?
- How do residents get access to schools?
- How are OSDS and wells serviced?
- How are the roads serviced?
- How will conserved lands be accessed?
- How will EMS service this area?

VNEMO Middle Peninsula

2000 Current – Ecological



2050 Impact – Ecological Loss

Onemo and Diggs: Inundated wetlands will result in fish, reptile, bird, and wildlife habitat impact and loss

Quantitative Estimates of Lost Wetland Functions			
Wetland Functions	Value (1996$) ($/acre/year)	Estimated loss of wetland acreage	Direct/Indirect/Induced Value of wetland Lose ($/year)
Commercial Factors			
Fishing and Shellfish Habitat	$48[a]	954.77	$45,828.96
Waterfowl Habitat	$253[b]	954.77	$241,556.81
Mammal and Reptile	$18[c]	954.77	$17,185.86
Damage Control Factors *Environmental Projection against erosion, wind, storms and flooding*	$289.67 [d] – $8,566.67[d]	954.77	$276,568.23 - $8,179,199.52
Recreational Opportunities *Consumptive (ie. fishing, timbering, etc) and Non Consumptive (ie. bird watching, sight seeing) uses*	$9[i] - $115[j]	954.77	$8,592.93 - $109,798.55
Total value lost or redistributed: $589,732.79 - $8,593,569.70			

Qualitative Losses from Wetland Inundation	
-flood control and mitigation -fish and wildlife habitat -nursery area for wildlife -biodiversity	-water quality (ie. assimilation of waste and pollutants) -coastal erosion prevention -altering aesthetics of River and Bay vista -waterfowl habitat loss may impact bird watching

[a] Bell, 1989 [b] Guta and Foster, 1975 [c] Farber and Costanza, 1987 [d] Gupta and Foster, 1975 and Thibodeau and Ostro, 1981 [i] Farber and Costanza, 1987 [j] Bell, 1989

Conserved Lands Impacted	
Bethel Beach Natural Area Preserve	Quantitative: 63.31 acres of terrestrial land converts to subaqueous land due to inundation Qualitative: -Public access and enjoyment of to terrestrial conserved land will be limited - Habitat loss will impact the globally rare northeastern beach tiger beetle and beach plant as well as colonial nesting birds

VNEMO Middle Peninsula

Total Economic Impacts of Selected Areas:
Summary by County

County	Anthropogenic		Ecological	Total Long term costs
	Short term	Long term		
Mathews	$63,984,342.58	$86,717,356.02	$589,732.79 – $8,593,569.70	$87,307,088.81 – $95,310,925.72
Middlesex	$41,541,858.60	$44,671,693.00	$63,990.61 – $932,469.41	$44,735,683.61 – $45,604,189.41
Gloucester	$25,885,992	$28,758,156.00	$695,464.67 – $10,137,634.63	$26,453,620.67 – $38,895,790.63
King and Queen	$10,790,810.41	$11,024,055.01	$1,217,772.89 – $17,745,360.94	$12,241,827.90 – $28,769,415.95
Essex	$8,280,739	$11,782,239.00	$300,552.25 – $6,280,217.50	$12,082,791.25 – $18,062,456.50
King William	$2,746,623.63	$2,811,867.75	$1,372,252.13 – $19,996,428.51	$4,184,119.88 – $22,808,296.26

VNEMO Middle Peninsula

Total Economic Impact of Selected Areas within the Middle Peninsula

Anthropogenic		Ecological
Short term	Long term	
$126,230,366.20	$185,765,366.80	$4,239,764.75 – $63,685,680.69

Total Short term Costs of Selected Areas in the Middle Peninsula
$157,470,131.60 – $211,916,046.90

Total Long term Costs of Selected Areas in the Middle Peninsula
$187,005,132.10 – $249,451,074.50

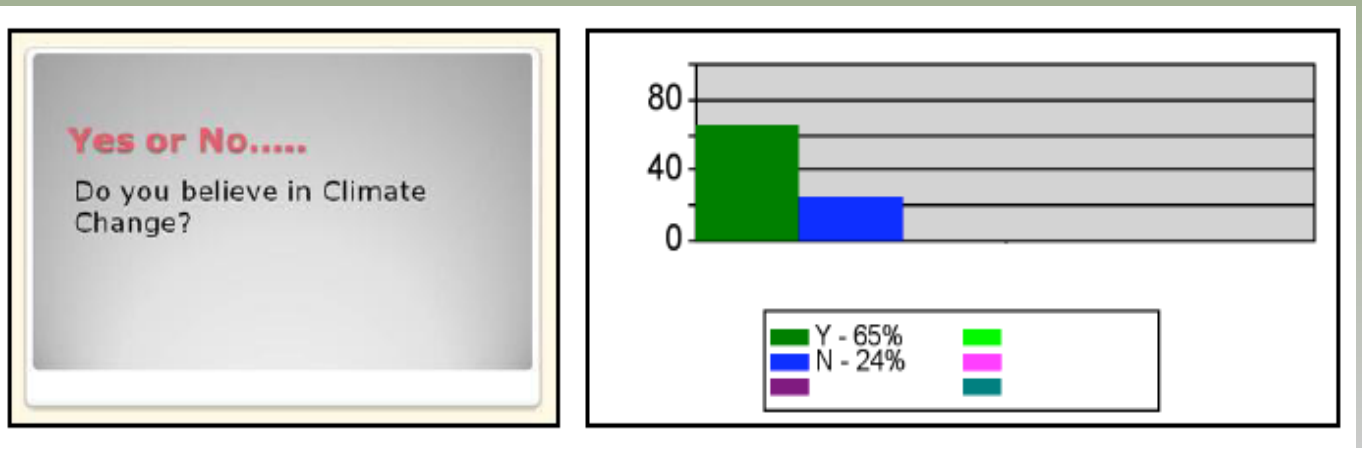
VNEMO Middle Peninsula

Year 2 Educational Initiative

Audience - General Public, Local Elected Officials and County Staff

Approach - Gathering regional stakeholder perceptions through the use of Qwizdom Software

Focus - Climate Change, sea level rise, and what is the role of local government in managing the impacts



VNEMO Middle Peninsula

Year 3 Adaptation Public Policy

- **"START" kit** - A regional Start Adaption and Response Today kit focused on…..
  - Local Scientific data
  - Kaiser-Permanente Natural Hazard Vulnerability Assessment Tool
  - Case studies
  - Sample Adaptation Ordinances from communities

- Once complete the kit will be transmitted to each governing body for public policy consideration

Todd Janeski
VNEMO Program Manager
todd.janeski@dcr.virginia.gov
804.371.8984
www.virginianemo.net