APPENDIX B: SAMPLE PRESENTATIONS

The following appendix contains slides from two presentations given by HRPDC staff on work for this project. The first presentation was given to a graduate student class at Old Dominion University on April 25, 2011. The second presentation was given to the Hampton Roads Planning District Commission on June 16, 2011. The event is described in greater detail in Appendix A.

CLIMATE CHANGE AND SEA LEVEL RISE IN HAMPTON ROADS

Benjamin McFarlane
Regional Planner
Hampton Roads Planning District Commission

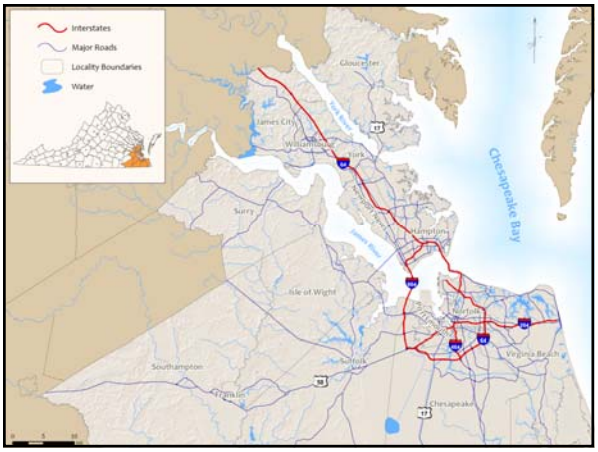
April 25, 2011

What is the HRPDC?

- 1 of 21 Regional Planning Agencies
- State enabled; locally created
- 16 Cities & Counties; several Towns; 1.7 million people; 3,000 square miles; 5,000 miles shoreline
- Commission – 45 local elected officials & CAO
- Staff – Executive Director & 45 staff
- Funding – Local contributions, grants, and contracts
- Functions – Economics, Housing, Transportation, Environmental, Emergency Management
- Budget $12,000,000 +
- Role – Policy & Technical Analysis, Planning & Engineering Studies, Cooperative Problem Solving, Coordination

What does HRPDC do?

- The Commission:
  - "**serves as a forum** for local and elected officials and chief administrators to **deliberate** and **decide** issues of **regional importance**"
- The Staff:
  - "provides the local governments and citizens of Hampton Roads credible and timely **planning, research, and analysis** on matters of mutual concern, and"
  - "**provides leadership and offers strategies and support services** to other public and private, local, and regional agencies, in their efforts to improve the region's quality of life."



What is Climate Change?

- Climate change refers to changes in long-term weather patterns
- "Greenhouse gas effect" main driver of climate change
  - Additional GHG emissions from human activity causing an increase in global average temperature
- 3 main effects:
  1. Temperature rise
  2. Changing precipitation patterns
  3. Sea level rise

Rising Temperatures

- Global average temperature has increased by 1.5°F since 1900
- Projected to increase a further 2-11.5°F by 2100
- Governor's Commission: +5.6°F(3.1°C) in Virginia by 2100

Changing Precipitation Patterns

- 11% overall increase in precipitation in Virginia (Governor's Commission)
- More concentrated rainfall punctuated by longer periods of dry weather
- More intense storm events
- Effect on quantity of storm events is uncertain

Sea Level Rise

- Global sea level rise caused by combination of thermal expansion and melting ice (considerable uncertainty with latter)
- Local sea level rise affected by ocean currents, winds, and subsidence
- Observed SLR of 4.42 mm/yr at Sewell's Point since 1927
- IPCC: 0.21-0.48m (8-19 inches) global sea level rise
- Chesapeake Bay Program: 0.7-1.6m (2.3 – 5.2 feet) along the Chesapeake Bay

Sector Impacts: Built Environment

- More frequent and persistent flooding from storm surge
- Permanent inundation of some areas if not protected
- Risk to industry and private property
- Infrastructure at risk: transportation, military, etc.

Sector Impacts: Natural Environment

- Flooding
- Inundation
- Species shifts
- Reduced water quality
- Ecosystem loss or transition
- Erosion
- Wetlands drowning

Sector Impacts: Water Supply

- Changes to available water supply from surface sources due to altered rainfall
- Changes to frequency and volume of precipitation will impact water supply infrastructure
- Potential reduced supplies during longer periods of dry weather
- Overwhelmed storage capacity during larger storm events
- Water quality impacts

Sector Impacts: Economy

- Damage to private and public property from storms and sea level rise
- Infrastructure at risk
- Vulnerable industries: tourism, shipping and shipbuilding, military
- Opportunities: wind energy development and logistical support, modeling and simulation

Sector Impacts: Socioeconomic

- Potential for injury and death during storm events and associated flooding
- Potential increases in diseases from air pollution as well as warm climate diseases
- Social justice concerns: some groups more vulnerable to climate change impacts

Hampton Roads Climate Change and Sea Level Rise Adaptation Initiative

- 3-year grant project with the Virginia Coastal Zone Management Program
- Year 1: Begin stakeholder process and identify broad impacts of climate change on Hampton Roads
- Year 2: Assessment of impacts and development of policy recommendations
- Year 3: Analysis of infrastructure and economic impacts and completion of the regional framework for mitigation and adaptation to climate change

Hampton Roads Climate Change and Sea Level Rise Adaptation Initiative

- Three parts:
  1. Coordination
  2. Outreach
  3. Research and Analysis

Coordination

- Working with other organizations and institutions to promote awareness of sea level rise and flooding issues in Hampton Roads
- ODU Initiative
- UVA-CRMES: Vulnerability of transportation infrastructure
- ODU: Economic impacts of flooding and sea level rise
- Storm Surge modeling with VIMS

Outreach

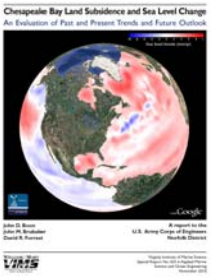
- Engaging local governments, citizens, and stakeholders through public meetings
- UVA-IEN/Wetlands Watch: Listening sessions in Virginia Beach
- Other public meetings to city councils and citizen groups

Research and Analysis

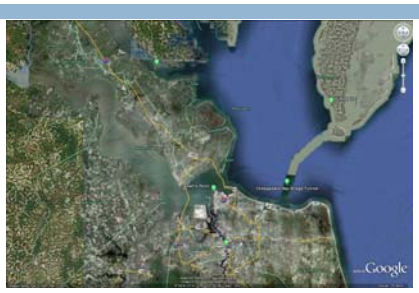
- HRPDC Climate Change/Sea Level Rise Impact Analysis and Policy Development
  - 3-year grant project with the Virginia Coastal Zone Management Program
  - Year 1: Begin stakeholder process and identify broad impacts of climate change on Hampton Roads
  - Year 2: Assessment of impacts and development of policy recommendations
  - Year 3: Analysis of infrastructure and economic impacts and completion of the regional framework for mitigation and adaptation to climate change

Identifying the Problem

- Sea level rise is both global and local
- Global rates combines steric and eustatic SLR
- Local rates include the movement of land relative to water



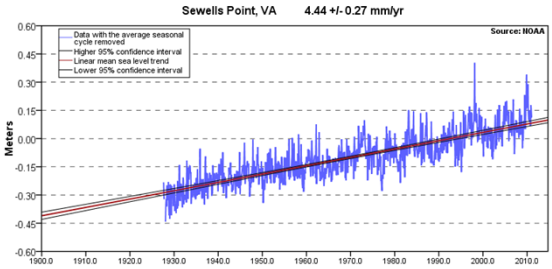
NOAA Tide Stations



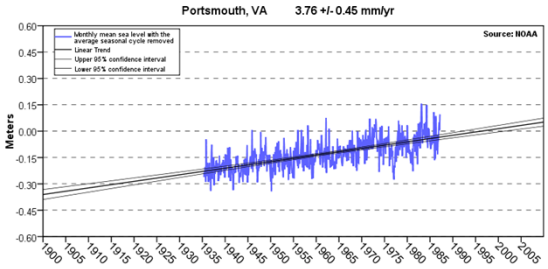
NOAA Tide Stations in Hampton Roads that measure sea level trends

www.tidesandcurrents.noaa.gov

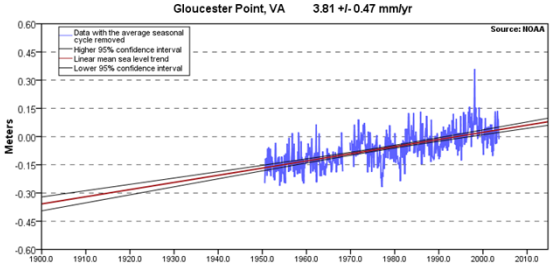
Norfolk, VA



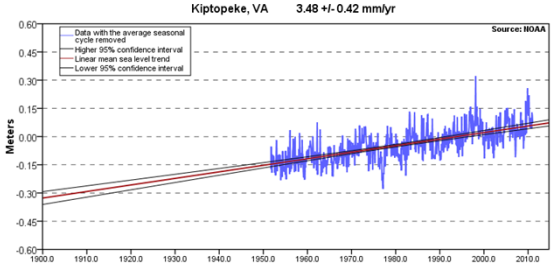
Portsmouth, VA



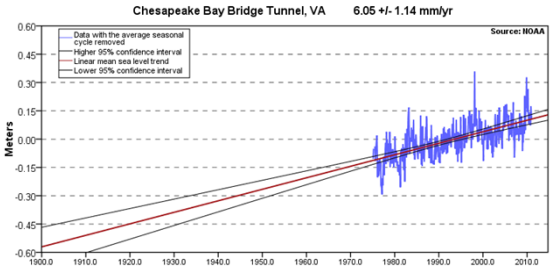
Gloucester County, VA



Northampton County, VA

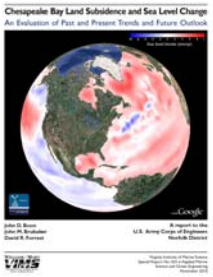


Chesapeake Bay



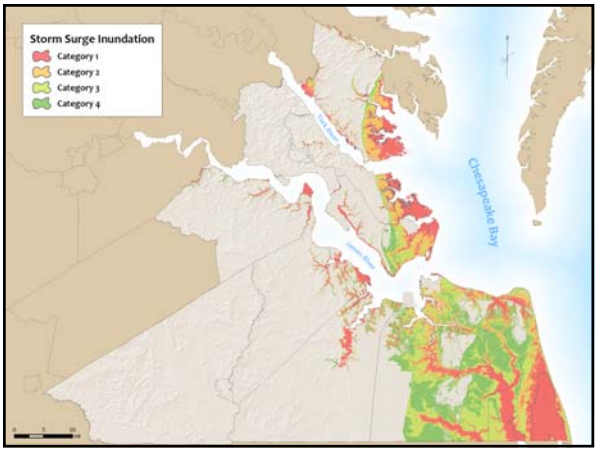
Identifying the Problem

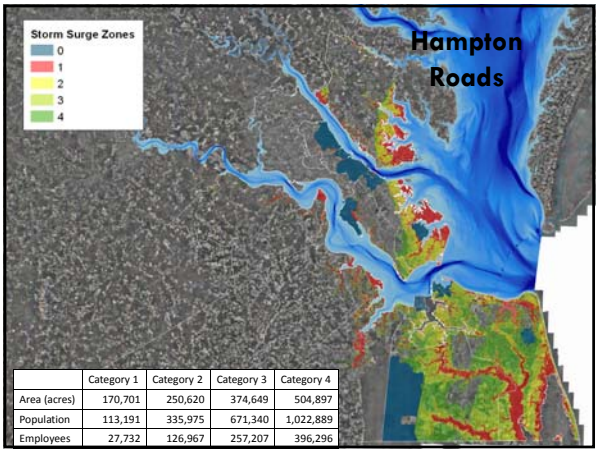
- The causes and the rate of local sea level rise are both important.
- In Hampton Roads, absolute sea level rise rates seem to be lower than average, but "local subsidence more than makes up for it."



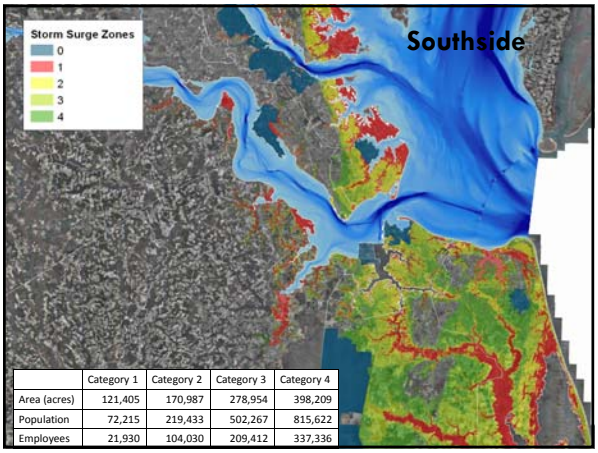
Analyzing Impacts and Vulnerability

- Estimates of population, economic activity, natural resources, and infrastructure at risk of temporary or permanent inundation from storm surge or sea level rise
- Data
  - Aerial imagery: Virginia Base Mapping Project (2009)
  - Population: U.S. Census Bureau (2010 Census)
  - Employment: Esri Business Analyst (2009)
  - Storm Surge: Virginia Department of Emergency Management (2007)

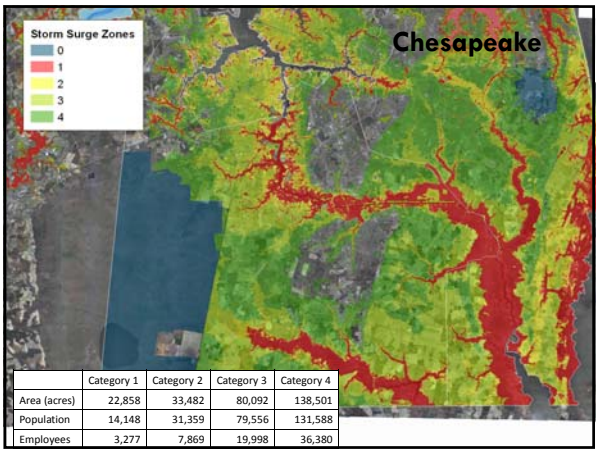




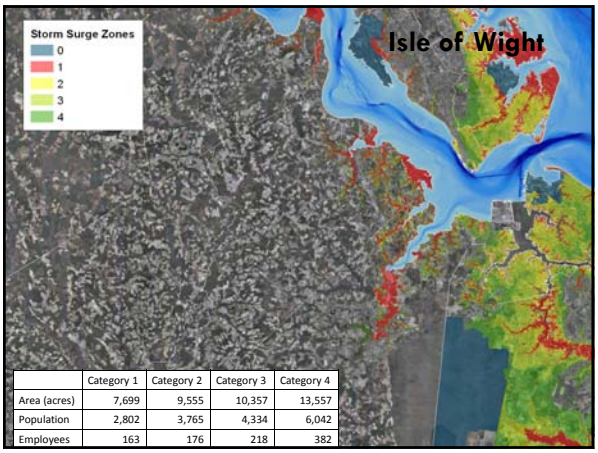
	Category 1	Category 2	Category 3	Category 4
Area (acres)	170,701	250,620	374,649	504,897
Population	113,191	335,975	671,340	1,022,889
Employees	27,732	126,967	257,207	396,296



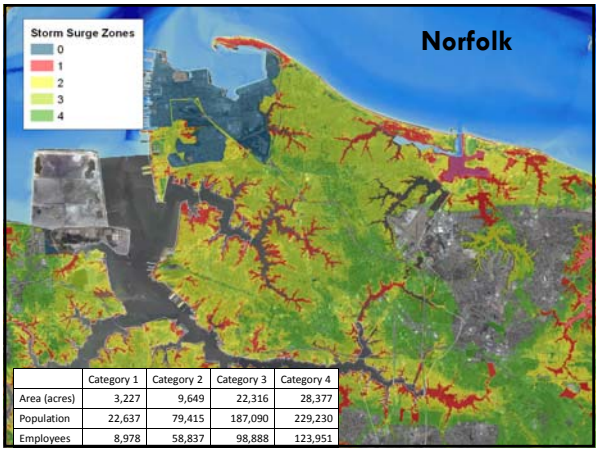
	Category 1	Category 2	Category 3	Category 4
Area (acres)	121,405	170,987	278,954	398,209
Population	72,215	219,433	502,267	815,622
Employees	21,930	104,030	209,412	337,336



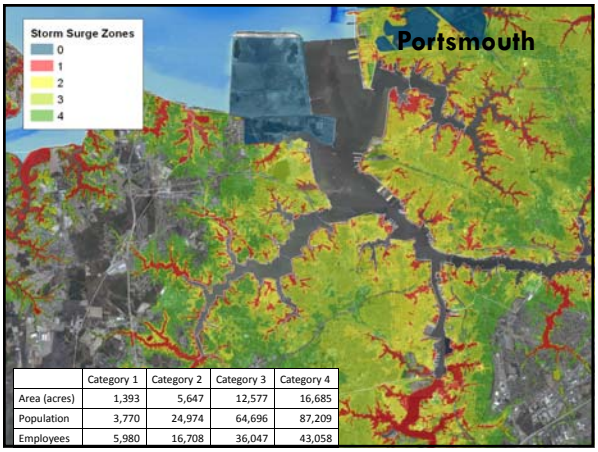
	Category 1	Category 2	Category 3	Category 4
Area (acres)	22,858	33,482	80,092	138,501
Population	14,148	31,359	79,556	131,588
Employees	3,277	7,869	19,998	36,380



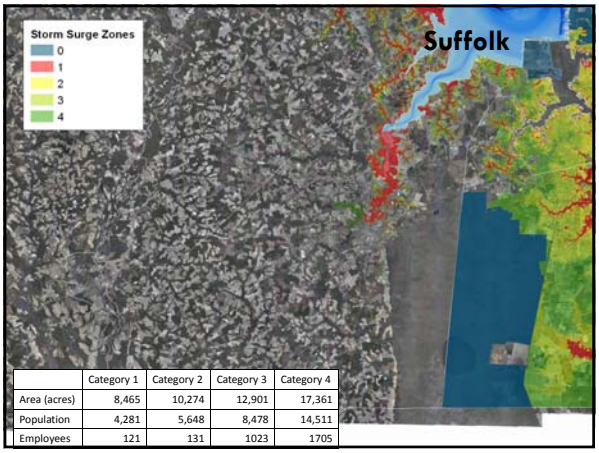
	Category 1	Category 2	Category 3	Category 4
Area (acres)	7,699	9,555	10,357	13,557
Population	2,802	3,765	4,334	6,042
Employees	163	176	218	382



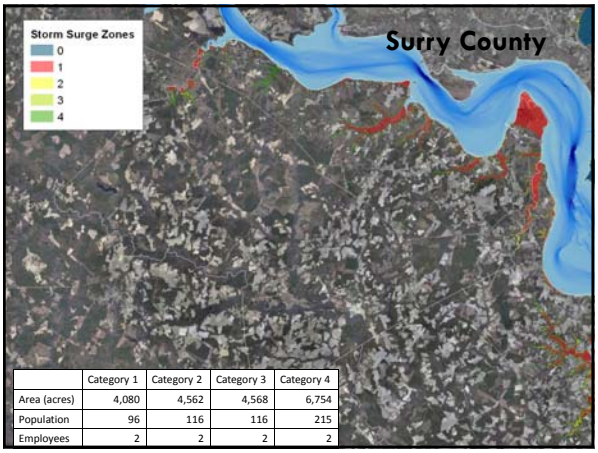
	Category 1	Category 2	Category 3	Category 4
Area (acres)	3,227	9,649	22,316	28,377
Population	22,637	79,415	187,090	229,230
Employees	8,978	58,837	98,888	123,951



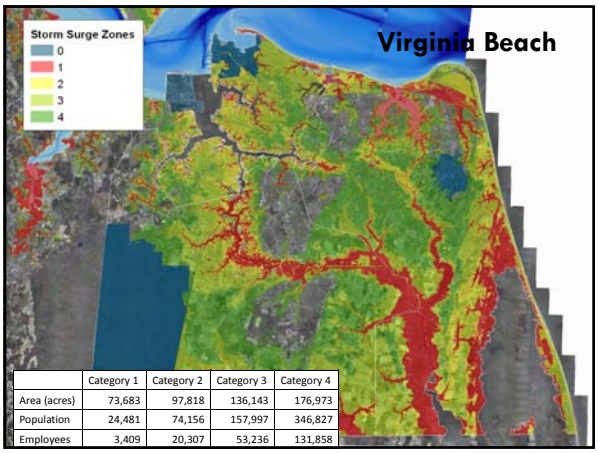
	Category 1	Category 2	Category 3	Category 4
Area (acres)	1,393	5,647	12,577	16,685
Population	3,770	24,974	64,696	87,209
Employees	5,980	16,708	36,047	43,058



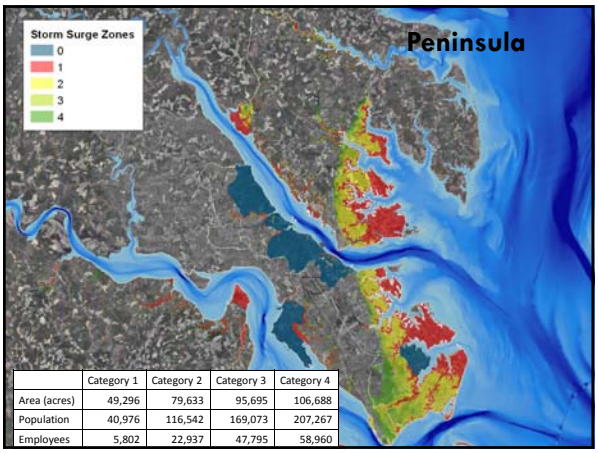
	Category 1	Category 2	Category 3	Category 4
Area (acres)	8,465	10,274	12,901	17,361
Population	4,281	5,648	8,478	14,511
Employees	121	131	1023	1705



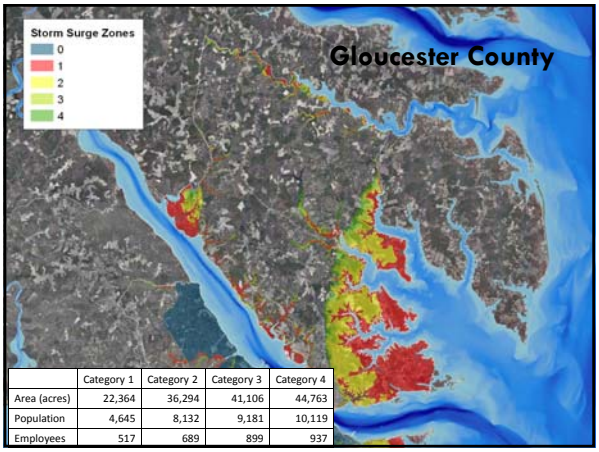
	Category 1	Category 2	Category 3	Category 4
Area (acres)	4,080	4,562	4,568	6,754
Population	96	116	116	215
Employees	2	2	2	2



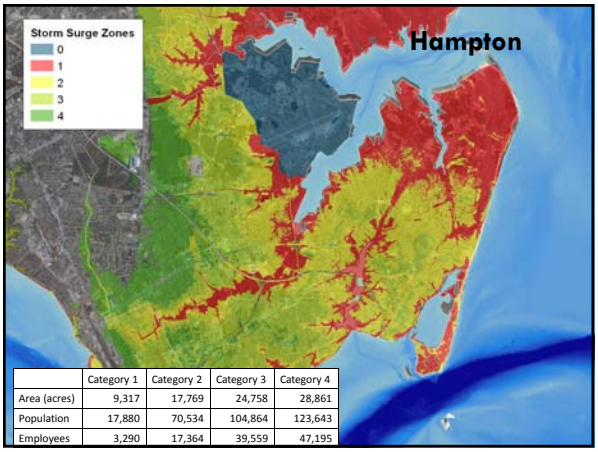
	Category 1	Category 2	Category 3	Category 4
Area (acres)	73,683	97,818	136,143	176,973
Population	24,481	74,156	157,997	346,827
Employees	3,409	20,307	53,236	131,858



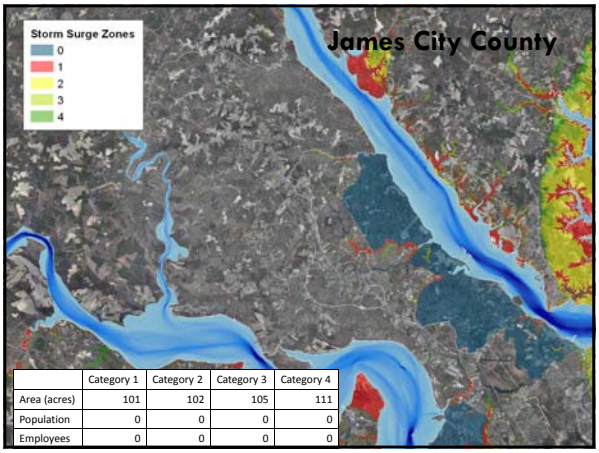
	Category 1	Category 2	Category 3	Category 4
Area (acres)	49,296	79,633	95,695	106,688
Population	40,976	116,542	169,073	207,267
Employees	5,802	22,937	47,795	58,960



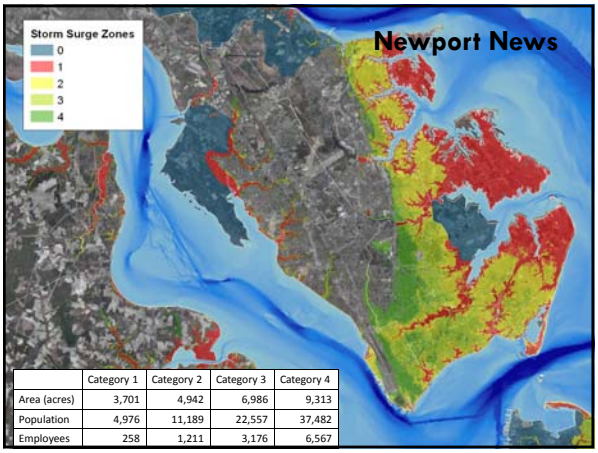
	Category 1	Category 2	Category 3	Category 4
Area (acres)	22,364	36,294	41,106	44,763
Population	4,645	8,132	9,181	10,119
Employees	517	689	899	937



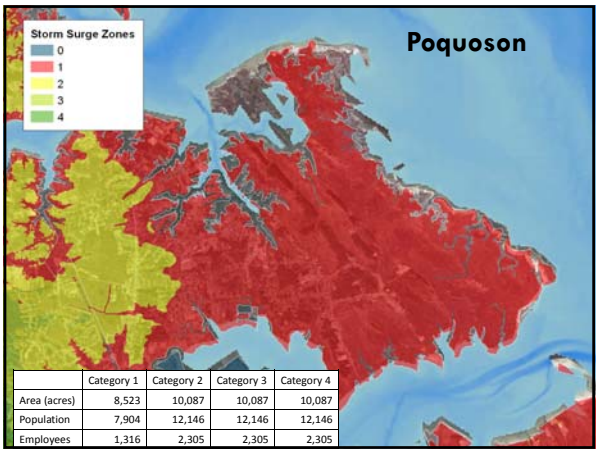
	Category 1	Category 2	Category 3	Category 4
Area (acres)	9,317	17,769	24,758	28,861
Population	17,880	70,534	104,864	123,643
Employees	3,290	17,364	39,559	47,195



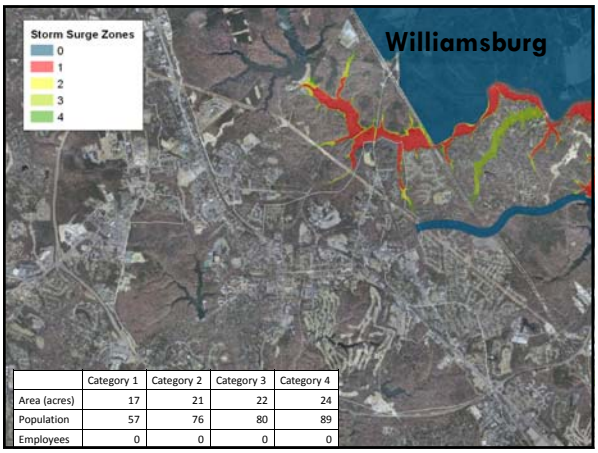
	Category 1	Category 2	Category 3	Category 4
Area (acres)	101	102	105	111
Population	0	0	0	0
Employees	0	0	0	0



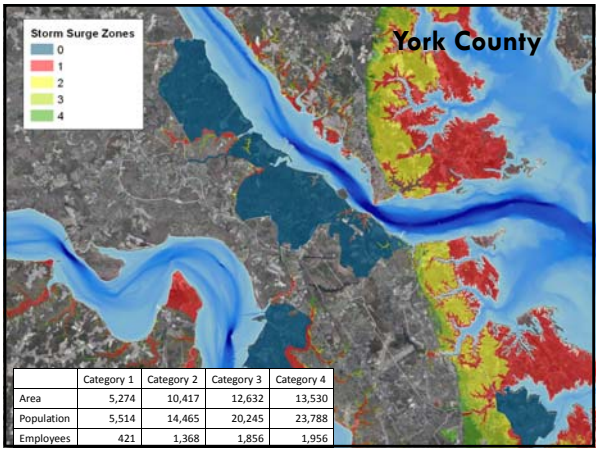
	Category 1	Category 2	Category 3	Category 4
Area (acres)	3,701	4,942	6,986	9,313
Population	4,976	11,189	22,557	37,482
Employees	258	1,211	3,176	6,567



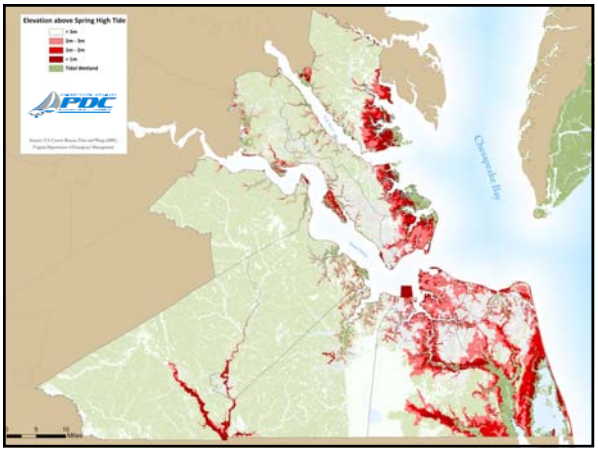
	Category 1	Category 2	Category 3	Category 4
Area (acres)	8,523	10,087	10,087	10,087
Population	7,904	12,146	12,146	12,146
Employees	1,316	2,305	2,305	2,305



	Category 1	Category 2	Category 3	Category 4
Area (acres)	17	21	22	24
Population	57	76	80	89
Employees	0	0	0	0



	Category 1	Category 2	Category 3	Category 4
Area	5,274	10,417	12,632	13,530
Population	5,514	14,465	20,245	23,788
Employees	421	1,368	1,856	1,956



Exploring Options for Adaptation

- Mitigation: reducing the amount of sea level rise that occurs
- Adaptation
  - Protection (seawalls, storm surge barriers)
  - Accommodation (elevating structures, beach nourishment)
  - Retreat (setbacks, easements)
- Near-term vs. Long-term solutions
  - Storm and Tidal Flooding ≠ Sea Level Rise

Adapting to Climate Change

- Adaptation will have some negative impacts
  - Dikes prevent flooding, but also prevent wetlands from migrating inland
  - Seawalls reduce erosion and protect against flooding, but result in the elimination of the beach and increased erosion at edges
- It will also be expensive
  - Seawall: >$6,500 in 2009 dollars (Herberger et al.)

Planning for Climate Change

- Challenges
  - Legal: What authorities to local and regional governments/agencies have?
  - Economic: How much adaptation can localities afford?
  - Political: How do localities and regions decide which areas to protect and which to retreat from?
  - Scientific: How do localities and regions know which areas are vulnerable and how much they will be affected?

Planning for Climate Change

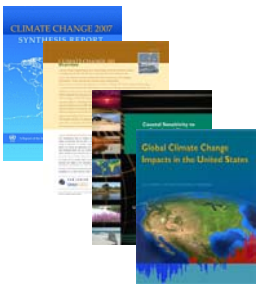
- Incorporate sea level rise and precipitation projections into building and infrastructure location and construction
- Alter zoning codes to reduce construction in vulnerable areas, through density restrictions, setbacks, and easements

Next Steps

- Engagement and discussions with stakeholders: local governments, businesses, citizens, other stakeholders
- More data and better models are needed to understand impacts
  - Consistent High-resolution elevation data (LiDAR)
  - Sea level rise and storm surge models
  - Natural system responses

Climate Change Resources

- Intergovernmental Panel on Climate Change (www.ipcc.ch)
- Pew Center on Global Climate Change (www.pewclimate.org)
- U.S. Global Change Research Program (formerly Climate change Science Program) (www.globalchange.gov)

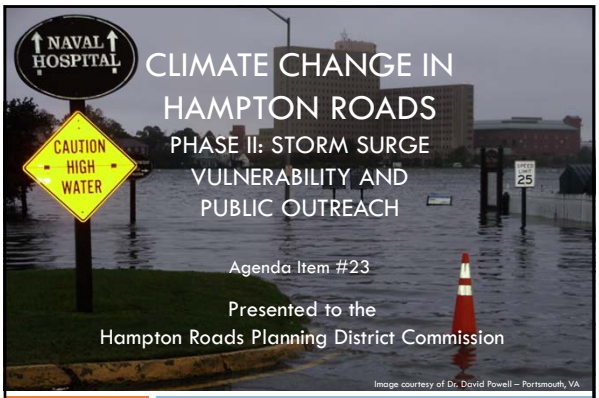


Climate Change Initiatives

- Local
- Regional
- State

Questions?

Benjamin J. McFarlane
Regional Planner
Hampton Roads Planning District Commission
bmcfarlane@hrpdcva.gov



CLIMATE CHANGE IN HAMPTON ROADS

PHASE II: STORM SURGE VULNERABILITY AND PUBLIC OUTREACH

Agenda Item #23

Presented to the
Hampton Roads Planning District Commission

Image courtesy of Dr. David Powell – Portsmouth, VA

June 16, 2011

Benjamin J. McFarlane
Regional Planner

Report Organization

2

- **Sea Level Rise in Hampton Roads**
- Case Studies
- **Data**
- **Methodology**
- **Results**
- Public Outreach
- Policy Options
- **Conclusions and Next Steps**

Sea Level Rise in Hampton Roads

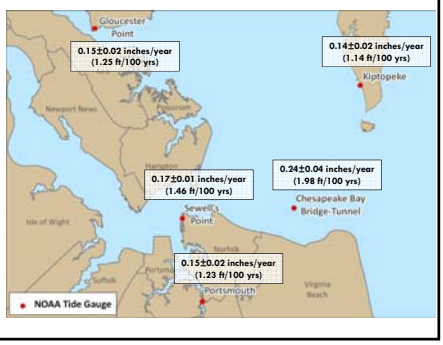
3

- Absolute sea level rise refers to the increase in mass or volume of the oceans
  - Typically reported as a global average
- Relative sea level rise is measured at the local level and includes the vertical movement of land
  - Typically reported for specific points such as tide gauges

Sea Level Rise in Hampton Roads

4

- Trends are based on measurements from last 30 to 80 years
- Regional average is 1-2 feet of sea level rise over 100 years



Data and Methodology

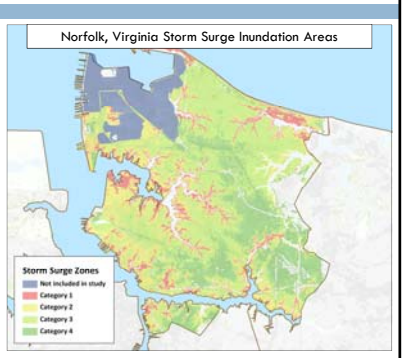
5

- Developed based on case study research and available data
- Use asset datasets from several sources with storm surge areas to estimate regional and local vulnerability to hurricane storm surge flooding and sea level rise
- Use geographic information systems (GIS) analysis to show which assets are in vulnerable areas and sum the results by locality and storm surge category

Results – Norfolk (example)

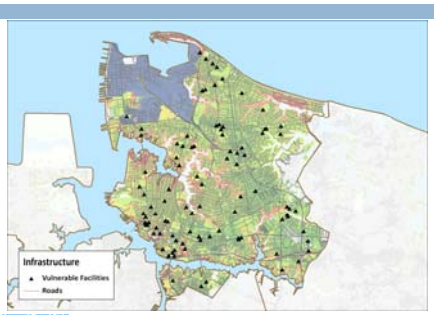
6

- Local results are included for each of the twelve Hampton Roads localities included in the 2008 Virginia Hurricane Evacuation Study



Results – Norfolk (example)

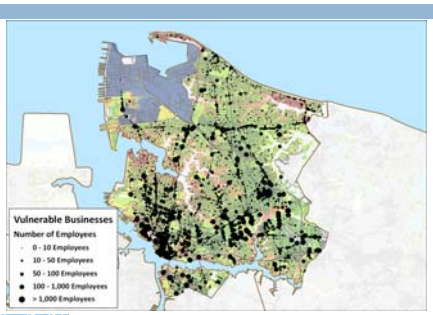
7



Roads and Critical Infrastructure Vulnerable to Storm Surge in Norfolk, Virginia

Results – Norfolk (example)

8

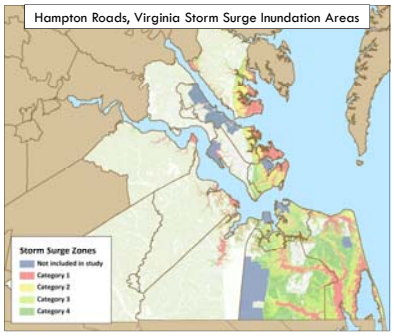


Businesses Vulnerable to Storm Surge in Norfolk, Virginia

Results – Region

9

- Overall, high level of exposure to storm surge across the region
- Southside is more vulnerable to larger events than the Peninsula
- Significant population, infrastructure, critical facilities, and businesses at risk



Conclusions

10

- Hampton Roads is significantly vulnerable to storm surge and sea level rise
- Baseline assumption of sea level rise equal to historical trend is appropriate
- Acceleration of sea level rise will depend on many factors, so it should be monitored and planning assumptions updated as needed
- New data should be incorporated as available

Next Steps

11

- HRPDC staff will continue:
  - To analyze regional vulnerability to sea level rise using elevation data
  - To research and develop policy options
  - To work with other regional partners, such as ODU and VIMS, on related projects

Recommended Action

12

- Approve report for distribution