Hampton Roads Sea Level Rise Planning and Technical Assistance

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HAMPTON ROADS SEA LEVEL RISE PLANNING AND TECHNICAL ASSISTANCE

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The views expressed herein are those of the authors and do not necessarily reflect the views of the U.S Department of Commerce, NOAA or any of its subagencies.

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Prepared by the staff of the Hampton Roads Planning District Commission

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ABSTRACT
This report documents the results of work by the Hampton Roads Planning District Commission on providing technical assistance related to sea level rise adaptation and planning to local governments between October 2013 and September 2015. The report consists of five major sections. The first part documents the development of new regional sea level rise inundation maps and the methodology used to create them. The second part covers the creation of a new regional local government committee to address issues related to flooding and sea level rise. The third section describes sea level rise research and analysis case studies. The fourth part documents technical assistance work provided to localities. The fifth section describes the HRPDC staff's public outreach, education, and coordination efforts. In addition to these sections, there are appendices with supporting documentation and information.

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Virginia Coastal Zone
MANAGEMENT PROGRAM

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Executive Summary

The Hampton Roads Planning District Commission is a state-enabled, locally-created regional planning organization for southeastern Virginia, representing seventeen member local governments with over 1.7 million citizens. Since 2008, the HRPDC's staff has worked on a series of studies, projects, and efforts to better inform the region's local governments on the impacts of climate change, including sea level rise, and possible steps to adapt or mitigate those impacts. The majority of these efforts have been funded in part by the National Oceanic and Atmospheric Administration through grants from the Virginia Coastal Zone Management Program.

This report documents the work done under a grant from the Virginia Coastal Zone Management Program from October 2013 to September 2015. It documents the work and products for five deliverables:

1) An update to regional sea level rise inundation maps
2) The creation of a regional sea level rise adaptation technical working group
3) Research and analysis case studies demonstrating how localities can plan for sea level rise
4) Technical assistance on sea level rise planning and adaptation to local governments
5) Coordination and public outreach efforts related to sea level rise

The report also contains appendices with additional information or supporting documents for each of the five deliverables. These include a regional map book of areas vulnerable to sea level rise, documentation of the models used to create the new sea level rise inundation maps, examples of local policies related to sea level rise adaptation, and representative samples of presentations and outreach materials.

Inundations Maps

The HRPDC staff developed a methodology in ArcGIS to analyze sea level rise scenarios and identify areas vulnerable to inundation. Through consultation with local government staff, the HRPDC staff mapped two feet of sea level rise above current estimated (2015) mean higher high water as a demonstration of the methodology and the ArcGIS model built to automate the process. This methodology can be used to create a suite of locally relevant sea level rise scenarios for local and regional analyses.

Research and Analysis Case Studies

In 2015 the General Assembly passed legislation requiring Hampton Roads localities to incorporate sea level rise into their comprehensive plans. The HRPDC staff identified several

areas throughout the country that currently address sea level rise in their local plans and policies. Three (3) case studies were analyzed to provide potential lessons learned for Hampton Roads localities. The case studies reviewed for this project were Boston, San Francisco, and Broward County, Florida.

Adaptation Technical Working Group

In March 2014 the Hampton Roads Planning District Commission formally created a new advisory committee for matters related to sea level rise and recurrent flooding. The committee includes representatives from all seventeen (17) HRPDC member localities, including planners, engineers, and senior community officials. The main goal of the committee is to develop specific recommendations related to recurrent flooding and sea level rise adaptation and mitigation for local governments. Additional roles are to be an advocate for state and federal support and to serve as the primary regional contact for federal agencies and academic institutions. The committee met six (6) times during the period of this grant.

Technical Assistance

The HRPDC staff continued to provide technical assistance to local government staff in the form of answering questions, recommending resources, and providing data. The HRPDC staff also worked closely with the staff of the Hampton Roads Transportation Planning Organization by helping them to select appropriate sea level rise and storm surge scenarios for their long range planning needs. The HRPDC staff also provided GIS layers for each of the selected sea level rise and storm surge layers to the HRTPO staff.

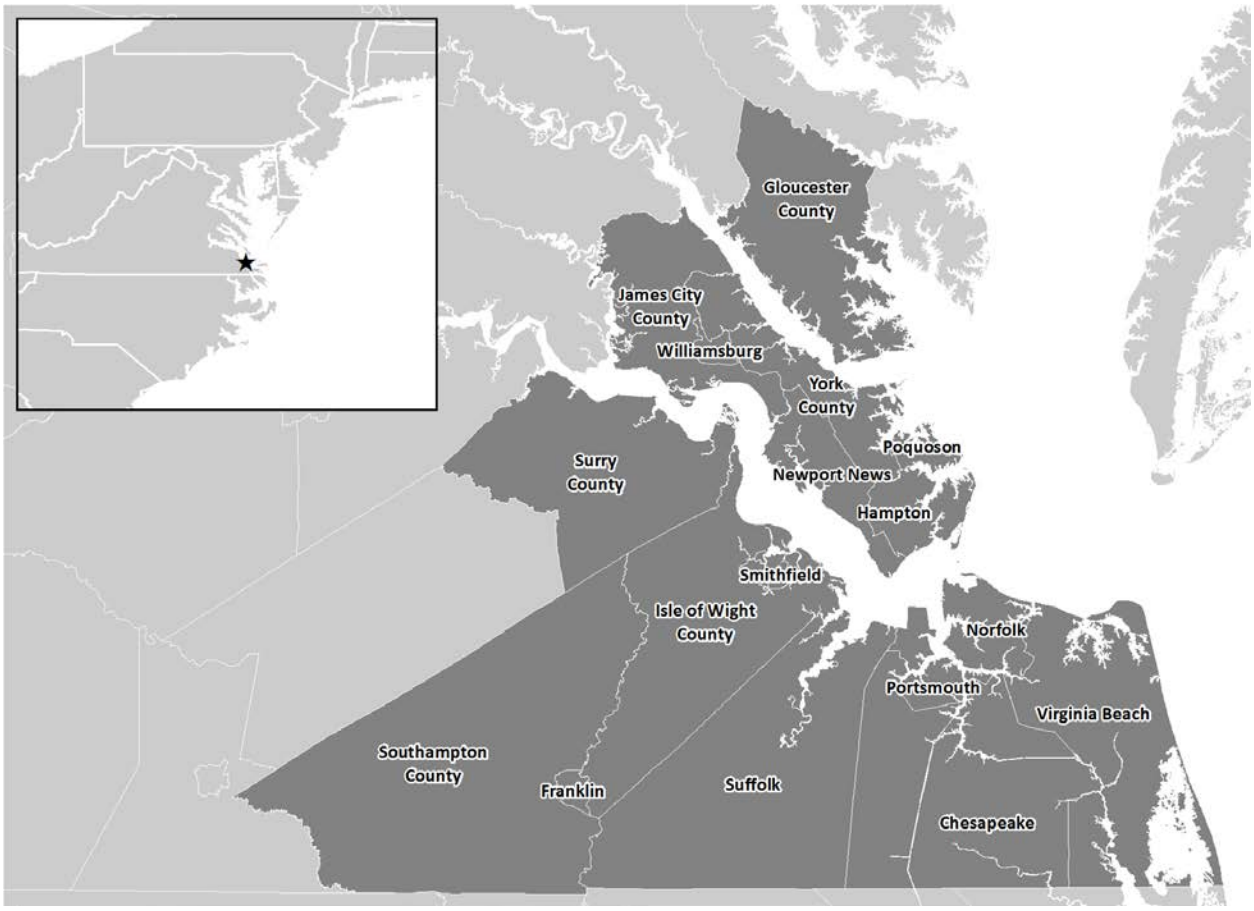
Coordination and Public Outreach

The HRPDC staff continued to work with local, state, and federal governmental organizations, academic institutions, and private and non-profit partners on projects and efforts related to sea level rise and flooding. Examples of specific partnerships included the Recurrent Flooding Subpanel of the Secure Commonwealth Panel, the ODU Intergovernmental Pilot Project, the Hampton Roads Adaptation Forum, the Dutch Dialogues, and the TRB International Conference on Surface Transportation System Resilience. The HRPDC staff provided information and gave presentations to members of the public upon request.

1. Introduction

The Hampton Roads region is strategically located at the confluence of the James and York Rivers, the Chesapeake Bay, and the Atlantic Ocean. The region, with a population of approximately 1.7 million residents, extends north into the Middle Peninsula and James City County, west to Southampton County, and south into northeastern North Carolina. It includes the most populous city in Virginia (Virginia Beach, with a population of nearly 450,000) in addition to many of the Commonwealth's oldest and most historic urban centers and communities, including the Cities of Norfolk and Portsmouth in South Hampton Roads and Hampton, Williamsburg, and Yorktown on the Peninsula. What many of these communities share is a strong tie to the water through commerce, culture, and history. The region's many waterways and shores dominate the way of life for many of the region's residents.

Figure 1: The Hampton Roads Planning District Commission



Although the region has always been considered vulnerable to flooding from coastal storms (documented in studies such as those by CoreLogic[1]), in recent years nuisance or recurrent flooding has become an increasingly important issue for local governments.[2] While the region is already vulnerable to both nuisance and storm flooding, sea level rise will increase the frequency of nuisance flooding and increase the severity of storm flooding. It will also result in the permanent inundation of some areas. Successfully adapting to sea level rise will require careful planning, analysis, and consideration of how sea level rise will affect Hampton Roads communities and how it should be incorporated into land use plans, infrastructure designs, and other decisions, both public and private. Many decisions made in the present will have lasting consequences, so it is important to begin planning for sea level rise and other climate change impacts sooner rather than later.

Since 2008, the Hampton Roads Planning District Commission (HRPDC) has worked on a series of projects and efforts to study and analyze the potential impacts of climate change on southeastern Virginia and to identify potential strategies for adapting to those impacts. Most of these efforts have been funded in part by the National Oceanic and Atmospheric Administration (NOAA) through grants from the Virginia Coastal Zone Management Program (VCZMP). Through these efforts several reports have been published by the HRPDC that have provided baseline vulnerability assessments to local governments and made recommendations for response strategies. In addition, the HRPDC has worked with other partners in the region and the Commonwealth, including Old Dominion University, the University of Virginia, and the Virginia Institute of Marine Science on related efforts to promote public awareness.

This report documents the work done under a grant from the Virginia Coastal Zone Management Program from 2013 to 2015. It builds on previous regional studies and is intended to provide information for communities in Hampton Roads and other regions to inform their adaptation planning efforts. This report documents the findings and results for five deliverables. The first is an update to regional sea level rise inundation maps. The second is the creation of a regional sea level rise adaptation technical working group. The third is a set of research and analysis case studies demonstrating how localities can plan for sea level rise. The fourth is a description of technical assistance provided to local governments on sea level rise planning and adaptation. The fifth is documentation of coordination and public outreach efforts related to sea level rise by the HRPDC staff. The overall goal of the report is to provide guidance

[1] CoreLogic (2013). *CoreLogic Storm Surge Report 2013*. Irvine, CA: CoreLogic.

[2] Mitchell, et al. (2013). *Recurrent Flooding Study for Tidewater Virginia*. Gloucester Point, VA: Virginia Institute of Marine Science. Online: http://ccrm.vims.edu/recurrent_flooding/Recurrent_Flooding_Study_web.pdf.

for Hampton Roads localities on how to incorporate sea level rise planning and adaptation into their projects, policies, and regulations.

This report consists of five major sections. The first part describes the methods used to map areas vulnerable to sea level rise. This includes a discussion of how the scenario was selected and a technical description of the methods used to create these maps. The second part focuses on the development of a regional technical working group that focuses on sea level rise adaptation; it covers the discussions that took place at each of the group's meetings during the grant period. The third part describes various case studies and technical analyses on sea level rise, which include assessments from outside the region on policies and measures to address sea level rise in addition to some analyses that are Hampton Roads-specific.. The fourth part describes technical assistance provided to local governments. The fifth part documents additional coordination and outreach efforts between the HRPDC and other agencies and stakeholders on sea level rise. In addition to these, there are three appendices. The first is a new sea level rise map book. The second is a diagram showing the process used to create the underlying GIS data layers for the map book. The final appendix is an example of a local planning document used to evaluate the potential vulnerability of development projects to sea level rise.

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2. Sea Level Rise Inundation Maps

Identifying areas vulnerable to flooding and sea level rise through the use of geographic information systems (GIS) can provide a number of benefits to a local government, two of which are considered in this study. First, these maps or data layers are a critical component of vulnerability or exposure analyses. These can help local governments or stakeholders model the potential extent of any impacts from flooding and sea level rise on existing development, both private and public, by comparing the extent of flooding or sea level rise with GIS datasets representing critical facilities, roads, housing, etc. Mapping vulnerable areas can also be used to inform public policies, such as comprehensive plans and capital improvement programs, or local legislative acts, such as zoning ordinances. For example, a map of areas vulnerable to flooding from a Category 1 storm surge plus three feet of sea level rise could be used to locate critical infrastructure away from potential flooding.

Since 2008 the Hampton Roads Planning District Commission has included geographic information systems (GIS) analysis of sea level rise impacts as a part of each of its VCMZP-funded grant projects related to climate change or sea level rise. Over time these analyses have grown more sophisticated and accurate as a result of advancing techniques in geographic analysis and the acquisition of better and more data. A clear example of this progress is the underlying elevation data which forms the foundation for any sea level rise or flooding analysis. In 2012, the HRPDC published its first analysis on the region's vulnerability to sea level rise. This analysis utilized an elevation dataset derived from the National Elevation Dataset with a horizontal resolution of approximately 98.4 feet (30 meters) and a vertical accuracy of 2.5 to 5 feet (0.762 to 1.524 meters). More recent analyses in 2013 and 2015 have used LiDAR-based datasets with a horizontal resolution of 5 feet (1.524 meters) and a vertical accuracy of less than a foot: 5.3 to 8.5 inches (0.135 to 0.216 meters). The implications of using better data are clear: greater accuracy and precision, which allows for better understanding of potential impacts and better planning to avoid or adapt to those impacts.

For this grant, the reasons for developing new regional sea level rise inundation maps were the acquisition of new elevation data and the identification of different scenarios needed for planning. In 2013 the HRPDC published its first LiDAR-based analysis of sea level rise vulnerability. This analysis used eleven separate elevation datasets of varying quality, accuracy, and resolution. In 2013 the HRPDC provided funding to a federal effort to acquire new LiDAR for eight localities in Hampton Roads. This data was of much better quality, and was used to update the regional digital elevation model (DEM) the HRPDC staff uses for sea level rise analyses. The new DEM is a mosaic of three datasets rather than eleven. In addition, the HRPDC

staff obtained new baseline tidal surfaces for mean lower low water (MLLW) and mean higher high water (MHHW) from NOAA's Office for Coastal Management (OCM). These tidal surfaces are used as the starting point when adding future sea level rise to existing conditions.

The level of detail and precision required for modeling and mapping inundation depends on the intended uses for the maps. A regional or state map might require only a very simple process comparing higher sea levels with land elevations, while a vulnerability analysis of stormwater outfalls and drains may require a more extensive analysis that takes into account surface connectivity and connections via the underground stormwater network. In addition to the new elevation data, the HRPDC staff incorporated a locally reviewed layer that represents bodies of water that are tidally influenced, including, in some cases, stormwater features that were identified by local staff as being subject to the influence of tides or storm surges. This component represents an improvement over the maps the HRPDC published in 2013.[3]

2.1. Projecting Sea Level Rise and Storm Surge

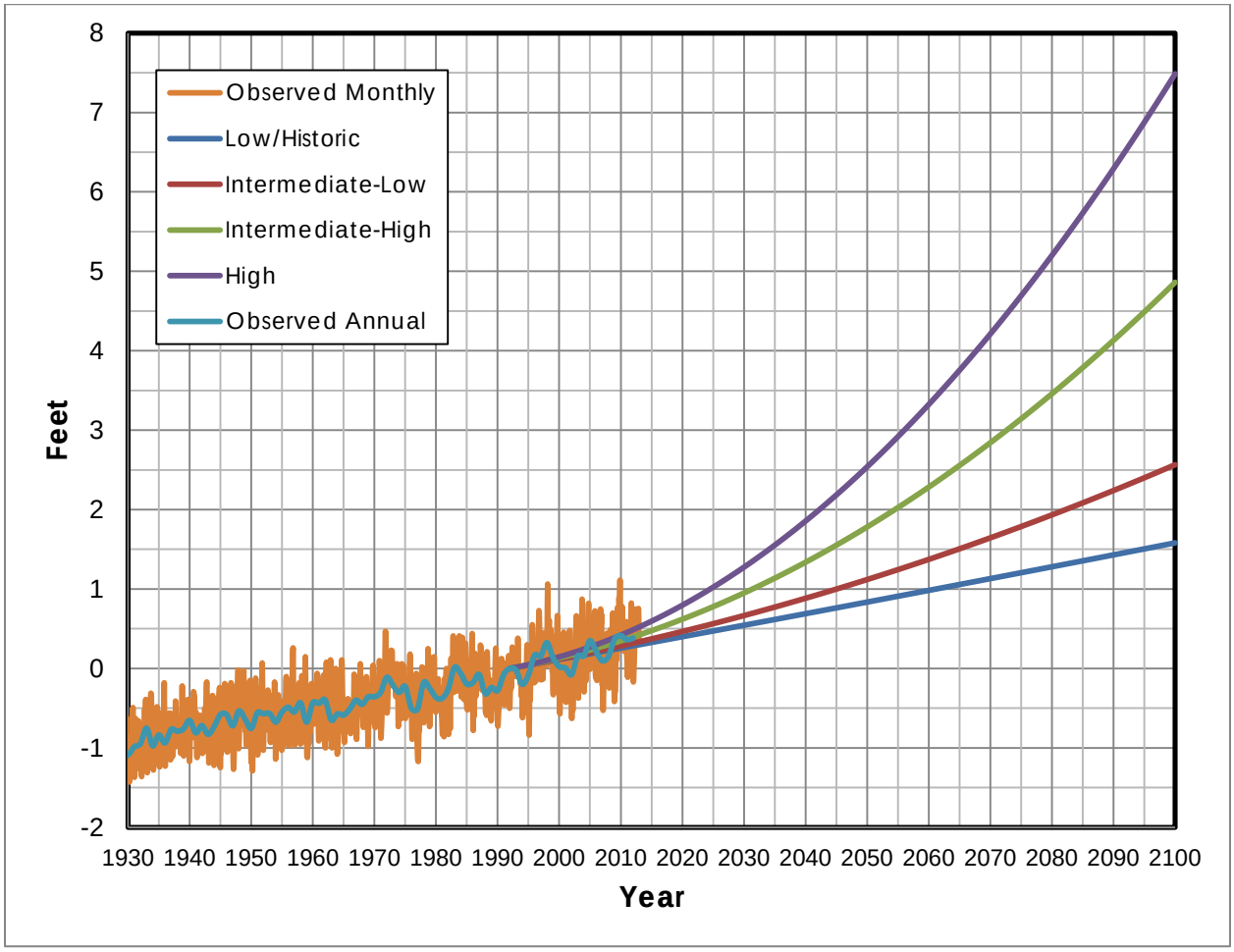
The first step in mapping areas vulnerable to sea level rise is to identify and select an appropriate amount of sea level rise. Global sea level rise occurs as a result of global warming, which causes glaciers and ice sheets to melt and oceans to expand in volume as a result of thermal expansion. Additional influences, such as shifting ocean currents and land subsidence or uplift, occur at the regional and local levels. While much research has been done on both local and global sea level trends, there is still considerable uncertainty in determining how much sea level rise will occur beyond the near future. To address this uncertainty, the most recent U.S. National Climate Assessment (NCA) incorporated a scenario approach to sea level rise planning, with each scenario incorporating different drivers of sea level rise depending on the level of confidence in projecting those drivers into the future.[4] For example, the highest scenario, which estimates 2.0 meters of global sea level rise between 1992 and 2100, is based on the maximum possible sea level rise due to thermal expansion and glacier and ice sheet loss by 2100. The intermediate-low scenario, on the other hand, accounts mainly for just thermal expansion, while the low scenario only accounts for the historic rate of measured sea level rise.

[3] McFarlane, Benjamin. *Coastal Resiliency: Adapting to Climate Change in Hampton Roads*. Chesapeake, VA: Hampton Roads Planning District Commission. Online: http://www.hrpdcva.gov/news/article/august/21/2013/the-coastal-resiliency-final-report.

[4] Parris, A., et al. (2012). *Global Sea Level Rise Scenarios for the US National Climate Assessment*. Washington, DC: National Oceanic and Atmospheric Administration. Online: http://cpo.noaa.gov/Home/AllNews/TabId/315/ArtMID/668/ArticleID/80/Global-Sea-Level-Rise-Scenarios-for-the-United-States-National-Climate-Assessment.aspx

In terms of relative confidence, historic tide gauge observations rank the highest, while projections of glacier and ice sheet loss rank lower. For Hampton Roads, these scenarios range from approximately 1.6 feet on the low end to 7.5 feet on the high end (see Figure 1).

Figure 2: Observed and Projected Relative Sea Level Change at Sewell's Point Tide Gauge, Norfolk, VA (1930-2100)



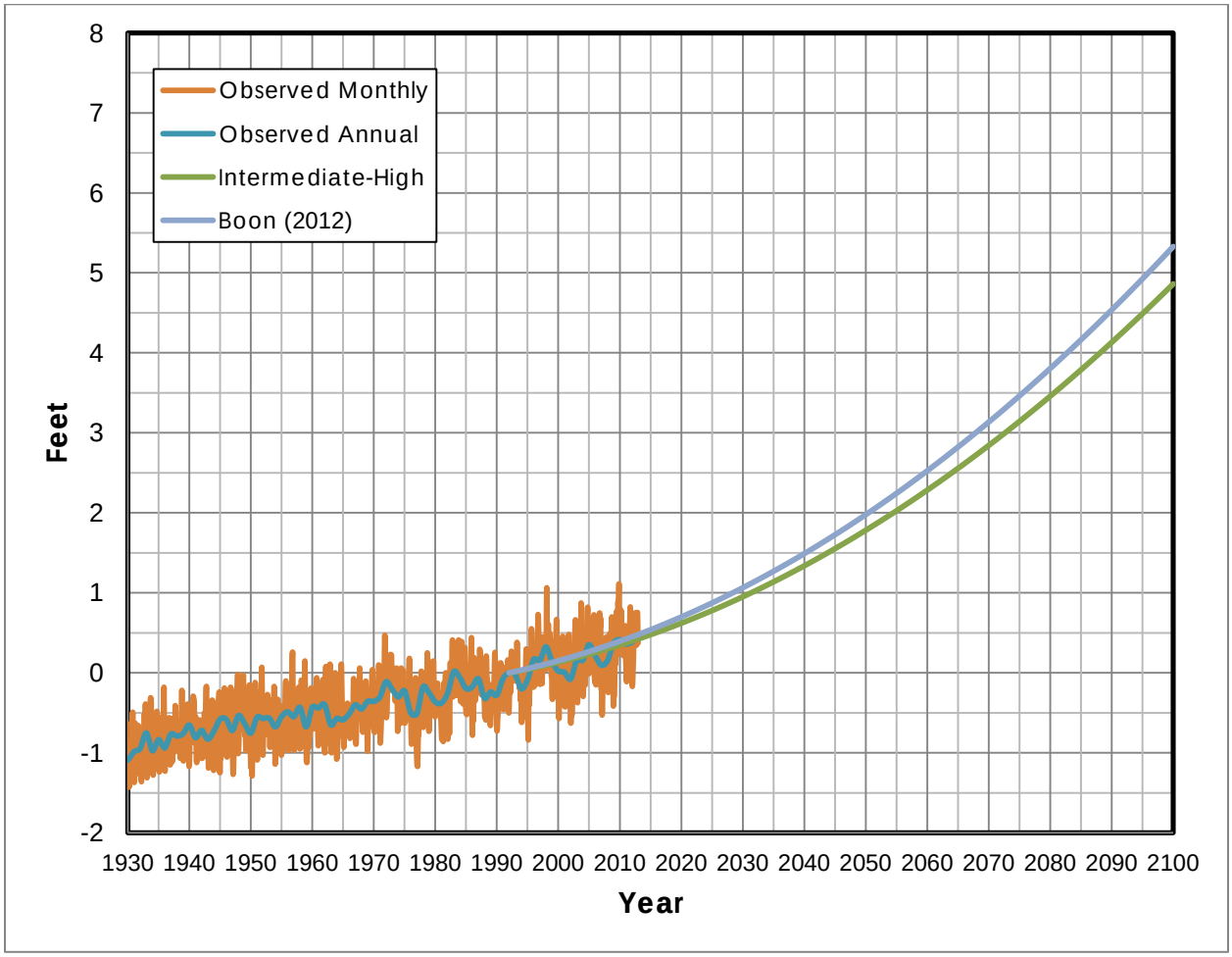
Recent research has provided further support to accelerating sea level rise. Scientists at both the Virginia Institute of Marine Science and Old Dominion University have identified accelerating sea level rise in the Chesapeake Bay and Mid-Atlantic regions using statistical analysis of tide gauge records.[5] [6] John Boon's calculations correlate very closely with the intermediate-high trend (see Figure 2). Sallenger et al. identified a "hotspot" of sea level rise

[5] Boon, John (2012). Evidence of Sea Level Acceleration at U.S. and Canadian Tide Stations, Atlantic Coast, North America. Coconut Creek, FL: Journal of Coastal Research (Vol. 28, pp. 1437-1445).

[6] Ezer, Tal and W. B. Corlett (2012). Is sea level accelerating in the Chesapeake Bay? A demonstration of a novel new approach analyzing sea level data. Geophysical Research Letters (Vol. 39).

along the mid-Atlantic coast from Boston to Cape Hatteras, which appeared to be experiencing accelerating sea level rise compared to global trends.[7] This acceleration appears to be associated with a slowing of the Atlantic Meridional Overturning Current (AMOC), known less formally as the "Gulf Stream." This finding has been reinforced by additional research from Old Dominion University.[8]

Figure 3: Comparison of Relative Sea Level Change Projections



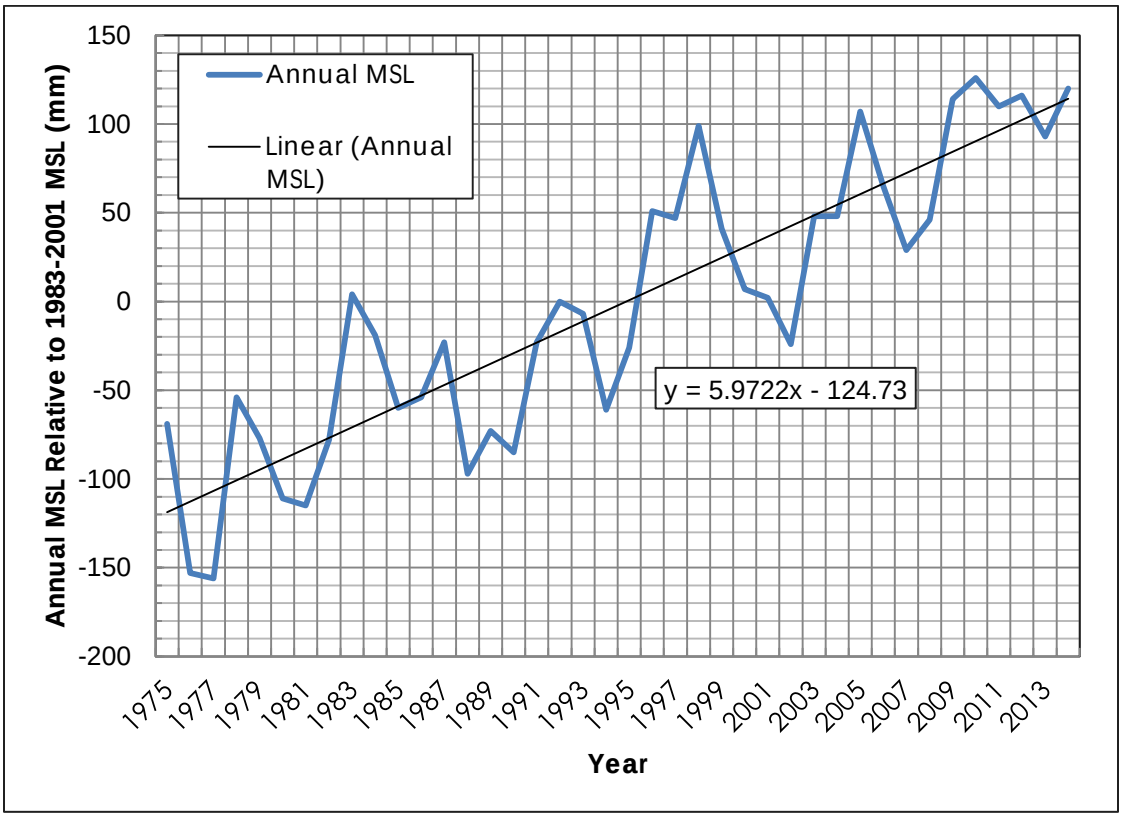
2.2. Scenario Selection

[7] Sallenger, A. H., K.S. Doran, and P.A. Howd (2012). *Hotspot of accelerated sea-level rise on the Atlantic coast of North America*. Nature Climate Change (Vol. 2 pp. 884-888).

[8] Ezer, Tal et al. (2013). *Gulf Stream's induced sea level rise and variability along the U.S. mid-Atlantic coast*. Journal of Geophysical Research: Oceans (Vol. 118, pp. 685-697).

The scenario document prepared for the NCA also provides guidance for how to plan for sea level rise based on risk preferences. From this perspective, the highest scenario is intended for use when there is little or no tolerance for risk, while the low scenario should be used when there is a high tolerance for risk.[9] However, while a long-term projection can be useful for some tasks, effective local planning often requires working with much shorter timescales than a century. A comprehensive plan might only look out twenty to twenty-five years, while a capital improvements program will only include projects planned to be built during the next five or six years. While these plans have relatively short horizons, the projects, developments, and other decisions they result in will likely last for decades if not longer. Therefore it is still important to consider longer time horizons when making decisions about certain types of projects, such as major public works.

Figure 4: Estimated Sea Level Change at Sewell's Point, 1975-2014



For this effort, the HRPDC staff worked with a newly established sea level rise advisory committee and the region's chief administrative officers to identify appropriate scenarios for the mapping effort. The previous sea level rise mapping effort published in 2013 utilized the global sea level rise scenarios developed by the National Oceanic and Atmospheric

[9] Parris et al. (2012)

Administration with a modification for local ground subsidence trends on top of mean higher high water. For this effort, the advisory committee recommended instead using one foot increments (one, two, and three feet) on top of both mean higher high water and mean lower low water, as these would have more utility and be more flexible for local planning needs. The HRPDC produced GIS data layers representing each of the six recommended scenarios to locality staff for comment and review. After further consultation with the committee and region's chief administrative officers, the HRPDC staff developed a seventh scenario which represents two feet of sea level rise from the present day. The six original scenarios were referenced to the tidal datums from the current National Tidal Datum Epoch (1983-2001). These can be interpreted as representing conditions for the midpoint of the epoch, which in this case would be 1992. Based on the recommendations from the chief administrative officers, the HRPDC calculated relative sea level rise between 1992 and the 2015, which was estimated at 0.4 feet through a linear trend analysis of mean sea level between 1975 and 2014 (see Figure 2).[10] Two feet of sea level rise was then added to this estimated amount to generate the final scenario (see Figure 3). A map book showing this sea level rise scenario is included in Appendix A. A regional map showing areas inundated or vulnerable to flooding under this scenario is included below (see Map 2).

Selection of this scenario does not reflect a regional consensus on using it as an official planning scenario. This map book and the methods used to create the maps should be viewed as a demonstration of a GIS model that can be used to create any given sea level rise scenario.

2.3. Methodology

The methodology used for this study builds on previous work by HRPDC as well as other sources, such as NOAA's "Mapping Coastal Inundation Primer," which identifies three steps to mapping inundation:[11]

1) Obtain and prepare elevation data
2) Prepare water levels
3) Map inundation

[10] The period from 1975 to 2014 was used because it is the most recent forty-year period on record. Guidance form the U.S. Army Corps of Engineers recommends using records of at least forty years in length to calculate sea level trends.

[11] NOAA Coastal Services Center (2012). *Mapping Coastal Inundation Primer*. Charleston, SC: National Oceanic and Atmospheric Administration. Online: http://www.csc.noaa.gov/digitalcoast/_/pdf/guidebook.pdf.

The elevation data used for this analysis was a combined dataset from three separate LiDAR acquisition efforts led by the U.S. Geological Survey and the Federal Emergency Management Agency:

1) USGS Eleven County Virginia LiDAR dataset, delivered in 2011, which included the Hampton Roads localities of Gloucester County, Isle of Wight County, James City County, Suffolk, Surry County, and Williamsburg
2) FEMA Southern Virginia Counties LiDAR dataset, delivered in 2012, which included Franklin and Southampton County
3) USGS Norfolk, VA LiDAR dataset, delivered in 2014, which included Chesapeake, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Virginia Beach, and York County

These datasets were mosaicked into a single digital elevation model by the HRPDC staff. Water levels for each of the working scenarios and the final scenario were produced by the HRPDC staff based on advice from the HRPDC Sea Level Rise Advisory Committee using data provided by the Office for Coastal Management.

The basic process for modeling inundation from sea level rise is to develop a water surface and compare that with land elevation data. In general, if the land elevation is less than the water surface, the area is inundated or flooded. Additional steps can be taken to account for hydrologic connectivity, which would remove low-lying but otherwise not vulnerable areas from the analysis. This analysis is similar to the one used by the HRPDC staff in 2013. For this effort, the HRPDC staff developed a twelve-step model in ArcGIS to automate the processing for a given sea level rise scenario.

1) Prepare input layers.
    a. Land elevation (provided by HRPDC)
    b. Tidal surfaces (provided by NOAA)
    c. Tidally connected waters (provided by HRPDC)
    d. Shoreline (provided by HRPDC)
2) Determine sea level rise scenario
3) Perform a Raster Calculation to identify areas with elevations below the projected tidal surface.
    a. CON(“Projected Tidal Surface” > “Land Elevation”,0,1)
4) Perform a Region Group to establish connectivity between inundated areas.
5) Perform a Raster to Polygon conversion to enable vector-based analysis.
6) Prepare the polygon field for hydrologic connectivity analysis
    a. Add Field, “Tidal” (Field Type = Short)
    b. Calculate Field (“Tidal” = X0)
    c. Make Feature Layer

7) Select Layer by Location using Tidally Connected Waters layer
8) Calculated Field for selected polygons ("Tidal" = X)
9) Select Layer by Attribute (Clear Selection)
10) Perform a Feature to Raster
11) Perform a Raster Clip using the shoreline input layer to create a layer for map publications
12) Perform a Raster to Polygon to create a layer for vector-based vulnerability analysis

A diagram of the ArcGIS model is included in Appendix B.

While the methodology attempts to account for hydrologic connectivity, it does not account for erosion or other shoreline changes that could result from sea level rise. Despite this limitation, these new maps are a significant improvement over the maps published in 2013. The new maps incorporate four distinct improvements:

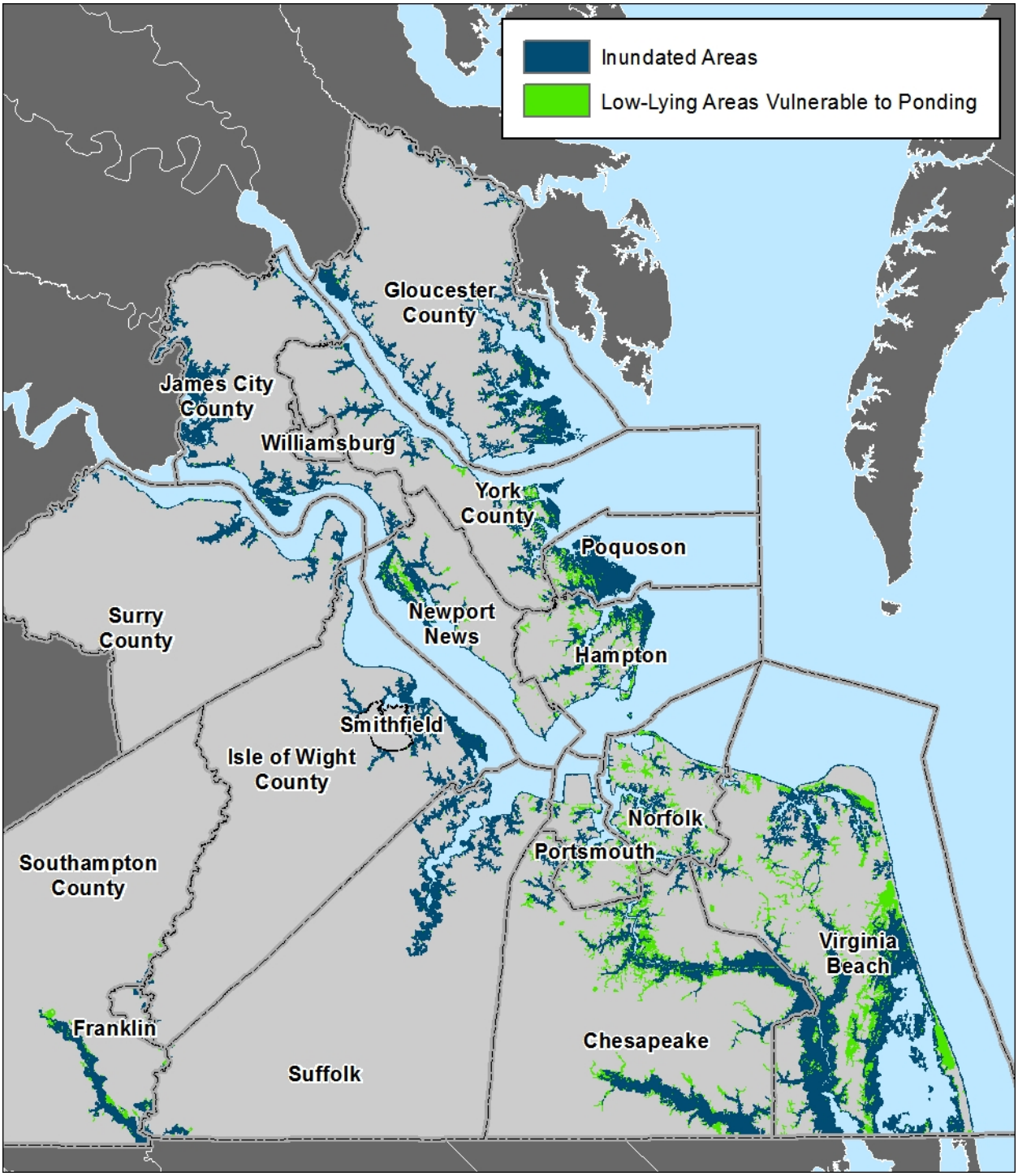
1) Higher resolution and more accurate elevation data
2) More accurate baseline tidal surfaces
3) More accurate hydrologic connectivity
4) Creation of a GIS model in ArcGIS model builder to automate the process (reducing both processing time and simplifying the process for generating multiple scenarios)

These improvements should make these maps and any other scenarios created using this methodology significantly more useful for local and regional planning efforts and analyses, two of which are discussed later in this report.

2.4. Applications for Hampton Roads Communities

1) The map book included in this report can be used as a public education and outreach tool.
2) This methodology can be used to create a suite of locally relevant sea level rise scenarios for local and regional analyses.

Figure 5: Areas Potentially Vulnerable to 2 Feet of Sea Level Rise



DISCLAIMER: Areas identified as vulnerable to sea level rise in this map are based on a projection of two feet of relative sea level rise above current (2015) mean higher high water for the Sewell's Point tide gauge in Norfolk, Virginia. This map is for illustrative purposes only and should not be used for site planning or evacuation decisions. During actual storm events, residents should follow instructions from local and state emergency management officials.

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3. Sea Level Rise Case Studies

As part of this grant the HRPDC staff briefed local government staff on several types of analyses that could be conducted for local governments interested in understanding the potential impacts of sea level rise. These types of analyses included various methods to estimate a locality's vulnerability or exposure to sea level rise and rely on local data to provide the most accurate and useful results. The HRPDC staff had several discussions with locality staff about potential studies or to provide input on local planning and analysis efforts.

In March 2015, Governor McAuliffe signed into law Senate Bill 1443, which added a new section to the Code of Virginia requiring localities who are members of the Hampton Roads Planning District Commission to address sea level rise in their comprehensive plans.[12] Specifically, the law requires localities to "incorporate into their next scheduled and all subsequent reviews of [their] comprehensive plan strategies to combat projected relative sea level rise and recurrent flooding." The law also requires localities to coordinate with each other in conducting these reviews. In response to this new legislative requirement, the HRPDC staff began identifying case studies of areas around the country that have already begun incorporating sea level rise into their plans and development policies. Three case studies were identified for this project: Boston, Massachusetts, San Francisco, California, and Broward County, Florida. A summary of potential applications for Hampton Roads communities is included at the end of each case study.

3.1. National Case Study #1: Boston, Massachusetts

3.1.1. Summary

The city of Boston and its surrounding area are significantly vulnerable to sea level rise and coastal hazards. Like Hampton Roads, Boston faces the challenge of adapting to a changing climate while addressing impacts to existing development, much of which has been in existence for decades if not centuries. To address these challenges, the Boston Redevelopment Authority, the city agency responsible for both urban planning and economic development, released two

[12] Code of Virginia § 15.2-2223.3

documents to begin the task of adapting private developments to climate impacts.[13] The first of these documents is the "Climate Change Preparedness and Resiliency Guidelines," which provides overall direction to how development projects should address climate change impacts and the process for how any adaptation measures will be reviewed by the city.[14] The second document is the "Climate Change Resiliency and Preparedness Checklist," a document that must be filled out by all developers of qualifying projects. The checklist requires developers to identify both expected climate-related impacts and any adaptation measures undertaken to address those impacts.

The "Climate Change Preparedness and Resiliency Guidelines" charge developers of qualifying projects (those "subject to Boston Zoning Article 80 Small and Large Project Review") with identifying how climate change would affect both a project and its environmental impacts. The guidelines also require developers to go beyond primary climate change impacts, such as sea level rise and higher temperatures, to include "secondary and cascading impacts" such as utility outages (electricity, gas) and system disruptions (telecommunications, transportation). The process for meeting these guidelines has four steps:

1) Complete the "Climate Change Resiliency and Preparedness Checklist"

2) Incorporate strategies to address climate change impacts to project components as necessary

3) Review of a completed checklist by the Boston Interagency Green Building Committee

4) Submission of an updated and final checklist including a written response to the Boston Interagency Green Building Committee to any comments received following step #3

The "Climate Change Resiliency and Preparedness Checklist" (see Appendix C) requires a thorough assessment of a project's susceptibility to various climate impacts and mitigation strategies incorporated into the project's design to address those impacts. There are four sections: project description, green building, extreme weather and heat events, and sea level rise and storm surge. The project description and green building sections require answers to

[13] Boston Redevelopment Authority (2014). *Who We Are*. Online: http://www.bostonredevelopmentauthority.org/about-us/planning-boston-s-future. Accessed June 2014.

[14] Boston Redevelopment Authority (2013). *Climate Change Preparedness and Resiliency*. Online: http://www.bostonredevelopmentauthority.org/planning/planning-initiatives/climate-change/preparedness-and-resiliency. Accessed June 2014.

several basic questions about the project. The two climate-related sections require a more in-depth analysis of expected climate impacts and how those impacts will be addressed. For example, the extreme weather and heat events section asks what extreme heat event characteristics will be used to design and plan the project, in terms of peak high (degrees), duration (days), and frequency (events per year). A developer is also required, for example, to describe the insulation values for the building's envelope elements. For the sea level rise and storms section, the checklist includes questions on flood mitigation measures, flood zones, and sea level rise and storm frequency projections.

3.1.2. Key Points

- The "Climate Change Preparedness and Resiliency Guidelines" provide an overview of the process for developers meeting requirements to address climate change impacts on projects.

- The "Climate Change Resiliency and Preparedness Checklist" is a mandatory comprehensive assessment of the impacts of climate change on projects and requires developers to consider those impacts in the planning and design of projects.

3.1.3. Lessons for Hampton Roads Communities

While it is unclear if existing local authority to regulate development would allow for a climate change checklist, the approach merits further investigation. The Boston example provides a useful example of a comprehensive checklist that is completed as part of the normal development process. In addition, such a checklist could allow cities and counties to address multiple goals, such as energy efficiency and hazard mitigation, in addition to climate change impacts. A review of whether or not Virginia localities have existing authority to require a checklist would be necessary before adoption and implementation.

3.2. National Case Study #2: San Francisco Bay Conservation and Development Commission

3.2.1. Summary

The San Francisco Bay Conservation and Development Commission, or BCDC, is a regional body established by the State of California to plan for and regulate development within the San

Francisco Bay, its tidal shores, its tributaries, and other related wetlands and waters. The BCDC was created in 1965 and has jurisdiction over parts of nine counties: Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma.[15] In addition to permitting, one of BCDC's major responsibilities is the creation and implementation of the San Francisco Bay Plan, which establishes findings and outlines policies related to a range of issues relevant to the San Francisco Bay, including dredging, shoreline protection, commercial fishing, recreation, and several others.[16] The Bay Plan was originally adopted by the Commission in 1969.

Recognizing the potential impacts of climate change on the Bay, the Commission authorized the BCDC staff to propose amendments to four sections of the plan to account for climate change: tidal marshes and tidal flats, safety of fills, protection of the shoreline, and public access. The staff was also authorized to develop a new section on climate change. Much of the technical work produced by the staff related to the impacts of sea level rise on the Bay's built and natural environments; this included an analysis of the areas vulnerable to flooding and inundation as a result of sea level rise, and an estimate of the economic value of assets at risk.[17]

As a result of this research and analysis, the Commission adopted Bay Plan Amendment No. 1-08 on October 6, 2011.[18] This amendment establishes the rationale for amending the Bay Plan to account for climate change, outlines the benefits of the proposed actions, and contains the amended and new findings and policies for the affected sections. The amended findings now incorporate climate impacts in addition to the previous findings on the importance of the Bay's resources. The new and amended policies also explicitly incorporate climate change impacts into the Commission's goals and requirements for development projects. For the new climate change section, the amendment includes, for example, findings on greenhouse gas emissions, sea level rise, flooding, resilience, mitigation, adaptation, and the vulnerability of different

[15] San Francisco Bay Conservation and Development Commission (2007). *San Francisco Bay Conservation and Development Commission*. Online: http://www.bcdc.ca.gov/. Accessed June 2014.

[16] San Francisco Bay Conservation and Development Commission (2007). *San Francisco Bay Plan*. Online: http://www.bcdc.ca.gov/laws_plans/plans/sfbay_plan.shtml. Accessed June 2014.

[17] San Francisco Bay Conservation and Development Commission (2011). *Living with a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and on its Shoreline*. San Francisco, CA: San Francisco Bay Conservation and Development Commission. Online: http://www.bcdc.ca.gov/BPA/LivingWithRisingBay.pdf.

[18] San Francisco Bay Conservation and Development Commission (2011). *Climate Change Bay Plan Amendment*. Online: http://www.bcdc.ca.gov/proposed_bay_plan/bp_amend_1-08.shtml. Accessed June 2014.

assets and communities. The new section also includes several policies related to climate change adaptation, including:

- Recommending risk assessments, including inundation maps, based on the vulnerability of a project to flooding that incorporates sea level rise
- Recommending that projects be designed to be "resilient to a mid-century sea level rise projection"; projects with longer lifespans should have an adaptive management plan
- Recommending that undeveloped areas that are vulnerable to flooding and ecologically important be prioritized for preservation or enhancement
- Recommending that the Commission develop a regional sea level rise adaptation strategy

To assist developers with meeting these new requirements, BCDC has posted a fact sheet on its website briefly explaining the new requirements.[19] The fact sheet describes which projects must conduct risk assessments and which sea level rise projections to use in the assessments. The policies for protecting developments and the shoreline, preserving public access, and ecosystem protection, restoration, and preservation are also included.

3.2.2. Key Points

- The San Francisco Bay Conservation and Development Commission has regulatory authority over the San Francisco Bay, its shores, and related waters. The Commission has developed the Bay Plan to establish and implement policies to utilize the Bay's resources while protecting and preserving them.
- The Commission adopted an amendment to the Bay Plan in 2011 that incorporated climate change into four existing sections of the Bay Plan and established a new section detailing the impacts of climate change on the Bay and policies to address those impacts.

[19] San Francisco Bay Conservation and Development Commission (2011). *New Sea Level Rise Policies Fact Sheet*. Online: http://www.bcdc.ca.gov/planning/climate_change/SLRfactSheet.shtml. Accessed June 2014.

- These new policies require developers to assess the risks that projects may face from flooding and sea level rise. They also establish minimum requirements for some types of projects, such as public access, shoreline protection, and ecosystem restoration projects.

3.2.3. Lessons for Hampton Roads Communities

The Bay Plan demonstrates how a plan can directly connect findings with policies, which may help provide support for new policies facing legal challenges in the absence of explicit authorization. The risk assessment requirement also connects sea level rise to increased flood risk, and mandates that projects address those flood risks. Since existing Virginia law allows localities to plan for flooding and regulate development within floodplains, this may be a useful template to follow in extending those regulations to address sea level rise. The new policies also provide examples of other steps that may be taken to adapt to sea level rise beyond increasing flood protection, such as allowing for upland migration of wetlands and encouraging preservation of undeveloped areas.

3.3. National Case Study #3: Broward County, Florida

3.3.1. Summary

In January 2010, four counties in Southeast Florida (Broward, Monroe, Palm Beach, and Miami-Dade) agreed to form the Southeast Florida Regional Climate Change Compact, a regional entity tasked with assessing the impacts of climate change on the region and with developing policies to respond to those impacts.[20] The Compact addresses both climate change adaptation and mitigation. The Compact has produced numerous reports and documents since its inception, including a unified sea level rise projection for Southeast Florida, a regional greenhouse gas emissions inventory, and a regional sea level rise vulnerability analysis. In addition to its regional work, the Compact has worked with the federal government and with Florida's state government to provide and implement tools to help local governments address climate impacts.

One of the most significant accomplishments of the Compact was its successful advocacy for state law enabling the designation of Adaptation Action Areas. This designation was authorized

[20] Southeast Florida Regional Climate Change Compact. *Southeast Florida Regional Climate Change Compact*. Online: http://southeastfloridaclimatecompact.org/. Accessed June 2014.

under HB 720, the Community Planning Act, which was adopted by the Florida legislature in May 2011.[21] The resulting law defines Adaptation Action Areas as those that "experience coastal flooding due to extreme high tides and storm surge, and that are vulnerable to the related impacts of rising sea levels for the purpose of prioritizing funding for infrastructure needs and adaptation planning."[22] Furthermore, local governments that designate Adaptation Action Areas are allowed to consider policies to improve resilience to coastal hazards.[23] Eligible areas include those areas with elevations below, at, or near mean high water, those which have a hydrologic connection to coastal waters, and those areas designated as evacuation zones for storm surge.

Following the adoption of HB 720, The Florida Department of Economic Opportunity began a project studying how sea level rise adaptation could be integrated into existing local planning processes.[24] A subsequently published report described various ways that localities could address sea level rise as part of their comprehensive plans and zoning ordinances. The report also describes how a locality should go about designating Adaptation Action Areas, including the policy language that should be adopted as justification and the actual methods for adoption and implementation. Planning tools identified include overlay zones, floodplain regulations, building codes, setbacks, buffers, incentives, permits, conditional zoning, rebuilding restrictions, transfer of development rights, stormwater utility fees, special assessments, impact fees, conservation easements, real estate disclosures, land acquisition and preservation, local task forces, and community outreach.

Broward County has already begun incorporating climate change adaptation into its comprehensive plan through a standalone Climate Change Element and accompanying Support Document adopted in February 2013. The intended goal of the included objectives and policies is to "achieve a sustainable, climate resilient community."[25] There are eight areas specifically addressed by the element's objectives:

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[21] Florida Department of Community Affairs Division of Community Planning (2011). *Adaptation Action Areas*. Florida Department of Community Affairs.

[22] Florida Statutes §163.3164(1)

[23] Florida Statutes §163.3177(6)(g)(10)

[24] Southeast Florida Regional Planning Council (2013). *Adaptation Action Areas: Policy Options for Adaptive Planning for Rising Sea Levels*. Southeast Florida Regional Planning Council. Online: https://southeastfloridaclimatecompact.files.wordpress.com/2014/07/final-report-aaa-11-6-13-1.pdf.

[25] Broward County (2013). *Comprehensive Plan Climate Change Element*. Broward County. Online: http://www.broward.org/PlanningAndRedevelopment/ComprehensivePlanning/Documents/ClimateChangeElement.pdf.

1) Greenhouse Gas Emissions Reduction, Renewable Energy Production and Distribution
2) Mitigation, Protection and Adaptation within the Transportation System
3) Mitigation, Protection and Adaptation within the Built Environment
4) Mitigation, Protection and Adaptation within our Natural Systems
5) Mitigation, Protection and Adaptation of Water Resources and Services
6) Interagency Coordination
7) Emergency Preparedness and Disaster Management
8) Social Considerations, Public Health and Education

Example policies include promoting alternative and renewable energy, identifying public infrastructure at risk from sea level rise, promoting migration and adaptation of natural resources, and protecting drinking water supplies. Policy 19.3.13 also states that the county will work with its municipalities to designate Adaptation Action Areas by 2017. Broward County has already begun this work by identifying "Priority Planning Areas for Sea Level Rise" on an official county map, which identifies those areas at risk of inundation by two feet of sea level rise.[26]

The accompanying support document provides the foundation for the Climate Change Element.[27] It defines key terms and addresses data and analysis requirements. Key analyses in the document include a county greenhouse gas emissions inventory by sector, a government facilities greenhouse gas emissions inventory, sea level rise projections and inundation maps, a summary sea level rise vulnerability analysis, and an assessment of climate change impacts on the county. The document also contains a section on implementation, which describes how the policies adopted in the Climate Change Element can be addressed through existing county programs.

3.3.2. Key Points

- Florida has passed legislation authorizing localities to designate Adaptation Action Areas within their comprehensive plans to implement policies promoting resilience.

[26] Broward County. *Priority Planning Areas for Sea Level Rise*. Online: http://gis.broward.org/maps/webPDFs/SeaLevelRise/PriorityPlanningAreasForSeaLevelRise.pdf. Accessed June 2014.

[27] Broward County (2013). *Comprehensive Plan Climate Change Element Support Document*. Broward County. Online: http://www.broward.org/PlanningAndRedevelopment/ComprehensivePlanning/Documents/CCElementSupportDoc.pdf.

- The Southeast Florida Regional Climate Change Compact has published several regional analyses to inform local and regional climate change adaptation planning, including a greenhouse gas emissions inventory, a unified sea level rise projection, and sea level rise vulnerability analysis.

- Broward County, Florida has adopted a Climate Change Element and Support Document as part of its Comprehensive Plan to guide the County's climate change adaptation efforts.

3.3.3. Lessons for Hampton Roads Communities

The Climate Change Element and Support Document provide a model for how Hampton Roads communities can incorporate climate change impacts into its comprehensive plan, which already has separate sections for policies, technical information, and references. The analyses used in the Florida example already exist in some cases, and could be incorporated into the plan with little effort. While communities are within their authority to identify areas that are vulnerable to sea level rise and flooding, it is less clear if they would be allowed to designate them as "Adaptation Action Areas" or to use sea level rise as the rationale for prioritization of projects and services. The many policies and objectives in the Broward County Climate Change Element could also be utilized by Hampton Roads communities as examples for local policies to adopt as part of their next comprehensive plan updates.

3.4. Applications for Hampton Roads Communities

1) Hampton Roads communities should consider mandating or encouraging vulnerability and adaptation assessments as part of its development review process.
2) Hampton Roads communities should consider preparing a separate climate change element for its comprehensive plan.
3) Hampton Roads communities should consider incorporating sea level rise into its infrastructure planning framework.

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4. Sea Level Rise Technical Committee

Regional coordination on sea level rise requires the participation and input from a wide range of government actors (local, state, and federal) in addition to academic researchers and other subject matter experts. For previous projects, the HRPDC relied primarily upon the agency's Joint Environmental Committee or Regional Environmental Committee to provide feedback on regional efforts. These meetings, which primarily included planners and stormwater managers, also allowed for local efforts to be shared with colleagues in different jurisdictions. However, recognizing the potential impacts of sea level rise on the work programs for multiple departments, the HRPDC decided as part of this grant to create a new group that would serve as the official advisory committee on sea level rise. In March 2014, the HRPDC staff briefed the Commission on a proposal to create a new committee to address recurrent flooding and sea level rise. The Commission approved this action, and in April 2014 the HRPDC Executive Director sent a memorandum to all HRPDC chief administrative officers asking them to appoint two representatives, one voting and one technical, to the new committee. The committee was given three objectives:

1) Develop specific recommendations related to recurrent flooding and sea level rise adaptation and mitigation for local governments.
2) Advocate for support and action by the state government and federal government.
3) Serve as the primary regional contact to coordinate efforts with federal agencies and academic institutions.

Currently the Sea Level Rise Advisory Committee includes members representing all seventeen (17) of the HRPDC's member jurisdictions, including representatives from city and county senior management, planning departments, public works departments, and emergency management departments. The committee met six (6) times during the period of this grant. In general, meetings feature one or more substantive presentations from the HRPDC staff or local government representatives, briefings from academic institutions on relevant projects, and updates from committee members on local government adaptation or planning efforts.

Table 1: Meetings of the HRPDC Sea Level Rise Technical Committee

Date	Attendance	Groups	Meeting Summary
June 20, 2014	30	17	This meeting featured presentations from Dr. Larry Atkinson (Old Dominion University) and Ms. Molly Mitchell (Virginia Institute of Marine Science) on their respective institutions' projects related to sea level rise and recurrent flooding. The meeting also included a status report from the HRPDC staff on regional efforts. The focus of the meeting was on a discussion regarding the new committee's structure and its areas of focus.
September 26, 2014	31	25	This meeting featured a briefing and discussion on a proposal for a Dutch Dialogues workshop in Hampton Roads. The committee also discussed by-laws and legislative priorities. The meeting also included a presentation and discussion on local floodplain management standards and whether any regional recommendations should be developed. Potential items up for consideration were freeboard requirements and whether or not to adopt the Limit of Moderate Wave Action (LiMWA) line into local ordinances.
December 19, 2014	30	19	This meeting featured presentations from the HRPDC staff on a proposal to study land subsidence and new regional sea level rise inundation maps. The meeting also included discussion of the ODU Intergovernmental Pilot Project and whether and how localities and the HRPDC should engage it. The committee also voted to recommend that the HRPDC adopt a resolution encouraging local governments to consider adopting freeboard requirements.
March 13, 2015	32	21	This meeting featured an update from the HRPDC staff on the Dutch Dialogues workshop, which included an overview of the site selection process. Mr. Matt Wall (VDEM) briefed the committee on the state's application for the National Disaster Resilience Competition. The HRPDC staff also briefed the committee on the status of regional sea level rise inundation maps and the proposed federal flood risk management standard. The committee continued discussions about a possible regional work program on sea level rise.

Date	Attendance	Groups	Meeting Summary
May 29, 2015	36	21	This meeting included discussions and updates on the Dutch Dialogues workshop, the National Disaster Resilience Competition, comprehensive plan requirements related to sea level rise, a coastal resiliency grant opportunity, and the Hampton Roads Adaptation Forum. The main focus of the meeting was a presentation and discussion on new regional sea level rise inundation maps.
July 31, 2015	25	19	The focus of this meeting was a discussion about the HRPDC's work program on sea level rise. This meeting included updates on the National Disaster Resilience Competition application and regional sea level rise inundation maps. Dr. Hank Meyer (Rutgers) briefed the committee on a proposal to pilot a NOAA tool, Port Tomorrow, in Hampton Roads with a focus on coastal resiliency.

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5. Sea Level Rise Technical Assistance

A major component of the HRPDC's work related to sea level rise and recurrent flooding has consisted of providing technical assistance to locality staff in the form of answering questions, recommending resources, and providing data. In addition to sending out the GIS data layers developed for this project's maps for local review, sea level rise data layers and guidance from previous projects was provided to three cities on request: Chesapeake, Norfolk, and Suffolk. In addition, the HRPDC staff consulted with staff from the City of Portsmouth on potential data needs for vulnerability analyses. The HRPDC staff also provided assistance to researchers conducting studies on sea level rise in Hampton Roads.

In addition to working with locality partners, the HRPDC staff has also been supporting efforts by the Hampton Roads Transportation Planning Organization (HRTPO), the federally designated metropolitan planning organization for Hampton Roads, to incorporate sea level rise and flooding into their planning and programming efforts. In 2013, the HRPDC staff provided assistance by developing inundation layers for the HRTPO's July 2013 study, "Hampton Roads Military Transportation Needs Study: Roadways Serving the Military and Sea Level Rise/Storm Surge."[28] This assistance continued in 2014 and 2015 with the HRPDC staff advising the HRTPO staff on how to develop appropriate scenarios for analyzing the potential impacts of sea level rise and storm surge on the region's transportation network. These discussions led to the HRTPO's selecting three scenarios for its initial vulnerability analysis:

1) Two feet of sea level rise above mean higher high water
2) Two feet of sea level rise plus a 25-year storm surge event
3) Two feet of sea level rise plus a 50-year storm surge event

Two feet of sea level rise was selected based on the intermediate scenarios for the National Climate Assessment and the time horizon used for the upcoming long-range transportation plan. The 25-year and 50-year storm surge events were selected based on design guidelines from the Virginia Department of Transportation. Once these scenarios were selected, the HRPDC continued to provide support by developing GIS data layers for each of the scenarios. For the first scenario, the methodology was the same as that used for the maps described earlier in this report. For the two storm surge scenarios, the HRPDC staff acquired layers

[28] Belfield, Samuel. *Hampton Roads Military Transportation Needs Study: Roadways Serving the Military and Sea Level Rise/Storm Surge*. Chesapeake, VA: Hampton Roads Transportation Planning Organization. Online: http://hrtpo.org/uploads/docs/Roadways%20Serving%20the%20Military%20&%20Sea%20Level%20Rise-Storm%20Surge%20Report.pdf.

developed for the FEMA Regional III Storm Surge Study by the U.S. Army Corps of Engineers. This data was provided as points with values for various storm surge events (e.g. 25-year, 100-year, 500-year). Two feet was added to the value for each point for the necessary storm surge scenarios, and then the dataset was interpolated to develop the inundation layer. Once the inundation layer was created, the methodology for determining which areas were vulnerable was nearly identical to the sea level rise mapping methodology discussed earlier. The HRTPO staff is currently using these data layers to complete its analysis of existing vulnerability of the regional transportation system to sea level rise and storm surge. The HRTPO is also considering how to use this information in the project prioritization process for the next long-range transportation plan.

6. Coordination and Outreach

Coordination with other governmental and non-governmental entities forms a significant part of the HRPDC staff's work on sea level rise. Current partnerships and efforts build on work done under previous grants. During the period of this grant, the HRPDC staff continued to work with state universities, including the College of William and Mary, Old Dominion University, the University of Virginia, and the Virginia Institute of Marine Science. The HRPDC staff also worked with several intergovernmental efforts, including the Recurrent Flooding Subpanel of the Secure Commonwealth Panel and the ODU Intergovernmental Pilot Project. Other efforts included the Dutch Dialogues workshop in June 2015 (held in conjunction with the Cities of Hampton and Norfolk and the Royal Netherlands Embassy) and the Transportation Research Board's International Conference on Surface Transportation System Resilience to Climate Change and Extreme Weather Events. The HRPDC staff also continued to present on sea level rise, flooding, and climate change to professional and citizen audiences throughout the course of the grant. Examples of organizations the HRPDC staff met with as part of this grant are the Fort Monroe Authority and the Portsmouth Partnership.

6.1. Secure Commonwealth Panel

The Recurrent Flooding Subpanel of the Secure Commonwealth Panel was established to develop and provide recommendations to the Secretary of Public Safety and Homeland Security on flooding and sea level rise. The HRPDC staff's role in the subpanel consisted of attending meetings of the data/mapping workgroup. The HRPDC staff also followed the overall activity of the subpanel to provide updates to local staff committees.

6.2. ODU Intergovernmental Pilot Project

The ODU Intergovernmental Pilot Project began in June 2014. The pilot project aims to bring together all levels of government (local, state, federal) with non-governmental partners, such as academic researchers and businesses, to develop a "whole of government" and "whole of community" approach to planning for sea level rise.[29] The HRPDC staff has supported the pilot project by participating on the steering committee, the legal work group, and the infrastructure work group.

[29] Old Dominion University (2015). *About the Center for Sea Level Rise.* Online: http://www.centerforsealevelrise.org/about-the-center-for-sea-level-rise/. Accessed July 2015.

6.3. Hampton Roads Adaptation Forum

The HRPDC staff continued to work with Virginia Sea Grant and Old Dominion University to plan meetings of the Hampton Roads Adaptation Forum. The forum began in 2011 and has since held a total of ten meetings. Most of these meetings are held at the Virginia Modeling, Analysis, and Simulation Center (part of ODU) in Suffolk, Virginia. The HRPDC staff's principal role is to help develop meeting agendas, identify and reach out to prospective speakers, and advertise forum meetings to local government staff. During the period of this grant the forum met six times.

Table 2: Meetings of the Hampton Roads Adaptation Forum, October 2013-September 2015

Meeting Date	Forum Topic	Total Attendance
October 2, 2013	Federal, State and Local perspectives for Adapting to Sea Level Rise and Flooding	58
March 28, 2014	Addressing Current and Future Vulnerability through Floodplain Management	69
September 19, 2014	Comparing Flooding and Sea Level Rise Risk Assessment Tools	61
January 23, 2015	Storm Surge Modeling Tools for Planning and Response	60
May 22, 2015	Megaproject Protective Structures for Hampton Roads	42
July 24, 2015	Communicating Frequent Flooding	53

6.4. Dutch Dialogues

Throughout the period of this project the HRPDC staff coordinated with several other parties, including local governments in Hampton Roads, private entities, and the Royal Netherlands Embassy, to plan and organize a workshop on integrated water management strategies modeled after the Dutch Dialogues held in New Orleans, Louisiana. [30] The goal of this workshop would be to identify strategies that would help Hampton Roads communities address flooding and sea level rise while also improving their residents' quality of life and providing opportunities for economic benefit. The HRPDC's role consisted of coordinating the initial discussion of whether to host the workshop and which sites to use as case studies. This process consisted of three multijurisdictional meetings in addition to six meetings with individual localities (Chesapeake, Hampton, James City County, Norfolk, Portsmouth, and Virginia Beach)

[30] Dutch Dialogues (2015). *Dutch Dialogues.* Online: http://dutchdialogues.com/. Accessed July 2015.

to discuss candidate locations and issues. The HRPDC staff then worked with a local government staff committee to select the final two sites to propose to the Dutch Embassy. The two sites, the Tidewater Drive District in Norfolk and the Newmarket Creek Watershed in Hampton and Newport News, were accepted by the embassy. Once the initial selection process was completed, the HRPDC staff worked with the workshop steering committee to arrange logistics and develop the agenda. The HRPDC staff also participated in the entire workshop, which ran from June 19 to June 23 at the Slover Library in Norfolk, as part of the regional group. More information on the Hampton Roads Dutch Dialogues workshop can be found at www.lifeatsealevel.org.

Table 3: Coordinating Meetings for Hampton Roads Dutch Dialogues Workshop

Meeting Date	Total Attendance	# of Parties Present
April 22, 2014	3	3
November 21, 2014	28	13
February 2, 2015	20	3
February 23, 2015	6	3
February 24, 2015	10	3
February 25, 2015	8	3
March 5, 2015	6	3
March 6, 2015	6	3
March 18, 2015	12	8
March 30, 2015	10	7

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6.5. TRB International Conference on Surface Transportation System Resilience

The Transportation Research Board held its first Conference on Surface Transportation System Resilience to Climate Change and Extreme Weather Events in Washington, D.C., from September 16-18, 2015. The goal of the conference was to bring together transportation professionals and share lessons learned and best practices on incorporating resilience into transportation planning, infrastructure design, and operations. The HRPDC staff supported this effort by participating as a member of the conference planning committee. Specific tasks included reviewing proposal abstracts, arranging sessions, and helping with general conference planning. During the conference, the HRPDC staff presided over one breakout session and served as support staff for two more.

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7. Findings and Next Steps

This report documents the results of a grant project from the Virginia Coastal Zone Management Program. It builds on previous efforts by the Hampton Roads Planning District Commission and others that have looked at how sea level rise could affect communities in Hampton Roads and at possible strategies local governments could use to mitigate negative impacts. By looking for lessons that can be directly applied at the local government level, this study aims to provide actionable information for communities looking to begin planning for sea level rise adaptation. In addition to these policy applications, the project also resulted in a new methodology for developing sea level rise inundation maps, which can be used by regional and local organizations to map specific scenarios of sea level rise for analysis and policy development. This project also led to the creation of a new regional advisory committee which will continue to discuss the impacts of sea level rise and potential adaptation measures. This new committee will assist the HRPDC staff in developing and implementing a sustainable regional program focused on planning for sea level rise.

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