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Fostering University Collaboration and Building Capacity to Respond to Coastal Resilience Challenges in Virginia: Findings from the Rotating Resilience Roundtables Workshop Spring 2019

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FINDINGS FROM THE ROTATING RESILIENCE ROUNDTABLES WORKSHOP SPRING 2019

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Hosted by:

OLD DOMINION UNIVERSITY

INSTITUTE FOR COASTAL ADAPTATION & RESILIENCE

CCRFR
COMMONWEALTH CENTER FOR RECURRENT FLOODING RESILIENCY

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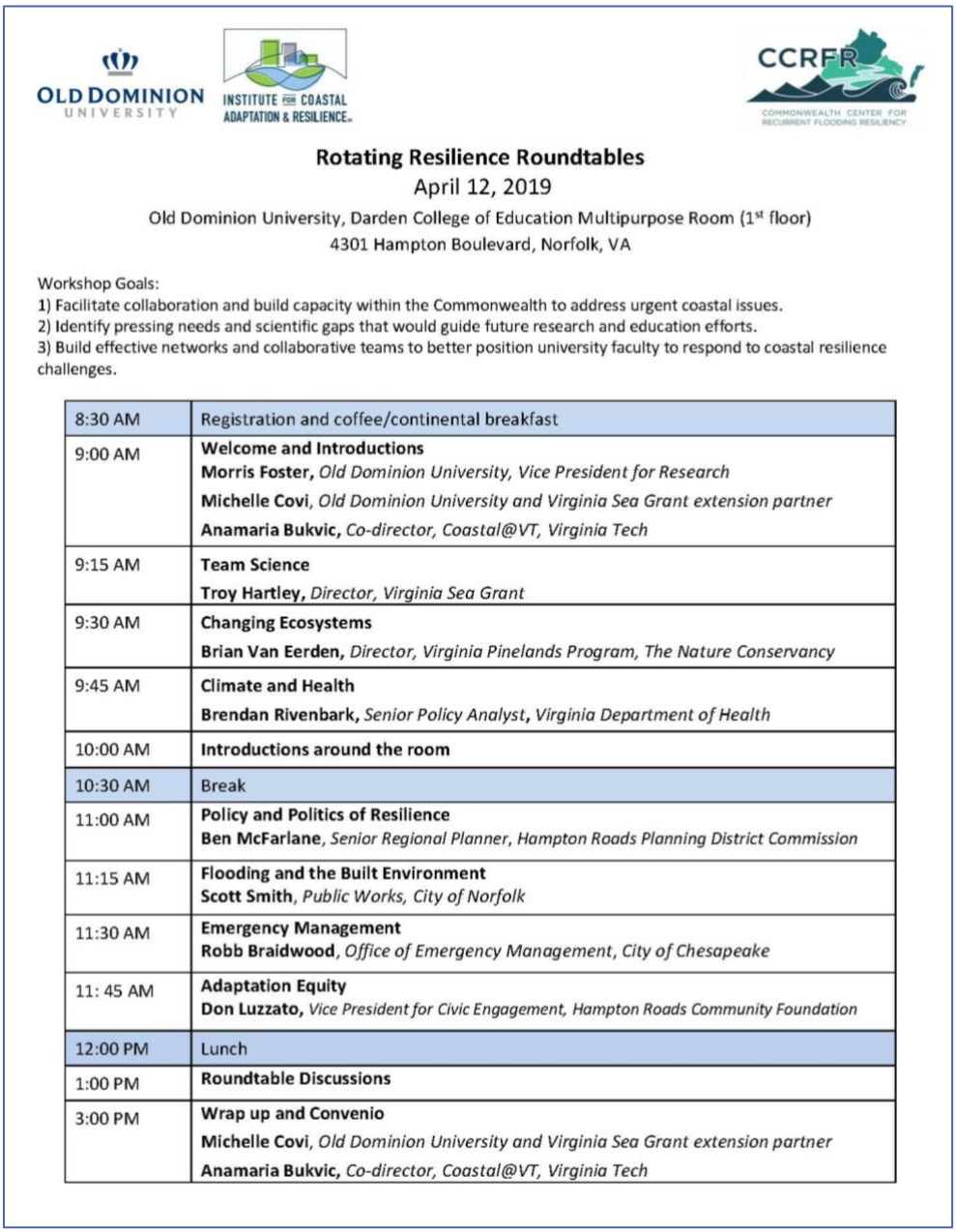
1. Background and Overview

Communities in coastal Virginia, particularly in the urban region of Hampton Roads and the rural Eastern Shore peninsula, are experiencing the impacts of climate change as part of everyday life. Among the most apparent impacts are sea level rise and associated flooding, but increasingly residents of the region are observing changing ecosystems, health impacts and complex social challenges are made more difficult. The region is experiencing the fastest rate of relative sea level rise on the U.S. east coast due to interactions between ocean currents, global sea level rise, high-water tables and ground subsidence (Adapt Virginia 2019; Atkinson et al. 2013). Emergency managers are having to deal with more severe storms due to increased intensity of rainfall (Smirnov 2017). While building resilience to sea level rise and flooding has become an important priority for many local governments in Hampton Roads, the Commonwealth has also recognized the importance of coastal resilience, and in 2018 appointed Rear Admiral Ann Phillips as Special Assistant to the Governor for Coastal Adaptation and Protection. As local, regional and state-wide governments plan for climate change, universities will play a key role in the integration of intellectual capacities and knowledge to address coastal resilience in the Commonwealth.

Since 2010, ODU has facilitated research and education in many aspects of climate change and sea level rise. Because of its location, special emphasis has been placed on adaptation to increased flooding resulting from sea level rise. Starting in 2012, ODU partnered with the Hampton Roads Planning District Commission and Virginia Sea Grant to host the Hampton Roads Sea Level Rise Adaptation Forum which connects research to adaptation practice. From 2014 to 2016, ODU was the home base for the Intergovernmental Pilot Project, a two-year project to develop a regional "whole of government" and "whole of community" approach to sea level rise preparedness and resilience planning in Hampton Roads. ODU collaborates with William & Mary's Virginia Institute of Marine Science and Virginia Coastal Policy Center in the Commonwealth Center for Recurrent Flooding Resiliency which provides scientific, socioeconomic and policy analysis to build flood resilience.

Old Dominion University/Virginia Sea Grant Climate Adaptation and Resilience Program and Coastal@VT organized the second Rotating Resilience Roundtables on April 12, 2019. The Rotating Roundtables' concept was designed to facilitate active engagement of faculty and stakeholders with different coastal resilience themes, as well as to stimulate problem identification, critical thinking, and alignment between the real-world issues and research questions. The event was envisioned as a "rotating" event hosted in sequence by different Virginia's Universities to meet the following objectives:

1. Facilitate interactions between academic and non-academic stakeholders to improve the alignment of science and the existing circumstances in Virginia's coastal zone.
2. Identify pressing issues and knowledge gaps vital for the future resilience research and programs.
3. Build effective networks between science-policy, science-industry, and science-NGO partners.
4. Foster collaboration around coastal issues between diverse groups of stakeholders to identify mutually acceptable resilience strategies and opportunities for shared benefits in the coastal zone.
5. Identify opportunities for resilience improvements in coastal-inland interface spaces.



Rotating Resilience Roundtables

April 12, 2019

Old Dominion University, Darden College of Education Multipurpose Room (1st floor)
4301 Hampton Boulevard, Norfolk, VA

Workshop Goals:
1) Facilitate collaboration and build capacity within the Commonwealth to address urgent coastal issues.
2) Identify pressing needs and scientific gaps that would guide future research and education efforts.
3) Build effective networks and collaborative teams to better position university faculty to respond to coastal resilience challenges.

8:30 AM	Registration and coffee/continental breakfast
9:00 AM	**Welcome and Introductions** **Morris Foster,** *Old Dominion University, Vice President for Research* **Michelle Covi**, *Old Dominion University and Virginia Sea Grant extension partner* **Anamaria Bukvic,** *Co-director, Coastal@VT, Virginia Tech*
9:15 AM	**Team Science** **Troy Hartley,** *Director, Virginia Sea Grant*
9:30 AM	**Changing Ecosystems** **Brian Van Eerden,** *Director, Virginia Pinelands Program, The Nature Conservancy*
9:45 AM	**Climate and Health** **Brendan Rivenbark,** *Senior Policy Analyst*, *Virginia Department of Health*
10:00 AM	**Introductions around the room**
10:30 AM	Break
11:00 AM	**Policy and Politics of Resilience** **Ben McFarlane**, *Senior Regional Planner, Hampton Roads Planning District Commission*
11:15 AM	**Flooding and the Built Environment** **Scott Smith**, *Public Works, City of Norfolk*
11:30 AM	**Emergency Management** **Robb Braidwood**, *Office of Emergency Management, City of Chesapeake*
11: 45 AM	**Adaptation Equity** **Don Luzzato,** *Vice President for Civic Engagement, Hampton Roads Community Foundation*
12:00 PM	Lunch
1:00 PM	**Roundtable Discussions**
3:00 PM	**Wrap up and Convenio** **Michelle Covi**, *Old Dominion University and Virginia Sea Grant extension partner* **Anamaria Bukvic,** *Co-director, Coastal@VT, Virginia Tech*

The findings of the first round table in Fall 2018 at Virginia Tech were presented in a white paper available in the ODU digital commons at https://digitalcommons.odu.edu/cgi/viewcontent.cgi?article=1017&context=odurc-presentations .

The second roundtable discussions focused on the themes of Changing Ecosystems, Climate and Health, Policy and Politics of Resilience, Flooding and the Built Environment, Emergency Management and Adaptation Equity. In addition, a keynote address about Team Science was presented by Virginia Sea Grant Director Troy Hartley to encourage thinking about team building while tackling these issues.

2. Transdisciplinary Research and Team Science

The Rotating Resilience Roundtable kicked off with an overview of transdisciplinary research and team science. The purpose of the presentation was to situate how the roundtable offers a mechanism to begin to develop transdisciplinary research through building research teams that address practice-relevant issues of coastal Virginia communities.

Dr. Troy Hartley, Director of Virginia Sea Grant and Research Professor of Marine Science and Policy at the College of William and Mary, identified the need for transdisciplinary research to address coastal resilience challenges. Dr. Hartley also elaborated on the need for team science to promote better collaborative relationships to address wicked problems in coastal resilience. Wicked problems were characterized as complex, demanding multiple issues, marked by high uncertainty and ambiguous solutions. These kinds of problems can be considered grand societal challenges requiring collaborative solutions of cross-disciplinary teams.

Dr. Hartley shared four relevant categories of integration needed to determine how teams share information and jointly tackle problems at hand. These degrees of integration were progressively divided into four categories:

- **Uni-disciplinary:** This integration exists within a single discipline, with similar methodology and conceptual approaches. The teams and their members collectively work on common problems.
- **Multi-disciplinary:** Diverse disciplines independently make their own decisions and bring it to the multidisciplinary table for discussion and decision-making. These interdependently made decisions are additive contributions to a problem at hand.
- **Inter-disciplinary:** This degree of integration develops synergies beyond additive contributions by merging different methods and perspectives from two or more disciplines in a cohesive manner.
- **Trans-disciplinary:** In this degree of integration, boundaries are blurred and transcended. The teams and disciplines in this category fundamentally develop novel frameworks, theories, models.

According to Dr. Hartley, the actual practice and management of team science is “wicked hard.” According to the NSF National Research Council report on *Enhancing the Effectiveness of Team Science***,** some of the obstacles in the management and integration of teams include: high diversity in language, culture, norm of disciplines/professions; time consumption and the energy sapping nature of deep knowledge integration; large size of teams which compound the challenges; goal misalignment among members and sub-groups; changing memberships over time which impacts group dynamics and group sustainability; geographic dispersion; and task interdependence and the unawareness of such interdependence.

In suggesting how team science can work better considering its potentially divergent nature, Dr. Hartley emphasized the need for “deep knowledge integration under such diversity**.**” Mental models were identified to be critical to attaining deep knowledge integration within and

between teams, and orchestrating individual learning and group processes. These mental models facilitate key issues such as:

- How do we see and make sense of the world?
- How do the factors that explain a phenomenon fit together?
- What is our conceptual framework or theory?
- How do we behave in the world, given these perceptions?

Moreover, self-competencies and teamwork competencies are strategies that can help team science work better. Team competencies can be attained through leadership and through the incorporation of diverse roles, such as translators, facilitators, conflict managers, visionaries, brokers, process designers, clarifiers, and cheerleaders, in the integration process.

Dr. Hartley used the example of the NSF Innovations in Graduate Education – Team Science program to illustrate how team science could be utilized to develop solutions to a resilience case study (using the case of Charles City, Virginia). He highlighted how team science and collaboration can cause cognitive discomfort and struggles because of the amplification of the uncertain, ambiguous, and time-consuming nature of wicked problems. Achieving deep knowledge integration requires being comfortable being uncomfortable. This can be facilitated by visualization; iterative and adaptive deliberation, use of scenarios, simulations and what-if thought experiments, active listening, tolerance for vagueness and ambiguity, and an attitude marked by curiosity, patience, and collaborative orientation. Dr. Hartley reiterated that team science and collaboration are wicked hard and are necessary for solving societies' grandest challenges.

3. Changing Ecosystems

The practical challenges related to changing ecosystems were discussed by Brian Van Erden, Director of the Virginia Pinelands Program of The Nature Conservancy. The presentation focused on the southern watersheds of Hampton Roads and the broader Albemarle Sound watershed, highlighting key needs of conserving forest cover for flood storage and abating storm surges in Back Bay. Mr. Van Erden discussed how forests capture, store, and use water.

The City of Virginia Beach and its partners have a great track record of protecting forestland; approximately 50% of Virginia Beach forestland is under conservation ownership, and there is a strong probability that it will be maintained as conservation land. However, the biggest unprotected blocks of forestland are in areas along the headwaters of North Landing River, West Neck River, Back Bay, and in older neighborhoods along Lynnhaven River. Mr. Van Erden discussed the work of the Virginia Beach Forest Conservation Working Group, a coalition of public and private partners interested in forest conservation, coastal flooding, and sea level rise adaptation, whose major goal is to closely look at how forests can contribute to flood abatement. Its vision statement reads, "Native forest conservation and restoration are integrated into stormwater management strategies on public and private lands to achieve more effective flood risk reduction in the City of Virginia Beach." Partners in the Virginia Beach Forest Conservation Working Group include Dewberry Virginia Tech, City of Virginia Beach, Lynnhaven

River NOW, Old Dominion University, Virginia Department of Game and Inland Fisheries, Virginia Department of Forestry, U.S. Fish and Wildlife Service, and Virginia Wesleyan University. The group recognizes that good science is critical to developing effective strategies, and it is important to understand how much and in what ways forests can contribute to those strategies. One example of research is the Virginia Beach Forests and Flood Reduction study which has as objectives: quantifying flood reduction benefits of forest cover and developing decision support tools to prioritize conservation efforts.

Mr. Van Erden noted that forest conservation is faced with the challenge of overcoming the high transactional costs of conventional land protection approaches. There is a need to look into how to conduct forest conservation beyond conventional land protection activities (e.g., timber leases), and a need for more policy and planning research.

The Back Bay/Knotts Island Channel Marsh Stabilization Project also seeks to address knowledge gaps in sediment dynamics, channel flow and wind boundaries, marsh evolution, the role of submerged aquatic vegetation, and changes in the tidal force with the break-up of the Albemarle/Pamlico peninsula and creation of a new inlet. The project also offers opportunity for studying potential approaches to marsh stabilization, such as thin-layer sediment deposition and the establishment of cypress.

In the roundtable discussion, participants recognized that dynamic ecosystems challenge our ability to cope with climate change, creating feedbacks that may amplify processes or diminish ecosystem goods and services. The discussion focused on gaps and improvements to systemic understanding. Environmental processes in the region need to be monitored so as to provide localized parameters for modeling and prediction. For instance, salt marsh accretion rates are available in surface elevation tables (SETs), yet there are gaps in the coverage or the type and frequency of data collection. Other environmental parameters that are especially dynamic given climate change must also be given increasing attention due to their increasing impact on ecosystems (and the potential diminution of ecosystem goods and services.) Examples include the need for improving the spatial extent of ground water modeling (rural and urban areas alike) and salinity in coastal waters and shallow aquifers. Ground water is a critical element affecting wetlands (ecologically and jurisdictionally). Salinity has a dynamic but vital influence on salt-fresh estuarine transition zones as well as agriculture, septic systems, and the ecosystems surrounding those land uses. Sea level and flooding itself are also a notable needed observation. While cities are increasingly giving attention to dense or highly trafficked areas, there is also a need to better assimilate flood observations to actually be able to answer the question "What flooded?" and validate and improve models. Currently, these observations have been mainly tackled based on jurisdiction, so there is an opportunity to integrate efforts with interoperable datasets or sensors. Providing a cogent and traceable history of recurrent flooding may also be instrumental to developing adaptive management and synchronizing the duality of mobile human population and ecosystems (e.g., marsh migration) and avoiding so-called "coastal squeeze" with sea level rise. It may be possible to effect expanded monitoring with more cooperation among science and conservation groups (e.g., universities, foundations and land managers) and possibly to transition traditional monitoring into 'citizen science.' In sum, this discussion emphasized the need for a wider coastal landscape view of monitoring and for monitoring to evolve to consider scientific as well as dynamic change with sea level rise.

Roundtable participants also identified a gap in emerging knowledge for a wider perspective of coastal landscape evolution with sea level rise. While there is extensive and deep knowledge gained about coastal salt marsh response to sea level, relatively less is understood about the state and potential resilience of coastal forests. Although, like marshes, coastal lowland swamp forests have oftentimes been degraded by coastal development (cutting, ditching, draining, and paving), there remain intact tracts within floodplains across the coastal plain. In the case of the Southern Watersheds of the Albemarle Estuarine System, these forests occupy a substantial amount of the landscape and provide not only ecosystem functions such as habitat and nutrient abatement, but also flood protection to immediately upland developed communities and farmland. New research is evaluating the quantity of evapotranspiration in coastal forests, and this may yield insight to inform local and wider policies that could maintain forest flood protection. However, as sea level rises and estuarine-fresh systems transgress, will coastal forests also be "squeezed" into immovable developed land, or will there be avenues of retreat and adaptation allowed within the landscape to promote forest as well as coastal marsh wetland conservation? The group felt that coastal forests would merit additional research for inventorying their extent and typology and developing practical as well as ecological information for afforestation or facilitated migration.

Other innovative approaches to ecosystems undergoing changing climate were considered. Scientists should exploit the capabilities of new insights in microbiology to evaluate ecosystem changes, ranging from wastewater effluent to microplastics to pharmaceutical and personal care products that reach or accumulate in the coastal zone. New unmanned aerial systems (UAS), Light Detection and Ranging (LiDAR), and satellite observations and in situ sensors should also be exploited to improve ecosystem monitoring and prediction. Some of these technologies may afford gap-filling in revolutionary ways, such as detection of failing septic systems, thresholds in marsh or forest health, or aquatic ecological changes or invasive species. All these and traditional monitoring methods ought also to consider the urgent need to capture baselines not just for the present or immediate recent climate, but also for the potential for significant biogeographic shifts within all ecosystems and the possibility of disequilibrium in ecological responses to shifting climate extremes (e.g., rainfall, flooding, temperatures, drought, salinity, water table elevations, and coastal storms.)

A few meta-level considerations were also raised during the roundtable discussion. As a group, roundtable participants urge that university, government, and private industry increasingly collaborate and share expertise, partnering to improve monitoring and data quality in a fragile funding environment. Many leading private industry consultants could find fruitful partnerships with academics, and vice-versa. In addition, a strong consensus points to the need to accelerate the pace at which science is put into practice. Advances in modeling that can be made using improved ecosystem observations should be embedded and applied to real-world projects in order to effect meaningful adaptation and resilience.

4. Climate and Health

Brendan Rivenbark, Senior Policy Analyst with the Virginia Department of Health (VDH), provided a detailed presentation on the steps the VDH currently has and is taking to address climate change and associated health issues. In Fall 2018, VDH introduced efforts to address the public health impacts of climate change, signaling that the public health impacts are an emerging priority for the Commonwealth. The VDH Climate Change Committee (C-3) was created to identify and mitigate public health threats of climate change, with focus areas including: sea level rise, air temperature/quality, water temperature/quality, extreme weather events, and the social determinants of health. The C-3 has been tasked with:

- Identifying health related impacts of climate change in Virginia
- Identifying vulnerable populations
- Outlining relevant data, programs, and research in collaboration with internal and external partners
- Developing recommendations for identification and mitigation of climate change impact

The presentation also focused on the issue of coastal flooding, which is becoming more frequent and severe, with storm events that are more devastating and consequential. This has

negative impacts on the fish and shellfish industries, as well as negative real property value impacts. Inland flooding is also forecasted to become more frequent and damaging, causing salt water intrusion into ground water and impaired septic system performance. Populations will face increased risk of exposure to sustained high air temperatures, poor air quality, and contaminated food and water sources which will further challenge already vulnerable populations.

Negative health outcomes associated with climate change were divided into five different categories:

- **Water quality and temperature** - including contaminated food consumption, harmful algal bloom exposure and, water-borne bacteria exposure.
- **Air quality and temperature** - including heat stress and exhaustion, exacerbation of cardiovascular diseases, pulmonary diseases, and kidney diseases; pre-term births; hypothermia; exposure to vector-borne disease; and exposure to carcinogens (i.e. Radon).
- **Sea level rise** - including the consumption of non-potable water, **c**ontaminated water exposure (sewer and/or well displacement), and malnutrition from reduced access to healthy crops due to salt-water intrusion and increased salinity levels in agricultural land.
- **Extreme weather events** - including limited potable water access due to drought, injury (flooding and other extreme weather events), PTSD, grief, depression, and anxiety (caused by extreme weather events and environmental stress), and reduced access to necessary, timely health care services due to flooding and other extreme weather events.
- **Infrastructure and social determinants of health** – including the displacement of populations; decreased property values; decreased tourism; damage and/or loss of businesses, schools, roadways, plumbing, housing, etc.; changes to animal migration and plant cycles; and negative outcomes to local businesses and economy.

The VDH plans to continually take new steps to mitigate against negative effects of climate change. VDH seeks to achieve this by partnering with many organizations including; Virginia Department of Environmental Quality, Virginia Secretary of Health and Human Resources, Virginia Clinicians for Climate Action, Sierra Club, Virginia Commonwealth University, Science Museum of Virginia, Old Dominion University, Longwood University, Virginia Institute of Marine Science, University of Virginia, Virginia Tech, Eastern Virginia Medical School, Liberty University, Virginia Advisory Council on Environmental Justice, Medical Society Consortium on Climate and Health, and City of Norfolk. Mr. Rivenbark highlighted the next steps for VDH, which includes continuing climate change research, holding regular C-3 meetings, convening regular meetings with external subject matter experts, and developing response plan and mitigation strategies.

The roundtable discussion mainly revolved around research related to climate change, heat stress, air quality and health. Specific focus areas included premature mortality, urban-rural differences, syndromic surveillance and emergency department data, and wildfires and respiratory health.

The participants agreed on the importance of asking more questions and finding answers on watershed processes, while emphasizing the need for conducting human health risk assessments. This involves looking at climate change, and the effects of bacteria, pathogens, etc. on human health. It was suggested that the perspective of others outside the system would be very helpful in these cases of risk assessments. For instance, health professionals at York University (England) are looking into the US water quality; what is going on with it, and how it feeds back into the system.

The continuous need for communication research was noted given the diversity of opinions and needs regarding the health effects of climate change. National studies on climate change perception (e.g., https://climatecommunication.yale.edu/about/projects/climate-change-in-the-american-mind/) show massive changes in how people think about climate change and what they are willing to support. Studies in Maryland looked at public opinion in the state: what residents think about issues such as clean energy, clean air, and runoff issues. Surveys of localized issues can be done at the statewide, municipal, household levels.

Another issue discussed was the challenge of finding funding for public health projects. However, data on the costs of the health effects can be compiled to lay the groundwork for policymakers and potential funders to understand the health care costs in Virginia that are associated with air quality, heat, etc.

On the topic of air quality, there is a need to understand and show how poor air quality correlates with health metrics such as increased hospital admissions. With heat impacts, one example would be pregnant women suffering from heat effects, and the higher risks of premature delivery (directly related to heat waves). Considering the high costs of neonatal care,

a cost estimate of this increased risk could be conducted. Collaborating with VDH by utilizing their statewide data will support further research.

Another topic that participants found notably important was the need for research on the psychological effects of climate change, and the relative impacts of various means of intervention. Variable include different forms of climate messaging, the use of 3D and other sophisticated visualizations compared to traditional means of conveying information on paper. Research also shows that access to green space is correlated to improved well-being, but questions about how to effectively implement green spaces were raised, such as: what are the benefits of co-creating and engaging with communities prior to putting these interventions in place? How do we ensure that the green space is designed around what residents want so that it supports well-being?

A variety of other projects were discussed including:

- Climate, wildfires and respiratory health – such as projects that assess the efficacy of N95 respirators in wildfire situations
- Dental hygiene – incorporating dental health facilities into emergency planning, and incorporating dental health into health care coalitions, applicability of dental techniques in mass casualty situations and identifying people who are casualties.
- Improving health outcomes by combining social and behavioral sciences.
- Recovery and rebuilding after catastrophic disasters.
- Rising sea level and hazardous materials, chemicals, radioactive materials – such as working with municipalities and other states and coordinating with federal municipalities on best practices.

Roundtable participants also emphasized issues related to environmental justice and vulnerable communities. Further research on vulnerable populations such as migrant farm workers, hotel workers, and lower-income residents, and improving health outcomes for these populations during and after disasters and emergencies is necessary.

Septic systems were discussed as a final topic, particularly as it related to legal and regulatory frameworks. This is an especially interesting area for exploration in public health considering that addressing the issue requires a broader discussion beyond just a single locality, and connects to issues affecting vulnerable populations, water supply, water quality, etc. Questions that arose include:

- Which level of government (state agency, locality, etc.?) have authorities to work on this issue?
- What can a locality do to determine/locate areas where the septic system is in trouble?
- How can they assist property owners and farmers with clean up?

In the case of septic systems, there is a legal piece missing and that could be studied and developed by students (e.g., law students at the Virginia Coastal Policy Center and/or MPH students at Old Dominion University). Students can be involved in interdisciplinary and/or multi-institutional projects, working together to study what can be done to improve water supply systems to expand freshwater programs. Student research could focus on the septic system problem, but also others such as problems associated with private wells and working with native tribes. The participants also highlighted how it is also pivotal to train the next generation of public health professionals on issues related to climate change and sea level rise. Old Dominion University has a training certificate in climate and sea level rise, and William & Mary offers training on the legal dimensions of public health and the environment.

5. Policy and Politics of Resilience

Ben McFarlane, Senior Regional Planner with the Hampton Roads Planning District Commission (HRPDC) Water Resources Department, provided roundtable participants with an overview of key issues underpinning the policy and politics of resilience. The focus of his presentation was on the challenges of working together as a region and within a federalist context. The presentation outlined the federalism landscape of the U.S., describing the policy responsibilities of the federal government, states, and localities in the context of issues related to resilience such as infrastructure and land use. The federal government is largely responsible for national programs, federal-level regulations, and major infrastructure funding such as for the transportation, water, and wastewater systems. States, in turn, provide funding, develop regulations, and establish enabling legislation that apply at the state and local levels. Local

governments are creatures of the state, and are mostly responsible for infrastructure funding and construction, as well as regulating land use and development. However, in most cases, regional entities have no official role in enacting legislation or policy. They are voluntary vehicles for collaboration and coordination when it serves the interest of regional stakeholders.

Mr. McFarlane described collaboration as a time consuming and difficult venture, which often involves huge transaction costs. Furthermore, parties in a collaboration do not always get all their wants and needs out of a collaboration. Regional collaboration is also challenging because localities do not always have the same priorities. Even an issue as important as sea level rise further serves to show the variance among actions and response mechanisms from one community to another. Nonetheless, collaborations can be successful if parties can find ways to reduce the costs or create benefits that outweigh the costs. An important lesson for regional stakeholders has been that they should collaborate only when it makes sense. As such, the key question for regional collaboration for resilience is: where and when does it make sense to work together? He argues that the political and policy landscape is conducive for collaboration in situations where:

- Stakeholders are facing similar circumstances;
- Parties have assets, infrastructure, or services that must connect or work together;
- It is not too expensive or too difficult to collaborate; and
- Stakeholders are working on a new problem, new practices or new solutions.

In considering policies related to resilience, it is important to recognize several factors. An important factor is recognizing that resilience requires acknowledgment of impending change, understanding that uncertainty is a major reality, and that resilience is hard, expensive, and complicated. Sea level rise policy offers an opportunity for regional collaboration and Mr. McFarlane made the case for regional policy to address sea level rise. Sea level rise has already occurred and is accelerating. Flooding is occurring more frequently in the region. However, higher standards – in terms of planning requirements, building codes, land use regulations, etc. – can reduce vulnerability and impacts, and will help keep the challenge from growing. Regional policy provides support for localities since local capacity to address sea level rise and be resilient varies by locality. Regional policy also makes regional coordination simpler and creates a default position for state and federal entities on policies and projects, thus driving the conversation about sea level rise that happens at the state and federal levels. More importantly, regional policy demonstrates to the public that the localities throughout the region are working together on the issue of sea level rise.

Across the region, it is recognized that sea level rise is occurring, but sea level rise is not always factored into the planning and project design stages. One way that the region has collaborated in terms of regional sea level rise policy is in agreeing to screen values for sea level rise that, in the planning process, provide estimates of the scale of the problem. Similarly, regional consensus on updated curves ensures that the same information is used for conducting cost-

benefit analysis of different adaptation options for projects throughout the region. This ensures that sea level rise is consistently incorporated within the planning and design processes.

Mr. McFarlane had specific policy recommendations for localities to incorporate sea level rise into their planning and infrastructure decisions using consistent screening values and by applying a risk-based engineering approach. The HRPDC recommended screening values strategies of 1.5 feet for near-term planning (2018-2050), 3 feet for medium-term planning (2050-2080), and 4.5 feet for long-term planning (2080-2100). In terms of risk-based engineering, his recommendations included using the best available sea level rise projections; explicitly accounting for construction timeline, project lifespan, criticality, and vulnerability to flooding; determining; possible sea level rise impacts; and performing benefit-cost analysis of adaptation options. In terms of regionwide implementation of screening values and risk-based engineering, he offered several key next steps related to incorporation of this approach into local guidance and policies, public facilities manuals, local ordinances, local comprehensive plans, and regional plans. Mr. McFarlane concluded his presentation with the key takeaway that regional coordination is hard, and it is not always desirable or easy to do, but there are increasing circumstances where it is the right approach to addressing sea level rise and building resilience.

The roundtable discussion revolved around several key topics or focus areas. Throughout the discussion, issues and concerns were raised, and questions were asked. More questions were raised with several providing some interesting insight for possibly moving forward with engaged research embedded in the Hampton Roads context.

The first question raised and discussed by roundtable participants was: What does resilience mean? This discussion revolved around several key points, including:

- The lack of a strong policy response that could be due to different definitions of resilience being used in conversations about policy.
- If the public doesn't understand what resilience means, how can they support policies that address resilience?
- The term takes on a different meaning depending on where you sit or where you come from.
- The term also has a different meaning when the focus is on short term versus long term impacts.
- Resilience has been used to refer to both 'bouncing back' to the status quo and 'bouncing forward' to an improved or better state. FEMA's approach to resilience, by not allowing building to higher standards, emphasized the status quo, which may address resilience in the short term, but not the long term.
- Do we need a definition that is more general and broad (like the approach taken by the City of Norfolk that encompasses sea level rise and recurrent flooding, a shifting economy, and a need to build strong, healthy neighborhoods), or more narrow and tailored to specific instances of resilience (e.g., resilience of the tourism industry to climate change effects)?

Should the focus be more practical (e.g., resilient transportation system)? How do we decide?

- Resilience is silo-less.
- Given how overarching and encompassing resilience can be, we may need to separate resilience into different components or steps.
- Separating resilience from climate change reduces some of the politics. However, resilience may continue to have political connotations, and the political environment will continue to determine the ability to respond.
- How do we use narrative around resilience to shape policy responses? Do we shape the narrative around politics or do we change the policy discussion around a new resilience narrative? Consider national security, for example.

Given the discussion of what resilience means and to whom, roundtable participants also raised concern that we don't know if we are asking the right questions or talking to the right people at the right level. At a high (macro) level, given the lack of progress on resilience policies, we may not be speaking to or engaging the right people. The conversation also needs to happen at the individual resident, neighborhood, or community (micro) levels. Do the same conversations take place at both levels? The conversation about resilience needs to include diverse groups of people at different levels, while emphasizing that we are all talking about same thing. Until that happens, we can't take next steps in terms of considering, approving, and implementing resilience policies.

Participants recognized that not everyone will agree (and they might not agree at the same time), but that it would be a mistake to gloss over differences. But, do we need everyone to agree? Maybe we need to let go of the idea of addressing resilience at a grand level, and tackle more manageable pieces. We consider approaching it based on functional or policy spheres (e.g., housing, transportation, etc.), recognizing that there are intersections. It will either be a success or a learning experience, but it will move us forward.

Roundtable participants emphasized the need for high-level leaders that support resilience efforts. However, the discussion also emphasized challenges with the policy process. The high-level turnover in the state legislature and at the governor level, for example, pose problems for the continuity of support over time.

Participants acknowledged that we have processes to come up with new rules and regulations, but wondered if the process could be improved to make it better or easier to adapt over time, thus allowing for the constant change that is needed for resilience. We need a nimble process that allows for continuous adaptive laws. But, being open to too much change can also paralyze the decision making process. We need a middle ground to allow more flexibility over time. Possible ideas included:

- Requiring the policy be evaluated whenever X happens.
- Putting a shelf-life on a policy.
- Incorporating performance metrics in the policy.

Another interesting question that came up in the roundtable discussion was: How do we encourage innovation and experimentation in resilience solutions and resilience policies? Participants acknowledged that we have not figured out how to deal with resilience regionally. The communities throughout Hampton Roads are not homogeneous, priorities differ between communities and there are no good ways to get the local priorities to bubble to the surface to reflect regional priorities. The language used also differs among cities. Given the diversity across the region, it is important to identify specific geographic areas where experimentation can take place, and then derive takeaways and lessons learned on how to make communities more resilient. Experimentation can also be encouraged within specific policy domains (e.g., land use planning, transportation, education), and lessons learned can be transferred to other policy domains and decision processes as appropriate.

Conversation at the roundtable also revolved around several issues and questions related to measurement and metrics.

- How much is resilience a priority among residents in Hampton Roads and across Virginia? The Life in Hampton Roads Survey has continuously assessed sea level rise issues affecting residents' quality of life. An ODU team conducted survey of 1500+ residents about preferences for adaptation actions. But maybe we need to better understand what Hampton Roads residents are concerned about and the factors related to those concerns (e.g., location, homeowner status, etc.). Do these same priorities resonate with policy makers? Do policy makers understand these concerns?
- How do we consistently assess vulnerability across Hampton Roads? How does Hampton Roads compare relative to other vulnerable areas using the same metrics? The discussion highlighted the need for consistent metrics for measuring vulnerability. This would provide not only comparison within Hampton Roads, but also contextualize the region's vulnerability relative to other regions (e.g., Miami, Charleston, etc.).
- How do we quantify the impacts (e.g., vehicle damage/loss, business interruption, school/work productivity)? Who has the information? We need a comprehensive assessment of impacts and put dollar values to the impact. The challenge is that some information may be proprietary, compartmentalized within departments within localities, or not available across all localities.
- How do we quantify the costs of not doing anything? Particularly in local governments, projects must be accompanied by analysis of benefits (e.g., averted losses, improved preparedness, etc.). But it may be difficult to measure the benefits in terms of improvements over 'not doing anything.'

6. Flooding and the Built Environment

Scott Smith, Coastal Resiliency Manager with the City of Norfolk addressed key issues related to flooding and the built environment. He focused on three themes related to gaps and needs for Hampton Roads cities in terms of functional and practical solutions to flooding.

- Flood-proofing of historic structures: Hampton Roads, particularly in cities like Norfolk and Hampton, has many historic structures that are vulnerable to flooding. Using the example of Norfolk, Mr. Smith shows that repetitive flood loss areas (both severe repetitive loss and repetitive loss) have overlap with historic districts. However, many historic structures, such as historic row houses, cannot simply be elevated. So, what options do cities have to reduce vulnerability of these historic structures?
- Methods of locating old or historic waterways. Flooding generally takes place in the old waterbeds, riverbeds, and creek beds that have been filled in. Reopening waterways (rather than pipes) is an option for managing flooding. However, an important question is how to figure out the locations of the historical waterways because while there are old maps, these maps are not very accurate. Thus, research is needed to find new methods for locating these old waterways. These methods would have applicability across various coastal communities.
- The impacts on groundwater tables of sea level rise and increased green infrastructure. The impact of sea level rise includes elevated groundwater and saltwater intrusion. In terms of green infrastructure, what are the impacts of elevated groundwater? Does green infrastructure make sense in areas with elevated groundwater? What effect does saltwater intrusion have on green infrastructure, in terms of impacts on vegetation and the types of plants appropriate for green infrastructure projects in situations where there is saltwater intrusion? There is a need to develop modeling methods that can help predict the impact of green infrastructure on groundwater

Mr. Smith also discussed how city staff should be educated on the need to bring stakeholders into the decision-making process and help these stakeholders understand how they are impacted by city decisions. Analysis of ecological services such as those of living shorelines and wetlands can be accessed via cost-benefit analysis. However, such analysis must incorporate soft factors. For example, the U.S. Army Corp of Engineers model emphasizes loss avoidance but does not take into account equity impact and does not quantify other costs and benefits associated with human factors.

The roundtable discussion highlighted several issues. First, was the need for a predictive model on how groundwater is affected by tides, especially under conditions of poor soil where soil moisture is an issue. This is a particular challenge for Norfolk. Secondly, since saltwater intrusion will be a problem resulting from sea level rise, conversations should focus on replacing trees in certain areas with trees that are salt

tolerant. Thirdly, it is important to incorporate residents' perspectives into built environment decision-making. Residents are concerned about environmental issues and their implications, especially when it happens in their back yard. On the other hand, residents' preferences may need to be balanced against other concerns. For examples, residents may indicate preference for green space in areas where concrete structures may be more appropriate, and vice versa.

Furthermore, flooding has implications for design, building, and construction standards. In Virginia Beach, the comprehensive sea level rise and flooding study found that the design standards needed to be changed to incorporate consideration of elevations for design. For example, the city needs to change its regulations to 3 feet or 6 feet to sea level rise for constructions. For residential areas, it is difficult to go out and elevate the buildings and flood-proof them. There is need to have new residential building rules. This is a research area to understand whether it works since regulatory processes are very slow and need to change. Consequently, there should be proof that certain things work for these regulatory bodies to be convinced for the need of change.

Two different issues surrounding elevating structures were further discussed. They include:

- **Elevation of roads:** Using Hampton Boulevard as an illustration, the roundtable discussion participants agreed that it floods a lot in the City of Norfolk and if the road is elevated, the adjacent of neighborhoods are still flooded. It was suggested that buying houses on one side of the road can allow improved/expanded drainage. However, which side of the road? If the land was green field, this would be less challenging. But for more urban communities like Norfolk with extensive private property, the problem of public support or acceptance of buyouts can be an issue.
- **Elevation of historic structures:** Historic structures due to their nature and value are affected by flood prone areas. Elevating historic structures is a challenge. Groups and individuals are passionate about maintaining these structures and additional constraints are in place if the structure is in the State's protection code. If not, individuals will abandon the properties because of the high expenses associated with property upkeep.

However, the roundtable discussion also acknowledged that elevation is not particularly helpful, as elevation is not appropriate for all structures and some may collapse if elevated. Elevation is a recommended solution, but that decision may trigger more difficult decisions and incur additional costs down the line. There are too many unknowns; for example, how to convince people to relocate if there is a need to do so. In such scenarios, low-income families moving to higher-income areas may create a problem. Hence, long-term consequences need to be taken into account. Public acceptance is also a problem for alternate solutions such as relocating from the danger zones/flood zones. The Dutch are expanding their canals and flood management, and compensating people who must move to other places. But these solutions face public hurdles. For example, mid to low-income property owners are not going to be able to be resilient due to high insurances if they have properties on the coasts. Rental income on coastal properties easily cover the entire mortgage payment of the property: a major reason why rental property owners do not want to abandon their properties.

The roundtable discussion also included examples of how NASA and Air Force bases are concerned about sea level rise. NASA is now elevating new facilities according to the standards for worst-case scenarios. Participants also discussed the lack of data about where flooding is a problem for the built

environment. There is need for more accessible data to understand where buildings are and which buildings or structures are vulnerable. More information is available for newer buildings, but there is limited information on older buildings and structures. In flood zones, first floor flooding is an issue, so data about finished floor elevations (FFE) is necessary, but such information is not available for a vast majority of buildings. Locations of first (finished) floor elevations can be identified through legacy creeks, satellite imagery, while large scale LiDAR assessments can be used for their evaluation. This data should be used to model risk and understand how to plan for the future.

7. Emergency Management

Mr. Robb Braidwood, Emergency Manager for the City of Chesapeake, provided an overview discussion about key issues faced by emergency managers and local research needs in emergency management. His primary point was that emergency management is about risks and how humans respond to risk and risky situations. He emphasized that in many different risk contexts, people tend to make bad decisions. This is because people do not recognize risks and how the risks may apply to them. According to Mr. Braidwood, this is the fundamental question in emergency management: How do we get people to understand risk and respond appropriately? Specifically, he notes that a key problem for emergency managers is the lack of understanding of why some people care about issue A, others care about issue B, and others don't care about either.

He also acknowledged the lack of collaboration and coordination in emergency management across the region. This is largely due to a lack of alignment across communities and localities in the region, and the lack of communication and sharing of information. He notes that much of the resilience work by local governments is funded by grants, but that such funding is limited. The lack of funding challenges emergency management practices at the local level, but the limited funding also forces collaboration within the region.

Mr. Braidwood used the example of hurricane evacuations to highlight issues that emergency managers do not understand and where more research is needed. These include:

- Understanding how people receive information about risk and act on this information. For example, consider residents in Evacuation Zone A. When a mandatory evacuation order is made for Zone A, those residents in Zone A are required to leave. Affected residents either listen to the message and leave, or they don't. Emergency managers see the resulting action or outcome, but the decision process to arrive at the action or outcome is not completely visible. The first question emergency managers must deal with are: Did residents listen? Did they evacuate? Emergency managers then ask the questions of residents who did not evacuate, such as: Why are you not listening? Did you even hear the message? Emergency managers need to know how to best communicate risk to people and how to message risk effectively.
- Once some residents evacuate, emergency managers also want information about: Where did residents evacuate to? When did they decide to leave? How did they leave? Who did not evacuate despite warnings?
- It takes 36 hours to completely evacuate Portsmouth, assuming no accidents and everyone leaves when they are told to leave. This requires significant advance notice. How do emergency managers balance the timing with the impact on and costs to residents (lack of income from being out of work, travel costs, accommodations costs, etc.), given the accuracy of forecasts and other considerations?
- Hurricane Maria in Puerto Rico is an example of a resource problem. Resource forecasting is one of the most important facets of emergency management. Agility does not correspond to or match response capacity. For example, localities need to order resources from FEMA 10 days ahead of an event, but 10 days may be too early to know if resources may be needed and what resources will be needed. Research to help emergency managers improve response capacity and better forecast revenues are needed.
- Getting high level decision makers (e.g., politicians, elected officials) to quickly make decisions prior to, during, and after an event is a challenge. Emergency managers need assistance in communicating risks to these decision makers, particularly in terms of when to order evacuation, whether shelters are needed, and when to open the shelters. More specifically, emergency managers need to know how to package information to support decision makers and how to present that information. Research on how visualization (graphics, maps, colors, etc.) can help communicate risk and improve understanding of decision makers would be beneficial. Improved understanding of how to be more effective in decision-making would be helpful.
- Emergency managers recognize that social resilience exists beyond the family network. However, it would help to have research that informs the understanding of social connections and networks, and how they support resilience.
- Preparedness is a key aspect of emergency management. More is known about response and recovery than preparedness. When trying to encourage residents to prepare, emergency managers are challenged with understanding why residents do not seem to care

about preparedness and why they are not taking actions to prepare. They recognize that addressing emergency management issues like preparedness cannot be top-down, but rather need to be addressed at the ground level. More research on how to engage at the ground and grassroots level would be beneficial.

In the roundtable discussion, there was a general consensus that there is no cookie cutter approach to communicating risk and engaging stakeholders in emergency management issues like preparedness. More social science research is needed to better understand the needs of different audiences, and how to engage, educate, and communicate with these audiences. Particular challenges relate to issues regarding the role of demographics – including race, age, income and education level, and how they affect not only engagement and communication but also access to resources and information. Levels of trust in government and differences in the trusted sources of information also pose challenges for emergency management. Emergency managers could benefit from research on ways to connect with under-resourced and vulnerable communities that also have a culture of distrust of government. Furthermore, as different communities have different access to resources and information, such disparities affect their ability to prepare for and respond to emergencies such as hurricanes, flooding, and other severe weather events. Funding is needed to conduct neighborhood-level education and outreach. Roundtable participants discussed the role of institutions of higher education as conduits for obtaining funding to support education and outreach of stakeholders and residents on emergency management issues.

8. Adaptation Equity

Equity in climate change adaptation is one of Virginia's most difficult challenges as communities develop responses to sea level rise, flooding and other impacts. Climate change will not impact all people in the same way. Developing climate change response plans that are equitable requires that the needs and vulnerabilities of all people are considered, with special attention to those groups that are already marginalized or disadvantaged. Don Luzzato, Vice President for Civic Engagement at the Hampton Roads Community Foundation raised the story of Tangier Island as a case study for coastal Virginia. Key questions raised include:

- What do we do when an island with a 300-year history cannot sustain as itself in the place that generations have called home?
- How do we enable the culture to continue when the island cannot?
- More broadly, how do we ethically support the continuation of communities when the place that they have always known is becoming untenable or unsafe? A seawall will not solve the underlying problem.

The roundtable discussion determined that we are in the issue identification stage of this topic of adaptation equity. Civic engagement is absolutely necessary for equitable adaptation but finding ways to effectively engage will be different among communities across the Commonwealth. Universities can play multiple roles, in serving as a resource for communities and as conveners or fora for discussions, in pursuing engaged research projects to address

emerging questions and developing new methodologies, in educating students to understand the complexity of adaptation and be a part of the workforce that will tackle the issues, and in reaching out to communities with science- based information. Roundtable participants discussed research gaps and found that communication research including determining effective messaging and messengers that can build trust is needed. There is a need to develop and test new methodologies for communication, the routes of impact, how to get people engaged and how to motivate people to act. Communication and civic engagement techniques need to be tested for different population groups and audiences.

The group agreed that there was a lack of social data to accompany ecological change and that social capital among vulnerable populations is not well understood. Governments tend to be risk- adverse, slow to change and are often financially constrained. Working with universities, localities could build infrastructure for conversation, especially on difficult topics, such as managed retreat. Research questions around retreat include: what is the role of eminent domain? How can we become better prepared to be ready to enter into a buyout process for homeowners? The roundtable participants wondered if universities might be able to lead a conversation about retreat, but also wondered what the university role is in educating non-university communities about the issues.

Don Luzzato noted that resilience will be a central issue for the next generation. There is a need for more educational and nonprofit work to engage with communities, especially those who have been disengagement because of past trauma, particularly for minority groups and marginalized populations. Universities can play an important role in Adaptation Equity, by helping to build a social infrastructure for conversation, co-producing knowledge with communities through engaged research and training of interdisciplinary researchers and resilience professionals starting at the undergraduate level.

9. Conclusion

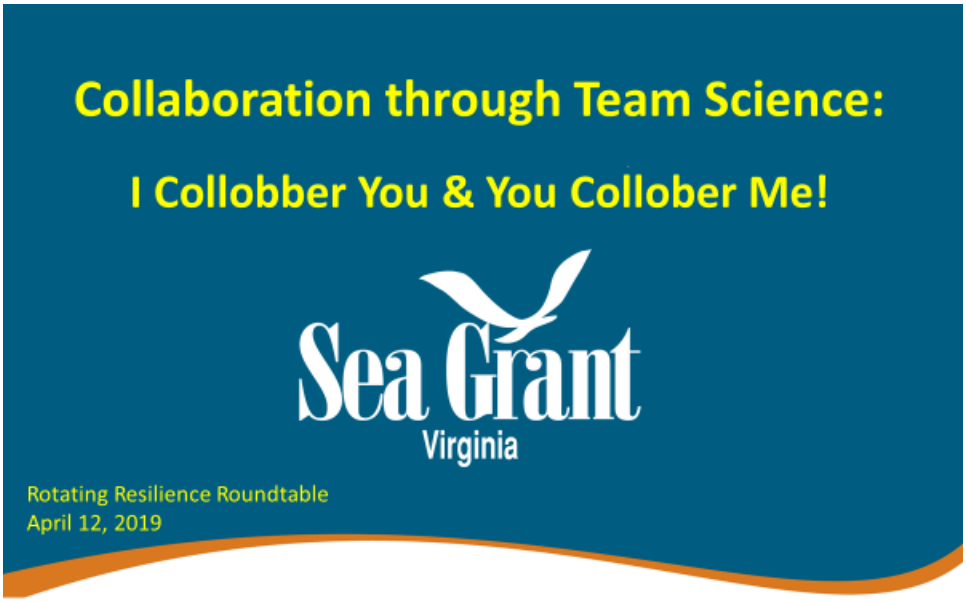
The second Rotating Resilience Roundtables held at Old Dominion University enabled participants from Virginia universities and organizations to identify some of the pressing research topics and questions related to coastal resilience. The next Rotating Resilience Roundtable event will use this knowledge to enable collaborative interdisciplinary research teams across the state to advance the discussion on research priorities with local partners from the Commonwealth and to select appropriate methodologies to study them. Such co-production of knowledge will ensure that contextual circumstances present in different coastal municipalities in Virginia are reflected throughout all stages of research process, therefore producing more impactful and policy-relevant science and practices for localities and the Commonwealth. To support this mission and in preparation for the long-term productive research partnerships among academia, private and public sector, and local governments, Coastal@VT embarked on an effort to develop an online tool that will facilitate networking among different stakeholders vested in coastal issues – a Convenio research collaboration matchmaking tool.

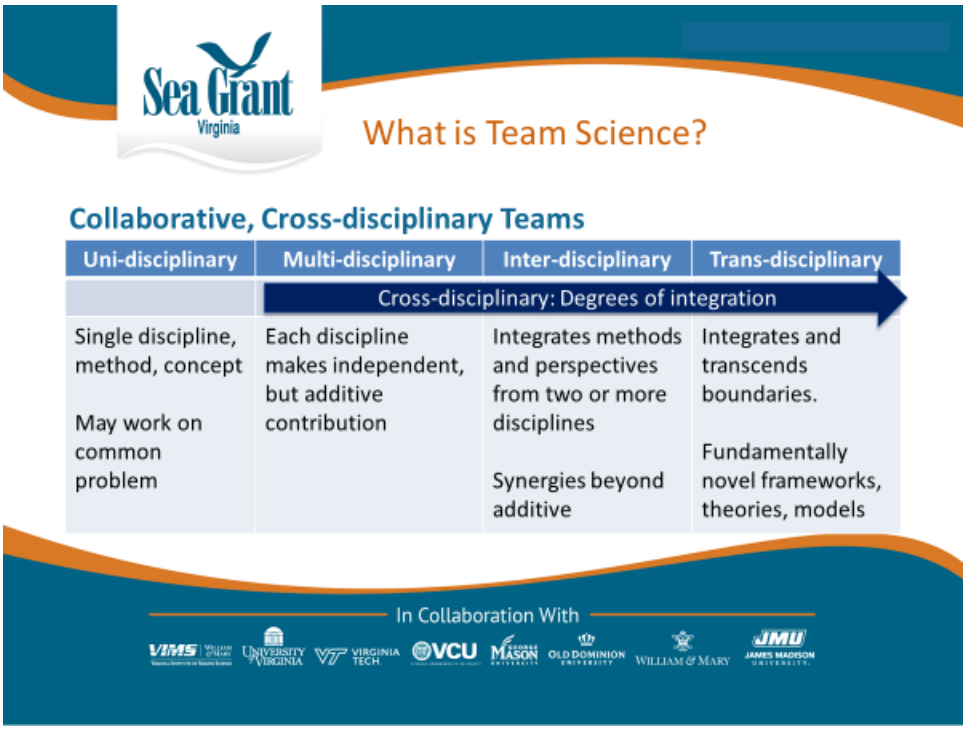
The platform was developed with support from Coastal@VT interdisciplinary research initiative and Fralin Life Science Institute in collaboration with the Creativity + Innovation Destination Area community

housed within the Institute for Creativity, Arts, and Technology at Virginia Tech. It is designed to address the identified need for a collaborative platform to connect researchers and other parties interested in partnership with researchers (e.g. local officials, NGOs, and industry) to increase mutually beneficial opportunities that support Virginia Tech's operations, including Ut Prosim and DA/SGA/Beyond Boundaries visions. The Convenio has been conceived as a tool to enable interactions based on research topics, skills, expertise, and collaborative opportunities among researchers and other stakeholders vested in coastal resilience. Its purpose is to match faculty with pressing societal problems in an integrative and discipline-agnostic way, and help identify intellectual property assets, capabilities, technology, skills, and knowledge that can help solve them. The overarching objective of Convenio is to build a landscape of partners with proven research track records and their professional identities and to build intellectual capacity to tackle coastal issues using transdisciplinary approach and co-production of knowledge between many disciplines and partners.

The collaborative team from Old Dominion University and Virginia Tech will expand the organizing group and rotate to another Virginia university in Fall of 2019 to continue to build momentum for resilience action by engaging academic/ stakeholder teams to address specific resilience needs identified in the first two of the Rotating Resilience Roundtable events. We hope to continue to rotate to other Virginia universities with faculty engaged in coastal resilience research and education each semester as opportunities allow. This report and the report from the first event, which can be found at https://digitalcommons.odu.edu/cgi/viewcontent.cgi?article=1017&context=odurc-presentations outline Virginia's coastal resilience gaps in research and education as identified by the academic and stakeholder participants. These reports are shared with government officials, university research centers and others focused on coastal community resilience, including the Commonwealth Center for Recurrent Flood Resilience whose mission includes "providing training, technical and non-technical services, and policy guidance in the area of recurrent flooding resilience to the Commonwealth and its local governments, state agencies, industries, and citizens" and which supported the Spring 2019 event.

10. Appendices





Why Team Science?

Complexity of phenomena

- "Wicked" Problems – complex, multiple feedbacks, high uncertainty, ambiguous solutions.
- Grand Societal Challenges

Call from funders – NSF, NIH, DOD

- University and other research institutions remain silo-ed.

Expectations of our students....and critical stakeholders (legislators)

In Collaboration With

Team Science is Wicked Hard

Study of six NSF-funded Interdisciplinary Centers

- Produced few new, interdisciplinary outcomes
- Mostly, same, disciplinary results patched together in multidisciplinary ways

Rhoten, D. 2003. *Final Report: A Multi-Method Analysis of the Social and Technical Conditions for Interdisciplinary Collaboration.* The Hybrid Vigor Institute: San Francisco.

In Collaboration With

Team Science is Wicked Hard

NSF-requested National Research Council. *Enhancing the Effectiveness of Team Science.* 2015

- High diversity – language, culture, norms
- Deep knowledge integration – time & effort
- Large size – compounding the challenge
- Goal misalignment – among members and sub-groups
- Changing membership – impacts group dynamics
- Geographic dispersion – w/out face-to-face
- Task interdependence – unaware of interdependence

In Collaboration With

So how do we do Team Science?

Deep knowledge integration under such diversity

- Mental Models
  - How do we see and make sense of the world
  - How do the factors that explain a phenomenon fit together – what is our conceptual framework, theory
  - How do we behave in the world, given this perception

Pennington, D.D. 2016. A conceptual model for knowledge integration in interdisciplinary teams: orchestrating individual learning and group processes. *J. of Environmental Studies Sciences.* 6(2016):300-312.

In Collaboration With


Sea Grant
Virginia
Cognitive discomfort, struggle
Uncertain, confused
Ambiguous, time-consuming


Sea Grant
Virginia
So how do we do Team Science?
Achieving deep knowledge integration – comfortable being uncomfortable
Visualization, external representations
Iterative, adaptive deliberations
Scenarios, simulations, what-if thought experiments
Active listening, tolerance for vagueness and ambiguity
Attitude – curiosity, patience, collaborative orientation
In Collaboration With

So how do we do Team Science?

NSF Innovations in Graduate Education – Team Science

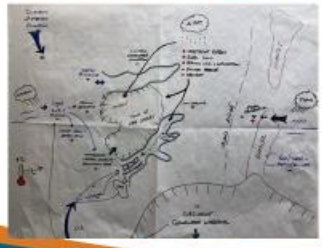
- VASG, VIMS, UVA, VCU, UCF
- Teamwork competencies
  - Psychologically safe domain – leadership
  - Roles – translators, facilitators, conflict managers, visionaries, brokers, process designers, clarifiers, cheerleaders
- Self-reflection competencies

In Collaboration With

So how do we do Team Science?

NSF Innovations in Graduate Education – Team Science

- Resilience case study – Charles City

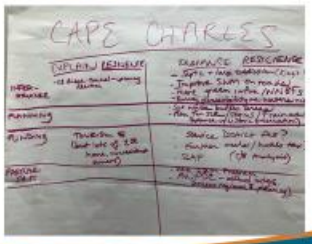


In Collaboration With

So how do we do Team Science?

NSF Innovations in Graduate Education – Team Science

- Resilience case study – Cape Charle



In Collaboration With

VIMS | UNIVERSITY OF VIRGINIA | VIRGINIA TECH | VCU | GEORGE MASON UNIVERSITY | OLD DOMINION UNIVERSITY | WILLIAM & MARY | JMU JAMES MADISON UNIVERSITY

Team Science. Collaboration

Wicked hahd

…but it solves Societies Grandest Challenges…

In Collaboration With

VIMS | UNIVERSITY OF VIRGINIA | VIRGINIA TECH | VCU | GEORGE MASON UNIVERSITY | OLD DOMINION UNIVERSITY | WILLIAM & MARY | JMU JAMES MADISON UNIVERSITY

Sea Grant Virginia

Thanks

In Collaboration With

VIMS | William & Mary | University of Virginia | Virginia Tech | VCU | George Mason University | Old Dominion University | William & Mary | James Madison University

Changing Ecosystems: Albemarle Sound Watershed

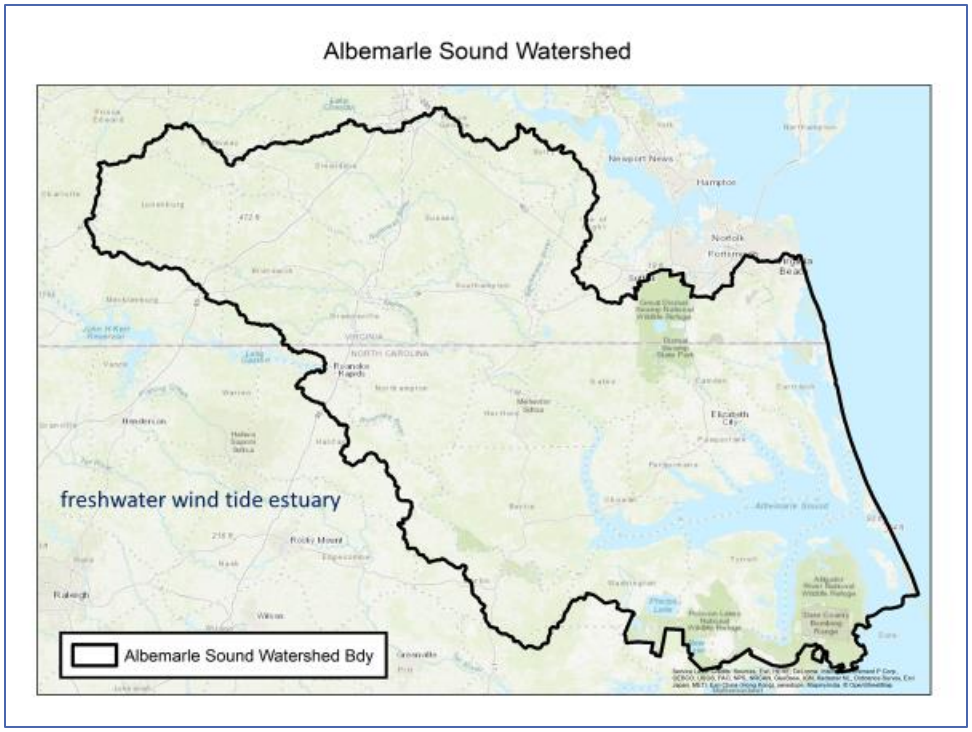
BRIAN VAN EERDEN

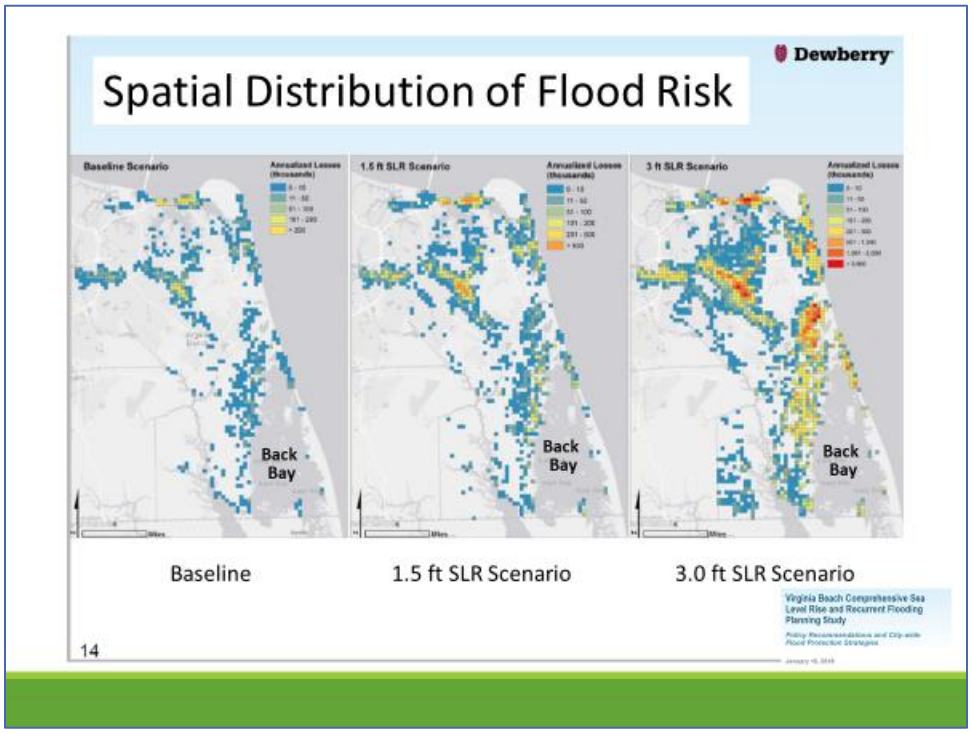
DIRECTOR, VIRGINIA PINELANDS PROGRAM

The Nature Conservancy

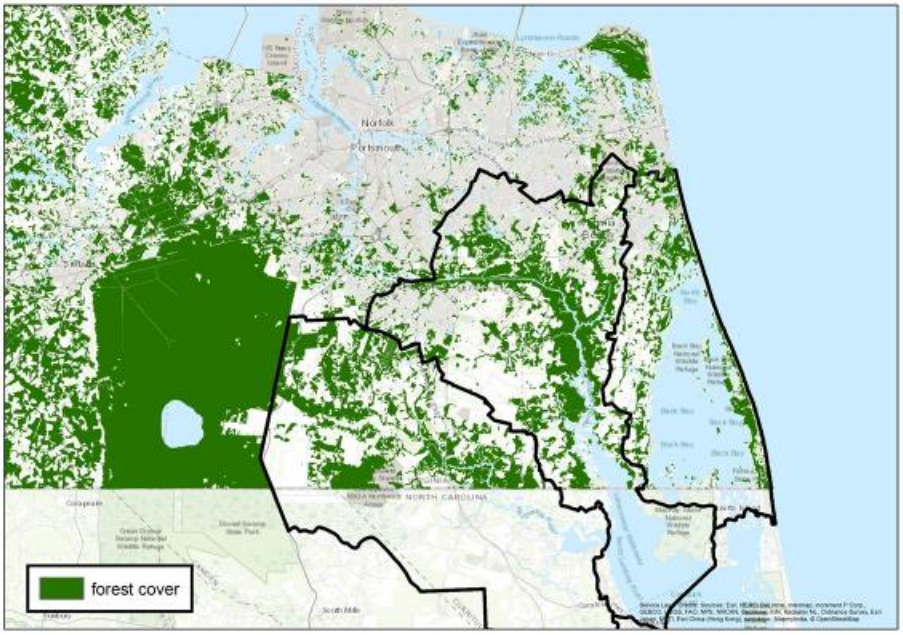
The "Southern Watersheds" of Hampton Roads

- **Conserving forest cover for flood storage**
- **Abating storm surges in Back Bay**


Albemarle Sound Watershed
freshwater wind tide estuary
Albemarle Sound Watershed Bdy

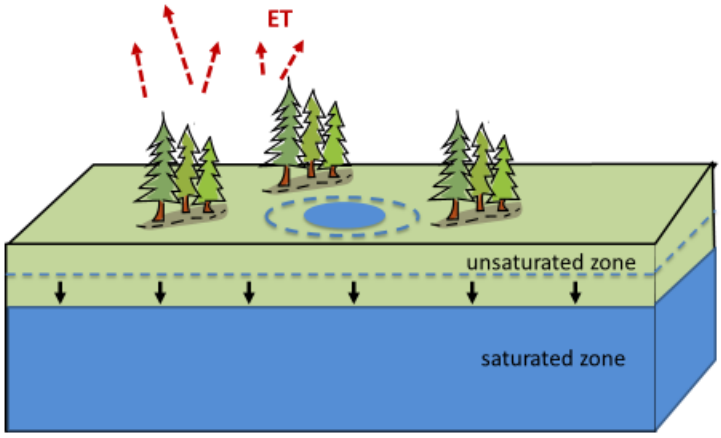

Dewberry
Spatial Distribution of Flood Risk
Baseline Scenario
1.5 ft SLR Scenario
3 ft SLR Scenario
Back Bay
Back Bay
Back Bay
Baseline
1.5 ft SLR Scenario
3.0 ft SLR Scenario
Virginia Beach Comprehensive Sea Level Rise and Recurrent Flooding Planning Study
14

Forest Cover



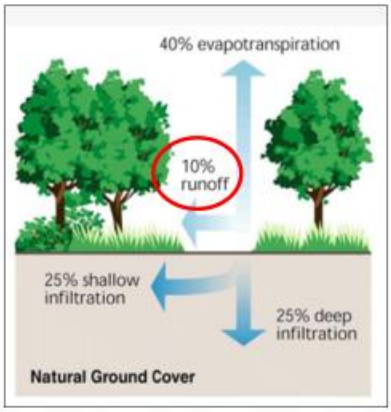
Forests capture, store and use water

***Evapotranspiration (ET)**: Plant water use and evaporation*
→ Replenishes Storage Capacity



Effect of forest cover on runoff

Water Budget for Natural Ground Cover Surface Area



Water Budget for 75% - 100% Impervious Surface Area

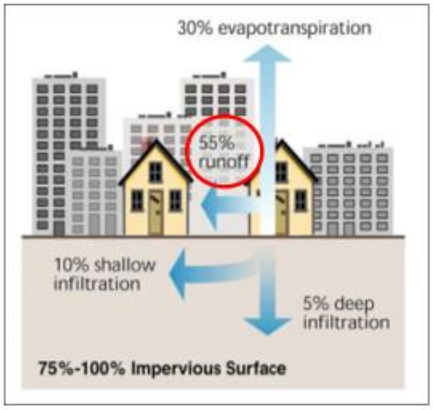
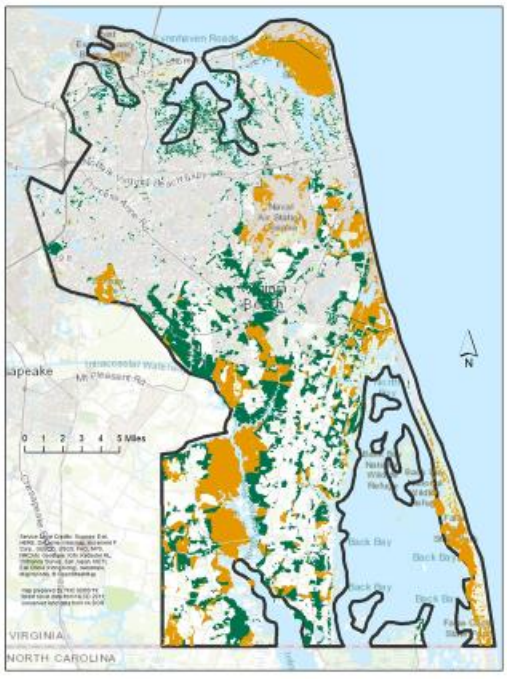


Photo courtesy of LEARN NC, www.learnnc.org



Approx. 50% of VA Beach forestland under conservation ownership

Conserved forestland
Forest cover not under conservation

Virginia Beach Forest Conservation Working Group

Vision Statement

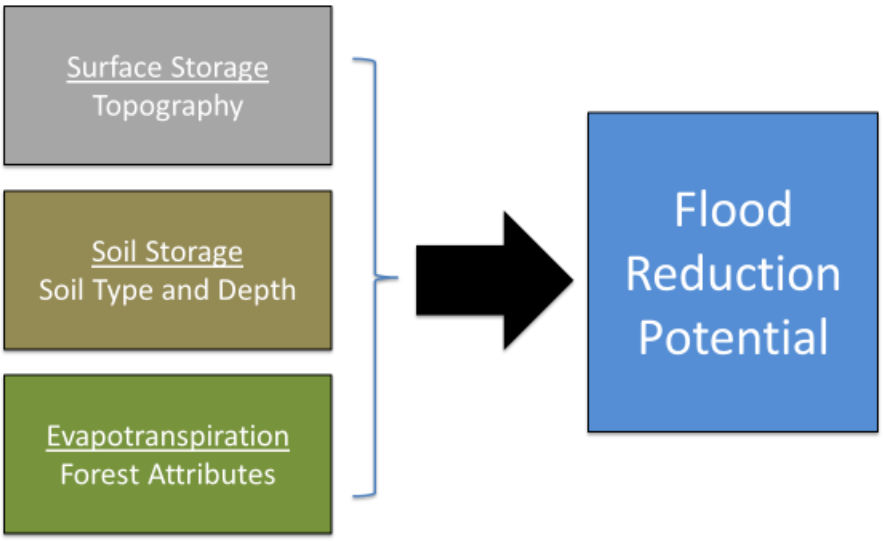
Native forest conservation and restoration are integrated into stormwater management strategies on public and private lands to achieve more effective flood risk reduction in the City of Virginia Beach.

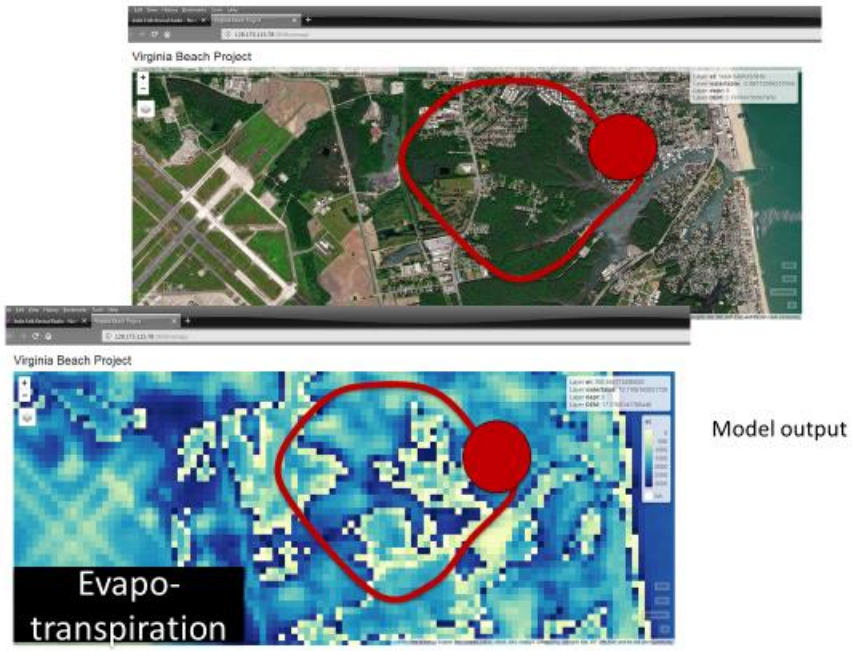
VA Beach Forests and Flood Reduction Study
Dr. Daniel McLaughlin, VA Tech

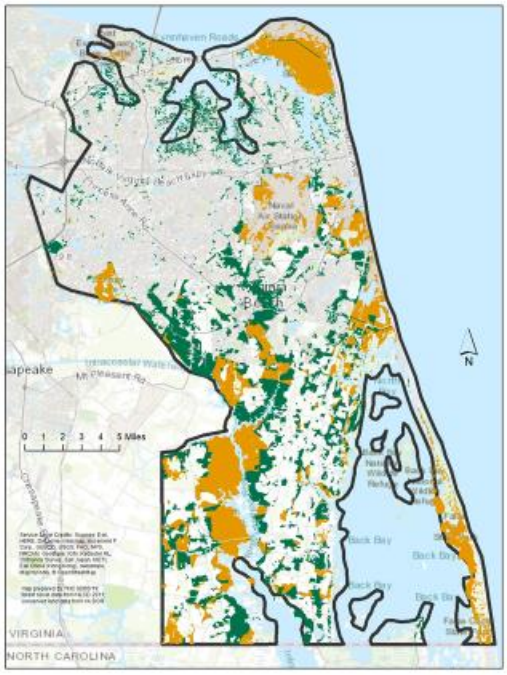
Objectives:

1) Quantify flood reduction services of forest cover
2) Develop decision support tool to prioritize conservation efforts

Forest Hydrology Model



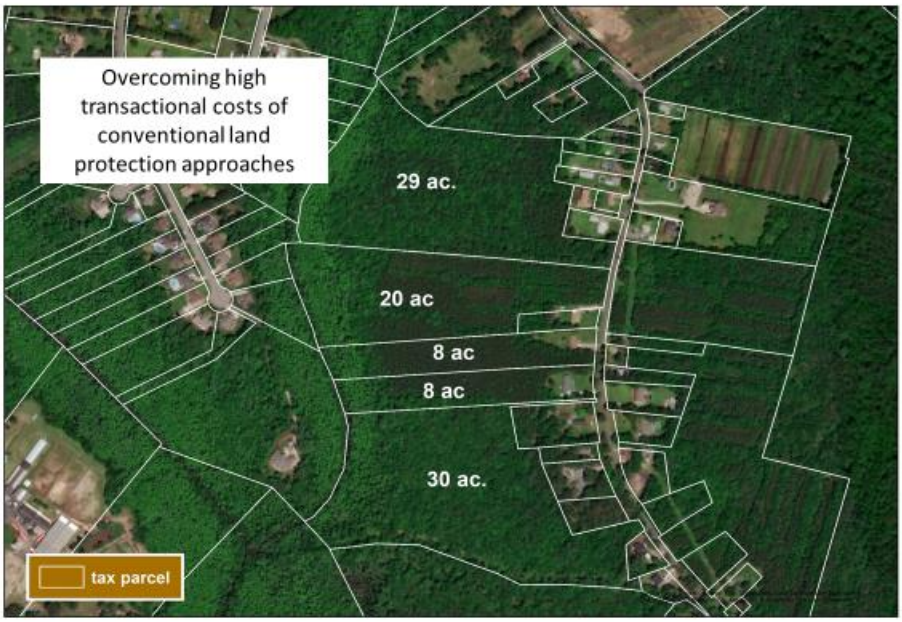




Approx. 50% of VA Beach forestland under conservation ownership

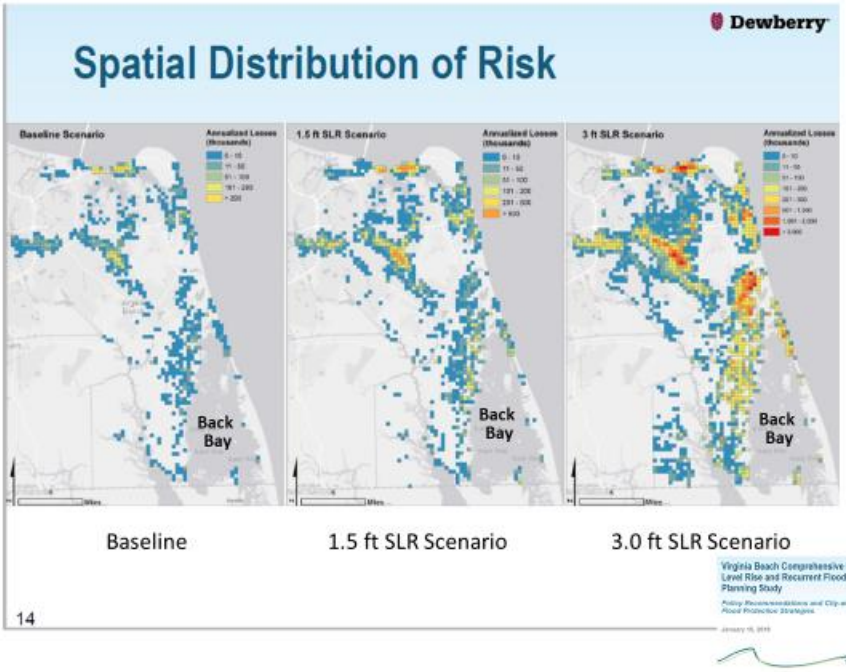
Conserved forestland
Forest cover not under conservation

Conservation challenges: scale

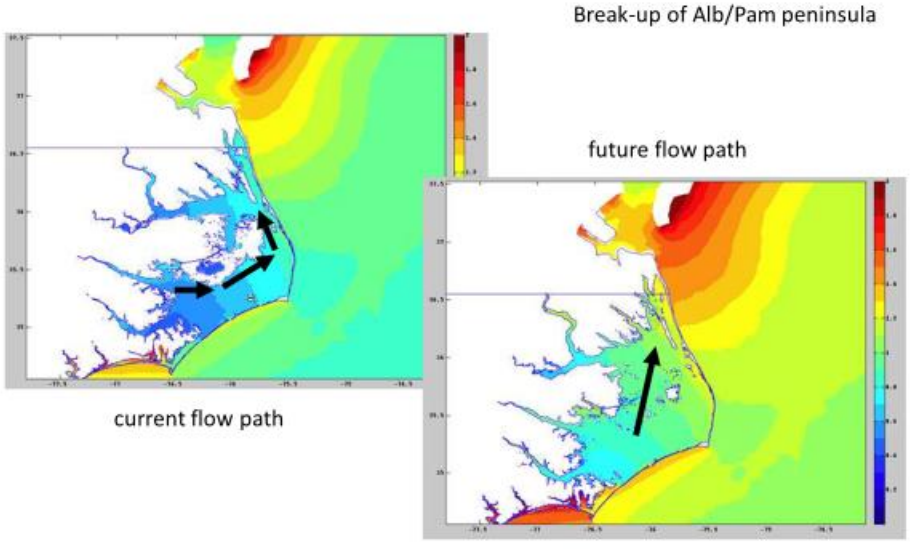


The "Southern Watersheds" of Hampton Roads

- **Conserving forest cover for flood storage**
- **Abating storm surges in Back Bay**



Changes in wind tide dynamics with sea level rise



Dewberry

Back Bay / Knotts Island Channel Marsh Stabilization Project

- Knowledge gaps
  - Sediment dynamics
  - Channel flow/wind boundaries
  - Marsh evolution
  - Role of submerged aquatic vegetation
  - Changes in tidal force with break-up of Alb/Pam peninsula; new inlet
- Marsh stabilization – potential approaches
  - Thin-layer sediment deposition
  - Establish cypress

The Virginia Department of Health's Efforts to Address Climate Change

April 12, 2019
Rotating Resilience Roundtable
Old Dominion University

Brenden Rivenbark
Senior Policy Analyst
Office of the Commissioner
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VDH VIRGINIA DEPARTMENT OF HEALTH
To protect the health and promote the well-being of all people in Virginia.

Virginia Department of Health

- Central Office supports 35 Local Health Districts that implement public health initiatives across Virginia
- Programs range from food safety to family planning services to ensuring that public drinking water facilities are supporting access to safe drinking water.
- In addition to protecting the health of Virginians, we serve to monitor disease outbreaks and predict potential public health risks.

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To protect the health and promote the well-being of all people in Virginia.

VDH Efforts to Address the Public Health Impacts of Climate Change

- The public health impacts of climate change are an emerging priority for the Commonwealth.
- To identify public health threats and mitigation tactics, the VDH Climate Change Committee (C-3) was created.
- The C-3 has been tasked with:
  - Identifying health related impacts of climate change in Virginia
  - Identifying vulnerable populations
  - Outlining relevant data, programs, and research in collaboration with internal and external partners
  - Developing recommendations for identification and mitigation of climate change impact
- Areas of Focus:
  - Sea Level Rise, Air Temperature/Quality, Water Temperature/Quality, Extreme Weather Events, the Social Determinants of Health

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CDC BRACE Framework

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To protect the health and promote the well-being of all people in Virginia.

Climate Change Effects in Virginia

- Coastal flooding is becoming more frequent and severe
- Storm events are more devastating, short and long term recovery is compromised
- Negative impacts on the fish and shellfish industries
- Negative real property value impacts
- Inland flooding will become more frequent and damaging
- Salt water intrusion into ground water
- Impaired septic system performance
- Populations will face increased risk of exposure to sustained high air temperatures, poor quality air, and contaminated food and water
  - This will further challenge already vulnerable populations

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Negative Health Outcomes Associated with Climate Change

Water Quality/Temperature
- Contaminated Food Consumption
- Harmful Algal Bloom Exposure
- Water-Borne Bacteria Exposure

Air Quality and Temperature
- Heat Stress and Exhaustion
- Exacerbation of Cardiovascular Diseases
- Exacerbation of Pulmonary Diseases
- Exacerbation of Kidney Diseases
- Pre-Term Births
- Hypothermia
- Exposure to Vector-Borne Disease
- Exposure to Carcinogens (i.e. Radon)

Sea Level Rise
- Consumption of Non-Potable Water
- Contaminated Water Exposure (sewer and/or well displacement)
- Malnutrition (from reduced access to healthy crops due to salt-water intrusion and increased salinity levels in agricultural land)

Extreme Weather Events
- Limited Potable Water Access (due to drought)
- Injury (flooding and other extreme weather events)
- PTSD, Grief, Depression, and Anxiety (caused by extreme weather events and environmental stress)
- Reduced access to necessary, timely health care services (due to flooding and other extreme weather events)

Infrastructure and Social Determinants of Health
- Displacement of Populations
- Decreased Property Values
- Decreased Tourism
- Damage and/or loss of businesses, schools, roadways, plumbing, housing, etc.
- Changes to animal migration and plant cycles
- Negative outcomes on local businesses and economy

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Public Health Impacts of Climate Change External Partners and Next Steps

- **External Partners** (include but are not limited to)
  - Virginia Department of Environmental Quality, Virginia Secretary of Health and Human Resources, Virginia Clinicians for Climate Action, Sierra Club, Virginia Commonwealth University, Science Museum of Virginia, Old Dominion University, Longwood University, Virginia Institute of Marine Science, University of Virginia, Virginia Tech, Eastern Virginia Medical School, Liberty University, Virginia Advisory Council on Environmental Justice, Medical Society Consortium on Climate and Health, City of Norfolk
- **Next Steps:**
  - Continue climate change research and regular C-3 meetings
  - Convene regular meetings with external subject matter experts
  - Develop response plan including an overview of the health impacts and suggested mitigation strategies by early 2020

VDH VIRGINIA DEPARTMENT OF HEALTH
To protect the health and promote the well-being of all people in Virginia.

Questions?

Contact:
Brenden Rivenbark
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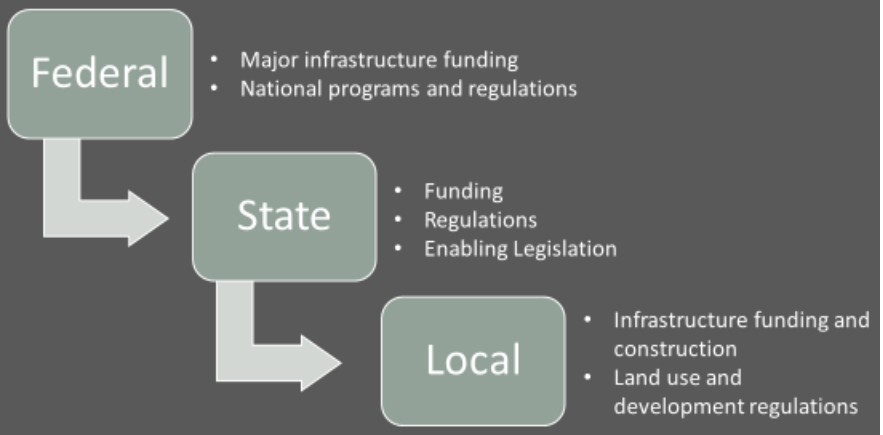
Policy and Politics of Resilience or: "Why Can't We All Just Work Together?"

ROTATING RESILIENCE ROUNDTABLE
OLD DOMINION UNIVERSITY
APRIL 12, 2019

BENJAMIN J. MCFARLANE, AICP, CFM
SENIOR REGIONAL PLANNER

Federalism at Work



3

Collaboration

Lesson from the Dutch Dialogues

- *Collaborate [only] when it makes sense!*

Collaboration is…

- Time-consuming
- Difficult
- You don't always get what you want

4

Collaboration

Where does it make sense to work together?

- When we're facing similar circumstances
- When something of mine has to connect or work with something of yours
- When it's not too expensive or too difficult
- When you're working on something new

5

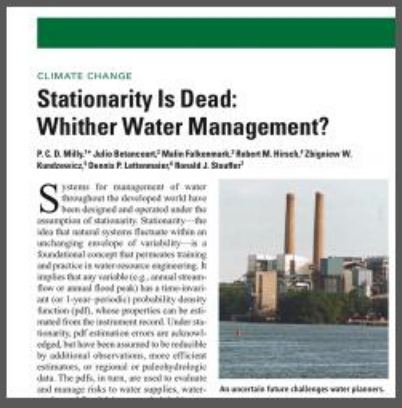
Factoring Resilience into Policy

Resilience requires acknowledging that change is happening

Change is not good for policy

Resilience requires that we deal with uncertainty

Resilience is hard! Expensive! Complicated!



CLIMATE CHANGE

Stationarity Is Dead: Whither Water Management?

P. C. D. Milly,[1]* Julio Betancourt,[2] Malin Falkenmark,[3] Robert M. Hirsch,[4] Zbigniew W. Kundzewicz,[5] Dennis P. Lettenmaier,[6] Ronald J. Stouffer[7]

Systems for management of water throughout the developed world have been designed and operated under the assumption of stationarity. Stationarity—the idea that natural systems fluctuate within an unchanging envelope of variability—is a foundational concept that permeates training and practice in water-resource engineering. It implies that any variable (e.g., annual streamflow or annual flood peak) has a time-invariant (or 1-year-periodic) probability density function (pdf), whose properties can be estimated from the instrument record. Under stationarity, pdf estimation errors are acknowledged, but have been assumed to be reducible by additional observations, more efficient estimators, or regional or paleohydrologic data. The pdfs, in turn, are used to evaluate and manage risks to water supplies, water-

An uncertain future challenges water planners.

Science (February 2008)

6

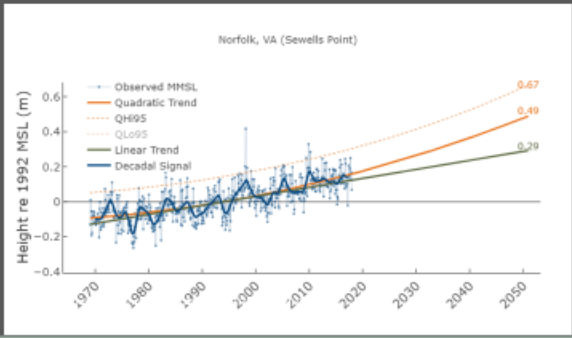
The Case for a Sea Level Rise Policy

Sea level rise has already occurred and is and accelerating

Flooding is occurring more frequently in the region

Higher standards reduce vulnerability and impacts

Adopting higher standards will help keep the challenge from growing



7

The Case for a Regional Policy

Provides support for localities

Makes regional coordination simpler

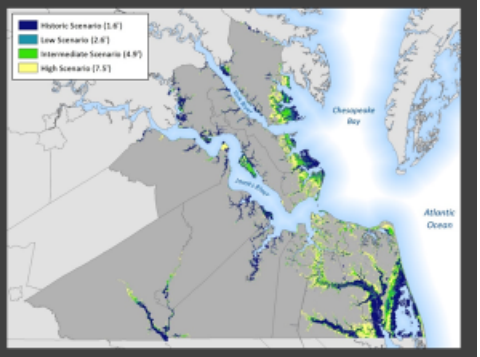
Creates a default position for state and federal entities on policies and projects

Demonstrates to the public that the region is working together on this issue

8

Regional Sea Level Rise Policy

- **What is the problem?**
  - Sea level is rising, but not always factored into project design
- **What are we doing?**
  - Screening values for planning to help estimate the scale of the problem
  - Updated curves for conducting benefit-cost analysis of different adaptation options



9

Policy Recommendations

Localities should incorporate sea level rise into their planning and infrastructure decisions using **screening values** and a **risk-based engineering approach**

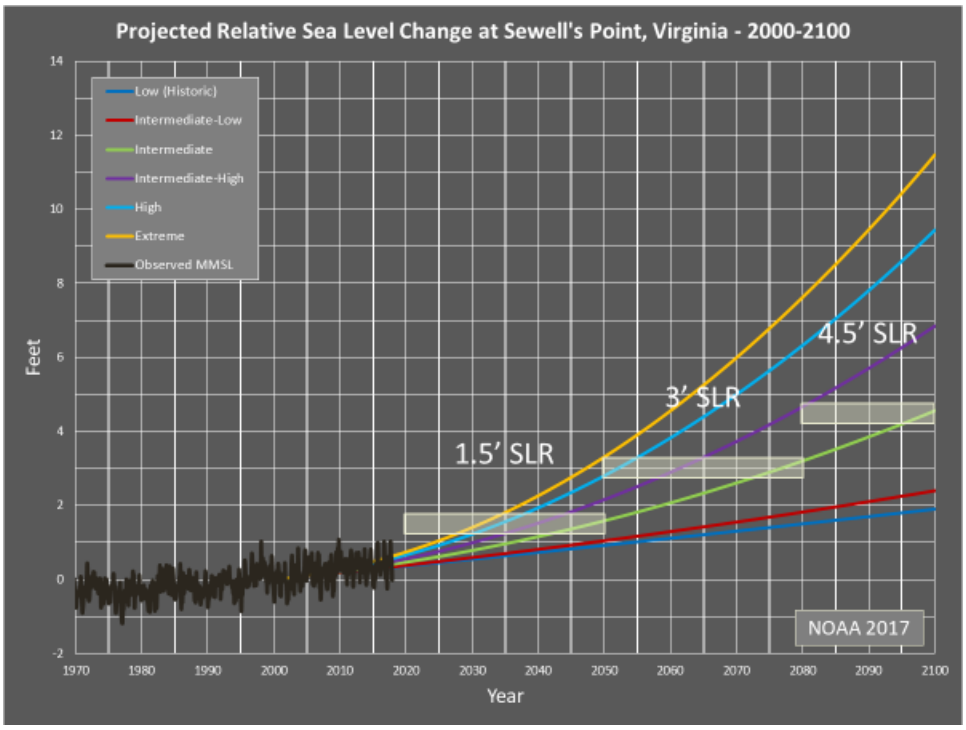
Screening values:

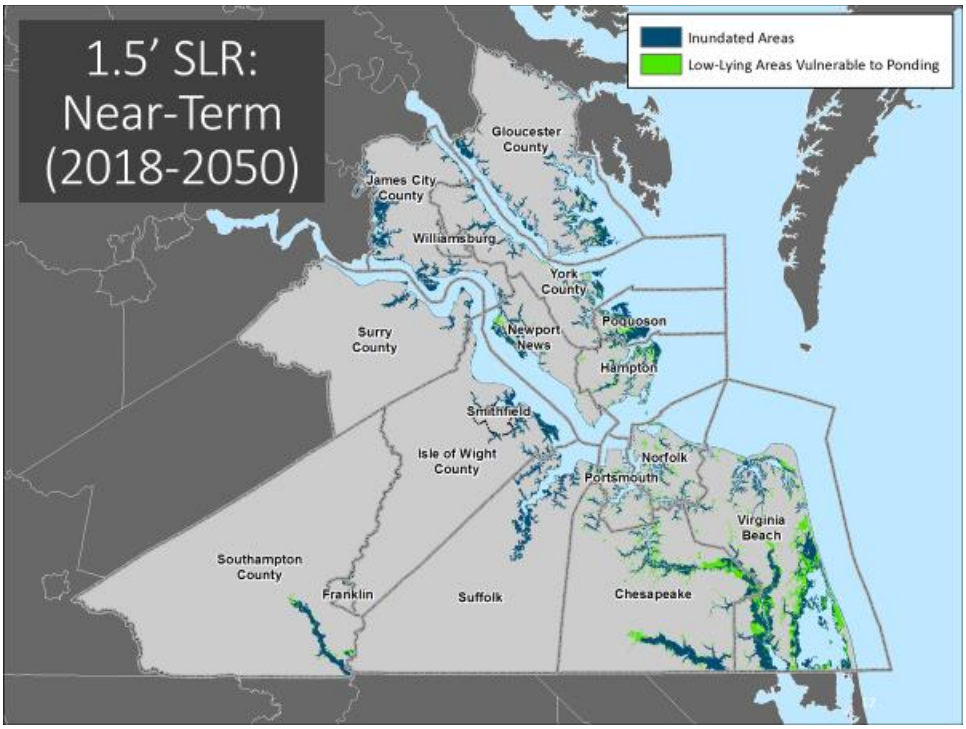
- 1.5 feet for near-term planning (2018-2050)
- 3 feet for medium-term planning (2050-2080)
- 4.5 feet for long-term planning (2080-2100)

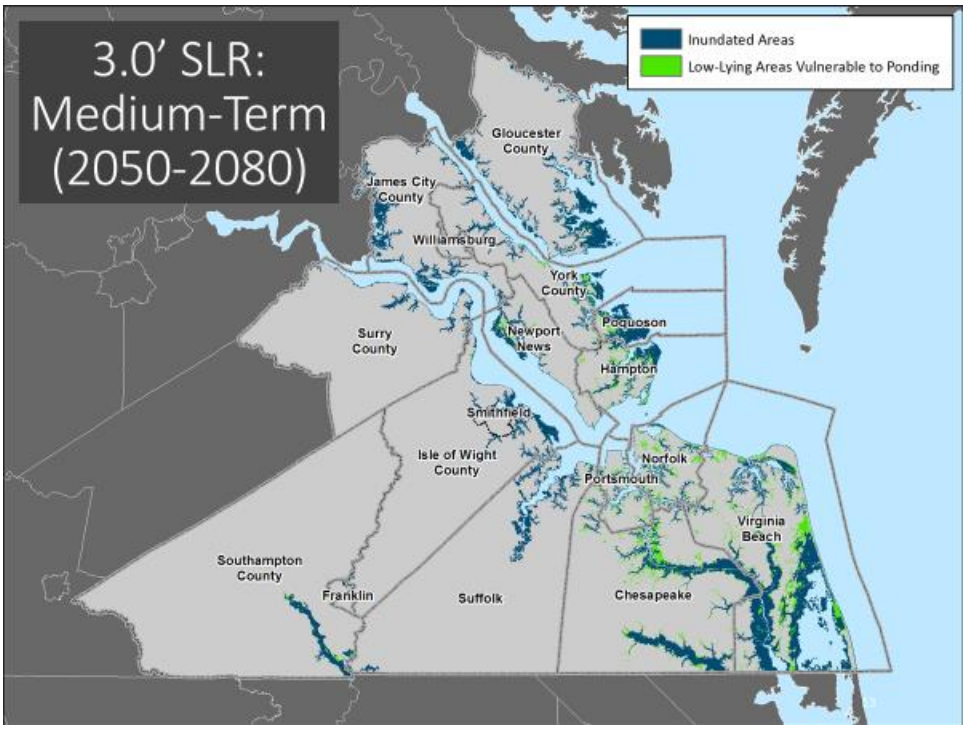
Risk-based engineering:

- Utilize best available sea level rise projections
- Explicitly account for construction timeline, project lifespan, criticality, and vulnerability to flooding
- Determine possible sea level rise impacts
- Perform benefit-cost analysis of adaptation options

10


Projected Relative Sea Level Change at Sewell's Point, Virginia - 2000-2100
Low (Historic)
Intermediate-Low
Intermediate
Intermediate-High
High
Extreme
Observed MMSL
Feet
Year
1.5' SLR
3' SLR
4.5' SLR
NOAA 2017


1.5' SLR: Near-Term (2018-2050)
Inundated Areas
Low-Lying Areas Vulnerable to Ponding
Gloucester County
James City County
Williamsburg
York County
Poquoson
Newport News
Hampton
Surry County
Smithfield
Isle of Wight County
Norfolk
Portsmouth
Virginia Beach
Southampton County
Franklin
Suffolk
Chesapeake


3.0' SLR:
Medium-Term
(2050-2080)
Inundated Areas
Low-Lying Areas Vulnerable to Ponding
Gloucester County
James City County
Williamsburg
York County
Poquoson
Newport News
Surry County
Hampton
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Isle of Wight County
Norfolk
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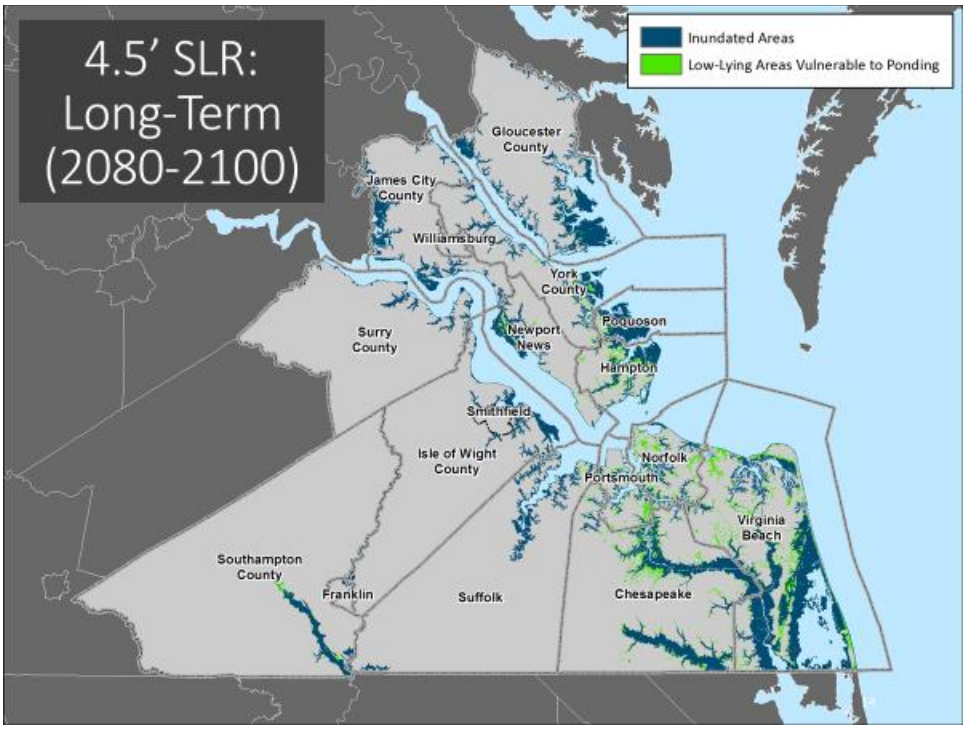
Virginia Beach
Southampton County
Franklin
Suffolk
Chesapeake


4.5' SLR:
Long-Term
(2080-2100)
Inundated Areas
Low-Lying Areas Vulnerable to Ponding
Gloucester County
James City County
Williamsburg
York County
Poquoson
Newport News
Surry County
Hampton
Smithfield
Isle of Wight County
Norfolk
Portsmouth
Virginia Beach
Southampton County
Franklin
Suffolk
Chesapeake

Next Steps – Implementation

15

Questions?

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16

THE CITY OF NORFOLK

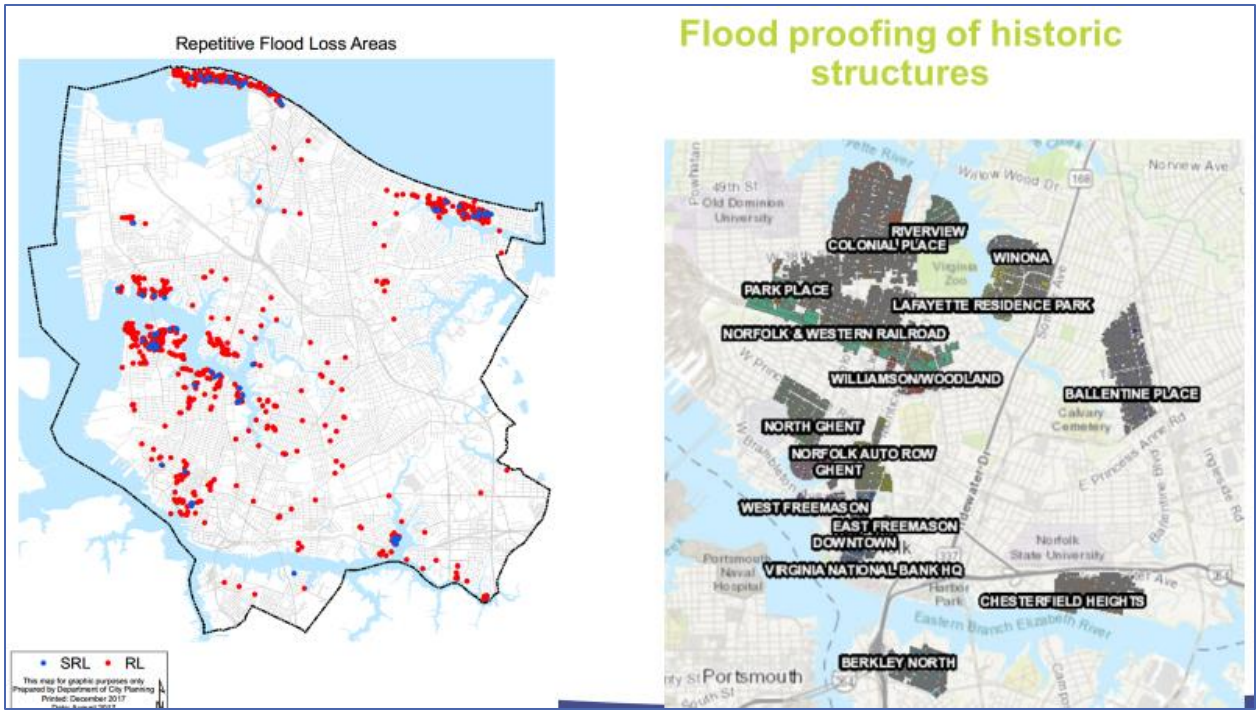
FLOODING AND THE BUILT ENVIRONMENT

Scott A. Smith, PE, LS, CPWP-M
Coastal Resiliency Manager

Topics for Discussion

1. Flood proofing of historic structures
2. Methods of locating old watercourses
3. The impacts on groundwater tables
   a) Impacts of Sea Level Rise
   b) Impacts of increased green infrastructure

NORFOLK


Repetitive Flood Loss Areas
SRL
RL
Flood proofing of historic structures
RIVERVIEW
COLONIAL PLACE
WINONA
PARK PLACE
LAFAYETTE RESIDENCE PARK
NORFOLK & WESTERN RAILROAD
WILLIAMSON/WOODLAND
BALLENTINE PLACE
NORTH GHENT
NORFOLK AUTO ROW
GHENT
WEST FREEMASON
EAST FREEMASON
DOWNTOWN
VIRGINIA NATIONAL BANK HQ
CHESTERFIELD HEIGHTS
BERKLEY NORTH
Portsmouth


Locating Old Waterways

The impacts on groundwater tables

a) Impacts of Sea Level Rise
   i. Elevated groundwater
   ii. Saltwater intrusion

b) Impacts of increased green infrastructure
   i. Elevated groundwater

c) Modeling methods?

QUESTIONS?

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