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Building Resiliency in Response to Sea Level Rise and Recurrent Flooding: Comprehensive Planning in Hampton Roads

by Joshua G. Behr, Rafael Diaz, Molly Mitchell

Introduction

Over the past few decades, the Hampton Roads region, with its extensive coastline, has been experiencing more frequent flooding from surges and precipitation caused by tropical storms, nor'easters and heavy thunderstorms (**Figure 1**). Recurrent flooding is "flooding that occurs repeatedly in the same area over time due to precipitation events, high tides or storm surge."[1] The recurrence of tidal/surge flooding in Hampton Roads has increased from 1.7 days of "nuisance" flooding per year in 1960 to 7.3 days per year in 2014.[2] Although there is no definitive region-wide data to document the increases in precipitation-induced flooding, there is much anecdotal, locality-specific evidence. With continued land subsidence and the projected increase in sea level rise, it is reasonable to expect that flooding events may become even more common.

Economic Impacts

Some may view recurrent flooding that makes local streets and neighborhoods either difficult to traverse or impassible for several hours as a temporary nuisance. While not necessarily catastrophic, such flooding can significantly disrupt the normal

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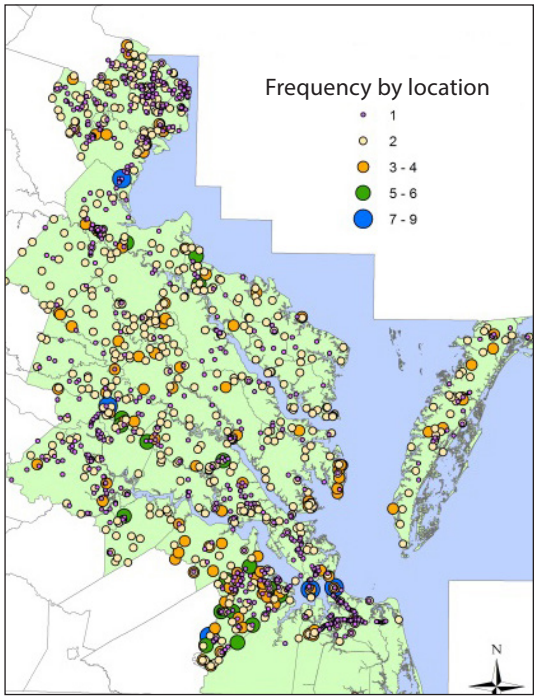
Figure 1: Flooding Frequency of VDOT Roads, August 19, 2008 to May 1, 2012



Source: Virginia Institute of Marine Sciences, "Recurrent Flooding Study for Tidewater Virginia," (2013).

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Residential street on a blue sky day contrasted with a typical heavy afternoon rain
Source: City of Portsmouth, Department of Planning

commerce and activity of the entire region. The seemingly minor inconveniences and local economic losses from each event can have a cumulative effect that results in considerable hidden costs to the region's residents and businesses, impacting the "bigger picture" vitality of the region.

Moreover, the economic impact of recurrent flooding may reach beyond Hampton Roads proper. Recognized as a geographic center for employment and logistics, the region boasts several critical transportation corridors and shipping ports and is home to multiple federal facilities essential to our nation's emergency readiness. Over time, Hampton Roads as a whole may become less attractive to homeowners, retirees, and investors as the costs of doing business increase and the quality of life is diminished due to recurrent flooding.

Comprehensive Planning and General Assembly Action

During its 2015 session, the General Assembly amended the Code of Virginia directing Hampton Roads localities, beginning in July 2015, to incorporate within their comprehensive planning processes strategies to combat sea level rise and recurrent flooding.[3] While specific strategies are not identified in the code, the term adaptation in response to sea level rise and recurrent flooding suggests an active response. Many adaptations are viewed as local government approaches, with the cities taking an active role in planning and coordinating responses across the geography of the cities.[4] Actions requiring huge capital investments in infrastructure may require a centralized authority.

Government Adaptation Strategies

Local government strategies in response to recurrent flooding fall into three broad categories: retreat, accommodation, and protection. A city's response to sea level rise, surge inundation and recurrent flooding may require a comprehensive response that uses more than one strategy depending on the neighborhood. For example, a comprehensive response may necessitate retreat from certain low-lying areas (e.g., preventing further development or purchase of properties); protection of other areas by adding coastal barriers and storm water improvements (e.g., building sea walls and living shorelines, improving storm water drains, leveling and improving street drainage, maintaining trees and ditches), and making accommodations in still other areas by accepting inconvenience, disruption, and property loss as the "new normal."

Many local government actions, however, cannot be effective without involving residents and businesses through coordination, cooperation, and communication (the three C's). Local government financial incentives and public information programs may encourage homeowners and small businesses to engage in adaptive behaviors and take actions that will mitigate flood-related losses. The adaptive capacity of a household or business may change in proportion to perceptions of risk, to tolerance for loss, and, of course, to financial resources. Local governments may encourage changes in behavior sooner rather than later, leading to decreased individual vulnerability and increased community resilience.

Household Adaptation Strategies

In response to the changing environment, households and businesses are taking adaptive measures without government involvement. Market forces may propel property owners to take actions to protect the value of their property, reduce risk to the household, or maintain the viability of a small business as a place of commerce. It may make economic sense, as well as provide peace of mind, to invest in efforts to head off or mitigate potential economic loss and suffering that may stem from flooding.

Residents of Hampton Roads are responding to recurrent flooding through actions that include raising the home, making structural improvements, flood proofing, purchasing flood insurance, grading and landscaping, sandbagging, clearing ditches near residences, purchasing high-water vehicles, relocating parking, adjusting schedules, budgeting for anticipated losses and moving out of flood prone areas altogether.

Working in Concert With Citizens

We recommend that city comprehensive planning include gathering insights into 1) household adaptation behaviors already taking place and 2) the adaptive capacity of households to respond. Local government planners also should consider residents' perceptions, behaviors and capacities. Since recurrent flooding and behavioral change vary across geography, there is also a need to map flooding hazards and adaptive responses.

Portsmouth as a Model

The City of Portsmouth is leading the way in responding to the General Assembly's directive by incorporating adaptive strategies into comprehensive planning processes. The city is actively engaged in understanding its residents' adaptive capacities and behaviors. For example, this year, the city interviewed 1,978 households, asking residents about frequency of flooding, flood-induced loss, risk perception, and mitigation behavior. It is anticipated that other Hampton Roads localities also will assess household adaptive capacity in an effort to support comprehensive planning.

Located within Hampton Roads, Portsmouth encompasses approximately 34 square miles of built-out urban and industrial area. The city has 40,848 housing units, 36,690 households, and roughly 96,000 residents, with a median household income of $46,166 and 18.4 percent of residents living below poverty level.

Due to Portsmouth's multimodal port, container shipping and ship servicing activities, the city's infrastructure supports significant container and commuter traffic on its major arteries. With approximately 50 miles of roadway less than 4.5 feet above mean high water, there is a high potential for road flooding at relatively low surge levels.

These 576 acres represent the third largest container terminal in the United States
Source: City of Portsmouth, Department of Planning

Recurrent Neighborhood Street Flooding

The frequency and extent of flooding within residential neighborhoods is not well documented, specifically the frequency of flooding in front of homes or neighborhood streets very near the homes. Roughly one third of Portsmouth residents report such flooding at least a couple of times a year and nearly half the residents report not being able to get either in or out of their neighborhoods within the past year due to flooding. Illustrated in **Figure 2** are those residential neighborhoods where street flooding is most frequent. Red areas indicate a concentration of households reporting frequent flooding.

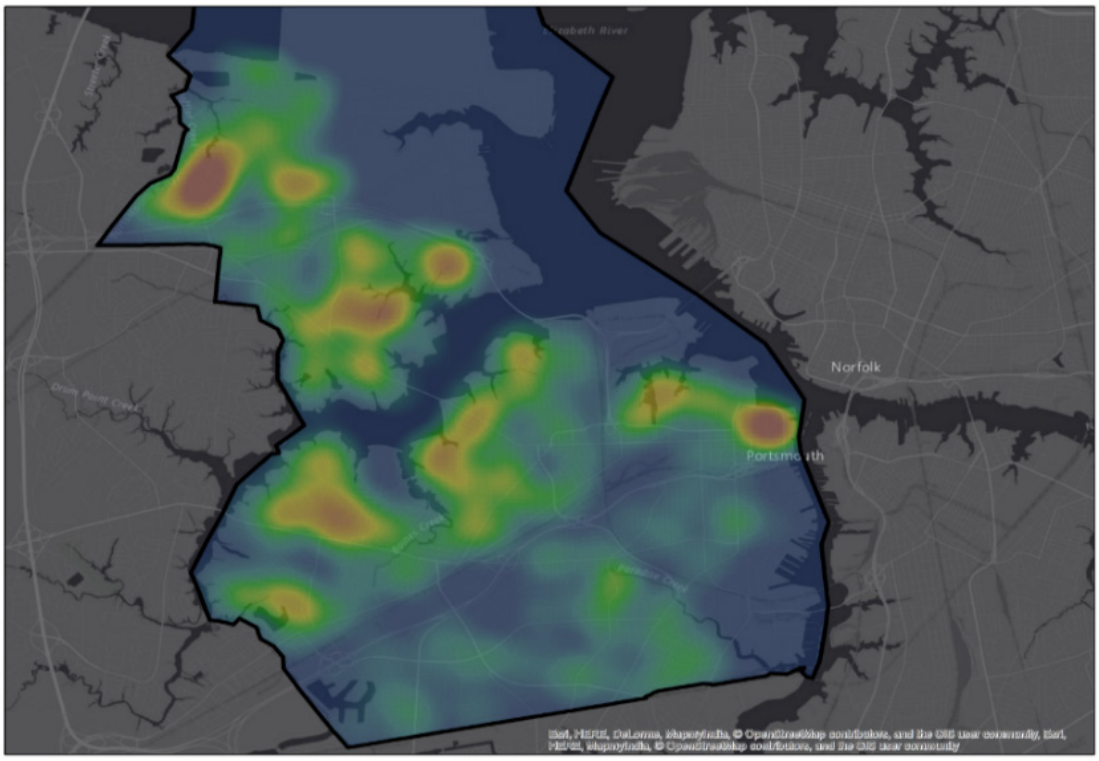
Fast Rising Water at Neighborhood Intersection
Source: City of Portsmouth, Department of Planning

Recurrent flooding significantly hampers the everyday activities of residents. For example, 27 percent of households report household members being unable to go to work due to flooding within the past year. In addition, the inability of residents to get in and out of neighborhoods at times and concern for family members traveling the roads in inclement weather may cause emotional distress. Also at risk are older and medically fragile residents who may fear isolation at times of heavy rains or high tides.

Property Damage

Property damage as a result of recurrent flooding is commonplace, especially among low- and moderate-income households. Many of these losses go unreported, yet the losses are persistent and constitute a meaningful burden for many households. For example, more than 18 percent of Portsmouth households report suffering some form of damage

Figure 2: Hot Spots Illustrating the Frequency of Residential Neighborhood Street Flooding



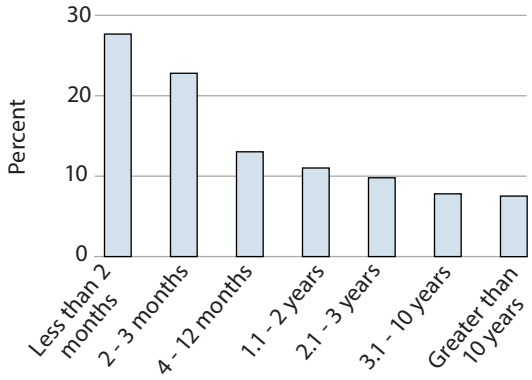
Source: Virginia Modeling, Analysis and Simulation Center at Old Dominion University, "Portsmouth Comprehensive Planning Support Report 1," October 15, 2015.

to vehicles, including total loss. The impact on homes may include damage to the interior, garage, crawl space, HVAC or duct work.

Time of Damage

The property damage suffered from recurrent flooding is repetitive and recent. As illustrated in **Figure 3**, about 27 percent of those households reporting flood-induced loss also report that a loss occurred recently.

Figure 3: Time of Damage

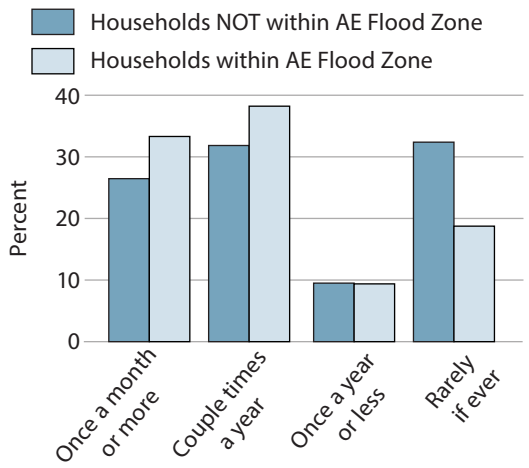


Source: Virginia Modeling, Analysis and Simulation Center at Old Dominion University, "Portsmouth Comprehensive Planning Support Report 1," October 15, 2015

Flooding Across the City

Perhaps surprising to some, flooding does not occur only in areas immediately adjacent to the shorelines and in flood zones. Recurrent flooding affects many residents across the city, including those farther from the shoreline or beyond a designated flood zone. For example, as shown in **Figure 4** while more than 38 percent of households within AE Flood Zones (meaning areas subject to inundation by the one-percent-chance annual flood event) report neighborhood street flooding a couple of times a year, nearly 32 percent of households not within AE flood zones also report flooding twice a year. These figures

Figure 4: Street Flooding



Source: Virginia Modeling, Analysis and Simulation Center at Old Dominion University, "Portsmouth Comprehensive Planning Support Report 1," October 15, 2015

suggest that recurrent flooding stems not only from surge-induced events taking place near coastal areas, but also from heavy precipitation and inadequate storm water systems inland. In addition, among those suffering damage within an AE flood zone, nearly 53 percent report some form of damage to the primary living structure. For households beyond the AE flood zone, this figure is 38 percent.

Household Adaptive Capacity

Several of the more common structural adaptations include installing French drains, sump pumps and gutters; adding soil and landscaping; and relocating HVAC systems. However, despite the roughly 80 percent of households that agree that sea level rise is already taking place within the city, most homeowners have not made structural adaptations.

The propensity of households to make necessary modifications can depend on household income, an understanding that sea level rise and recurrent flooding are related, and a sense of efficacy. We find that low- and moderate-income homeowners are less likely to make changes to the property compared with higher-income households. Also, those agreeing that sea level rise and neighborhood flooding are related are more likely to take adaptive measures. Further, nearly 37 percent of residents say that there is not enough solid information about sea level rise for the city to invest money responding to it. And more than 50 percent of residents disagree that it is the household's responsibility to take steps to deal with potential future flooding.

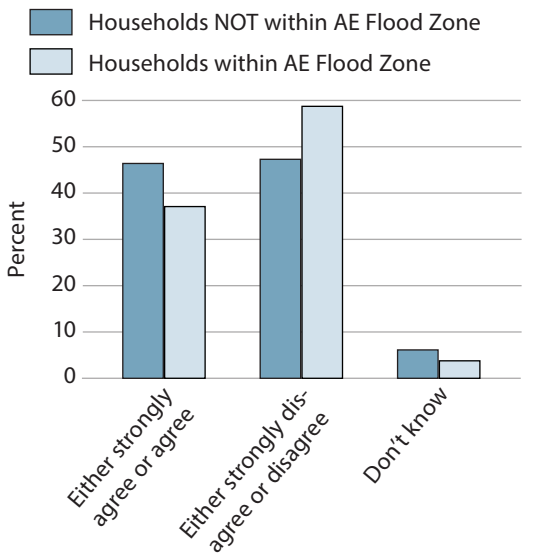
Negative Impact on Economic Opportunity and Home Values

There is strong perception among residents that future economic opportunities will be curtailed by changing sea levels; this view is even more strongly held by residents who experience difficulty getting in or out of their neighborhoods due to flooding. Private property is often a resident's largest single asset and is a primary vehicle for the intergenerational transfer of wealth, particularly for those living in low- and moderate-income areas. For homeowners, there is a profound feeling that they are currently suffering from the negative economic impacts of recurrent flooding. About 30 percent of residents agree that flooding specifically has negatively impacted the value of their homes. This rises to 33 percent among those who have not paid off their mortgages, to 41 percent among National Flood Insurance Program (NFIP) policy holders, and to 45 percent among those who find themselves on occasion unable to get in or out of their neighborhoods. As home values in particular neighborhoods decline due to sea level rise and recurrent flooding, pressures on the home values are expected to continue. With no relief in sight, the dynamics may encourage strategic defaults on mortgages.

Permitting of New Homes and Renovations

Local government strategies for adapting to both sea level rise and recurrent flooding often include restrictions on new-home construction and remodels and renovations in flood-prone areas. Nearly 84 percent of Portsmouth residents support restrictions on permitting of new-home construction. However, only 44 percent support restrictions on remodels and renovations (**Figure 5**).Homeowners within the flood zone are less supportive of restrictive-renovation permitting (37 percent). When government action comes at the expense of personal property rights, enthusiasm for the adaptive measure may be tempered.

Figure 5: Restrict Permitting of Renovations



Source: Virginia Modeling, Analysis and Simulation Center at Old Dominion University, "Portsmouth Comprehensive Planning Support Report 1," October 15, 2015

Building Resiliency

A resilient community is one that has effectively reduced its vulnerabilities. There is a co-evolutionary process whereby a region that has experienced recurrent disruptive events continually alters itself politically and socially, and modifies its infrastructure to better adapt to future events.[5] Actions in the Hampton Roads region, including approaches to comprehensive planning, and in the General Assembly are needed to plan adequate responses.

Given enough time and awareness of the hazards, strategies to adapt can be implemented

to mitigate personal and community vulnerabilities. However, many circumstances may reduce a household's willingness to carry out adaptive strategies to potentially minimize loss.[6] Failure to take corrective measures may result from having limited resources, inadequate perceptions of the hazards or a diminished sense of effectiveness. After experiences with past flooding, some people may view the failure to engage in hazard adjustment as rational.

Community resilience, as defined by the National Institute of Standards and Technology (NIST), is the ability to prepare for and adapt to changing conditions and recover rapidly from disruptions. Resilience, however, is a necessarily broad concept and does not lend itself easily to quantification.[7] Nonetheless, investments in broad, capital-intensive responses to recurrent flooding undertaken by a centralized local authority; smaller household actions taken independently of government; and policies and programs that are cooperative efforts between agencies and property owners may reduce vulnerability and increase coastal resilience.

Local governments are well-suited for the three C's of coordination, cooperation, and communication. While sea level rise and recurrent flooding are region-wide and issues of both state and federal concern, adaptive response is still very much a local effort. The decentralized and fragmented nature of the governance in the region may actually be a strength in the sense that it allows for experimentation in adaptive strategies. Local governments should be expected to partner with the citizens they serve. State and federal agencies ought to provide the training, technical support, and block-grant-style financing and matching funds to support localities' development and implementation of their comprehensive plans to deal with the effects of sea level rise and land subsidence.

ABOUT THE AUTHORS

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Endnotes

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