Making Space for Water: Building Resilience Amidst Norfolk's Rising Tide

New public policies and design strategies are essential as climate change and sea level rise threaten coastal communities. This paper examines an ongoing University of Virginia design research investigation in Norfolk, Virginia—one of the most threatened coastal cities in the United States.

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Eleven of the world's fifteen largest cities are located along the coast or on estuaries, while over 50% of the population of the United States lives near the coast.[1] A recent USGS report explains how "a sea-level rise of ten meters would flood about 25% of the U.S. population, with the major impact being mostly on the people and infrastructures in the Gulf and East Coast States."[2] Even one meter of sea-level rise would severely impact many cities. The massive monetary and social investments in existing urban settlements, the importance of maritime transportation, and even the intrinsic human attraction to water indicate the extent of this problem. How can architects in practice and the academy respond to the challenge of water-related risk? The *Water, Water…Everywhere* call for papers claims, "We need to think more deeply about how we live with water, design with water and engage in dialogue with water across the history of the constructed environment. As a discipline, architecture should work to innovate, develop and revise our practices to build new knowledge about how we accommodate, repel or efficiently use water across multiple scales."[3] A growing body of research has developed typologies and best practices for generic sites, while others engage the particularities of vulnerable places through design research.

THE CASE OF NORFOLK

Sea levels in Norfolk and Southeastern Virginia are rising faster than anywhere else on the East Coast of the United States. With land in the region sinking at a rate of 0.12 inches/year, subsidence exacerbates the threat of rising seas.[4] The Hampton Roads metropolitan area, where the Elizabeth River serves as one of the world's busiest ports, ranks 19th worldwide in value of assets at risk from storm surges and tidal flooding by 2100 ($84.6 billion current assets; $581.7 billion future assets according to the Hampton Roads Planning District Commission). Nearly 25% of Norfolk city land lies in the 100-year floodplain, including the downtown and its waterfront. The Virginia Institute of Marine Science and the Center for Coastal Resource Management predict that sea level here could rise as much at 7.5 feet by 2100. Over the years, tidal tributaries have been filled or piped, the Elizabeth River shoreline has been hardened with concrete bulkheads, and extensive shipping channel dredging has

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transformed river flow. The Virginia Department of Emergency Management's Storm Surge Inundation Map shows that Norfolk can expect to be flooded by storm surge from Category 1- Category 4 hurricanes.[5] Typical high tides overflow stormwater infrastructure at low-lying streets. Meanwhile, three factors limit coastal resiliency on the Elizabeth: loss of 50% of tidal wetlands since 1945; intense urban development along a majority of shore that limits the ability of marshes to migrate as sea level rises; and a lack of regulatory and public acceptance of natural approaches to shoreline development. Flooding is already happening and the question is not if or when, but how much. Given these challenges, Norfolk was selected as a pilot municipality for the Rockefeller Foundation's 100 Resilient Cities initiative, which has funded the hiring of a Chief Resilience Officer for Norfolk. In addition, Norfolk and two other Hampton Roads cities have been awarded a $120 million grant from the US Department of Housing & Urban Development's National Disaster Resilience Competition. Harbor Park is a important intervention area within the *Norfolk Coastal Adaptation and Community Transformation Plan* prepared for the HUD competition. As a complex threshold at the meeting of the Chesapeake Bay and the Atlantic Ocean, Norfolk and the Hampton Roads metropolitan region of 1.7 million inhabitants possesses particular problems and potential for creative solutions at the meeting of land and water.

RESILIENCE RESEARCH AT HARBOR PARK

In partnership with the City of Norfolk and the Elizabeth River Project, a UVA research team directed by Professor Phoebe Crisman developed adaptive design proposals for Harbor Park on the Eastern Branch of the Elizabeth River (Figure 1). This vacant 36-acre, coastal brownfield is cut off by elevated highways from downtown Norfolk and the economically challenged, racially diverse public housing neighborhoods of Tidewater Gardens and Grandy Village. Once a thriving working waterfront, current conditions are the result of massive, mid-twentieth century demolition projects in Norfolk. This destruction was supported by Federal urban renewal funds appropriated in the Housing Act of 1949. Bordering Harbor Park to the Northwest, for instance, the vibrant East Main Street district was leveled to make way for a new civic complex and highway interchange. Today the area is a landscape of large-scale transportation infrastructure—elevated I-264 passes overhead, a new Light Rail Line bisects the site, Norfolk's Amtrak Station occupies the eastern edge, and the Elizabeth River Ferry docks on baseball game days. While the area is served by multiple modes of transportation, they are not well connected into a coherent movement network. The massive Harbor Park Stadium floats amidst acres of surface parking devoid of buildings. Prior to extensive landfill operations in the nineteenth century, much of the site was a wetland and tidal tributary of the Elizabeth River's Eastern Branch (Figure 1). Today most of the Harbor Park redevelopment

Figure 1: Harbor Park district with Downtown Norfolk in the background (City of Norfolk, 2014) left; Aerial drawing of the Elizabeth River with Newton's Creek Basin in the lower right corner of image (1837) right.

area is located within the 100-year flood plain. Clearly it is time to reconsider that designation, since the area floods at least once a year. Professional consultants to the City have proposed high-rise commercial and residential buildings protected by conventional floodwalls on this vulnerable site.

As a critical alternative to that normative approach, the UVA research team reconceived the half-mile long, crumbling industrial edge as a living shoreline that demonstrates resilient strategies. Their proposals range from reclamation of all 36-acres as an 'inundation park' without new building development, to the creation of a narrow riparian buffer park with flood walls and levees that protect new midrise blocks. The proposed protective measures are designed to actively engage the people of Norfolk in restorative and recreational public places that reconnect this wasteland with downtown Norfolk and nearby neighborhoods. Along with urban strategies, the group is imagining new ways to live and educate in this watery landscape. The City has offered the Elizabeth River Project (ERP) a prominent Harbor Park parcel for their Environmental Center that would attract visitors to the waterfront and make their efforts more visible to the public.

Figure 2: Site section and site plan, Zephaniah Ruggles, UVA School of Architecture, 2015.

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UVA students in Crisman's Fall 2015 studio designed alternatives for a small, off-the-grid building that promotes health and wellness, connects outside and inside in provocative ways, employs sustainable materials and innovative details, and educates about resilient and zero carbon architecture. Along with natural ventilation, daylighting, and water views, ERP sought architecture in harmony with the natural systems of the site. They also wanted the occupation of the building to be designed as a resilient system over time. These desires were situated within their larger concern for safety from floods and storms. The studio experimented with several building typologies that work with fluctuating water levels, while providing interactive exhibitions, workshops, and offices, along with outdoor classrooms, boat docks, constructed wetlands, and water filtration gardens. Architecturally, the most conventional and expensive approach is to build 'business as usual' buildings behind sea walls or earthen levees. The UVA studio proposed resilient strategies that elevated habitable areas on piers above anticipated flood levels, designed lower levels to be inundated by occasional flooding, and used floating buildings that could adapt to rising waters.

CONNECTING INTERDEPENDENT SCALES + COMMUNITIES

This scalar interconnectedness requires designers to think across territories and time. In doing so, one cannot help but consider social, economic, ecological, and architectural issues. Scalar interdependence has been theorized in publications about resilient or fracture-critical systems. In *Designing to Avoid Disaster,* for instance, Thomas Fisher argues,

> "Resilient systems…cannot exist in a vacuum. Unless redundancy and resistance to sudden failure occur at multiple scales, the system remains as vulnerable as its weakest link. The lack of resilience at one scale can cancel out an abundance of it at another; particularly if the fracture-critical systems exists at a larger scale or in support of the more resilient one."[6]

Figure 3: View of new intertidal island, site section, site plan, Nicole Zaccack, UVA School of Architecture, 2015.

In order to understand Harbor Park within a larger set of systems, for instance, the group studied the Chesapeake Bay watershed, the Hampton Roads metropolitan area and Norfolk's place within it, the Elizabeth River and its Eastern Branch, the Harbor Park redevelopment area, and the Environmental Center architecture. They discovered that the Harbor Park 'neighborhood' or 'district' exists in name only. Currently Harbor Park is an isolated, largely forgotten zone whose disconnection results from numerous physical, social, and economic transformations. Until the late nineteenth century, most of the 36-acre area was a large tidal water body known as Newton's Creek Basin. Norfolk grew on higher ground around this basin. With the introduction of new transportation modes, the 'unnecessary' tidal wetland basin was filled to accommodate massive railroad marshaling yards that again blocked pedestrian, vehicular, and water movement across the area. Newton's Creek was channelized and connected to the Elizabeth River as Mahones Canal. The newly created land became a busy entrepôt and working waterfront between downtown Norfolk and eastward residential expansion. Between 1965 and 1980 Mahones Canal had been mostly culverted and rendered invisible. As part of Norfolk's twentieth century urban renewal efforts and changing transportation requirements, railroad lines and wharf buildings were demolished and a disconnected urban void remained. Severed from adjacent districts, Harbor Park lacks both advocates and residents. Understanding human communities is an important aspect of literally and conceptually reconnecting interdependent systems and scales. Communities are or should be involved at each level. As Paul Kibel notes in *Rivertown: Rethinking Urban Rivers,*

> "The current debates over the use of urban riverside lands therefore raise questions that are of particular concern in the post-urban-renewal era. If parkland and open space are going to be created, who will be the primary users and beneficiaries of these new resources? Will new riverfront proposals come from within the community where these lands are located or from developers outside the community? What role will governmental agencies and policies play in the process?"[7]

This site is a study in shifting priorities—from Norfolk's focus in the 1950's and 60's on eradicating 'urban blight,' to the 1980's and 90's prioritization of increasing tax base, to current concerns about climate change, sea-level rise mitigation, and urban resilience.

MITIGATING SEA LEVEL RISE + RESTORING THE POST-INDUSTRIAL WATERFRONT

Many seaboard settlements, and particularly older East Coast cities, are filled with disused industrial sites with opportunities to combine restoration and sea level rise mitigation efforts. Contaminated sites must be remediated before new uses can arrive. Norfolk's riverfront is lined with vacant brownfield sites in need of regeneration. The combined challenge of remediation, flood mitigation, and long-term sustainability require a radical rethinking of how to intervene. There are compelling recent examples of industrial waterfront regeneration that vary widely in size, location, and configuration. For instance, New York City's Hudson River Park, Brooklyn Bridge Park, and East River Esplanade were commercial waterfronts that have been recently reconfigured with public access and flooding in mind. Further afield, two excellent examples from China are Turenscape's Houtan Park in Shanghai and SWA Group's Wusong Riverfront Landscape Infrastructure Pilot Project in Kunshan City. Many of these projects model a synergetic relationship between post-industrial waterfront restoration and sea level rise mitigation.

EMBRACING NORFOLK'S RISING TIDE: THE HARBOR PARK STUDIO

The Elizabeth River Project, a non-profit, community based environmental group who has worked to restore the Elizabeth River for over twenty years, convened local stakeholders to generate environmental restoration goals for the Eastern Branch. ERP produced an excellent policy document, but specific physical proposals were not developed.[8] In order to generate

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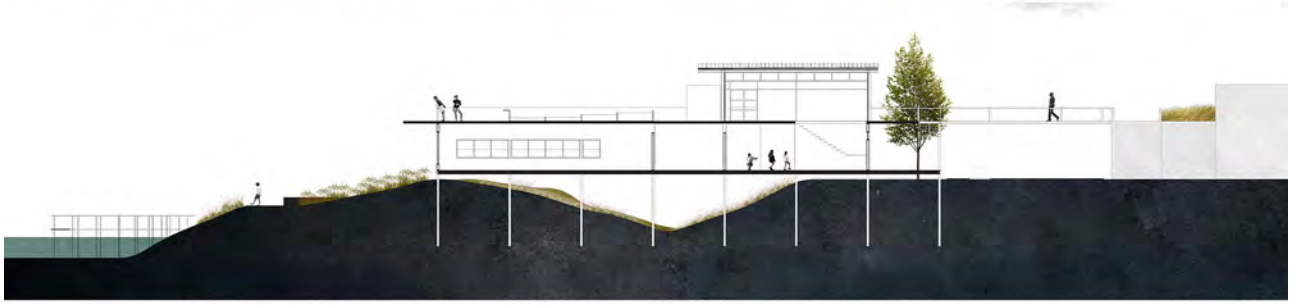

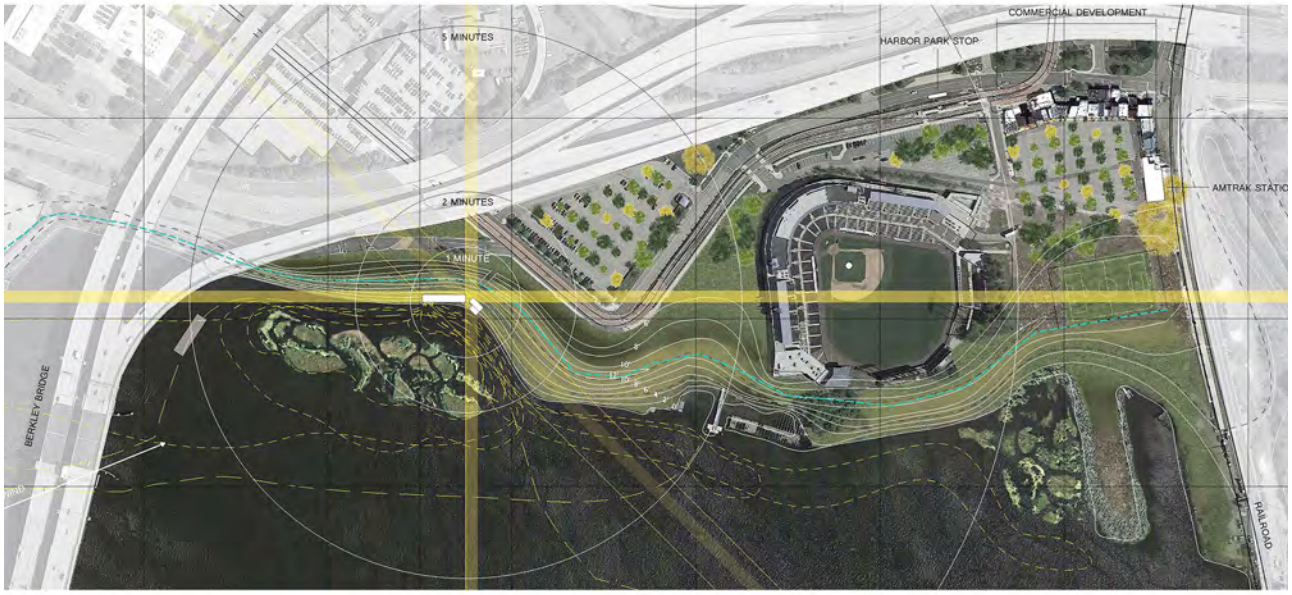
5 MINUTES
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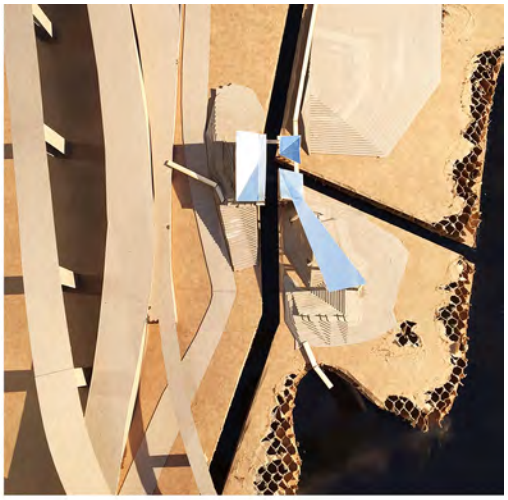
innovative design ideas, Professor Phoebe Crisman incorporated a Fall 2015 undergraduate architecture studio into the larger UVA research effort. Her students worked in four teams to research climate change and sea level rise; water, wetland and wildlife habitat; human culture and settlement history; and environmental education. They prepared case studies of shoreline restoration parks and environmental center precedents as well. They gained firsthand experience at several sites in the Norfolk area—learning about the Living Building Challenge at the Chesapeake Bay Foundation's Brock Environmental Center, experiencing a constructed wetland at Paradise Creek Nature Park, and studying sustainable building strategies onboard the UVA student-designed and built Learning Barge that will dock at Harbor Park.[9] Students proposed a self-sufficient Environmental Center, outdoor education spaces, and a living shoreline that together demonstrate resilient urban and architectural strategies.

Going beyond a mitigation mindset, the UVA studio sought to create an urban environment that truly embraces Norfolk's rising waters. They developed adaptive designs that explored several types of flood prevention for this stretch of Norfolk waterfront. Natural prevention approaches included living shorelines, riparian buffers, wetlands, intertidal islands, and other forms of new or restored ecologies. Synthetic prevention proposals included vertical or sloped floodwalls, berms, and jetties. In most cases, natural and synthetic strategies were combined in creative ways. For example, Zeph Ruggles designed a 200' wide living shoreline by regrading excavated fill into a gently sloping vegetated wetland (Figure 2). This intertidal zone creates healthy habitat, filters river sediments, and prevents erosion. A public pier projects through the wetland to the shipping channel, thereby allowing boat and pedestrian access to coexist with shoreline restoration. As series of demonstration basins step up to the education center and include an oyster bed, sedimentation pool, aquatic vegetation habitat, and dry grasses that filter stormwater onsite. Nicole Zaccack's proposal excavates a canal and uses the fill to construct a linear intertidal island (Figure 3). Located between the new island and shore, a half-mile long series of basins treat polluted river water and increase biodiversity and habitat. This restorative design strategy creates a protected place for kayaking and interacting with the River. An upland botanical garden and wet meadow surround the elevated environmental center, which serves as a public viewing tower directly connected to the Berkley Bridge pedestrian walkway. These approaches were informed by a careful study of the layered physical transformations of the site. As one of the most at-risk areas in Norfolk, Harbor Park has the potential to ameliorate risk to nearby areas by foregoing new building development. In similar locations, for instance, adaptive migration or coastal unbuilding is underway. Residents are relocated and their property is purchased for public mitigation use. Costly building removal is not necessary here. Only the Harbor Park Stadium has been built since the area was cleared by urban renewal. Many students decided to protect the stadium for continued use, while creating a resilient wetland park that reduces the effects of future flooding and storm surge for the surrounding neighborhoods and downtown Norfolk.

Some studio proposals designed a flood prevention system of continuous walls or berms. Emmitt Moore's scheme cuts back the hardened shoreline and builds a twelve-foot berm to resist floodwaters (Figure 5). Integral to the berm, the environmental center becomes a threshold and public access point to the water. The building's river-facing wall is clad in aquarium glass to register and make tidal changes visible to visitors. This lower level and its gardens are vertically connected, via an outdoor amphitheater, to a rooftop terrace along a continuous elevated promenade. The building is both part of the flood prevention infrastructure and the popular Elizabeth River Trail. While also using a continuous berm, Caroline Kraska shapes the shoreline to create a sheltered wetland zone (Figure 4). Tightly situated between the berm and river's edge, the environmental center mediates vertically between land and water. The entire lower level, designed to be periodically inundated, contains outdoor learning labs, kayak storage, and interactive wetland basins.

Figure 4: View of water collection swale and N-S site section, Jenny Adair (above); Site plan, river elevation, N-S section, Caroline Kraska (below), UVA School of Architecture, 2015.



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Another crucial consideration is the collection and storage of flood and stormwater onsite. Combinations of urban bioretention, absorption and water treatment, canals, dry ponds, and underground cisterns were proposed. Scott Levine designed a network of canals to manage water, structure future urban development, and promote pedestrian and small craft movement throughout the Harbor Park area (Figure 5). The proposed environmental center fragments into three separate buildings on earthen berms that define and engage the intersection of two canals. The canals create a strong identity for the revitalized district. Jenny Adair cut a continuous dry swale to capture and filter stormwater for groundwater recharge (Figure 4). Excavated soil is used to form a linear protective berm parallel to the swale. During extreme weather events, this redundant system will offer additional flood protection. The environmental center is elevated on piers and spans the swale to connect with the restored riparian buffer and wetland beyond. An upper floor links the existing, elevated Berkley Bridge pedestrian walkway with a public rooftop terrace and access to the living shoreline park below. Both proposals effectively exploit normative water management systems to structure urban movement and instigate sectional complexity in the associated buildings. By studying relationships between environmental restoration and human dwelling at multiple scales, the research team has imagined new resilient possibilities for this toxic stretch of liminal urban land. During the next phase of this investigation, a funded team of University of Virginia faculty will work closely with the City of Norfolk and the Elizabeth River Project to analyze several approaches for implementation feasibility.

MAKING VISIBLE

The ongoing faculty research project, along with associated studio proposals, assist the City of Norfolk in their ambitious efforts to plan for sea level rise and climate change. Working within watery landscapes and environmental restoration processes, architects can reveal that which is often hidden—hydrological flow, tidal estuary ecology, invisible toxins, and the geology and settlement history of the Elizabeth River shoreline. In varied ways, these designs seek to reveal relationships between ecology and constructed systems from the infrastructural to the architectural scale. They tell stories about the inextricable link between water and land, the properties and environmental impact of building materials, and the balance between human activity and a living shoreline. While focused on the Harbor Park district of Norfolk, this research proposes translatable strategies for coastal resilience in vulnerable urban settlements threatened by sea level rise, environmental degradation, and the loss of cultural heritage. The intense global interest in the urban implications of climate change and sea level rise, as well as the poetic possibilities at the threshold of land and water, underscore the timely significance of architects making space for water.

ENDNOTES

1. Vivien Gornitz, “Coastal Populations, Topography, and Sea Level Rise,” *NASA* (March 2000).
2. F*act Sheet fs002-00: Sea Level and Climate,* (United States Geological Survey, 2011).
3. Jori Erdman, “Water, Water Everywhere…” *ACSA Annual Conference Call for Papers* (2015).
4. Jack Eggleston and Jason Pope, *Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region, Circular 1392* (USGS, 2013). *The Chesapeake Bay: Geologic Product of Rising Sea Level* (USGS Fact Sheet 102-98) http://pubs.usgs.gov/fs/fs102-98/ accessed 9/12/15. Nathalie Baptiste, “Atlantic Surging, Virginia Sinking,” *The American Prospect* (Winter 2015).
5. Virginia Department of Emergency Preparedness & Response, http://www.vaemergency.gov/readyvirginia/stay-informed/hurricane/storm-surge
6. Thomas Fisher, *Designing to Avoid Disaster: The Nature of Fracture-Critical Design* (New York: Routledge, 2013): 100.
7. Paul Kibel, *Rivertown: Rethinking Urban Rivers* (Cambridge: MIT Press, 2007): 3-4.
8. The Elizabeth River Project convened a team of almost 90 stakeholders from government, science, business, and citizen groups to create the *Eastern Branch Environmental Restoration Strategy* (2014).The University of Virginia’s Institute for Environmental Negotiation facilitated the process.
9. The Learning Barge is a floating, environmental fieldstation built by the University of Virginia and operated by the Elizabeth River Project. See Phoebe Crisman, “Working on the Elizabeth River,” *JAE,* v.61:1 (2007): 84-91. Also http://www.elizabethriver.org/#!the-learning-barge/c11py

Figure 5: View of canal system, wetlands, and environmental center, site model, Scott Levine (above); South elevation, plan, and views, Emmitt Moore (below), UVA School of Architecture, 2015.