Resilient Waterfronts and Community Shorelines

TEC Significance

The Hudson River is well-known for the charming and historic, scenic waterfront villages towns and cities that line the shore from Tarrytown to Troy and serve as home to over one million residents and nearly 600,000 jobs (in towns that directly front the water). The Hudson waterfront is also host to critical transportation, freight, energy and wastewater infrastructure, port facilities and parkland that sustain how we live and interconnect our region. To date, the Hudson River waterfront has served as a valuable resource to support thriving communities, employment centers and infrastructure. But, as the impacts of climate change – increased frequency of high-intensity storms, sea level rise and extreme temperatures – become increasingly manifest in our region, our shoreline communities and vital infrastructure are at risk.

This is particularly true for those sections of the waterfront where historic development patterns and practices such as building on fill and in floodplains have exacerbated the threat of flooding. Today and into the future, portions of our communities, major pieces of infrastructure (including commuter and freight rail lines, wastewater treatment plants and power generating facilities) and remnants of the industrial past are located directly in an advancing floodplain. Thus, there is an urgent need to make our waterfront more resilient to the accelerating consequences of climate change.

Resilience can be defined as the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions (Federal Executive Order 13653). If the communities of the Hudson are to be thriving places that minimize their impacts on natural resources, steps will need to be taken to ensure that they become resilient to rising seas and increased and more intense storms and precipitation events.

The land use decisions we make at the river's edge to ensure that our communities and infrastructure are more resilient will both affect and be affected by many of the other TECs in this study. The waterfront is the place where residents engage with the river. As steps are taken to make it more resilient, estuary education will be required to help residents become stewards of the river and its riparian areas and floodplains, while better understanding the changes that may need to be made. Such changes could include an increase in restored natural systems in or around communities, including tidal and intertidal wetlands and shallow water habitats. Additionally, behavior changes and new investments will be needed to minimize impacts from waste and stormwater runoff. Investments in industry and commerce along the waterfront – which contributes to the resilience of local economies – will help to ensure water access and navigability. Sediment will also be influenced, in positive and negative ways, through Actions improved tributary connectivity, as well as climate impacts like sea level rise and increasing precipitation intensity.

Goal

Hudson River shorelines and community waterfronts are more resilient to extreme storms, less vulnerable to the effects of flooding and sea level rise and contribute to both the ecological function of the estuary and continued economic vitality of riverfront municipalities.

TEC Context

Historical Context

The relationship between the Hudson River and the people that have used its shores dates to the region's native inhabitants who fished, hunted and settled along its banks. Colonization led to the establishment of permanent communities along the shore. Industrialization transformed the river into a regional economic engine with manufacturing - including lumbering, brick-, iron- and cement-making – and goods movement driving growth in communities along the waterfront, including the one-time state capital of Kingston and current state capital in Albany. Over time, much of the manufacturing that dominated the river phased out, leaving behind a legacy of polluted waters and contaminated land. In recent years, cleanups and revitalization plans have established new uses along the waterfront, reconnecting the people to the River. Today, the Hudson waterfront supports a new generation of waterfront parks and uses, driving economic development through tourism and mixed-use development along the river's edge.

Current state

The Hudson River estuary comprises around 328 miles of shoreline, of which about 49% is considered natural, 41% engineered and the remainder a combination of hard and soft substrate. Most of the engineered shoreline is revetment and a smaller amount is bulkhead, with very small portions as cribbing or gabion.

Between the Governor Mario M. Cuomo Bridge and the Federal Lock and Dam at Troy, NY, 21 villages, 41 towns and 10 cities directly front the Hudson River, with a total population of 1.3 million and close to 600,000 jobs (based on 2010 Census data). Approximately 178,000 residents live within ½ mile of the waterfront in about 76,000 units of housing, 3% of which are public housing. Over 105,000 jobs are located within ½ mile of the shoreline. As the number and intensity of storms increases, our communities will contribute additional storm water runoff into the river, threatening its water quality and sensitive habitats.

The Hudson River shoreline is also heavily influenced by transportation-related infrastructure, including passenger and freight rail. The Metro-North Hudson Line includes 12 stations between Tarrytown and Poughkeepsie. Amtrak's Empire Corridor line extends north from Poughkeepsie to the Albany-Rensselaer station on the eastern shore of the river. On the western shore, the River Subdivision – a freight line owned by CSX – runs north along the shoreline to the Town of Esopus, before turning more inland as it continues north. The transportation lines that move people and goods up and down the river are crucial pieces of infrastructure that help to drive the region's economy.

Additionally, within a ½ mile of the river's edge are the following pieces of critical infrastructure: 24 wastewater treatment plants (fewer than the total number of plants in the entire Hudson River estuary); 10 hospitals; 9 power plants generating 6,382.5MW of electricity; 6 ports; and nearly 7,500 acres of waterfront parkland. There are also 68 designated Superfund sites within ½ mile of the waterfront.

Trends and Drivers

Given their location along the shoreline of a tidal river, it's important to consider the vulnerability of communities and infrastructure to flooding from storms and sea level rise. The following chart shows how many people and places are at risk from storm flooding today, from future storm flooding and from permanent sea level rise flooding alone:

At risk of flooding	Temporary flooding in the current 100-year floodplain	Temporary flooding in the future 100-year floodplain + 48" sea level rise	Permanent flooding in the future with 54" of sea level rise
Population	7,288	12,131	3,089
Housing Units	3,596	6,068	1,445
Passenger Rail Stations	4	11	1
Wastewater Treatment Plants	13	18	13
Hospitals	1	1	0
Power Generating Facilities	0	3	0
MW Capacity from Power Plants	0	1,913.5 MW	0
Port Facilities (active wharves, docks receiving or shipping cargo)	78	92	42
Superfund Sites	12	15	6
Public Housing Units	17	21	0
Nursing Home Beds	80	80	0
Rail Freight Distribution Centers	9	2	0

Numerous towns are already engaged in resilience planning and design projects, including five that are working with the Hudson River Estuary Program to understand and prepare for the risk of future floods. These include the Village of Catskill, City of Kingston, Town of Stony Point, Village of Piermont and City of Hudson. Also, the waterfront municipalities of Albany, Bethlehem, Cold Spring, Croton-on-Hudson, Marlborough, Nyack, Peekskill, Piermont, Poughkeepsie, Rensselaer, Saugerties, Stony Point, Tarrytown and Troy have each begun or are about to begin developing plans through the Local Waterfront Revitalization Program of the NYS Department of State. Several of these communities have also participated in Climate Adaptive Design (CAD) program, in partnership with the Estuary Program and Cornell's Department of Landscape Architecture.

Constraints

Funding is a major constraint for waterfront climate adaptation. Large amounts of funding will be needed to invest in strategic armoring, strategic relocation of uses, shoreline restoration and stormwater green infrastructure. Another constraint is physical space. Given the geological context of the estuary (narrow floodplains with steep valley walls), new development will be limited and redevelopment in floodplains will be challenging. Lack of political will is also a constraint. Strong political

leadership is necessary to secure funding, overcome entrenched behaviors and to make forward-looking decisions beyond the next election cycle. Finally, confidence in models and adaptation strategies is always improving, but we are limited to the best information we have at the time.

Action Table

Objectives	Quantifiable Actions	Timeframe
Objective 1: Policies and practices are upgraded to ensure high and consistent levels of resilience that equitably reduce risk for all populations	1A. Statewide guidance and standards are produced to advance resilient development and adaptation in the floodplain	2020
	1B. Sea level rise projections are incorporated into state funding, siting and permitting practices	2020
	1C. 25% of waterfront municipalities adopt statewide guidance into municipal law	2030
	1D. 75% of waterfront municipalities adopt statewide guidance into municipal law	2070
	1E. An inventory of areas most appropriate for fortification/accommodation/relocation is developed	2020
	1F. Communities at greatest risk of flooding and erosion are identified as high priority to conduct vulnerability assessments and develop adaptation plans	2020
	1G. 100% of the communities at greatest risk of flooding and erosion have conducted vulnerability assessments and developed adaptation plans	2030
	1H. 75% of the communities at greatest risk of flooding and erosion have made zoning changes to reflect vulnerability assessment/adaptation plans discouraging growth in high flood risk areas while encouraging growth and redevelopment in low flood risk areas	2030
	1I. The state building codes are updated to reflect statewide flood risk management guidance	2020
	1J. An inventory of prioritized areas for strategic relocation of uses is developed in all relevant waterfront communities	2020
Objective 2:	2A. Inventory all locations and the condition of hardened/engineered shorelines which are not	2020

Community shorelines are adapted to improve ecological values and resilience to climate change impacts	protecting critical facilities or other vital community infrastructure, and identify and prioritize opportunities for their restoration with ecological enhancement	
	2B. Replace hardened/engineered shores with natural designs in places identified as high priorities for shoreline restoration; specific goals will be based on the inventory and prioritization (see 2A above)	2030/2070
	2C. Inventory/track and evaluate erosion protection projects that use innovative, nature-based features	2020
	2D. 25% of erosion protection projects incorporate innovative, nature-based features	2030
	2E. 75% of erosion protection projects incorporate innovative, nature-based features	2070
	2F. Develop statewide guidance for resilient waterfront parks	2020
	2G. Inventory and rate all waterfront parks for resilience against the state guidance	2020
	2H. All waterfront parks not already rated as highly resilient will be adapted to increase resilience	2070
Objective 3: Critical infrastructure is adapted to be resilient to flooding and sea level rise	3A. Asset management plans for all wastewater treatment facilities in the floodplain will be conducted to determine need for upgrades	2020
	3B. All wastewater treatment plants will be upgraded to 100-year storm plus high sea-level rise flooding standards	2030/2070
	3C. Asset management plans for all power generating facilities in the floodplain will be conducted to determine need for upgrades	2020
	3D. All power generating facilities will be upgraded to 100-year storm plus high sea-level rise flooding standards	2030/2070
	3E. Asset management plans for all rail lines, stations and facilities in the floodplain will be conducted to determine need for upgrades	2020
	3F. All at-risk rail stations will be upgraded to 100-year storm plus high sea level rise flooding standards	2030

	3G. Protection and elevation of the Metro North Hudson/Amtrak Rail Line will be studied, and cost estimated	2030
	3H. The most at-risk sections of the Metro North Hudson/Amtrak rail line will be elevated or adequately protected	2030/2070
	3I. Asset management plans for all social infrastructure (public housing, hospitals, nursing homes) in the floodplain will be conducted to determine adaptation needs	2020
	3J. All social infrastructure will be adapted to 100-year storm plus high sea level rise flooding standards	2030/2070
	3K. Asset management plans for all contaminated and Superfund sites in the floodplain will be conducted to determine necessary adaptation measures	2020
	3L. All at-risk contaminated and Superfund sites will be upgraded to 100-year storm plus high sea level rise flooding standards	2030/2070
Objective 4: Communities are supported and sharing best practices around adaptation	4A. Estuary communities have access to predictable funding streams and technical assistance to implement adaptation projects	2020/ongoing
	4B. A peer-to-peer adaptation learning network for municipal officials is instituted	2020
	4C. 10 waterfront communities become certified "Climate Smart" communities	2020
	4D. 25 waterfront communities become certified "Climate Smart" communities	2030
	4E. 50 waterfront communities become certified "Climate Smart" communities	2070

Action Narrative

For the waterfront communities of the Hudson River estuary to become more resilient and less vulnerable to the effects of climate change, a shift away from the status quo will be necessary. Objective one puts forward actions to improve the current policies and practices that govern how we plan and develop at the water's edge and increases knowledge of what types of adaptation should happen in which places. Steps include helping communities take stock of their current zoning policies and development practices in the floodplain and considering whether they can be made more resilient. The guidance being offered by the state through the implementation of the Community Risk and Resilience

Act (CRRA) (including model laws, flood risk management and natural resilience measures) offer opportunities for communities to directly adopt standards and change practices at the local level. The state building code (which is reviewed every five years) should be updated to set a standard for resilient building practices. Ultimately, all changes (zoning, building codes, development practices, prioritizing sites for buyouts, etc.) will need to happen with a robust public process, but research and analysis by universities and non-profits and guidance by the state can help to advance and inform these efforts. The outcome will be a shift away from risky development in flood-prone areas.

Objective two advances ways to ensure balance between the built and natural environments in ways that ensure the resilience of both. Some areas of the built environment can be returned to more natural states; others will need enhanced protection. Both methods can better incorporate natural functions. New York State's Sustainable Shorelines program can help to advance the use of natural and nature-based features to protect the built environment. Waterfront parks also play an important role along the shore, providing recreational opportunities and habitat. They can also help to make the communities around them more resilient. Statewide guidance can help to promote resilience in waterfront parks.

Objective three offers actions to meet the challenge of making wastewater treatment, energy, rail, social infrastructure and contaminated sites more resilient to flooding from storm surge and sea level rise. Asset management plans will help to identify at-risk infrastructure and over time, resilient upgrades can to ensure healthy water quality, stable energy supply, mobility and healthy, equitable communities throughout the region. All facilities should be upgraded to be resilient to flooding from the current 100-year storms in the short run and the combination of sea level rise and storms in the long run. Funding and knowledge sharing across boundaries will help communities to meet their resilience goals.

Objective four promotes the concept of a peer-to-peer adaptation learning network to promote shared services and learning opportunities. Networks could be new or built on existing networks, such as the Hudson River Estuary Program's waterfront resilience task force learning group or the Rockland Riverfront Communities Council. The growing list of Climate Smart Communities could also serve as a network for sharing. Ultimately, a stable source of adaptation funding and technical assistance will enable these communities to take necessary actions.

Research Needs

The greatest research needs for resilient waterfronts and shorelines include a summary of best practices for adaptation that will inform steps municipalities can take. There are many options for communities to take to become resilient, but information sharing across the region will help this network of municipalities to make the most informed decisions for their community with limited adaptation funding available. Also, further research on which developed waterfronts are the best suited to accommodate restored and natural shorelines that benefit the river is needed. This could dovetail with the need to understand which areas might be most cost-effective for strategic relocation in the long-term. Finally, understanding where developed shorelines can help to support wetland migration as sea levels rise will provide a clearer picture of the pathways for this critical habitat.

Beyond Scope Ideas

- How would the estuary be impacted by a regional storm surge barrier at the mouth of NY Harbor currently under consideration by the U.S. Army Corps of Engineers?
- How do we ensure long-term, stable funding for adaptation?

Bibliography

Census 2010 (Total Population and Housing Units).

LODES Workplace Area Characteristics, US Census, 2014.

Passenger Rail, US Department of Transportation Federal Railroad Administration (Railroad Geographic Information System), 2015. http://fragis.fra.dot.gov/GISFRASafety/.

Wastewater Treatment Plants, US Environmental Protection Agency, Facility Registry Service, 2016. https://catalog.data.gov/dataset/epa-facility-registry-service-frs-wastewater-treatment-plants.

USA Hospitals, Esri and United States Geological Survey, 2016. https://www.arcgis.com/home/item.html?id=f114757725a24d8d9ce203f61eaf8f75

Power Plants, US Energy Information Administration, 2016. https://www.eia.gov/maps/layer_info-m.php.

Environmental Remediation Sites, New York State Department of Environmental Conservation, 2008. http://gis.ny.gov/gisdata/metadata/nysdec.remediationsites_KML.xml

Assisted Housing – Public Housing Buildings – National Geospatial Data Asset, US Department of Housing and Urban Development, 2016. https://catalog.data.gov/dataset/assisted-housing-public-housing-buildings.

Nursing Home Weekly Bed Census, New York State Department of Health, accessed 08/23/2016. https://health.data.ny.gov/Health/Nursing-Home-Weekly-Bed-Census-Last-Submission/izta-vnpq/data

Passenger Rail, US Department of Transportation Federal Railroad Administration (Railroad Geographic Information System), 2015. http://fragis.fra.dot.gov/GISFRASafety/

Port Facilities, Department of Homeland Security – Homeland Infrastructure Foundation-Level Data, 2016.https://hifld-dhs-gii.opendata.arcgis.com/datasets/20c50b1ac0dc4a28acd76687044bdc89_2

Resilient Waterfronts and Community Shorelines

Team Lead

- Rob Freudenberg, Regional Plan Association, robertf@rpa.org

Contributing Team Members

- Catherine Alcoba, U.S. Army Corps of Engineers
- Jeff Anzevino, Scenic Hudson
- Kristin Marcell, Hudson River Estuary Program/NYSDEC and Cornell Water Resources Institute
- Sarabrent McCoy, Regional Plan Association
- Barney Molloy, Hudson River Watershed Alliance