Town of Cortlandt & City of Peekskill

Community Resilience Building Workshop
Summary of Findings
June 2017

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Table of Contents

A workshop participant's doodle of Peekskill.

Cover Image: View of the Peekskill Waterfront ©The Nature Conservancy (Gillian Cowley)

OVERVIEW

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Municipalities, regional planning organizations, states and federal agencies need to increase resiliency and adapt to the likelihood of extreme weather events and mounting natural hazards. For communities in the Hudson Valley, this need is strikingly evident. Recent devastating events such as Tropical Storm Irene and Superstorm Sandy have reinforced this urgency and compelled leading communities such as the Town of Cortlandt and City of Peekskill to proactively plan and mitigate potential risks. Ultimately, this type of leadership will reduce the exposure and vulnerability of Cortlandt and Peekskill's citizens, infrastructure and ecosystems, as well as serve as a model for communities across the Hudson Valley, New York, and the Nation (Figure 1).

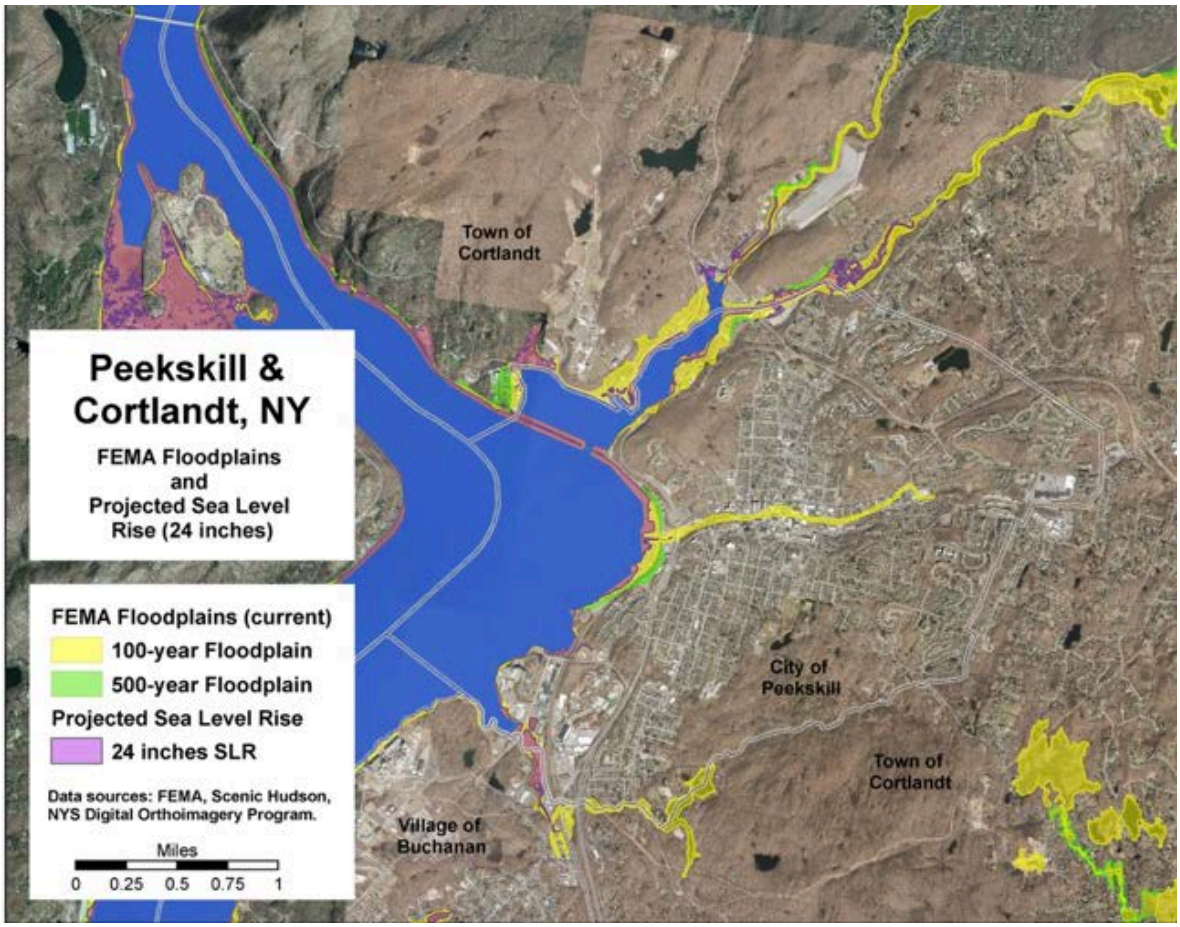


Figure 1. Predicted Floodplains and 24-inch Sea Level Rise in Peekskill and Cortlandt

In the fall of 2016, The Nature Conservancy, Historic Hudson River Towns and the Hudson River Watershed Alliance approached officials in the Town of Cortlandt and the City of Peekskill to discuss and identify resilience needs relative to infrastructure, habitat restoration and community resilience. As a result, an integrated strategy was introduced to both communities that incorporates current climate projections, identifies areas of risk and develops adaptation strategies. The Community Resilience Building (CRB) Workshop, a unique "anywhere at any scale" community-driven process (www.CommunityResilienceBuilding.com), provides an appropriate platform to engage elected officials, staff and business leaders from the Town of Cortlandt and City of Peekskill communities. The purpose of the facilitated, joint-community workshop is ultimately to guide implementation of priority adaptation actions for the City of Peekskill and the northern portions of the Town of Cortlandt. The workshop's central objectives are to:

- Define extreme weather and articulate local natural and climate-related hazards
- Identify existing and future vulnerabilities and strengths
- Develop prioritized actions for the municipalities and broader stakeholder networks
- Identify opportunities for the community to advance actions to reduce risk and increase resilience

This report provides an overview of the top hazards, the current community strengths and concerns, and suggested actions to improve the Town of Cortlandt's and City of Peekskill's resilience to natural and climate-related hazards today and in the future. The summary of findings will benefit from further comments, corrections and updates from workshop attendees and additional stakeholders alike. The collective community leadership on hazards and community resilience will benefit from the continuous and expanding participation of all those concerned.

PROJECTED FUTURE CONDITIONS

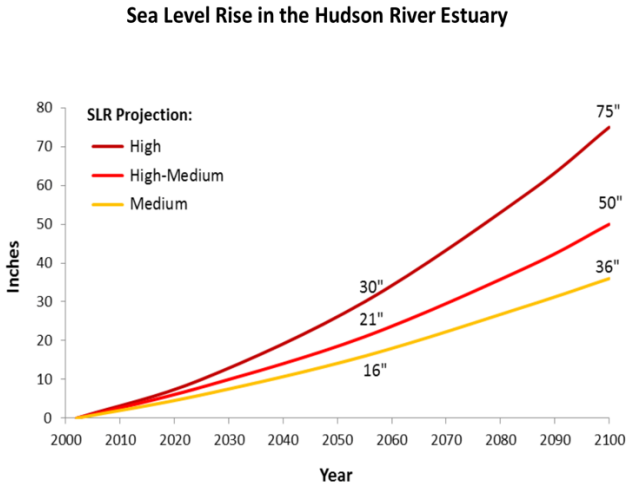
Current climate and environmental conditions (i.e. magnitude and intensity of storms and drought, sea levels, etc.) are projected to change in ways that will profoundly influence current interactions with natural resources. Various platforms are available to better understand and evaluate how different climate change scenarios are likely to impact Hudson Valley communities, including:

- The Nature Conservancy's Natural Resource Navigator
- Scenic Hudson's Sea Level Rise Mapper
- Columbia University's Hudson River Flood Decision Support Tool
- NY Climate Change Science Clearinghouse

As these and other tools clearly indicate, there are many possible scenarios that could manifest themselves over the course of the century. The numerous factors, both global and local, that influence these outcomes make the extent of these scenarios difficult to predict. Thus, it is important to plan for a range of scenarios as evidenced by NY's Community Risk and Resiliency Act . General trends and rough estimates can be employed for adaptation planning purposes. For example, the riverfront communities of the mid-Hudson region, generally, should be preparing for a *minimum* of 3-6 foot rise in mean sea level by 2100.

The entire Hudson Valley region should consider the potential ramifications of:

- Hotter summers
- Increased frequency and length of heat waves and droughts
- Shorter, milder winters
- Potential for more, or fewer, cold spells
- More winter precipitation
    - If rain = more flooding
    - If snow = 10” of snow or more per storm
- Increased severity and frequency of big storms
- More flooding due to slightly increased precipitation and development



Source: Scenic Hudson Sea Level Mapper

Details on the range of projected future conditions are available through the New York State Water Resources Institute and through the tools referenced above in the Projected Future Conditions section.

Main Street in the City of Peekskill
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Figure 2. Projected inundation areas (various shades of blue indicating depth) and current 100 year floodplains (orange highlighted areas) with 6 feet (72 inches) of sea level rise for Annsville Cove. The image was produced using Scenic Hudson's Sea Level Rise Mapper.

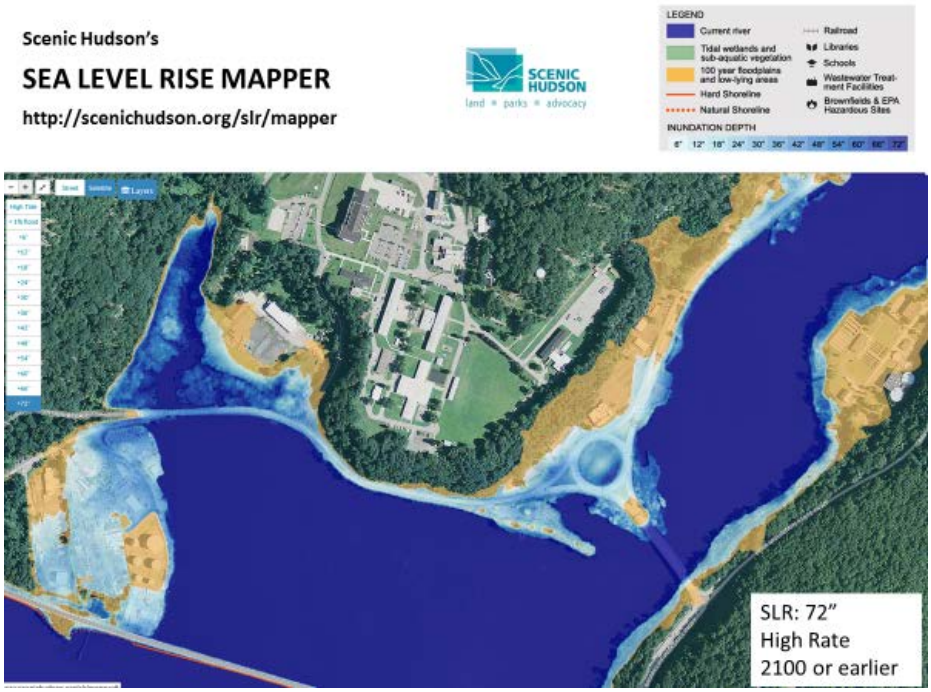

Table 1. Community assets (Infrastructure, Environment and Social) at risk with various sea level rise scenarios and current 100-year storm in both Cortlandt and Peekskill. Source: Columbia University's Center for International Earth Science Information Network Hudson River Flood Decision Support Tool.

Impact Scenarios for Town of Cortlandt and City of Peekskill						
Type of Impact	**18" of SLR with current 100 YR Storm**		**30" of SLR with current 100 YR Storm**		**48" of SLR with current 100 YR Storm**	
	Cortlandt	Peekskill	Cortlandt	Peekskill	Cortlandt	Peekskill
Infrastructure						
Total Damaged Buildings	38	NA	53	NA	64	3
Buildings with Substantial Damage	2	NA	4	NA	9	NA
SPDES Wastewater	1	NA	1	NA	1	NA
Bridges	6	3	6	3	7	3
Railroads (Linear Miles)	47	6	48	6	50	6 *1 Station
Environment						
Inundated Land Area (Acres)	847	91	900	100	949	109
Inundated Impervious Surface Area (Acres)	146	34	162	38	175	41
Inundated Wetlands (Acres)	208	3	210	3	212	3
Social						
Social Vulnerability Index of Impacted Census Blocks (Unitless)	5	9	5	9	5	9
Social Vulnerability Index of Entire Municipality	5	9	5	9	5	9

SUMMARY OF FINDINGS

Top Hazards

During the joint CRB workshop, Cortlandt and Peekskill participants confirmed the top natural hazards for Annsville Creek, Peekskill waterfront and inland areas.

1) *Coastal Storms*: Determined by participants to be the greatest hazard, extreme coastal storms such as Superstorm Sandy, are capable of producing storm surge and significant coastline flooding. Projected rises in future mean sea levels will increase the impacts of such storms.

2) *Inland Flooding*: Caused by intense precipitation and subsequent runoff, be it rain or snow.

3) *Periods of Extended Heat and Drought.* Summers in the Hudson Valley could shift toward higher peak temperatures with more sporadic precipitation events which may stress municipal and private resources, including public water supplies and private wells, while exacerbating challenges faced by already vulnerable communities.

These hazards have growing direct impacts on residents and resources such as natural areas (wetlands, watersheds, parks), roads, drinking and wastewater systems, and other critical infrastructure.

Areas of Concern

Neighborhoods: Water Street (Peekskill), Travis Point, Main Street., Sprout Brook Road, Railroad Ave., Low income/Public housing facilities.

Ecosystems: Annsville Cove on Hudson River, Peekskill Landing and River Walk, Lents Cove, numerous coastal tributaries, Lake Mitchell, forested uplands associated with New York State and local parks.

Transportation: Metro-North Hudson Line including Peekskill Station, parking lot and Annsville Causeway, Annsville Circle, Route 9, Route 6, Route 202, Main Street, Railroad Street, Water Street, Central Avenue, Highland Avenue, Lockwood Drive Bridge.

Infrastructure: Wastewater treatment plant, pump stations (i.e. Pumping Street Station), schools, Department of Public Works (DPW) facilities and fuel storage, private bulk storage facilities, industrial parks and contractor yards, transfer station, incinerator, McGregory Brook culverts, drinking water well.

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Current Concerns and Challenges Presented by Hazards

The Town of Cortlandt and City of Peekskill identified several themes and challenges common to one another; community-specific challenges were also identified relative to the impacts of natural hazards. In recent years, the Mid-Hudson Region, including Cortlandt and Peekskill, has experienced a series of highly disruptive and damaging weather events including Tropical Storm Irene (August 2011), Superstorm Sandy, (October 2012), and winter Nor'easter Nemo (February 2013). Impacts from Irene included significant coastal flooding, heavy-rain induced inland flooding, and wind damage. Sandy caused coastal flooding and extensive power outages across large portions of the region. Nemo dropped more than three feet of snow, knocking out power and isolating residents and neighborhoods. The magnitude and intensity of these events across New York over the course of just 18 months has increased awareness of natural hazards, along with climatic change, and motivated communities to comprehensively improve resilience at the municipal, county, and regional level.

Figure 3. Community assets identified on a base map. See Appendix.

This series of extreme weather events highlights how hazard impacts vary across the municipalities, from the low-lying coastal area to the forested uplands at the northern and eastern boundary of Cortlandt. The western part of the town and city border the Hudson River and are exposed to damage from coastal flooding and surge during storms. The heavily forested northern uplands and highly populated eastern areas experience the effects of tree damage from wind, snow, and ice as well as damage from inland flooding during heavy precipitation events. Longer periods of elevated heat, particularly in July and August, raises concerns about heat islands and citizen well-being. The combination of these issues presents a challenge to preparedness, response, and mitigation priorities and requires comprehensive yet tailored actions for locations throughout the planning area.

Workshop participants agree that both communities are experiencing more intense and frequent storms events. The impacts, particularly during Tropical Storm Irene and Superstorm Sandy, affected the daily activities of most residents. Coastal areas, which are significant transportation corridors, experience greater impact from major storms and increases in average tidal ranges, resulting in more routine flooding events in certain low lying places.

Additionally, there is a general concern about the need and challenges of being prepared with contingency plans for seasonal worst case scenarios (i.e., major hurricanes (Cat-3 or above)) particularly in the late fall/winter versus summer due to more intense winter storms. Finally, there were strong indications that expanding joint planning and response opportunities are critical, and that exploring and implementing additional shared services will yield significant rewards in the future.


Hudson River view from Peekskill Riverfront
©The Nature Conservancy (Gillian Cowley)

Current Strengths and Assets

Because of recent experiences with extreme weather, the Town of Cortlandt and City of Peekskill are well acquainted with the existing assets within their respective communities (Figure 3). The long-standing practices of the county and municipalities have required routine upgrades and response exercises for emergency management professionals. Reinforcing and expanding these supportive practices and assets will generate greater benefits to the community through increased resiliency to future storms, and the long-term impacts of ongoing increases in storm surge, sea level, air temperature, precipitation, and drought.

- Clearly, the responsive and committed leadership of the elected officials is a very much appreciated strength in both communities.
- Cortlandt and Peekskill have solid, highly experienced and well-coordinated emergency management professionals with access to adequate resources in times of need. The "Code Red" and Reverse 911 programs are on-going strengths as is the presence of Camp Smith, an installation of the New York Army National Guard. A strength for Cortlandt is the continued presence and management of emergency boats. Police, fire and emergency management services are also strengths for both communities, although Cortlandt police service is provided by ounty and State police.
- Recent upgrades to the wastewater treatment facility and numerous other engineering upgrades are projects that have improved the resilience of both communities.
- Supportive social services such as Jan Peak Homeless Shelter and the Salvation Army, as well as faith-based organizations and food pantries, are also important community assets. However, there is uncertainty about how well the non-governmental community fulfills community needs during events.
- The area from Lents Cove, north to the Peekskill Waterfront and Annsville Cove are considered assets to both communities as they provide direct access to the Hudson River for recreation while retaining many "green infrastructure" attributes which help to protect adjacent infrastructure and provide green space.

Specific Categories of Concerns and Challenges

Vulnerable Transportation Network

Primary concerns of both communities are the vulnerability of the transportation network, particularly the Annsville Circle area and the Metro-North infrastructure, during and after extreme events.

Flood-vulnerable Roadways

Road blockage prevents emergency management services from reaching stricken areas, reduces public access to evacuation routes and critical facilities like gas stations, grocery stores, hospitals and pharmacies. In addition, impassable roads can limit access to sheltering facilities and limit evacuation routes.

Residents and businesses are reliant on Routes 9, 6 and 202 which may at times become impassable due to flooding and tree falls. One particularly problematic area is Annsville Circle (State owned and maintained). Although current "blue sky" conditions do not generally disrupt this area, future sea level rise, coupled with either coastal or inland flooding, is likely to significantly impact this important travel corridor.

Other vulnerable roadways, managed by the City or Town, include Railroad Street, Water Street, Lower Central Avenue, Highland Avenue, Rockcut bridge and the Lockwood Drive bridge. Multiple challenges are identified for each of these roads, potentially including under-sized culverts. All the challenges require attention as the roads are currently vulnerable to either coastal or inland flooding; this susceptibility can only be expected to increase with time.

Railroad Station and Rail Line

While not directly managed by Peekskill or Cortlandt, the Metro-North Station and associated rail line, including the Annsville Causeway, provide a critical artery for access to employment and facilitates transportation along the Hudson River Valley between Albany and New York City. Rail line closures keep commuters from reaching work and reduces the number of tourist visits. Peekskill recognizes that the resilience of this asset is paramount to the long-term viability of its community. It was noted that this asset is shared by all the municipalities serviced across this rail system and beyond.

Communication

The participants' discussion on communication services included topics such as emergency alerts, general community engagement and improving inter-municipal coordination.

"Code Red" and Reverse 911

The current emergency management communication system in the area is "Code Red" while Reverse 911 is managed by Westchester County. Participants acknowledge the need for both systems to operate on a bi- or multi-lingual platform and the need to increase efforts that encourage or require enrollment, particularly registration of cell phone numbers.

Community Engagement

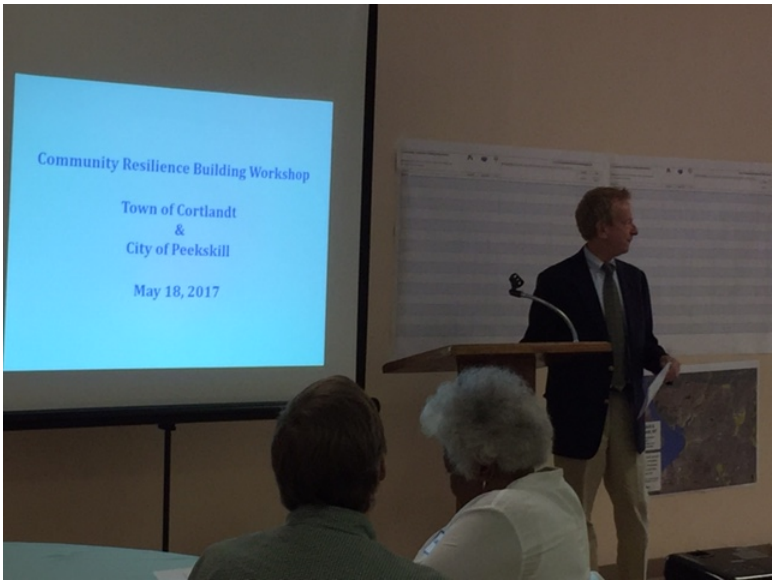
During non-emergency periods, it is strongly recommended that both communities adopt multi-lingual social media platforms to reach a growing non-English speaking audience. Multi-lingual communication is way to better unify and inform the entire community.
While participants genuinely appreciated the diverse group gathered for the initial workshop, they also lamented that there were several people/organizations that were not included from additional sectors. Effort should be made to broaden the representation of the participants informing the CRB process. In addition to providing input, they must be encouraged to participate in decision-making. Recommendations of organizations to invite in the future include NYS Department of Transportation, Con Edison, Fire Department leadership, community-based non-governmental organizations' leadership and local businesses.

Expanding Current Municipal Interaction

Several opportunities and challenges can benefit from further inter-municipal communication and collaboration. For example, various Police Departments currently operating in the community, refinement of the emergency response procedures and evacuation plans as well as resolving the transportation challenges identified above. Emergency transportation and evacuation planning was a consistent topic of discussion and a timely review of existing plans is recommended, particularly in the Town of Cortlandt.

Wastewater Systems

Current conditions do not impact the wastewater treatment facility located along Annsville Cove and recent actions have improved this facility's resilience. If sea level rise exceeds more than four feet, this facility will become increasingly susceptible to service disruption and inundation. Ancillary to the plant itself, significant concerns center around pump stations, particularly the Pumping Street Station. Other lines, running under roadways and throughout both communities, appear vulnerable to inland flooding events.



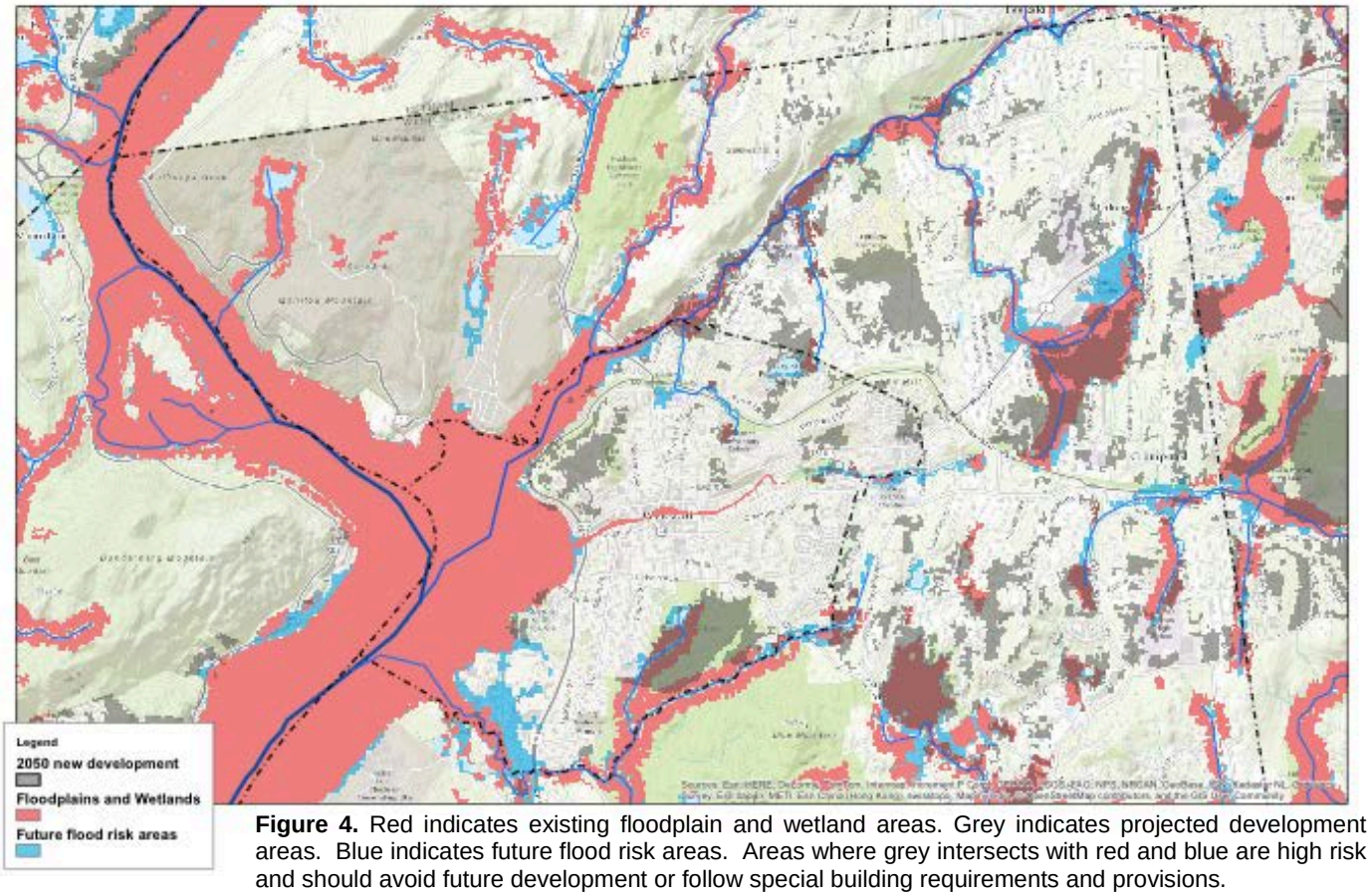


Figure 4. Red indicates existing floodplain and wetland areas. Grey indicates projected development areas. Blue indicates future flood risk areas. Areas where grey intersects with red and blue are high risk and should avoid future development or follow special building requirements and provisions.

Top Recommendations to Improve Resilience

A common thread throughout the workshop discussions was the recognition that government services, residents, businesses and other stakeholders likely need to improve preparation by completing a coordinated, community-based contingency planning effort that covers a longer time horizon and addresses broader areas of concern. A second strong commonality was that improved and expanded community coordination and collaboration will significantly improve resilience with the region. These and additional core highlights are addressed below.

Highest Priorities

- Create a resilient transportation network consisting of roads and rails that circumvent, eliminate or correct existing vulnerabilities. A dialogue among communities, and county and state agencies should begin soon so that modifications can be planned, designed and implemented while viable alternatives exist, and before existing infrastructure is fully compromised.
- Develop a comprehensive, coordinated and multi-lingual communications plan for both communities to foster greater community engagement, improve social cohesion amongst interested and vulnerable residents and develop relationships with stakeholder and civic groups.

- Develop a stream initiative to better understand the form and function of the numerous tributaries running throughout both communities; implement appropriate measures to reduce the risk of flooding impacts (i.e. culvert right-sizing, bridge replacement, protection of floodplains, etc.); and further protect natural features that contribute to flood resilience.

High Priorities

- Review existing contingency plans for the DPW Facility and fuel depot; initiate efforts to identify relocation site(s) during major storm events.
- Begin identification and engagement of a broader constituency including ethnic communities, businesses and commuters to better inform efforts to improve community resilience.
- Ensure waterfront assets are maintained or redesigned to maximize flood resilience; existing open space that provides natural resilience is protected by statue or code; and emergency response resources are located away from likely impact areas.
- Ensure sewer pumping stations are protected against intensifying inland flood events.

Moderate Priorities

- Examine long-term flood proofing or relocation options for high-risk residential buildings and neighborhoods; particularly for Travis Point, Main Street, Sprout Brook Road, Water Street, and Railroad Avenue. Look to best practices, experts, and existing infrastructure (i.e. Scenic Hudson's Lock Dock Park) from other municipalities for guidance.
- Modify building codes for residential, commercial, and industrial structures to require elevation for homes and businesses significantly damaged post- disaster to help minimize impacts from subsequent events. Immediate engagement efforts should focus on Water Street businesses, bulk storage facilities at Roa Hook and Lents Cove.
- Re-evaluate immediate and longer term implications of coastal and inland flooding on existing structures and proposed (re)development; particularly Water Street, Route 9 and Roa Hook Contractor Yards.
- Initiate dialogue to share DPW services and/or co-locate equipment out of harm's way.
- Integrate sustainable-resilient flood proofing options into redevelopment plans.
- Develop effective ongoing inventory and response approach to ensure proper support for vulnerable populations in the City and Town before, during, and after disasters. For example, ensure that all senior citizen centers and senior housing locations, Blue Mountain School and Oakside School are included in emergency response procedures. Also conduct of comprehensive inter-municipal review of emergency transportation, sheltering and evacuation protocols and procedures,
- Initiate dialogue with local DPWs and/or NYS Department of Transportation to upgrade road/stream crossing culverts - feasibility and implementation - to improve passage of larger volumes of water and debris flows; particularly along McGregory Brook.
- Re-examine historic conditions in state statute and other mandates that currently preclude more progressive watershed management approaches. Seek to modify existing constraints posed by outdated policy to help enhance resilience at the watershed scale across communities.

- Look to identify and integrate preferred watershed management practices to enhance resilience through current natural resource inventory and other open space update efforts in the future.

Lower Priorities

- At the wastewater treatment plant and associated infrastructure, continue to plan for future high water events and annually review emergency management plans.
- Install a storm water basin and restore habitat at Camp Smith checkpoint; ensure Camp Smith's participation in emergency planning.
- Evaluate relocation options for the Lents Cove Industrial Park.
- Ensure fire crews are trained and prepared to deal with wildland fires in the forested areas north of Annsville Cove.

Rail station along the Hudson River in Peekskill, NY
©The Nature Conservancy (Gillian Cowley)

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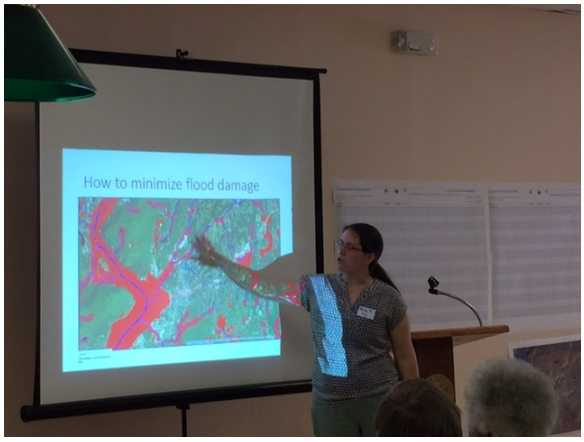
- Jesica Youngblood, Planner
- Jim Howard, Code Enforcement Officer



Other

- Rich Bottali, MNR – Sustainability & Environment
- Mary Pat Driscoll, Captain, Trinity Cruise Line
- Tom Lauro, Commissioner, Westchester County, Department of Environmental Facilities
- Sean Martin, Camp Smith Environmental Officer
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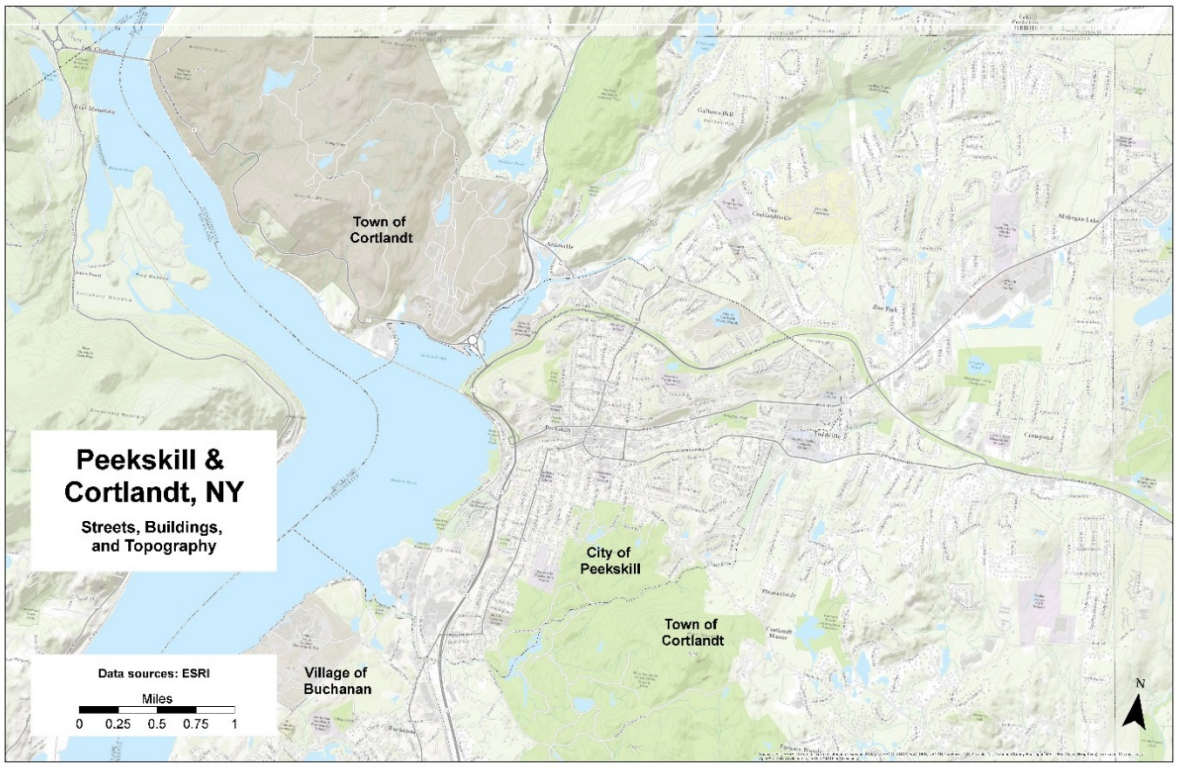
APPENDIX I

CRB Workshop Base Map and Participatory Mapping Exercise Outputs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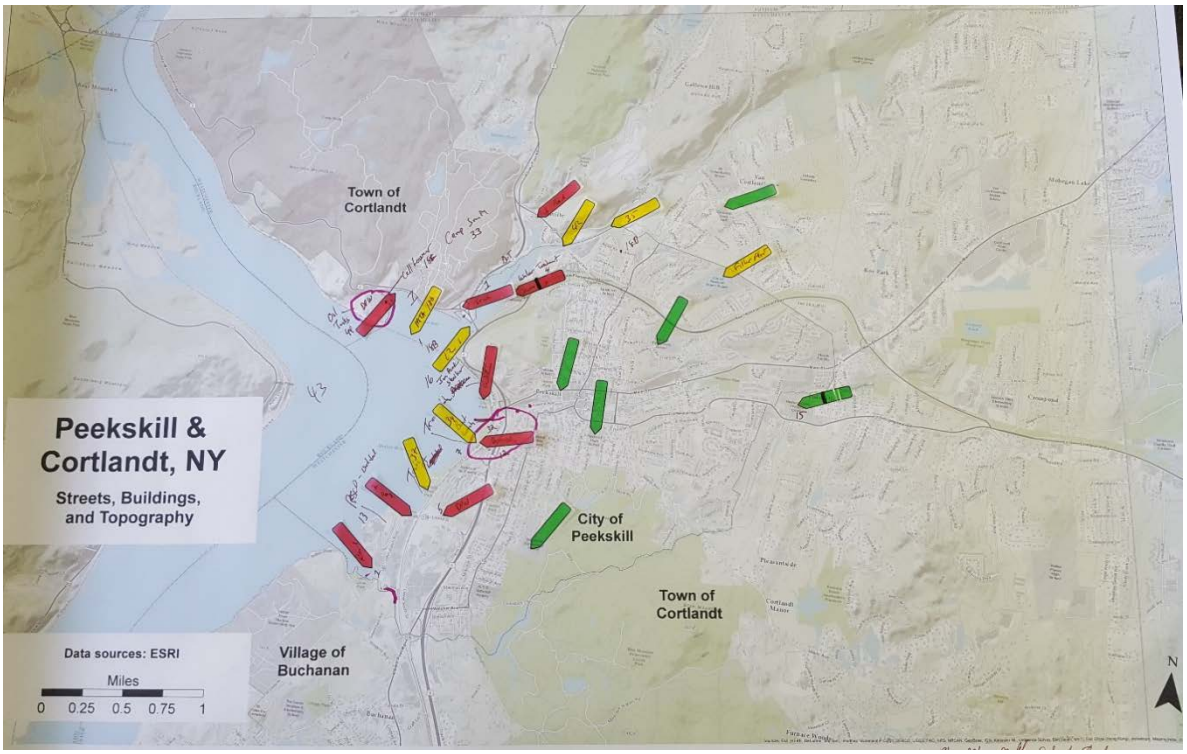
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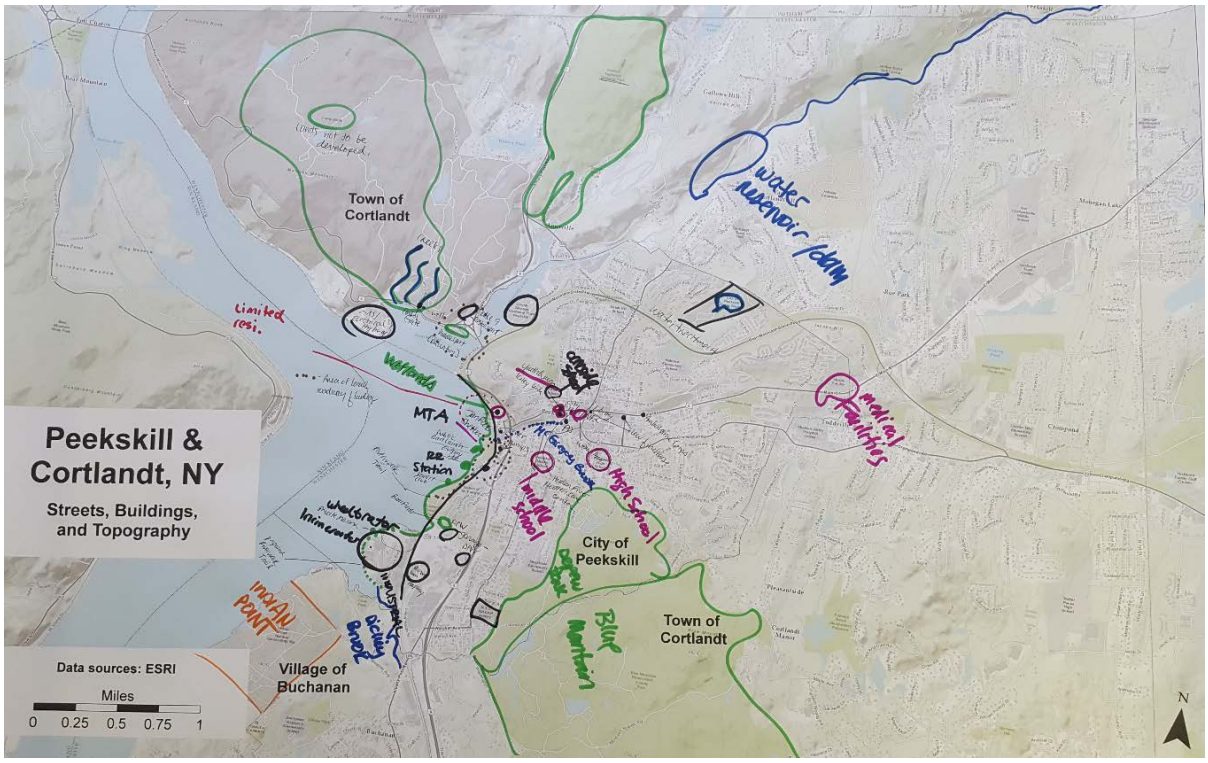
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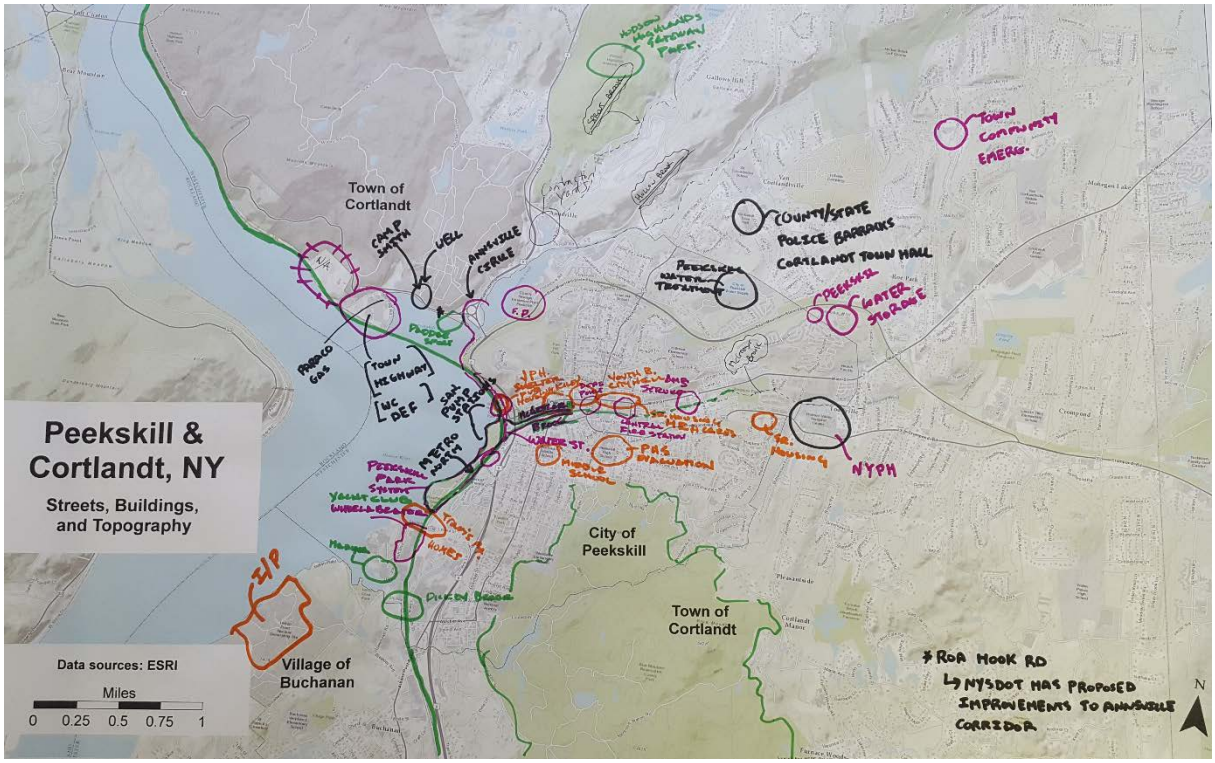
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Appendix II: CRB Workshop Presentations

Slide #1 Resource for investigating climate change and hazard vulnerability.

Climate and Flooding Overview

- Predicting the future is inherently uncertain
- Data and models can supplement local knowledge
- Resources available to inform decisions:
- TNC Natural Resource Navigator
  www.naturalresourcenavigator.org
- Scenic Hudson Sea Level Rise Mapper
  http://scenichudson.org/slr/mapper
- Columbia Hudson River Flood Mapper
  http://www.ciesin.columbia.edu/hudson-river-flood-map/
- NY Climate Change Science Clearinghouse
  https://www.nyclimatescience.org/

Slide #2 Regional climate projections for the southern Hudson Valley to 2050. Data from TNC Natural Resource Navigator.

Changes in climate by 2050

Summer max temperature	+4.6 degrees F
Days above 95 deg F	8.6 more days
Winter min temperature	+5.5 degrees F
Days below freezing	25.8 fewer days
Annual total precip	+1.3 inches
Winter precip	+1 inch
Summer precip	-0.6 inches

Slide #3 Summary of expected climate changes. vulnerability.

What it could mean

- Hotter summers
- More heat waves and droughts that last longer
- Shorter, milder winters
- Potential for more or less cold spells
- More winter precipitation
  - If rain = more flooding
  - If snow = 10" of snow

Slide #4 Predicted changes in extreme precipitation magnitude and frequency for 2040-60. Data from the Northeast Regional

Changes in climate by 2050: extreme precipitation

	10-yr Event	100-yr Event
Current event rainfall	4.5"	8.1"
Future event rainfall	5.2"	9.2"
% increase in rainfall	15.5%	14.0%
Future recurrence interval of current rainfall amount	5 years	62 years

Slide #5 Summary of expected impacts of changes in extreme precipitation.

What it could mean

- Big storms will be slightly bigger
- Big storms will be about twice as likely in any year
- The same amount of rainfall could cause more flooding due to development

Slide #6 County and municipal data on past flood frequency and impacts from the NYS DOH. NFIP (National Flood Insurance Program)

Vulnerability to flooding

- Flood events in county (1954-2013) = 41
  - 5 flood disaster declarations

	Peekskill	Cortlandt
# res prop in floodzone	8	39
#NFIP policies	53	129
$ paid NFIP claims	$485,464	$1,990,460
# repetitive properties (losses)	5 (2.8)	10 (3.8)

Slide #7 Socioeconomic impacts under projected flooding scenarios with sea level rise. Social vulnerability index scores indicate relative risk of harm and lower ability of community to recover from flooding impacts. Data from Columbia Hudson River Flood Mapper.

Social vulnerability

Impact Scenarios for Town of Cortland and City of Peekskill						
Type of Impact	18" of SLR with current 100 YR Storm		30" of SLR with current 100 YR Storm		48" of SLR with current 100 YR Storm	
	Cortlandt	Peekskill	Cortlandt	Peekskill	Cortlandt	Peekskill
Infrastructure						
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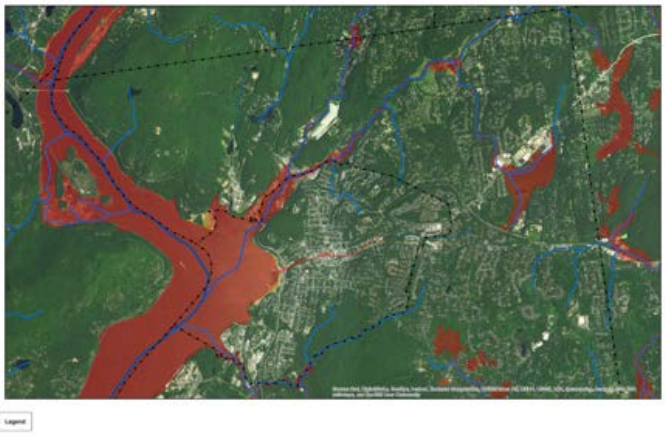
SPDES Wastewater	1	0	1		1	NA
Bridges	6	3	6	3	7	3
Railroads	47 linear miles	6 linear miles	48 linear miles	6 linear miles	50 linear miles	1 Station & 6 miles
Power Transmission Lines	13 linear miles	1 linear mile	13 linear miles	1 linear mile	13 linear miles	1 linear mile
Environment						
Inundated Land Area	847 acres	91 acres	900 acres	100 acres	949 acres	109 acres
Inundated Impervious Surface Area	146 acres	34 acres	162 acres	38 acres	175 acres	41 acres
Inundated Wetlands	208 acres	3 acres	210 acres	3 acres	212 acres	3 acres
Social						
Social Vulnerability Index of Impacted Census Blocks (Index Score is unitless)	5	9	9	5	9	5
Social Vulnerability Index of Entire Municipality	5	9	7	5	7	5

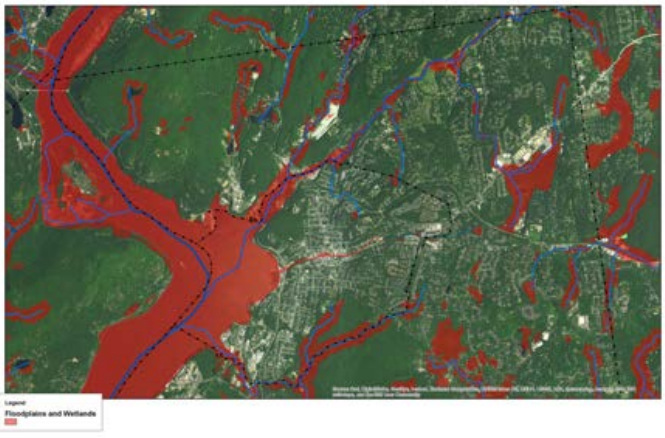
Slide #8 Areas important to reducing and mitigating flood damage, including floodplains, wetlands, and natural riparian areas. These areas are expected to be important to maintaining stream function and reducing and capturing floodwaters under current conditions. (map data from TNC Natural Resource Navigator)

FEMA 100-yr floodplain

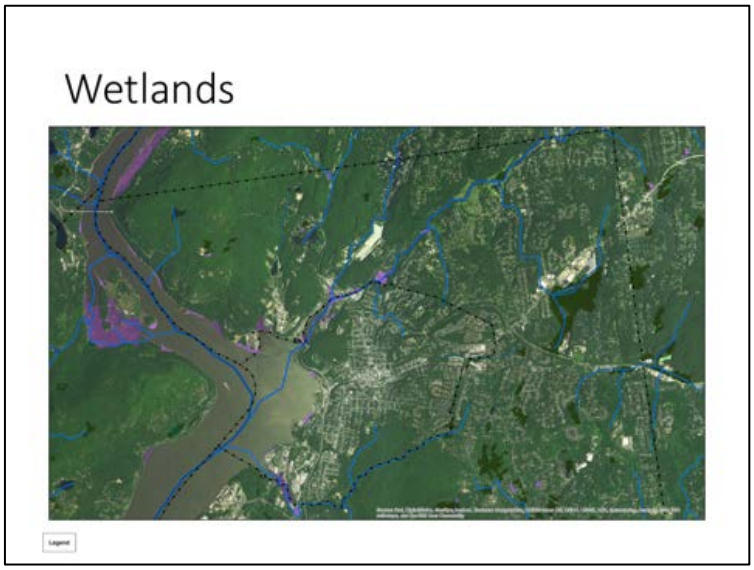


Slide #9 FEMA-mapped 100-yr floodplains are very likely to flood (1% chance of flooding in any given year). Development in floodplains is at risk of damage and may also worsen flooding downstream.

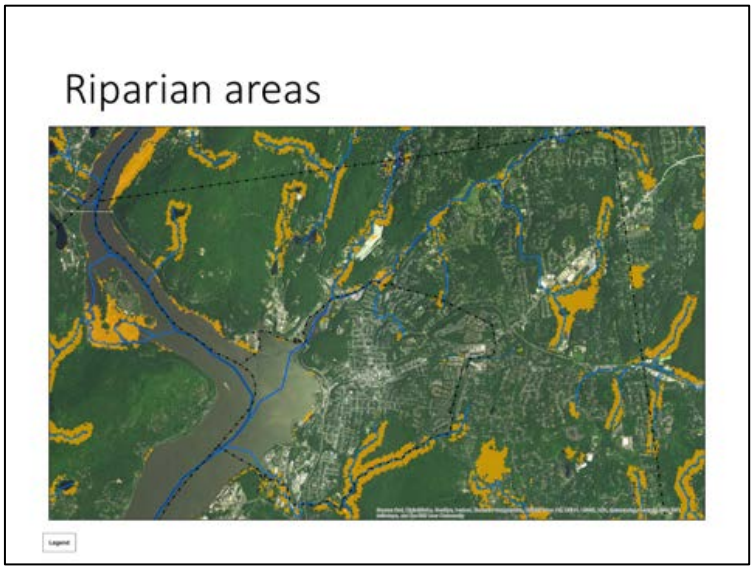
How to minimize flood damage



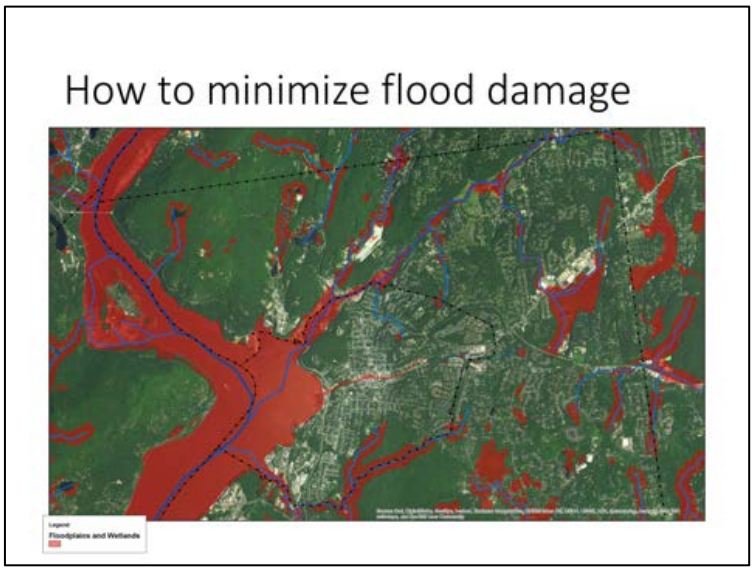
Slide #10 Wetlands of all kinds and sizes help to capture and slowly release stormwater, reducing the frequency and severity of flooding. Tidal wetlands on the Hudson River also help to reduce the impacts of storm surge.



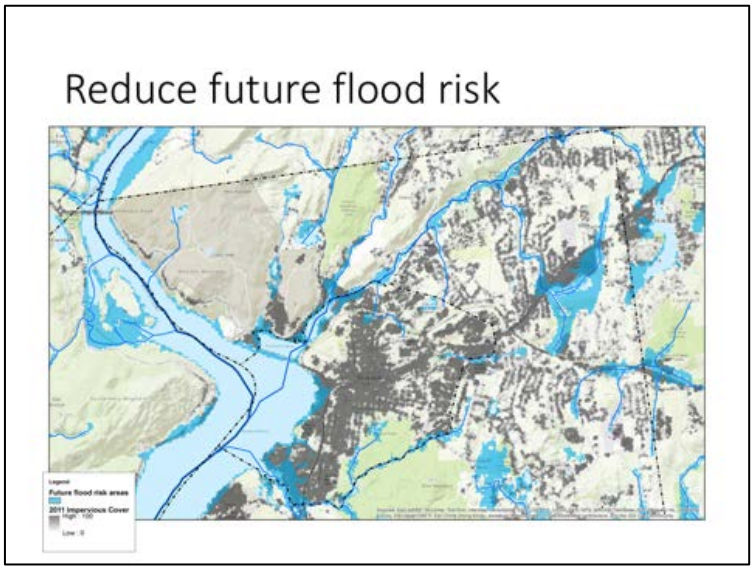
Slide #11 Intact riparian areas both within and outside the floodplain support the ability of streams to process floodwaters and maintain stable stream banks.



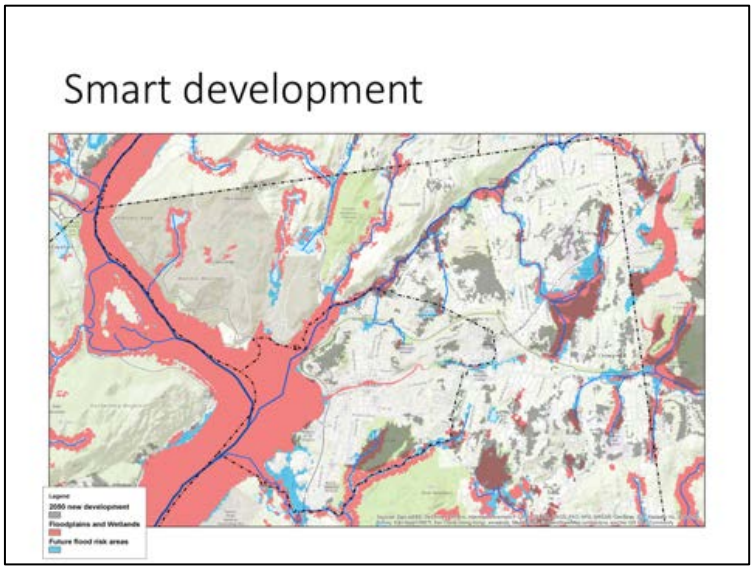
Slide #12 Keeping development out of these critical areas helps to maintain the services these natural systems currently provide to the community.



Slide #13 Increased extreme precipitation and sea level rise is expected to increase flood risk, both by increasing severity and frequency in existing flooded areas, as well as expanding flooding to areas where it currently doesn't occur (blue). Grey areas indicate the locations of existing infrastructure which may be at greater risk of flooding in the future.

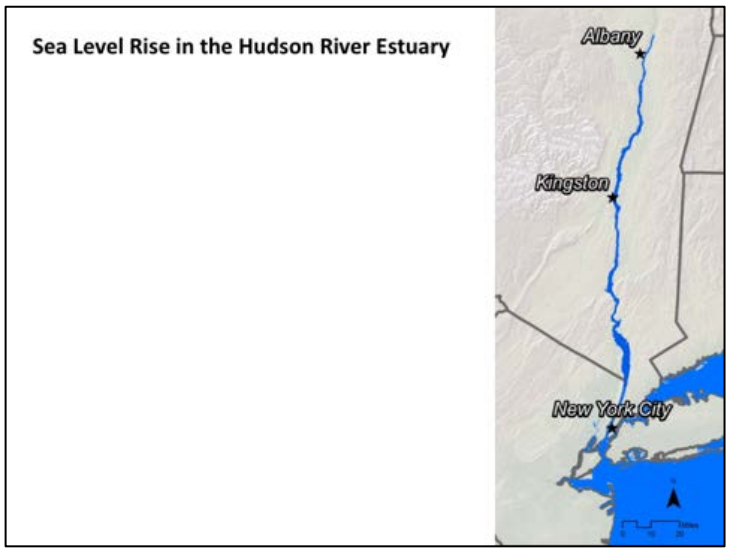


Slide #14 Projections of new development patterns to 2050 (grey) show potential overlap with critical natural areas (red) and future flood risk (blue).

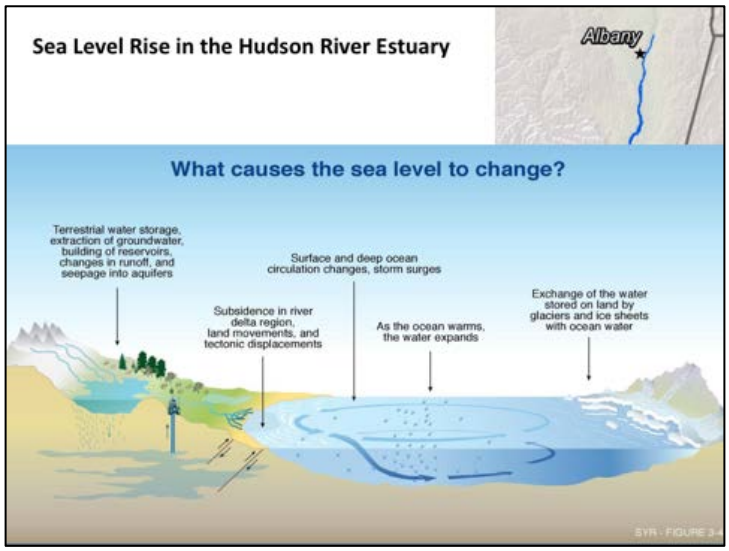


SLR Mapper and SLAMM Presentation

Slide #1 This entire length of the river is an estuary (to the federal dam in Troy), meaning it is connected to the ocean and experiences daily tides.

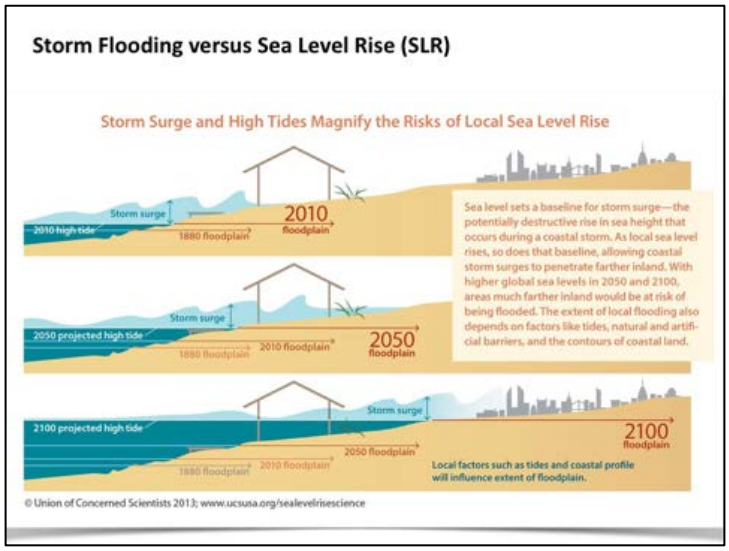


Slide #2 The primary causes of sea level rise globally: warming ocean water expands, increase water delivery to oceans from ice on land.

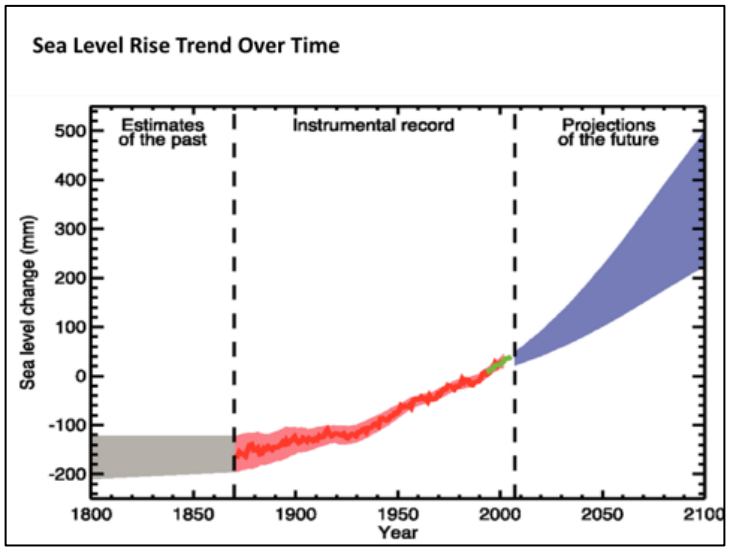


Slide #3 Tidal flooding caused by rising sea levels- this kind of flooding happens even without a storm event.
Photo: Charleston, SC- tide-flooded roadway (from UCS blog)

Slide #4 Sea level rise and storm surge compound flooding problems. Higher mean sea levels will cause storm surge events to arrive on land on a higher level, exposing more people and infrastructure to risk.



Slide #5 Although sea level has been rising since the early 1900's, the rate of rise is quickening. There is uncertainty in projections of SLR (and climate change) into the future. Therefore, planning for multiple scenarios is necessary.



Slide #6 NYS Community Risk and Resiliency Act establishes several scenarios which should be considered when undertaking coastal projects. The Low and Low-Medium Scenarios have or will soon be surpassed and more attention should be given the Medium, High-Medium and High scenarios.

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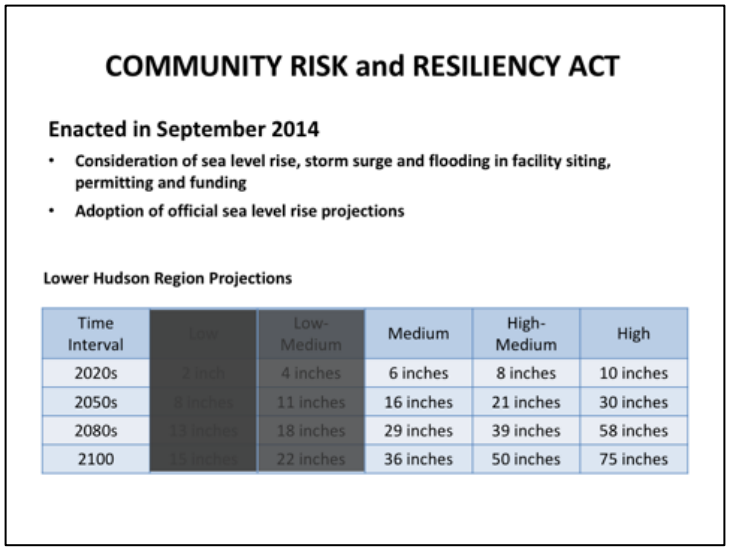
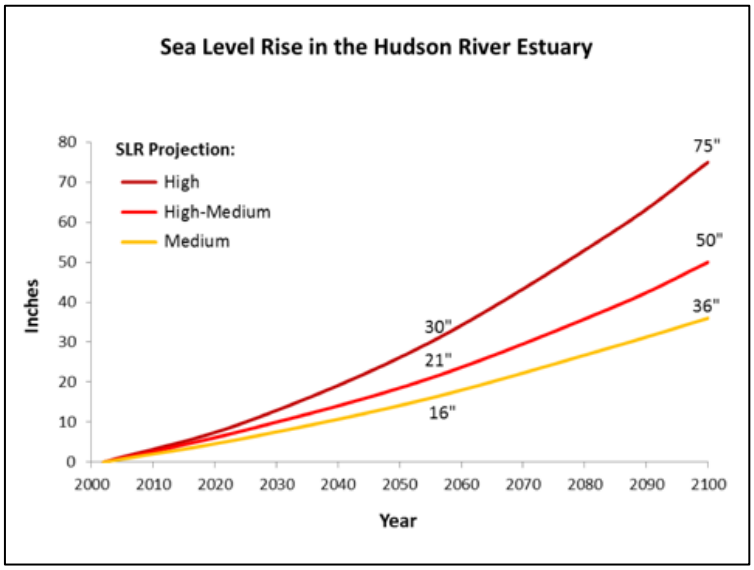
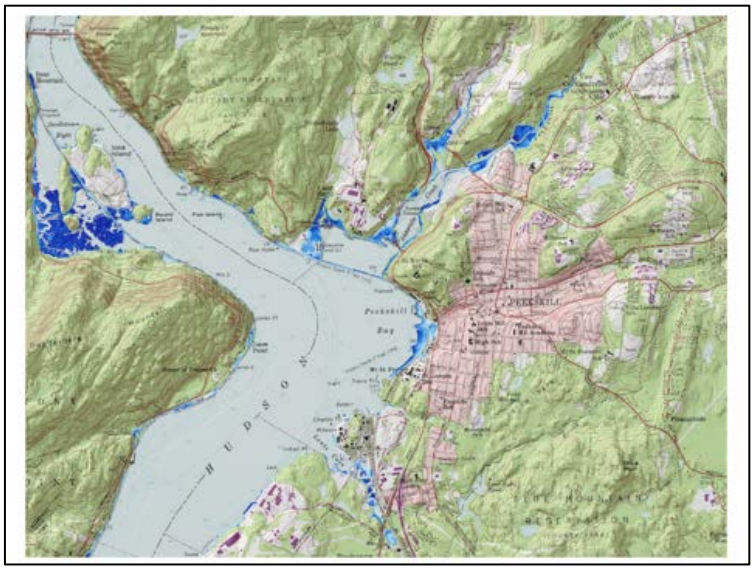


Time Interval	Low	Low-Medium	Medium	High-Medium	High
2020s	2 inch	4 inches	6 inches	8 inches	10 inches
2050s	8 inches	11 inches	16 inches	21 inches	30 inches
2080s	13 inches	18 inches	29 inches	39 inches	58 inches
2100	15 inches	22 inches	36 inches	50 inches	75 inches

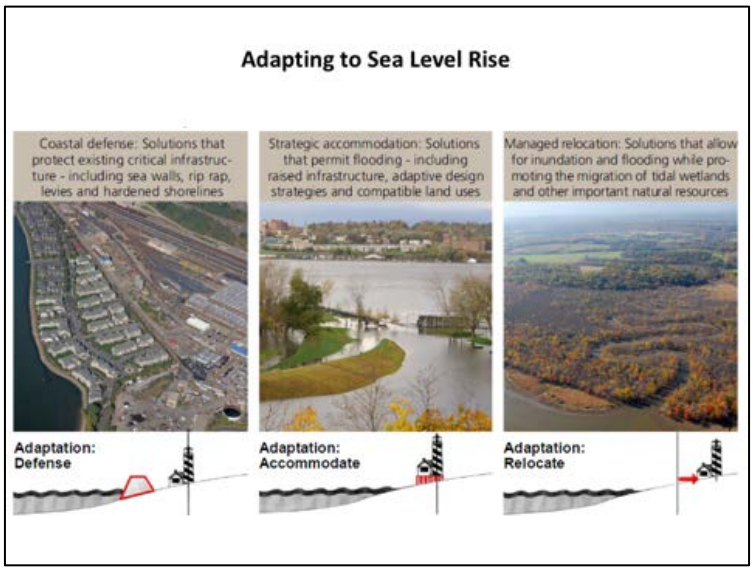
Slide #7 Graphical representation of the Community Risk and Resiliency Act projections (Medium, High-Medium, High).



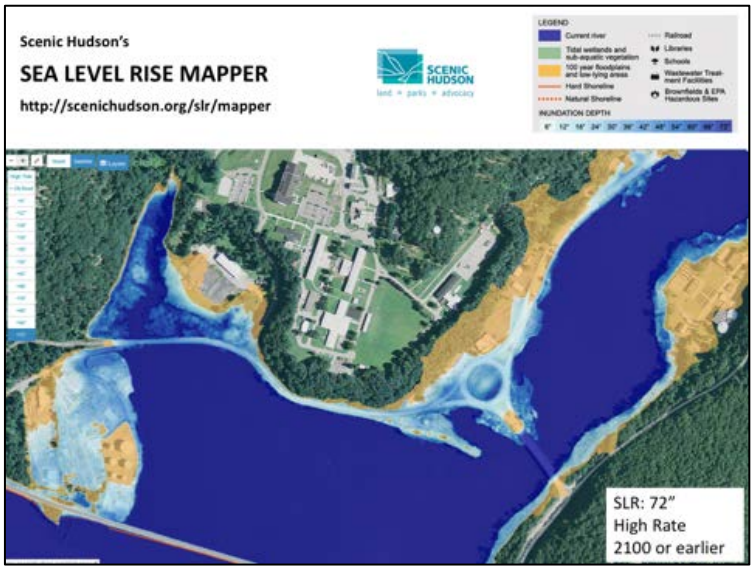
Slide #8 Areas of projected future inundation around Peekskill Bay, Annsville Cove and Lents Cove Areas in light blue represent shallower inundation, darker blue represents deeper areas of inundation. There are steep slopes along much of the shores of Peekskill and Cortlandt, which limits the extent of future inundation due to SLR.



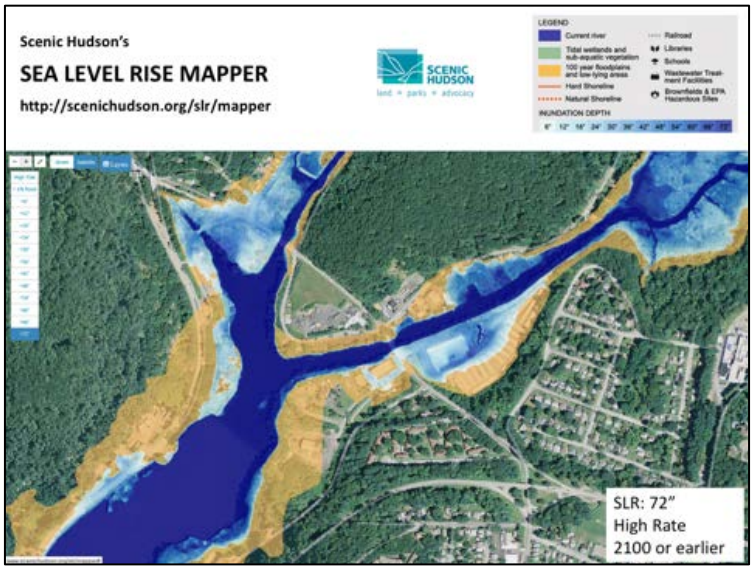
Slide #9 There are three broad categories of adaptation strategies: Defend, Accommodate and Relocate.



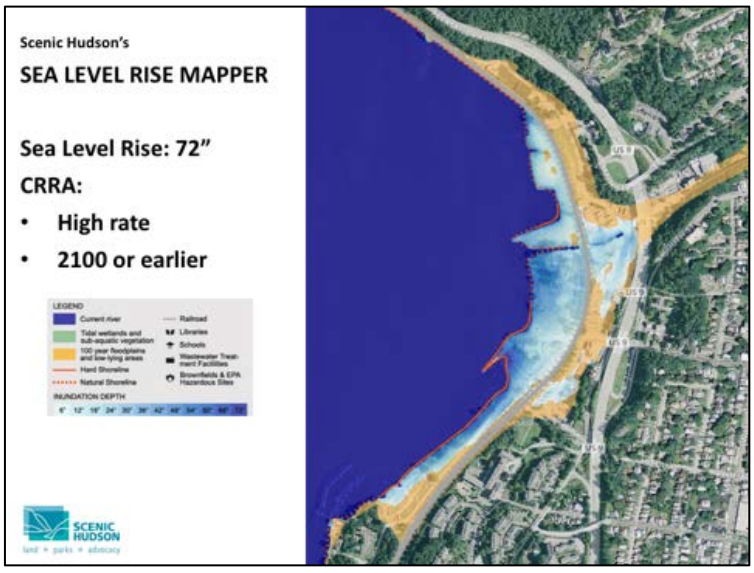
Slide #10 Affected resources: Town of Cortlandt Sanitation, Gas/oil, paddlesport center, major roads. Wastewater treatment plant is already in the floodplain and will remain above inundation.



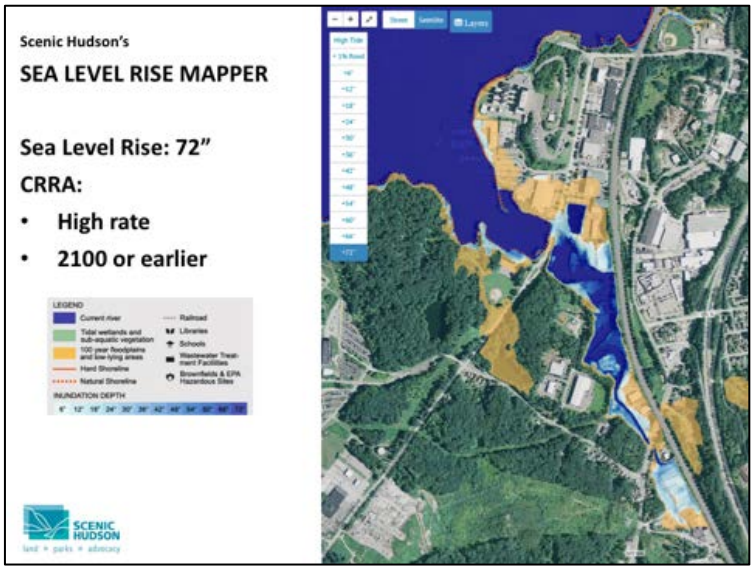
Slide #11 Confluence of Annsville Creek, Sprout Brook, Peekskill Hollow Creek. Affected resources: Businesses, residential (along PHC)



Slide #12 Affected- Open space, train station, business

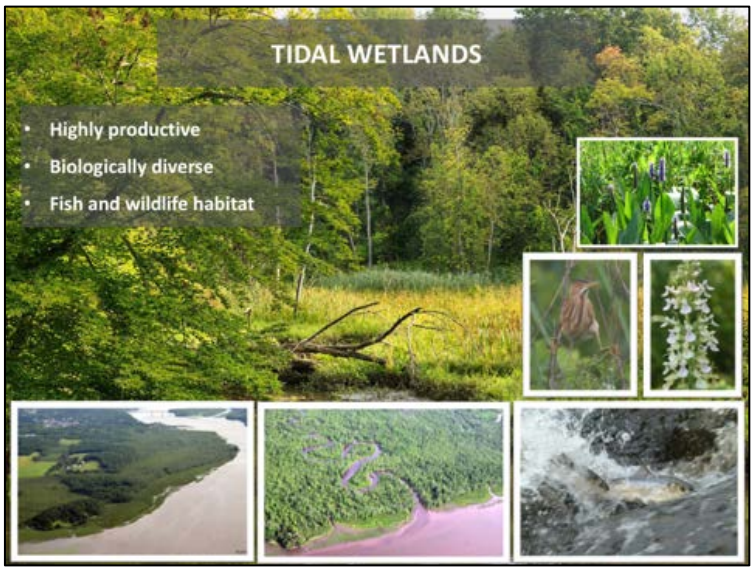


Slide #13 Dickey Brook. Affected- a few businesses, State superfund site?



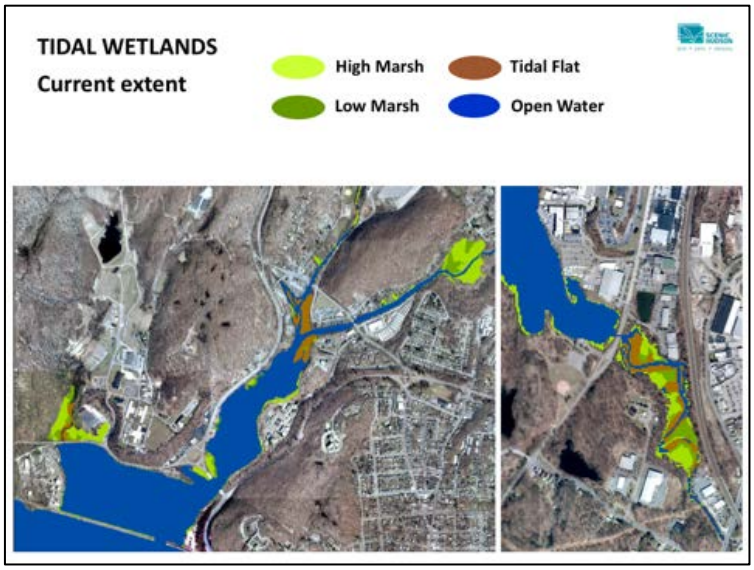
Slide #14 Tidal wetlands are an important resource for the estuary and are also impacted by SLR.

Slide #15 Tidal wetland functions/values include…

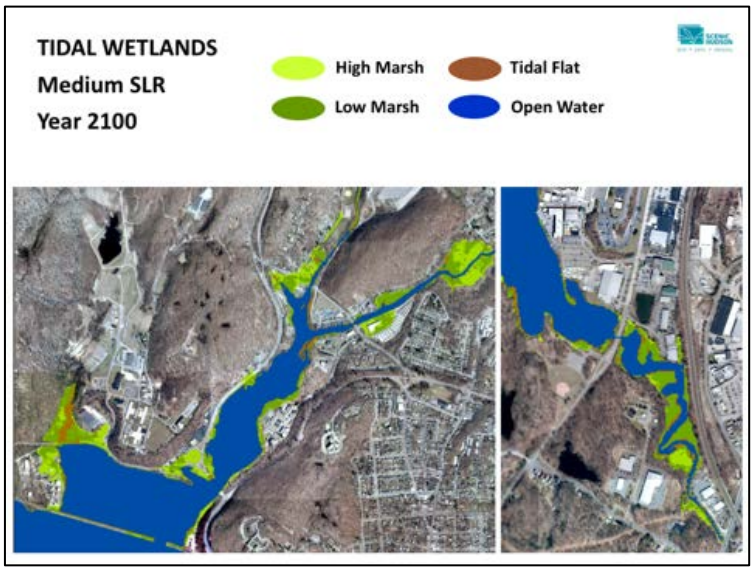


Slide #16 And tidal wetlands are also an important resource to people, protecting some waterfront communities from the impacts of storms, and providing economic and recreational opportunities.

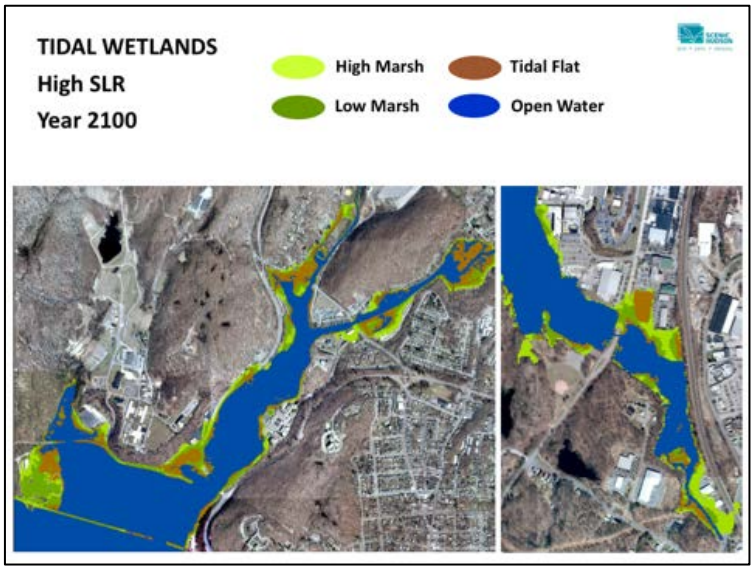
Slide #17 Current locations of different types of tidal wetlands (not including submerged aquatic vegetation).



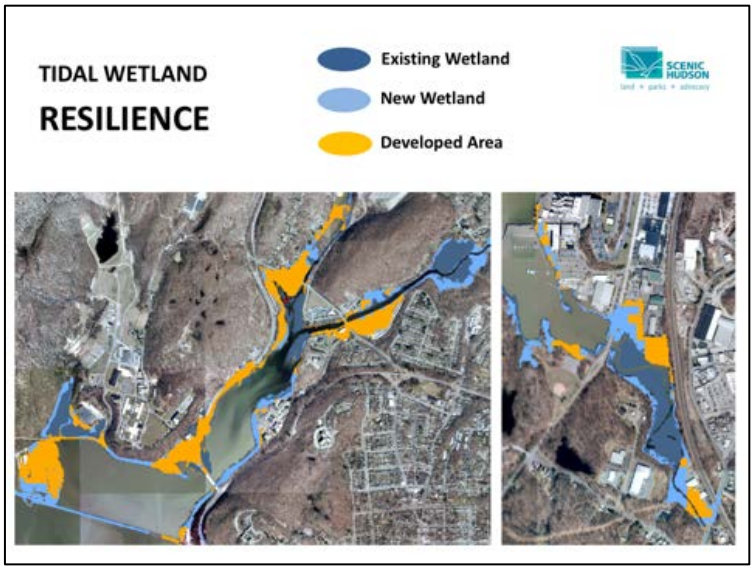
Slide #18 Future projected locations of tidal wetlands under Medium SLR by year 2100.



Slide #19 Future projected locations of tidal wetlands under High SLR by year 2100.



Slide #20 Another way to look at tidal wetlands: current wetland areas (dark blue) and future wetland areas. Areas in orange are where existing development is in the pathway of wetlands projected to advance with SLR (indicating a blocked route for wetlands and a vulnerability to SLR for development).



Slide #21 Likelihood of existing wetland areas becoming too deep for intertidal wetlands with SLR.