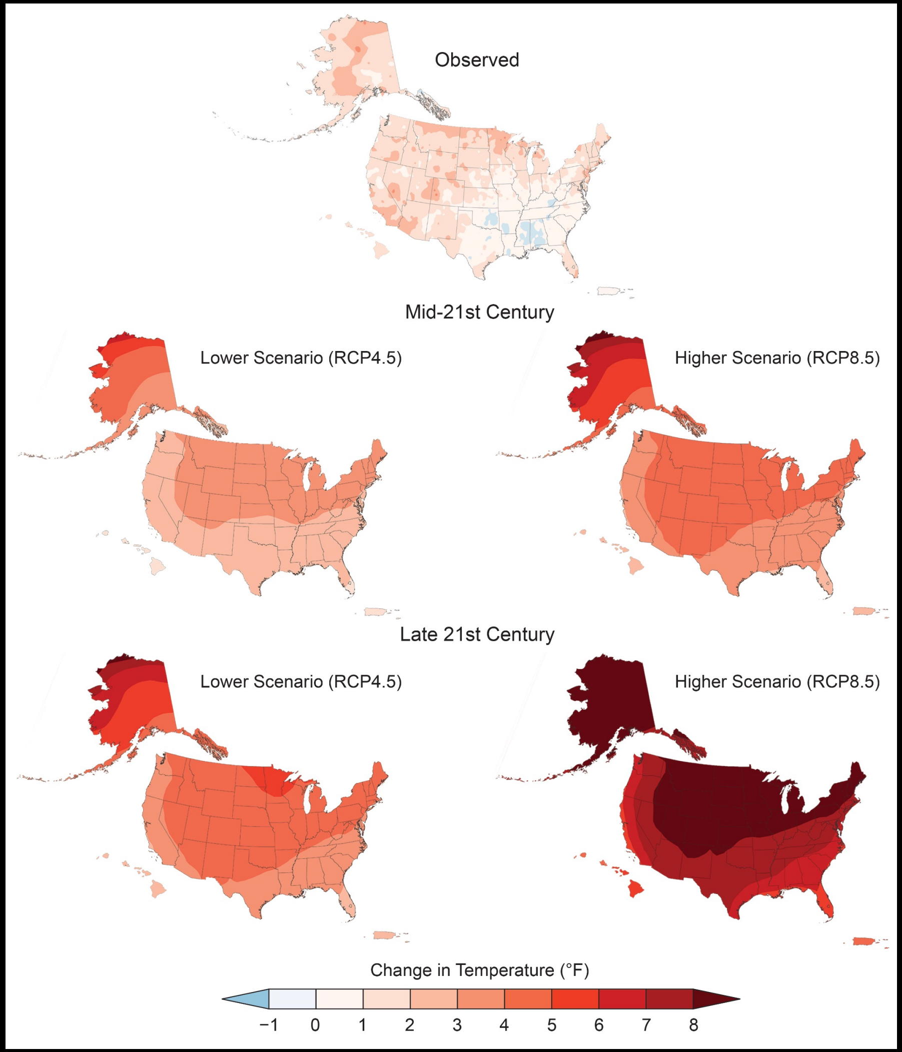
Climate Change Effects on Water Quality in the Hudson Valley

Overview

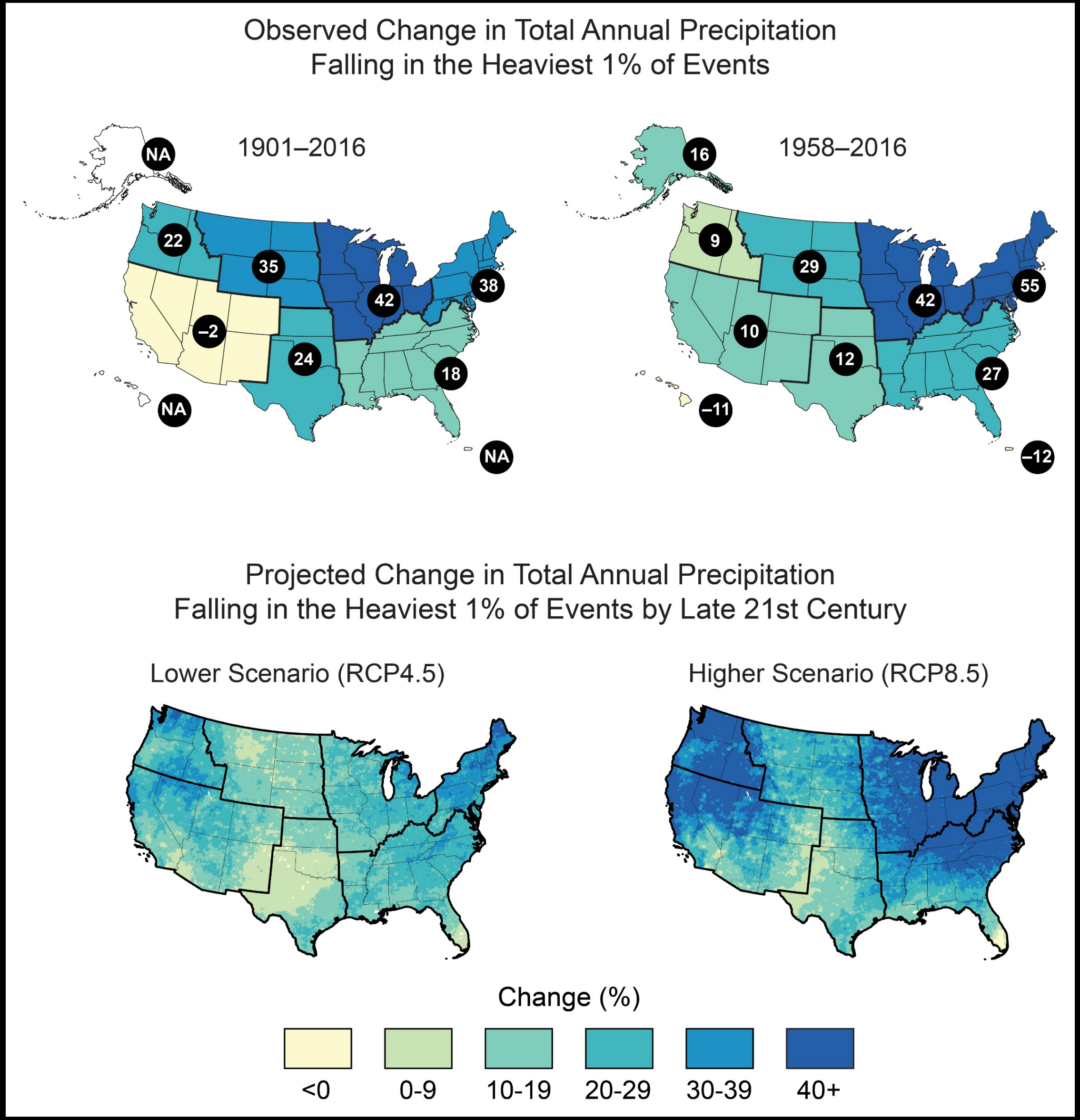
- Climate modeling for increased intensified storm events in the Northeast
- Impacts on water quality throughout the Hudson Valley
- Drivers of degraded water quality
- Mitigation strategies

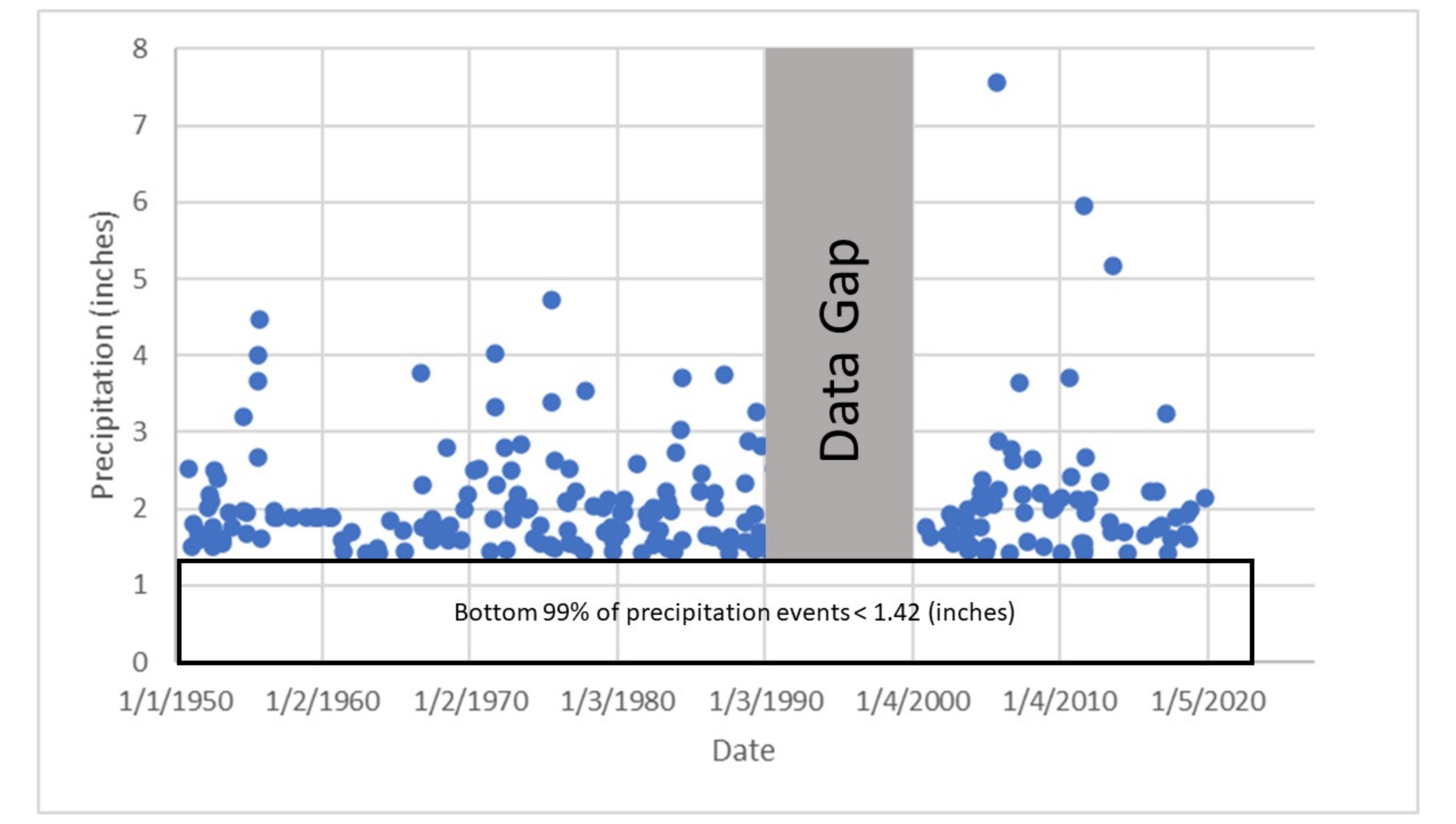
Why are we seeing intensified storm events as a result of Climate Change

- Increases in heavy precipitation are supported by physical relationships between temperature and humidity
- Trends are consistent with what would be expected in a warmer world
- Increased evaporation rates = higher levels of water vapor in the atmosphere = more frequent and intense precipitation extremes

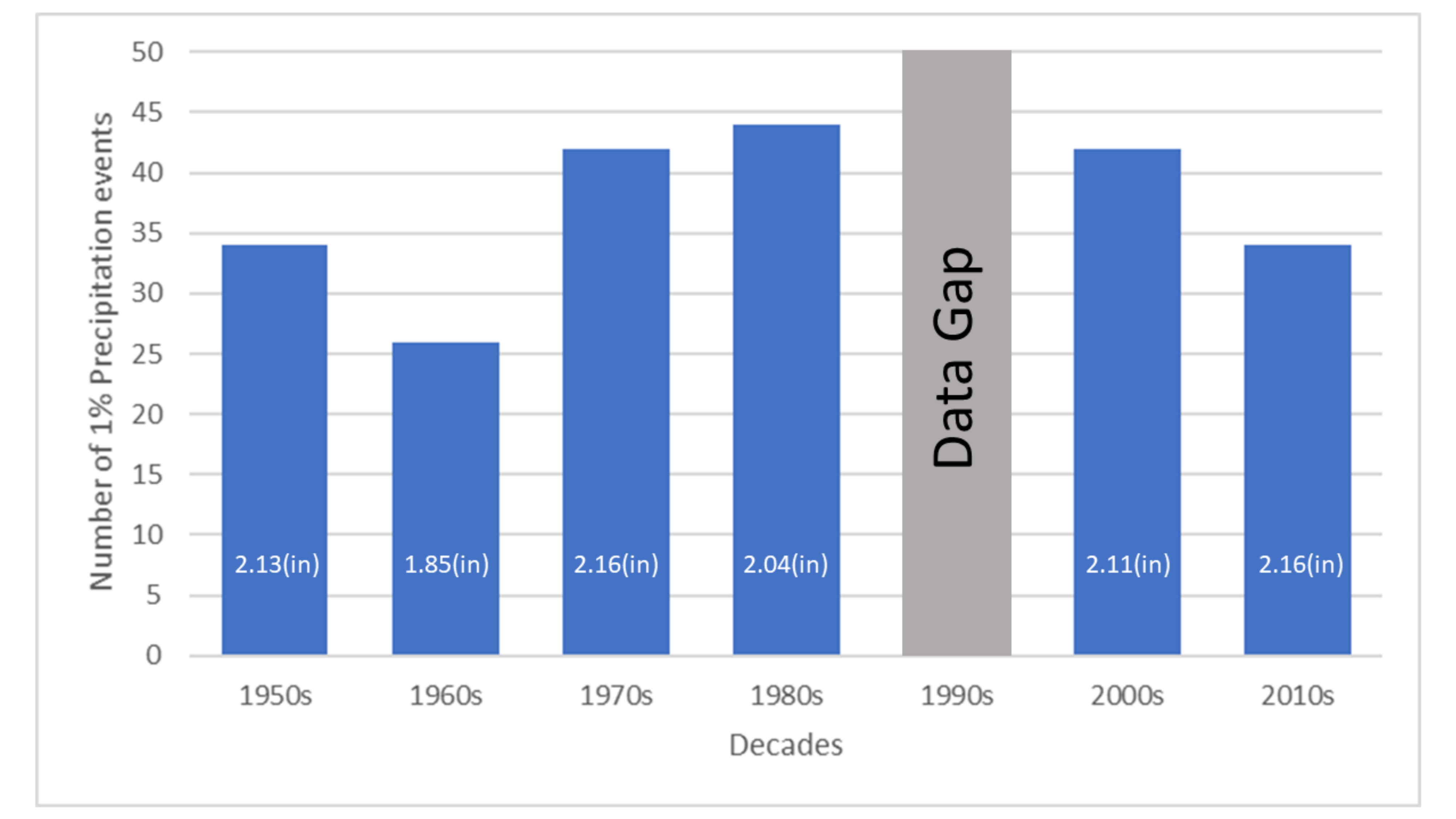


How are these climate change impacts affecting the Hudson valley





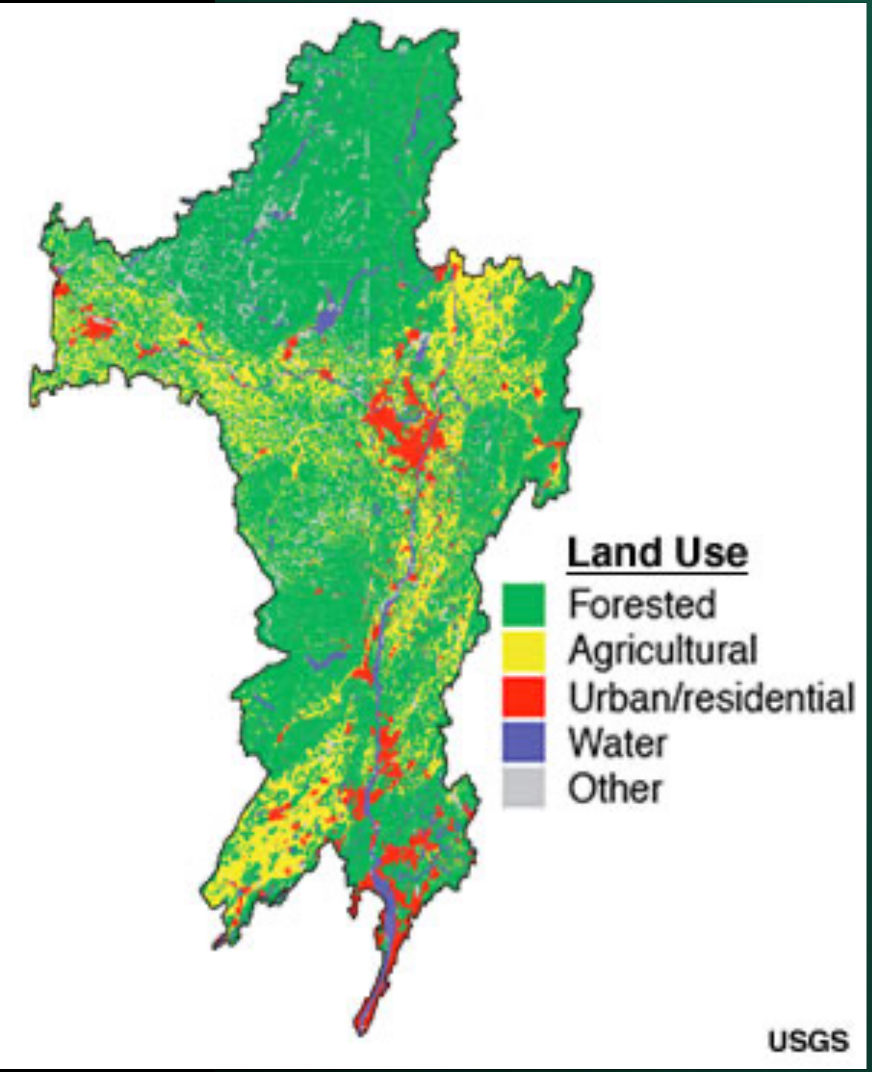
The top 1% of precipitation of daily precipitation events from 1950 to present
are plotted demonstrating the storm intensity change within the Hudson Valley, meteorologic data from Poughkeepsie airport NOAA station.



The number of the top 1% of daily precipitation events from 1950 to present in the Hudson Valley, meteorologic data from Poughkeepsie airport NOAA station. The white text shows the mean precipitation of these intense precipitation events at a decadal scale to show changes in storm intensity in relation the number of storm events.

Land Use Distribution of the Hudson Valley

- The Hudson Valley is characterized by three primary land uses: Forests, Agriculture, and Urban Space.
- Urban space is concentrated in areas such as Albany, Poughkeepsie, Newburgh, and Yonkers.
- There are nearly 900,000 acres of farmland in the Hudson Valley (Valley Table).
- 75% of the Hudson Valley is forested (NYNHP).



Land Use: Urban Space

- Characterized by **widespread coverage of impervious surfaces (asphalt, rooftops, etc)**.
- Precipitation will collect and travel along streets/sidewalks until it can enter back into the groundwater system
- Would result in an increase in urban flooding, greater strain on sewer and drainage infrastructure, and higher levels of polluted runoff entering the water supply
- Polluted runoff must be treated

Land Use: Forests

- Forests have a much greater capacity for natural infiltration but is still at risk from increased precipitation intensity.
- In mixed forests and alpine environments, extreme precipitation alters hydrologic cycles and ecosystem processes.
- In broadleaf forests, extreme precipitation poses increased risk to riparian and lowland forests due to excessive flooding, inundation, and streambank erosion.
- In all forest environments, soil erosion, flooding, and sea level rise will be prevalent.

Land Use: Agriculture

- The Hudson Valley is renowned for its agriculture but due to climate change, it could have serious impacts on water quality.
- Will experience an increase agricultural runoff (fertilizer, nutrients, and waste) washing into the water supplies like the Hudson River.
- Can result in eutrophication, deoxygenation, and disruption of aquatic environments.

Chloride Mitigation - Management

- Anti-icing and pre-wetting
- Assessment of location:
  - Level of salt application rate
  - Plow types – dependent on evenness of the road
  - "No/low salt locations"

Chloride Mitigation – Alternative Solutions

Product	Relative Direct Cost	Effective Lower Limit (degrees F)	Corrosive?	Aquatic Toxicity	Other Environmental Impacts
Road Salt or Rock Salt	Low	15	Yes	Moderate	Roadside tree damage
Potassium Chloride	Moderate	12	Yes	High	Potassium fertilization
Magnesium Chloride	Moderate	5	Yes	High	Magnesium addition to soil
Calcium Chloride	Moderate	-25	Very	Moderate	Calcium addition to soil
CMA - Calcium Magnesium Acetate	High	-17	No	Indirect	Decreased aquatic oxygen
Potassium Acetate	High	-15	No	Indirect	Decreased aquatic oxygen
Sand	Low		No	Indirect	Sedimentation

- Agricultural-based alternatives:
  - Corn steepwater
  - Cheese and pickle brine
  - Fermentation byproducts
  - De-sugared molasses

Turbidity and suspended sediment challenges in reservoirs

- Reduced Sediment Loads Downstream of Dams
- Loss of Reservoir Capacity
- Concentrated deposits of sediment loads downstream if the reservoir is flushed

Turbidity and suspended sediment mitigation(Hudson Valley)

(Siemion J. et al 2016)

- Watersheds in the Hudson Valley have received funding for research on sediment management on the rivers and reservoirs.
- Stony Clove and Warner Creek have been studied for the effectiveness of sediment and turbidity reduction projects (STRP)
- The STRP methods included
- Restoring streambed elevation and flood plain access
  - Installing in-stream hydraulic and grade control structures
  - Armoring streambanks with rock.
  - Hillslope stabilization included regrading slopes, installing surface and subsurface drainage systems, and importing fill and restoring stabilizing vegetation (Fig 4.)

Figure 4. Reach 1 of Stony Clove Creek, New York, *A*, before (March 2011) and *B*, after (September 2015) the 2012 sediment and turbidity reduction project. Photographs by Wae Danyelle Davis

Mitigation for Eutrophication and Nutrient Loading

- Less reliance on chemical N or P based fertilizers
- Natural methods like manure and other organic matter

Works Cited

Kirchmeier-Young, M. C., & Zhang, X. (n.d.). *Human influence has intensified extreme precipitation in North America*. https://doi.org/10.1073/pnas.1921628117/-/DCSupplemental.y

Kondolf, G. M., Gao, Y., Annandale, G. W., Morris, G. L., Jiang, E., Zhang, J., Cao, Y., Carling, P., Fu, K., Guo, Q., Hotchkiss, R., Peteuil, C., Sumi, T., Wang, H., Wang, Z., Wei, Z., Wu, B., Wu, C., & Yang, C. T. (2014). Sustainable sediment management in reservoirs and regulated rivers: Experiences from five continents. *Earth's Future*, *2*(5), 256–280. https://doi.org/10.1002/2013ef000184

Marko, I., Škultétyová, I., Hrudka, J., & Rózsa, G. (2020). Studying The Effect Of Urban Runoff From The Roadway And Analysis Of The Chemical Composition Of Stormwater. *20th International Multidisciplinary Scientific GeoConference SGEM 2020*, *20*(1.3). DOI:10.5593/sgem2020V/L3/s02.32

McHale, M. R., Siemion, J., & Murdoch, P. S. (2020). *Prepared in cooperation with New York City Department of Environmental Protection and the The Water Quality of Selected Streams in the Catskill and Delaware Water-Supply Watersheds in New York*.

Mukundan, R., Pierson, D. C., Schneiderman, E. M., O'Donnell, D. M., Pradhanang, S. M., Zion, M. S., & Matonse, A. H. (2013). Factors affecting storm event turbidity in a New York City water supply stream. *Catena*, *107*, 80–88. https://doi.org/10.1016/j.catena.2013.02.002

Neilsen, D., Novesky, J., & Fears, L. (2015). *Growing Agriculture in the Hudson Valley*. Valley Table. Retrieved April 26, 2022, from https://www.valleytable.com/vt-article/growing-agriculture-hudson-valley

Schlesinger, M. (2016). *The Hudson Valley's Forests and Their Iconic Wildlife*. Teaching the Hudson Valley. Retrieved April 26, 2022, from https://www.teachingthehudsonvalley.org/wp-content/uploads/Hudson-Valley-Forests-and-Wildlife.pdf

Siemion, J., McHale, M. R., & Danyelle Davis, W. (2016). *Prepared in cooperation with the Ashokan Watershed Stream Management Program Suspended-Sediment and Turbidity Responses to Sediment and Turbidity Reduction Projects in the Beaver Kill, Stony Clove Creek, and Warner Creek Watersheds, New York, 2010-14*.

Swanston, C., Brandt, L. A., Janowiak, M. K., Handler, S. D., Butler-Leopold, P., Iverson, L., Thompson III, F. R., Ontl, T. A., & Shannon, P. D. (2017, September 6). Vulnerability of forests of the Midwest and Northeast United States to climate change. *Climate Change*, *146*, 103–116. DOI 10.1007/s10584-017-2065-2

Waller, D. M., Meyer, A. G., Raff, Z., & Apfelbaum, S. I. (2021, February 1). Shifts in precipitation and agricultural intensity increase phosphorus concentrations and loads in an agricultural watershed. *Journal of Environmental Management*, *284*. https://doi.org/10.1016/j.jenvman.2021.112019

Picture references

https://www.popsci.com/climate-scientists-predict-more-powerful-intense-rainstorms-this-century/

https://hudsonvalleylighting.hvlgroup.com/Blog/Post/the-hudson-valley-a-quick-guide

https://www.power-h2020.eu/water-issues/water-quality/

https://blogwine.riversrunby.net/wp-content/uploads/2014/03/HV-Watershed-land-use.jpg

https://www.caryinstitute.org/sites/default/files/downloads/report_road_salt.pdf