

# CHANGE IN THE MOHAWK WATERSHED AND VULNERABILITY TO INFRASTRUCTURE

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Recent flooding in the Mohawk watershed should be evaluated in the context of a changing and dynamic hydrologic system (Garver and Cockburn, 2011). Climate and hydrologic data suggest that important changes have occurred in NY State in the past few decades and it is important to understand what these changes mean in different sectors of the State (Figure 1; Hayhoe, et al., 2006; Frumhoff et al., 2007).

The 2012 IPCC report that focuses on managing risks of extreme events advocates approaching change and hazard reduction at a local level. They note that: “Data on disasters and disaster risk reduction are lacking at the local level, which can constrain improvements in local vulnerability reduction. There are few examples of national disaster risk management systems and associated risk management measures explicitly integrating knowledge of and uncertainties in projected changes in exposure, vulnerability, and climate extremes” (IPCC, 2012).

The recently released ClimAid study (Rosenzweig et al., 2011) notes that the annual average precipitation in NY State has been increasing by nearly 1 cm per decade since 1900 and there has been an increase in the frequency of heavy rainfall that is especially pronounced in the Northeast (Shaw et al., 2011; see also DeGaetano, 2009; USGRCP, 2009). The first part of this conclusion is misleading because it ignores the longer precipitation records in NY State. For Albany, the early 1900’s were a long-term low in a nearly 190-year precipitation record, but despite this variation in the long-term trend (see Figure 2), the recent decade has been the wettest on record. Instrumental records show that the distribution of precipitation in the last few decades has not been uniform (Figure 2). Thus, a key to future flood mitigation and watershed management is to recognize variation in the regional distribution of these changes in precipitation, and the relative intensity of precipitation because this change has not been uniform across the State.

The geography of the Mohawk basin is uniquely positioned to reveal changes in the hydrologic

regime in this part of the Northeast because the Mohawk River is fed by two primary tributaries: the West Canada Creek drains part of the Adirondacks and the Schoharie Creek drains part of the Catskill Mountains. Hence the hydrology of the basin is sensitive to changes in continental-tracking atmospheric systems (captured mainly in the West Canada Creek basin) as well as Atlantic coastal systems (captured mainly in the Schoharie Creek basin). This is the only basin in NY State that has this unique geographical position.

Our reading of the hydrologic record of rivers in the Mohawk watershed suggests that the most significant change has been in the last thirty years and much of this change can be attributed to an increase in the amount of precipitation and the frequency of extreme precipitation events in the Catskill Mountains (Frei et al., 2002; Burns et al., 2007; Garver and Cockburn, 2011). Changes in the record are subtle, but important. Climate models show that projected changes in mean annual precipitation for the Catskills range from an increase of ~10% to a decrease of 30% by the latter part of this century (Frei et al., 2002): thus our conclusion is that climate modeling in its current form is not likely to be helpful for guiding near-term management decisions.

The recent period of high discharge on the Mohawk corresponds to the wettest decade on record at Albany according to NOAA records and these records extend back to the early nineteenth century (Figure 4). Discharge records collected by the U.S. Geological Survey show that the relative flow from the Schoharie has increased relative to the West Canada Creek since 1996 (Garver and Cockburn, 2011). This change could reflect greater precipitation in the southern part of the basin, decrease precipitation in the northern part of the basin, or both. Regional precipitation records show that the change can be largely attributed to an increase in precipitation in the Catskills and along the Atlantic seaboard (Burns et al., 2007; see Figure 1).

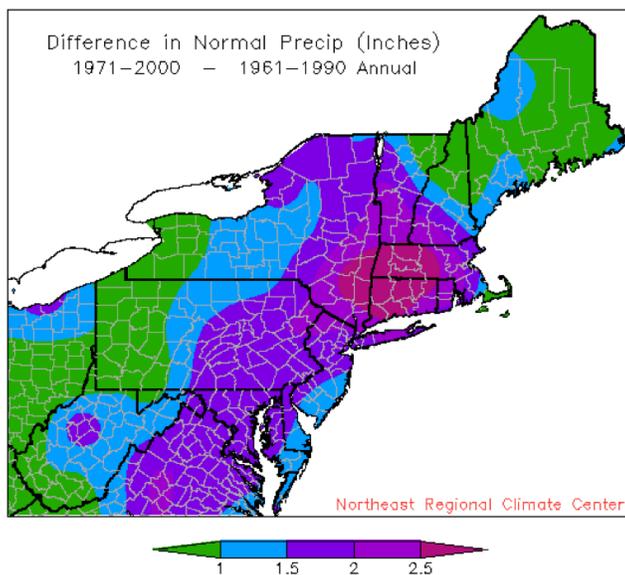
The abundance of water in the Schoharie Creek presents a considerable management challenge partly because much of this water appears to be associated with high discharge events, many of which have caused significant flooding that is locally chronic. The Irene and Lee events of 2011 were one example of this new emerging extreme situation, and it needs to be emphasized that a major increase in water in this basin was recognized prior to flooding of Irene and Lee (i.e. Garver and Cockburn, 2011).

Recent work has shown that regionally there has been an increase in the number of heavy and very heavy precipitation events (Groisman et al., 2004; DeGaetano, 2009), and the number of cyclonic systems in the North Atlantic has increased in size and number over the last 25 yr, but this data set consists of small numbers (Webster et al., 2005; Changnon, 2008). Thus it has been suggested that the most dramatic and significant change in the hydrology in the Mohawk watershed is related to Atlantic-tracking storms, which have had a significant effect on flooding in the southernmost part of the watershed (Garver and Cockburn, 2011).

One of the most important implications of this situation is that the recent floods in the Mohawk Watershed may be part of an emerging trend of increased water and sediment mobility in the system (Cockburn et al., 2009). If so, there are serious implications for the ability of the system to handle this water including an aging

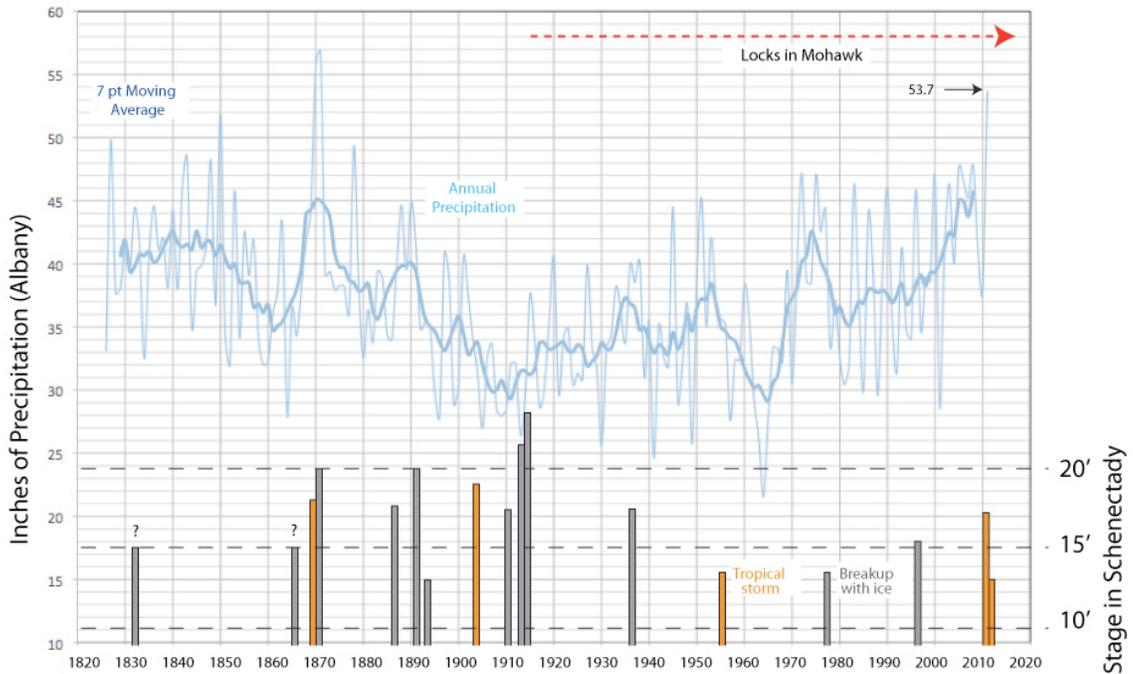
infrastructure that is underfit for this new hydrologic regime. Examples of infrastructure vulnerability include bridges, dams, stormwater and sewer outfall systems that in many cases are more than 50 yr old. Some of these structures are crucial to the State as they include water supply for NY City (Gilboa Dam) and other local municipalities, hydropower generation (Blenheim Pump Storage), and major transportation arteries including I-90 and rail lines that are key connections in the Eastern Corridor: all of which were damaged or impaired in the recent Irene/Lee events and will continue to be vulnerable in future events.

It is unlikely that we can engineer our way out of this situation without using cost-prohibitive strategies, but instead we should focus on innovation and smart design. We have dams, and locks in many places in the watershed, but none are used for flood mitigation, this should change. It might be a good time to reevaluate flood mitigation strategies in the basin, especially in the Catskill-draining rivers, like the Schoharie Creek. We will not be able to prevent flooding in the Mohawk watershed and instead we have to be clever as to how we live with this changing natural hazard. This will include gradually clearing predicted floodways and using engineering solutions that anticipate more frequent extreme events.



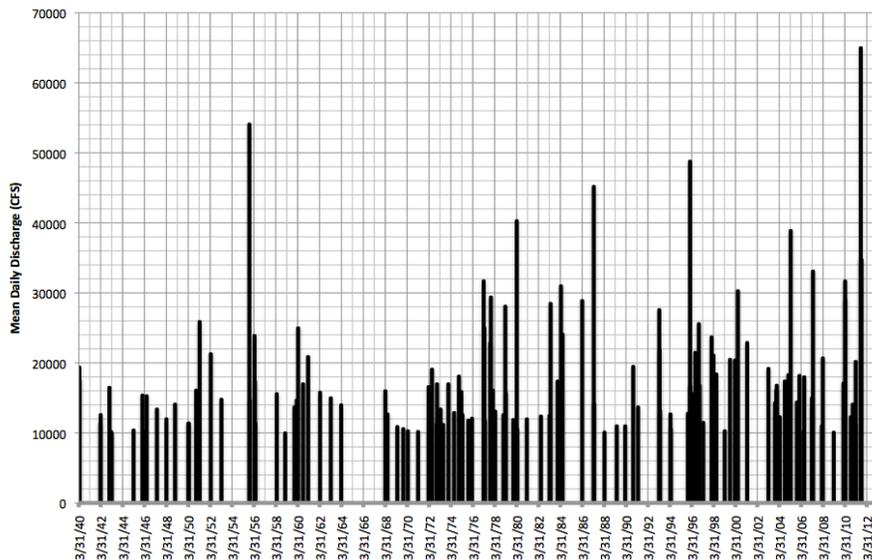
**FIGURE 1: Increase in NE precipitation (Northeast Regional Climate Center).** Increase in precipitation is indicated by the shift in the new normals (30 year averages used for understanding daily weather variations) established by the National Weather Service. This maps shows the increase in annual precipitation in eastern NY (and Mass / CT) up to 2.5 inches annually in the normal period from 1961 to 1990 and then between 1971-2000. This difference is largely due to a decrease in the early part and an increase in the later part of the record. Note that in areas with high relief and high topography (i.e. Catskills), floodwaters can be especially damaging because rivers in these settings tend lack significant flood plans. The new normals released in 2011 (1981-2010) have not yet been integrated into this analysis.

### Floods on the Mohawk River (Schenectady)

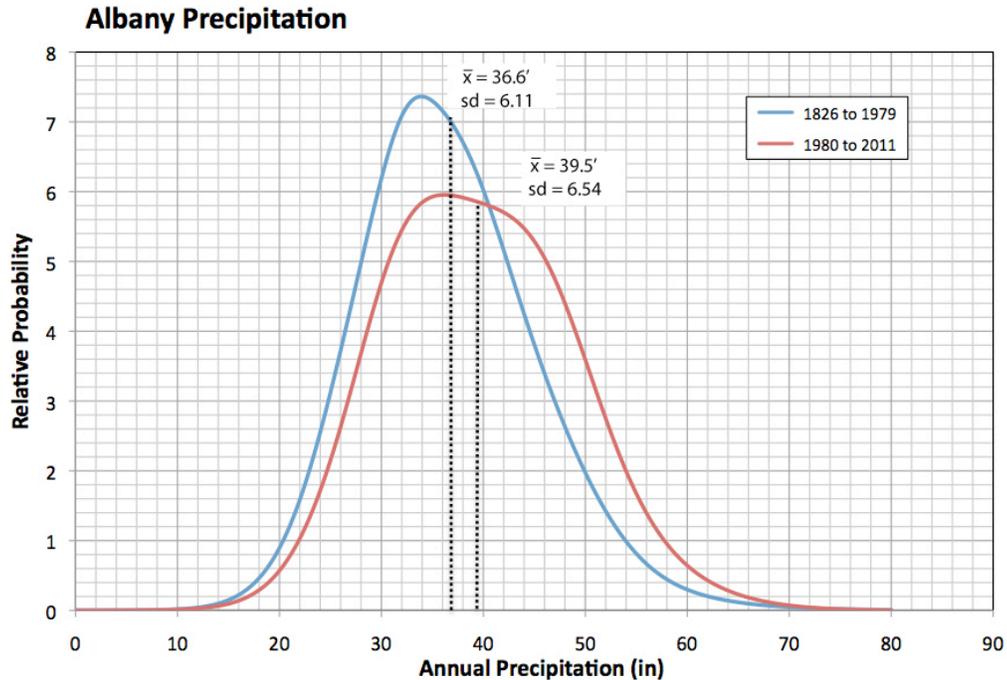


**FIGURE 2: Major Floods on the Mohawk River.** The flood history for the Schoharie Creek, which drains the Catskill Mountains, is partly revealed through discharge records from the U.S.G.S. gauge at Burtonsville NY, which is near the confluence of the Schoharie Creek and the Mohawk River. The tempo and rhythm of flooding has changed dramatically since 1980 (Precipitation data from NOAA/NWS, Albany station. Data for stage elevations of Mohawk flood waters in Schenectady from Garver unpublished, Johnston and Garver, 2001, and Scheller et al., 2008 and references therein).

### All floods on Schoharie >10 k cfs (Burtonsville)



**FIGURE 3: Floods on the Schoharie (larger than 10 k cfs at Burtonsville).** The flood history for the Schoharie Creek, which drains the Catskill Mountains, is partly revealed through discharge records from the U.S.G.S. gauge at Burtonsville NY, which is near the confluence of the Schoharie Creek and the Mohawk River. The tempo and rhythm of flooding has changed dramatically since 1980.



**FIGURE 4:** Change in precipitation in Albany (NY) over the entire record (1829 to 2011). Here we plot annual events summed as a probability density function for 1826 to 1979 and 1980 to 2011. One of the basic tenants of evaluation of regional change is to measure and understand subtle (or not subtle) changes in the geometric mean, and overall distribution of a number of key climate parameters. This analysis shows an increase in annual precipitation in the last several decades (data: NOAA/NWS data collected for Albany NY; estimation kernel for probability density of four).

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