CURRENT TRENDS AND FUTURE POSSIBILITIES: MONITORING FOR THE FUTURE AND HOW WATERSHED DYNAMICS MAY BE AFFECTED BY GLOBAL CLIMATE CHANGE

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It is predicted that mean annual temperature and mean annual precipitation will increase as a result of global climate change (NECIA, 2006). This change will have profound implications for northeastern watersheds and in particular the Mohawk. We suspect that there are several key changes that need to be considered for possible active monitoring systems and baseline studies. Climate-change scenarios would predict the following large scale, basin-wide changes: 1) **Variability in discharge**. A change in the precipitation patterns, which might mean that Atlantic tracking storms become a more significant factor, especially in the southern tributaries in the basin; 2) **Increase in Precipitation.** A change in overall precipitation across the entire basin; 3) **Temperature increase.** Increase in mean annual temperatures and an overall decrease in the overall freezing season. This has particularly important implications for the overall snowpack in the basin, and the dates and duration of the formation of ice on rivers and lakes in the watershed.

In this study, we evaluate the overall framework of global climate change in the Northeast as presented by NECIA (2006) and consider the impacts on the Mohawk Watershed. We then take the next step and ask what this might mean for active monitoring and basin-wide surveys that should be initiated now to better understand these changes.

Expected Climate Change Impacts for the Northeast. It is not our intent to entirely review the literature on climate change and its predicted impacts. It is vital to note that the impacts will be felt in the northeast and that water resources are likely to be the most severely impacted (Figure 1, 2). Weather observations made at the Albany International Airport and compiled by the National Climate Data Center (NCDC) under the National Oceanic and Atmospheric Administration (NOAA) indicate that the observations and predictions applicable to the Northeast are relevant for our area as well (Figure 3, 4, 5).

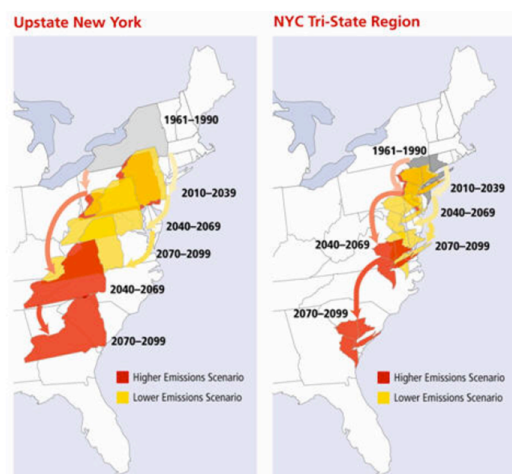

Figure 1: Estimated climate 'migrations' for Upstate New York and New York City, based on average summer heat index under lower- and higher-emissions scenarios projected by GCMs (NECIA, 2006).

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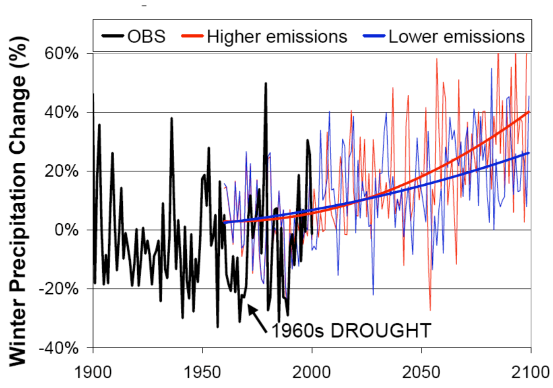

Figure 2: Observed and projected changes in winter precipitation. Predicted values are based on two different emissions scenarios (NECIA, 2006).

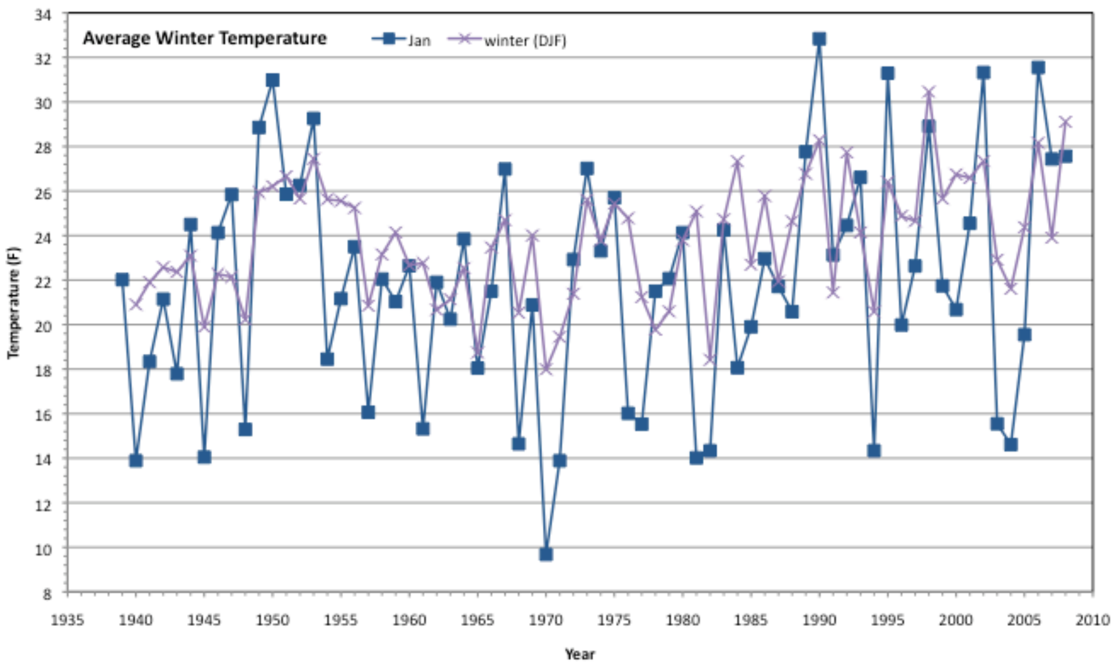

Figure 3: Winter temperatures recorded at Albany Airport through the 20th century. Both January average and Winter (December, January, February) averages were determined from daily observations.

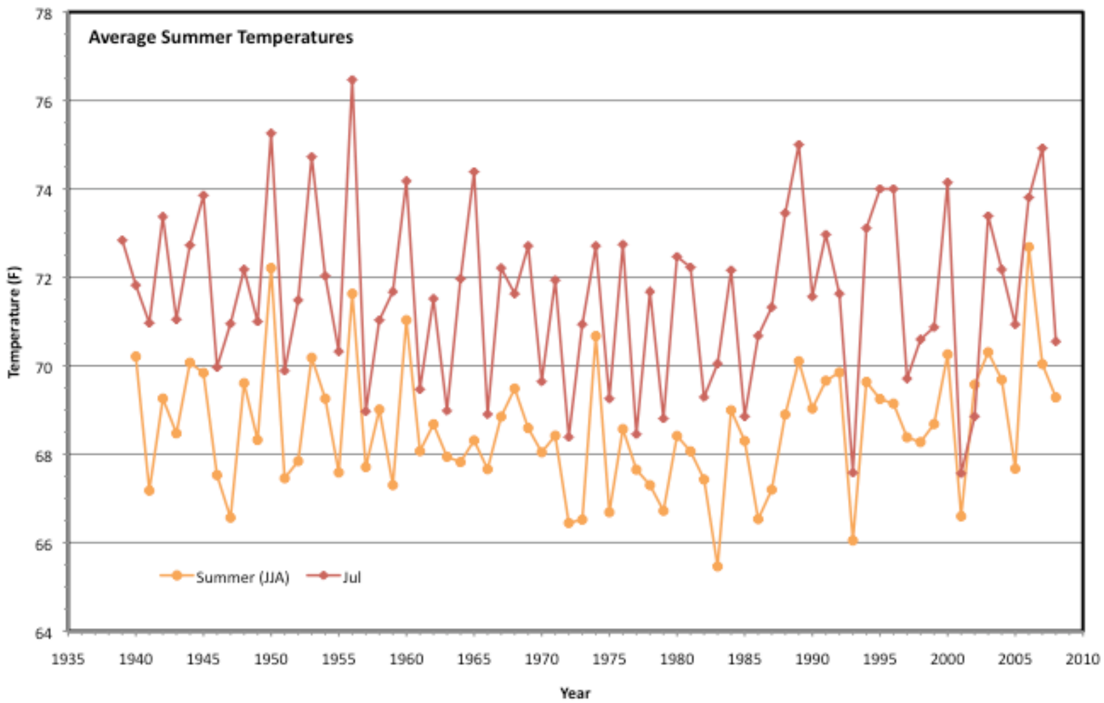

Figure 4: Summer temperatures recorded at Albany Airport through the 20th century. Both July average and Summer (June, July, August) averages were determined from daily observations.

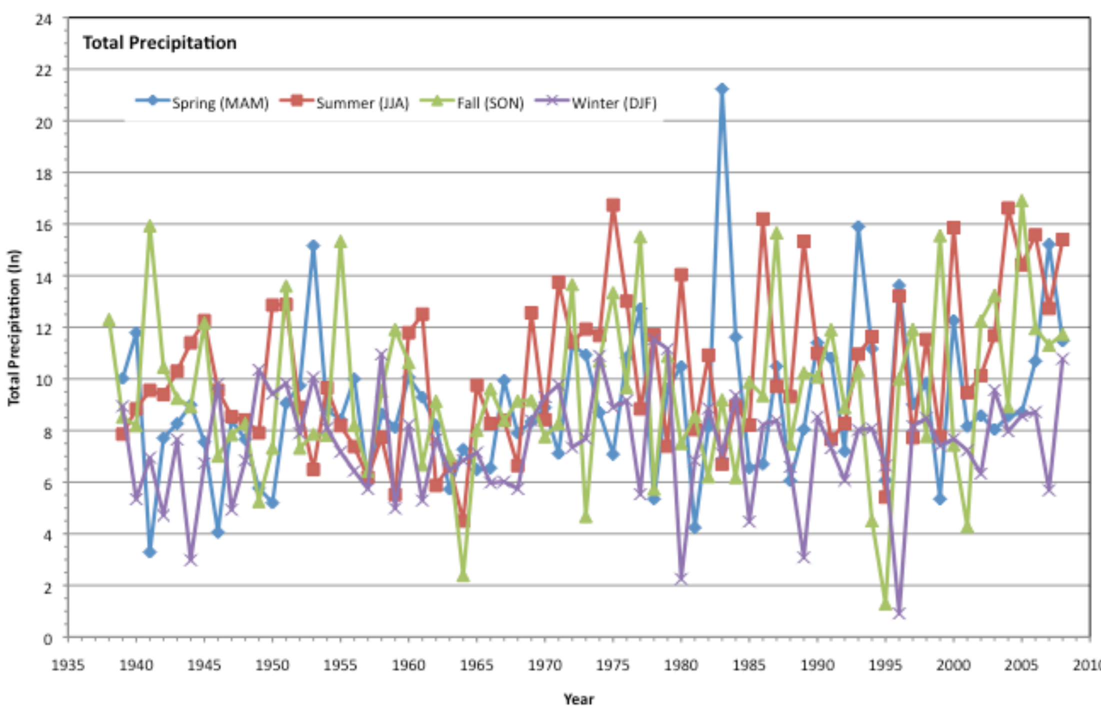

Figure 5: Total precipitation for each season, as observed at the Albany International Airport. The drought through the 1960s is clearly observed; the trends in recent decades suggest increased precipitation outside of the winter season.

Discharge and Flooding. We might anticipate an increase in the frequency and severity of rapid, high-discharge events that tend to be localized and therefore affect small tributaries. An example of such an event is the July 2008 outburst that was characterized by extremely high local rainfall that was very heterogeneous in its intensity. This event caused an extremely flashy discharge that resulted in considerable runoff in Chuctanunda Creek and Bowman Creek in Schenectady County.

Spring break up is likely shift to earlier in the year but the mean ice-out date, or the mean break up date might be imperceptibly different because historical variation has been high (Johnston and Garver, 2001).

The overall increase in discharge and frequency and severity of flooding appears to have already affected the basin in part because precipitation is high as determined from the historic records (Burns et al., 2001; Kern, 2008). Discharge data seem to suggest that the change in flood frequency and flood severity is more dramatic in the southern tributaries (i.e., Schoharie Creek, Figure 6; Kern, 2008).

Ice jamming and ice-jam flooding is a function of total ice thickness, rapidity of melt/thaw, and the rate of rise of discharge. We might expect earlier ice-out dates that have already been recognized in New England (Hodgkins et al., 2005). We might also see an increase in the number of mid-winter break up events, as we saw in January 1996, the most dramatic and damaging in recent history (Lederer and Garver, 2001). However, if winters are, on average, warmer, the decrease in the overall thickness of the ice pack may serve to lessen the severity of ice jam events.

One important change we can anticipate is the total number of low-flow events that occur annually or that might be related to prolonged drought. To a certain extent low flow and drought conditions are the most dramatic shocks and stresses to aquatic ecosystems. A key aspect of this is dramatic rise in water temperatures that reduce dissolved oxygen, and lethal combination for many aquatic organisms. This just occurred on the West Canada Creek (2007), as the relatively low amount of precipitation in that summer stressed the ecosystem and as a result fishing on this highly productive river was closed. While this event is a bit complicated because of a variety of demands on water from that river and the Hinckley reservoir, the lesson from this event is clear. During this low flow, restrictions were put in place, the aquatic ecosystem was stressed in what was otherwise a year of exceptionally high average flow on that river.

Water Temperature in the rivers and streams might change as well, which would have a dramatic impact on aquatic ecosystems. This change might be especially profound for fauna that have a life cycle timed to water temperature. Those organisms that take their reproductive clues from water temperature may shift dates for spawning, larval growth, and emergence. Note that if this effect is significant, there will likely be a widening gap between those organisms timed to daylight compared to those timed to water temperature, which is the case for some birds, and some fish. If this shift is dramatic, there might be important implications for fish and game management.

Sediment mobility. Higher average discharge and more variable discharge will have important implications for sediment mobility in the watershed. Highly variable discharge will likely increase bank erosion and mobilize sediment and debris in small tributaries. Highly saturated conditions cause increase in slope instability, and an increase in slumps and landslides may increase sediment supply in a non-linear way. A greater than average sediment load will obviously affect canals and the main trunk of the Mohawk that has a number of anthropogenic sediment traps (dams and locks). The increase in sediment supply may result in increased turbidity, and this would have additional consequences for aquatic ecosystems.

Monitoring Focus. The goal of this presentation is to outline the major processes likely to exhibit the impacts of climate change in the Mohawk Watershed. In all these cases, water resources may become limited. Understanding the additional consequences (e.g., aquatic ecosystem impact, navigability) will not be possible until the immediate physical processes are understood. The limited number of gaging stations along the lower reaches of the Mohawk and its smaller tributaries will certainly hinder our efforts at understanding the ongoing changes.

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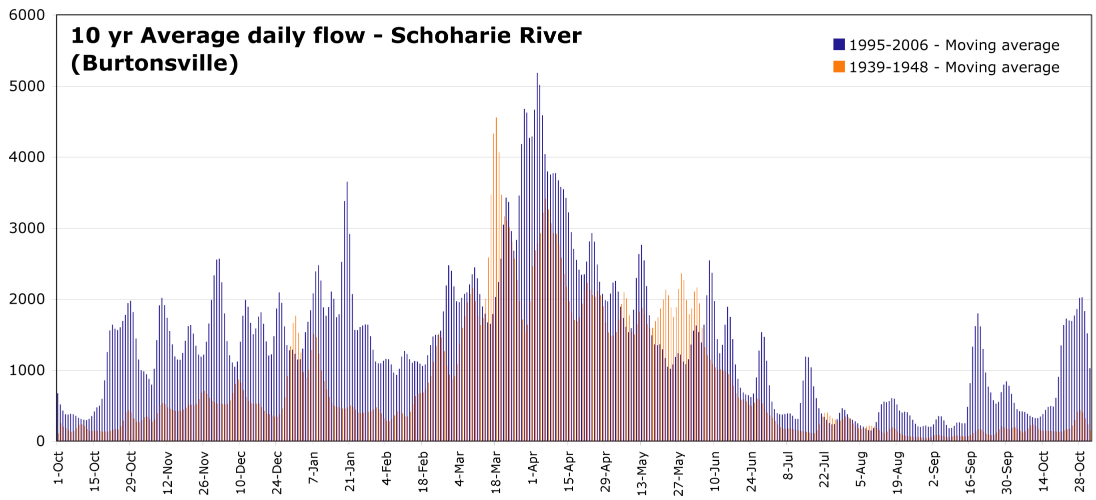

Figure 6: Daily discharge on the Schoharie Creek as measured at Burtonsville. This shows a comparison of two different decades. The blue is from 1995 to 2006, and the Red is from 1939-1948. Both lines are a 3-point moving average. This plot shows the difference in seasonal patterns, which appear especially different in the winter and the autumn.