The 1960s drought and subsequent transition to a wetter climate in New York City’s Catskill Mountains watershed

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New York City first drew water from the Croton watershed (Old Croton Aqueduct 1842, New Croton Aqueduct 1890).

Then turned to Catskills. Ashokan Reservoir and Catskill Aqueduct 1915.

Capture of Delaware River water began in 1937. Rondout Reservoir 1950, Neversink 1954, Pepacton 1955, Cannonsville 1964. And that was it.

19 reservoirs and 3 regulated lakes. 95% water delivered by gravity. Croton water is filtered but Catskill water is unfiltered. Considered a poster child of ecosystem services!
Precipitation data (GPCC gridded) across the Catskills region show the 1960s drought and a remarkable post 1970s pluvial
Observed Catskill precipitation. Trend 8mm/month

24 IPCC AR4 model mean precipitation. Trend 1mm/month

Only an insignificant part of the wetting is consistent with modeled climate change.
Spring and fall have wetting trends. 1960s drought appears year round.
Catskills region precipitation history as seen from individual rain gauges
Niamias (1966) persisted via positive air-and reduced precip and occlusion and/or stability which caused early springtime low off east coast and cold water which caused early occlusion and/or stability and reduced precip and persisted via positive air-sea interaction.

Namias identified the cause of the drought as

NATURE AND POSSIBLE CAUSES OF THE NORTHEASTERN UNITED STATES DROUGHT DURING 1962-65

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ABSTRACT

During the past 4 years noteworthy weather fluctuations of a persistent kind have occurred over large portions of the United States, the most prominent of which have been the deficiency in precipitation over the Northeast and the excess over the Southwest and the Northern Plains. The nature of these abnormalities is described with the help of seasonal frequency distributions of precipitation determined for 40 climatologically homogeneous areas of the country. From this and other material it is shown that the Northeast drought has been largely a spring and summer phenomenon at the same time when abundant rains occurred over the Northern Plains and Far Southwest.

The large-scale upper-air currents favoring or inhibiting precipitation through interactions with air masses and storms are next described. The most consistent year-to-year feature of these upper winds in the quadrennial has been the persistence of one southward dip in the westerlies just off the eastern seaboard and another over the Far Southwest.

A hypothesis is proposed for the cause of the aberrant upper-wind currents which considers the atmosphere and ocean as a complex coupled system. Abnormalities of sea-surface temperature are created by anomalous surface wind drag and by extraction of heat by anomalous air masses. The ocean thus serves as a reservoir whose heat transfer affects sequences of atmospheric systems. An attempt is made to show that a feedback system of this type has been operating efficiently during the past 4 years so as to produce the observed anomalous weather patterns.
Catskills precipitation is only well correlated with precipitation in east - and northeast in summer.

Pepacton reservoir
Strongest correlations to SST are in local Atlantic. Overall positive caused by association (coincidence?) between century long wetting and global warming. High SLP over Atlantic immediately northeast of Catskills associated with wet. High implies onshore flow. (Looking at storm track anomalies on to-do list.)
Correlation with SLP and SST by season and plotting only where statistically significant reveals no believable hemispheric teleconnections to Catskills precipitation.
Regression of winter 500mb height anomaly on Catskill precipitation shows a NA/Atl wave train.

Summer association is a purely mid-latitude Rossby wave train.
As identified by Namias, the 1960s drought was characterized by a spring low over the Atlantic to the NE. Cool SSTs are consistent with northerly flow, probably not causal.

Ashokan Reservoir
Consistent with northerly flow west of the low, the East Coast was under powerful winter and spring subsidence during the drought causing drying.

Engineers inside Catskill Aqueduct siphon, 1923
The post drought wetting (hard to attribute from the Reanalysis) is strongest in MAM and SON when flow anomaly had southerly aspect.
However there is an intriguing link of early 1970s wet shift to strengthening of local and hemispheric storm track (Chang and Fu 2002, Harnik and Chang 2003) seen in Reanalyses, radiosondes and 20CR

Catskill Precip (bk solid), 250 mb $V'^2$ 20CR (gry solid), NCEP (dsh)
All SST-forced GCMs examined fail to simulate the 1960s drought and subsequent pluvial
The MAM and SON 20th Century wetting trends are not consistent with IPCC AR4/CMIP3 model estimates of response to radiative forcing.
CMIP5 results show 20th Century wetting trends greater than can be explained as response to radiative forcing. Models do predict DJF and strong MAM wetting trends in 21st Century.
How unusual is the 107 year wetting trend in the Catskill region?

Distribution of all 1900-99 (scaled to 107 year) trends in 76 IPCC AR4/CMIP3 runs

Distribution of all 107 year trends (starting in 1856, 1878, 1900) in 96 SST-forced atmosphere GCM runs

Only SON trend falls outside model range. Why?
Engineers inside aqueduct illuminated by multiple synchronous flashes - or are they post-Dada artists?
Finishing touches to the lined aqueduct
Century long instrumental records reveal two climate mysteries in New York City’s Catskills watershed: the 1960s drought and the pluvial we are living in.

New multispecies tree ring reconstructions for region by Neil Pederson (Lamont Tree Ring Lab) reveal even more mysteries!
In NYC watershed, the 1960s drought was excelled in earlier centuries ....

... in particular by the mysterious late 15th Century Mexico-Mississippi-Eastern megadrought

... also, multi-century wetting trend
Conclusions

The 1960s drought - the drought of record in the northeast - appears to have resulted from a random sequence of atmospheric events ...

To quote Gene Rasmusson, via Chet Ropelewski, ‘sometimes it’s just one damned thing after another’ ...

The Atlantic SSTs look caused by the atmosphere circulation anomaly not vice versa ....

The post drought wetter climate remains a mystery, no evidence of SST or radiative forcing of it. Associated with apparent strengthening of northern hemisphere storm track .... Tree ring records suggest pluvial part of a centuries long trend to a wetter climate ...

A return of the 1960s drought would be a real blow amidst rising temperatures and increased precipitation intensity ...