Hurricane Irene and Tropical Storm Lee: How unique were they in the Catskill Mountains?

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Collaborators

NYCDEP: BWS Water Quality Modeling staff, various other colleagues;
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Increase in Frequency of Extreme PRCP & SF events IS A WARM SEASON TREND

US National Climate Assessment 2014

% change in precipitation falling in heaviest 1% 1958 -2012

% change in river flooding 1920s-2008

Streamflow: http://nca2014.globalchange.gov/highlights/report-findings/extreme-weather
Precipitation: http://nca2014.globalchange.gov/highlights/overview/overview#intro-section-2

Matonse and Frei (2013); Frei et al (2015)
Irene in the Catskills: Schoharie Creek, Prattsville

“My mother is 94 years old and my uncle is 92. They never saw anything like this in their lives.”
Thomas Hitchcock, quoted in Brandon, Carman & Ryan *Goodnight Irene*

Immediately after Irene, Sep 1, 2011, photo by Dannyelle Davis, NYCDEP
“Until catch basins were built higher up on the mountainsides in the 1960s, annual flooding was a problem.”
Davis, Around Windham

Jul. 1935

Catskill Mountain News
July 12, 1935

The Delaware Express
Sep. 23, 1938

1955: August (sibling storms), October

Connie & Diane, Aug. 1955

The Poconos
Shafer, Devastation on the Delaware
NYSERDA funded study:
Hydrology, Vulnerability and Adaptation Implications of Hurricane Irene and Tropical Storm Lee:
Case Study of the Mid-Hudson Valley and Greater Catskills Regions
Solecki et. al. (2014)

Emergent Vulnerabilities Based on Interviews with Stakeholders:
1) Transportation, agricultural and tourism sectors were the most heavily impacted
2) Flooding in previously un-flooded (according to local knowledge) areas (e.g. in higher elevation areas that are not floodplains)
3) Predicted return interval for floods not a good indicator of actual frequency.
4) Infrastructural weaknesses (e.g. road washouts)
5) Disproportionate socioeconomic effects (on availability of affordable housing)
Climate Station Availability

**Goal:** develop a station-based dataset for historical climate analysis

**Problem:** station availability varies in time, and has dropped in recent years.

**Method for Downloading:**
- Download all stations in watershed counties with data 1960s – 2012, and all stations in previous analyses
- Add a few additional stations with long records (e.g. West Point);

http://www.catskillslark.org/maps/maps.htm
Data Availability for PRCP
Years with >=80% non missing days
For all 71 downloaded stations
Data Availability for PRCP
Years with >=80% non missing days
For all 71 downloaded stations

Method to produce time series that are appropriate for historical analysis

• Evaluate correlation between stations with same name, or within 10km, during overlap period

• Combine stations when appropriate

• Retain resulting records for historical analysis if they meet predetermined criteria
Data Availability for PRCP
Stations with >=80% non missing days
During >= 80% of the years 1960-2012
Including all combined stations
Data Availability for PRCP
Stations with $\geq 80\%$ non missing days
During $\geq 80\%$ of the years 1960-2012
Including all combined stations
Data Availability for PRCP

# of stations per year with >=80% non missing days

During >= 80% of the years 1960-2012
Top 25 1-day events, Warm Season only (Jun-Nov)

Top events ranked by median station value. Ranked by top station value may be slightly different.
Top 3 1-day events, Warm Season only (Jun-Nov)

# sta with top 3 PRCP (red) and SF (blue) 1day totals 1950-2015 WARM

- Largest
- 2nd Largest
- 3rd Largest
Top 3 60-day events, Warm Season only (Jun-Nov)
LONG TERM STATIONS: Top 3 1-day events, Warm Season only (Jun-Nov)
LONG TERM STATIONS: Top 3 60-day events, Warm Season only (Jun-Nov)

# sta with top 3 PRCP (red) and SF (blue) 60day totals 1900-2015 WARM

- **Largest**
- **2nd Largest**
- **3rd Largest**
Conclusions

• Irene and Lee were unique extreme streamflow (i.e. flooding) events. They were extreme, but not unique, precipitation events.

• Discrepancy between the precipitation and streamflow records because streamflow magnitude depends on antecedent conditions.

• Fall 2011 was unique: 1-5 day events in the top 3 for SF, 30-60 day events in top 3 for both PRCP and SF.

• The period 1996-2011 was uniquely wet and extreme.

• The 1930s, 1950s (especially 1955) (and to a lesser extent the 1970s) were also extreme periods.
Deep gorge created in Frost Valley (Ulster County Route 47) when floods after Hurricane Irene blew out a culvert below the road in Oliverea, NY. http://en.wikipedia.org/wiki/Effects_of_Hurricane_Irene_in_New_York#Orange_County
Satellite images from NASA:
http://earthobservatory.nasa.gov/NaturalHazards/event.php?id=51826
http://visibleearth.nasa.gov/view.php?id=52066

Maps from NOAA daily weather maps; movies by Glenn Liu
Track image by A. Jeu, Hunter College, made from HURDAT2 data
Storm Total PRCP

Oct 2010

Data Source: PRISM