The Passaic River Basin and Climate Change

Passaic River Symposium VI

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Montclair State University
October 10, 2014
Outline for this morning

1. Greetings from the ONJSC
2. Climate system
3. Climate past to present
4. Causes of climate change
5. Our climate future
Office of the NJ State Climatologist

Data

Information

Knowledge

Decision

Latest from the NJWxNet

Latest temperatures across NJ appear in the above map. Click on the map or here, the New Jersey Weather and Climate Network, for much more information.

Frequently Updated Climate Data

- Winter 2013-2014 Snow Event Totals
- Monthly and Annual Statewide (1895-Present)
  - Monthly Station
  - Monthly Maps

Latest News

- Flash flooding in Stewartsville (Warren County) on June 13, Photo courtesy of Dave Debour
- On the Mild and Dry Side: June 2014 Summary and Mid-Year Recap
  - Dr. David A. Robinson
  - July 4, 2014

NJclimate.org
Basking Ridge, NJ

Latest NWS Forecast

This Afternoon
Partly sunny, with a high near 83. Northwest wind 5 to 7 mph.

Party/Sunny
83 °F

Tonight
Partly cloudy, with a low around 59. Calm wind becoming north around 5 mph after midnight.

Party/Cloudy
59 °F

Thursday
Mostly sunny, with a high near 82. North wind 3 to 6 mph.

Mostly/Sunny
82 °F

Thursday Night
Mostly clear, with a low around 55. Calm wind.

Mostly/Clear
56 °F

Friday
Mostly sunny, with a high near 86. Calm wind becoming east around 6

Latest Conditions

76 °F

Wind
5 mph from the N
Wind Gust
8 mph from the N

Temperature
<table>
<thead>
<tr>
<th>Now</th>
<th>This Hour</th>
<th>Last 6 hr</th>
<th>Today</th>
<th>Last 24 hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>76</td>
<td>75</td>
<td>77</td>
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<td>10</td>
<td>--</td>
<td>15</td>
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<td>---</td>
<td>--</td>
<td>0.05</td>
<td>1.09</td>
<td></td>
</tr>
</tbody>
</table>

Values in blue are minimums, values in red are maximums. Data as of Jul 18 12:35 PM. View expanded tabular data for this station: 5 Minute / Hourly / Daily

Trends and Climatologies

Temperature / Dew Point
Basking Ridge, Somerset County, NJ (#285)
Community Collaborative Rain, Hail and Snow Network:

7AM 22 Aug – 7AM 23 Aug, 2010

www.cocorahs.org
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Passaic Basin Weather - Climate “Players”
The big picture: a NJ squeeze play
Oh no….the polar vortex!
A precipitation rich state......

......most often
Sometimes too much…

Fairfield: 11 March 2011
Sometimes too little......

Wanaque Reservoir: February 1981
Wetlands: always a concern
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Climate past
Ice sheets expanded to and retreated from northern New Jersey at least three times during the last Ice Age. Glaciers scoured valleys, shaped hills, and left behind significant deposits, including some of the state's best sources of drinking water. The oldest of the glacial deposits, the pre-Illinoian, were laid down more than 800,000 years ago. During the Illinoian stage, about 150,000 years ago, an ice sheet again covered northern New Jersey. The most recent glaciation was during the late Wisconsinan substage, about 21,000 years ago.
The famous erratic known as Tripod Rock. Stony Brook Mountains, near Montville, N.J., Boonton 7 ¼° Quadrangle.
Historical Crests for Passaic River at Little Falls

(1) 17.50 ft on 10/10/1903
(2) 14.19 ft on 08/30/2011
(3) 12.91 ft on 04/07/1984
(4) 11.97 ft on 03/16/2010
(5) 11.88 ft on 04/18/2007
(6) 11.81 ft on 03/13/2011
(7) 11.05 ft on 09/09/2011
(8) 10.73 ft on 05/31/1968
(9) 10.11 ft on 04/04/2005
(10) 10.08 ft on 06/01/1984
(11) 9.84 ft on 09/18/1999
Paterson: October 1903 (Army Corps of Engineers)
Little Falls: March 2007 (Army Corps of Engineers)
Wayne: April 2010 (Army Corps of Engineers)
Irene rainfall: 28 August 2011
Peak Annual Flow of the Passaic at Little Falls
Fairfield
I 287: Boonton
29 October 2011 snow storm

Bergenfield

30 October

Wantage
Sandy
Maximum
Wind Gusts
Hundreds of thousands of trees down......
Sandy
Total Precipitation
Hoboken
Holgate

Photo: Will Randall-Goodwin
Global land & ocean temperature anomalies: 1880-2013

0.65 deg C/century
Trends in annual mean New Jersey temperature; 1895-2013

- Long-term upward trend of 2.2°F per 100 years
- More rapid warming since 1980
- The three warmest years have occurred since 1998
- 2012 was the warmest year on record

data source: National Climatic Data Center
Unusually warm and cold months in NJ

- Unusually warm and cold months are defined as the five warmest and coldest for each calendar month (total of 60 warm and 60 cold plus ties)
- 41 cold months occurred before 1930
- 32 warm months occurred since 1990
- Since 2000, there have been 25 warm months and 2 cold months
Hot outside?

shut up
Trends in annual mean New Jersey precipitation: 1895-2013

- Long-term upward trend of 4.1” per 100 years
- Large decadal variability (early 1960s drought, wet 1970s, very wet in last decade)
- Most of the upward trend comes from changes in spring and fall
Unusually wet and dry months in NJ

- Unusually wet and dry months are defined as the five wettest and driest for each calendar month (total of 60 wet and 60 dry plus ties)
- No obvious long-term trend in frequency of wet or dry months
- Wettest month for 6 of 12 calendar months (March, April, June, August, October, and December) has occurred since 2003
Percentage of US with a much greater than normal fraction of precipitation derived from extreme 1-day events: 1910-2012
Change in amount of precipitation from very heavy events

- Period: 1958 to 2011
- Very heavy = the heaviest 1% of precipitation events
- A similar analysis indicates that recent decades have are also higher than the first half of the 20th century

US National Climate Assessment 2014

NJclimate.org
Sea level rise: global and regional: 1880-present

- Local sea level rise along the NJ coast has been more rapid than the global rise due to land subsidence (combination of post-glacial movement of earth’s crust and compaction of coastal plain sediments)

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Purple: Church & White (2011) GSL  
Blue: Tide gauge data  
Green: Long-term sea-level signal
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≈1.3 mm/y GIA  1.7 mm/y NJ  
An additional ≈1 mm/y on the shore
1962 Life Magazine
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Is climate presently changing in NJ & elsewhere?

Preponderance of evidence suggests climate change is occurring and humans are responsible for a significant portion of recent changes.

1. theory
2. observations
3. models
The Greenhouse Effect

Some solar radiation is reflected by the Earth and the atmosphere. Some of the infrared radiation passes through the atmosphere, and some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.

Solar radiation passes through the clear atmosphere.

Most radiation is absorbed by the Earth's surface and warms it. Infrared radiation is emitted from the Earth's surface.

Theory

Modeling
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New Jersey's future climate

- Rising temperatures
- Steady or increasing precipitation
- Increasing variability and extremes
  - storms, flood, drought, heat
- Rising sea level
Changing Annual and Seasonal Temperatures

2041-2070 minus 1971-2000

North American Regional Climate Change Assessment Program

Kunkel et al. NOAA Tech. Report NESDIS 142-9, 2013
Changing Annual and Seasonal Precipitation

2041-2070 minus 1971-2000

North American Regional Climate Change Assessment Program

Kunkel et al. NOAA Tech. Report NESDIS 142-9, 2013
Warmer $\downarrow$

More Precipitation

Warmer $\downarrow$

More Evaporation
A change in extremes?

Manville

17 September 1999
# 2 crest 21.0’ (nearby Blackwells Mills: 1921-present)

14 March 2010
# 6 crest 16.2’ (1 May 2014 #7 crest 15.9’)

16 April 2007
# 3 crest 19.2’

28 August 2011
# 1 crest 21.2’
## Future sea level in NJ: Miller & Kopp

### Total sea level rise projections for New Jersey.

<table>
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<tr>
<th></th>
<th>Total cm</th>
<th>Total inches</th>
<th>Total feet</th>
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<tbody>
<tr>
<td>2050 best</td>
<td>40</td>
<td>16</td>
<td>1.3</td>
</tr>
<tr>
<td>2050 low</td>
<td>23</td>
<td>9</td>
<td>0.7</td>
</tr>
<tr>
<td>2050 high</td>
<td>60</td>
<td>24</td>
<td>2.0</td>
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<tr>
<td><strong>2100 best</strong></td>
<td><strong>96</strong></td>
<td><strong>38</strong></td>
<td><strong>3.1</strong></td>
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<tr>
<td>2100 low</td>
<td>50</td>
<td>20</td>
<td>1.6</td>
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<tr>
<td>2100 high</td>
<td>147</td>
<td>58</td>
<td>4.8</td>
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</tbody>
</table>

All values with respect to a year 2000 baseline.

Based in the slightly lower melting figures of Shepherd et al. (2012), subsidence rates of 1-2 mm/yr in excess of global, and dynamic oceanographic effects.
Seaside Heights

1 foot (likely by ~2040)

3 feet (likely by 2090s)

6 feet (~5% chance by 2100)

More major storms ahead?

.... future destructive storms are to be expected......

........with the atmosphere and ocean becoming primed for a greater frequency of such events.
Sandy: 29 October 2012
A unique recipe for disaster

Ingredients

1. Sandy
2. Wavy jet stream
3. Blocking high
4. Deep trough

Additional ingredients......adding insult to injury

a. Warmer than average sea surface temperatures
b. Landfall close to high tide
c. Astronomical high tide
d. Higher sea level than 50-100 years ago

Dilemmas........ present & future
Thanks
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