Climate Change and NJ Extreme Weather

Disasters: The New Normal?
5th Annual Conference of the NJ Voluntary Organizations Active in Disasters

Breakout session

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April 2, 2019

Little Falls, NJ
11 August 2018

(Miguel Galo, Special to NorthJersey.com)
Office of the NJ State Climatologist

Helping decision makers

Locals trusting locals
Overview

1. Setting the scene
2. NJ Weather & climate extremes
3. Changing climate and why
4. What lies ahead
5. Is it too late to do anything about this?
6. Keeping an eye out for extremes
The Global Risks Perception Survey (GRPS), discussed in the chapter “Fractures, Fears and Failures”, is the World Economic Forum’s source of original data harnessing the expertise of the Forum’s extensive network of business, government, civil society and thought leaders. The survey was conducted from 28 August to 1 November 2017 among the World Economic Forum’s multistakeholder communities, members of the Institute of Risk Management and the professional networks of our Advisory Board Members.
The Earth's Complex Climate System

Solar heating:
- Nitrogen, oxygen, argon, water vapor, carbon dioxide, and other greenhouse gases

ATMOSPHERE

CRYOSPHERE:
- Valley glacier
- Snow cover
- Continental glacier
- Sea ice

HYDROSPHERE:
- Ocean
- Lakes and rivers

BIOSHHERE:
- Human activities

LITHOSPHERE:
- Volcanism
NJ’s Weather/Climate: A Year-Round Squeeze Play

http://www.richhoffmanclass.com/chapter8.htm
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Jersey Extremes
Nor'easter: March 1962

Harvey Cedars
1960s Drought
Floyd: September 1999

Bound Brook

New Brunswick
Irene
August 2011

Manville
Sandy 2012

Hoboken
Mantoloking
Holgate

Photo: Will Randall-Goodwin
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Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II, 2018
Global surface air temperatures over ocean and land: 1880-2018

- Evidence of current global warming
  - Global temperature increasing at 0.13 °C per decade
  - Ocean temperatures increasing to depths of 9800 feet
  - Sea level rise
  - Temperatures in Arctic increasing at twice global rate

New Jersey annual temperature: 1895-2018

Long-term upward trend of 2.2°F per 100 years

6 of the 7 warmest years have occurred since 2006

2012 was the warmest year on record

data source: National Centers for Environmental Information
U.S. precipitation change

Map: 1991-2012 compared to 1901-1960

Graphs: Decades Compared to 1901-1960

National Assessment, 2014
New Jersey annual precipitation: 1895-2018

2018: wettest on record

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

data source: National Centers for Environmental Information
### Temperature - For each calendar month the 5 warmest and 5 coldest years in New Jersey

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
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Observation: The extreme warmest months tend to be after 1990. The extreme coldest months tend to be before 1930.

### Precipitation - For each calendar month the 5 driest and 5 wettest years in New Jersey

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
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Observation: There is no obvious trend in the distribution of extreme wettest and driest months.

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Dr. David A. Robinson  
NJ State Climatologist  
Rutgers University  
http://climate.rutgers.edu/stateclim/  
for more information:

Jeffrey L. Holfren  
NJ State Geologist  
New Jersey Geological & Water Survey  
NJ Dept. of Environmental Protection  
http://www.njgeology.org  
February 2019

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https://climate.rutgers.edu/stateclim/NJ_monthly_extremes.pdf
8518750 The Battery, New York

2.84 +/- 0.09 mm/yr

https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8518750
Why the change?

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
Natural mechanisms influence climate

Natural mechanisms:

Changes in solar output

Changes in the amount of volcanic aerosols in the atmosphere

Internal variability of the coupled atmosphere-ocean system (e.g., ENSO, monsoon systems, NAO)
Human factors also influence climate

Non-natural mechanisms

Changes in the concentrations of atmospheric greenhouse gases

Changes in aerosols and particles from burning fossil fuels and biomass coal (sulfate aerosols) – cooling
biomass (black carbon) – warming

Changes in the reflectivity (albedo) of Earth’s surface and the hydrologic cycle

Atmospheric CO₂ at Mauna Loa Observatory

Smoke from fires in Guatemala and Mexico (May 14, 1998)
• The Earth reflects radiation not absorbed by the atmosphere & surface (lost heat).
• Strong *greenhouse gases* delay the exit of absorbed radiation back to the space (enhancing atmosphere & surface temperatures).
Where the anthropogenically-generated heat is going

Nuccitelli et al., 2012
Coupled Climate Model Schematic
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But first:

Are we already seeing changes in extremes as a result of the changing climate?
Sandy: 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

Repetitive Jersey Flooding

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’

all photos by D. Robinson
## New Jersey Summer Heat

11 of the 15 hottest summers since 1895 have occurred in the last 20 years.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Year</th>
<th>Summer Avg. Temp.</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>2010</td>
<td>75.7°</td>
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<tr>
<td>2</td>
<td>2016</td>
<td>74.9°</td>
</tr>
<tr>
<td>3</td>
<td>2005</td>
<td>74.8°</td>
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<tr>
<td>4</td>
<td>2011</td>
<td>74.6°</td>
</tr>
<tr>
<td>5</td>
<td>2018</td>
<td>74.3°</td>
</tr>
<tr>
<td>5</td>
<td>1999</td>
<td>74.3°</td>
</tr>
<tr>
<td>7</td>
<td>2012</td>
<td>74.2°</td>
</tr>
<tr>
<td>8</td>
<td>2002</td>
<td>74.0°</td>
</tr>
<tr>
<td>9</td>
<td>1949</td>
<td>73.9°</td>
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<tr>
<td>10</td>
<td>2006</td>
<td>73.6°</td>
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<tr>
<td>10</td>
<td>1988</td>
<td>73.6°</td>
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<td>12</td>
<td>1955</td>
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<tr>
<td>12</td>
<td>2013</td>
<td>73.5°</td>
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<tr>
<td>12</td>
<td>1973</td>
<td>73.5°</td>
</tr>
<tr>
<td>15</td>
<td>2008</td>
<td>73.4°</td>
</tr>
</tbody>
</table>

The 15 warmest summers (June–August) across New Jersey since 1895.
A shift in the distribution of summer temperatures in the Northern Hemisphere
Now to the future
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
Climate Science Special Report: Our globally changing climate. Fourth National Climate Assessment, Volume I, 2017
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
Our choice affects how high sea level will be
Sea-level rise along the NJ shore, above year 2000 levels

Likely sea-level rise of 1.0-1.8 ft between 2000 and 2050.
Under RCP 8.5, likely 2.4-4.5 ft by 2100.
Under RCP 2.6, likely 1.7-3.1 ft by 2100.
Seaside Heights

1 foot (likely by ~2040)
3 feet (likely by 2090s)
6 feet (~5% chance by 2100)

Expected number of flood events changes significantly with SLR

Expected number of floods events at Atlantic City under
NJCAA central estimate, high emissions (1.4’ by 2050, 3.4’ by 2100)

**2012:**
A 10% chance each year that a storm will cause a flood that exceeds 6 feet of inundation

**2045:**
A 50% chance each year that a storm will cause a flood that exceeds 6 feet of inundation

**2062:**
A 99% chance each year that a storm will cause a flood that exceeds 6 feet of inundation

**2100:**
Daily flooding at high tide

Lisa Auermuller, based on NJCAA (2016)

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Challenges Requiring Attention

- **Knowledge**: Develop a better understanding of the details of future climate change.

- **Mitigation**: Reduce emissions of carbon dioxide and other greenhouse gases.

- **Adaptation**: Increase the resilience of society to climate change.

- **Activism/Leadership**: Raise public awareness of the challenges posed by climate change and the need to mitigate and adapt. Participate…..vote.
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A Little Bit of This and a Little Bit of That: February and Winter 2019 Recaps

Tuesday, March 5, 2019 - 9:23pm

Top Story

Latest Extremes

<table>
<thead>
<tr>
<th>City, State</th>
<th>Temp</th>
<th>City, State</th>
<th>Temp</th>
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<tbody>
<tr>
<td>Hillsborough, NJ</td>
<td>67</td>
<td>Harvey Cedars, NJ</td>
<td>49</td>
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<tr>
<td>Mannington Twp., NJ</td>
<td>66</td>
<td>Seaside Heights, NJ</td>
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<td>New Brunswick, NJ</td>
<td>66</td>
<td>Sea Girt, NJ</td>
<td>50</td>
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<td>West Deptford, NJ</td>
<td>66</td>
<td>Atlantic City Marina, NJ</td>
<td>52</td>
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<tr>
<td>Hamilton, NJ</td>
<td>66</td>
<td>High Point Monument, NJ</td>
<td>52</td>
</tr>
</tbody>
</table>

Latest Conditions & Forecast

New Brunswick, NJ
Rutgers University Meteorology Program

66°F

Wind
5 mph from the ESE

Wind Gust
11 mph from the SSE

Strong winds on February 25th uprooted a tree in Perth Amboy (Middlesex County), which fortunately landed between two buildings. Photo by Twitter user @budpct.
NJWxNet stations measure:

- Air temperature
- Wind speed and direction
- Dew point/Relative humidity
- Precipitation
- Barometric pressure
- Solar radiation
- Soil temperature
- Soil moisture
- Snow depth

Solar power

Cellular communications

Ability for expansion built into station design

Pittstown: Rutgers Snyder Research and Extension Farm
Sea Girt, NJ
National Guard Training Center

Latest NWS Forecast

Today
Partly sunny, with a high near 59. South wind 9 to 18 mph.

Partly Sunny
59 °F

Tonight
Mostly cloudy, with a low around 49. South wind 14 to 17 mph.

Mostly Cloudy
49 °F

Sunday
Showers likely, mainly between 7am and 1pm. Mostly cloudy, with a high near 55. South wind 13 to 18 mph becoming west in the afternoon. Chance of precipitation is 70%. New.

Showers Likely
55 °F

Sunday Night
Partly cloudy, with a low around 31. Northwest wind 14 to 18 mph, with gusts as high as 29 mph.

Party Cloudy
31 °F

Monday
Sunny, with a high near 47. Northwest wind 13 to 15 mph.

Party Sunny
31 °F

Latest Conditions

50 °F

Wind
8 mph from the SSE

Wind Gust
14 mph from the SSE

Temperature | Now | This Hour | Last 6 hr | Today | Last 24 hr
---|---|---|---|---|---
Temperature | 50 | 49 | 50 | 44 | 50 | 44 | 62
WindChill | 47 | -- | -- | -- | -- | -- | --
Dewpoint | 44 | 44 | 45 | 42 | 45 | 42 | 45 | 41 | 49
Wind Speed/Gust | 8 | -- | 14 | -- | 15 | -- | -- | 15
Precip | -- | 0.00 | 0.00 | 0.00 | 0.00

Values in blue are minimums, values in red are maximums. Data as of Mar 30 11:00 AM.

View expanded tabular data for this station: 5 Minute / Hourly / Daily
Community Collaborative Rain, Hail and Snow Network (CoCoRaHS)

Daily observations by trained volunteers of all ages
CoCoRaHS maps demonstrate varying distribution patterns of NJ precipitation:

7AM 31 July – 7AM 1 Aug 2016

7AM 13 May – 7AM 14 May 2017
Summing up:

Climate continues changing, locally and globally. This includes changes in extremes.

Change will continue and likely accelerate in the foreseeable future. Expect more extremes.

Impacts will expand, becoming increasingly noteworthy.

While ongoing change is certain, time remains for mitigative and adaptive actions to address and attenuate conditions.
Thanks

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