New Jersey
2021 Rainfall Studies
Summary

Study 1: Changes in Hourly and Daily Extreme Rainfall Amounts in NJ since the Publication of NOAA Atlas 14 Volume (NOAA/NERCC)

Study 2: Projected Changes in Extreme Rainfall in New Jersey based on an Ensemble of Downscaled Climate Model Projections (NOAA/NERCC)

Primary Investigator: *Art DeGaetano, Ph.D., Northeast Regional Climate Center, Department of Earth and Atmospheric Science, Cornell University, Ithaca NY*

What did the studies look at?

Two recent studies conducted in partnership with the New Jersey Department of Environmental Protection (DEP) looked at current rainfall data in New Jersey from NOAA Atlas 14 (Bonnin et al. 2006) by incorporating 19 additional years of climate data for New Jersey.

What is NOAA Atlas 14?

The NOAA Atlas 14 is a federal resource for precipitation totals based on ongoing investigations of historical rainfall patterns across the US. In New Jersey, the NOAA Atlas 14 is often used as a guideline to assess flood potential in waterways and in the design of stormwater infrastructure. However, Atlas 14 was last updated in 2006 and includes data only through 2000 for New Jersey. Consequently, nearly two decades of data are not reflected in the current standard values of precipitation intensity in the state.

Overall, what did the studies show?

Results from these studies show higher rainfall amounts estimated from the longer and more complete dataset (1950-2019) compared to those reported in the current version of NOAA Atlas 14 (1950-2000) and include updated ranges of possible rainfall outcomes for the state through this century. These long-term rainfall projections were developed from a combination of 47 climate model simulations under moderate and high future emissions scenarios. The modeled storms included those corresponding to chances of occurrence each year of 50% (also known as a 2-year storm), 20% (a 5-year storm), 10% (a 10-year storm), 4% (a 25-year storm), 2% (a 50-year storm), and 1% (a 100-year storm).

How will DEP use the data?

In the face of a changing climate, the new data from these studies is essential to the DEP's mission of planning for climate impacts today and into the future. Notably, the studies will inform the ongoing development of the NJPACT (Protecting Against Climate Threats) rules in response to Governor Murphy's Executive Order 100. The rules being developed regulate construction within flood-prone areas and require

stormwater management in consideration of a number of factors, including present and projected storm events such as the 2-, 10- and 100-year storms. The Flood Hazard Area Control Act and implementing rules in particular are based on the 100-year storm with added safety factors in some areas to address potential increases in flooding resulting from historic development.

It is furthermore important to note that despite the name of these storm events, which focus on probable recurrence intervals, it is incorrect to assume such a rainfall occurs only once every century. In fact, a location that recently experienced a 100-year event stands just as great a chance of experiencing such an event next year as it did this year – one chance in 100. For this reason, FEMA and others now generally refer to the 100-year storm as the one percent (1%) storm since rainfall has a one percent probability of equaling or exceeding the predicted amount in any given year.

What were the findings of each study?

Below is a short summary of the main findings from the two studies, with particular emphasis on estimated rainfall amounts associated with 100-year storm events with a duration of 24 hours (100-year, 24-hour storm), as that storm is particularly relevant to DEP's regulation of flood prone areas.

Study 1: Changes in Hourly and Daily Extreme Rainfall Amounts in New Jersey since the Publication of NOAA Atlas 14 Volume

This study shows that rainfall amounts associated with 100-, 50-, 25-, 10-, 5-, and 2-year storm occurrences in New Jersey are higher than those reported in NOAA Atlas 14 (1950-2000) once the additional 19 years of climate data are factored in.

Key Findings:

- The revised rainfall amounts indicate that the current version of NOAA Atlas 14 does not accurately reflect precipitation intensity conditions in the state, particularly for 24-hour and 48-hour storm events.
- At more than half of the stations analyzed, extreme precipitation amounts are 2.5% higher now than those published in 2006.
- In some places, the additional data result in a more than 10% increase in rainfall amounts above the outdated estimates.
- The results presented in this report suggest that future rainfall patterns cannot simply be assumed to follow historical trends. As climate change continues to affect rainfall events in New Jersey and elsewhere, the author recommends that routine updates in extreme rainfall amounts be carried out as frequently as every 20 to 30 years.

Study 2: Projected Changes in Extreme Rainfall in New Jersey based on an Ensemble of Downscaled Climate Model Projections

Study 1 suggests that future extreme rainfall events might lead to precipitation amounts well above current estimates. As a result, a second study was carried out to estimate future changes in rainfall amounts for New Jersey under various climate change emission scenarios.

The author used a methodology similar to that adopted in the NOAA Atlas 14 study to estimate average precipitation amounts for 100-, 50-, 25-, 10-, 5-, and 2-year storm events (24-hour duration) across three time periods. Average precipitation amounts for mid-century (2020-2069) and late-century (2050-2099) projections were then compared to rainfall estimates from the historical period (1950-1999) to derive a county-specific "Change Factor" (CF) for storms across all recurrence intervals (i.e., from 100- to 2-year storms). The "Change Factors" can be converted into a percent change, which in turn allows for the estimation of future rainfall amounts in New Jersey counties. The Department created Table 1 to reflect the expected percent change in the 100-year, 24-hour storm for each county. This study is based on rainfall projections from 47 downscaled[1] global climate model simulations representing historical (1950-1999), mid-century (2020-2069), and late-century (2050-2099) periods under moderate- (RCP 4.5) and high-emissions (RCP 8.5) scenarios[2]. The two modeled scenarios chosen for this report correspond to future warmings of 1.8˚C (3.2˚F) [RCP 4.5] and 3.7˚C (6.7˚F) [RCP 8.5] by 2100.

Key Findings:

- The data from this study clearly indicate that there is a high likelihood that precipitation intensity will increase into mid and late century in all parts of the state, but the projected changes will be greater in the northern part of the state than in the southern and coastal areas.
- Under a scenario of moderate emissions (RCP 4.5) projections suggest that the amount of precipitation associated with the 100-year, 24-hour storm will increase, on average, by 20% to 25% in northern counties (Table 1).
- For the 100-year, 24-hour storm, the models suggest a 17% chance that precipitations associated with this this type of storm will increase by as much as 45% to 50% in some counties (Table 1, Figure 1).
- More frequent storms, such as the 2-year and 10-year, 24-hour storms are expected to see increases in precipitation intensity, on average, of 5% to 15% across the state by the end of the century.

References

Bonnin, G.M., Martin, D., Lin, B., et al. 2006. NOAA Atlas 14: Precipitation-Frequency Atlas of the United States, volume 2, Version 3.0.

IPCC. 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change Stocker, T.F., et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[1] Downscaling is a technique used to extrapolate climate patterns from global climate models to address regional climate investigations, such as changes in rainfall amounts specific to New Jersey.

[2] The moderate and high emissions scenarios correspond to Representative Concentration Pathways models RCP 4.5 and RCP 8.5, respectively. These models project changes in radiative forcing, or changes to the atmospheric energy (heat) balance associated with various climate change scenarios (IPCC 2013).

Table 1. Percent change in precipitation associated with 100-year, 24-hour storm events for 2050-2099 under RCP 4.5 emissions scenario for all New Jersey counties. The reader can refer back to Appendix A-D in the full study for more detailed change factors and projections for each recurrence interval.

	% Change in Precipitation		
County	**17th Percentile**	**Median**	**83rd Percentile**
Atlantic	-15	10	39
Bergen	-4	15	37
Burlington	-8	6	32
Camden	-4	14	39
Cape May	-5	13	32
Cumberland	-15	6	39
Essex	-6	12	33
Gloucester	-5	14	41
Hudson	-8	4	23
Hunterdon	-9	13	42
Mercer	-8	9	36
Middlesex	-12	10	33
Monmouth	-8	7	26
Morris	-5	20	46
Ocean	-6	7	24
Passaic	-7	22	50
Salem	-5	11	32
Somerset	-7	17	48
Sussex	-5	21	50
Union	-7	11	35
Warren	-5	15	37

Figure 1. Projected (2050-2099) increase in rainfall amounts (in %) above the 1950-1999 historical period associated with the 100-year, 24-hour storm across New Jersey. The reference period projections shown here represent the upper likelihood of occurrence and have an 83% likelihood of being below this value. Likewise, there is a 17% likelihood that the value presented for each county will be above this number. Northern counties are expected to see the highest increases in precipitation totals, with values up to 50% higher than historical trends.