Regional Effects on Rainfall in Contrast to Larger Scale

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ABSTRACT

Flooding is one of the most widespread and costly natural disasters in the world. Increase in global temperatures intensify the water cycle creating more extreme natural events. The natural water cycle relates to climate as well as land-surface conditions. According to the Clausius–Clapeyron relationship, As the temperature increases, the water cycle becomes more intense leading to an increase in the amount of water vapor in the atmosphere that rises and as a result, the amount of precipitation over the area. This influx of precipitation induces the amount of water that goes through the process called runoff. With more impervious areas, urban land-surface might induce more water to flow as runoff. On the other hand, an urban city might tend to trap heat combined with location near topographic barriers, such as a mountain range, leading to the 'rain shadow' effect. In this project, we investigate whether there has been any trend in precipitation extremes in the northeast, with a particular focus on urban centers. We also explore larger scale climate variables those might have triggered some of the extreme flooding events, such as column moisture content and the wind conditions. Using known historic event dates, we examine where the moisture came from to cause some of the most disastrous events. This study helps us to understand where, when and how an extreme flooding occurred in the history, and how weather conditions played a role. Regional variables, which affect the amount of precipitation, include what is known as a 'heat-island,' and causes the rain shadow effect. An urban city's tendency to trap heat combined with location near topographic barriers, such as a mountain range, leads to the 'Rain shadow' effect. This effect occurs when air mass moves from a low elevation area to a higher one, this movement causes the mass to expand and cool. This cooler air mass form clouds that cannot retain water as well as warmer clouds. Therefore, as the cooler cloud moves up the mountain it drops rain and snow. However, once this cloud crosses the boundary and moves down the barrier the air is warmer which make the clouds dissipate.

INTRODUCTION

In the regional area of New York City, increased rainfall is a result of higher temperatures, which intensify the territorial water cycle. Due to urbanization, the city's aging infrastructure, encroachment of proper drainage canals and reduced natural drainage, these new extreme rainfalls causes heavy flooding in, major industrial areas making a negative impact on the city. The purpose of this research is examine changes in precipitation levels over the last sixty-six years to show the effects of rainfall on an urban center, focusing mainly on the Northeast and New York City. When humans populate urban cities they change the land surface thus changing nature's evaporation mechanism and making way for further natural disasters. In New York City, urbanization aided the devastation Hurricane Sandy caused the city. Asphalt roads in New York inhibit natural absorption, creating abnormal rates of runoff.

METHODOLOGY

After receiving the raw data we ran the data through a series of codes and programs to receive the desired results.

1. Using MATLAB and Excel we parsed through hourly rainfall data from 1948 through 2013
2. Using MATLAB we merged hourly data into Daily Rainfall data to find a trend in daily rainfall over the 66 years using Excel
3. We used Python to verify all of the Daily Rainfall data gathered using MATLAB
4. The Daily Rainfall data was turned into Monthly Data and then Yearly Data
5. We used MATLAB to calculate the number of Wet Days per year
6. This data gathered using MATLAB was plotted on Excel (Slope of Points) – trend of the slope points [Charts shown in Results Section]
7. This Excel data was taken and plotted using each weather stations Latitude and Longitude using GIS (ArcGIS) to see the correlation between Elevation/Land Cover on the amount of precipitation.
8. Using NOAA we were also able to find perceptible water content and vector wind during Hurricane Sandy. This was done to see how water content and wind affect urban flooding.

RESULTS

Figure Explanations

Figure 1 – Trend of the Maximum Daily Rainfall on land cover map.

Figure 2 – Maximum daily rain fall *(1948 – 2013)* trend correlation on Elevation map.

Figure 3 – Sum of annual rainfall *(1948 – 2013)* trend correlation on elevation map.

Figure 4 – Annual number of Wet Days *(1948 – 2013)* trend correlation on elevation map

Figure 5.1 – Perceptible water content during H.Sandy October 29th 2012

Figure 5.2 – Vector wind during H.Sandy *(Oct. 29th 2012)*

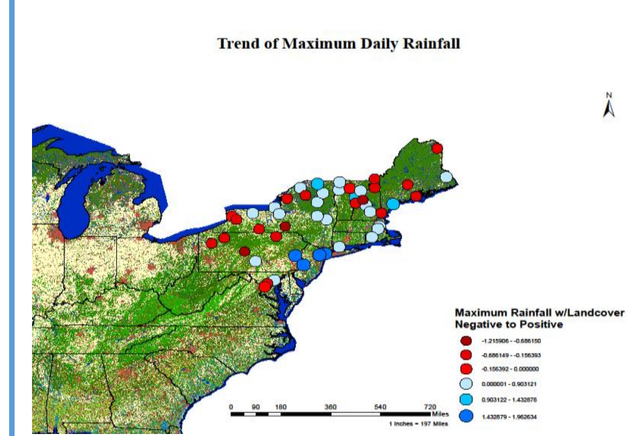

Figure 1

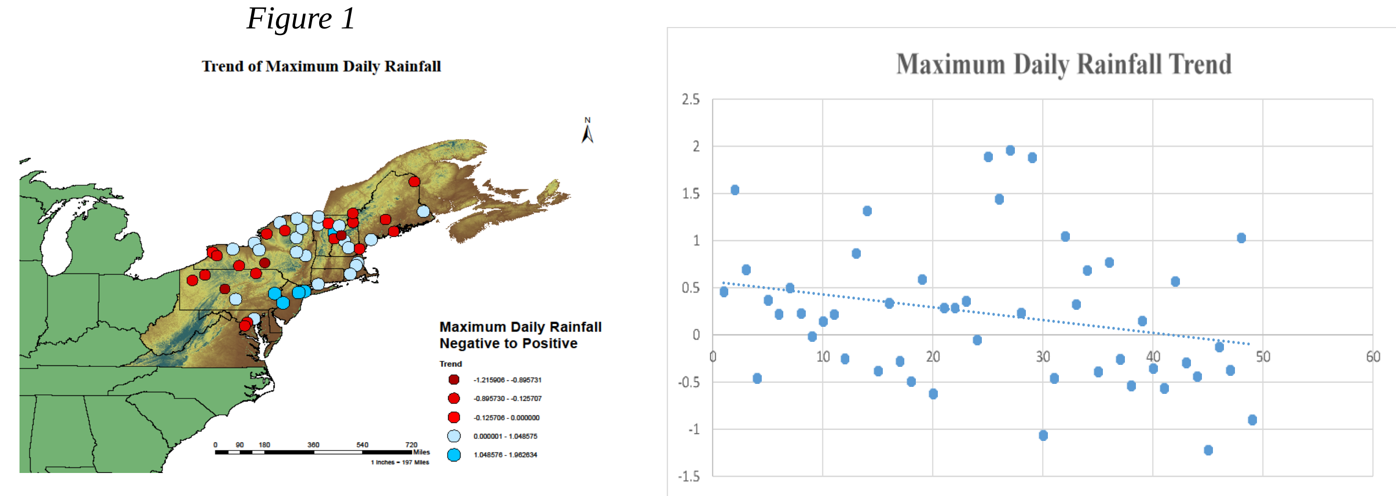

Figure 2

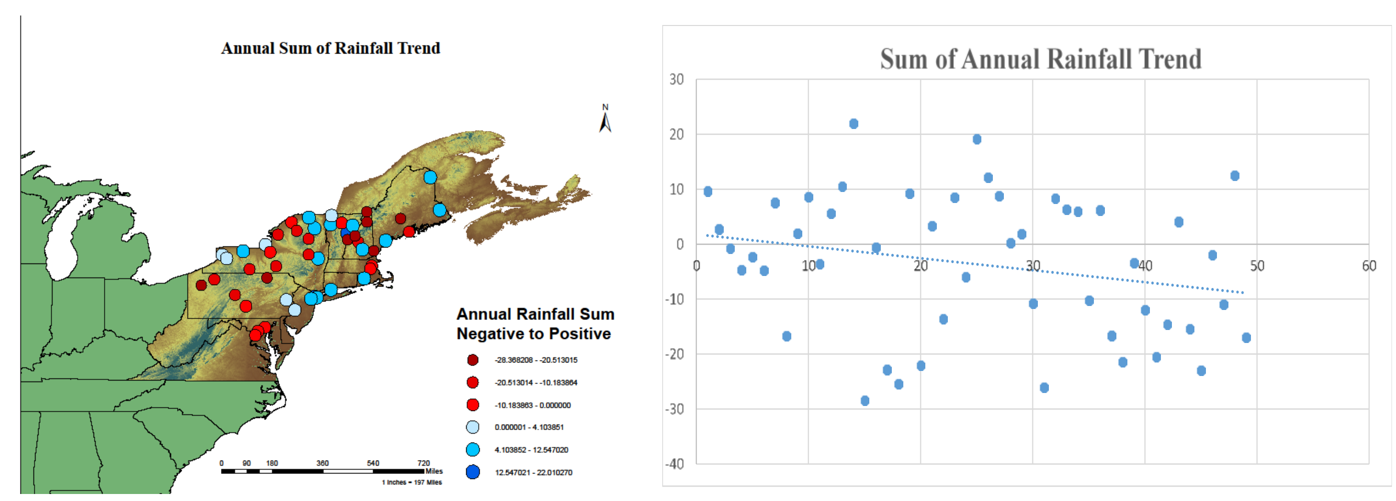

Figure 3

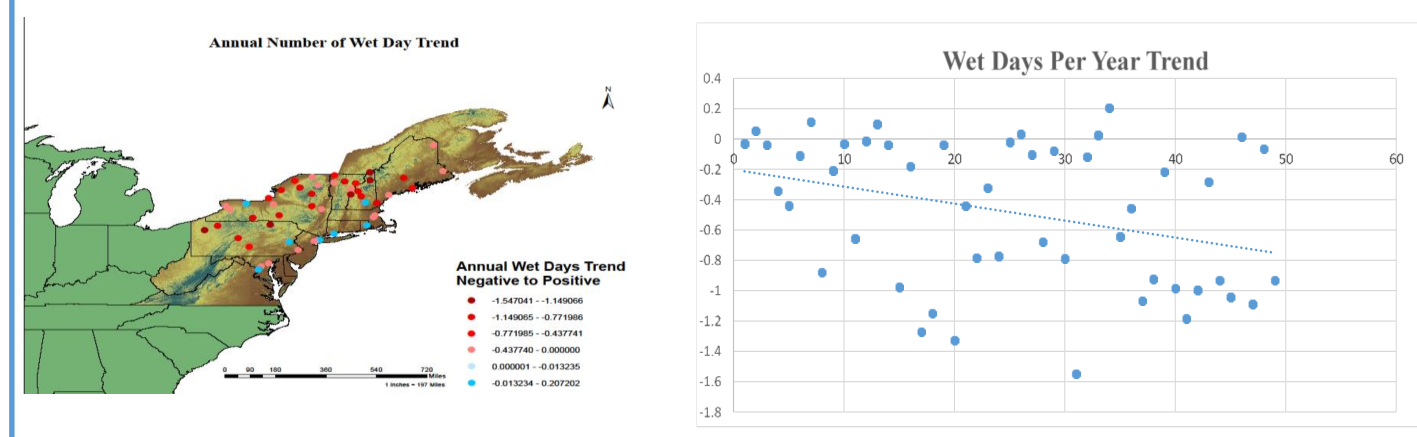

Figure 4

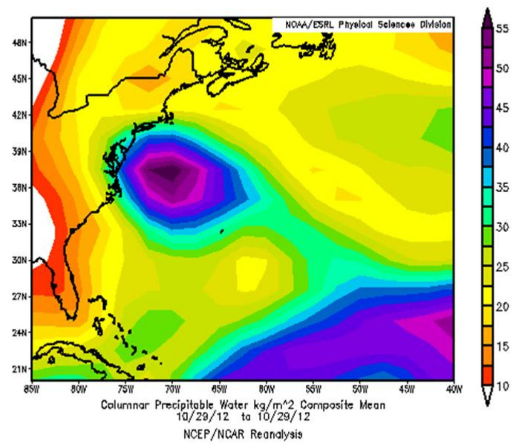

Figure 5.1

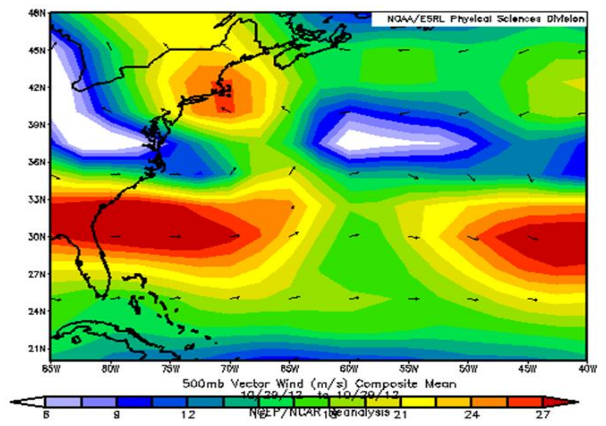

Figure 5.2

DISCUSSIONS & CONCLUSIONS

For figures 1 through 4 we had data for maximum daily rainfall, wet days, and the Sum of Annual rainfall for all 66 years for the 49 weather station. This data was plotted all for the years on a map for Station 1 and then the slope was found its trend line. The same procedure was Station 2 and the rest of the 49 Weather Stations. Each of the map and chart has the slope of every line for every weather station plotted. For figure 5.1 and 5.2 the perceptible water (water content) and vector winds are shown for the 29th of October in 2012 ; the date of Hurricane Sandy. The water content shows the amount of water vapor that is in the hair and the vector wind illustrates where the wind gust is blowing therefore indicating where the moisture will end up. We predict that if we can calculate the moisture for the 66 years across 16 water stations in New York will taking into account the vector wind. We will be able to have a better understating of why specific areas flood as much as they do in addition to why certain areas are perceptible to heavy rain fall due to urban in fracture and low evaporation and transpiration rates due to human activity.

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ACKNOWLEDGEMENTS

THIS RESEARCH PROJECT AND MY HIRES SUMMER RESEARCH INTERNSHIP ARE FUNDED BY THE PINKERTON FOUNDATION UNDER THE CUNY CREST INSTUTUTE.

THIS RESEARCH PROJECT AND MY UNDER GRADUATE/GRADUATE RESEARCH FELLOWSHIP IS FUNDED BY THE NATIONAL OCEANIC AND ATMOSPERIC ADMINSTRATION- COOPERATIVE SCIENCE CENTER FOR EARTH SYSTEM SCIENCES AND REMOTE SESING TECHNOLOGIES (NOAA-CREST) UNDER THE COOPERATIVE AGRREMENT GRANT #:NA16SEC4810008

The Pinkerton Foundation

The City College of New York

CUNY CREST HIRES