Overview

The urban environment is especially vulnerable to extreme precipitation events due to the density of infrastructure and population. The stochasticity of extreme precipitation creates a technical barrier to producing outcomes in these high-density locations. This project blends downscaling methods through a storylines lens to provide multiple scenarios and levels of information to decision makers and community members. Collaborating with municipal practitioners defined the parameters of the study and conversations with community leaders provided a much needed lived-experience perspective.

A Brief Introduction to Future Extreme Precipitation Data

<table>
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<tr>
<th>Pseudo-global Warming (PGW)</th>
<th>Statistical Downscaling</th>
<th>Dynamical Downscaling</th>
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<td>Perturbing current of historical weather model analysis by an informed future change.</td>
<td>Constructing a statistical relationship between historical GCM output and fine resolution climatology data sets, then applying that relationship to projected GCM output. Examples include data downscaling sources such as BCMA, MACA, or LOCA.</td>
<td>Using GCM output as initial and lateral boundary conditions of a numerical weather/climate model based on solving physical equations.</td>
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Storylines

This study explores three examples of fluvial flooding in the urban environments of Ellicott City, MD, Portland, OR, and Phoenix, AZ. The Weather Research and Forecasting (WRF) model is used to simulate the storm events for both historical and pseudo-global warming (PGW) projected scenarios. Each storm event serves as a personal story to communicate how climate change may worsen severe events that we are already experiencing today. Analysis between the historical and PGW simulations shows that the warmer environmental temperature alters duration, intensity, and the spatial distribution of precipitation.

1. Ellicott City, MD on July 30th, 2016
   - Mesoscale Convective Storm
2. Portland, OR on October 31st, 2015
   - Atmospheric River
3. Phoenix, AZ on September 8th, 2014
   - Hurricane-induced convective storm

How does PGW work?

PGW consists of applying a pre-determined change in temperature to the environmental temperature of historical climates or weather events. An ensemble average approach is used and variables such as atmospheric temperature, surface temperature, skin temperature, sea-surface temperature, and sea ice extent are considered. PGW can explore how specific storms respond to a warmer environment by utilizing the Clausius-Clapeyron equation which states that every 1°C increase in temperature, results in a 7% increase in atmospheric water vapor capacity.

The change for the future environment is calculated from a 17-member CMIP5 ensemble. Monthly average temperature from the Historical (1990-1999) and RCP8.5 (2090-2099). This produces a temperature delta that varies in x, y, and z.

The Big Picture

Different data sources and modeling techniques answer different science and application questions. Combining multiple methods in a storylines approach gives a fuller picture of how extreme precipitation may change in a warmer world. Data sets like LOCA can offer insight into how climate scale variables may change. PGW offers finer temporal resolution and event-based precipitation change.

Understanding the benefits and drawbacks of each data source is an integral part of any adaptation and resilience project.

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