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It's Getting Wetter in Wooster: A Climatological Analysis of Recent Pluvial Conditions in Northeast Ohio and Implications for Water Management

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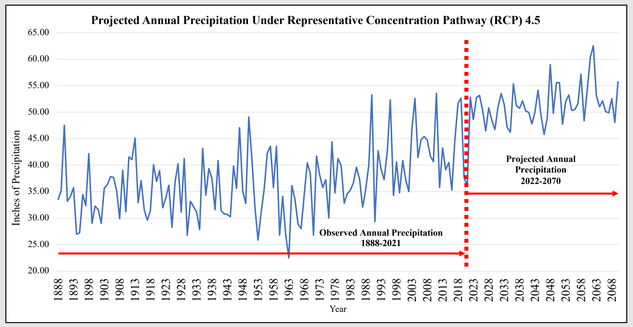
THE COLLEGE OF WOOSTER

RESEARCH QUESTIONS:

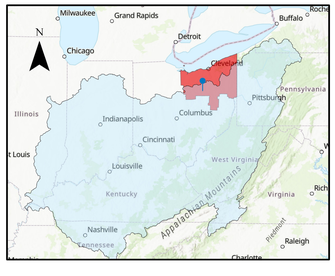
1. What are the driving forces responsible for the observed and projected changes in pluvial conditions Northeast Ohio?
2. How can key principles of stormwater management be applied to the strengthening pluvial in Northeast Ohio?



STUDY AREA:

This research is focused on the Northeast Ohio region, which is comprised of 18 counties. Wayne County, located on the southern edge of the region, is home to the Wooster Experimental Station. All observational data used in the climate analysis was recorded at this station, and it was strongly correlated with the entire region.

Study Area



Spatial Reference
Name: WGS 1984 Web Mercator Auxiliary Sphere

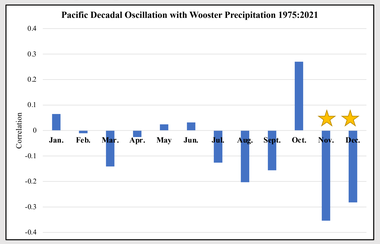
Source:Fayette GIS, VGIN, Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, Esri, USGS

Located in Northeast Ohio, Wooster is a community on the outskirts of the Ohio River Valley (ORV) that is home to approximately 30,000 residents.

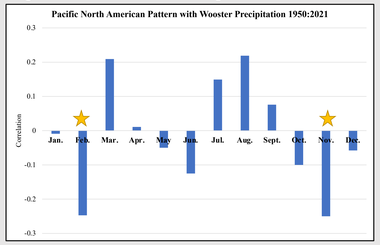
Climatological data for this research was recorded at the Wooster Experimental Station, a weather station that is managed by the National Weather Service. Located on the campus of the Ohio State College of Food, Agricultural and Environmental Science (CFAES), this station has been recording daily observations since the late 1800's.

CLIMATIC ANALYSIS:

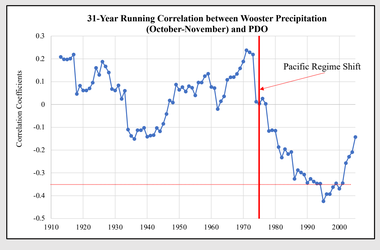
Using historic monthly data from the Wooster Experimental Station (1888-2021), the statistical relationships between precipitation and climate indices were tested using the KNMI Climate Explorer tool.



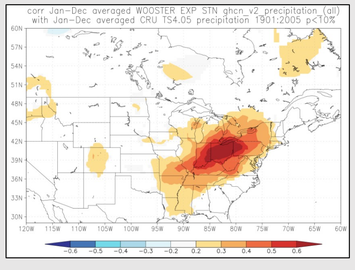
- Existing research points to the Pacific Decadal Oscillation (PDO) as a possible driver of the Northeast Ohio hydroclimate.
- November and December reported the only statistically significant results. When averaged, a strong, negative correlation exists (r=-0.33, p=0.02).
- It is believed that the 1975 Pacific regime shift influenced the the relationship between the PDO and Wooster precipitation.



- The Pacific North American Pattern (PNA) has been linked to winter precipitation variability in the ORV.
- February and November reported the only statistically significant correlations. A winter average (November-February) was taken, resulting in strong, negative correlations (r=-0.4-0.6, p=0.05).
- The generally weak correlations could be attributed to Wooster's location on the outskirts of the ORV.



- Prior to 1975, the relationship between the PDO and Wooster precipitation was virtually nonexistent.
- The Pacific 1975/76 regime shift is indicated in this running correlation, with statistically significant correlations occurring only after the shift (r=>-0.35).



- Spatial correlations indicated that precipitation was strongly correlated, regionally.
- From this, it was determined that conditions in Wooster could represent the entire Northeast Ohio region.

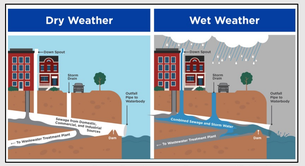
KEY FINDINGS:

- The PNA and PDO both have a marked connection to the precipitation record in Wooster, Ohio in the fall/winter seasons, supporting existing literature in this field of study and further supporting the idea that Wooster's location in the Ohio River, proximity to Lake Erie, and geographic positioning within the United States makes it more susceptible to various climatic influences.
- Notable shifts in the global climate system have an observed impact on the precipitation variability in Wooster, Ohio, and given the complexities of the climate system, further analysis (i.e., more sophisticated climate modeling) is recommended.
- Pluvial management, specifically relating to the management of stormwater is becoming a crucial aspect of modern society, and its importance will only increase with projections for a strengthening pluvial in Northeast Ohio.

MANAGING THE PLUVIAL:

Stormwater management plays a critical role in the conveyance of excess of rainwater runoff that is a result of heavier, more frequent precipitation events. Utilizing trainings from the Ohio StormwaterOne platform, solutions to the challenges presented by strengthening pluvial conditions in the region could be suggested.

StormwaterONE Online Training & Credentials



Credit: City of Richmond Department of Public Utilities

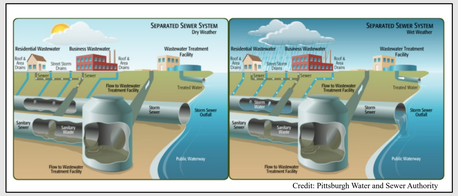
Combined Sewer Systems (CSS) are used to manage the flow of rainfall runoff, industrial waste, and raw sewage in one, shared infrastructural system. In a CSS, heavy rainfall events can cause discharges, or overflows of pollutants into natural bodies of water. Over 700 municipalities in the United States have permits from the National Pollution Discharge Elimination System, which regulates Combined Sewer Overflows and the environmental risks they pose.

Image Credit: NE Ohio Regional Sewer District

The Northeast Ohio Regional Sewer District has budgeted approximately **3** billion dollars for a **25**-year project that seeks to control stormwater flows, including the construction of **7** underground storage tunnels. Storage tunnels, constructed with heavy machinery, are estimated to capture **365** million gallons of CSOs for treatment, annually.

Image Credit: NE Ohio Regional Sewer District

"Twenty-first century trends in hydroclimate are so large that future average conditions will, in most cases, fall into the range of what we would today consider extreme drought or pluvial states…"
(Stevenson et al., 2022)



Credit: Pittsburgh Water and Sewer Authority

The primary goal of the Municipal Separate Storm Sewer System (MS4) is to capture and release rainfall runoff in a system that separates it from industrial waste and/or raw sewage. Unlike the CSS, heavy rainfall events do not pose a threat to water quality because the risk for combined sewer overflows is significantly minimized or even eliminated using this type of system. Over 7,000 cities and smaller entities, such as municipalities, have MS4 permits that operate according to federal, state, and local regulations.

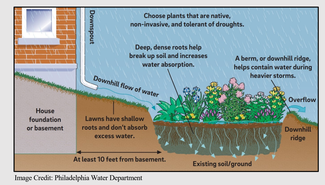


Image Credit: Philadelphia Water Department

MS4s use different components to slow down and capture rainfall runoff, including rain gardens, bioswales, green roofs, retention/detention reservoirs, and pervious pavement, among others. Each of these methods can increase rates of infiltration, which is more beneficial to the natural system, as opposed to excess rainfall runoff.

Image Credit: Pittsburgh Water and Sewer Authority

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