Internal Spatio-temporal Dynamics of Greenspaces Influence Connectivity to Urban Landscapes

H35F-1100

Vivien Rivera, Liliana M. Hernandez, Colleen O'Brien, William M. Miller, Aaron I. Packman
Civil and Environmental Engineering; Northwestern University, Evanston, IL

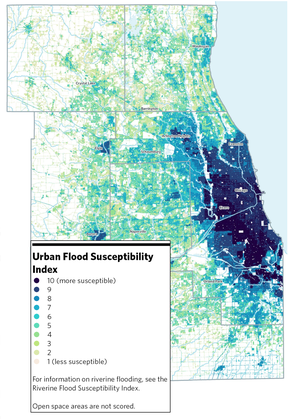
Northwestern McCORMICK SCHOOL OF ENGINEERING

National Science Foundation

Introduction

Motivation
- Increasing urban population and urban expansion
- Climate change causing changing weather patterns
- Financial and social costs associated with urban flooding
- Limited ability to evaluate GI's stormwater storage capacity

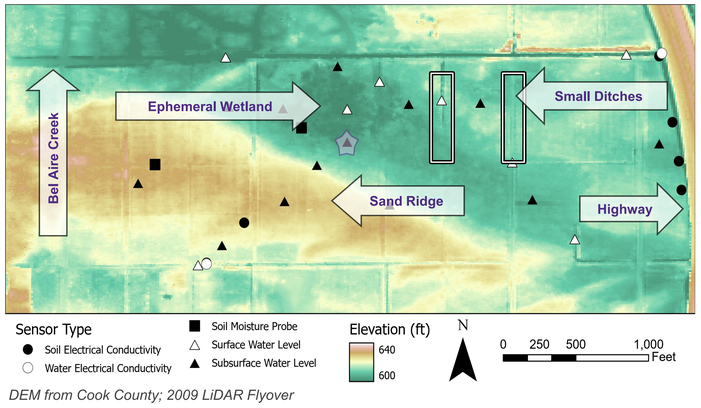
Objectives:
- Apply GIS methods and signal processing approaches to examine GI response to precipitation
- Explore impacts of rainfall duration and intensity on shallow groundwater storage
- Use conventional hydrograph analysis methods to evaluate storage in a wetland



Flood susceptibility index for Chicago, IL (Chicago Metropolitan Agency for Planning, 2018)

Site Overview: Gensburg Markham Prairie

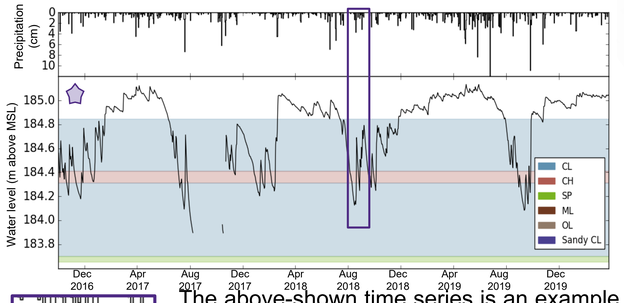
- 40 ha of well-preserved tallgrass prairie, 40 km south of Chicago
- Owned by Northeastern Illinois University (NEIU) and managed by TNC as part of the Indian Boundary Prairies (IBP)
- Surface water storage in small channels and ephemeral wetland in winter and spring
- Surface channel (Bel Aire Creek) flows west to east, fed by wetland
- North-south ditches disconnected from main channel
- Elevated ridge of medium-grained sand bisecting the site

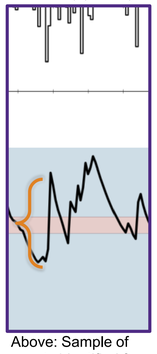


DEM from Cook County; 2009 LiDAR Flyover

Time Series Hydrograph Analysis

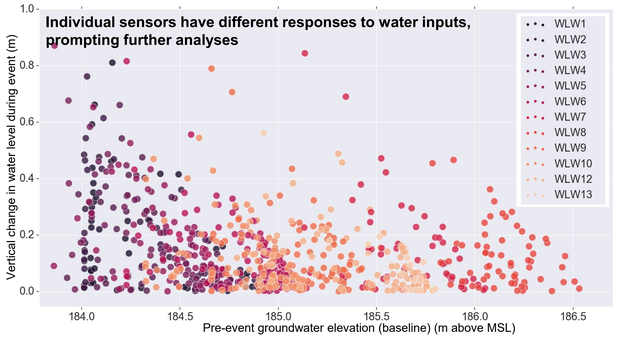
Instrumentation and data:
- 23 water level sensors in surface and subsurface, 3 years
- Soil moisture (surface and 1-m profile), 2 years
- Precipitation (local and regional)
- Air and water temperature

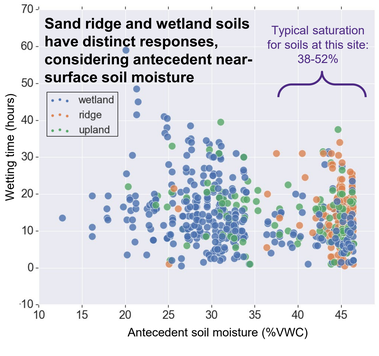


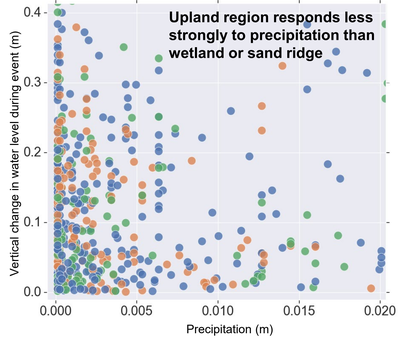


Above: Sample of events identified for these analyses

The above-shown time series is an example of typical well behavior in GMP. At left is an example of an event identified in this time series. Python was used to extract each peak and calculate statistics including duration of wetting, water table rise, and relaxation curve slope, following established methods for hydrograph analysis. For each peak, we identified the corresponding precipitation event (up to 24 hours in duration) and near-surface soil moisture (top 40 cm). This resulted in 647 peaks for which soil moisture and rain data were available. Multivariate analysis was used to identify trends and correlations between extracted statistics and antecedent conditions.



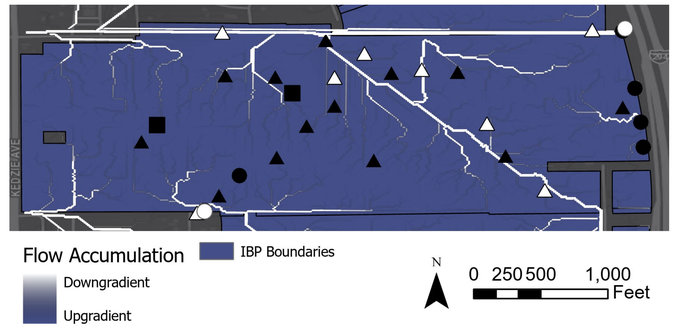




Soil moisture is a good gauge of available subsurface stormwater storage. Timing of this infiltration can depend on soil porosity and on surface connectivity within the prairie. Longer surface flow paths result in delayed arrival of stormwater in the wetland.

Conclusions and Further Questions

At GMP, stormwater storage is influenced by antecedent conditions, including water level and soil moisture. Storage capacity within the prairie is largely in the ephemeral wetland, which provides longer-term surface storage in the winter and spring and subsurface storage in the summer and fall. Although the wetland and sand ridge are capable of storing comparable water volumes during precipitation events of similar magnitude, infiltration in the wetland is considerably slower. It is important to understand that the presence of standing water in the prairie does not imply that storage is at capacity and the prairie is able to continue receiving stormwater runoff after a major storm event.



Continuing challenges and ongoing work:
- Consider sensor position within the prairie and proximity to main flowpaths (above) or major features
- Account for undersampling in the sand ridge during summer and fall due to dry sensors
- Quantify snow water volume and consider the effects of of rain-on-snow events
- Develop sitewide map of characteristic response to a storm of a given intensity and duration
- How does this prairie (GMP) compare to other greenspaces* experiencing the same weather events?

*visit Colleen's poster, #H35E-1081

Acknowledgments:
- **NSF EAR-1541891**
- **NSF RAISE #1848683**

The Nature Conservancy

Contact:
Vivien Rivera
vivienr@u.northwestern.edu
Questions? Scan me!