Urbanized watersheds have higher low flows than forested watersheds in the Eastern U.S.

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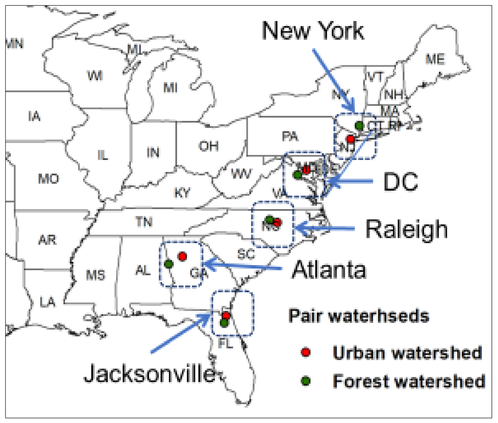
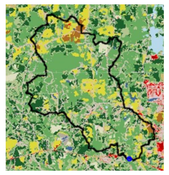
OBJECTIVES

- **Empirically quantify the differences in streamflow patterns and water balances using a quasi-paired watershed approach across a diverse hydroclimatic gradient in the eastern U.S.**
- **Explore how ET and ISA processes explain the hydrologic differences identified**
- **Provide fundamental knowledge about the benefits of forests in mitigating storm runoff and baseflow/low flow at multiple scales for managing urban watersheds.**

Quasi-paired Urban-Forest Watersheds in Eastern U.S.



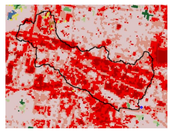
Paired Watersheds Raleigh, NC (example)



Forest watershed

Deciduous Forest
Evergreen Forest
Mixed Forest

Drainage area: 21.62 km²
Forest cover 72%
Developed area: 12%



Urban watershed

Developed, Open Space
Developed, Low Intensity
Developed, Medium Intensity
Developed, High Intensity

Drainage area: 3.0 km²
Developed are: 99%

DATA & METHODS

- **Quasi-Paired Watershed Study: Small USGS gaged watershed with similar climate and close proximity**
- **Sites span across a large latitudinal gradient with different temperature and forms of precipitation, and vegetation phenology**
- **Monthly ET estimated from SSEBop methods (Senay et al., 2013, JAWRA)**

Hypotheses: ET-Infiltration Tradeoff

- **Forested watersheds have higher ET due to higher vegetation coverage and leaf area index (LAI)**
- **Urbanized watersheds have higher impervious surface area (ISA), but lower infiltration capacity, and lower ET**
- **Magnitude/timing of baseflow and lowflow are controlled by the combination of ET and storage capacity of the watershed**

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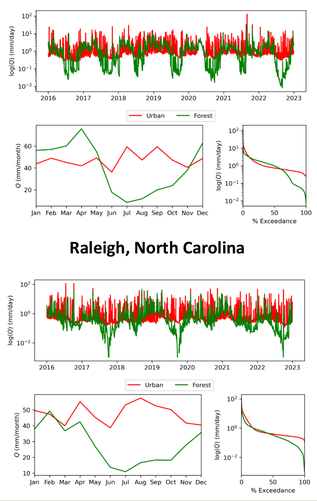
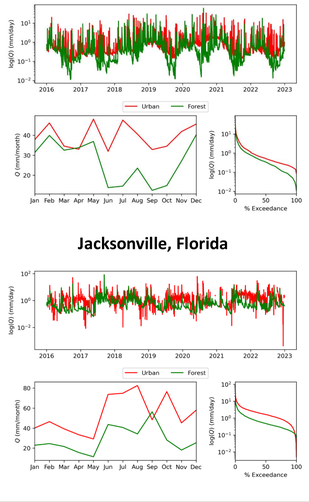
Results

A Comparison of Daily and Monthly Streamflow Patters across a Climatic Gradient

Elizabeth, New Jersey (Urban) and New York (Forest)

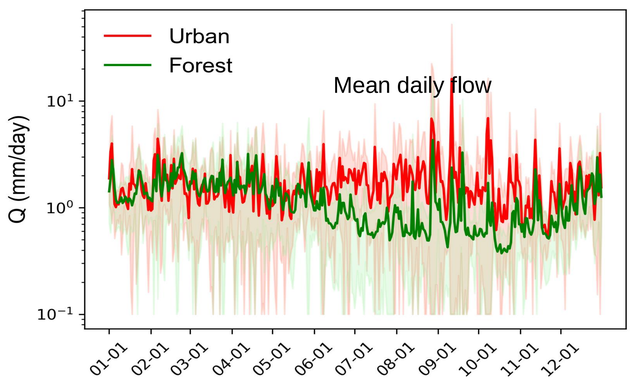


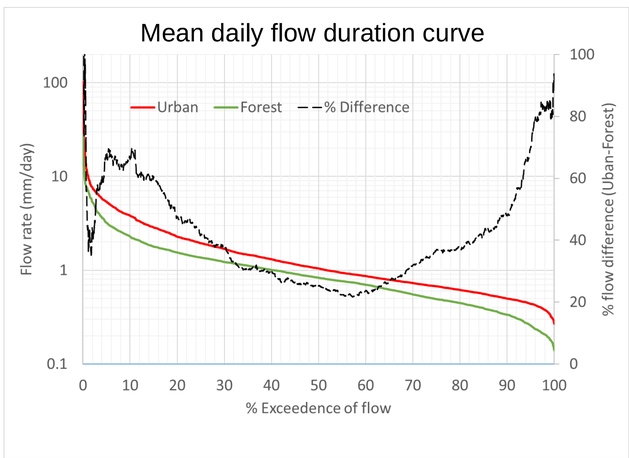
Washington DC



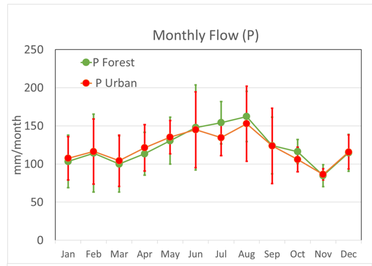
Raleigh, North Carolina

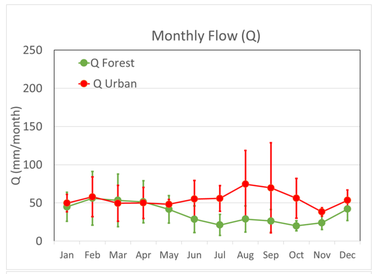
Jacksonville, Florida

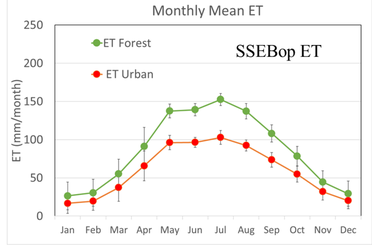


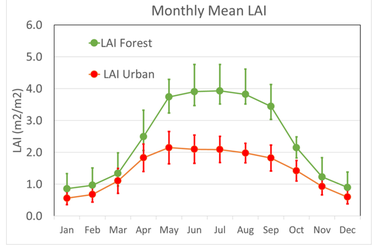


A Comparison of Monthly Water balances

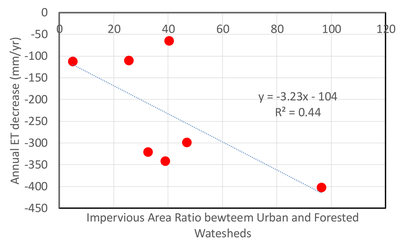


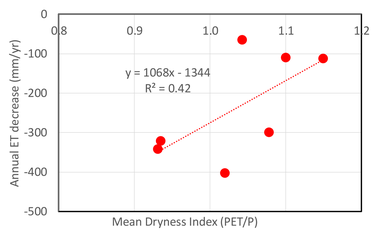






Environmental Controls on ET Decrease in Urban Watersheds





Difference in annual ET = 1146.3 -0.84 P - 4.1* IMR R^2=0.86 p=0.0193, n=7
IMR= impervious areas ratio (urban/forest ISA); P = precipitation (mm/yr)

KEY FINDINGS

- ✓ **Streamflow in urban watersheds are 1.5 higher than in forested watershed in the growing seasons due to their lower ET rates; differences in ET are larger in wetter regions with higher ISA differences.**
- ✓ **Forests can mitigate hurricane flooding impacts due to their higher ET in forests resulting higher antecedent water storage in the growing season.**
- ✓ **Streamflow in forested watersheds is more variable seasonally than urbanized watersheds and less variable at daily/event scale.**
- ✓ **Forests play a 'soil sponge' role through their large 'water pump' functions.**
- ✓ **Urban planning should include ET – 'biological drainage' functions in addition to consideration of impervious surfaces areas (ISA).**