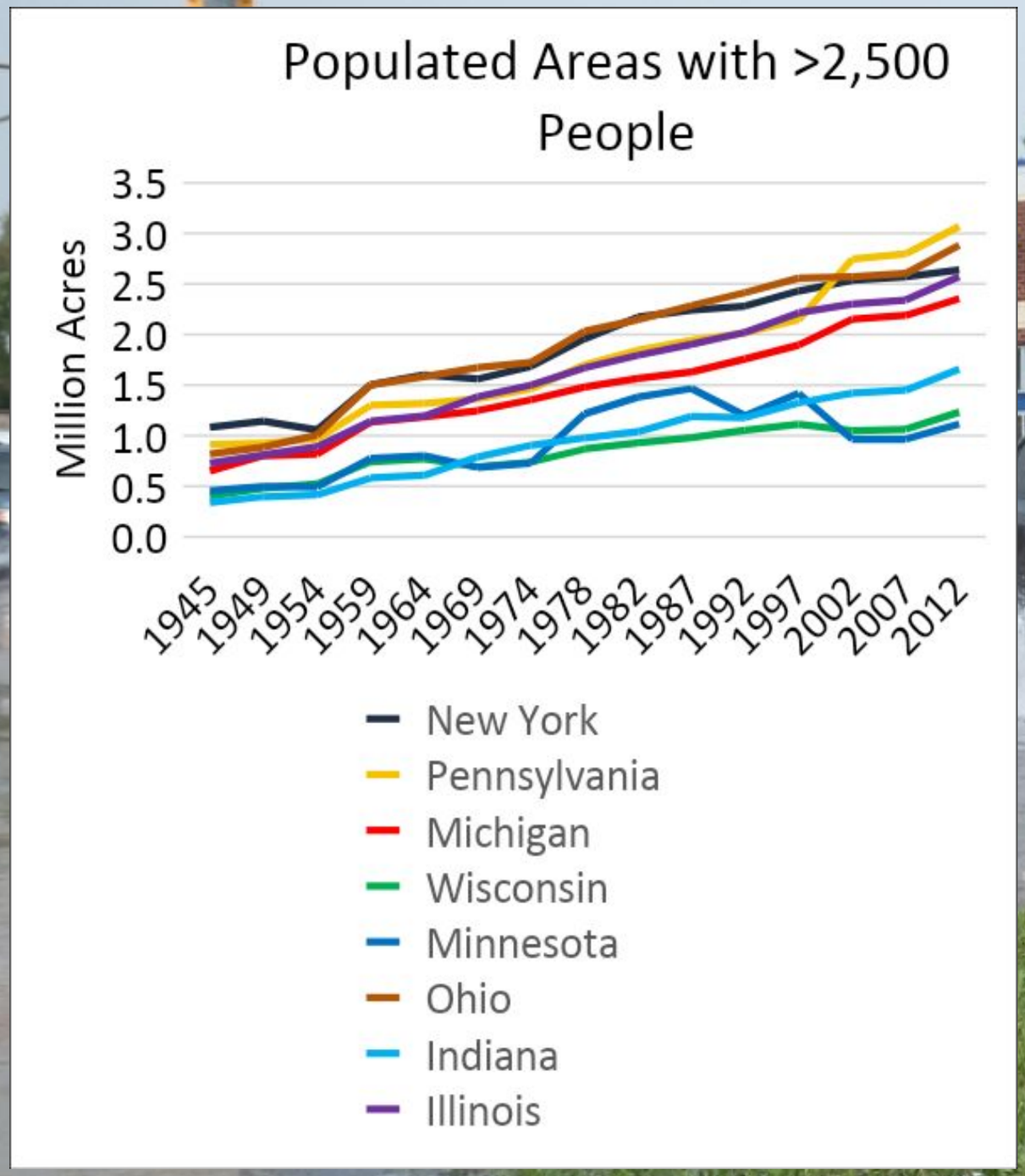
Assessing Stormwater Volume Reduction by Urban Trees

Funded through the Great Lakes Restoration Initiative

Urban Stormwater



Madison.com

Source: USDA Economic Research Service

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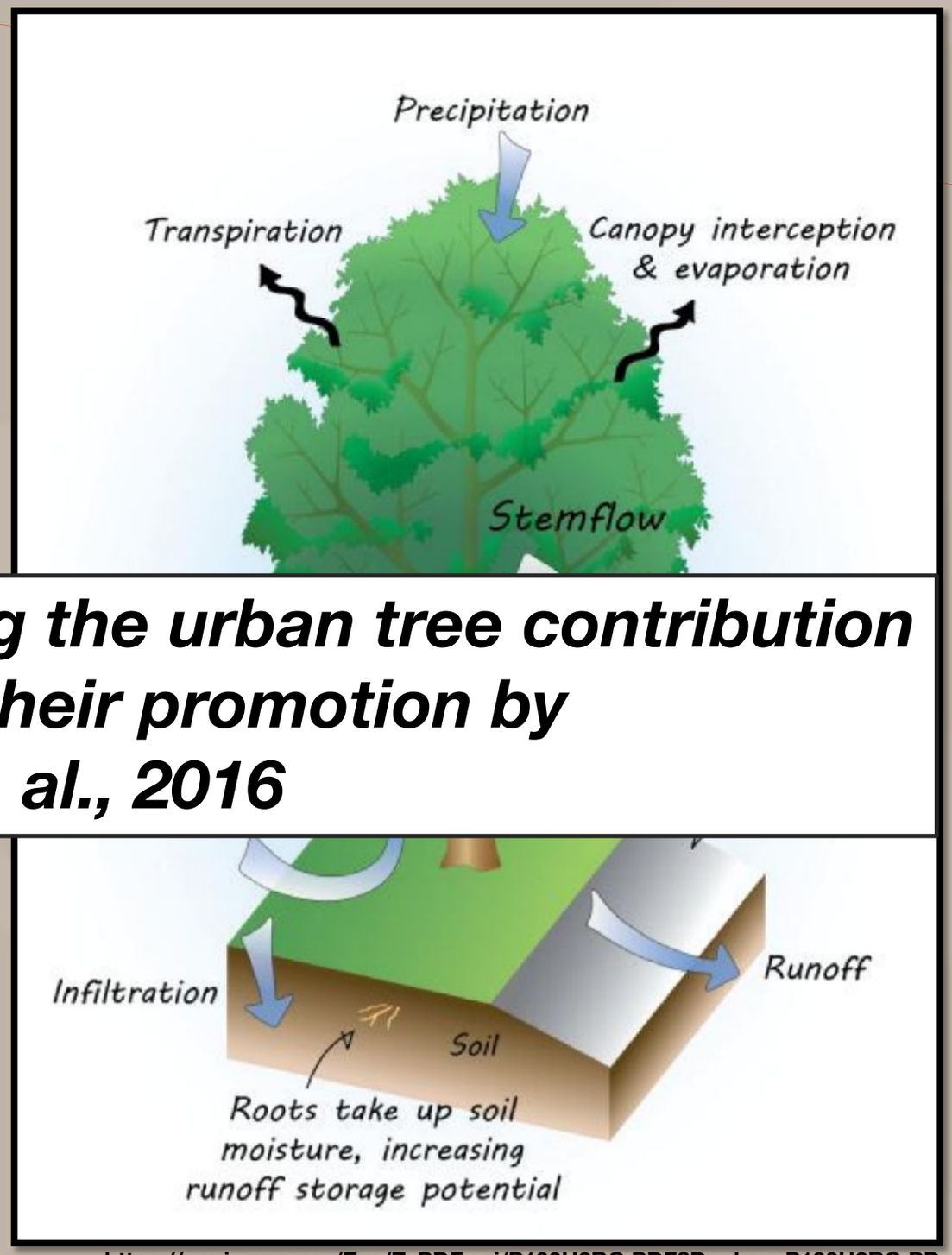
Trees are an increasingly important part of stormwater management

- Washington D.C. – 46% tree canopy reduces need would have to contend with 19 million additional cubic feet of stormwater
- California Central Valley – For every 1,000 trees, stormwater is reduced by 1 million gallons



"…inadequate research quantifying the urban tree contribution to rainfall/runoff processes limits their promotion by stormwater managers" Kuehler et. al., 2016

https://nepis.epa.gov/Exe/ZyPDF.cgi/P100H2RQ.PDF?Dockey=P100H2RQ.PDF

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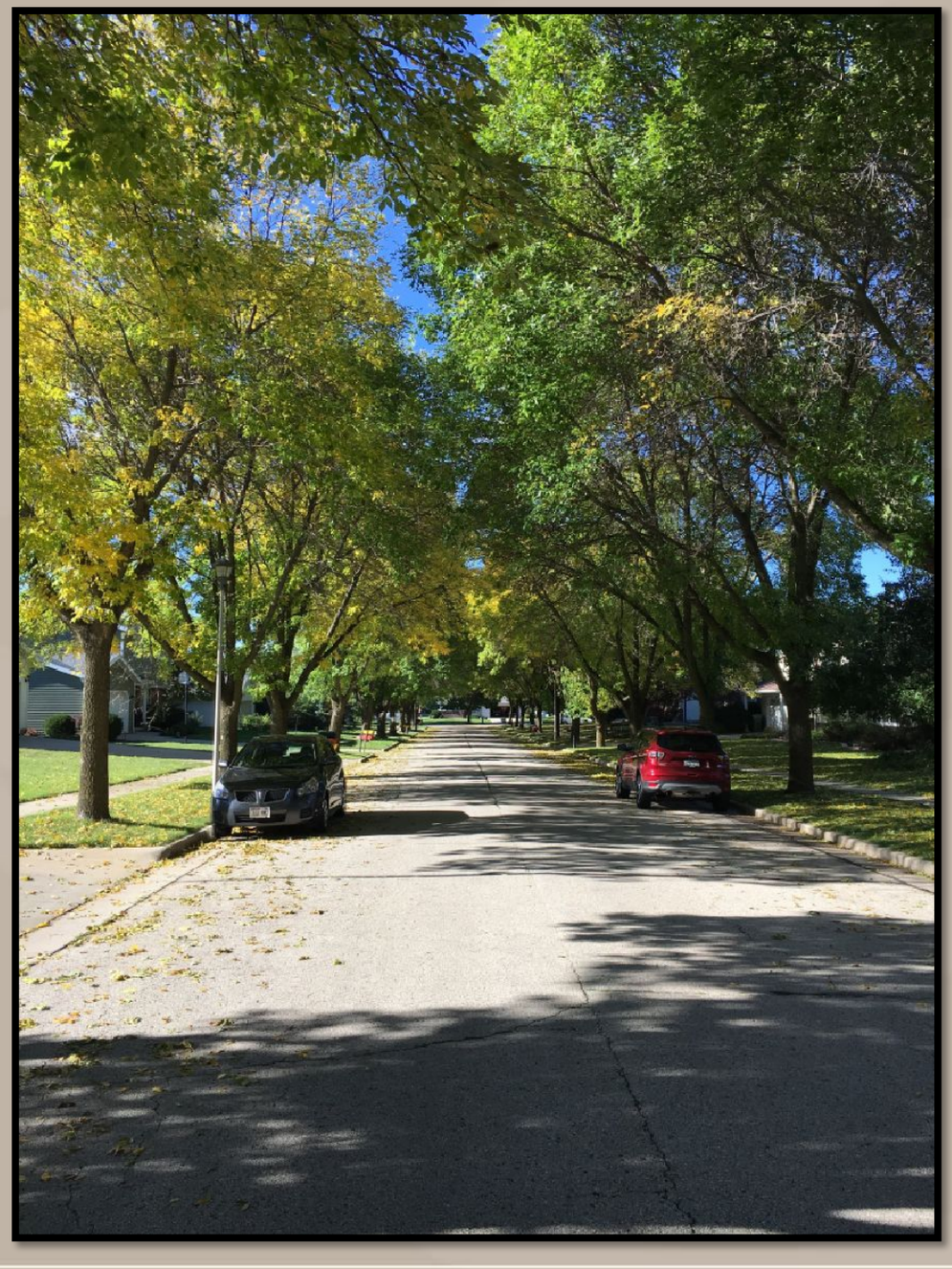
Runoff Reduction by Trees: Highly Variable and Difficult to Measure

Great Lakes RESTORATION

"The standard conversion factor of 59 gallons per tree per year and 18 gallons per tree seedling and shrub established will be used for purposes of review"

- Final report will use i-Tree or National Tree Benefit Calculator



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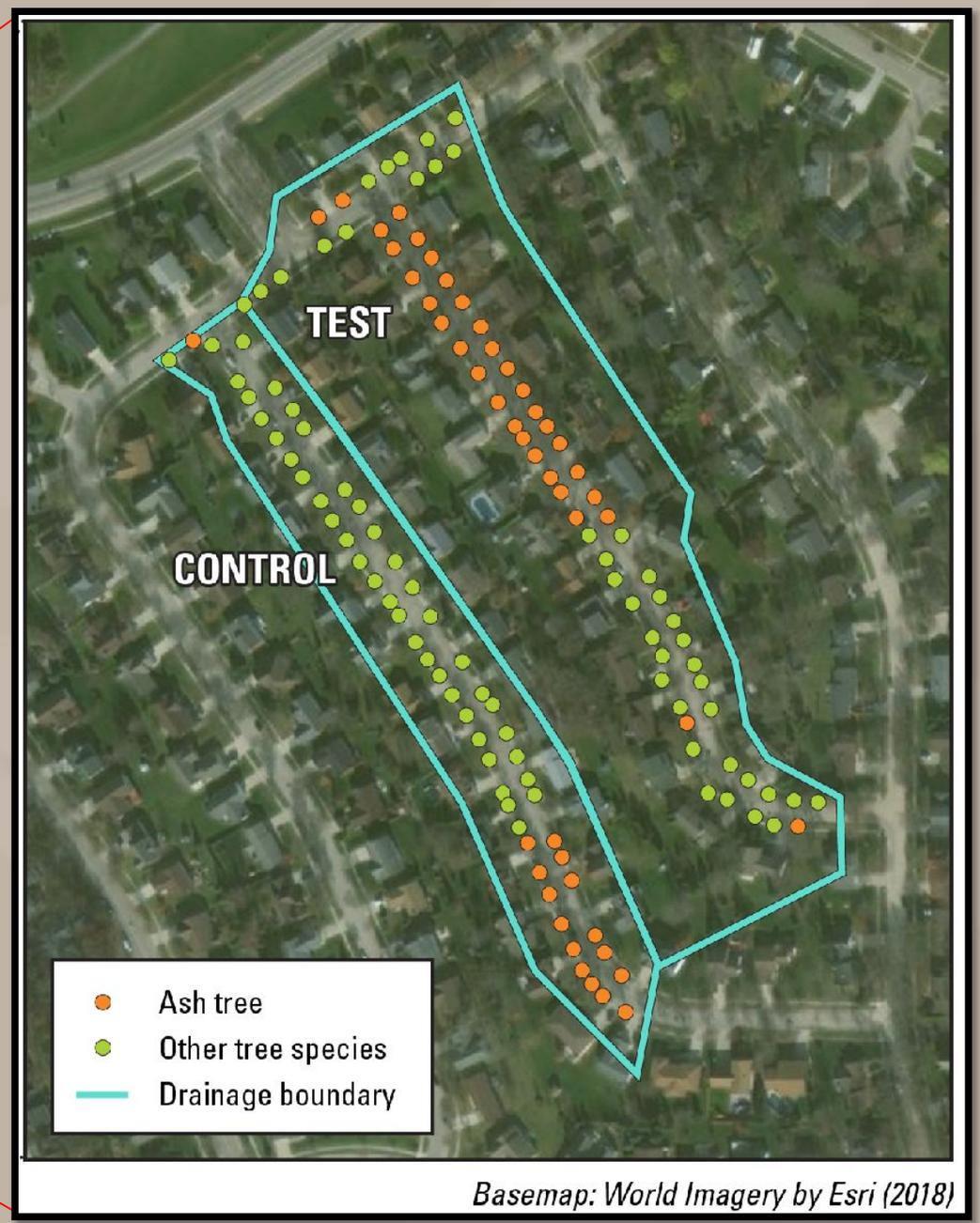
Great Lakes Restoration Initiative - Lake Michigan Drainage Basin

Fond du Lac, WI

This study will use a paired-basin approach to characterize the impact of tree removal on stormwater runoff characteristics from two medium-density residential catchments



Basemap: World Imagery by Esri (2018)

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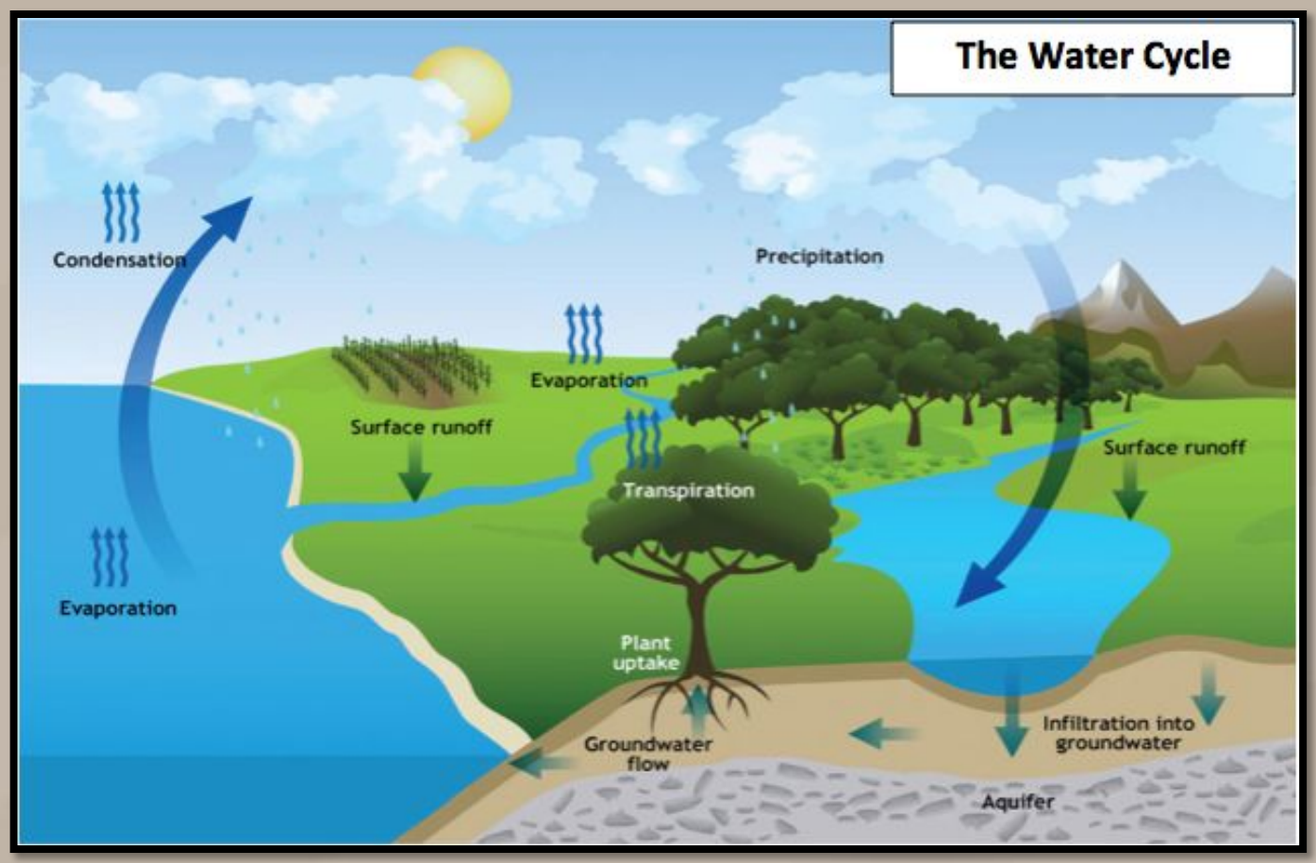
Trees as Part of the Urban Water Balance



https://www.treesmatter.org/STBlog/3250197

- Measure components of the urban water balance
- Apply measurements to improve models (i-Tree)

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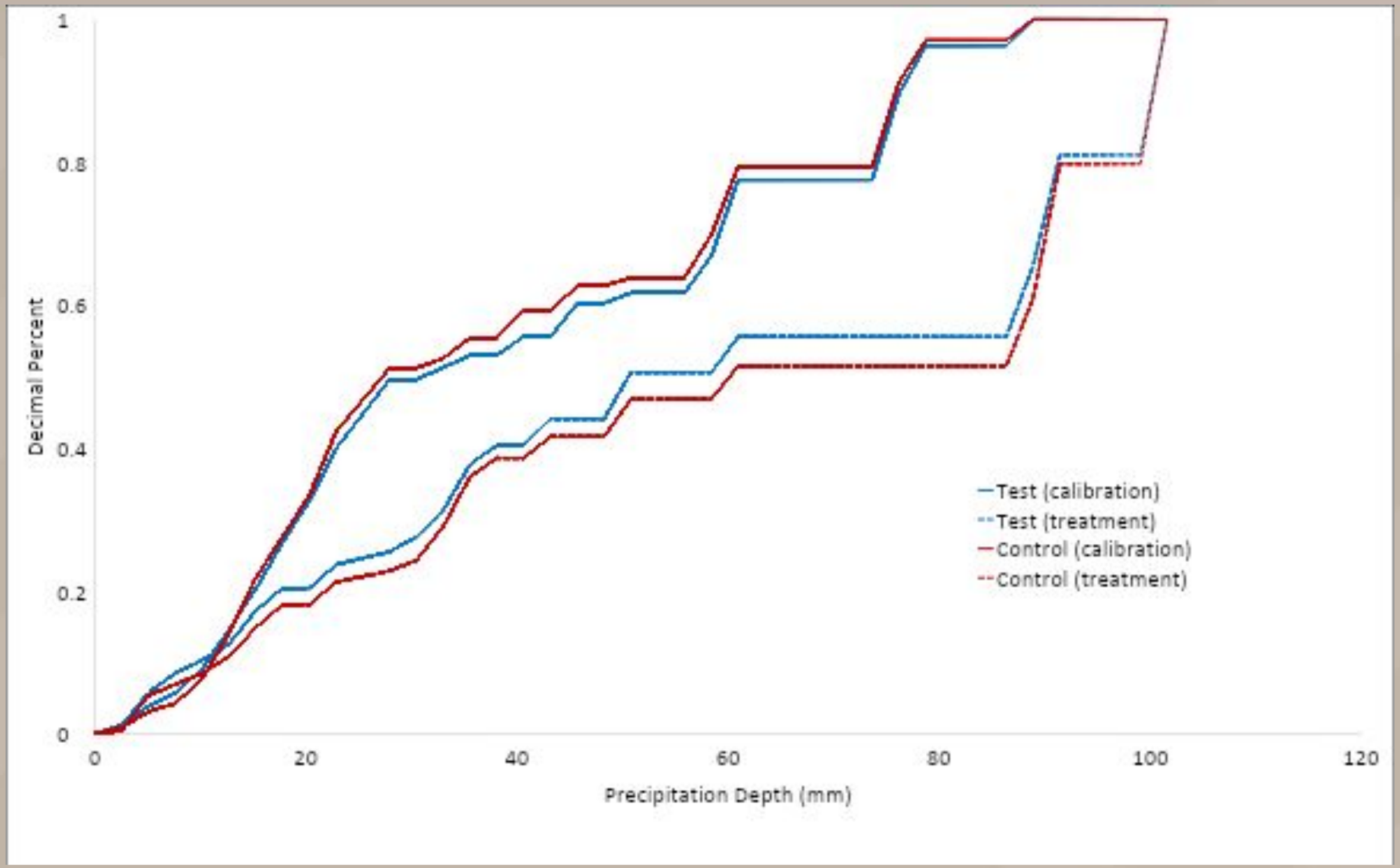
Cumulative Distribution of Runoff Volume



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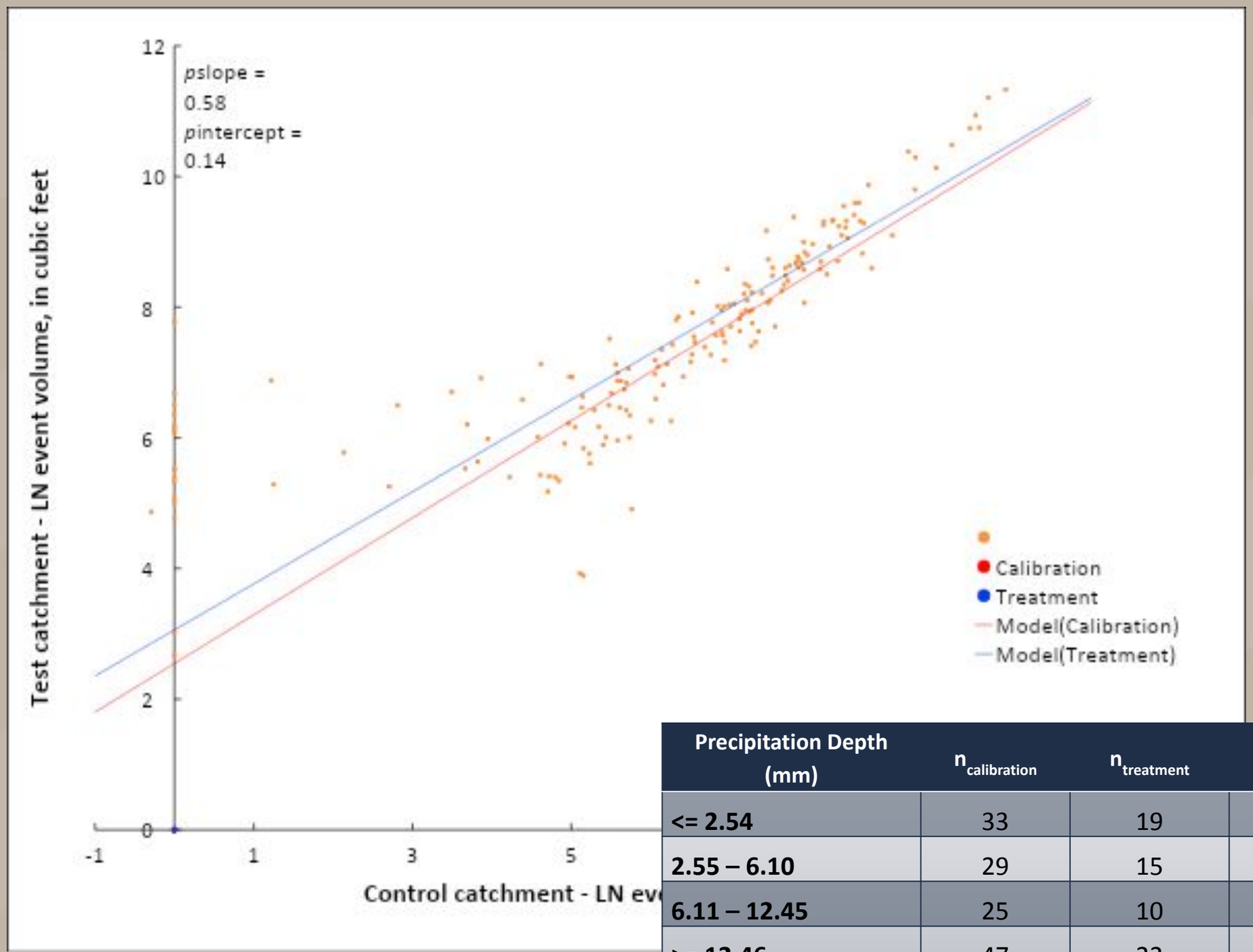

Precipitation Depth (mm)	$n_{calibration}$	$n_{treatment}$	p_{slope}	$p_{intercept}$	Percent Change
<= 2.54	33	19	0.56	0.68	169
2.55 – 6.10	29	15	0.15	0.04	115
6.11 – 12.45	25	10	0.16	0.15	16
>= 12.46	47	22	0.74	0.02	23
All events	130	64	0.58	0.14	66

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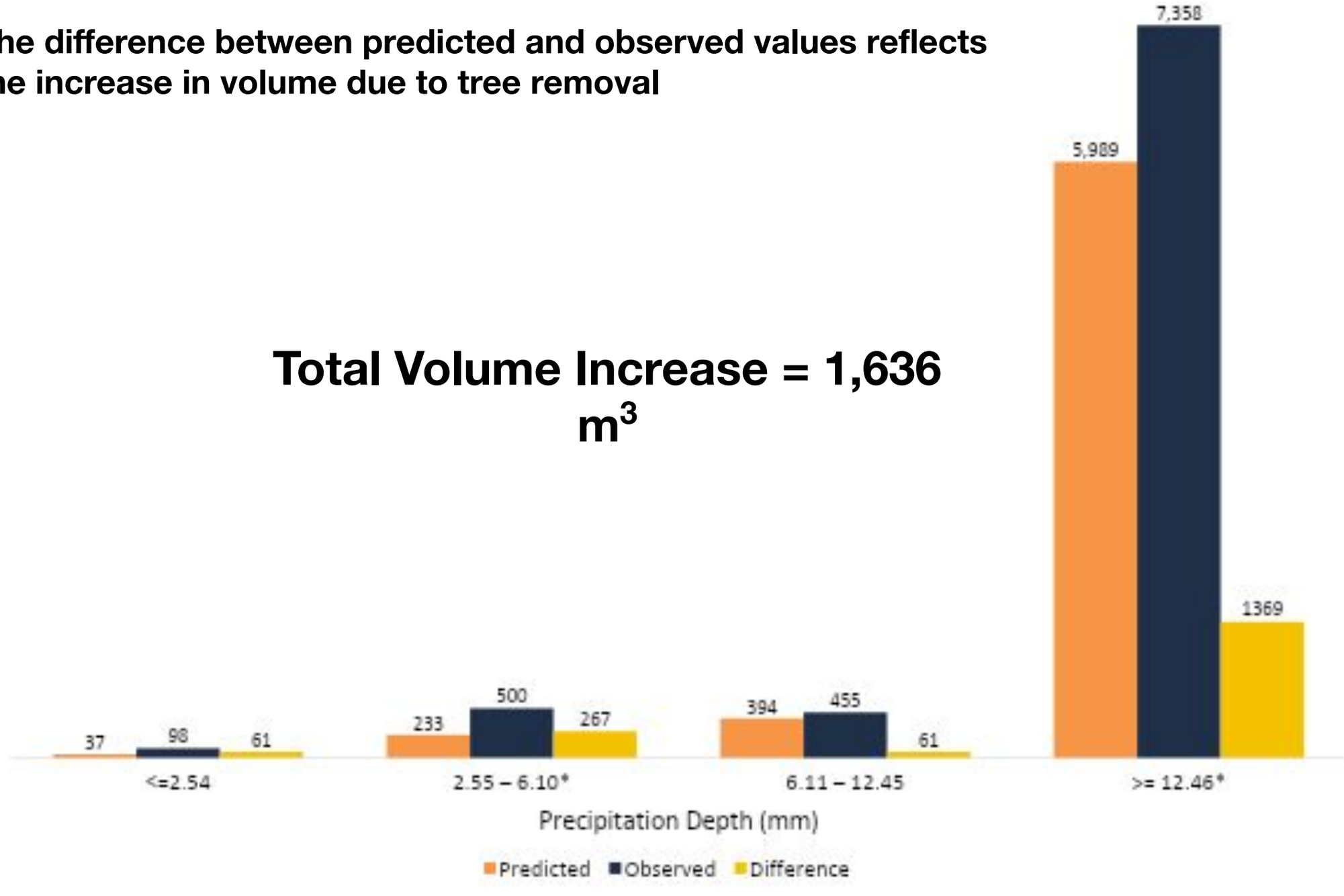
Predicted vs. Observed Runoff Volumes

The difference between predicted and observed values reflects the increase in volume due to tree removal

Total Volume Increase = 1,636 m^3



1,636 m^3 = 19% of total runoff

2,990 m^2 of canopy = 574 liters/m^2

31 trees removed = 52,774 liters/tree

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37.8 in

43
%

32,184 ft^2

57
%

432,185 gal = 19% of total runoff

32,184 ft^2 of canopy = 14 gal/ft^2

31 trees removed = 13,941 gal/tree

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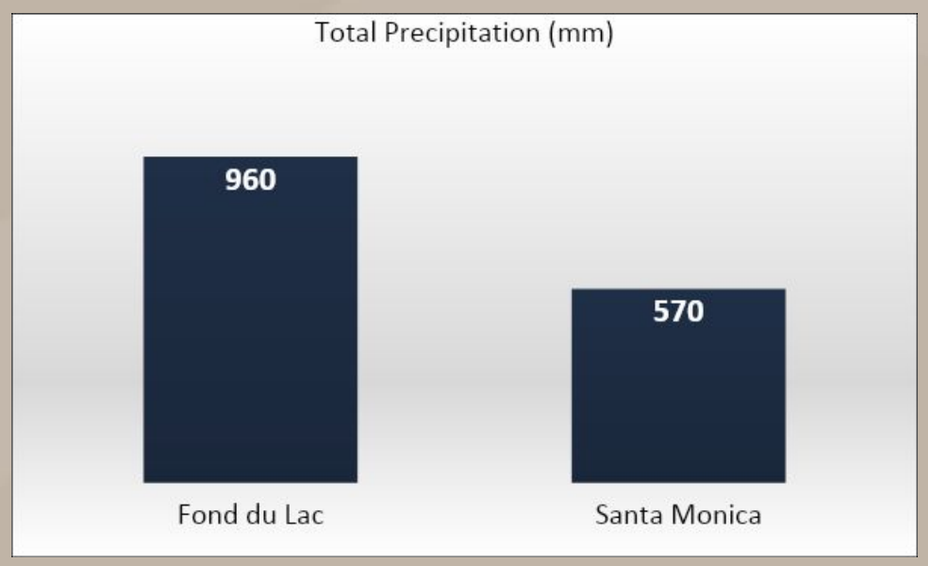
Comparison to Previous Studies

Location	Annual Per Tree (m^3)	Interception (%)	Method
Fond du Lac, WI	52.7	43	Measured
Vancouver, BC	--	49-61	Measured
Melbourne, Aus.	--	29-44	Measured
Oakland, CA	--	14-27	Measured
Santa Monica, CA	6.6	27-65	Modeled
Modesto, CA	3.2	--	Modeled
Montgomery County, MD	7.6	--	Modeled
Cincinnati, OH	6.7	--	Modeled



- **High variability among diversity of species, age, structure, etc.**
- **Annualized volume reduction per tree may be too general**
  - **Volume reduction as percent of annual precipitation is better**
  - **Volume reduction per unit area of canopy worth exploring**

U.S. Forest Service: i-Tree Modeling

- Calibrate i-Tree Hydro using hyperlocal weather and discharge data
- Simulate discharge with and without tree cover
- Validate model predictions with post-tree removal discharge observations
- Assess performance and identify necessary improvements to i-Tree

Figure 1. GIS assessment of land cover

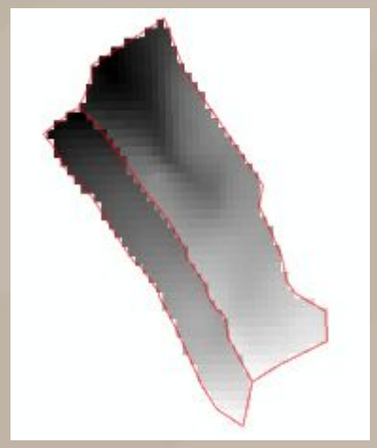


Figure 2. GIS assessment of topography

Table 1. Preliminary estimate of change in surface runoff with loss of trees

Basin Name	Preliminary Estimate of Change in Runoff if All Trees are Removed [a]
Holly Tree lane Basin	+93.5 m^3 (+1.32% of base case surface runoff)
Birch Tree Lane Basin	+186.7 m^3 (+1.36% of base case surface runoff)

[a] Difference in surface runoff if current tree canopy % in each area is converted to the land cover that was beneath that canopy, either herbaceous or impervious cover.

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Upper Midwest Water Science Center

Monitoring and predicting the impacts of trees on urban stormwater volume reduction

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Much has been learned about how effectively individual green infrastructure practices can reduce stormwater volume, however, the role of urban trees in stormwater detention is poorly understood. This study will quantify the effect of tree removal on the urban hydrologic cycle and measure the impact that trees have on stormwater runoff volume.

BACKGROUND

The use of green infrastructure in urban areas has increasingly been accepted as a means to reduce adverse impacts of stormwater on sewer systems that service Great Lakes communities, and to a larger degree, Great Lakes water quality. Over the last decade, much has been learned about how effectively individual green infrastructure practices can reduce stormwater volume; however, one element that remains poorly understood is the role of urban trees in stormwater detention. Research is needed to provide quantitative data on how trees affect the urban water cycle through their unique influence on storage and losses such as throughfall, evapotranspiration and subsurface flows, in particular at the different spatial scales and complex urban mosaics in which bioretention and street trees are planted. While there is a body of evidence to suggest trees are an integral part of urban watershed management, few field studies have quantified the stormwater volume reduction capabilities of urban trees, and in the context of the whole-water cycle. A synthesis of past research by Kuehler et al. (2016) and Berland et al. (2017) revealed that several knowledge gaps remain on the role of trees in stormwater management. Many of these gaps center around the need for a more holistic understanding of urban tree canopy,

Status - Active

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