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Integrating a canopy interception spreadsheet tool with WinSLAMM for site stormwater design: potential water quantity and quality benefits

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Presentation Overview

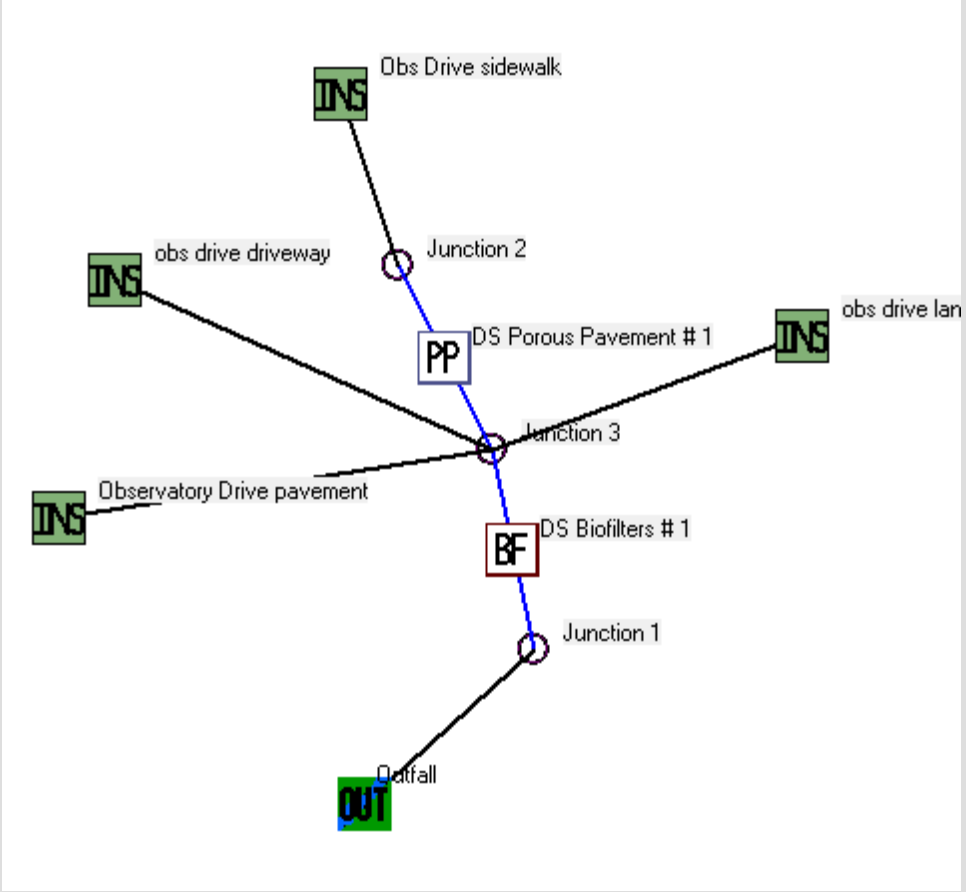
- UW Madison project walkthrough
- Review of WinSLAMM model
- Discussion of spreadsheet tool used to evaluate interception volume
- Incorporation into WinSLAMM and results
- SPREADSHEET EXERCISE
- Implications and potential future uses

Project Overview

- UW-Madison redevelopment stormwater study
- Stormwater control driven by MS4 permit & TMDL
- Evaluation of several stormwater BMPs
- WinSLAMM preferred model
- Asked to evaluate trees

WinSLAMM Model

- **Rainfall-runoff-pollutant loading model**
- **Widespread use & regulatory acceptance in Wisconsin**
- **Continuous rainfall model, 1981 series used in Wisconsin**
- **Doesn't model trees (yet)**



Model Inputs

- Complex Model
- Pollutant loading routines based on data
- Several inputs
  - Rainfall series
  - Pollutant probability distribution
  - Particulate solids concentration
  - Particle size distribution
  - Runoff coefficient data
  - Source area land use
  - BMP geometry, soil characteristics, outlets
  - Others

- Output
  - Pollutant load
  - Runoff volume
  - Treatment efficiency
  - Others
- Detailed output available
  - BMP-specific
  - Event-specific
  - Others

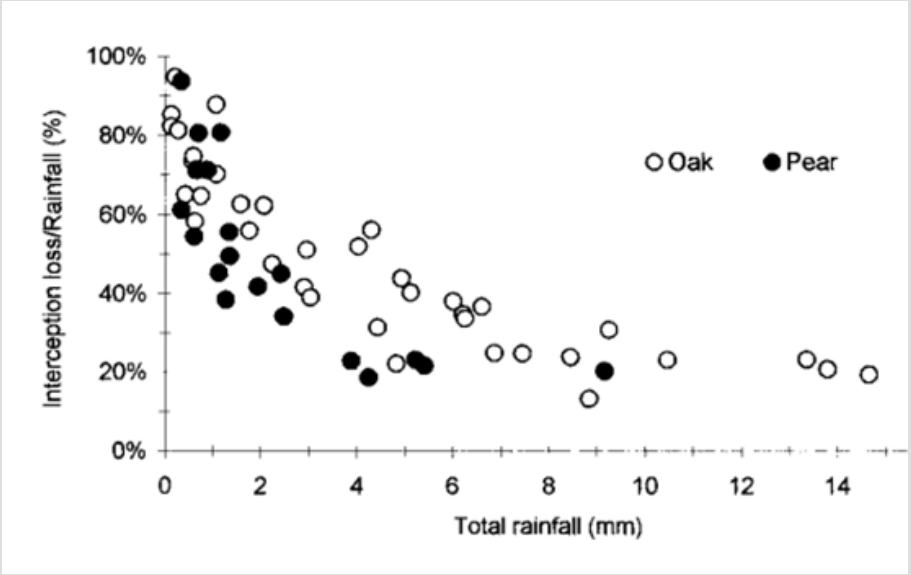
Tree Modeling Approach

- Proof-of-concept
- Integrate with WinSLAMM
- Modify rainfall input to simulate canopy interception
- Change in soil & runoff generation not simulated

(USEPA, 2016)

Tree Canopy Interception

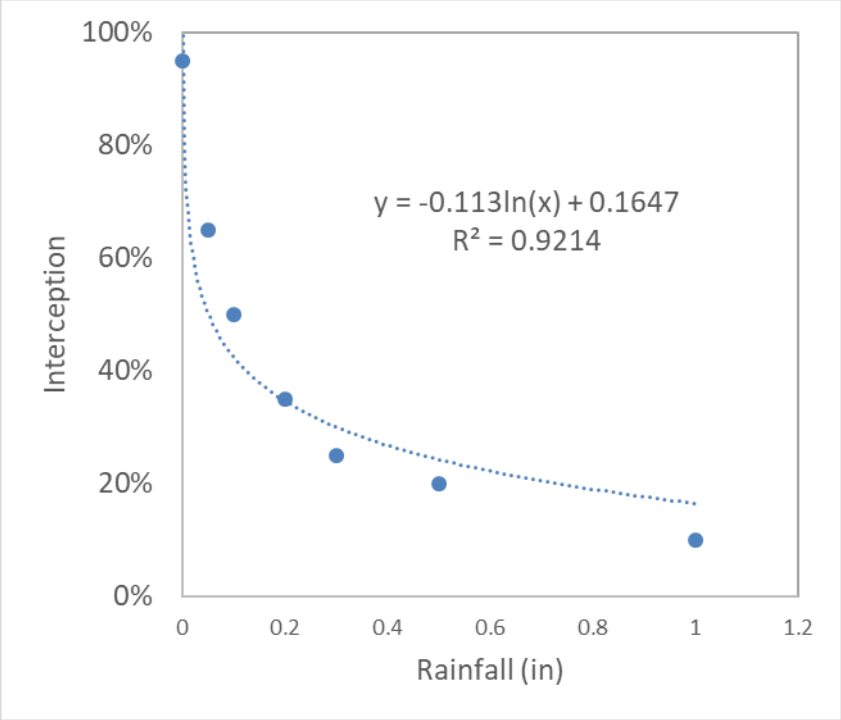
- Monitoring data from California study (Xiao et al., 2000)
- No Wisconsin data
- Literature indicates interception volume increases with rainfall
- Percentage of rainfall intercepted decreases with rainfall



(Xiao et al., 2000)

Modeling Interception

- Regression based on Xiao data
- Similar relationship in Belgian study (Staelens et al. 2007)
- Seasonal weighting for leaf growth

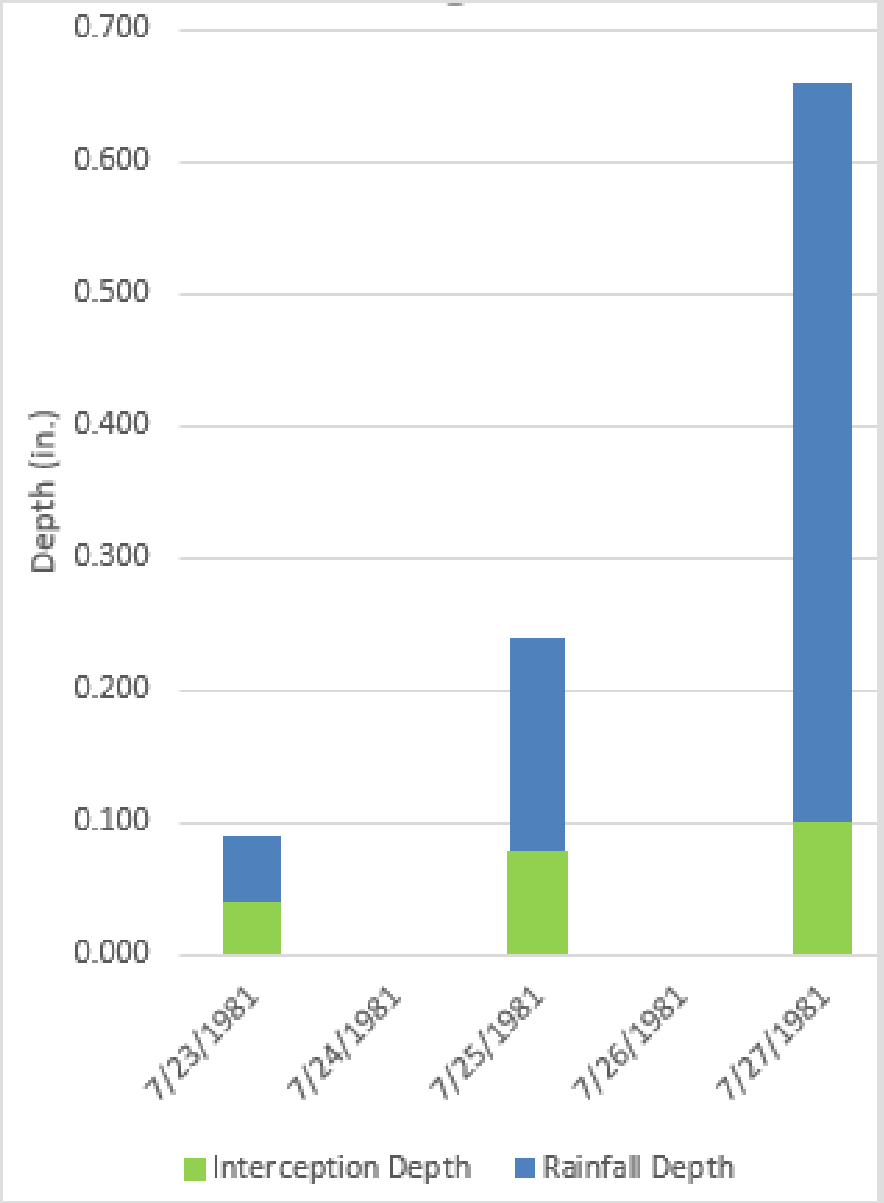


Some Limitations

- Based on limited data (but could easily refine with more / local data)
- Only considers areas with full canopy coverage
  - Rainfall data is a global input to model
- Does not consider antecedent moisture in the canopy

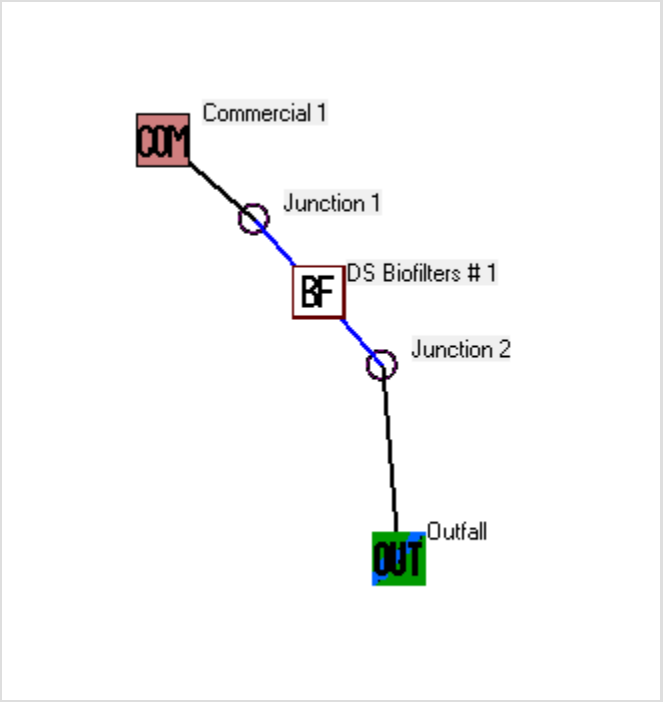
Interception Simulation

- Applied regression to 1981 rainfall series
- Assumed 0.1” maximum interception depth
- Reduced rainfall accordingly
- Interception volume approx. 12% of annual rainfall



Runoff Simulation

- Used edited rain file in WinSLAMM
- Source area annual runoff volume & TSS load reduced by 11% with tree cover
- Significantly improved “downstream” biofiltration performance



Biofilter Performance Simulation

- **Analysis to simulate retrofit**
- **Varied the following:**
  - **Biofilter area**
  - **Depth of engineered soil**
  - **Native soil infiltration rate**

BIOFILTER DETAILS			Runoff volume and TSS Reduction Resulting from Tree Canopy Cover
Area (ft^2)	Engineered Soil Depth (in)	Native Soil Infiltration Rate (in/hr)	
500	24	0.13	15.3%
1,000	24	0.13	17.0%
500	12	0.13	16.4%
1,000	12	0.13	15.9%
500	12	1.60	15.9%
1,000	12	1.60	15.5%
500	24	1.60	15.8%
1,000	24	1.60	15.8%

Spreadsheet Exercise

- **Excel workbook**
  - 4 annual rainfall series
  - Adjusts rainfall depth to account for interception
  - Seasonal modifier to account for leaf growth and leaf fall
- **Worksheet**

Implications for Design

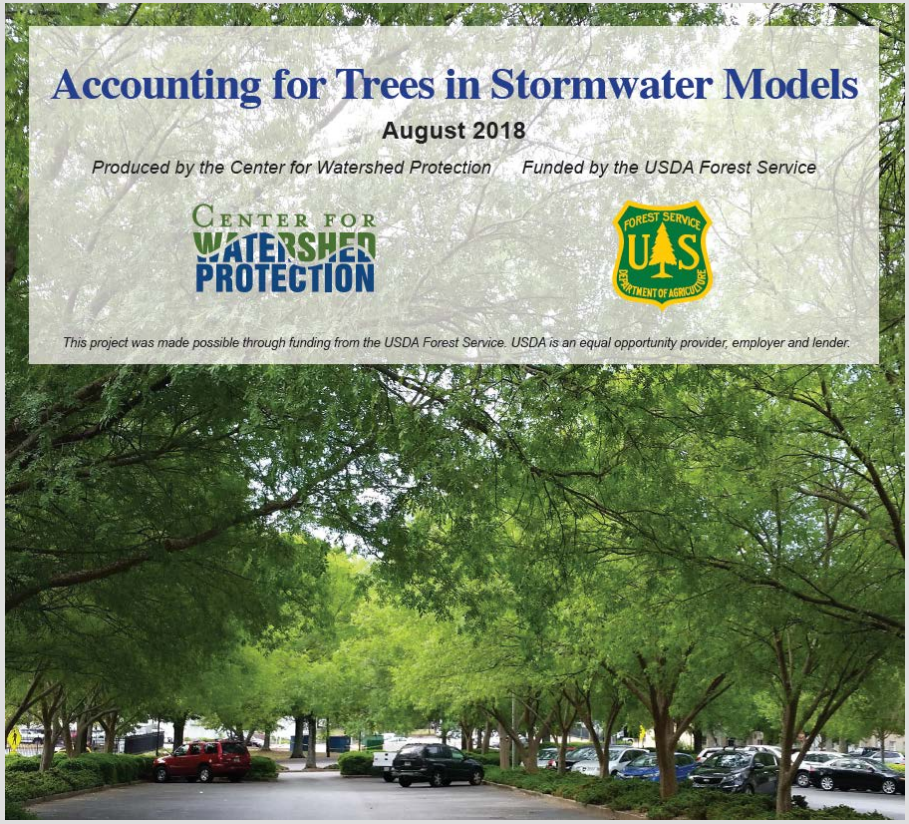
- Incorporate mature trees into development planning
- Long-term crediting programs
- Retrofits to incorporate trees for stormwater benefits where other BMPs are not feasible
- Use trees to augment existing stormwater BMPs

Next Steps

- **More local data**
  - **Water quality**
    - **Seasonal P inputs**
  - **Runoff volume**
  - **Runoff peak discharge**
  - **Long-term BMP performance**
    - **Leaf litter clogging**

Next Steps

- **Expand on existing tools for ‘proof-of-concept’**
  - **CWP and US Forest Service tools**
  - **Guidance on how to incorporate trees into commonly used stormwater models**



Next Steps

- **Emphasize need for updates to include trees in models**
  - **Trees influence multiple aspects of water balance**
  - **Partial canopy coverage**
  - **Canopy location**
  - **Long-term analysis to account for tree growth**

For instance, in WinSLAMM: Incorporate tree canopy as a control practice?

Source Area #	Source Area	Area (acres)	Source Area Parameters	First Control Practice	Second Control Practice
	Roofs	0.000			
1	Roofs 1				
2	Roofs 2				
3	Roofs 3				
4	Roofs 4				
5	Roofs 5				
6	Roofs 6				
7	Roofs 7				
8	Roofs 8				
9	Roofs 9				
10	Roofs 10				
11	Roofs 11				
12	Roofs 12				