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

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water | ecology | community
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

![Graph showing interception as a function of rainfall with equation and R² value.]
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

<table>
<thead>
<tr>
<th>BIOFILTER DETAILS</th>
<th>Engineered Soil Depth (in)</th>
<th>Native Soil Infiltration Rate (in/hr)</th>
<th>Runoff volume and TSS Reduction Resulting from Tree Canopy Cover</th>
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<tbody>
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<td>Area (ft²)</td>
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</table>
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?