Webcast sponsored by EPA’s Watershed Academy

Speakers:
• Dr. Anthony Aufdenkampe, Senior Environmental Scientist, LimnoTech
• Dr. Barry M. Evans, Senior Research Associate, Penn State University and Adjunct Faculty member at Stroud Water Research Center
• Bill Brown, Chief, TMDL Development Section, Pennsylvania Department of Environmental Protection

Thursday, March 9, 2017
1:00pm – 3:00pm Eastern

Webcast Logistics

• To Ask a Question
  • Type your question in the “Questions” tool box on the right side of your screen and click “Send.”

• To Report any Technical Issues
  • such as audio problems
  • Type your issue in the “Questions” tool box on the right side of your screen and click “Send” and we will respond by posting an answer in the “Questions” box.
Speakers

- **Dr. Anthony Aufdenkampe**, a Senior Environmental Scientist at LimnoTech in Minnesota. He serves as the project manager for *Model My Watershed* at Stroud Water Research Center.

- **Dr. Barry M. Evans**, a Senior Research Associate at Penn State University and Adjunct Faculty Member at Stroud Water Research Center. He is the author of the (MapShed) model that has been incorporated into the Model My Watershed online tool.

- **Bill Brown**, who is Chief of the TMDL Development Section at Pennsylvania’s Department of Environmental Protection.

Overview of Today’s Webinar

- WikiWatershed and the Model My Watershed Web App
  - Motivation & Vision
  - Delaware River Watershed Initiative (DWRI)
- “Site Storm Model” in Model My Watershed
  - Introduction and Micro Site Storm Model
  - Case Study A: Conservation Scenario vs. Development Scenario
  - Case Study B: Preliminary Conservation Planning
- “Multi-Year Watershed Model” in Model My Watershed
  - Introduction to MapShed (GWLF-E)
  - Incorporation of Core MapShed Components into Model My Watershed
  - Case Study C: Watershed Improvement Plan (WIP) Based on Prior TMDL Assessment
  - Case Study D: Simple MS4 Application
  - Case Study E: More Comprehensive MS4 Application
- WikiWatershed into the Future
  - Big Water Data: Visualization & Analytics for Everyone
Model My Watershed

Project Team

Anthony Aufdenkampe, David Arscott, Melinda Daniels, Steve Kerlin, Tara Muenz, Barry Evans
Robert Cheetham, Matt McFarland, Arianna Robbins
David Tarboton, Jeffrey S. Horsburgh, Emilio Mayorga, Scott Haag, Ali Shokoufandeh
Nanette I. Marcum-Dietrich, Millersville Univ.; Carolyn Staudt, Concord Consortium

Model My Watershed

Project Support

William Penn Foundation
National Science Foundation • grants DRL #0929763 & DRL #1418133
Stroud Water Research Center
Virginia Wellington Cabot Foundation
The Dansko® Foundation
Generous donations from Peter Kjellerup and Mandy Cabot
The Future of Water Protection

- Information and knowledge are foundations of a functional democracy.
  - Informed citizenry is key to protecting watersheds, but …
  - It is presently nearly impossible to get a complete picture of information and data from the dozens of federal, state, municipal, academic and volunteer sources.
- Can we harness the power of Wikipedia, Facebook and Google Earth to bring people together to share information?

WikiWatershed

A Web toolkit to support citizens, conservation practitioners, municipal decision-makers, researchers, educators, and students to collaboratively advancing knowledge and stewardship of fresh water.
Three Programs

• Model My Watershed® – a watershed-modeling Web app to:
  • analyze real land cover, soil and other geospatial data,
  • model storm water runoff and water quality, and
  • compare conservation or development scenarios in your watershed

• Monitor My Watershed® – an new Web app (late 2017) for:
  • interactive map-based discovery, visualization, and sharing of data
  • from federal, state, academic and citizen sources; and
  • resources to assist citizens to monitor their watersheds using
    low-cost monitoring approaches based on sound science (EnviroDIY)

• Manage My Watershed® – a envisioned social networking
  Web app to support a community of practice for the protection of
  freshwater resources and to engage citizens with policy-makers.

MMW Web Application

• Decision Support System for water conservation
  • Rapid visualization of watershed data
  • High-performance geospatial analysis capabilities
  • Science-based predictions of human impacts on
    stormwater runoff and water quality

• Intuitive user interface & satisfying user experience
  from any web browser

• Easy to share watershed-model scenarios,
  watershed-monitoring data

• Features for public and professional users alike
Delaware River Watershed Initiative

- A collaboration among >50 leading conservation organizations in DRB to:
  - protect tens of thousands of acres of land from development, restore streams,
  - test innovative approaches in ecologically significant places, and
  - monitor results over time.
- Funding: William Penn Foundation (WPF)
  - >$60M since 2014,
  - planning for a second phase

Introduction to Model My Watershed Data Visualization and Analysis
Web Demo

http://wikiwatershed.org
https://app.wikiwatershed.org

Introduction to Model My Watershed Site Storm Model
Site Storm Model: Core Components

- Simulates a hypothetical 24-hour storm
  - Total precipitation is variable
- Runoff model:
  - SLAMM: Source Loading and Management Model for Windows; urban small storm algorithms from Robert Pitts & WinSLAMM
  - TR55 for rural areas and large storms
- Water quality
  - EPA STEP-L: Spreadsheet Tool for Estimating Pollutant Load
- Compare Scenarios
  - Land cover change
  - Conservation practice / Best Management Practice (BMP) implementation

Case Study A:
Scenarios for Conservation vs. Development
Anytown, USA
Web Demo

http://wikiwatershed.org
https://app.wikiwatershed.org

Case Study B:
Preliminary Conservation Planning at Cooch’s Bridge
Web Demo

http://wikiwatershed.org
https://app.wikiwatershed.org

Questions?

WikiWatershed?
MMW Site Storm Model?
Case Study?
Overview of “Multi-Year Watershed Model” in Model My Watershed

Barry M. Evans, Ph.D.
Penn State University & Stroud Water Research Center

Bill Brown, Chief, TMDL Development Section,
Pennsylvania Dept. of Environmental Protection

Introduction to MapShed Desktop Application
Brief History

- **MapShed** is a “desktop” application that includes:
  - A GIS package for generating input parameters
  - The GWLF-E watershed simulation model

- Generalized Watershed Loading Function (GWLF) model
  - Substantially enhanced over 15 years to become GWLF-E
  - GWLF-E available within EPA BASINS model framework

- MapShed is an update of AVGWLF, which was:
  - Developed using ArcView 3.x software (AVGWLF)
  - Used by PA DEP and a number of other government and research organizations since 1999.
  - Efforts to re-configure to work in non-commercial GIS platform (MapWindow) began in 2010.
  - First “non-beta” version of MapShed released to public May 2012.

Core Components/Functions

- Pre-processor
  - used to overlay and manipulate GIS layers, weather files, and other data for purpose of creating input files for the core watershed simulation model (GWLF-E)

- GWLF-E model
  - run with prepared input files to estimate nutrient (N and P), sediment, and pathogen loads for a given watershed (or watersheds)

- BMP simulator
  - a module for evaluating the potential benefits of BMP implementation

- Other tools
  - to visualize, evaluate and compare model output
Use MapShed to create a project and load various data layers...
...then use MapShed to derive input data for the GWLF-E model

When input file has been prepared, open up the GWLF-E model
Review and edit input data

Run the GWLF-E model
Various types of annual, monthly and daily output created

All output written to Excel files to provide additional control in management and display of data
Input can be edited to reflect BMP implementation levels

Specify various BMP settings for a given scenario, and then re-run GWLF-E to estimate potential load reductions....
... and compare the results...
Incorporation of Core MapShed Components into Model My Watershed

Key Activities

• Re-produce *MapShed* geoprocessing routines in Model My Watershed
  • Translate routines and formats from MapWindow to Geotrellis/GDAL/PostGIS
• Re-program GWLF-E from Visual Basic to Python
  • For multi-user processing on Linux and Apache Spark
• Use national GIS and weather data
  • Rather than state or regional
• Compare model output
  • Desktop MapShed vs. MMW on Amazon Cloud
  • Using same input data
Additional Datasets for Watershed MultiYear Model (MapShed)

Weather Stations
USGS Base Flow Estimates (Soon)

Soil Nitrogen Estimates (Soon)
New Weather Station Data (Soon)

USDA Cropland Layer (Soon)
Case Study C: Watershed Improvement Plan (WIP) Based on Prior TMDL Assessment

Basic Steps

• Run model to estimate pollutant loads from various sources for purpose of evaluating where focus should be with respect to future remediation efforts.
• Once loads have been identified and quantified, use MMW to simulate load reductions from various BMPs and remediation measures to assess potential load reductions that might be achieved.
TMDL Results

- Stream impairments primarily caused by siltation and nutrient enrichment from agricultural sources.
- Analysis determined that Total P should be reduced by 38% and Sediment should be reduced by 44%.
- Various assessments are now being made as to where BMP implementation may be most effective in achieving these reduction targets as part of an ongoing Watershed Improvement Plan (WIP).
- In recent past, MapShed has been used in Pennsylvania to simulate pollutant loads and potential reductions; but Model My Watershed can now be used to accomplish this.
Web Demo

http://wikiwatershed.org
https://app.wikiwatershed.org

BMP Simulation Results

• Prior TMDL determined that Total P should be reduced by 38% and Sediment should be reduced by 44%
• With MMW, mean annual TP and sediment loads were estimated to be 18,316 kg/yr and 7,648,782 kg/yr, respectively
• Given the above “current” loads, the reduced “target” loads should be about 18,316 * 0.62 = 11,356 kg/yr for TP, and 7,648,782 * 0.56 = 4,283,318 kg/yr for sediment
• Can also download the model input file created by MMW and do subsequent editing and model runs with “desktop” version of the GWLF-E model
Case Study C:
Simple MS4 Application

Background

• In Pennsylvania, all regulated areas (e.g., MS4s) are required to develop a “Pollutant Reduction Plan” to reduce sediment loads associated with their jurisdictions by at least 10% as part of the NPDES permit process.

• Pollutant load estimates, including potential load reductions achieved via future BMP implementation, can be accomplished using MMW.
Basic Steps

- Use MMW to quantify distribution of land use/cover within a given MS4 (municipality or urban) area.
- Enter area values (e.g., acres) for each of the land use/cover categories in a given area into a spreadsheet (e.g., Excel).
- Apply Chesapeake Bay loading rates for N, P and sediment to the area values to generate estimates of total mean annual loads for each pollutant type for each land use/cover type.
- Estimate potential load reductions that might be possible with BMPs/remediation measures.
- In PA, BMP reduction coefficients must be based on “Performance Standard” approach.

Performance Standard Approach
Web Demo

http://wikiwatershed.org
https://app.wikiwatershed.org

<table>
<thead>
<tr>
<th>Land Use/Cover</th>
<th>Acres</th>
<th>Impervious Fraction</th>
<th>Total N</th>
<th>Total P</th>
<th>Sediment</th>
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<td><strong>5456</strong></td>
<td></td>
<td><strong>91,100</strong></td>
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<table>
<thead>
<tr>
<th>Loading Rates (lb/acre/yr)</th>
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<tbody>
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<td>Total N</td>
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<tr>
<td>Impervious Developed</td>
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<td>Previous Developed</td>
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<tr>
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Case Study E: More Comprehensive MS4 Application

Estimated Pollutant Reductions (Target = 10% reduction of sediment)

What if we captured 1 inch of runoff from all impervious surfaces (100%)?

<table>
<thead>
<tr>
<th>Land Use/Cover</th>
<th>Total N</th>
<th>Total P</th>
<th>Sediment</th>
<th>Reduced N</th>
<th>Reduced P</th>
<th>Reduced Sed</th>
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<td>162,758</td>
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</table>

Totals                   | 91,300  | 4,578   | 2,598,376| 49,710    | 1,681     | 1,035,365   |

Percent Reduced          | 45.5    | 58.9    | 60.1      |

Reduction coefficient for TN: 0.60
Reduction coefficient for TP: 0.70
Reduction coefficient for Sediment: 0.75
Basic Steps

- Use *MapShed* to estimate pollutant loads within a given watershed and the contribution of one or more “urban areas” to those loads.
- Use *MapShed* (GWLF-E model) to estimate potential load reductions within one or more “urban areas” based on use of future BMPs/remedial measures.
- This activity requires use of “Urban Area Tool” functions which currently do not exist in MMW, but will be implemented within a few months.
Skippack Creek Watershed in MapShed

Skippack Township
Skippack Creek Watershed in MapShed
### GWLF-C Average Loads by Source for Watershed 10

<table>
<thead>
<tr>
<th>Source</th>
<th>Area (ac)</th>
<th>Total Lsoap (lb)</th>
<th>Total Load Rate (lb/acre)</th>
<th>Total Lsol (lb)</th>
<th>Total Load Rate (lb/acre)</th>
<th>Total Lnit (lb)</th>
<th>Total Load Rate (lb/acre)</th>
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<td>1008.0</td>
<td>0.05</td>
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<td>3033.9</td>
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<td>1098.9</td>
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<td>0.00</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
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<td>1008.0</td>
<td>0.05</td>
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<td>0.05</td>
</tr>
</tbody>
</table>

### View loads for municipality

<table>
<thead>
<tr>
<th>Source</th>
<th>Source Area (ac)</th>
<th>Total Lsoap (lb)</th>
<th>Total Load Rate (lb/acre)</th>
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</tbody>
</table>

### Source weighting

- Farm Animals: 0.0
- Tile Drainage: 0.0
- Stream Banks: 0.0
- Groundwater: 0.0
- Untreated Waste: 0.0
- Septic Systems: 0.0

**Totals:**

- Lsoap: 21781.4
- Lsol: 716.5
- Lnit: 716.5
Skippack Creek Watershed in *MapShed*

![GWLF-E Model Simulation](image)

**Web Demo**

http://wikiwatershed.org

https://app.wikiwatershed.org
Questions?

MapShed?
MMW Multi-Year Watershed Model?
Case Studies?

WikiWatershed Web App
into the Future
Big Water Data: for Everyone

- Scalable Cloud Infrastructure
  - Computation: Amazon EC2; Apache Spark
  - Data storage: Amazon S3 / Elastic Block Store

- 100% open-source software stack:
  - Geoprocessing: GeoTrellis
  - Data I/O: Python; PostGIS; PostgreSQL
  - Models: Python modules and/or wrappers
  - Web framework: Django Python

https://github.com/WikiWatershed

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Big Water Data: for Everyone

Partnership between:

- Academic modelers, who:
  - Prototyped all code
  - Provided technical support for bug fixes

- Commercial software developers, who:
  - Led user experience (UX) design
  - Developed user interface (UI)
  - Implemented all code on Amazon cloud infrastructure
Future Developments: WPF Phase 2

- Enhance Model My Watershed
  - Import/Export
  - Better Share and Compare
  - Improve performance
- Develop Monitor My Watershed
  - Water data hub, via web-services from USGS, EPA, state and academic sources
  - Water data sharing, via EnviroDIY.org's open-source data loggers
- Partnerships & Training in DRWI
Future Developments: Other Projects?

• Add new models?
  • HSPF?, SWAT?, SWMM?
  • Water Temperature?, Flooding?
  • Ecosystem services? / natural capital?

• Add new modeling features?
  • Detailed site design?, Customizable BMPs?

• Add enhanced data?
  • Future land-cover forecasts?
  • Localized data?, Global data?

• Add model output viewers/explorers?
  • National Water Model?
  • Calibrated model results for TMDL studies?

Thank You!
Speaker Contact Information

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Pennsylvania Department of Environmental Protection
Phone: (717-783-2951)
WillBrown@pa.gov

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More Details to Come!

www.epa.gov/watershedacademy
Participation Certificate

If you would like to obtain participation certificates type the link below into your web browser:


You can type each of the attendees names into the PDF and print the certificates.

Questions?