Improving Watershed Models through Stakeholder Involvement

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50 Years of Watershed Modeling: Past, Present, and Future

Boulder, CO September 25, 2012

Laura Weintraub, P.E.
EPA’s Watershed Approach Framework

People working together to protect public health and the environment - community by community, watershed by watershed.

Carol M. Browner, Administrator
U.S. Environmental Protection Agency, June 1996

- Preferred way to strategically address priority water resource goals in a hydrologically defined geographic area through...
  - Sound science
  - Integration of regulatory and voluntary programs
  - Stakeholder involvement

- Opportunity for more successful watershed planning and TMDLs with robust modeling AND stakeholder involvement

- Engaged stakeholders can...
  - Improve direction on project goals
  - Provide high quality, site-specific data
  - Actively use the model
Open Modeling Process: Promotes Ongoing Communication and Peer Review

- Clarify Objectives / Set Goals
  - Select Model and Assemble/Review Available Data
  - Design Conceptual Modeling Strategy
  - Develop/Calibrate Model
  - Evaluate/Confirm Model
  - Apply Model for Decision Support

Ongoing Communication and Review

- State Agencies
- Science Advisory Panels
- Watershed Stakeholders
Case Studies of Three Watersheds
TRUCKEE RIVER, NV
The Watershed: Truckee River

- 3000 mi$^2$ watershed
- 140 river miles from Lake Tahoe to Pyramid Lake
- Highly managed system
- Inter-basin transfer at Derby Dam
- Depleted flows in lower river
- Multiple state/tribal stakeholders with competing uses
The Issues:
Dissolved Oxygen Impairment and TMDL Review and Revision

• Excess nutrients / low flow lead to reduced DO
• 1994 nutrient TMDL limits potential for regional growth
• Numeric N and P WQS are not site-specific, lack linkage to DO response
• 3rd-parties leading review / revision of numeric nutrient criteria and TMDL
  – Improved dataset / tools since 1994
  – Evolving water quantity management with improved “low flows”
  – NDEP supports need for action
The Tools: Linked Modeling Approach

RiverWare or TROM
- Demands, Water Operations, In-stream Flow Targets
- Reservoir Releases, Diversions
- Diversions
- TMWRF Effluent

WARMF
- Meteorology, Land Use, TMWRF Effluent and Re-use
- Tributary Flows, Nonpoint Sources

TRHSPF
- In-stream Water Quality
WARMF: Watershed Analysis Risk Management Framework

- First developed in late 1990’s under sponsorship from EPRI
- Peer-reviewed, public domain
- Applied throughout U.S.
- Predicts watershed flow and nonpoint loads based on:
  - land use
  - meteorological conditions
  - water management
  - watershed improvements
- Output linked to TRHSPF water quality model
The Stakeholders

WQS / TMDL Stakeholders

WQS / TMDL Principal Parties

3rd-Parties
- City of Reno
- City of Sparks
- Truckee Meadows Water Authority (TMWA)
- Washoe County

• US EPA
• NDEP

• City of Fernley
• City of Fallon
• US Fish and Wildlife Service
• US Bureau of Reclamation

• Pyramid Lake Paiute Tribe (PLPT)
• Truckee Carson Irrigation District
• Lyon County
• Storey County
• Churchill County
Stakeholder Input

- Funded by WRWC
- Joint process led by four “3rd-parties” (Reno, Sparks, TMWA, Washoe County)
- Active guidance, review and dialogue with NDEP and US EPA
- Data from many regional sources – TRIG (http://www.truckeeriverinfo.org/)
- Recent model database extension and confirmation runs
  - Land use data from various local sources
  - Detailed stakeholder review of results
- 3rd-parties lead one-on-one and broader stakeholder meetings
- Hands-on model training

*Relationship building has been key!*
Value Gained / Lessons Learned

• 3rd-Party Process requires regulator coordination/approval and stakeholder support

• The process is slow and complex
  – Lack of momentum (recent delays with WQS review)
  – Competing water quantity issues in watershed
  – Ongoing education of involved parties

• Frequent meetings / discussions have broken down some barriers within group – important to build trust

• Technical tools provide foundation for open discussion
  – Common language for discussion
  – Can reduce tendencies to gravitate to emotional / political differences

• Success in regional water planning and management hinges on effective stakeholder collaboration
MAUMEE BASIN, OH
The Watershed: Maumee River

- 6,300 mi²
- Major tributary of the Western Basin of Lake Erie
- Highly agricultural watershed (>70% cropland)
The Issues: Ecological Concerns

• Watershed export of sediment and nutrients:
  – Phosphorus (P), especially soluble reactive P
  – Nitrogen (N)
  – Suspended solids

• Eutrophication & sedimentation impacts in Western Lake Erie Basin (WLEB):
  – Harmful algal blooms (HABs)
  – Nuisance benthic algae in WLEB
  – High sedimentation rates in Federal navigation channel

October 2011
The Tools: Great Lakes Watershed Ecological Sustainability Strategy (GLWESS)

• Link ecosystem improvement outcomes to type, placement and number of BMPs applied in watershed
• Test transaction framework that will pay for water stewardship practices based on how well nutrient and sediment loads are reduced from farmlands
• Models used to support transactions
  – SWAT watershed models
  – Western Lake Erie Ecosystem Model (WLEEM)
• Agricultural community will be ultimate end user
Transactions ↔ Ecological Endpoints

Transactions

Candidate Transactions
- Reverse auction
- Certification

Final Evaluation of Transactions
- Type
- Location(s)
- Funding

Improved Management Practices
- Type of practice(s)
- Affected land area

Changes to crops, tillage, drainage, etc.

Watershed Models (SWAT)

Flow, sediment, nutrient loading

Model Linkage

Flow, sediment, nutrient loading @ Waterville

Western Lake Erie Ecosystem Model (WLEEM)

Ecological Endpoints

Improved “Indices of Biological Integrity” (IBIs)
(Various locations in stream network)

Reduced Nutrient & Sediment Delivery
(@ tributary mouths)

Reduced Algal Production and Sediment Problems in Western Lake Erie
- Microsystis blooms
- Sedimentation/turbidity

*Relative ecological benefits
*Bid ranking ($/lb algal reduction)
Linked Watershed-Lake Models Support Transactions

- Physically-based tool estimates ecological benefits of candidate agricultural management actions
- Provide guidance on “target” areas for transactions
- Evaluate and rank candidate transactions & associated management actions
- Work with stakeholders to get the best possible return on investment - ideally, enough to ultimately solve the HAB problem

**Total Phosphorus Yield Reduction**

**Concept for Reverse Auction Approach**

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<th>Total Cost</th>
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The Stakeholders

- Funded by Great Lakes Protection Fund (GLPF)
- Project team: The Nature Conservancy, LimnoTech and Michigan State University
- Partners:
  - NRCS-CEAP (Natural Resources Conservation Service-Conservation Effects Assessment Program)
  - Conservation districts
  - Farm owners/operators
  - Soil and water conservation districts
  - Drain commissioners
  - Agribusiness
  - Municipal and county planning agencies
  - State and federal resource agencies
  - Universities
  - Non-governmental organizations
Stakeholder Input

- Sharing site-specific data for watershed characteristics
- Visits to farms and farmer interviews
  - Understand willingness and values
  - Provide a “reality check” on reasonable land management practices and BMPs
  - Survey farmers regarding crops, management practices, soils – feedback to SWAT model
- Plan to conduct stakeholder workshops to pilot test reverse auction approach
  - Determine how best to implement the concept to maximize acceptance, participation, and return on investment
  - Need to build trust and confidence in the tools
- Meetings with retailers and agribusiness leaders
Value Gained / Lessons Learned

- Stakeholders input and feedback has helped modelers understand needs up front
  - Must have strong communication to successfully relate model results and limitations to non-technical audience
- Improved model parameterization and scenario development
- Overarching Goal → Successful pilot transactions will lead to expanded marketing and implementation of achievable BMPs
  - Share tools with a farmer to provide him/her with estimates of benefits that his/her conservation actions can have on the watershed
  - Will need to be practical and realistic in eyes of stakeholders
  - Will need to have strong business case
- Stay tuned for success stories.....
GREEN RIVER BASIN, KY
The Watershed: Green River

Area: ~9,220 mi\(^2\)

Water Use:
- 167 surface withdrawals
- 26 groundwater withdrawals
- 302 point sources

Power Plants:
- 4 coal-fired – once-through and closed cycle cooling
- 2 planned IGCC plants
- 2 small biofuel plants

Four flood control reservoirs operated by USACE
The Issue: Water Availability Planning for Power Plant

- 2500 MW; once-through and closed-cycle cooling
- Water source is Green River, KY
- Considering power plant changes
  - Conversion of two once-through units to closed-cycle cooling
  - Conversion to dry ash handling
- Limited understanding of impacts of change in water use on water risk in the context of available water and competing demands with other water use sectors
The Tool: Water Prism

- Watershed-scale decision support system for:
  - Understanding and verifying water risks
  - Exploring water saving benefits across sectors
  - Encouraging stakeholder collaboration

- Computes system water balance on regional scale

- Projects consumptive and withdrawal demands for 40- to 50-year horizon

- Explores water saving strategies through scenarios
Water Prism Design Overview

- Land Use, Climate, Topography, etc.
- Watershed Model (WARMF, TWLF)
- Population, Energy Demand, Irrigated Land Use
- Available Surface Water
- Groundwater Storage
- Water Prism Access Database
- Water Prism DSS
- Ground Water Data

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River 30
Critical Month-August

- Agriculture
- Ecosystem
- Electric Power
- Industrial
- Municipal

BAU Water Balance

- BAU Consumptive Demand
- Water Use Entities
- Industrial
- Agricultural
- Municipal
- Urban/Residential
- Economic
- Energy
- Irrigated Land Use

Figure 3.1: Groundwater storage development through time.
The Stakeholders and Water Saving Strategies

**Agricultural**
- Retirement of agricultural land
- Low water crops
- Water efficient irrigation

**Ecosystem Demand**
- Sensitivity to range of ecosystem constraints

**Electric Power**
- Plant decommissioning
- Retrofit to advanced cooling technologies
- Non-traditional water sources
- In plant water reuse
- Low water renewable generation (wind, solar PV)

**Industrial**
- Non-traditional water sources
- In plant reuse
- Low water landscaping; rainwater capture

**Municipal**
- Low water landscaping; Rainwater capture
- Greywater recycling
- Water efficient appliances and fixtures
- Distribution system maintenance, leak detection
Electric Power Sector Example

Increased consumptive demand risk with conversion of power plant to closed cycle cooling and dry ash handling.

Consumptive Demand (BAU):
- Relatively low risk

Prism Scenario:
- Increased risk
Stakeholder Input

• Phase 1: Two prototype applications; focus on electric power industry
• Verified accuracy of water use data from public sources
  – Improved model inputs
  – More accurate results
• Scoped and define reasonable and insightful management scenarios
• Feedback -- recognized Water Prism as potentially valuable tool for planning and stakeholder education of electric power water use
Value Gained / Lessons Learned

• Water Prism intended to promote stakeholder collaboration and education
  – Highly visual and intuitive output graphics
  – Identify most critical months of year for a system
  – Analyze consumption and withdrawal risks -- can differ greatly
  – Identify local water issues even if broader basin risk is low
  – Consider reasonableness of environmental flow limits
  – Consider tradeoffs with various water saving strategies

• Provides single framework to evaluate multi-sector water use at facility, sector and/or basin scale

• Phase 2 and beyond...
  – Expanding to more comprehensive risk assessments increased collaboration from other sectors
Closing Thoughts on Stakeholders and Watershed Modeling

- We are still struggling with model-stakeholder connection
- Potential benefits for all parties
  - Better data and more accurate model
  - More trust and buy-in of tools
  - All sides learn from each other
  - Open doors to leverage other efforts
  - Strengthen relationships
- Reduces chance that models will “go on the shelf”
- Important but can be resource intensive
  - Place value on the long-term benefits of the investment
  - Plan for it (budget, schedule)
  - Expect it to be a complicated but rewarding process
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