Replacing Regional Factors: A Multiple Model Approach Based on SPARROW

Ross Mandel
Andrea Nagel
Interstate Commission on the Potomac River Basin
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Topics

- Motivations and Goals for Using SPARROW to Replace Regional Factors
- Role of Replacing Regional Factors in Development of Land Simulation Targets
- SPARROW Overview
- Running SPARROW to help determine Land EOS targets
- Alternative Optimization Approach
- Issues with Empirical Load Estimates

Motivations for Using SPARROW to Replace Regional Factors (aka “Slop Factors”)

- Watershed Model is mostly accounting tool: there should be no surprises in Watershed Model results
- Multiple Modeling Approach: Integrate results from other models (i.e. SPARROW) to represent transport processes at smaller scale than Watershed Model

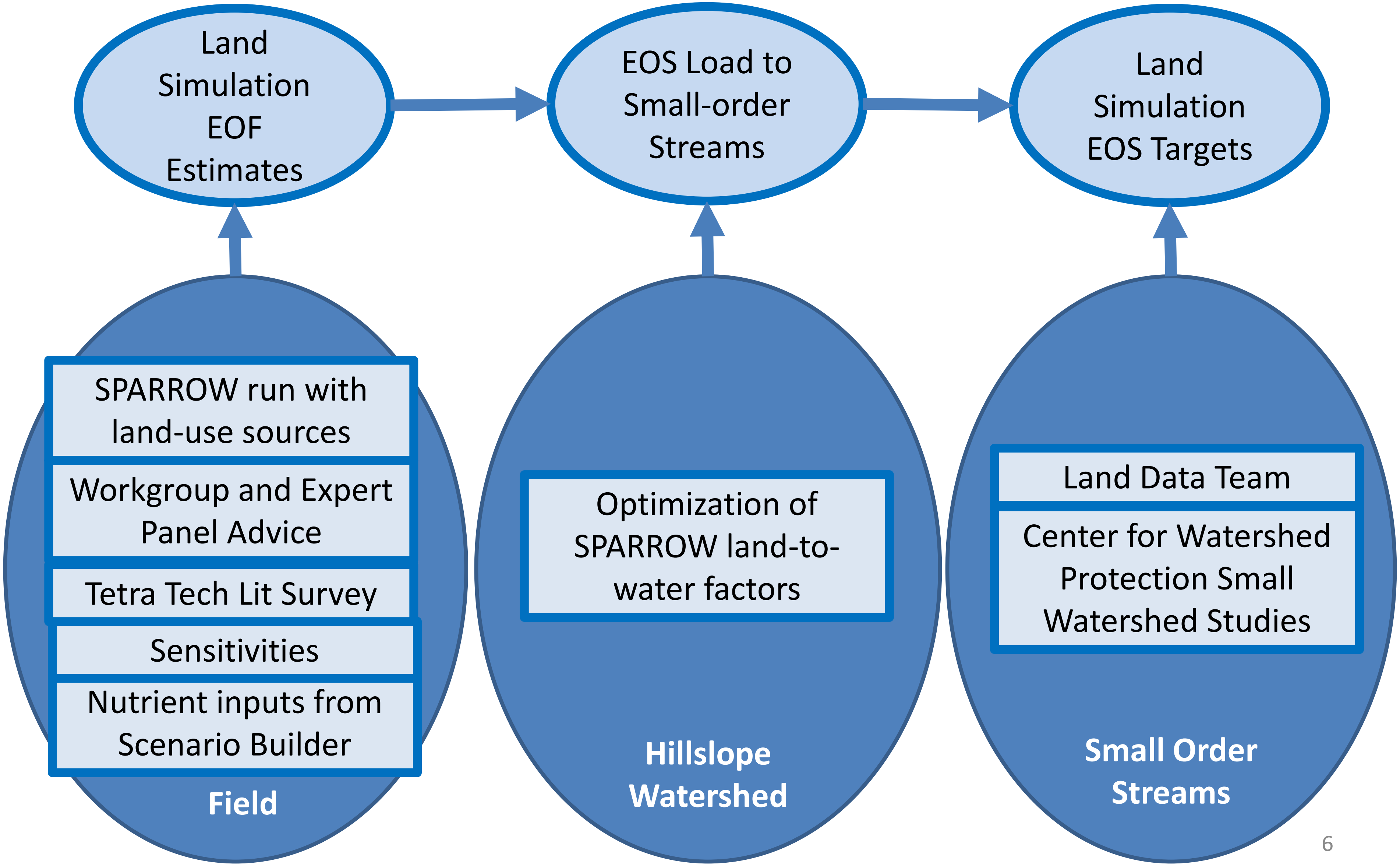
Goals

- Replace regional factors with modifications to land simulation targets incorporating transport factors
- Remove calculations from river calibration
- Base modifications on empirical load estimates for river reaches
- Establish modification on a clear physical (geology, soils) basis that represents effects of transport

Scale, Models, and Targets

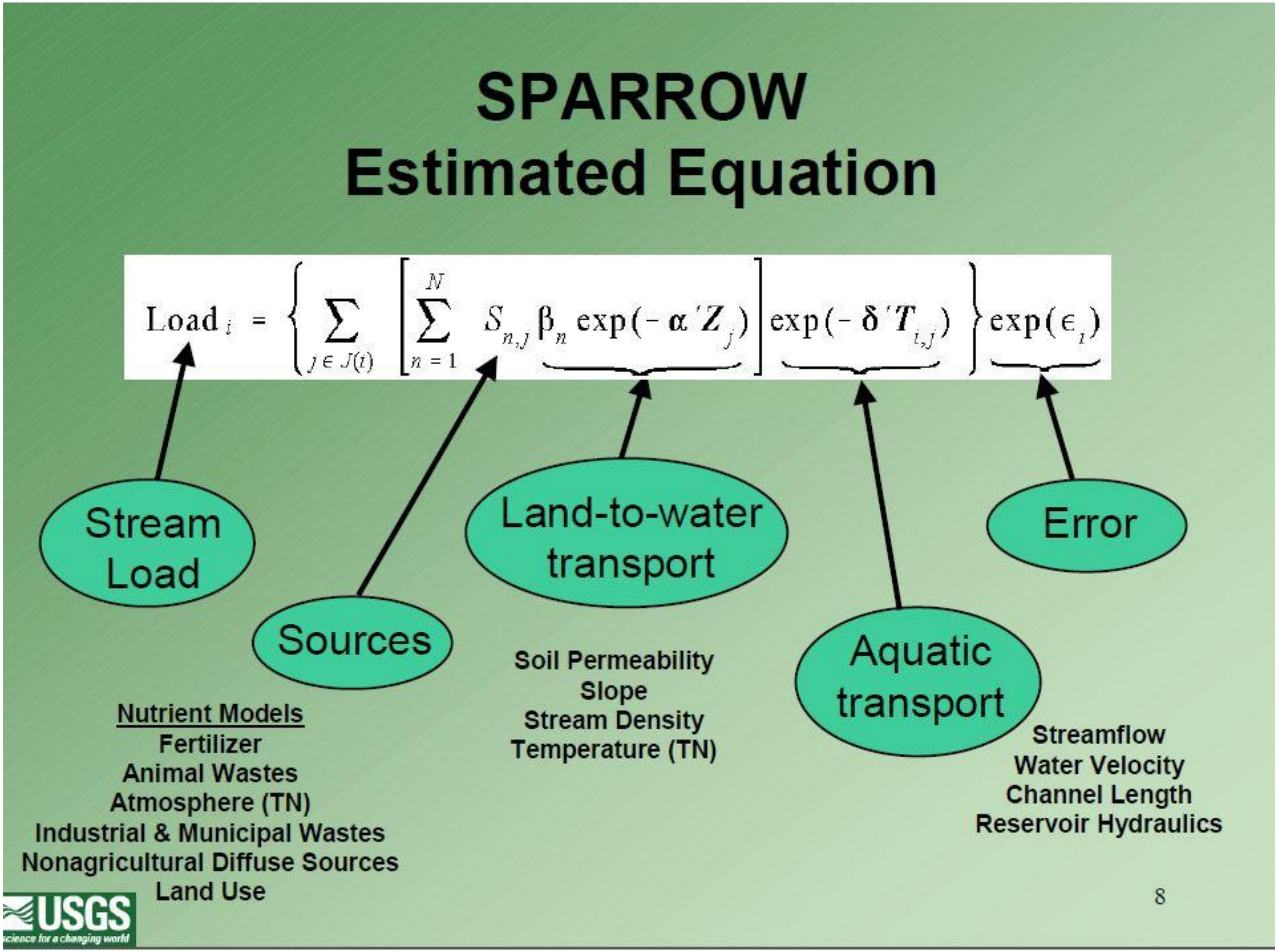
Scale	SPARROW	P5 Sediment	P5 Nutrients	P6?
Field—EOF	Sources & Coefficients	EOF Loads	Land Simulation + Regional Factors	EOF Loads
Hillslope Watershed	Land-to-Water Delivery Factors	Delivery Factors		Land-to-Water Delivery Factors
Small-order streams	NHD+ Streams			Small-Order Stream Processes
Large-order Streams	NHD+ Rivers	Reach Simulation	Reach Simulation	Reach Simulation

Land Simulation Target Development



SPARROW: Spatially Reference Regression on Watershed Attributes

- Non-linear regression of watershed attributes vs. loads
- FLUXMASTER: Empirical calculation of loads
- Watershed Attributes:
  - Sources (fertilizer, urban land, etc.)
  - Land-to-water delivery factors: water capacity GW recharge
  - Reach attributes: reservoirs, travel time
- Estimate Chesapeake Bay basin-wide coefficients of watershed attributes



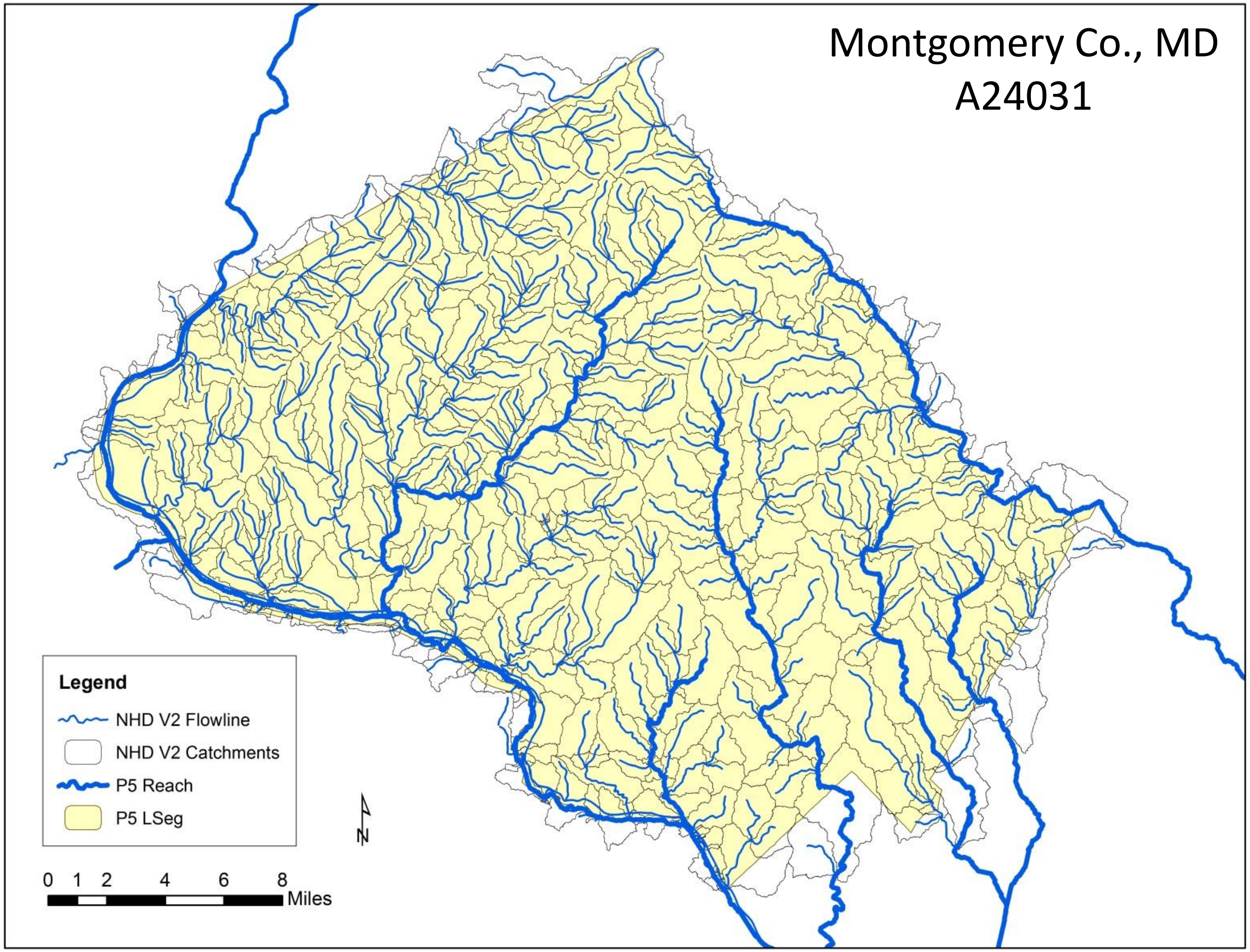
Smith et al., (2002) Overview of SPARROW Modeling
http://water.usgs.gov/orh/nrwww/National_sparrow_overview.pdf

SPARROW Chesapeake Bay TN &TP Models

80,579 NHD+ reaches; average watershed size approx. 500 acres

	TN	TP
Sources	Point sources Fertilizer Manure Atmospheric Deposition Urban	Point Sources Fertilizer Manure Siliciclasitc rock Crystaline rock Urban
Land-to-Water Delivery	Enhanced Vegetative Index Available Water Capacity Groundwater Recharge Percent Piedmont Carbonate	Soil erodibility Hydrologic Group A soils Percent Coastal Plain Precipitation
Reaches	Streams: Travel time Reservoirs: Hydraulic load	Reservoirs: Hydraulic load
Calibration Stations	181	184
Flux R^2	0.978	0.951
Yield R^2	0.858	0.730

SPARROW Scale vs. P6 Scale



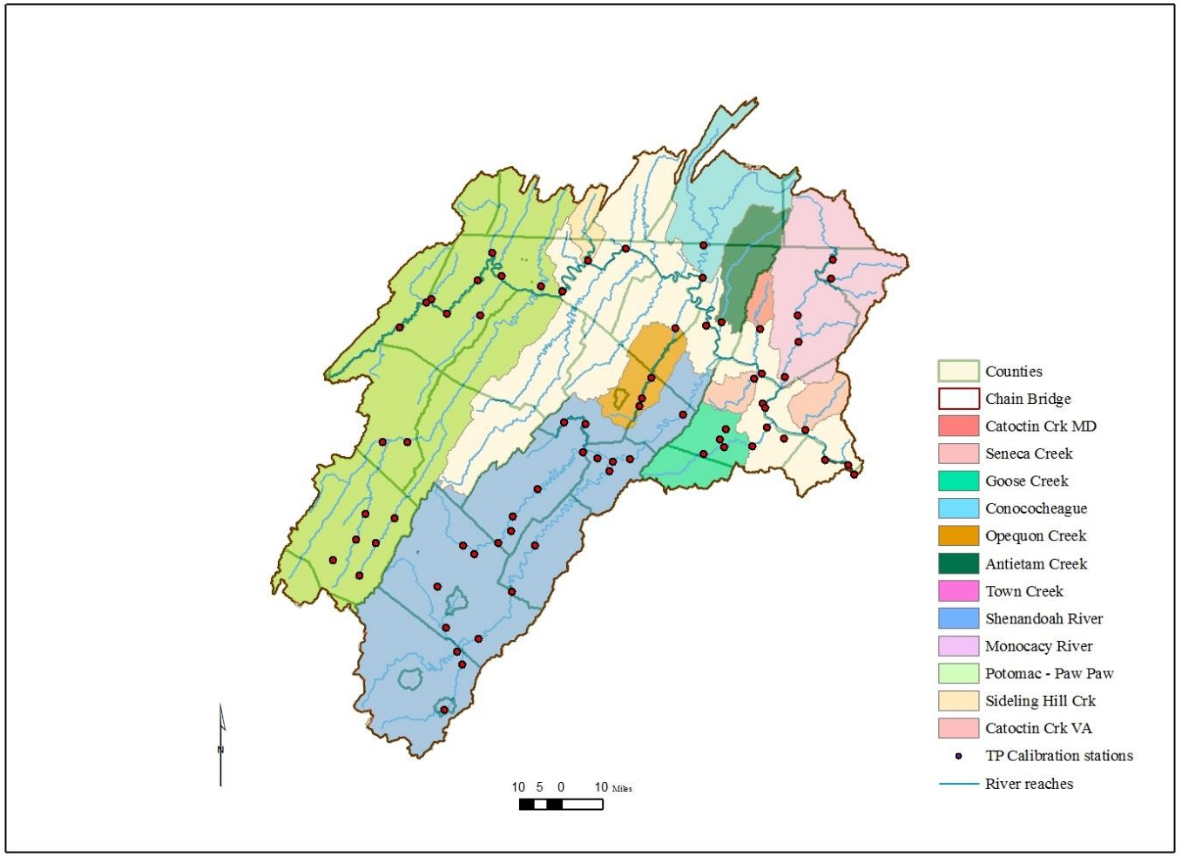
Proposed SPARROW Simulation to Help Set Land Simulation Targets

Scale	Input	Output	P6
Field	P6 EOF targets on land segment basis	Keep Fixed	EOF Loads
Hillslope Watershed	Land-to-Water Delivery Factors	Calibrate with SPARROW	Land-to-Water Delivery Factors
Small-order streams	NHD+ Streams	Calibrate with SPARROW or Fix with CWP/Land Data Team Information	Small-Stream Processes
Large-order Streams	NHD+ Rivers		Reach Simulation

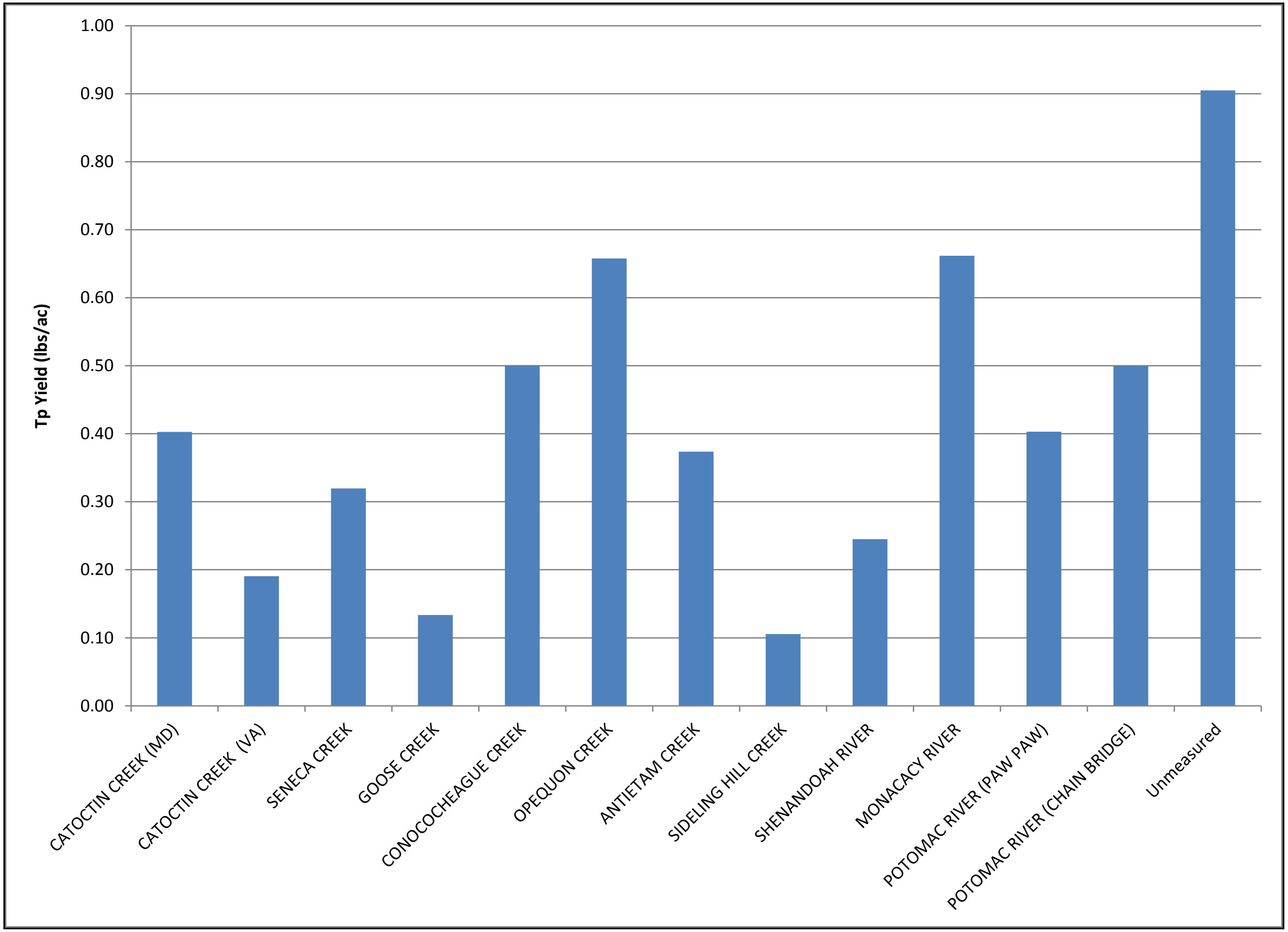
Issues with Empirical Load Estimates

- Possible Modifications to Empirical Load Estimates from FLUXMASTER
  - Calibrated SPARROW model
  - Load Estimates for USGS non-tidal network
  - Possible enhancements to non-tidal network (Baltimore City Reservoir Monitoring)
  - Can estimates from smaller scale watersheds be used?
- Geographical Consistency of Empirical Load Estimates
  - Potomac River Basin TP Loads
- Primacy of RIM Stations

Potomac River Tributary Watersheds

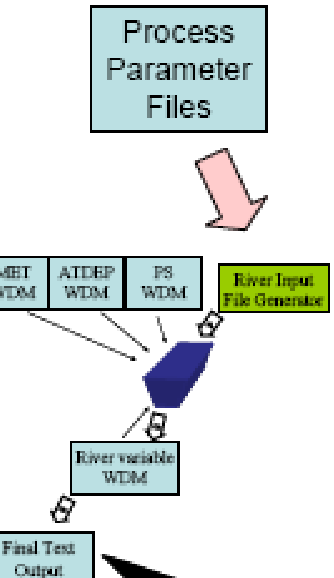


FLUXMASTER Yields
Potomac River Basin



Nested Optimization

River Calibration



- Assume the sensitivity of the simulation to each parameter
- Determine an appropriate adjustment direction for each parameter
- Take a small step in that direction

- Calculate necessary EOS to unbias the calibration
- Adjust EOS by that amount

Contact Information

Ross Mandel
Interstate Commission on the Potomac River Basin
rmandel@icprb.org

Exploratory Optimization Outside SPARROW at Land Segment Scale

- Starting point:
  - EOS Loads by land segment based on EOF land simulation targets
  - Empirical load estimates (EL) from FLUXMASTER/ SPARROW calibration dataset
- $EL = \sum_{i=1}^{\substack{upstream \\ land\ segments}} EOF_i * \exp(\sum_{j=1}^{Factors} c_j * Fij)$
  - c_j: coefficients
  - F_{ij}: SPARROW land-to-water factors

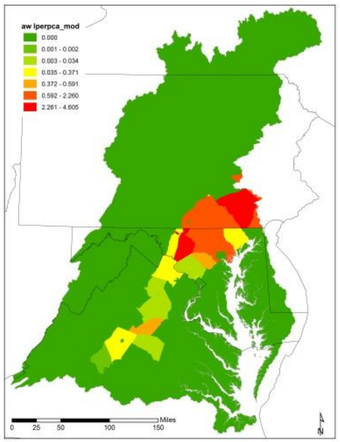
- Solve for c_j by non-linear optimization

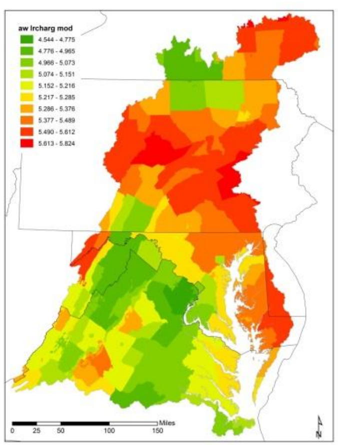
Exploratory Optimization Methodology

- P532 Land Simulation Targets
- Factors aggregated to land segment scale
- EOS calculations in R batch file
- Optimization uses PEST
- No BMPs, PS, in-stream attenuation

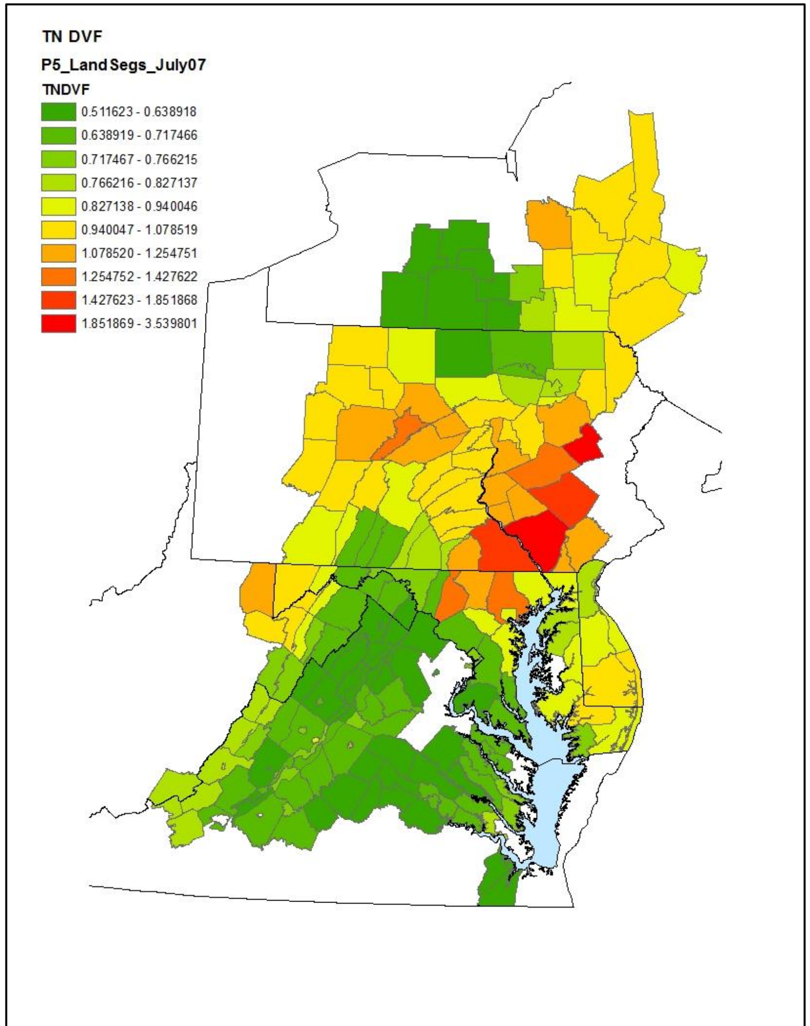
TN land-to-Water Delivery Factors by Land Segment

Piedmont Carbonate

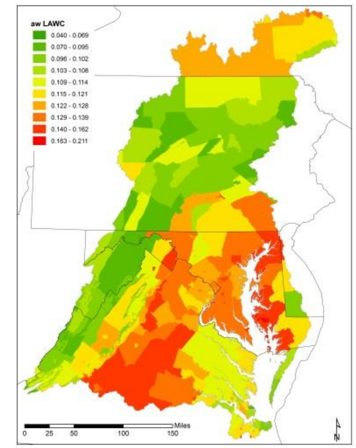


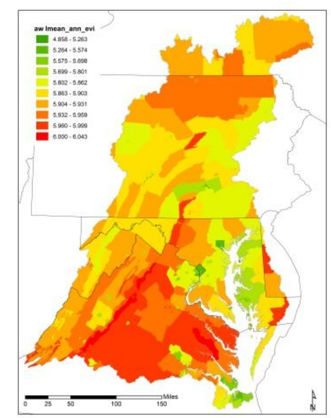


Groundwater Recharge



Soil AWC





Average EVI

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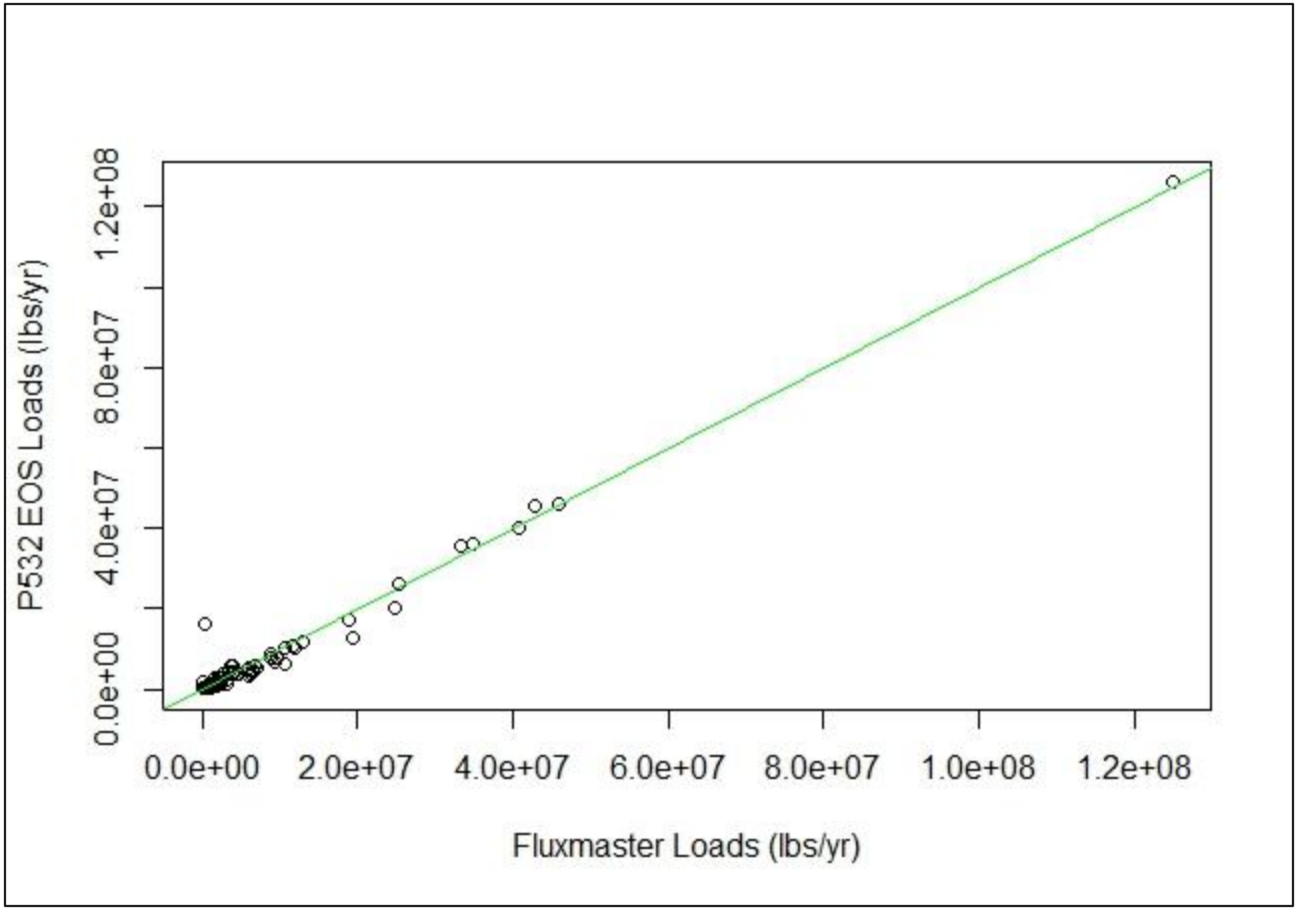
TN P532 EOS vs. FLUXMASTER Loads



Optimization Error