Evaluating BMP Scenarios under CEAP: Approaches to handling a multitude of runs and large datasets

M.W. Gitau, L. Chiang, I. Chaubey, M. Sayeed
Department of Agricultural and Biological Engineering
Purdue University

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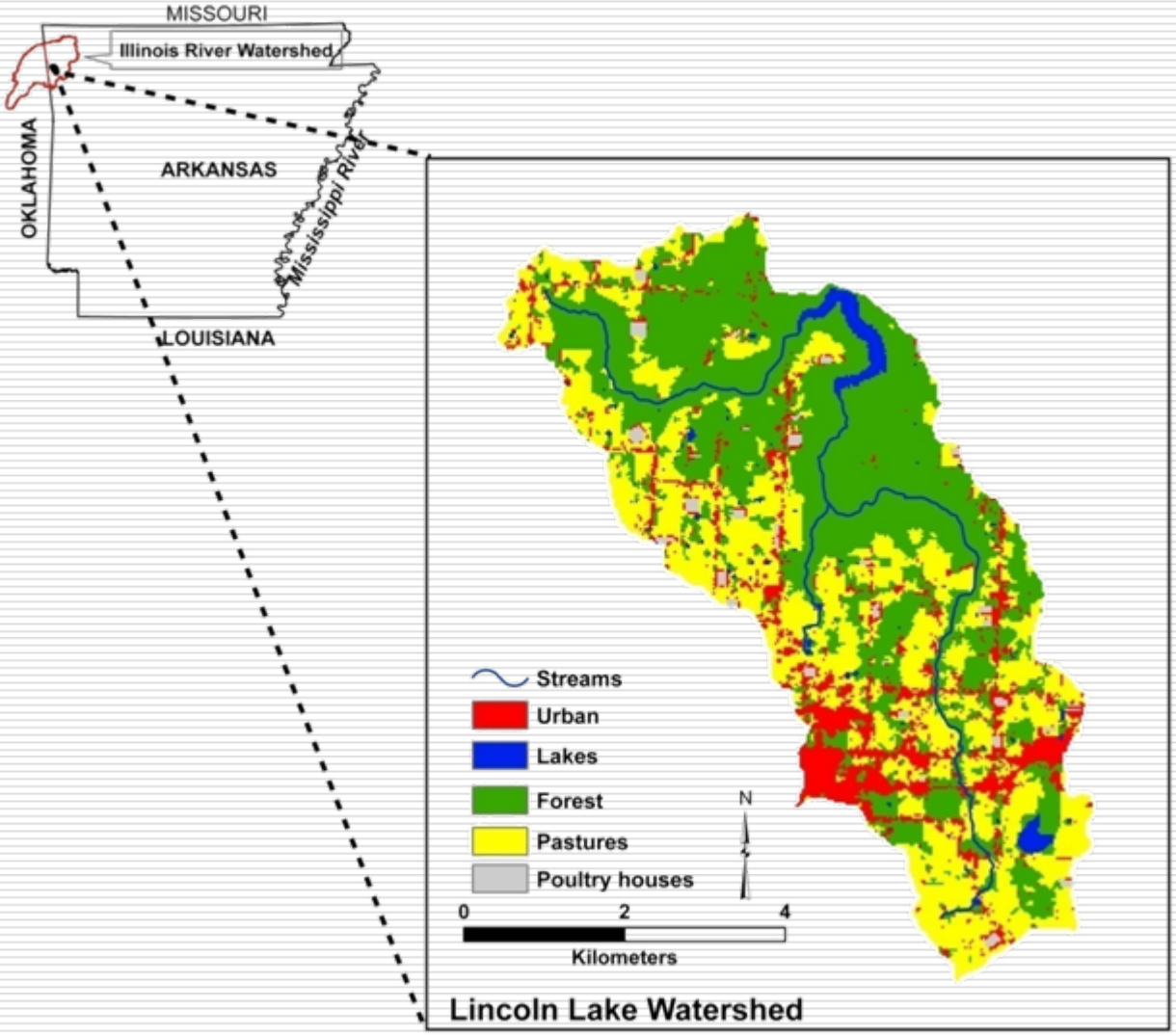
AGRICULTURAL AND BIOLOGICAL ENGINEERING

Study site description



- Tributary Illinois River
- Size - 32 km^2
- Land use
  - Pasture 36%
  - Forest 39%
  - Urban 12%

Issues in the Lincoln Lake Watershed

- Land application of animal manure
- Land use changes
- BMP implementation
- Water quality impacts
- Primary concern - phosphorus

Objectives/tasks

- Analyze various BMPs and their effects on water quality in the watershed – SWAT model
- BMPs including grazing/pasture mgt, manure applications, buffers
- Incorporate uncertainties in future weather patterns over a 25-year (2004-2028) period.

Sample Scenarios

Scenario Numbers

	Buffer Width					
	0 m			30 m		
	Grazing and Pasture Management					
Manure application (tons/acre)	NG	OG	OVG	NG	OG	OVG
No application	1	20	39	115	134	153
Spring application, 2NA	7	26	45	121	140	159
Summer application,2NA	13	32	51	127	146	165
Fall application, 3NA	19	38	57	133	152	171

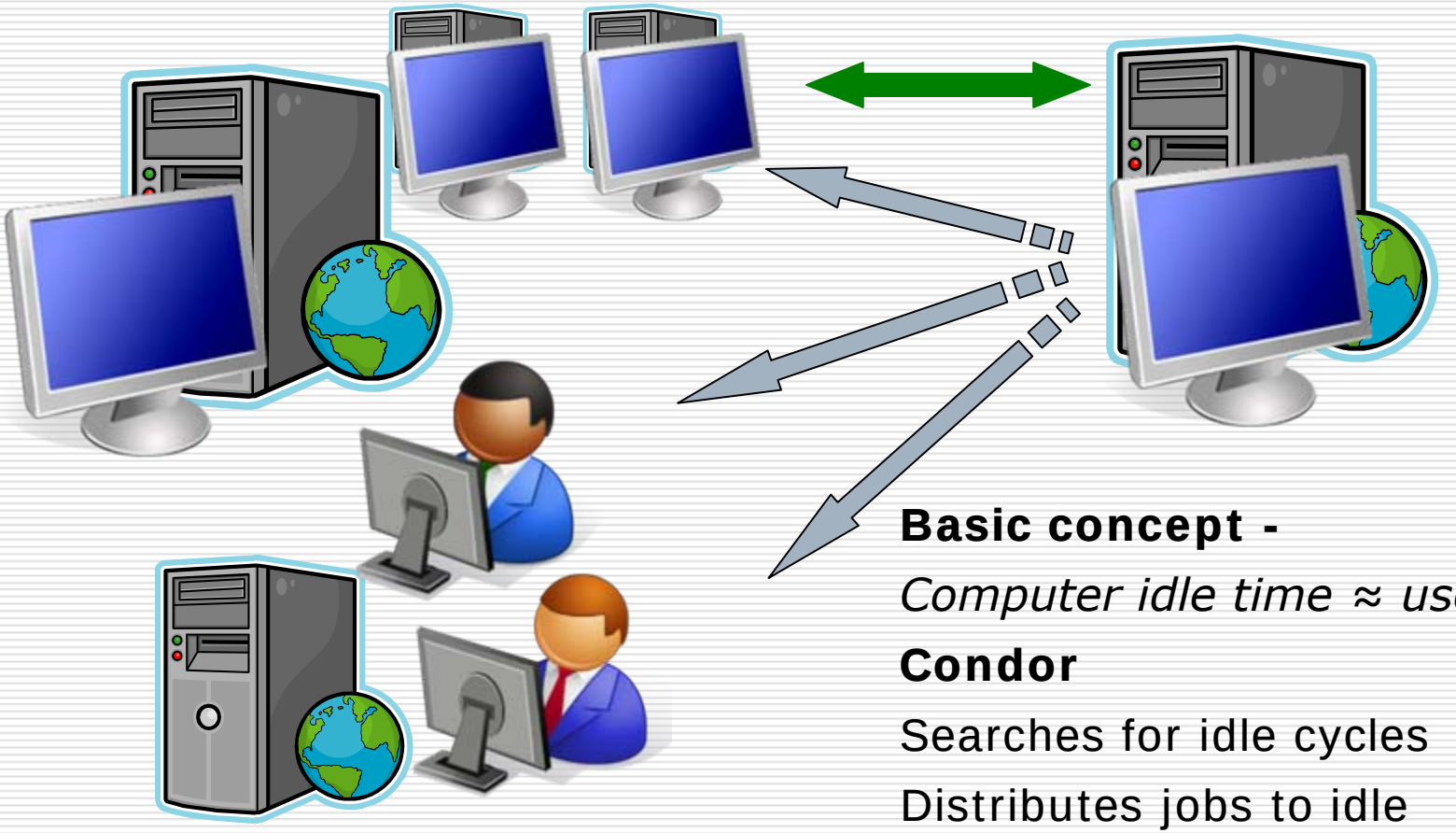
NG- no grazing; OG- optimum grazing; OVG-overgrazing. NA – no amendments.

Scenario 172 - current conditions

Challenges

- Number of runs
  - 172 BMP scenarios, 250-1000 weather data/scenario = 43,000-172,000 runs
  - Time/run = 8-10 mins (LINUX); 5,700-29,000 CPU hrs (0.7-3.3 yrs, 1 machine)
- Space – temporary storage for output
  - Output files 1*59 Mb, 3*2.5 Mb per run
  - Total 67.5 Mb/run – minimum 2.5 Tb

Approaches - *Condor*



Basic concept -

Computer idle time ≈ use time

Condor

Searches for idle cycles

Distributes jobs to idle

Results sent back on completion

Front end user has priority

Approaches - *Condor*

- Modified, configured SWAT to run with Condor and produce minimum required output for each run
- Prepared input files for batch runs – weather, management, options
- Developed scripts and post-processing tools to handle model runs and outputs.

Experience

# of jobs submitted	Time to completion	Comments
1 scenario, 1000 jobs total	10-15 days	200-300 jobs done, 700-800 jobs idled Forceful release required to run and complete idled jobs Faster on evenings, weekends (fewer users)
3 scenarios, 250 jobs each	2-15 hrs	More efficient - the three scenarios distributed to 3 diff machines (possibly) Speed still influenced by number of users (to a lesser extent)

Experience - general

- CONDOR can handle large volumes of runs over long periods
- Submitting a large number of jobs at once causes system overload, longer run times, job failure
- Ownership/membership of cluster is important in job prioritization

Solutions

- Handle 250 weather realizations per scenario, total 43,000 runs
- Submit 2-3 batches of 250 runs at a time – this is effective/efficient
- Submit more jobs in evenings and weekends
- TeraGrid – very efficient, Southern Region Grid (University of Oklahoma)

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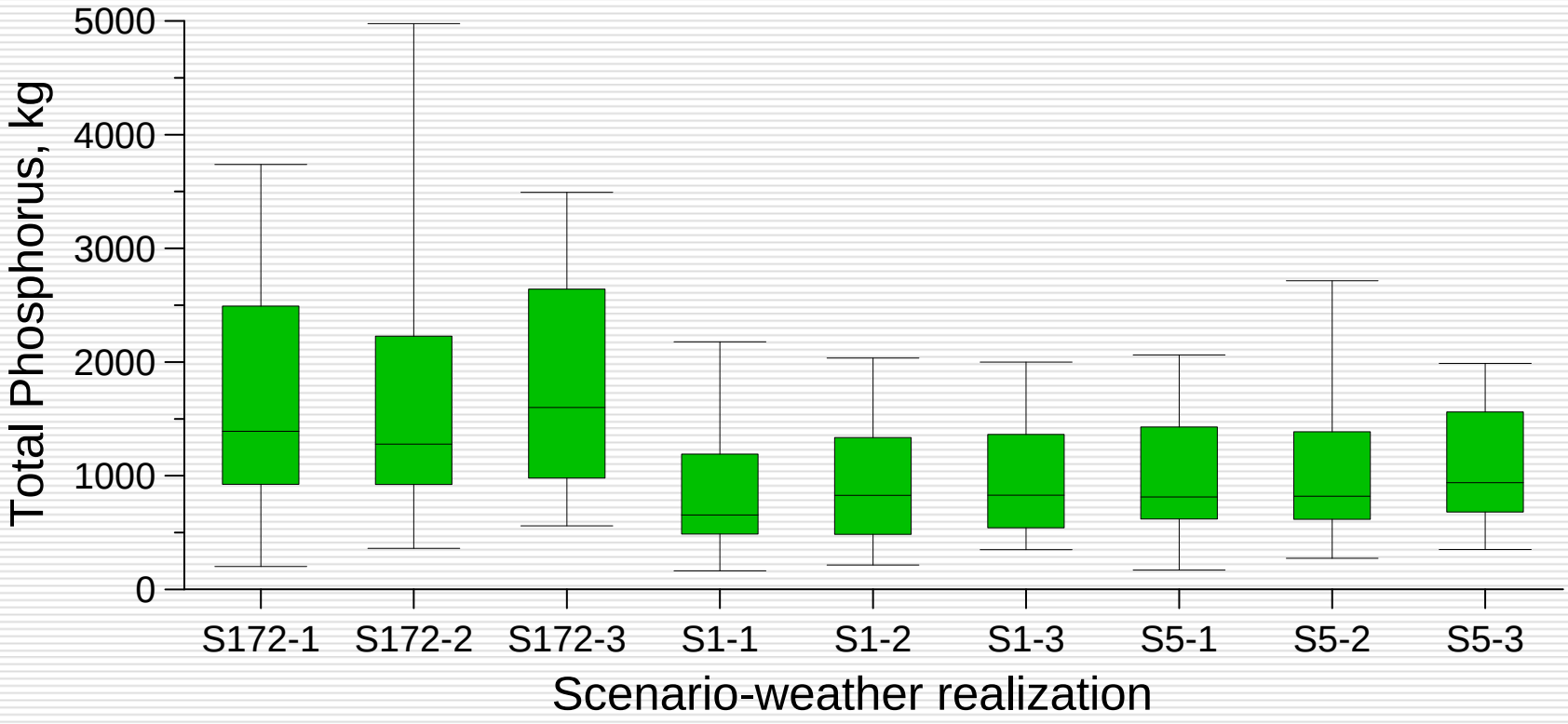
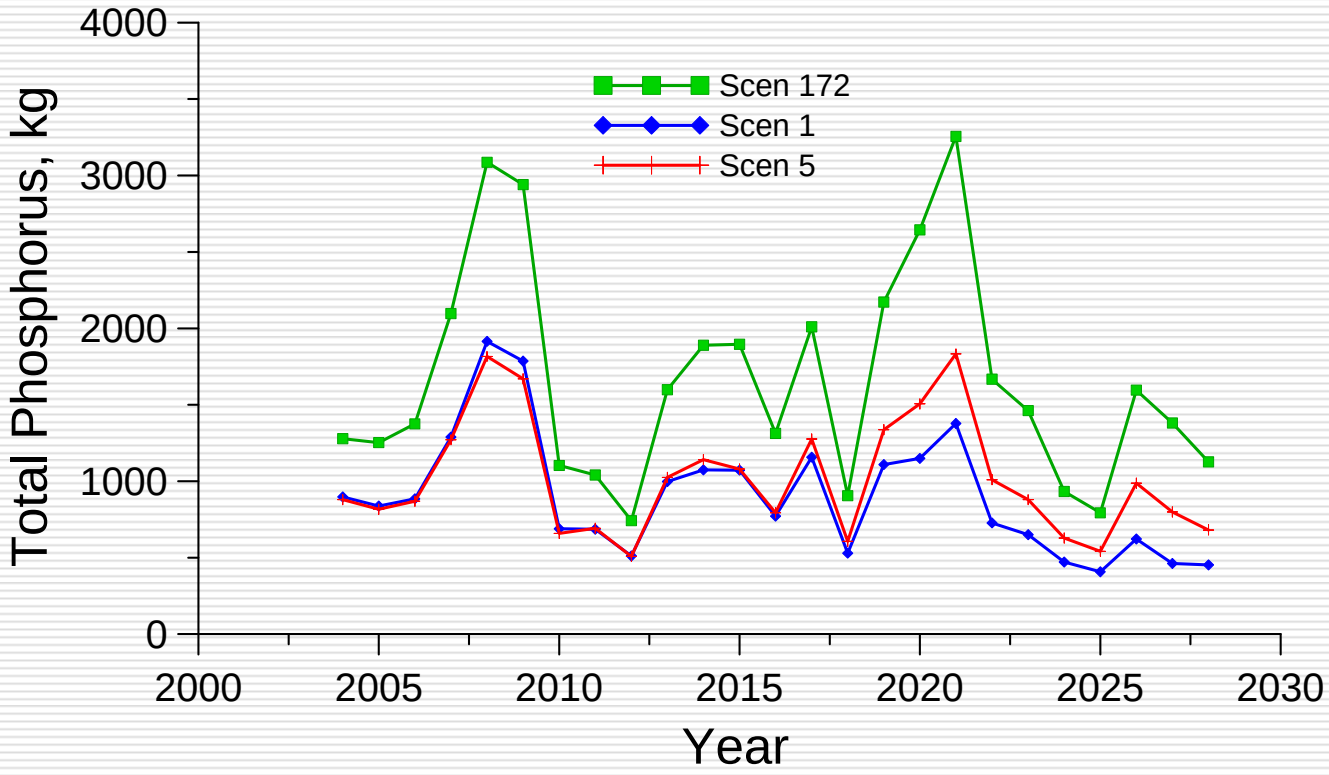
Sample output – weather realization & scenario output



Scenarios: 172- current conditions; 1- no grazing, no application, no buffer; 5- spring application 1 ton/acre, no grazing, no buffer.

Sample output – scenario comparisons



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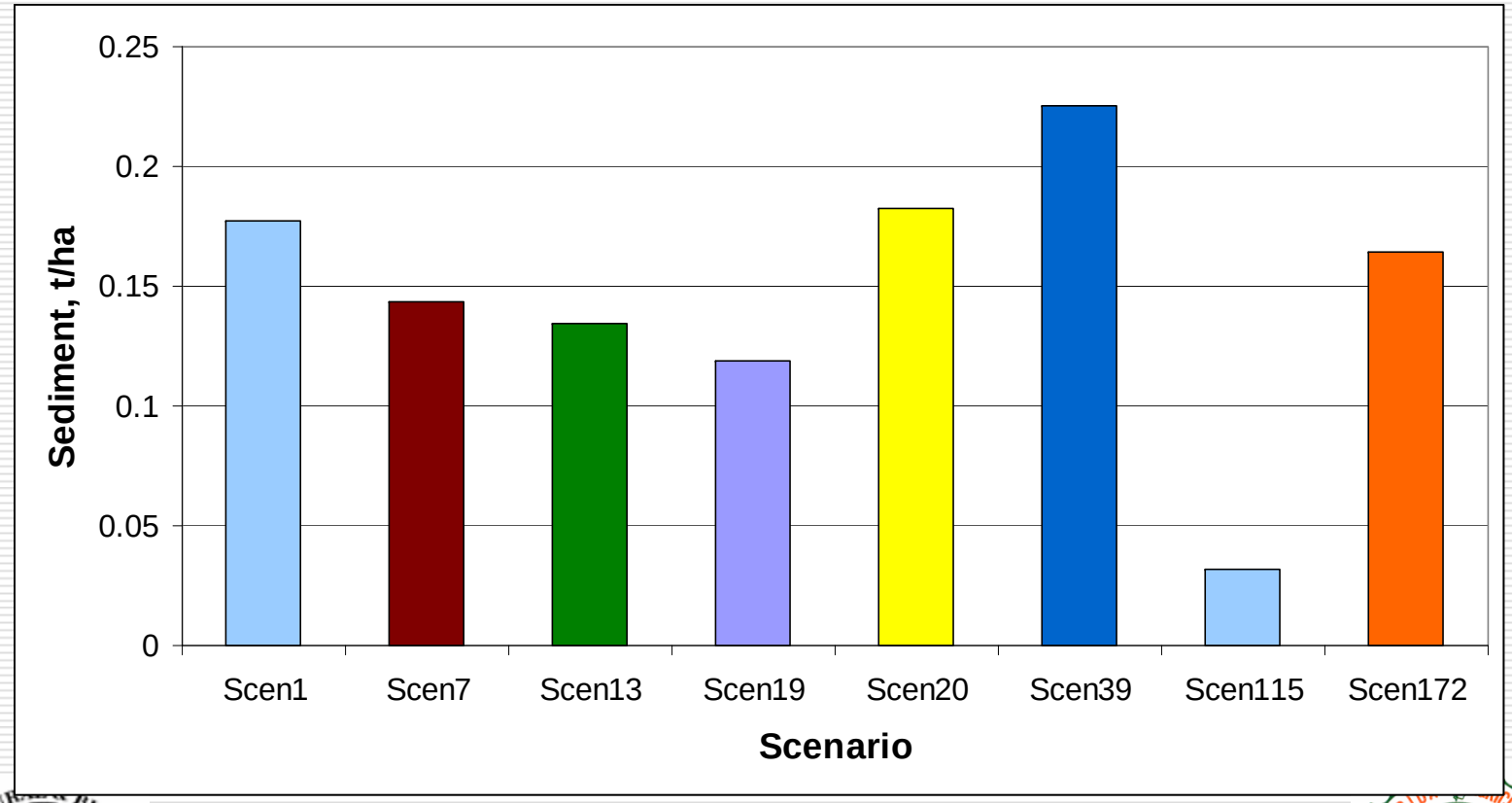

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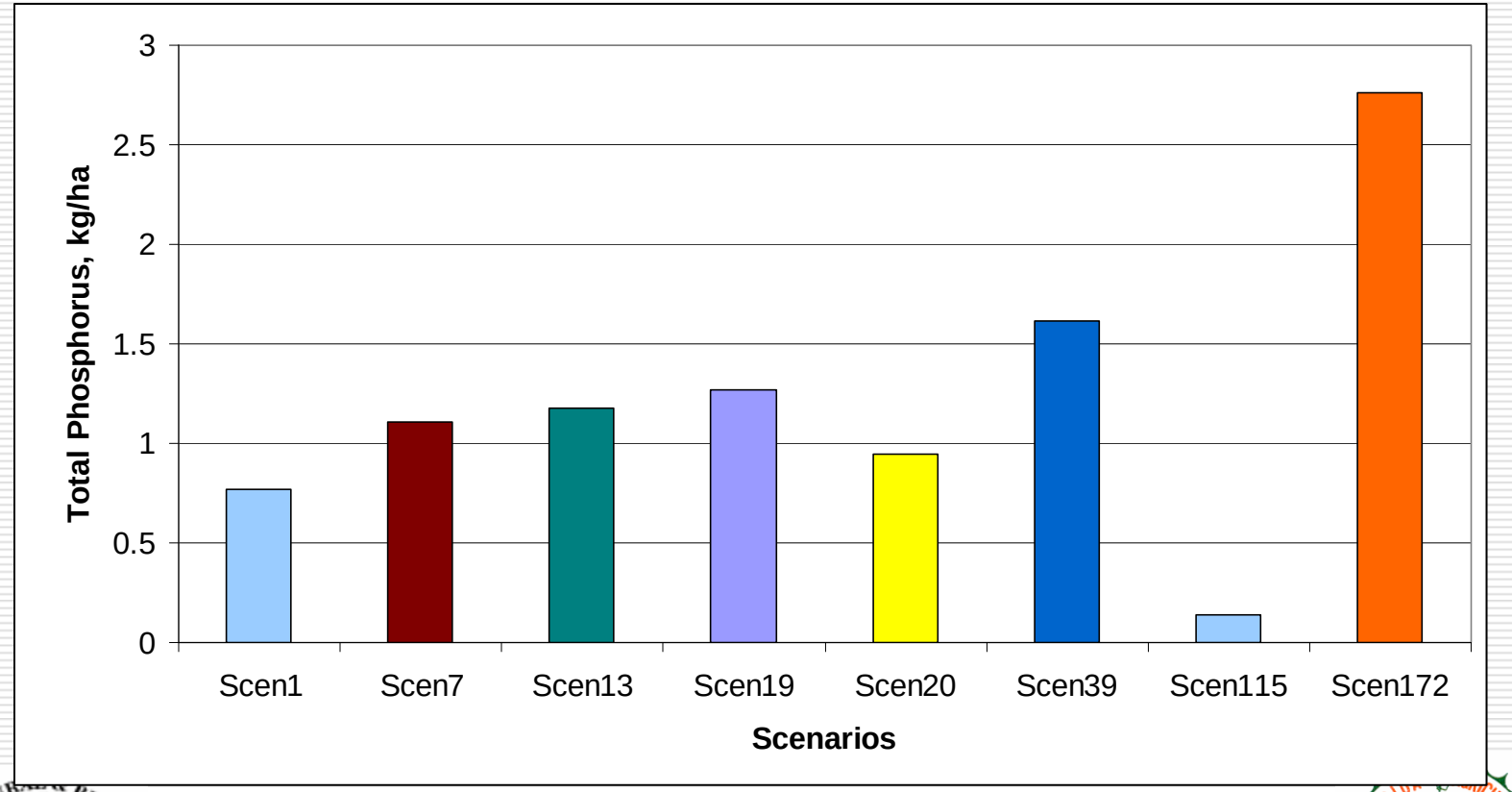
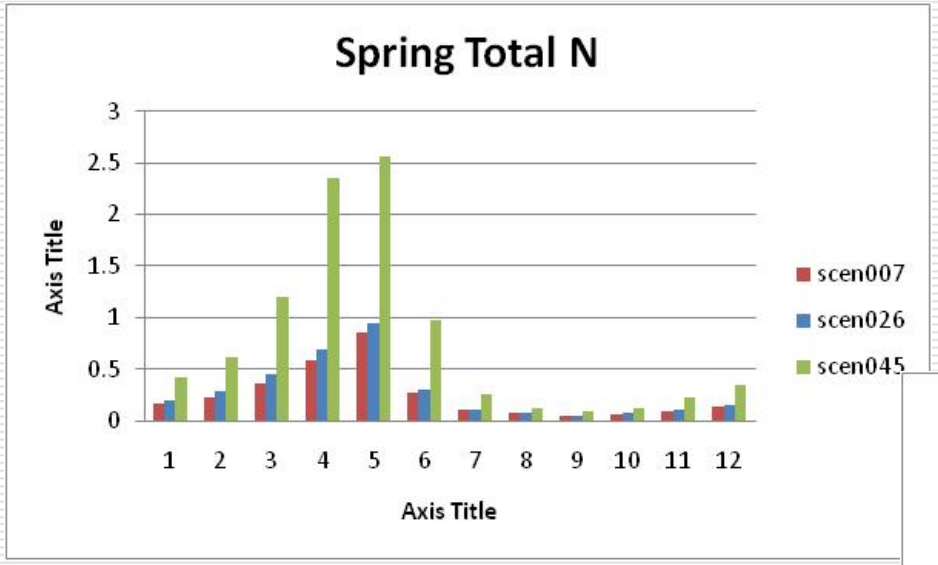
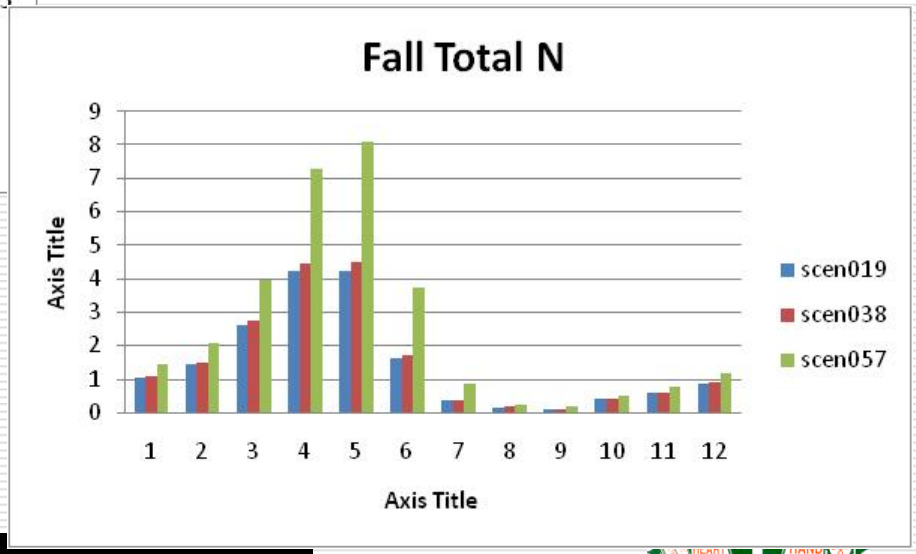
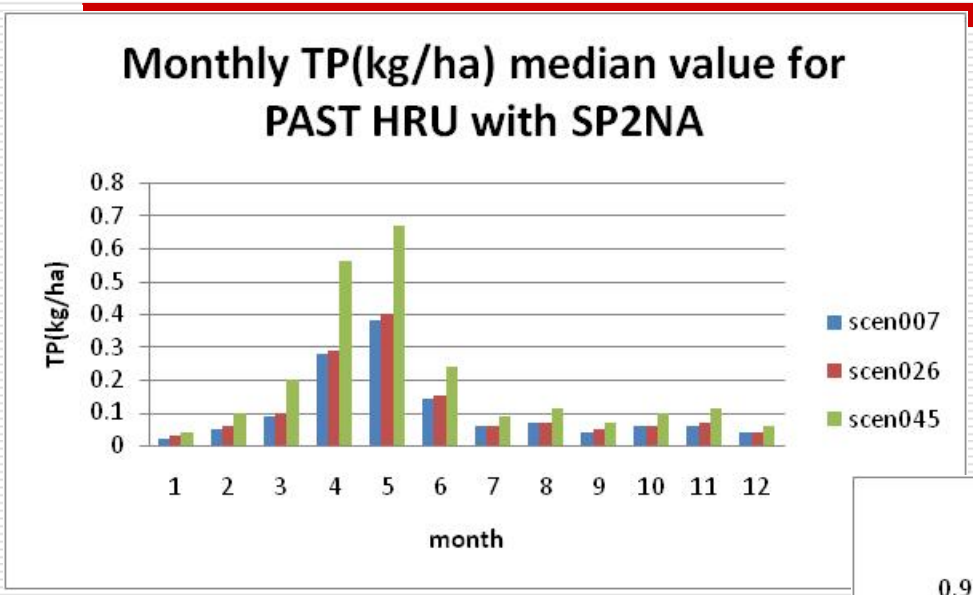
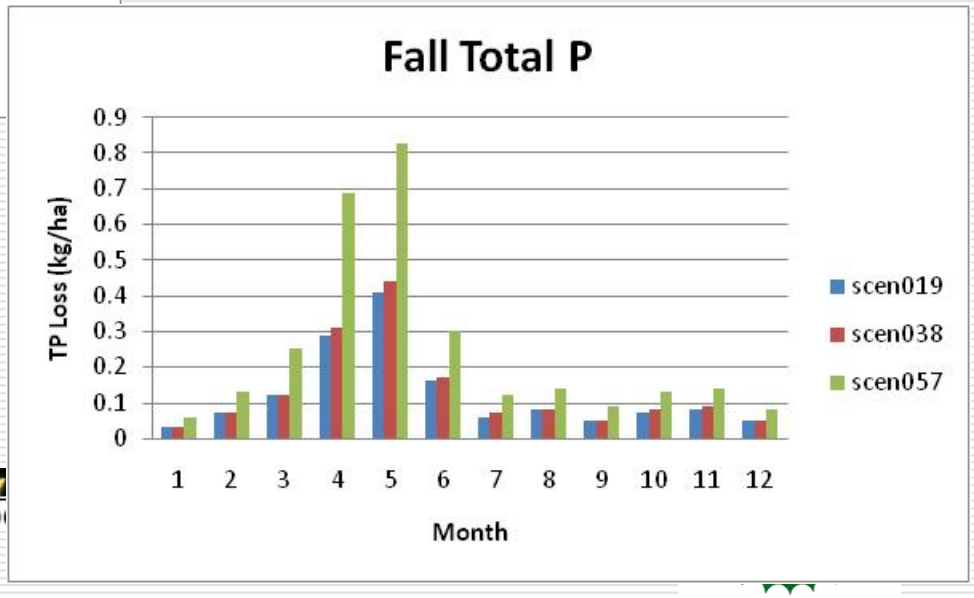


BMP Impacts on Monthly Losses

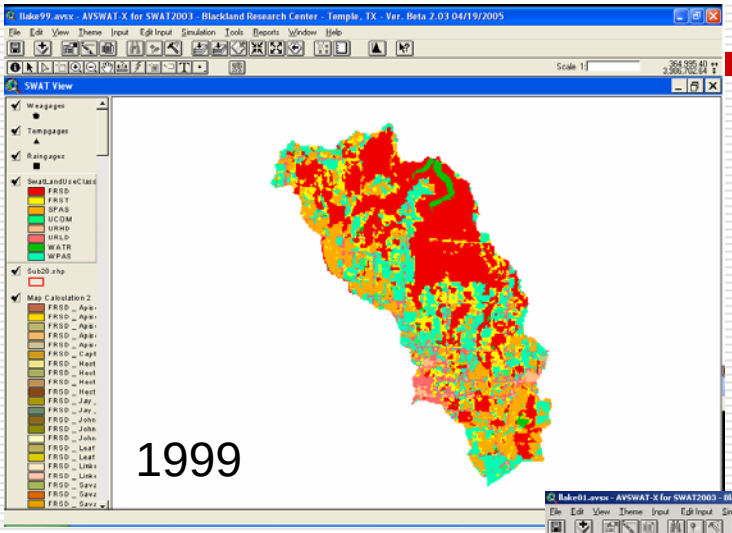





Monthly TP(kg/ha) median value for PAST HRU with SP2NA
TP(kg/ha)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10 11 12
month
scen007
scen026
scen045


Fall Total P
TP Loss (kg/ha)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10 11 12
Month
scen019
scen038
scen057

SWAT Modeling – BMP effectiveness over various time periods

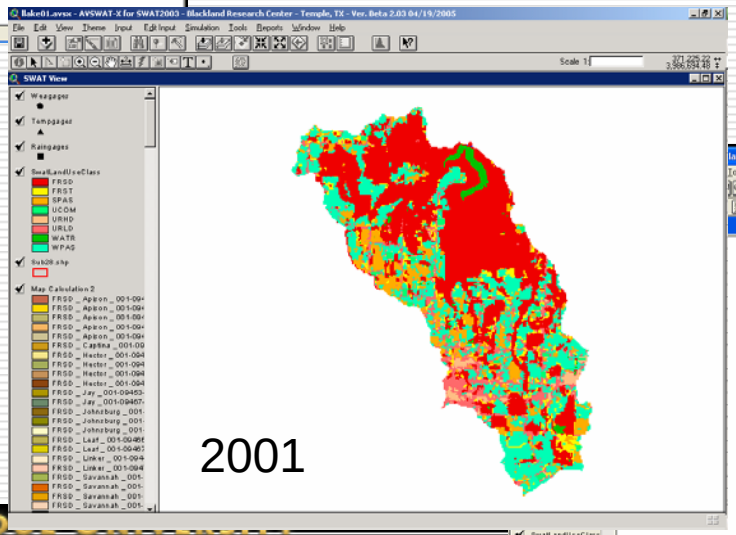


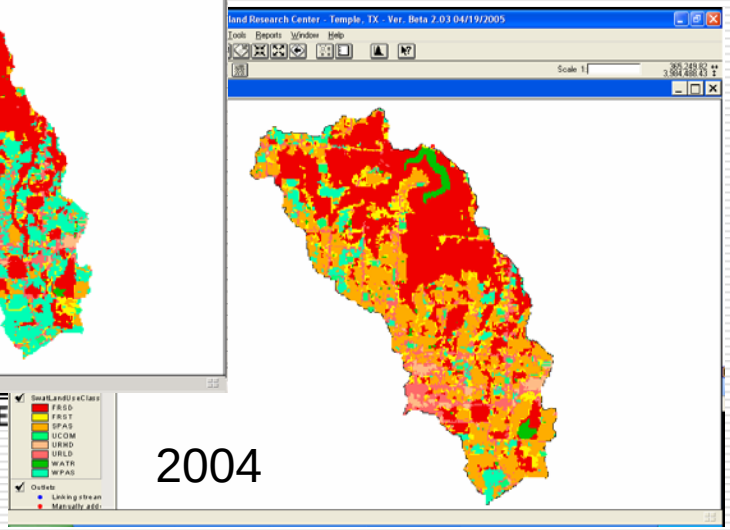
Different model set up for each period

Captures transition to urban land use

Transition to and from pastures

System established to track units over the years





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Applicability and Future Directions

- Scenario outputs currently being used for economic analyses in watershed
- Results will aid watershed planners in designing management interventions for water quality protection
- Study sets the stage for inherently computationally intensive research on optimizing BMP selection/placement.