

# Factors affecting phosphorus loads to surface waters: Comparing the roles of precipitation and land management practices

Melissa Motew

PhD Candidate, UW–Madison

Nelson Institute for Environmental Studies  
Center for Sustainability and the Global Environment

YAHARA2070



# Outline

- Project description
- Model framework
- Field-scale experiment
- Future work

# Water Sustainability and Climate in the Yahara River Watershed



**WISCONSIN**  
UNIVERSITY OF WISCONSIN-MADISON



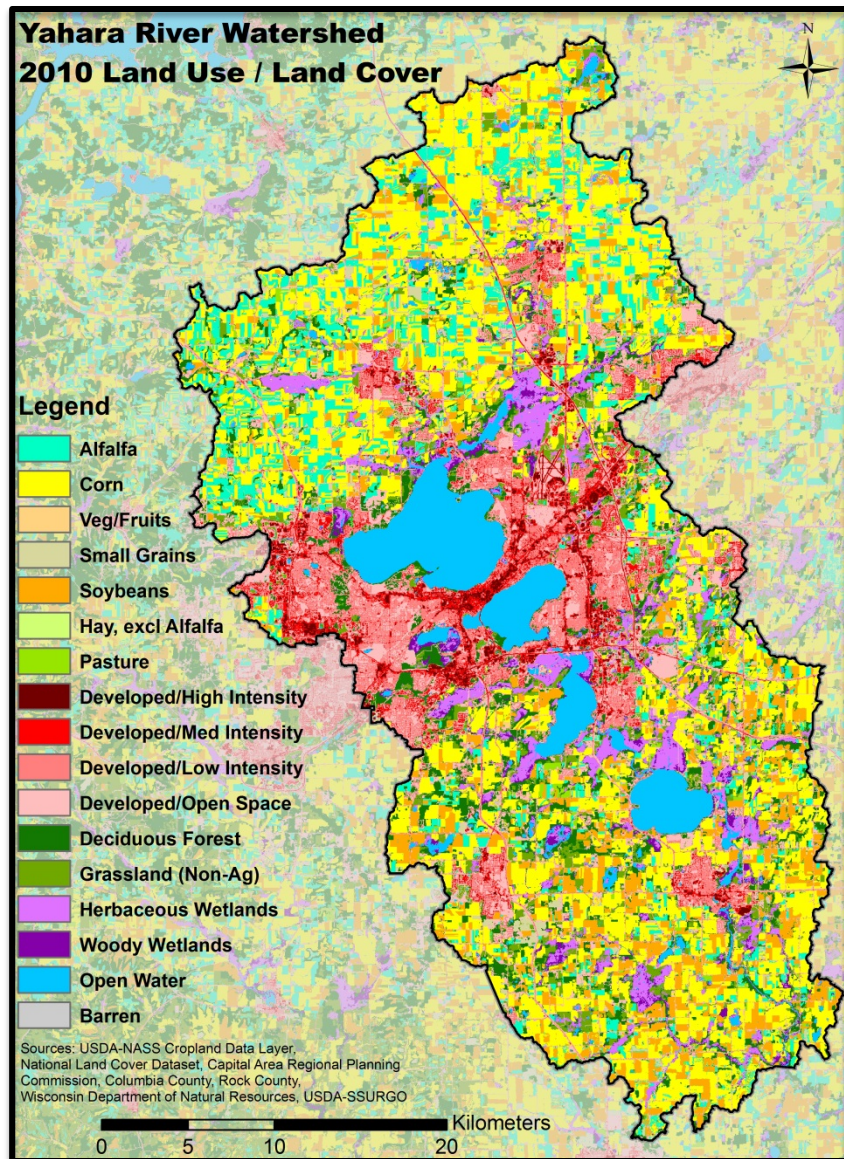
Research funded under  
grant DEB-1038759  
Water Sustainability and  
Climate (Category 2)





# Central Question

How will ecosystem services vary and how can they be sustained in the Yahara River watershed as climate, land use, land cover, the built environment, and human demands change in the future?



2015-2070



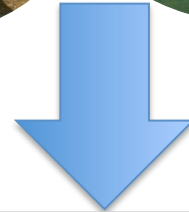
# Surface Water Quality



# Modeling Approach

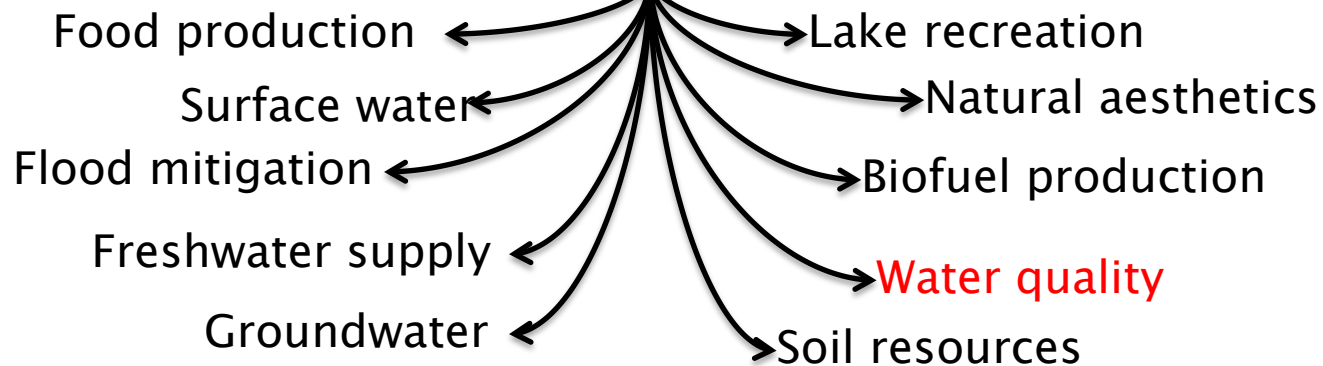


**Supply input  
driver data  
to models...**

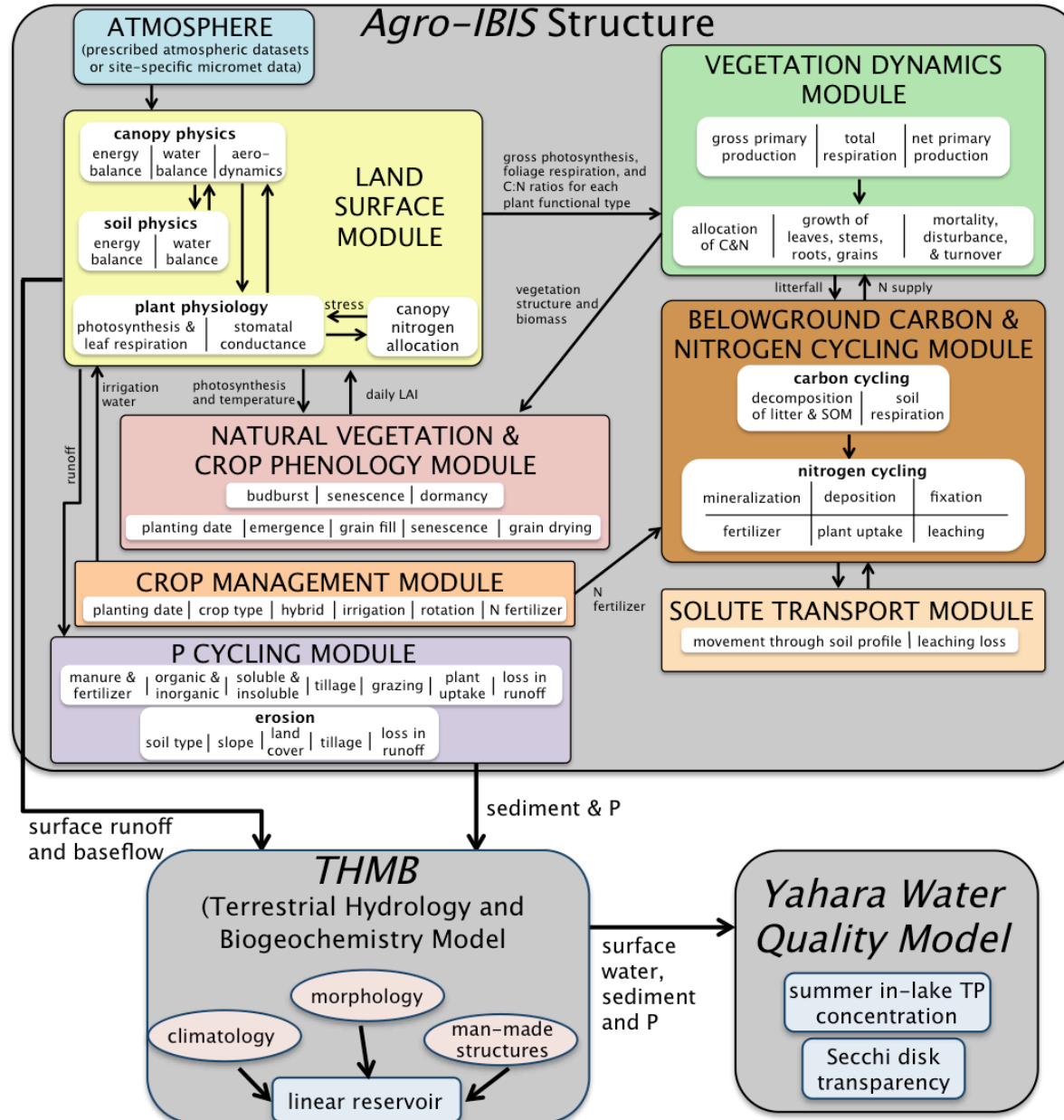


**Process-based  
numerical  
models**

**...to gauge  
their impacts  
on ecosystem  
services**



# Model Suite





# Effects of Precipitation, Tillage, Soil P Concentration, and Manure Rate on Field-Scale P loading

For a typical Wisconsin cornfield...



...how do these factors compare in a given year?

Precipitation



VS

Tillage



VS

Legacy P



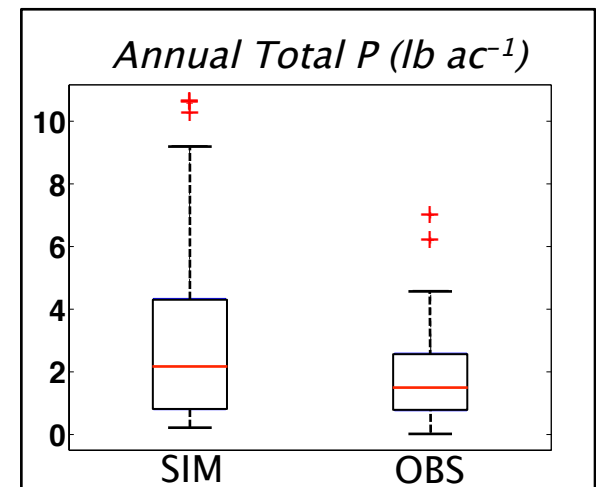
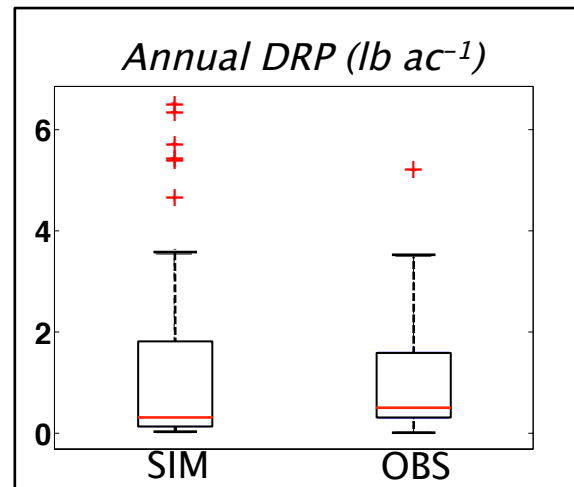
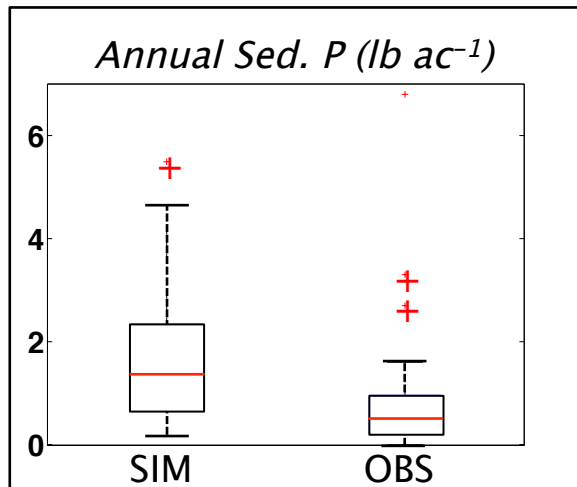
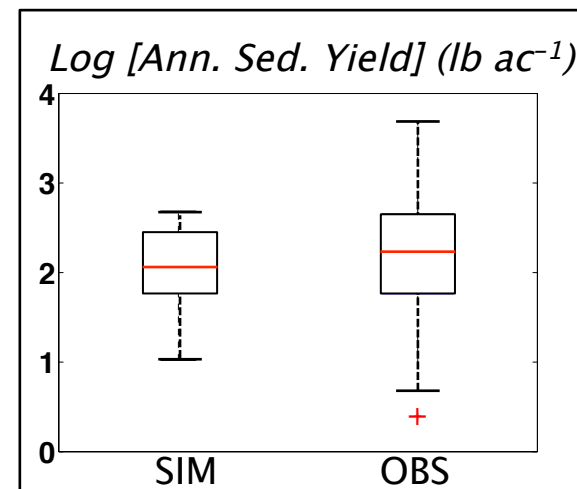
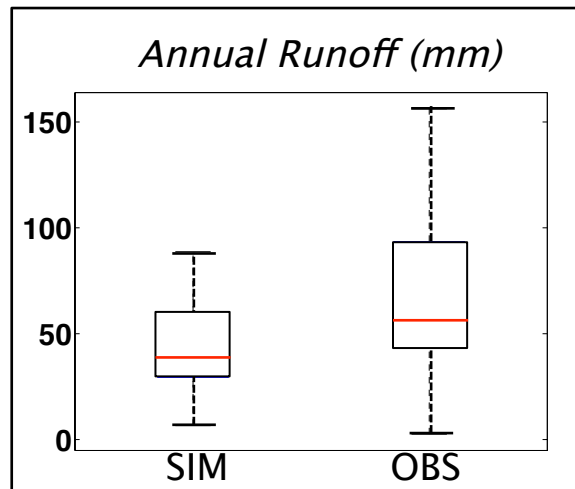
VS

Manure Application



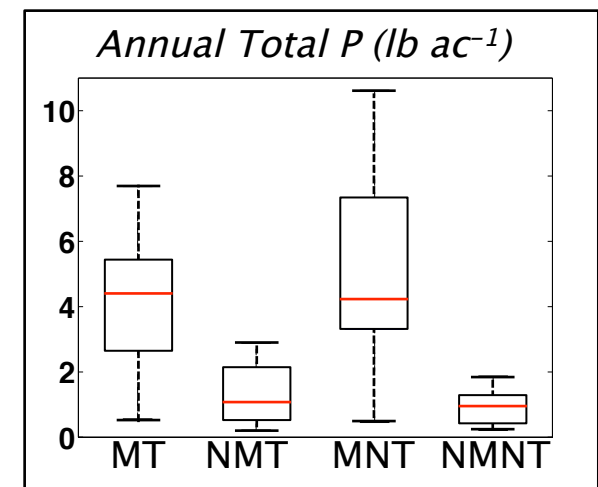
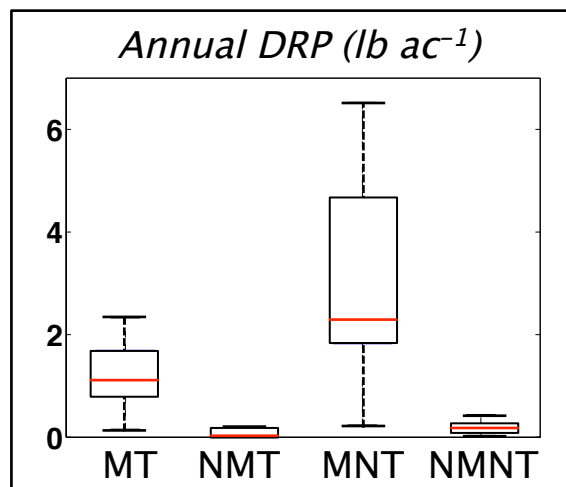
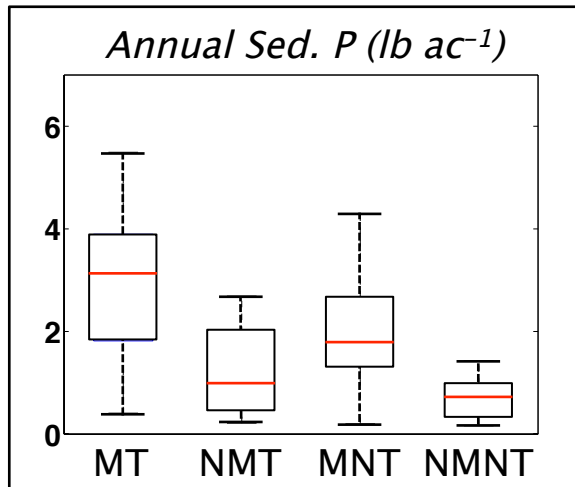
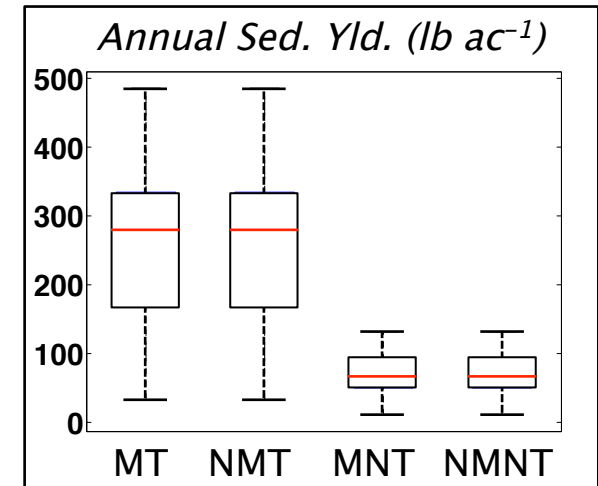
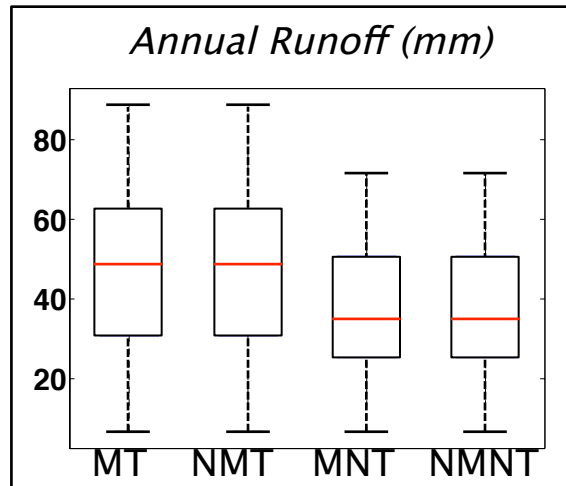


# Field-Scale Evaluation of P Module: Runoff, Sediment, and Runoff P

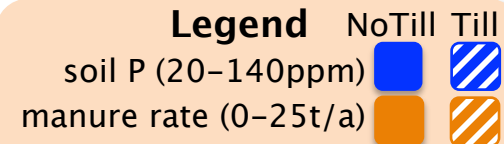
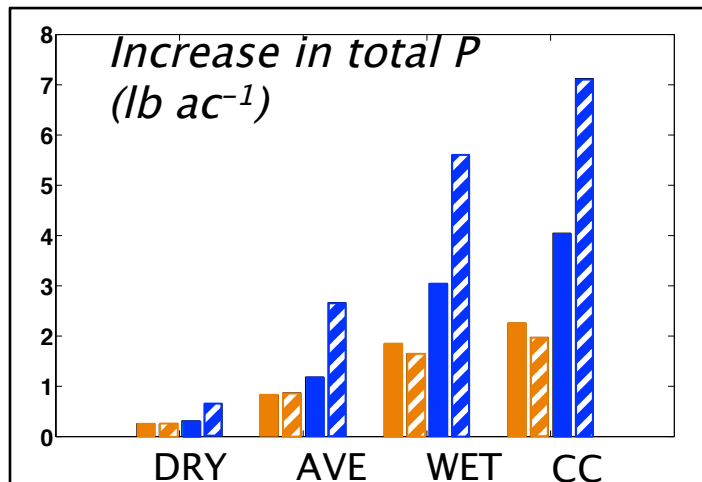
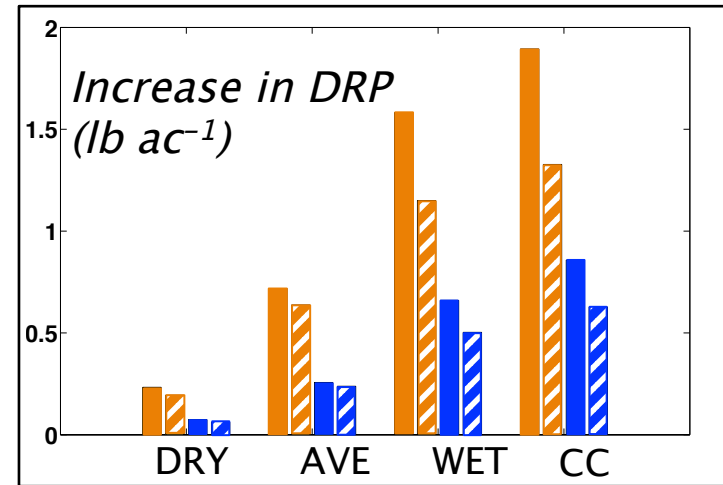
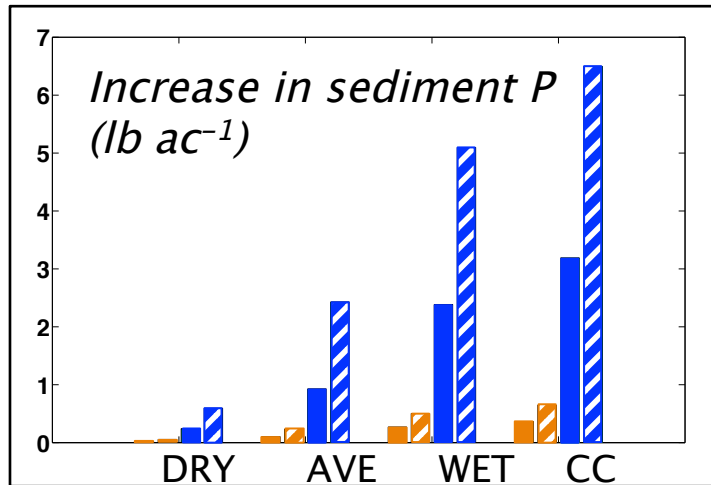


# Field-Scale Calibration of P Module: Manure Application and Tillage

MT = Manure, Tilled  
NMT = Manure, No Till  
NMT = No Manure, Tilled  
NMNT = No Manure, No Till



# Results: Effects of precipitation, tillage, soil P concentration, and manure rate on P load



## Simulation Details

DRY = 1988 (historic drought)  
 AVE = 2011 (average precipitation)  
 WET = 2008 (historic flooding)  
 CC = WET + 20% (artificial “climate change” year)  
 Location: northern Yahara Watershed  
 Manure applied Oct 1; Tilled on Oct 2  
 Slope: 4%  
 Soil type: silt loam

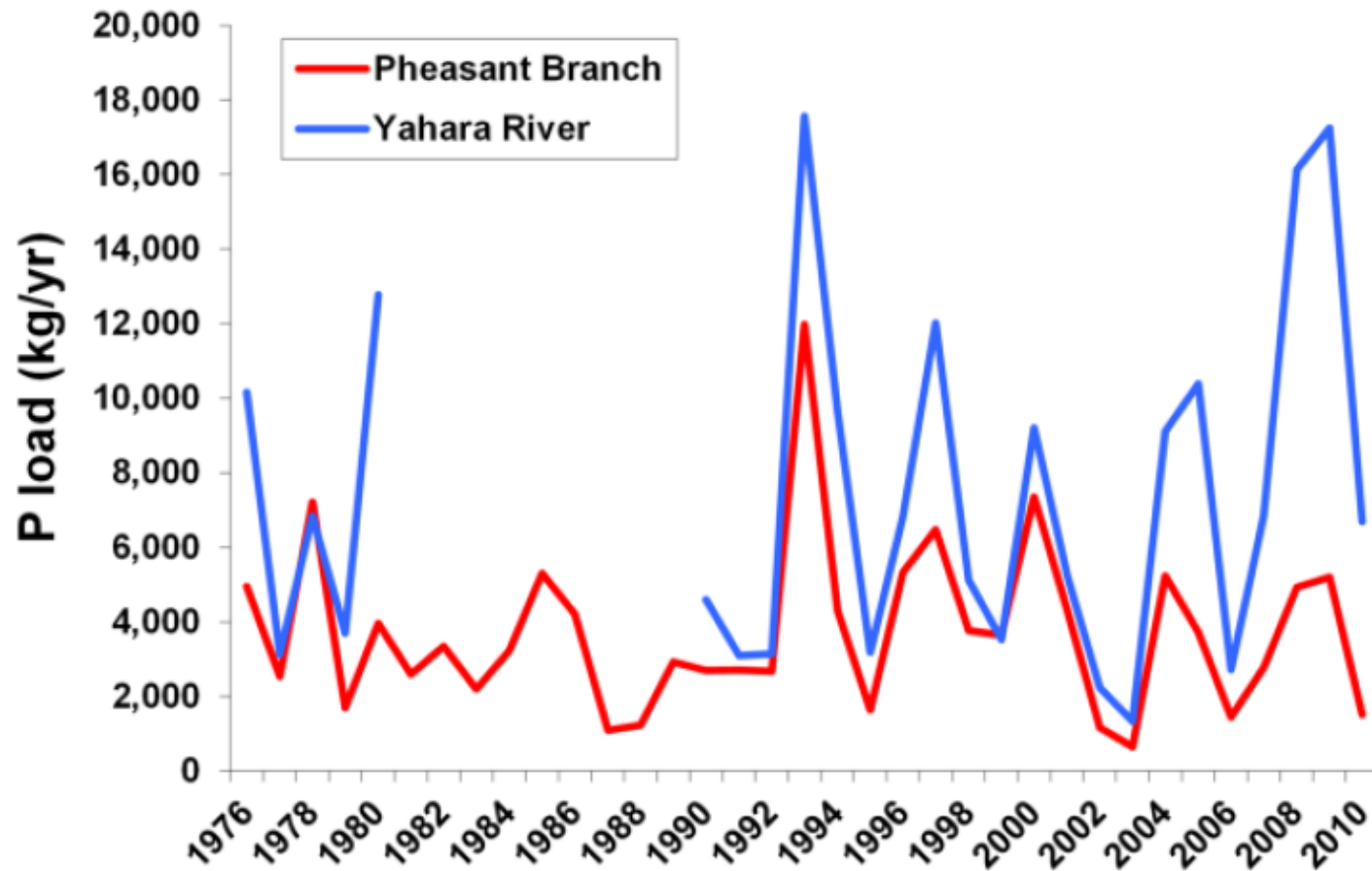


# Summary

Our results emphasize:

- the threat of increasing precipitation
- the possible\* benefits of conservation tillage
- the overarching problem of soil P accumulation

# Future Work: Historical drivers of water quality



(USGS data from Lathrop & Carpenter, 2011)

No trend in loads since 1976 despite mitigation efforts.

# YAHARA2070

yahara2070.org

## *Abandonment and Renewal*



## *Connected Communities*



## *Accelerated Innovation*



## *Nested Watersheds*





# Backups

# Research Elements

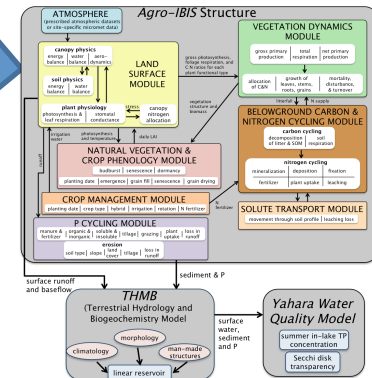
Integrated Scenarios =

- Qualitative Narratives
- **Quantitative Modeling**
- Biophysical Field Studies / Monitoring
- Landscape Analyses of Ecosystem Services
- Regional Governance

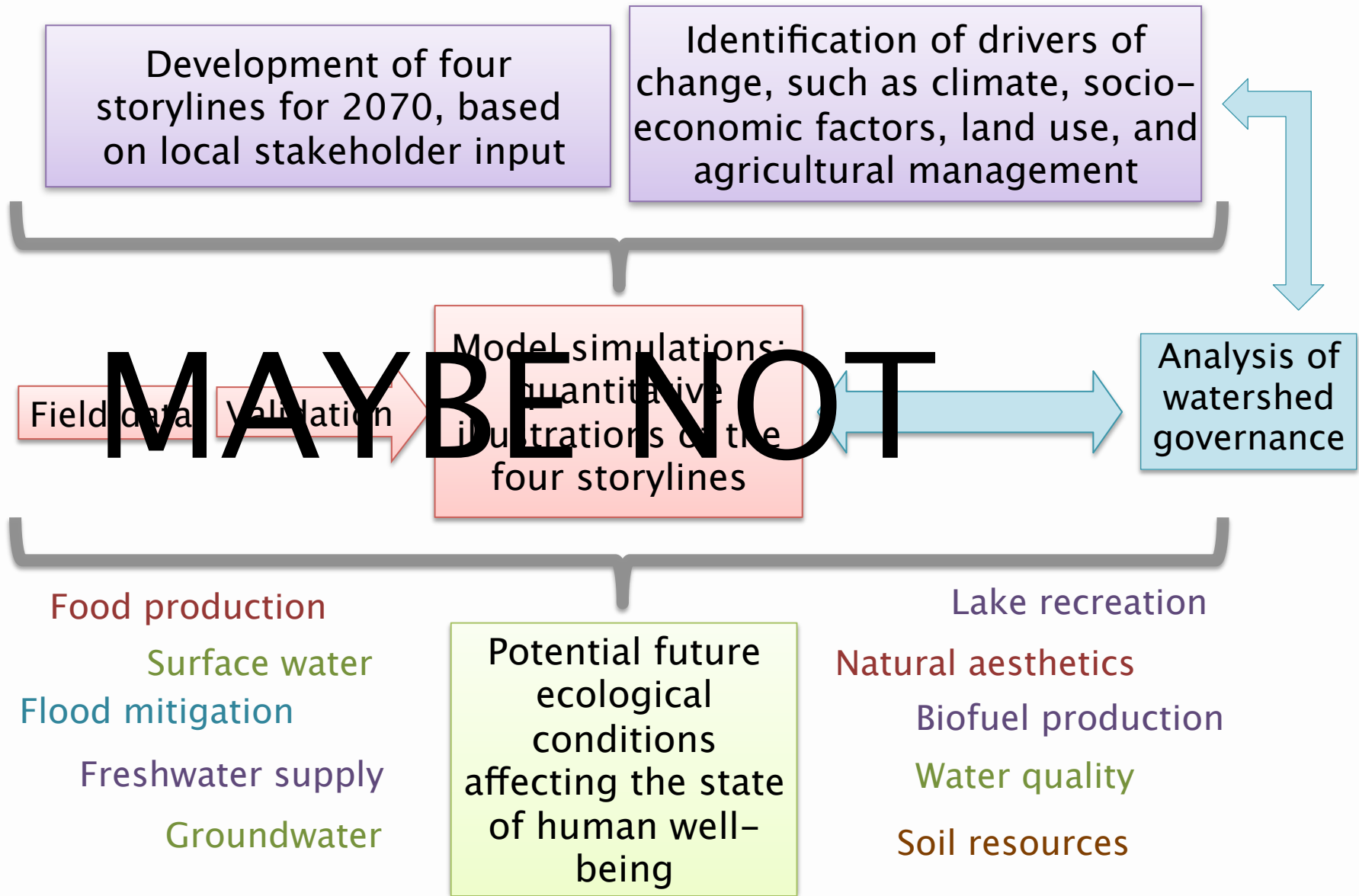
Narratives



Models



# Research Process/Framework





# Non-point Source Nutrient Pollution



**Lake users warned on algae, bacteria**  
Mendota, Kegonsa have advisories; 2 beaches closed  
By Bill Novak  
The Capital Times  
Algae advisories were in effect for Lakes Mendota and Kegonsa. Marshall Park and Spring Harbor beaches, both on Lake Mendota, have the lakes and from drinking the water if blooms show up. lently ill in blue-green toxic algae incidents on Lake Kegonsa in 2004, and people need to do everything they can to avoid it and have their pets avoid

