Global Water Futures Inaugural Annual Science Meeting 2018

Nitrate fluxes in agricultural catchments:

Spatio-temporal variations driven by flow pathways and transport mechanisms

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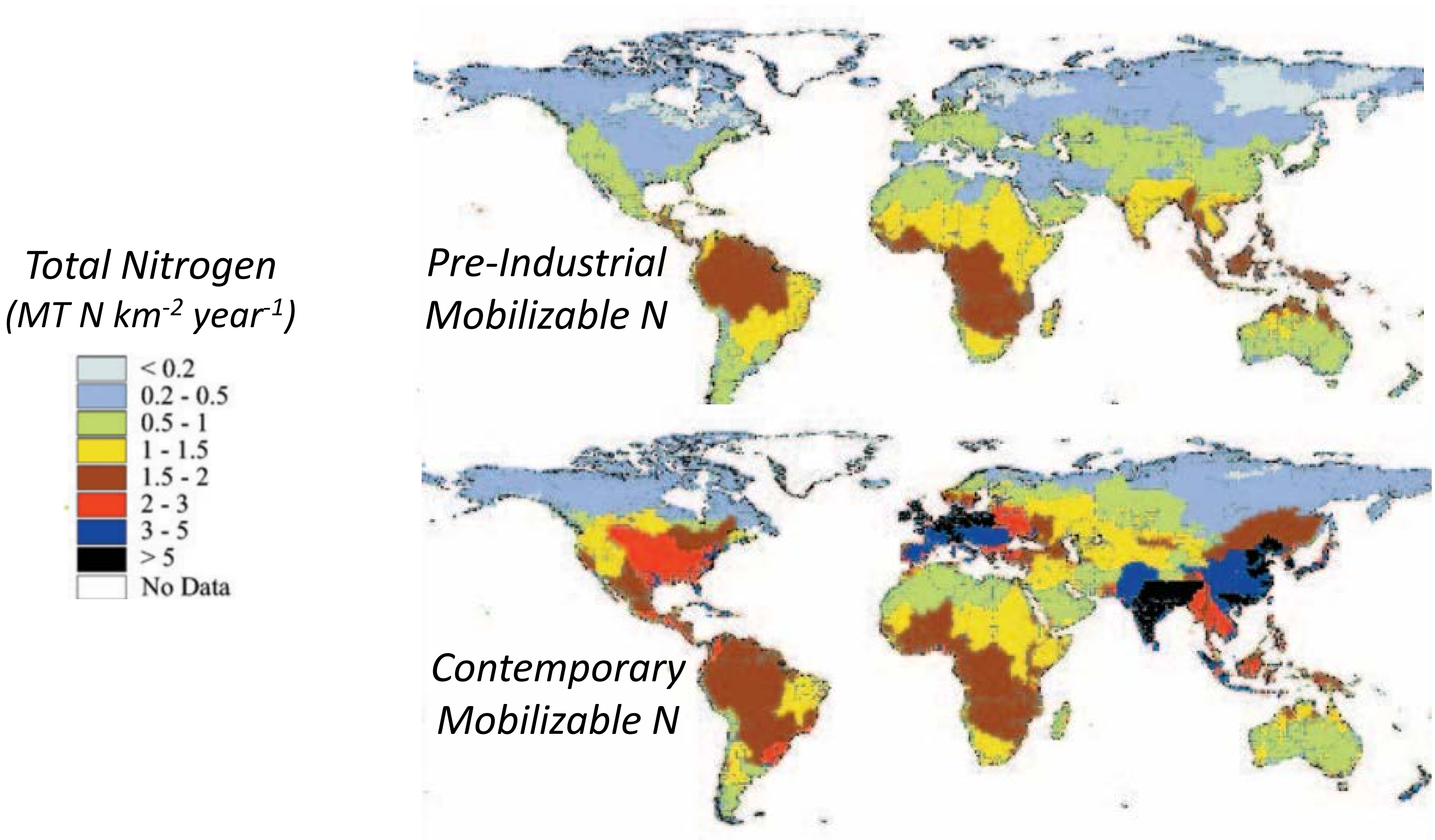
What is the issue?

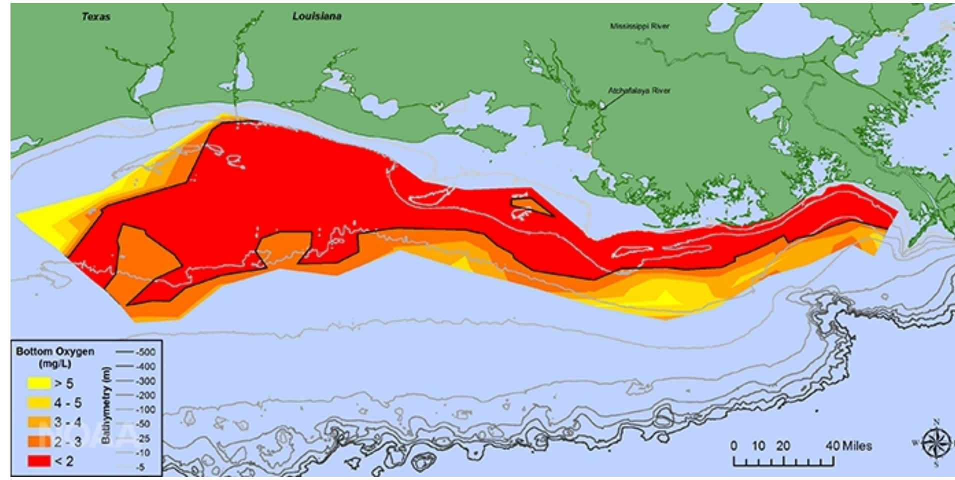
Elevated N concentrations and loadings



Green et al., *Biogeochemistry* 68.1 (2004)

Why is it important?

- ***Harm to fish and aquatic life***
- ***Pollution of drinking water wells***
- ***Causing <u>eutrophication</u> and <u>hypoxia</u>***

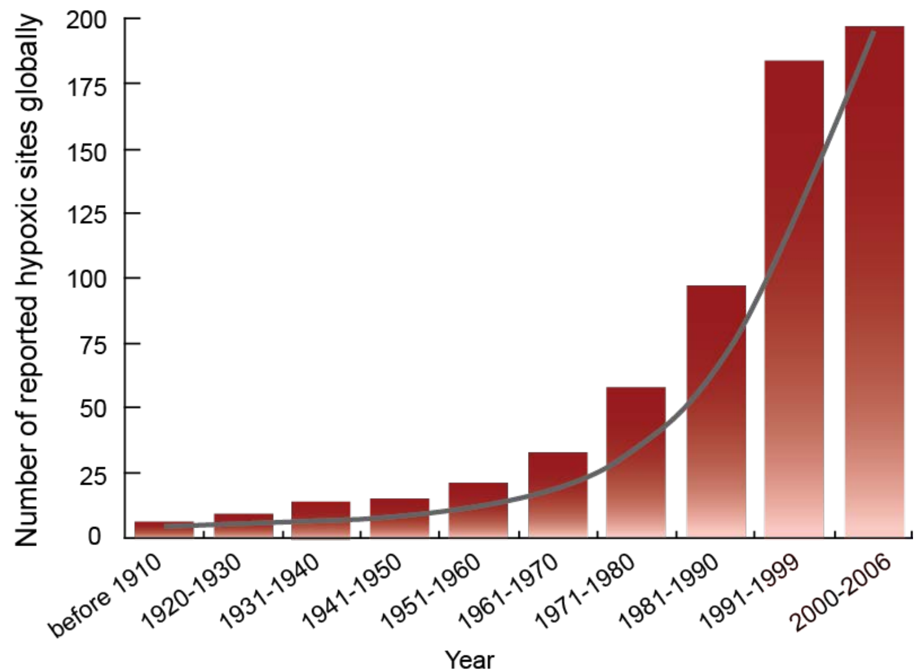


2017 Gulf of Mexico dead zone:

<u>8,776 mi^2, 1.2 x Lake Ontario</u>

Global scale:

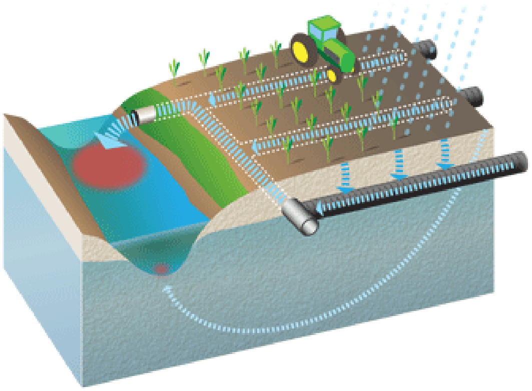
<u>Increasing number of reported hypoxic sites</u>

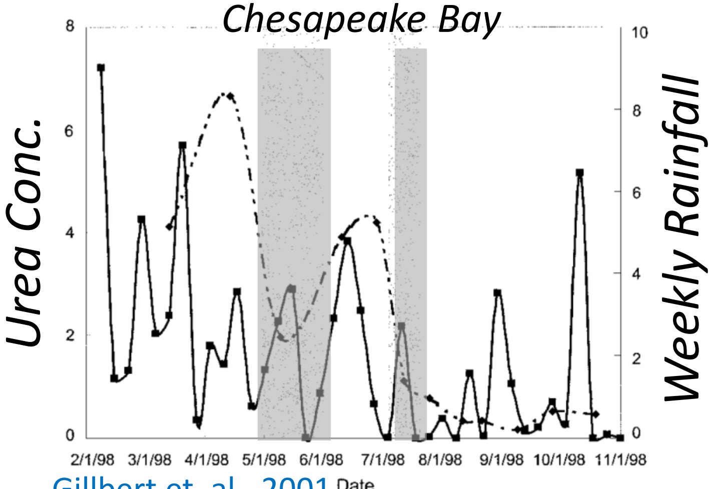


Adapted from Diaz, R.J. and R. Rutger Rosenberg. 2008. Spreading Dead Zones and Consequences for Marine Ecosystems. *Science* 321, 926.

Nitrogen sources and forms

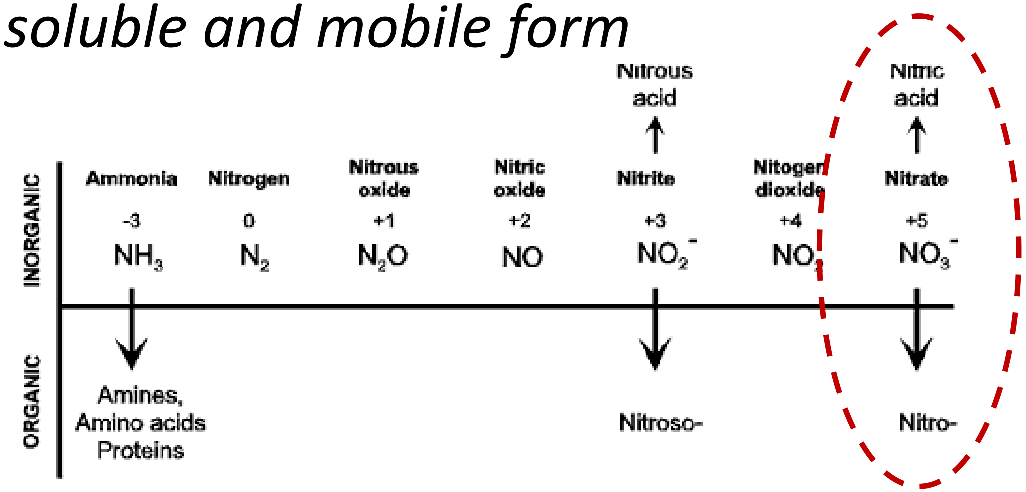
- ❑ *Mostly agricultural*





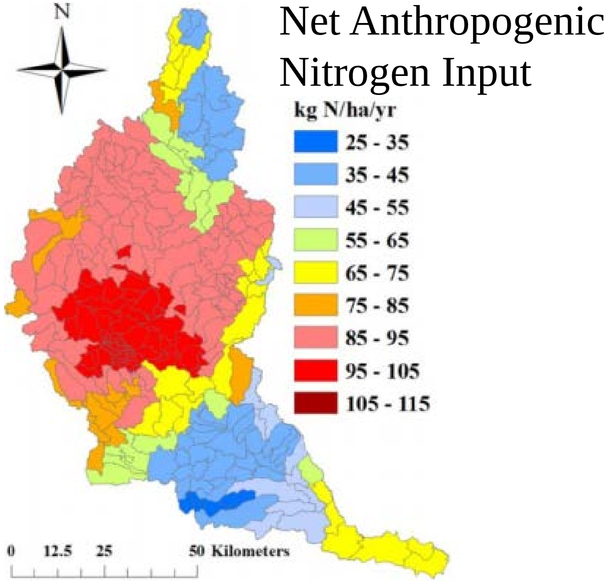
Gillbert et. al., 2001

- ❑ *Nitrate as the soluble and mobile form*



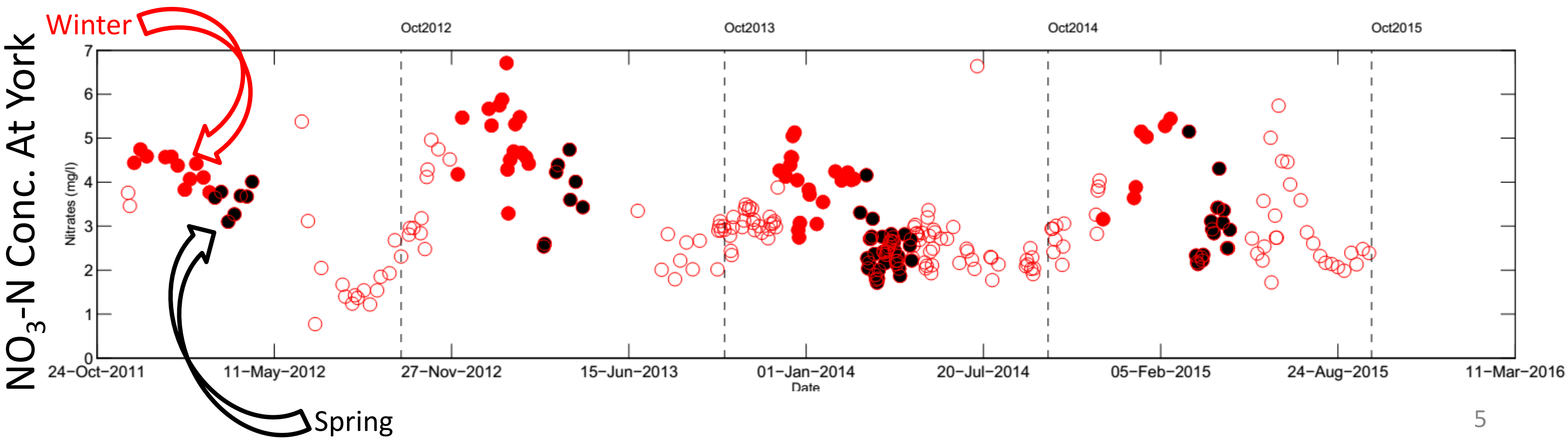
- ❑ ***Understanding the fate and transport of N within watersheds is the key for reliable predictions***

Grand River Watershed (GRW)



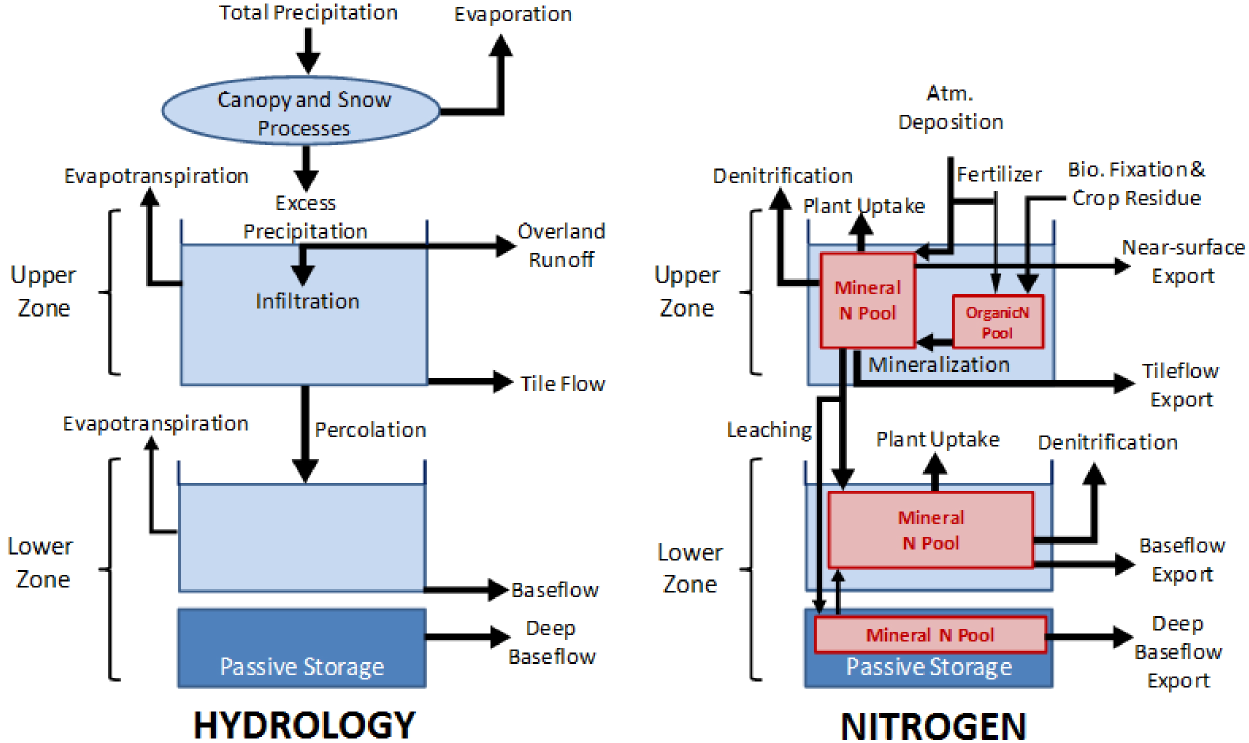
Zhang (2016)

Nitrate dynamics:



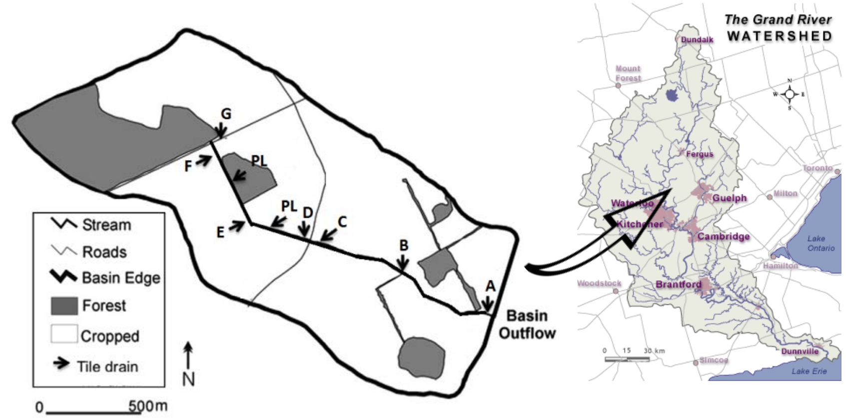
Objectives

Develop a N model for GRW to guide management options



- Explore the possibility of **using field data** for **constraining flow partitioning** in the model (small-scale modeling)
- Implement **spatially-varying parameters** to incorporate flow pathways variations (large-scale modeling)

Small-scale Experiment



Strawberry Creek Catchment:

<u>Available tile discharge data:</u>

- ➢ Daily discharge at one tile
- ➢ Scattered measurements at all tiles

<u>**Calibration scenarios:**</u>

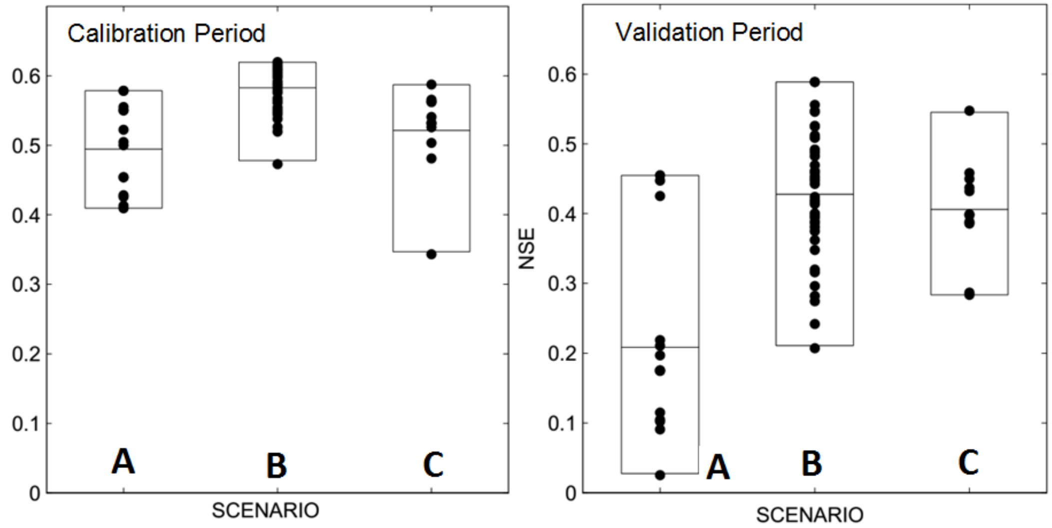
A. Only streamflow *(Nash-Sutcliffe Efficiency metric, NSE)*

B. Streamflow + tile flow*
    * constraint: 40-60% of annual water yield *(based on previous studies)*

C. Streamflow & tile flow**
    ** constraint: 40-60% of annual water yield *(based on previous studies)*
    & used daily tile flow data

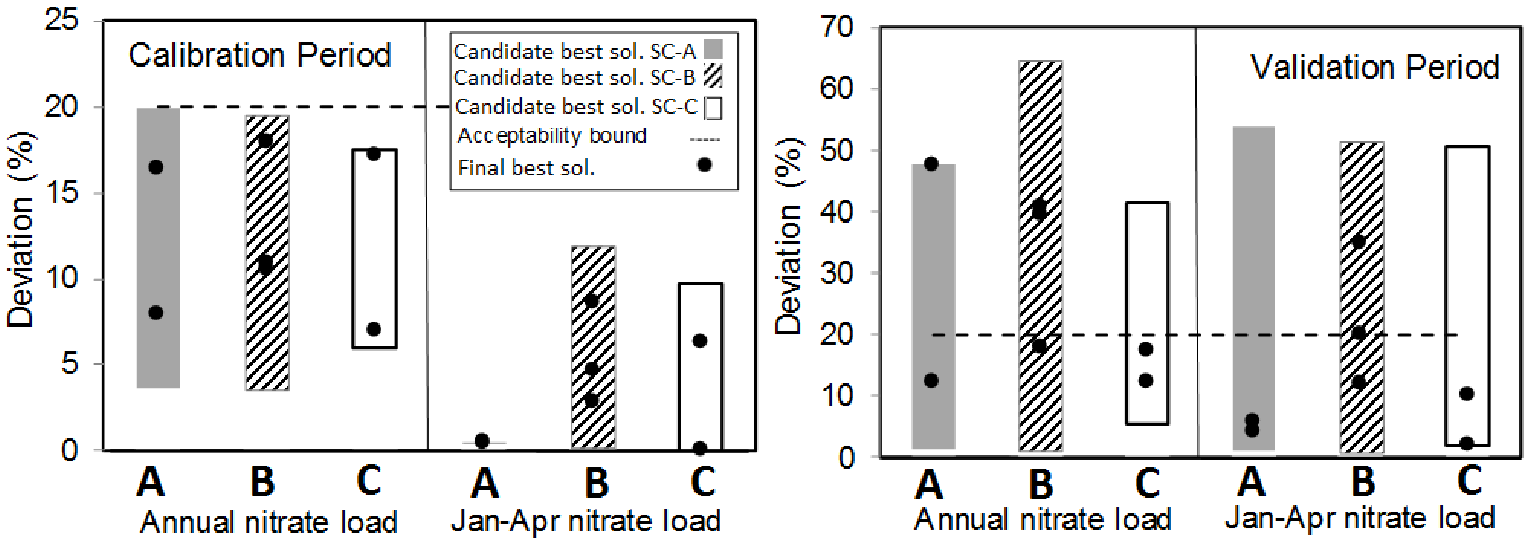
Small-scale Experiment

Nitrate loading NSE:



& signatures:

Acceptable



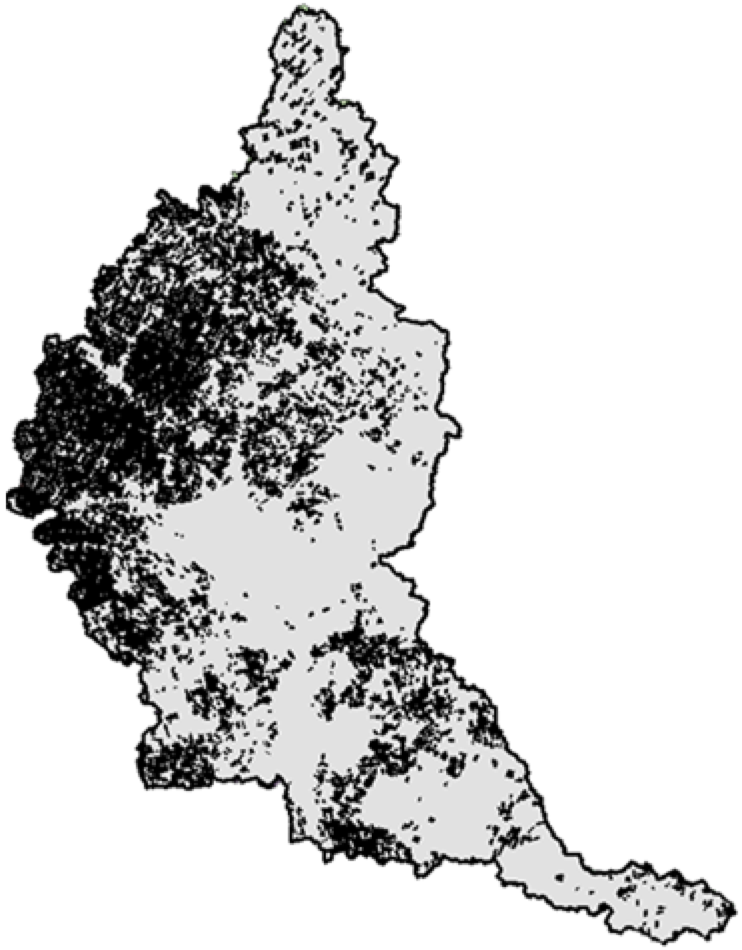
Acceptable

Large-scale Experiment

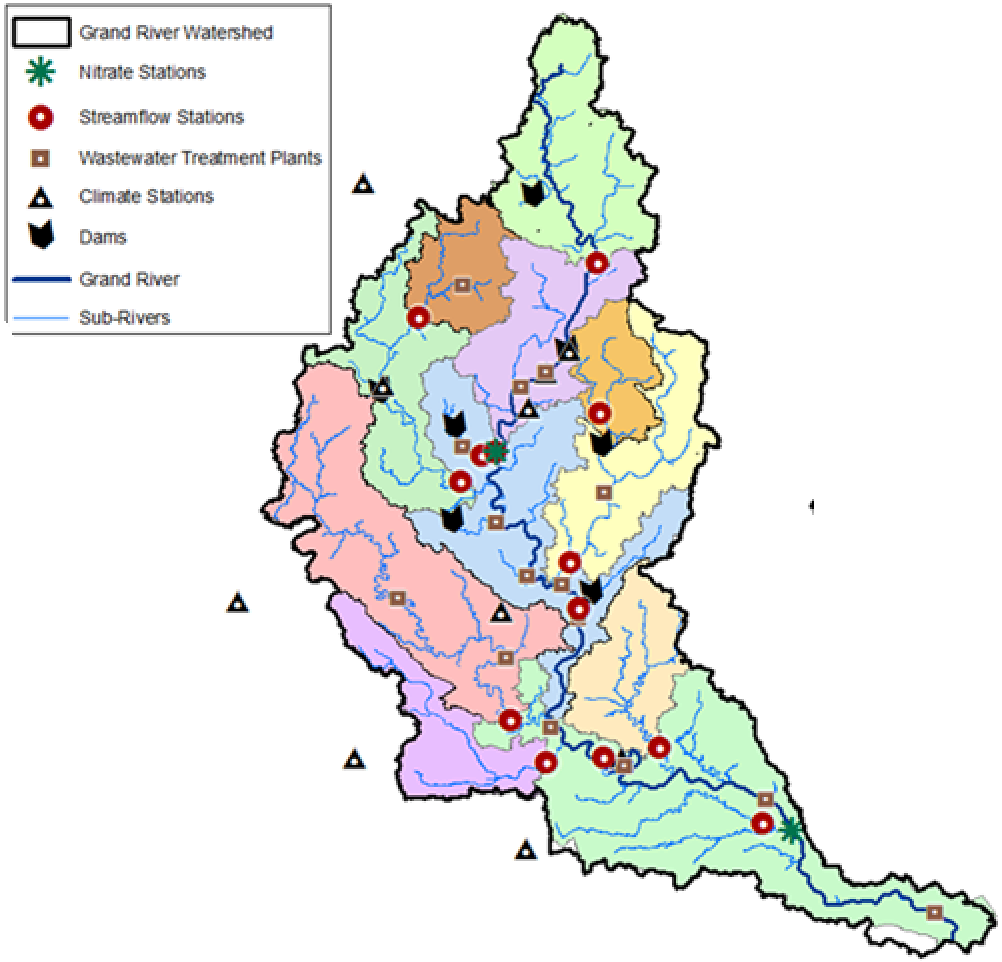
Grand River Watershed:

- Independent calibrations from north to south (spatially-varying parameters)

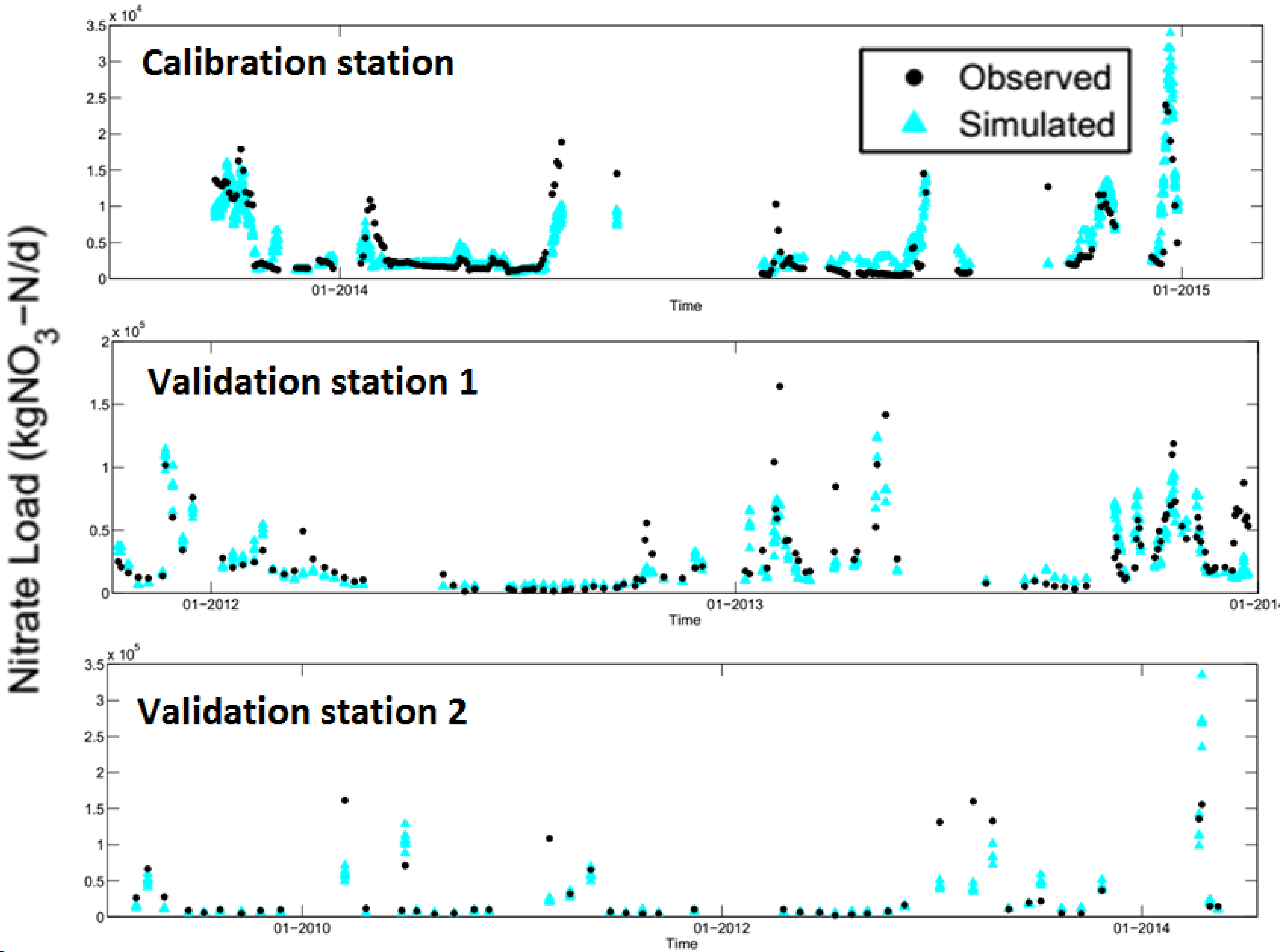
Tile-drained Areas



Calibration Zones

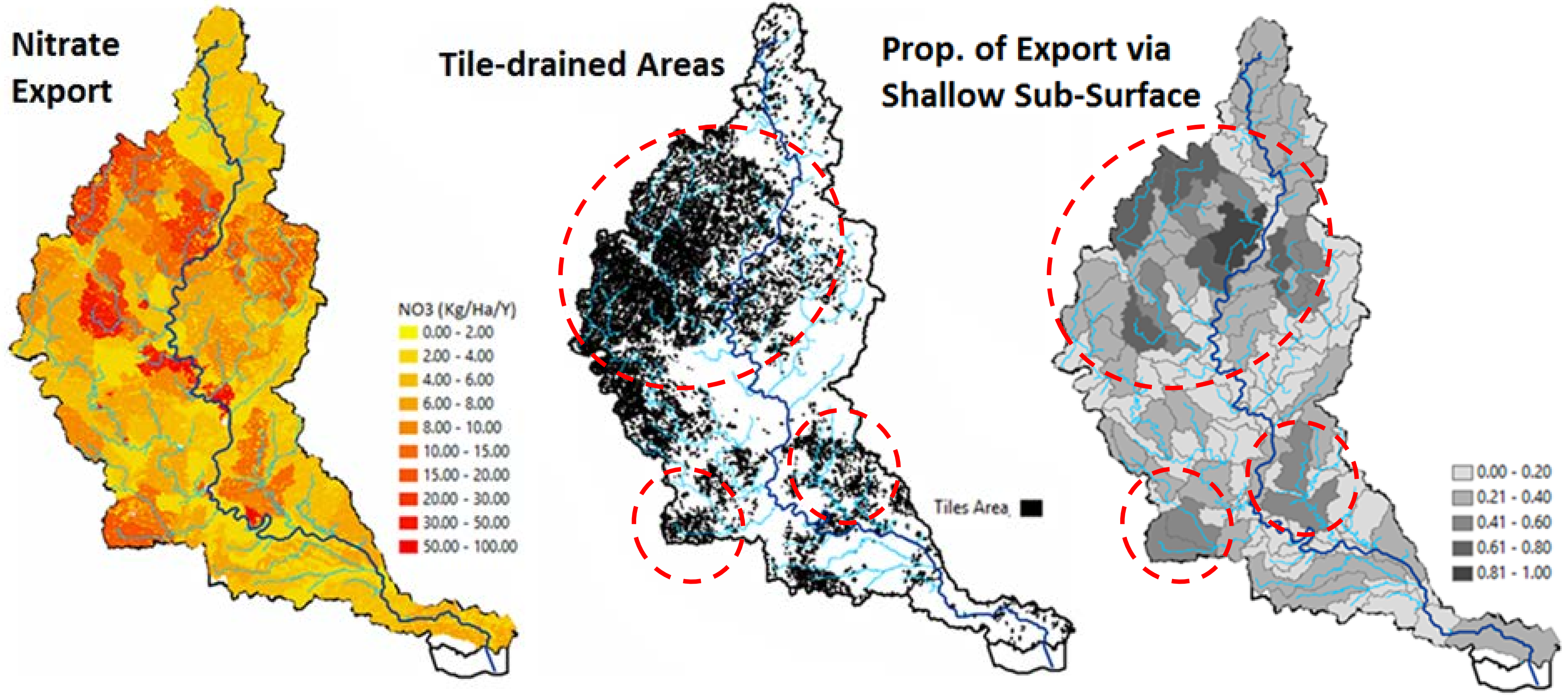


Large-scale Experiment



Large-scale Experiment

Spatial variability of nitrate export controlled by **inputs** and **flow paths**:



Conclusions:

- Elevated N loadings put drinking water supply at risk and impact ecosystem health, e.g., through eutrophication of receiving waters
- Constraining hydrologic partitioning in models enhances their biogeochemical predictive capability
- Obtaining an estimate of the annual proportion of water coming through tiles improves predictions
- Watershed-scale nitrate response is controlled by input fluxes as well as the spatial variability of flow paths

Thank you

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Special thanks to my co-authors, and supporting organizations: