Role of Prior Converted Croplands on Nitrate Processing in Agricultural Landscapes

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Prior Converted Croplands

- Wetlands that were drained prior to the Swampbuster provisions of the 1985 Food Security Act.
- PCCs can revert to wetland status if land is not cropped for five consecutive years.
- Although drained, substantial evidence for PCCs retaining some wetland character.
- Evidence for biogeochemistry of CPPs being an important determinant of nitrate export.

Field Scale Observations

Drainage Status of PCCs

Crop growth Patterns

Wet year (2015)

Dry year (2010)

- Crop growth patterns reflect different water holding capacities
- Soil biogeochemistry highly dependant on water content

Crop growth *vs.* Topography

Crop growth *vs.* Topography

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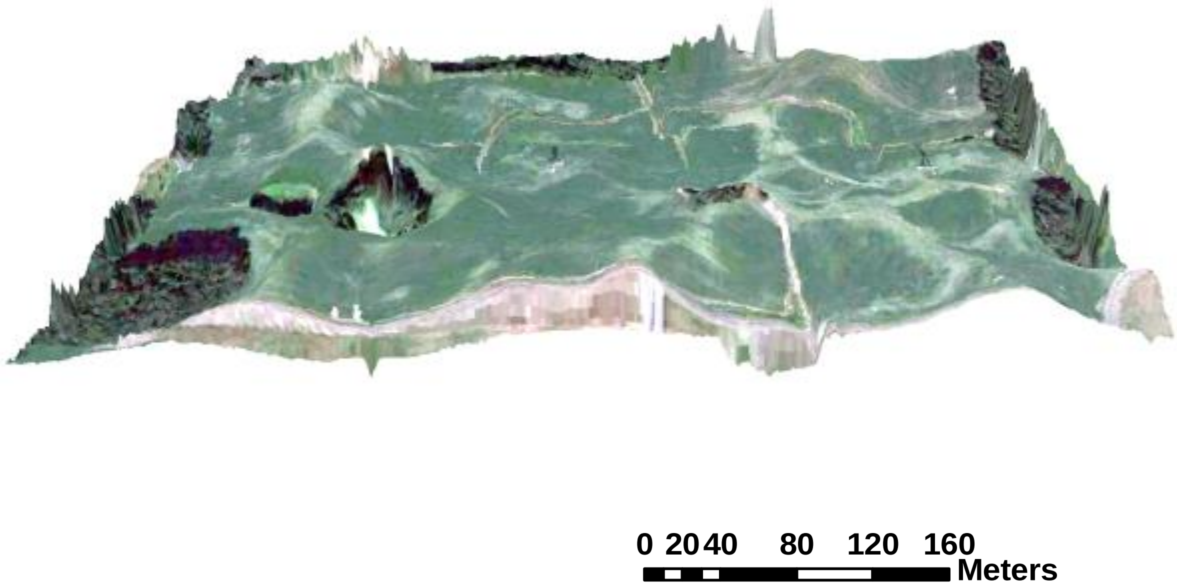
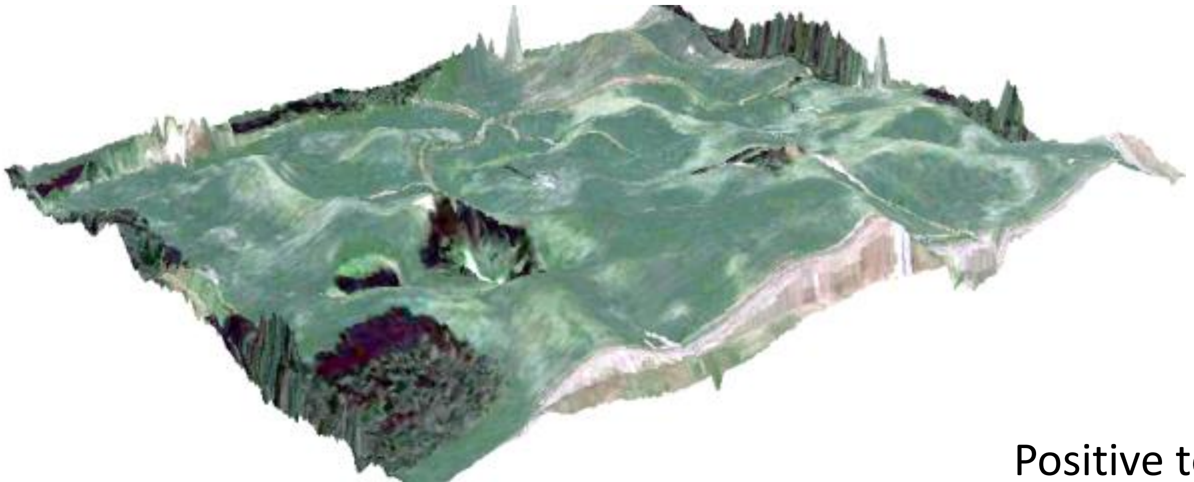
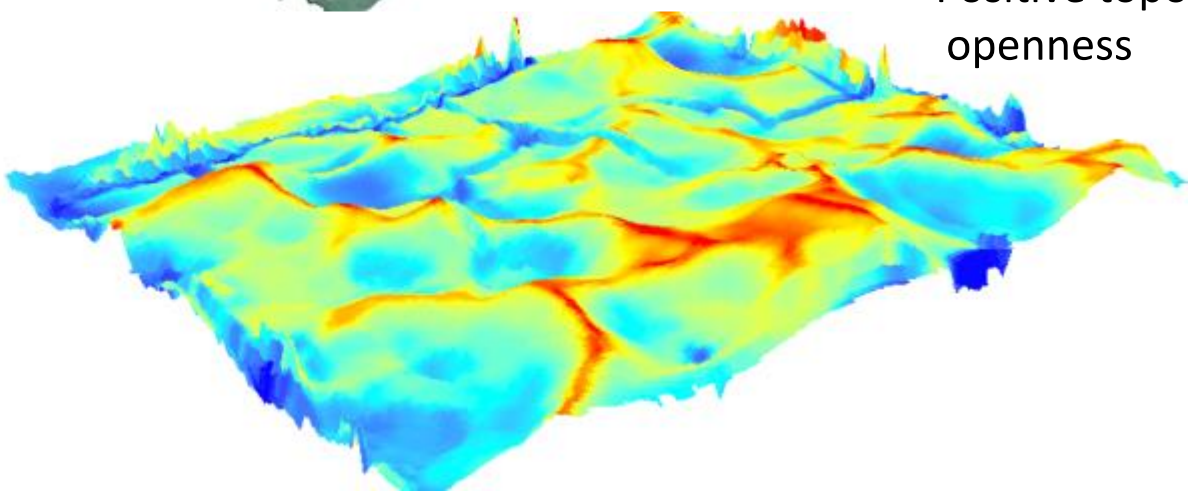


Representing depressions in the landscape



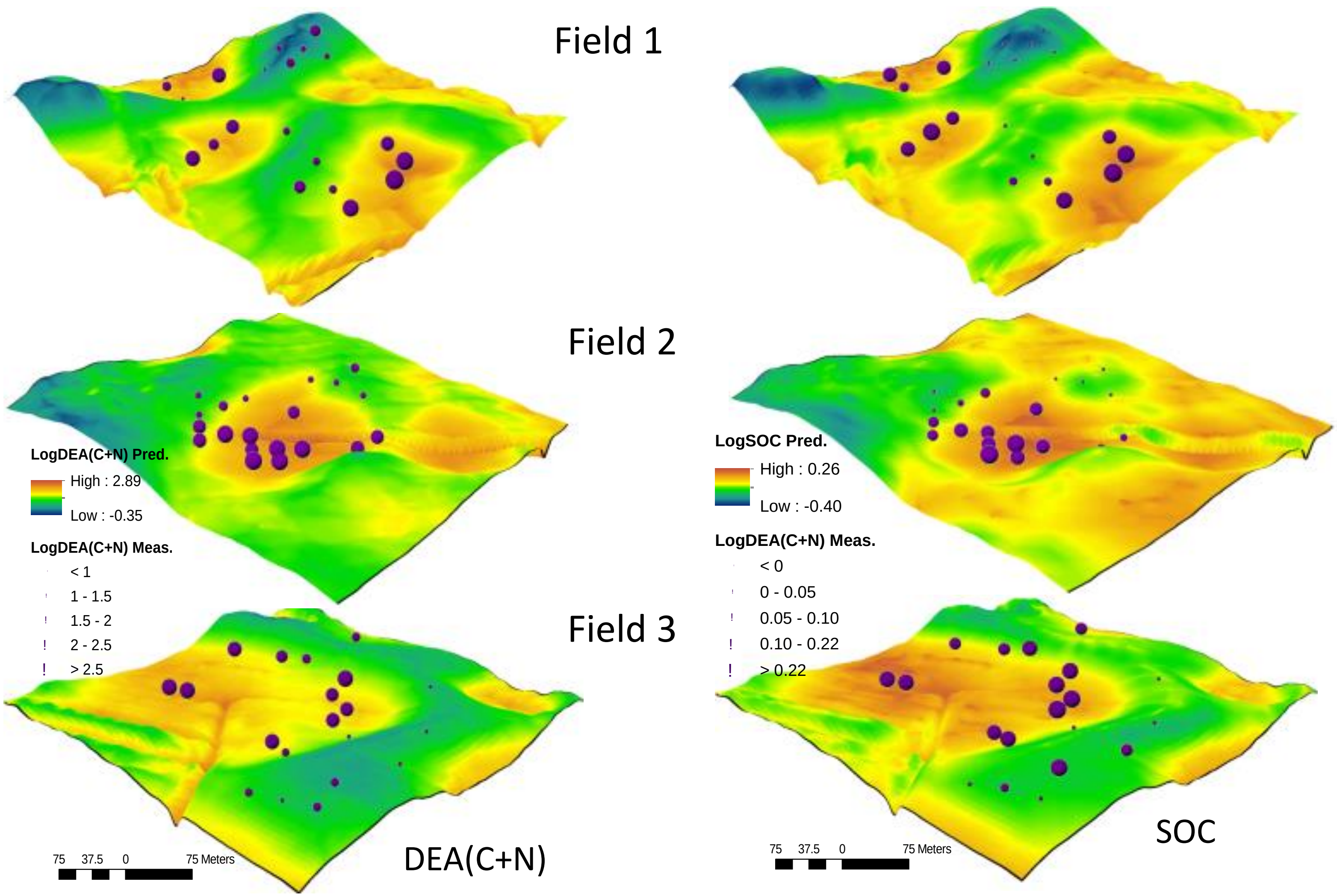


Positive topographic openness

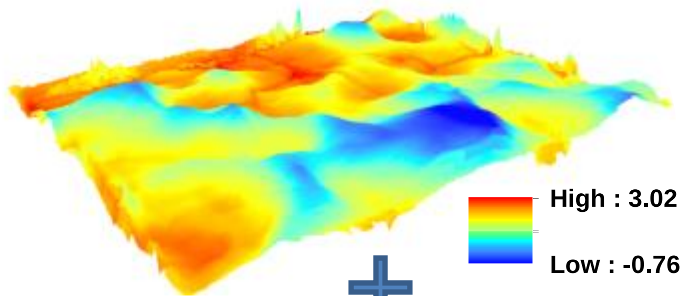
May provide a useful tool for mapping PCC’s

Mapping Denitrification Potential & SOC

Predicted *vs.* Observed

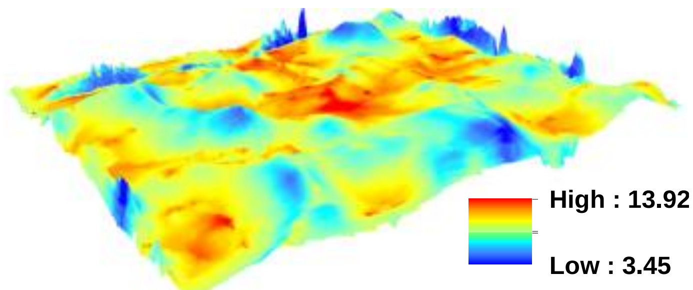


Denitrification potential map based on a topographic model



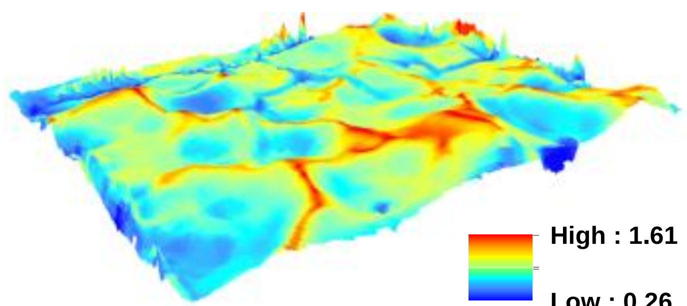
Local Relief

+



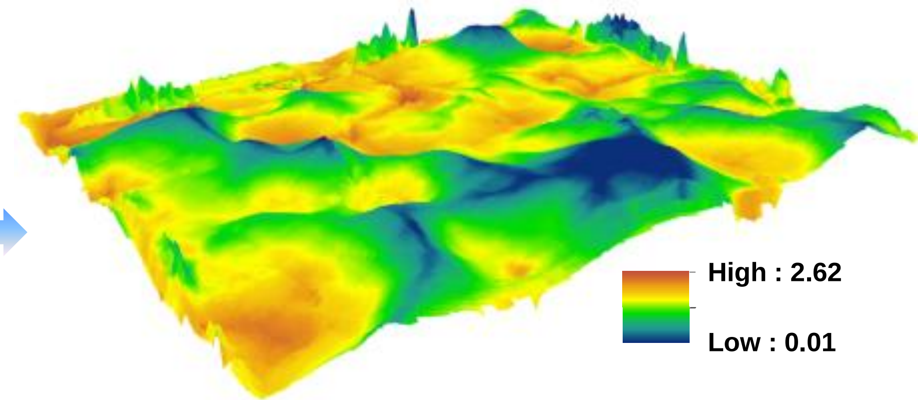
Topographic Wetness

−



Topographic Openness

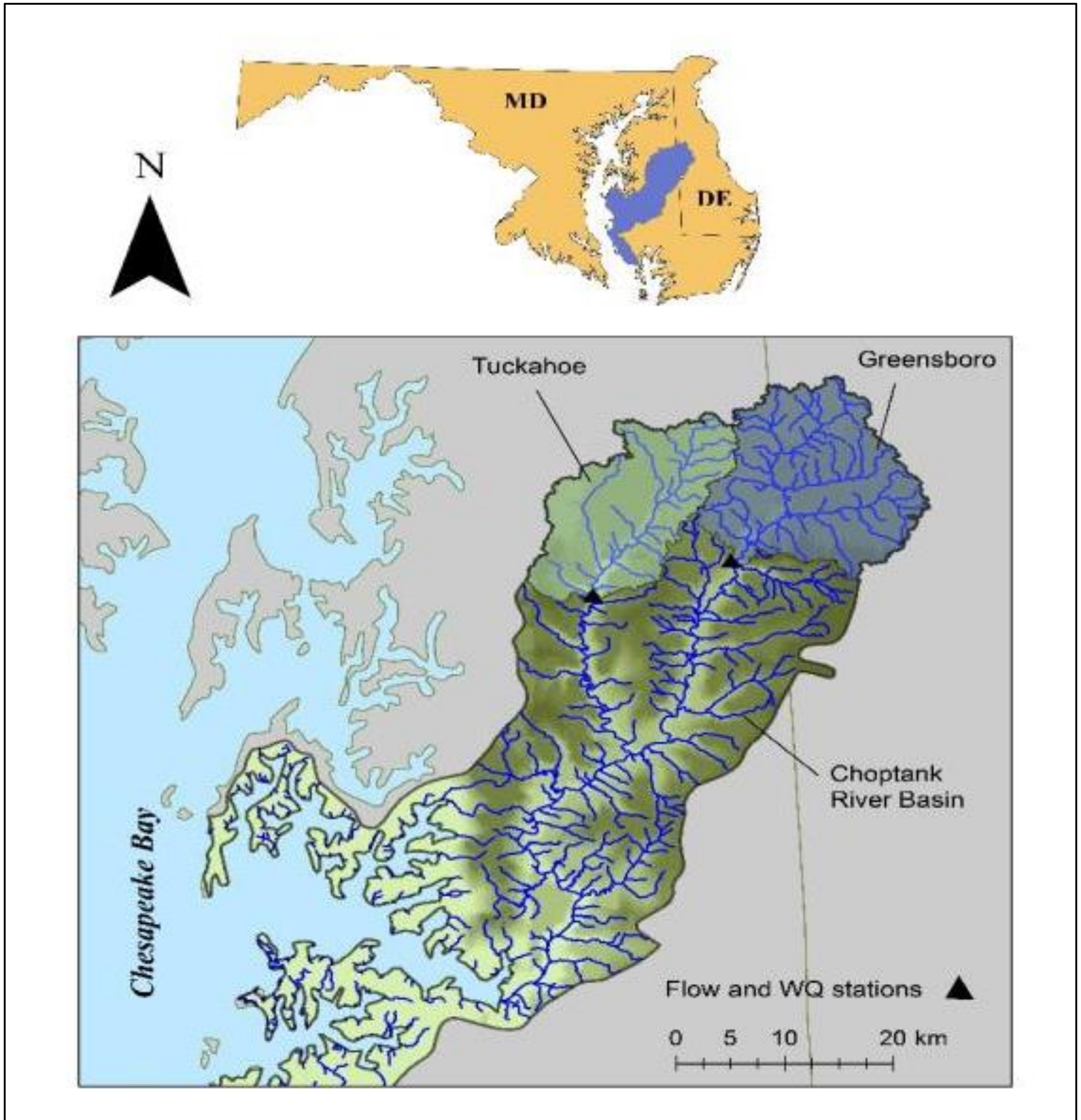
Over 60% of the variance accounted for by three parameter models



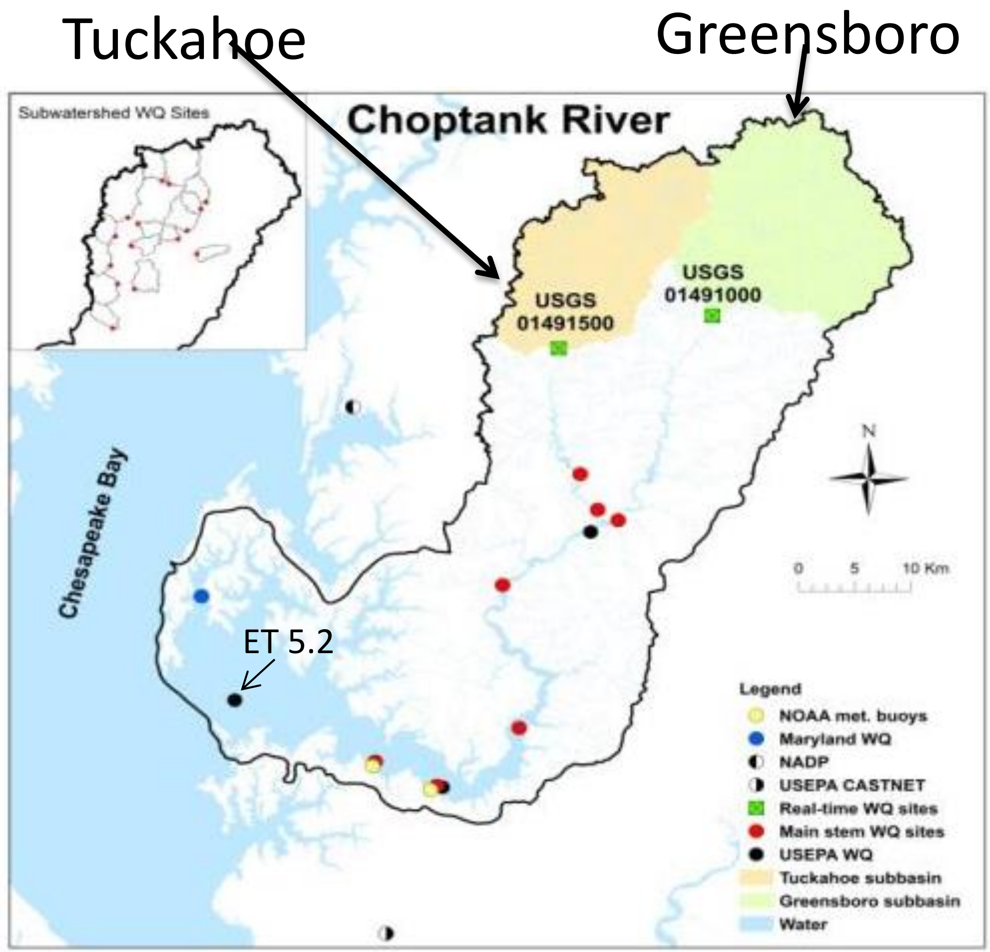
PCCs have elevated denitrification potential which can be mapped using Lidar

Watershed Scale Observations

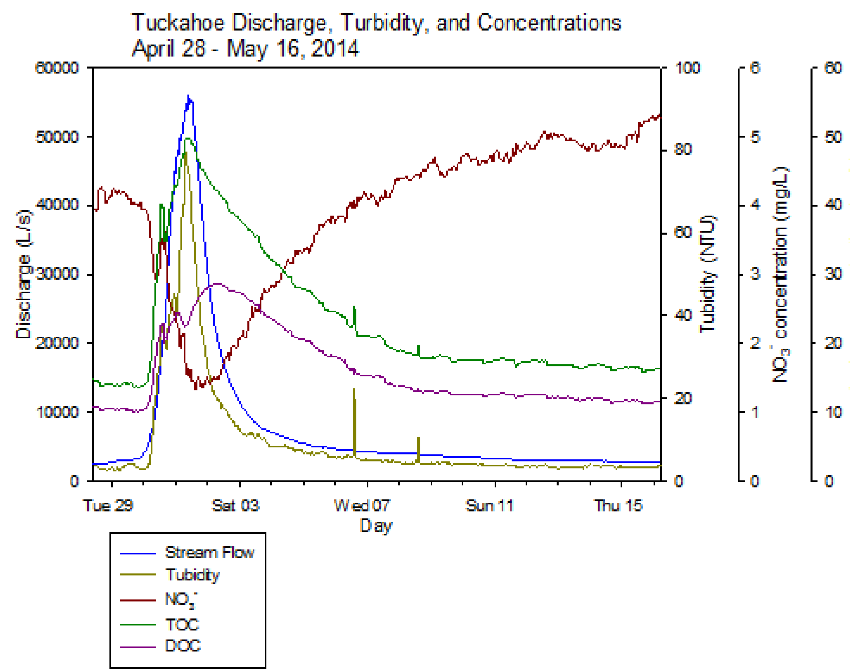
Choptank Watershed

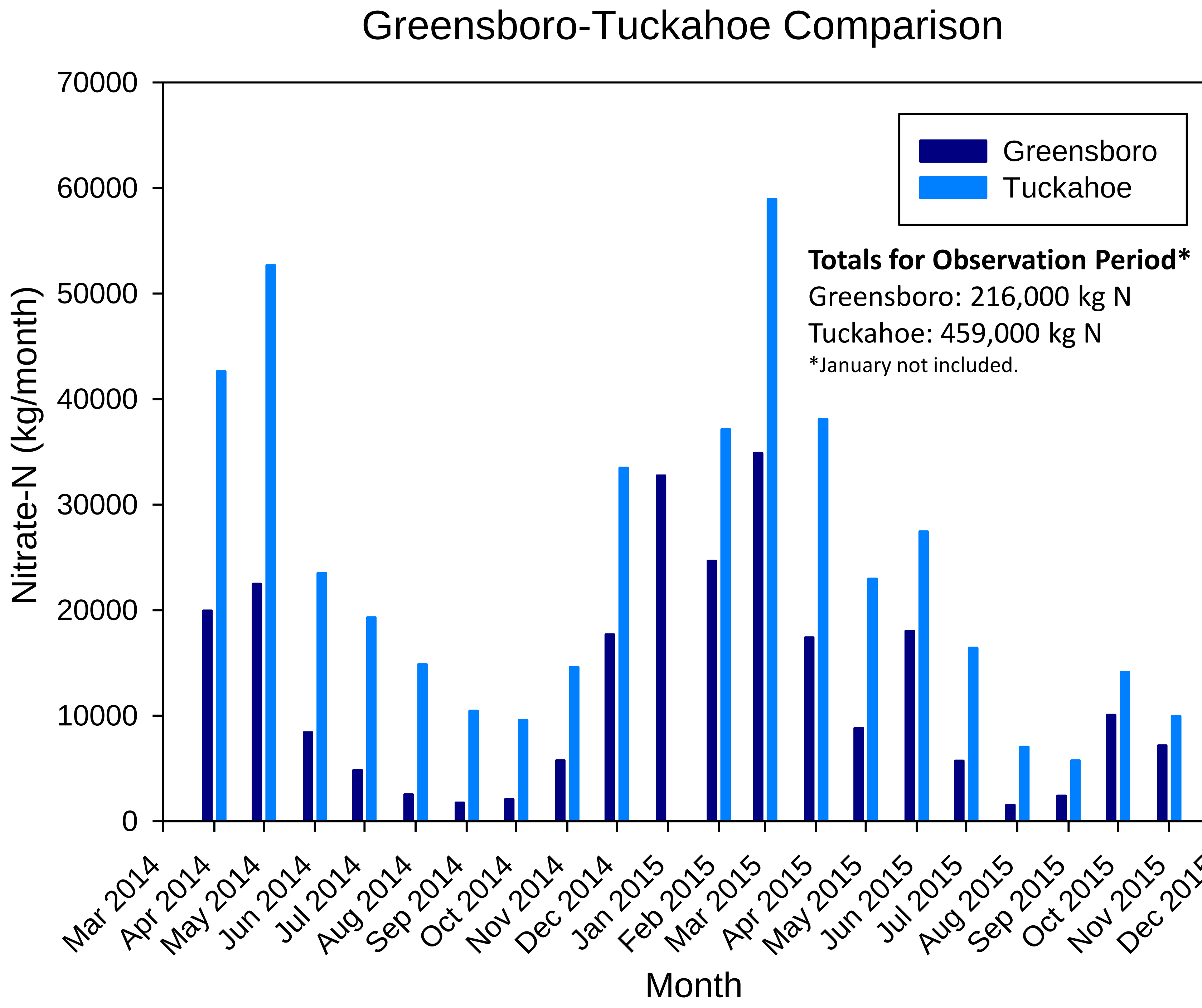


Subbasin Comparison



Real time water quality monitoring




Greensboro-Tuckahoe Comparison
Greensboro
Tuckahoe
Totals for Observation Period*
Greensboro: 216,000 kg N
Tuckahoe: 459,000 kg N
*January not included.
Nitrate-N (kg/month)
0
10000
20000
30000
40000
50000
60000
70000
Mar 2014
Apr 2014
May 2014
Jun 2014
Jul 2014
Aug 2014
Sep 2014
Oct 2014
Nov 2014
Dec 2014
Jan 2015
Feb 2015
Mar 2015
Apr 2015
May 2015
Jun 2015
Jul 2015
Aug 2015
Sep 2015
Oct 2015
Nov 2015
Dec 2015
Month

Subbasin Comparison

Land use

	Total area	Cropland
Subbasin	km^2	km^2
Greensboro	293	129.9
Tuckahoe	226	129.3
Ratio G/T	1.3	1.0

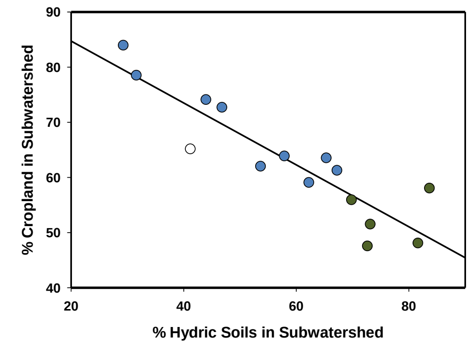
Land use *vs.* Drainage Class

Tuckahoe	A (%)	B (%)	C (%)	D (%)
Cropland	0.39	57.10	6.58	35.92
Non-cropland	1.70	37.54	4.41	56.35

Greensboro	A (%)	B (%)	C (%)	D (%)
Cropland	3.07	33.85	19.26	43.82
Non cropland	5.33	19.29	9.35	66.04

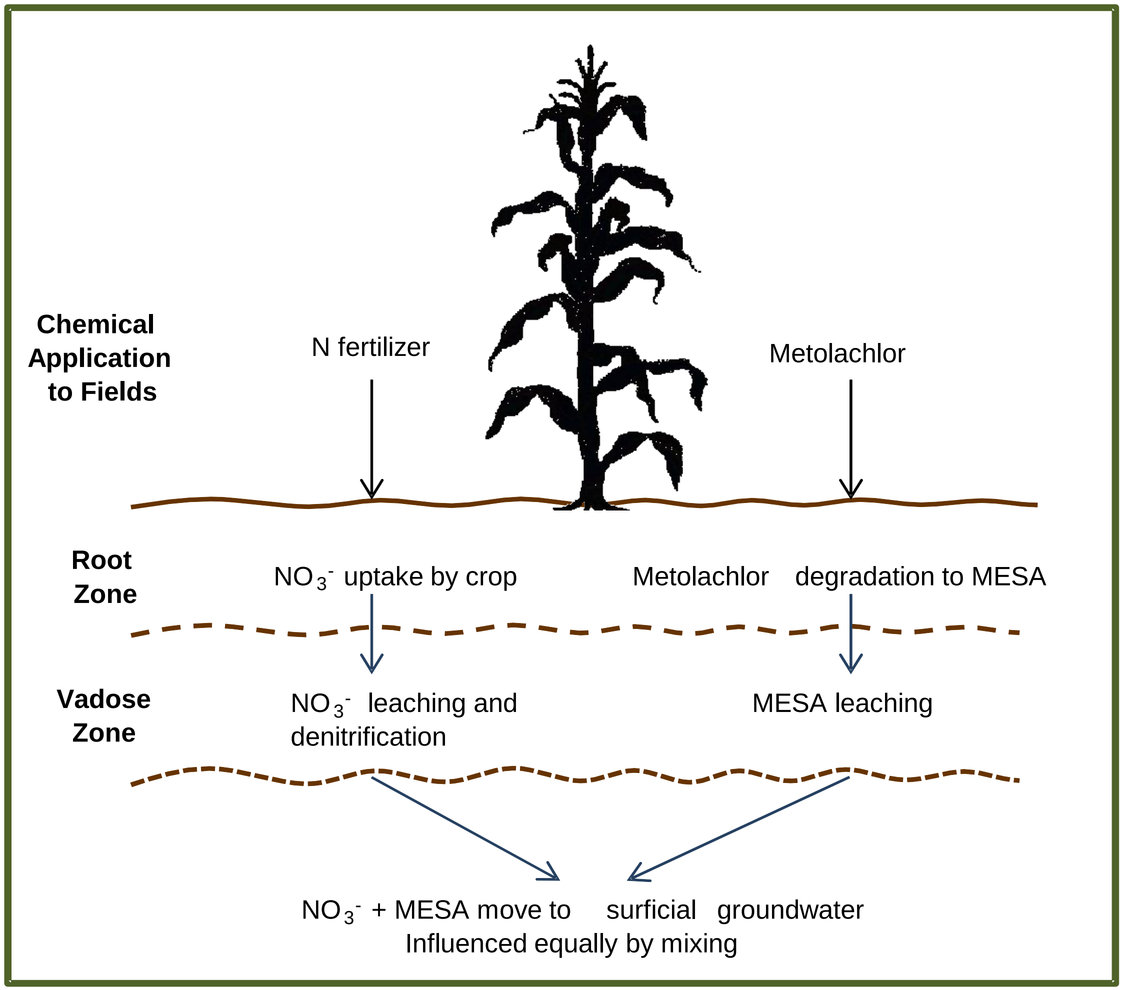
Cropland on poorly drained soils (C + D)
Tuckahoe subbasin 42 %
Greensboro subbasin 63 %

Development of a Conceptual Model



- Watershed parameters are greatly entangled
  - Ex: Cropland area *vs.* drainage condition
- Streams do not uniformly sample land uses
  - Ex: Close association of ditch drainage with cropland
- Ditch drainage only partly modifies drainage status
- A new reference frame is required to disentangle
  - MESA is a metabolite of metolachlor, a common herbicide
  - MESA forms in the vadose zone as does nitrate
  - MESA acts as a conserved transport analog of nitrate

MESA: A Conserved Tracer for Assessing Nitrate Fate

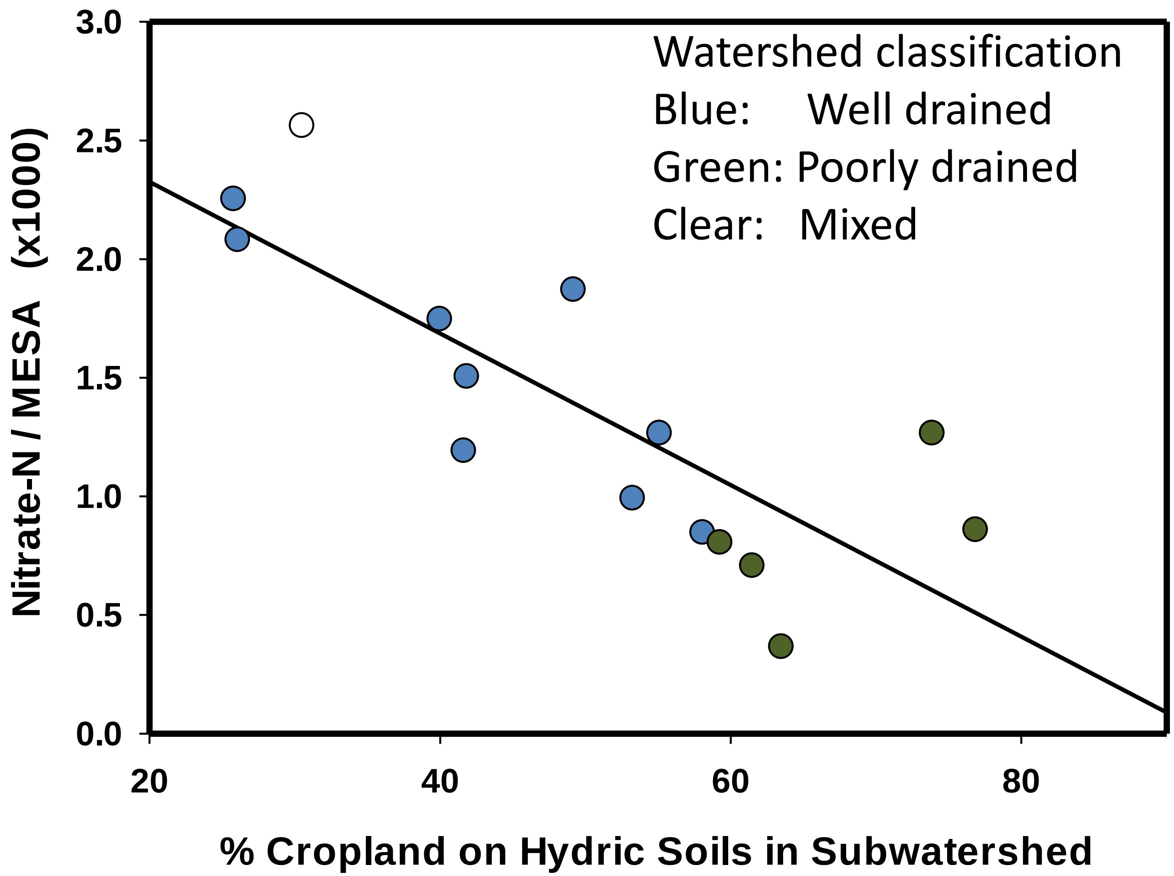


Vadose Zone Associations

- Agricultural nitrogen fate is most related to the local condition of application
  - Vadose zone processes during nitrate movement to groundwater are the most important determinant.
  - Non local groundwater and in stream processes are of secondary importance.

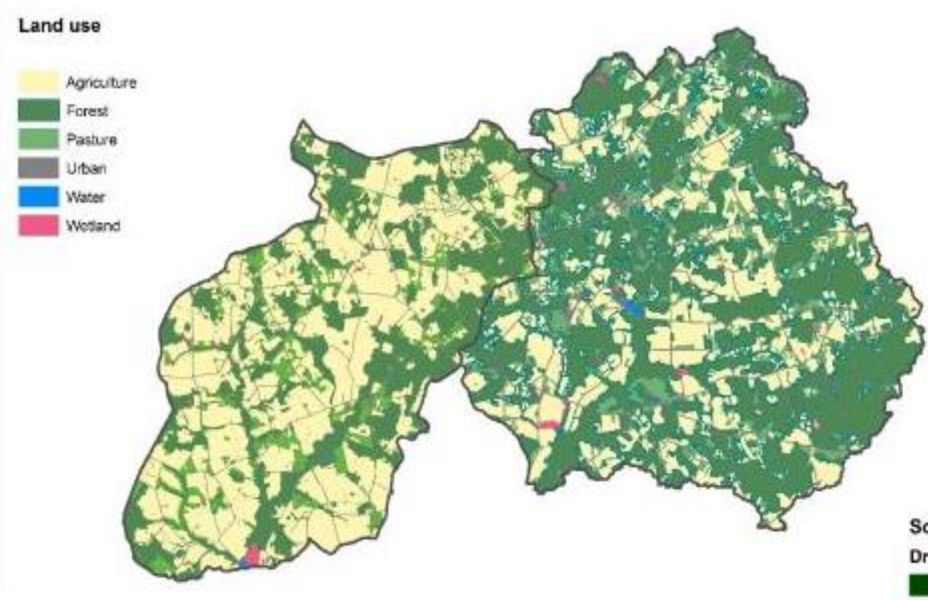
A Critical Watershed Parameter

Study of 15 sub-watersheds (HUC 12) with diverse land use and drainage status

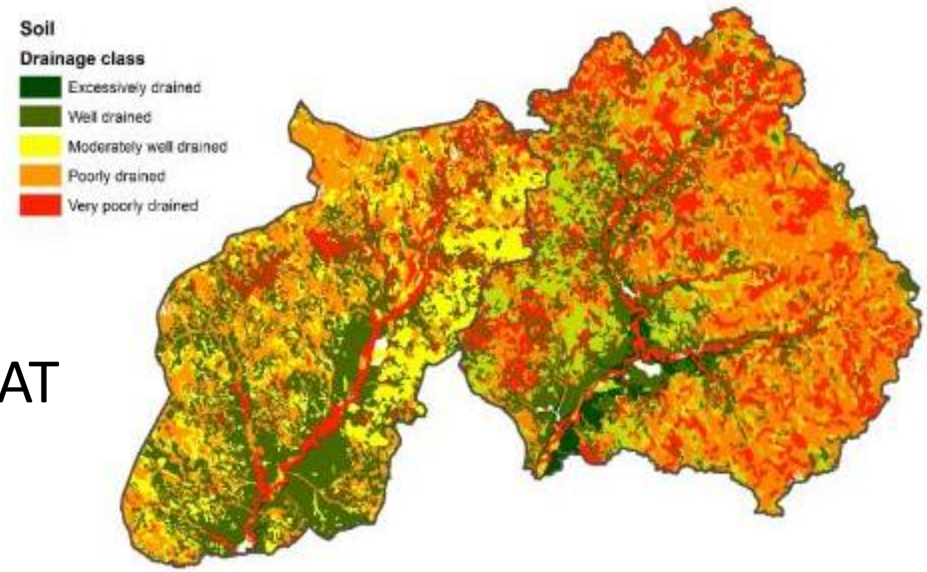


Modifying SWAT to Better Represent PCCs in Agricultural Landscapes

Land use and Soil Drainage Class



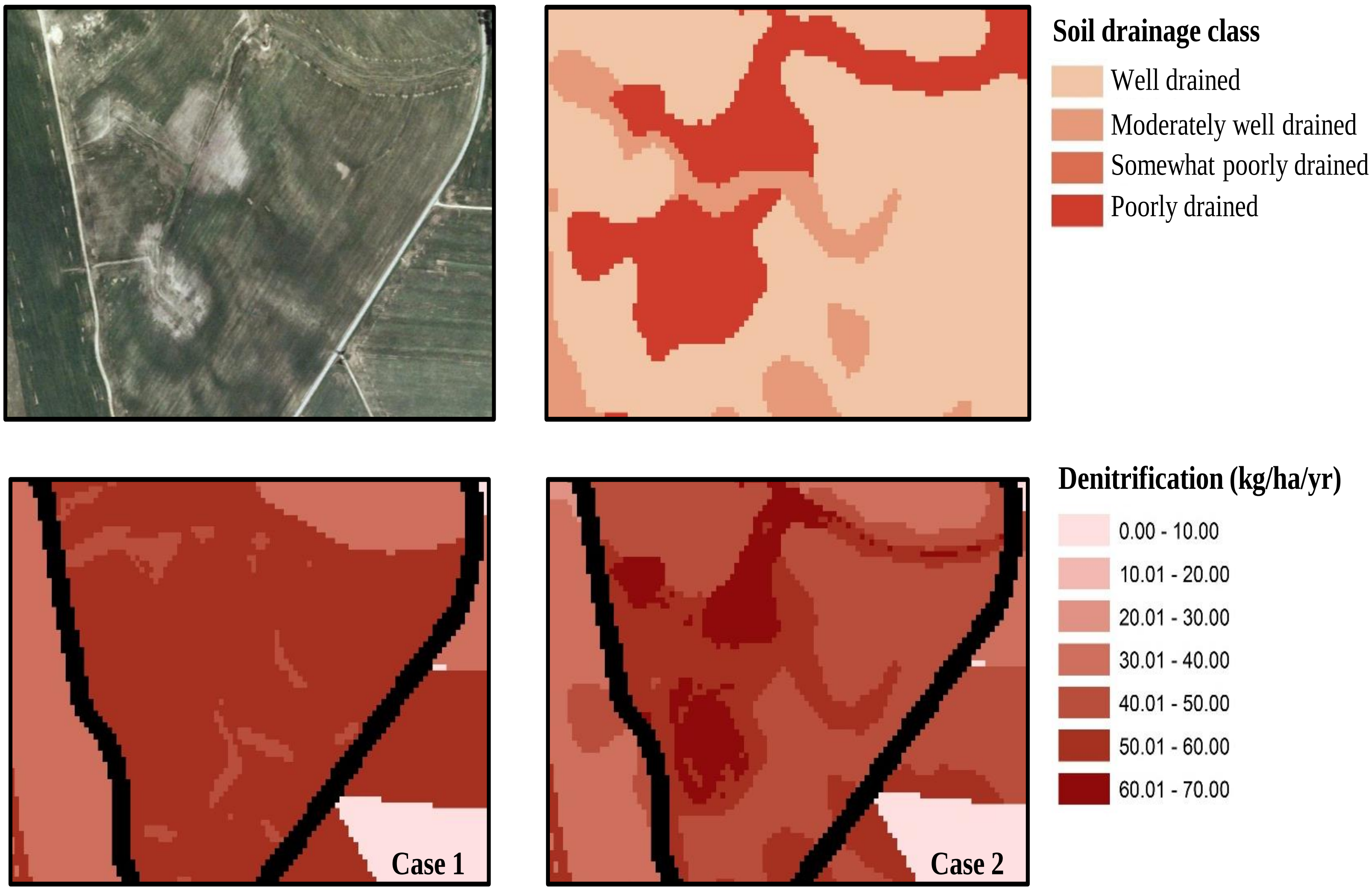
Two data layers that feed into SWAT



Implementation of a Conceptual Model

- Can process-based models accurately represent complex landscape interactions?
- We implemented the SWAT model
  - Novel parallel calibration approach for paired basins to constrain model parameters.
  - Use of real time WQ data for Cal/Val
  - Modified the model to better reflect local vadose zone associations (varied denitrification likelihood based on local drainage condition)

Improved Landscape Representation



Conclusions

- High resolution DEMs can help map and characterize the biogeochemistry of PCCs
- PCCs play important role in determining fate of agricultural N in watersheds
- Watershed models such as SWAT can be modified to better represent PCC influence
- Special emphasis should be placed on mapping and conserving PCCs in agricultural landscapes

Collaborations

- USGS – Water Science for Maryland, Delaware and District of Columbia: Judy Denver
  - Co-location of water quality sensors at gage sites
- USDA NRCS – Conservation Effects Assessment Project (CEAP) Team: Bill Effland & Lisa Duriancik