Designing for environmental and socioeconomic sustainability

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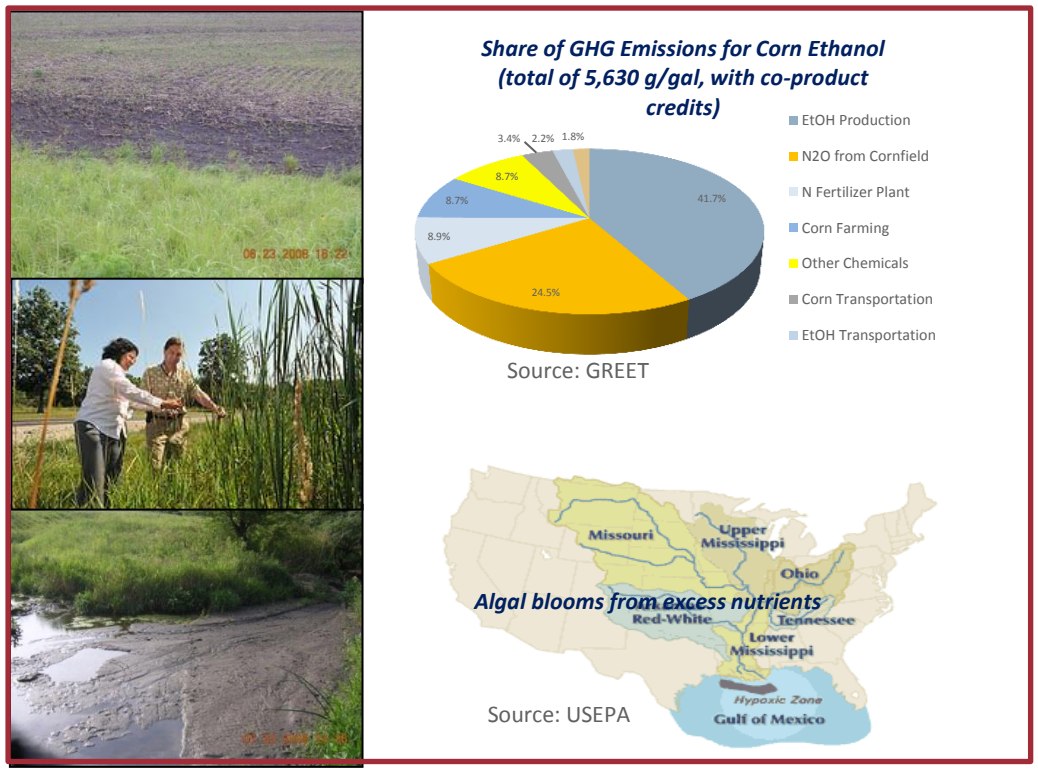
Energy Systems Division

Incorporating Bioenergy in Sustainable Landscape Designs Workshop 2: Agricultural Landscapes

Argonne National Laboratory June 25, 2014

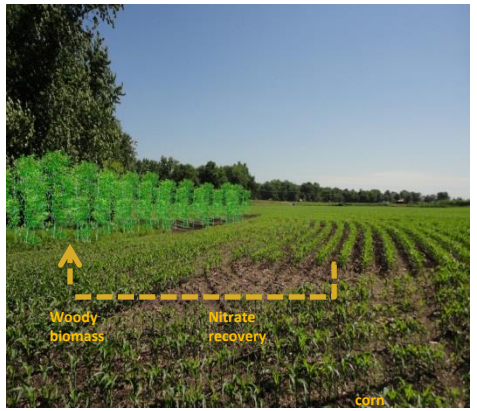
The vision: sustainable, multipurpose landscape
Apply resource recovery principles to biomass production



Source: GREET

Source: USEPA

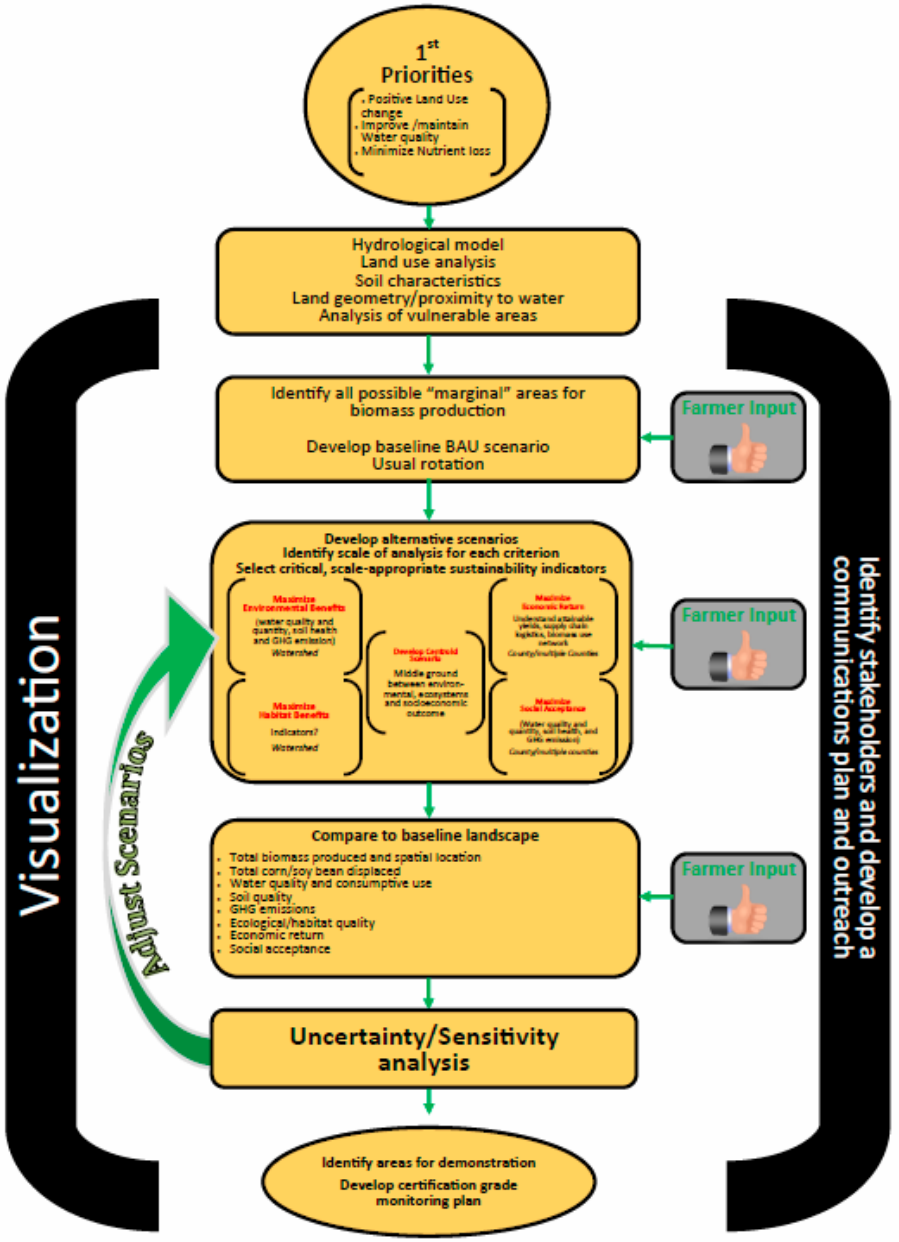
Logo credit: International Phytotechnologies Society



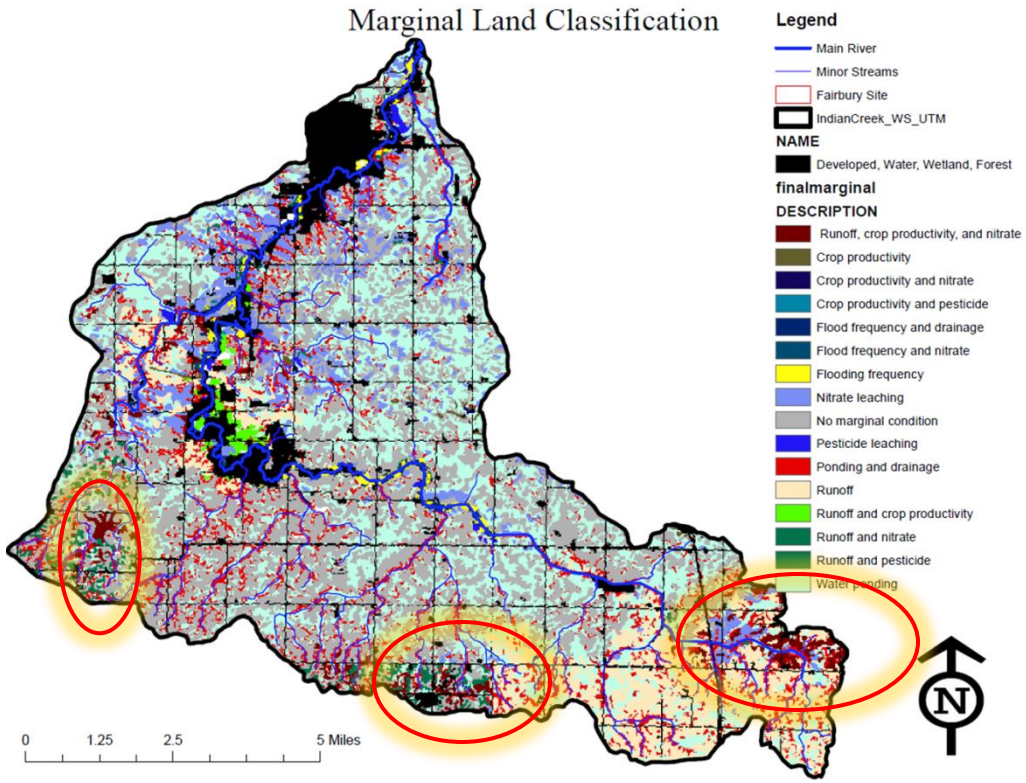
Design elements

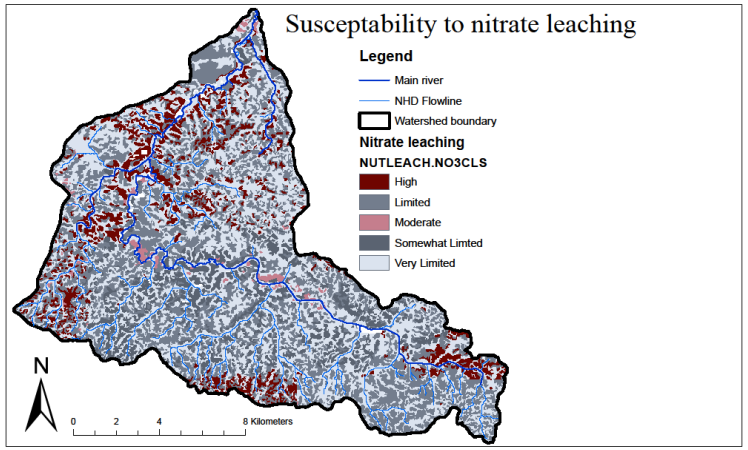
- Site and scale
  - Field, watershed
- Objectives – what do we want to do
  - Multiple objectives to prioritize
- Crop characteristics
  - Crops
  - Functions
  - Models
  - Visualizations for feedback

- Engineering function into land use

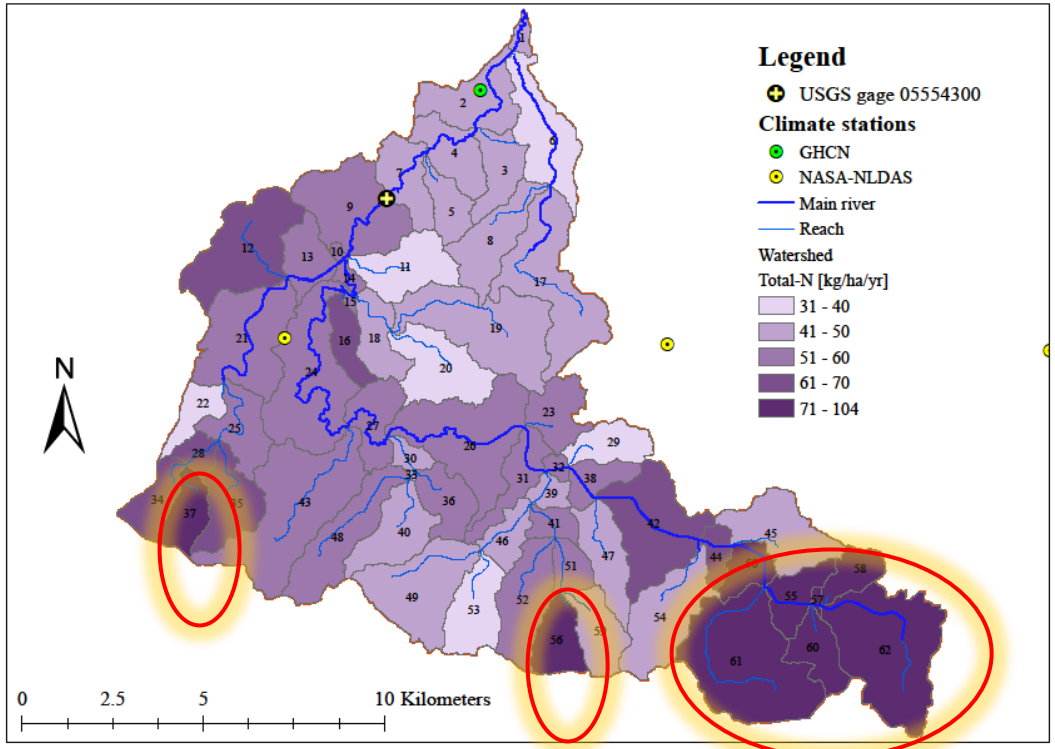


Watershed land properties as a base for design

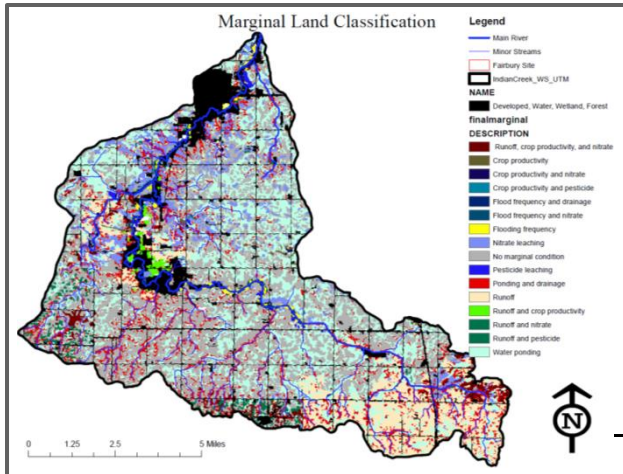




Comparing marginal classification and SWAT model hotspots



All impairments- total acreage



Total acreage with at least two forms of marginality

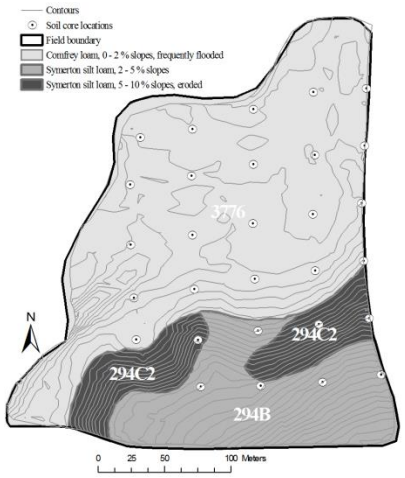
8,372 acres

Sample acreage under marginality

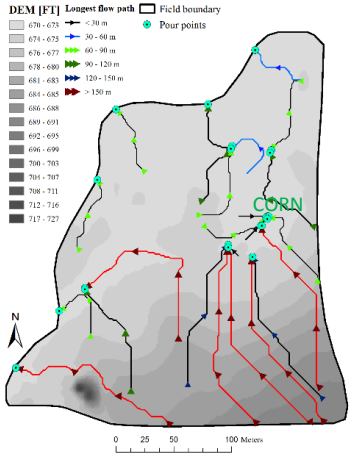
Marginality	Acreage	Acreage enrolled in Conservation Stewardship Program (CSP)
Frequent flooding	286	56
Flooding and Nitrate leaching	18	3
Flooding and drainage	540	48
Run-off, crop productivity, and nitrate leaching	968	308
Run-off and crop productivity	335	96
Total	2,147	511

Field scale site - Sub-field productivity and environmental data aid the design

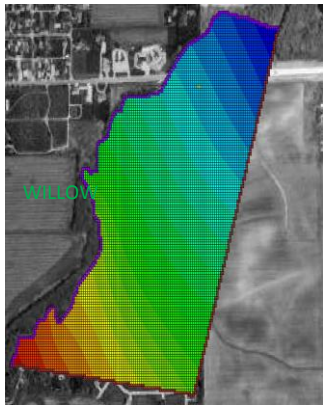
Soil classification



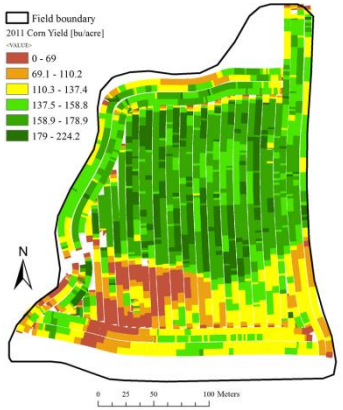
DEM and flow path lengths

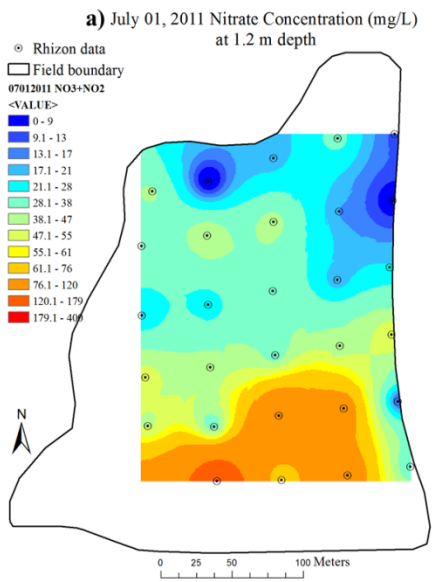


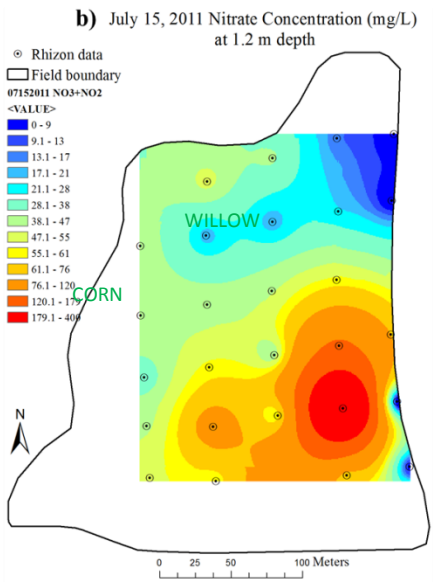
Hydrogeological model

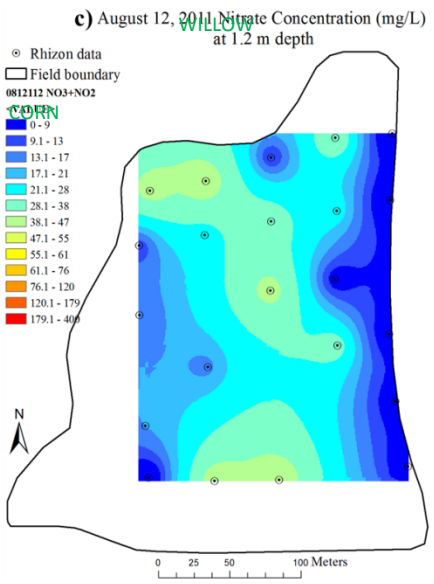


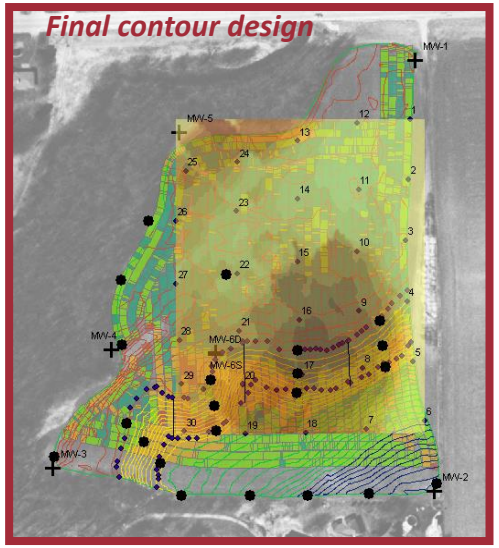
2011 corn yield map



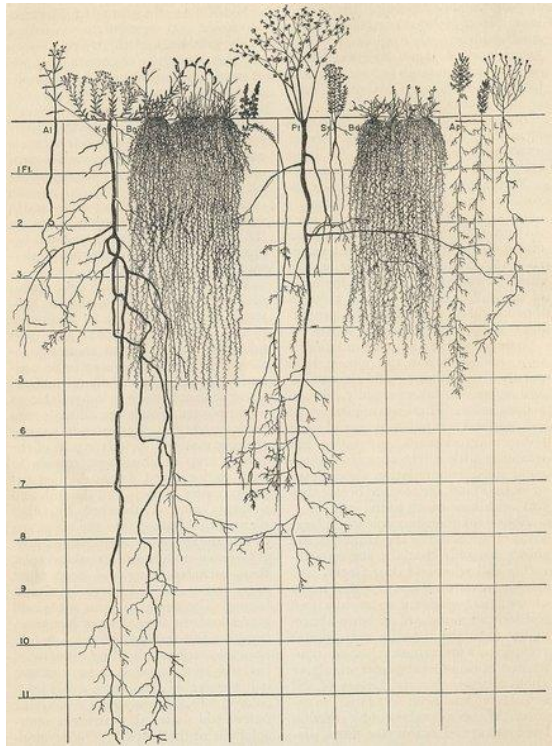




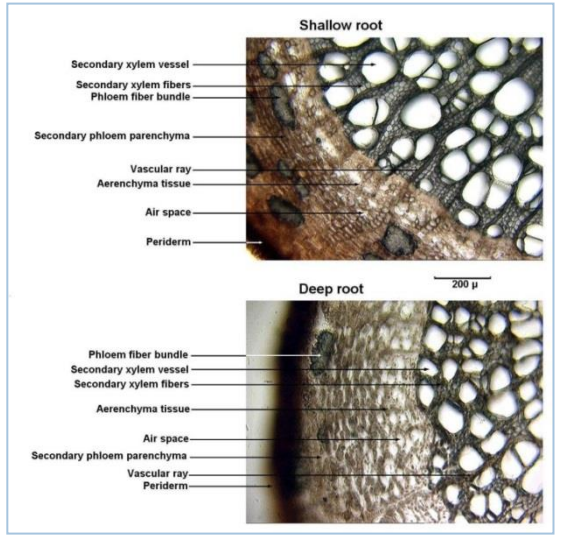




Deep rooted and/or phreatophyte perennials are engineering tools

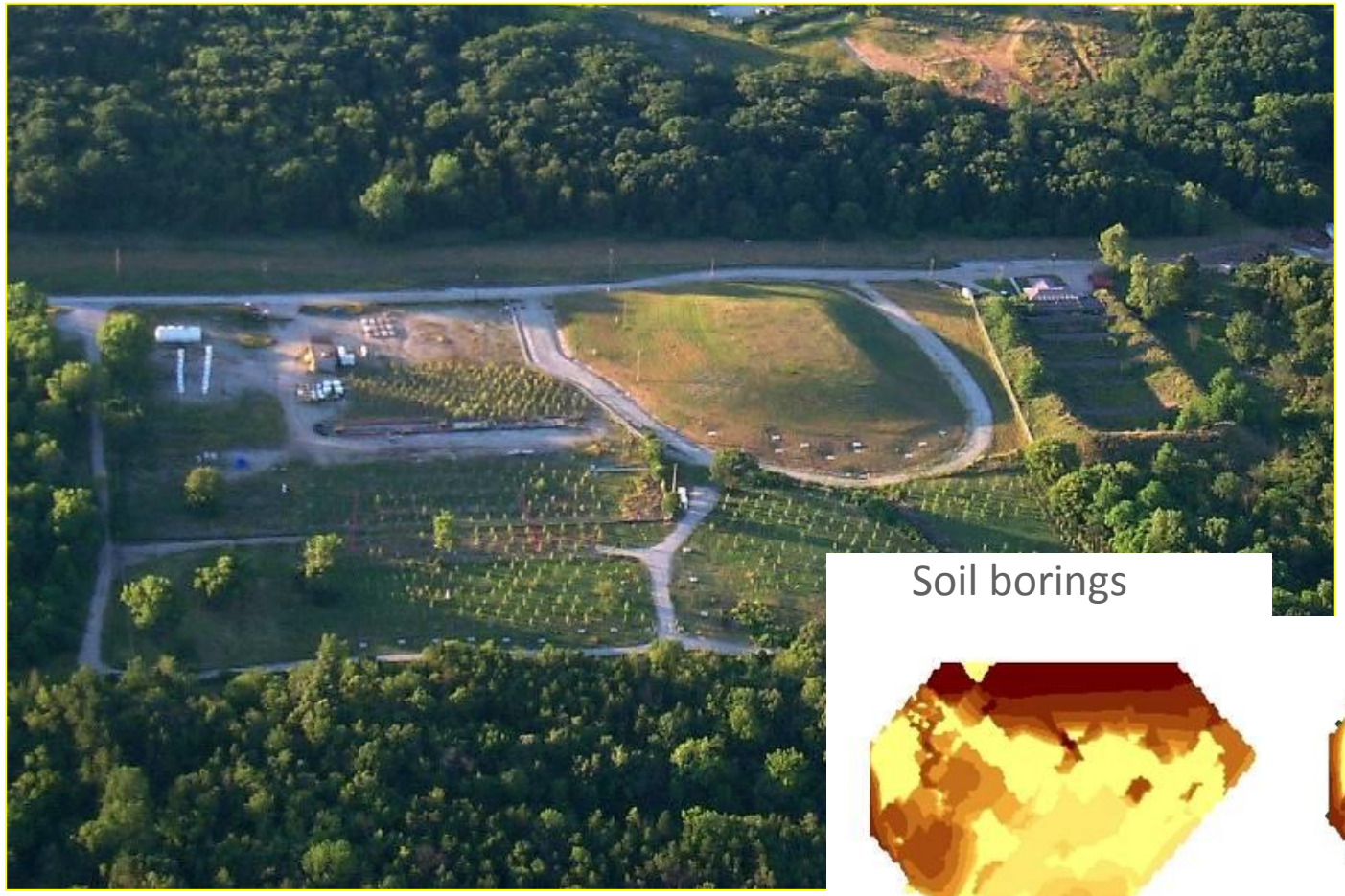


Source: J.E. Weaver



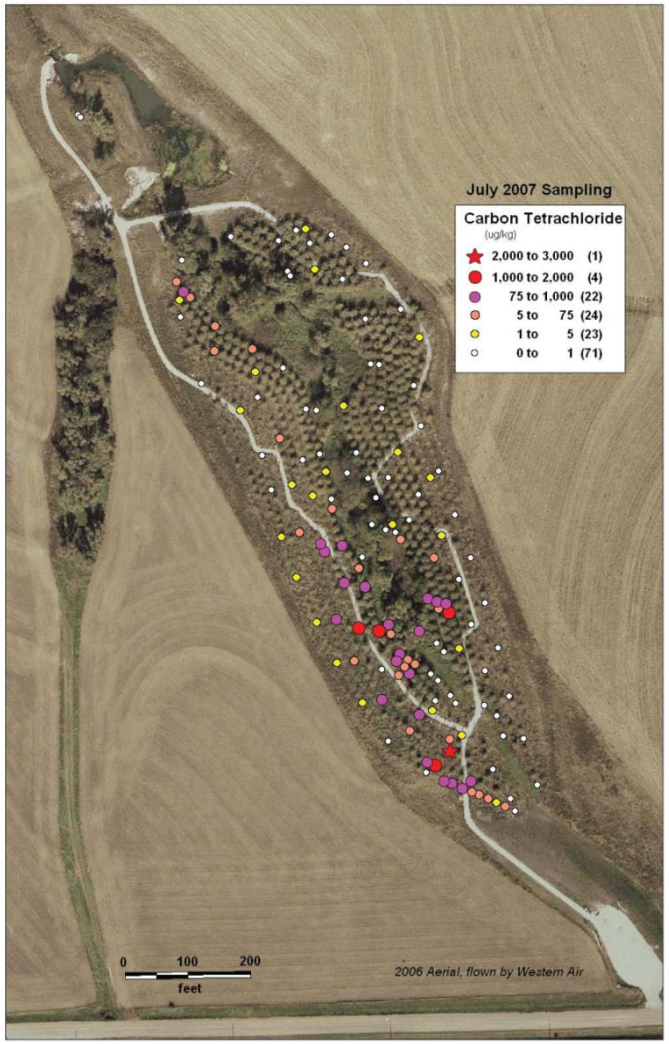
Know where your roots are growing

plume delineation through tissue tracer analysis confirms rooting depth



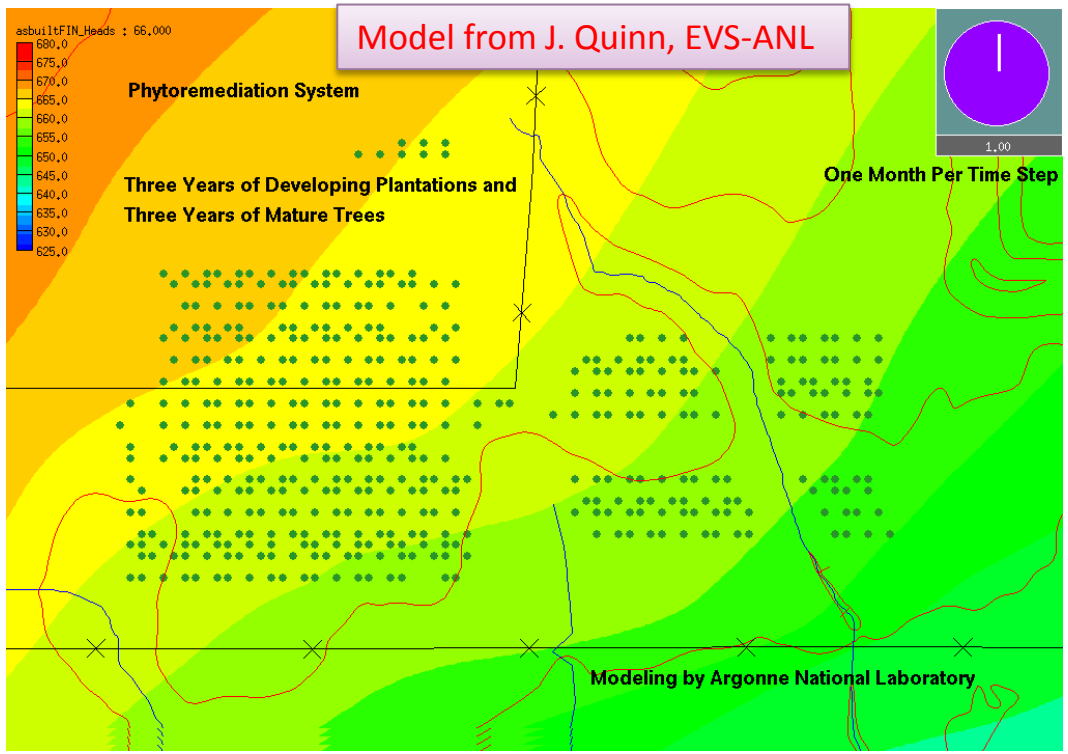
Soil borings

Nearest neighbor willow trees



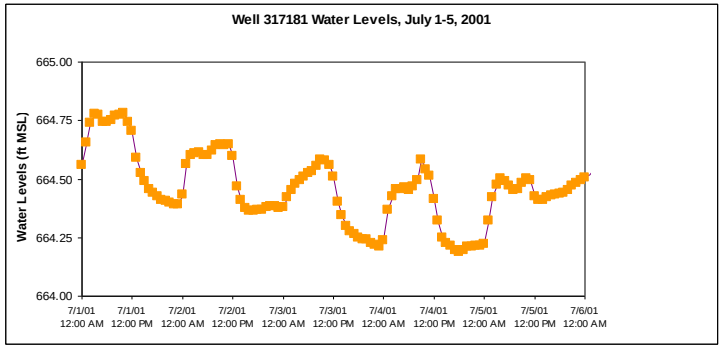
Water Resources allocation addressed by groundwater modeling and water use measurement

- Understand hydrology, from field to watershed, to determine amount of water withdrawal vs recharge/flow that is sustainable for a specific local context
- Plant to target specific sustainable consumptive use, and measure at maturity

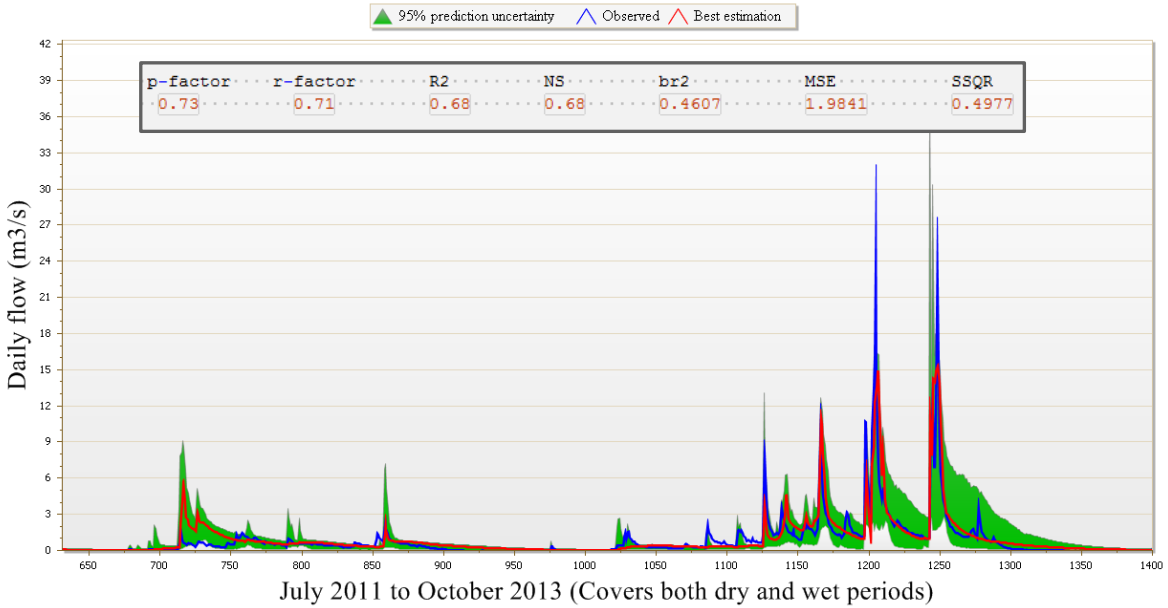


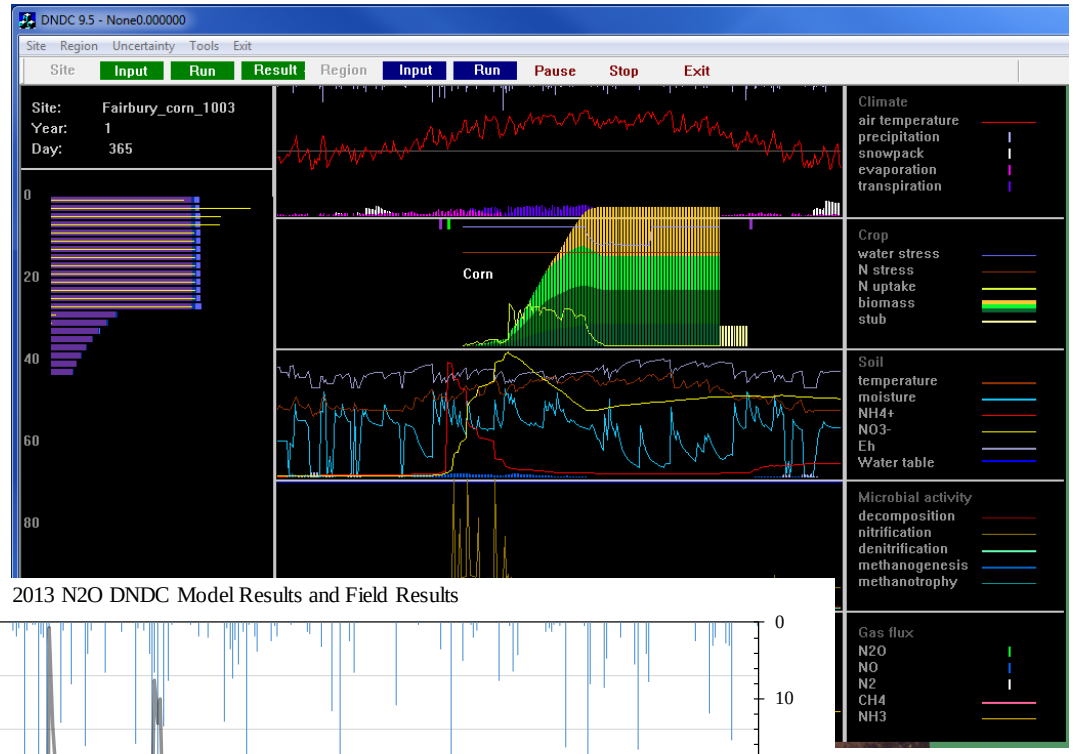
Quinn J.J., M.C. Negri, R.R. Hinchman, L.M. Moos, J.B. Wozniak and E. G. Gatliff (2001). *Predicting the Effect of Deep-Rooted Hybrid Poplars on the Groundwater Flow System at a Large-Scale Phytoremediation Site*. Int. Journal of Phytoremediation Vol.3 n. 1, pp. 41-60.

	2008		2009	
Tree	DBH (cm)	Total Wood Sap Flow (L/day)	DBH (cm)	Total Wood Sap Flow (L/day)
Mean	19.2	121.7	23.2	173.7
Min	15.9	34.4	18.4	76.8
Max	22.9	219.8	29.3	248.4
StDev	3.5	57.5	2.7	44.3

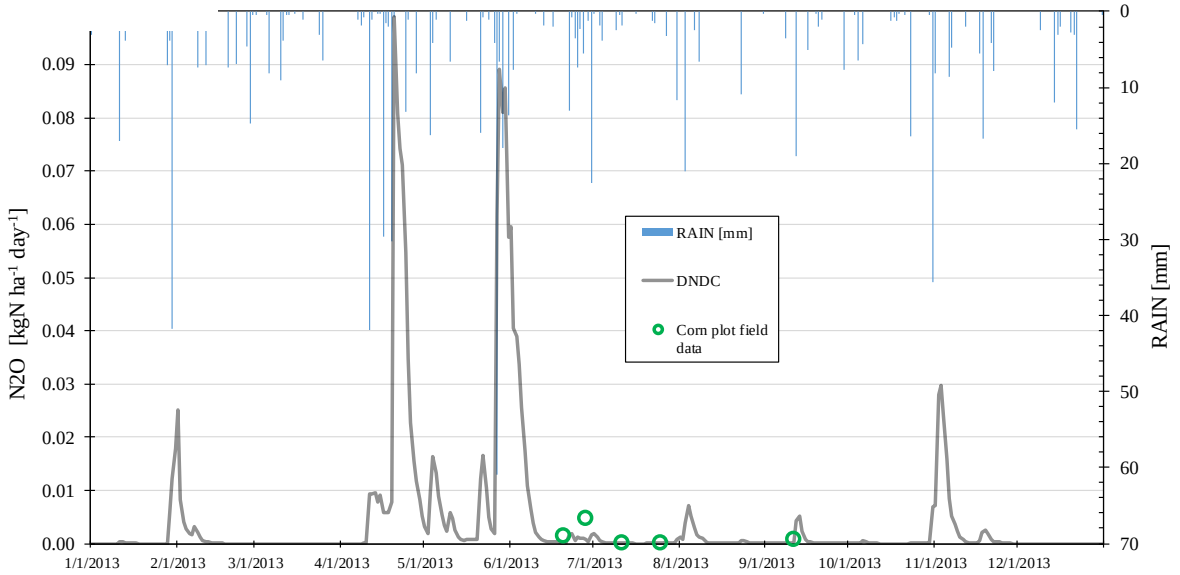


Tools: SWAT, Denitrification-Decomposition [DNDC] model simulations

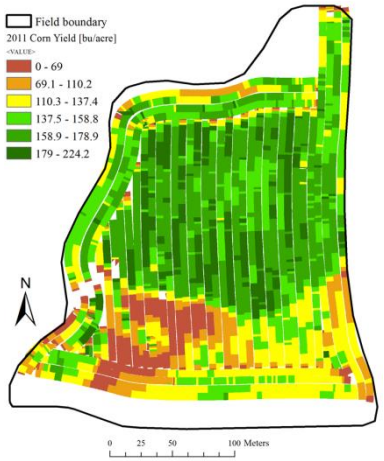


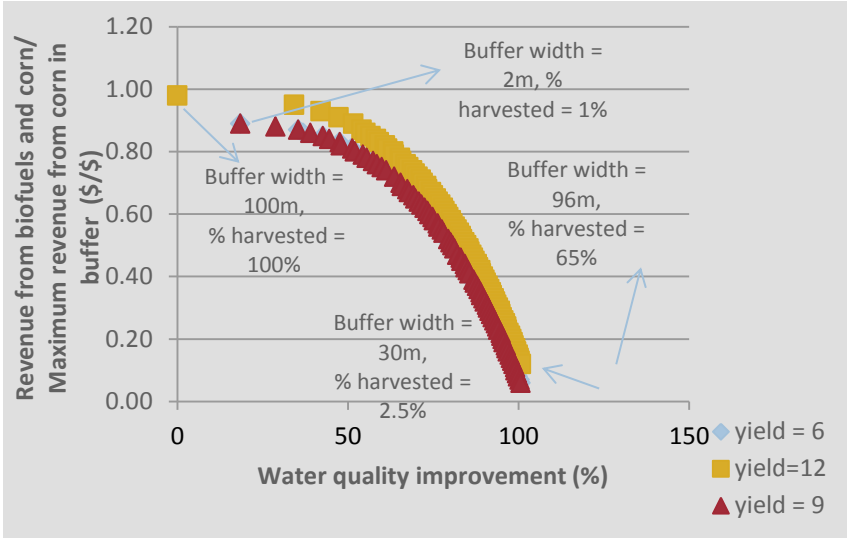


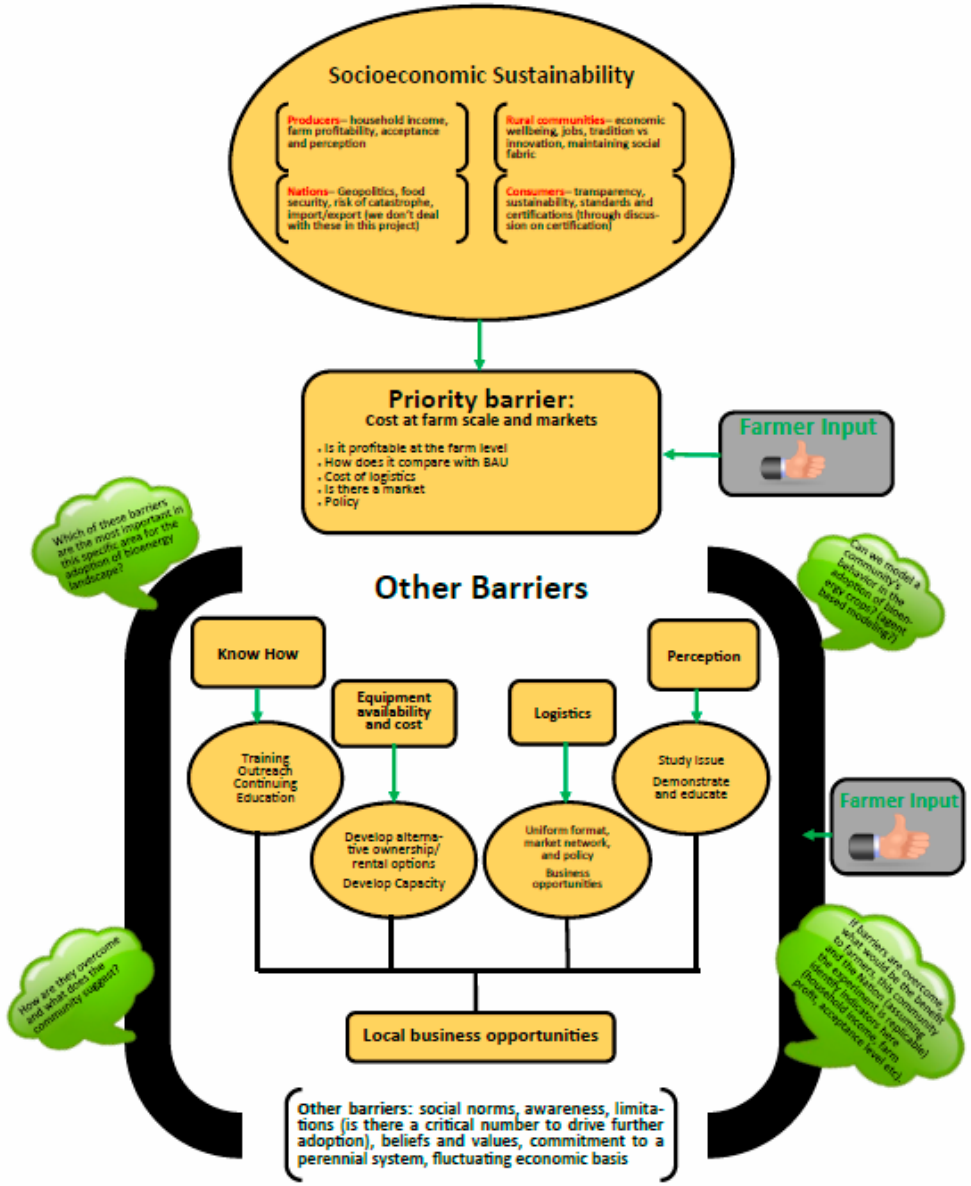
2013 N2O DNDC Model Results and Field Results



Socioeconomic sustainability







A sustainable bioenergy landscape

Marcita in Tavernasco, Italy.
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E. Detaille, Charge of the 4th Hussars at the battle of Friedland, 14 June 1807 - http://upload.wikimedia.org/wikipedia/commons/1/10/Detaille_4th_French_hussar_at_Friedland.jpg

http://www.griffini.lo.it/laScuola/prodotti/Monachesimo/economia/lavoroagricolo.htm

Thank you to the team

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