ASSESSMENT AND VALORIZATION OF ECOSYSTEM SERVICES THROUGH FIELD RESEARCH AND SCALE UP

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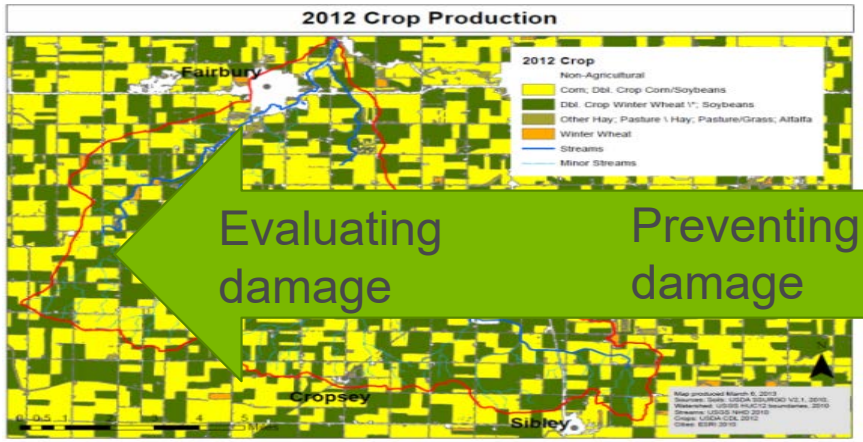
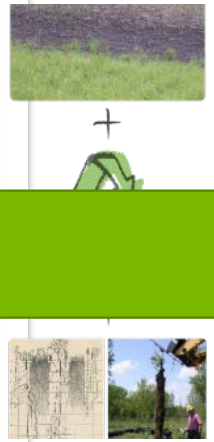
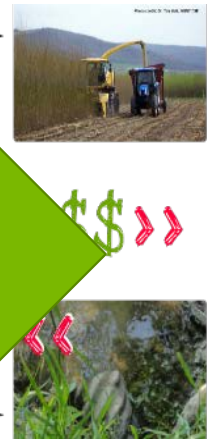
TOWARDS A TOTAL ECONOMIC VALUATION OF LANDSCAPE MANAGEMENT - THE ROLE OF BIOENERGY





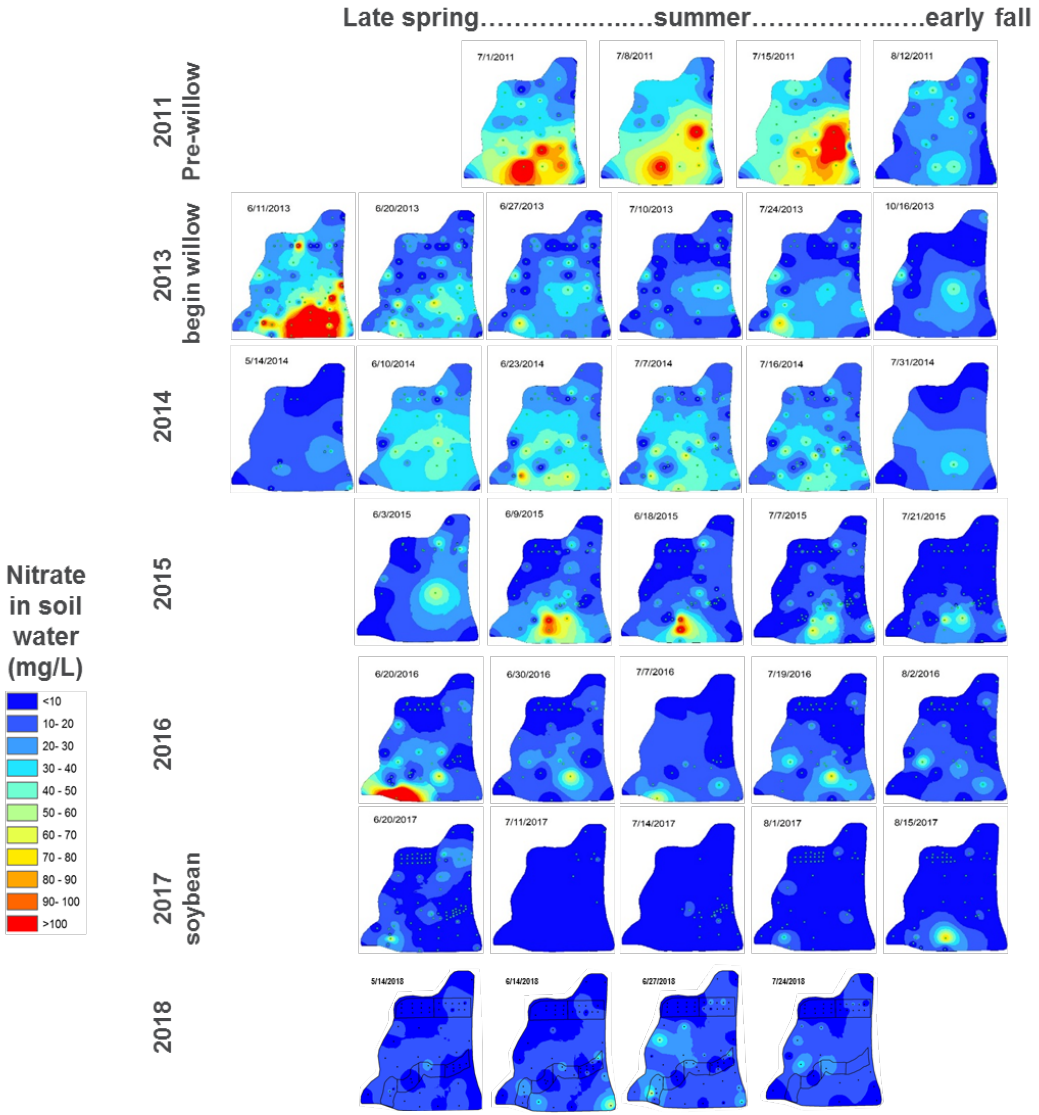


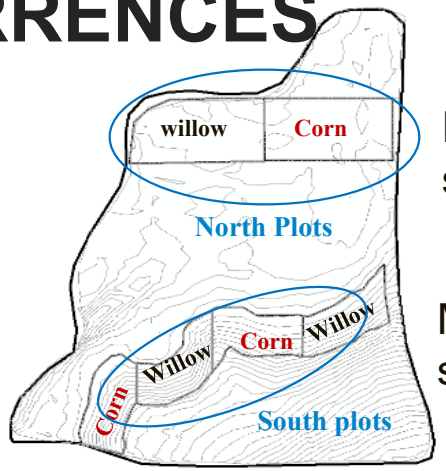
Evaluating damage

Preventing damage

Enhancing natural capital and human wellbeing

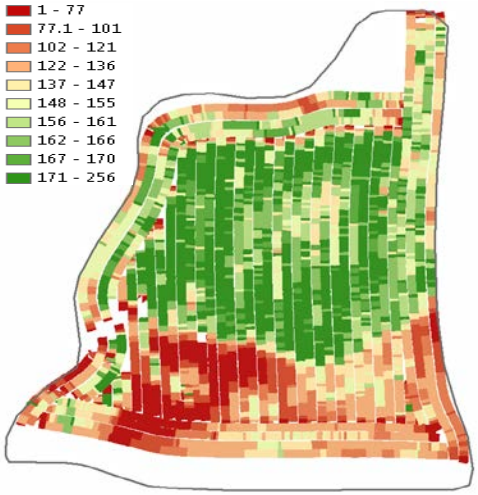
SOIL WATER NITRATE CONCENTRATION (AT 5 FT BGS) HAS SEASONAL RECURRENCES





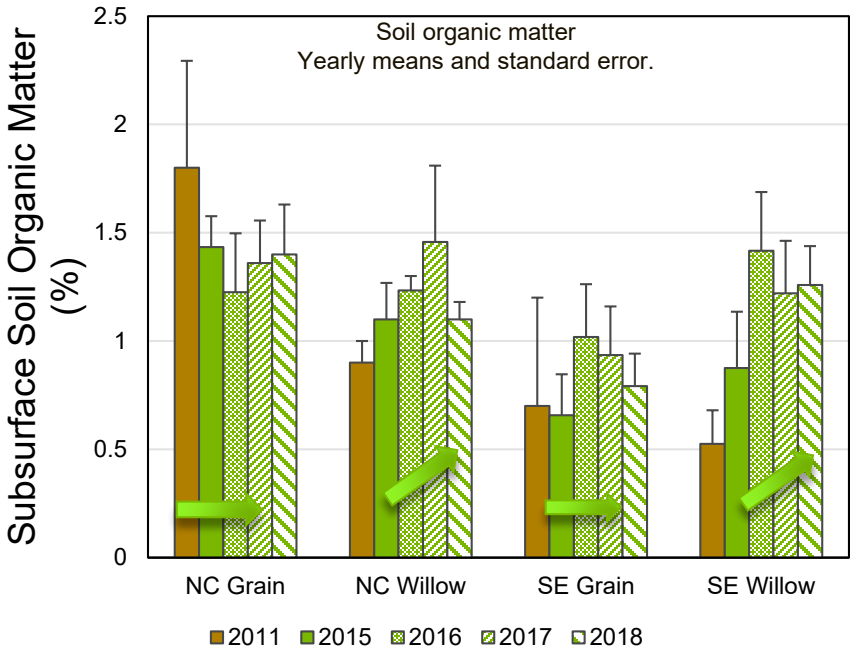
Fertile soil

Marginal soil

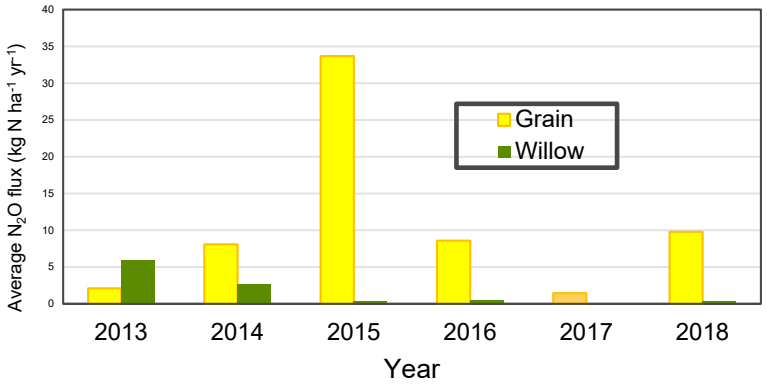


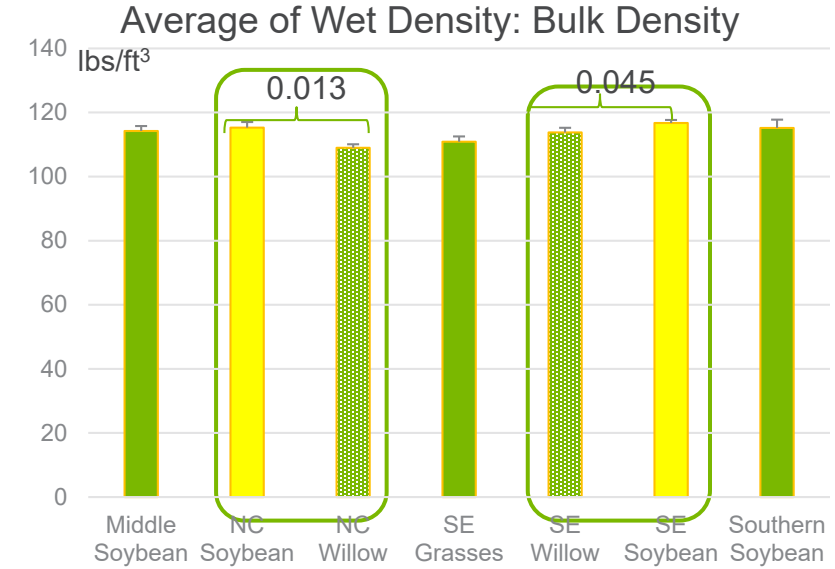
Yield map: areas of **low** (RED) and **high** (GREEN) yields (bu/ac). Low yield areas coincide with high nitrate losses.

SOIL QUALITY AND GHG EMISSIONS



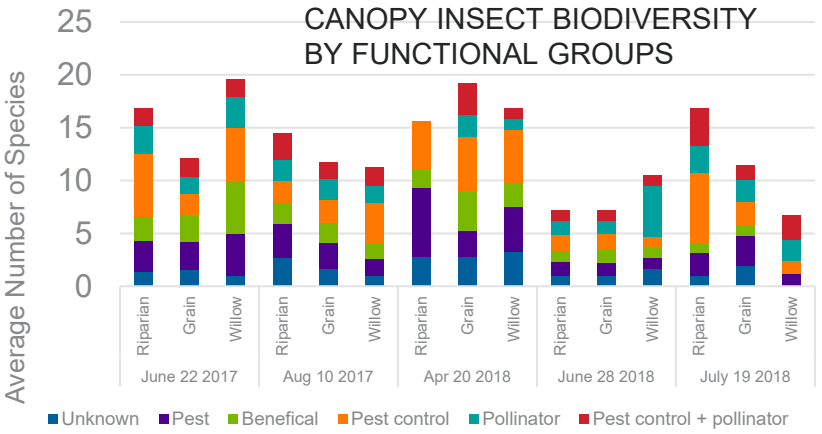
Subsoil samples collected from the bottom 6 inches of a 4-foot core.
Zumpf et al. (2017)





Troxler 3440 moisture-density gauge on June 14th and June 15th, 2017

Significantly lower bulk density under willow than soybean



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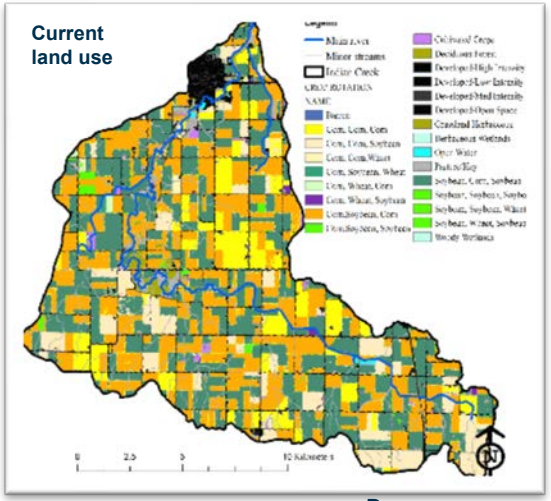
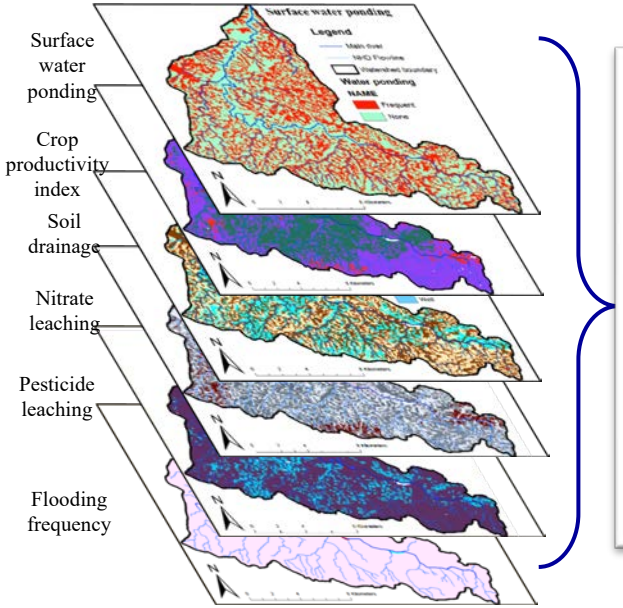
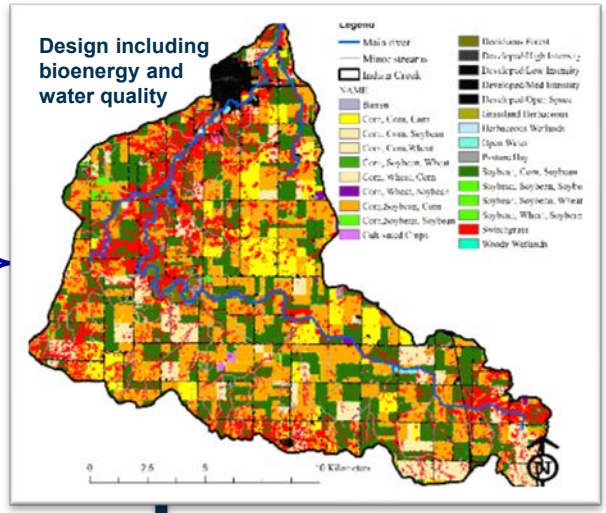
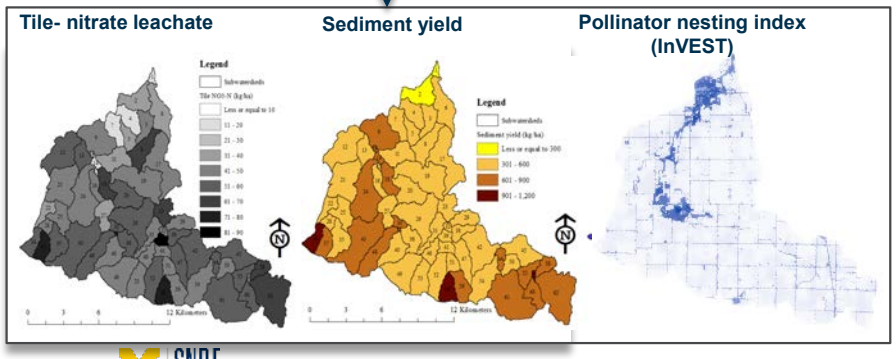
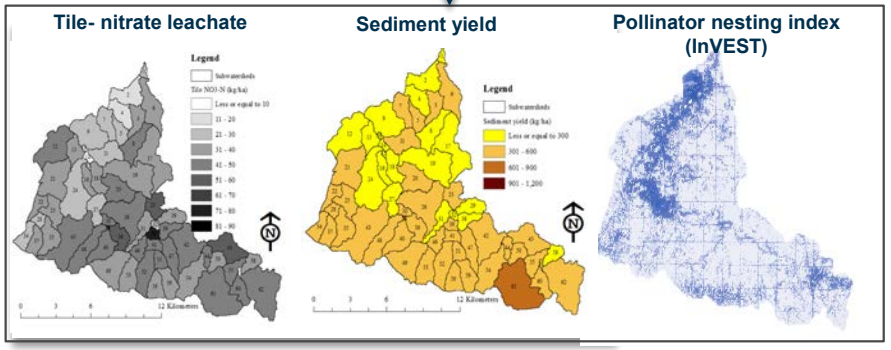
SCALING UP TO WATERSHED DESIGN TO INCREASES ECOSYSTEM SERVICES







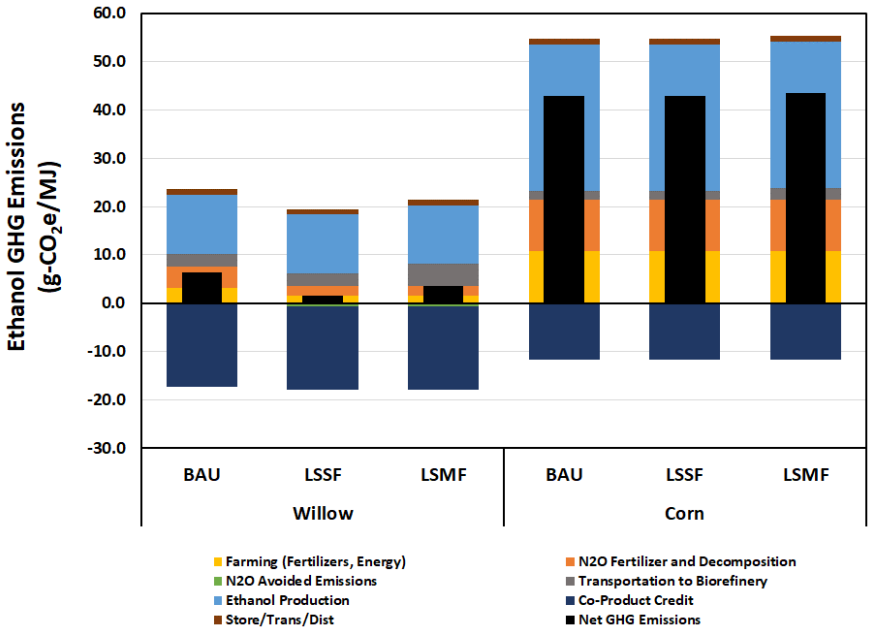




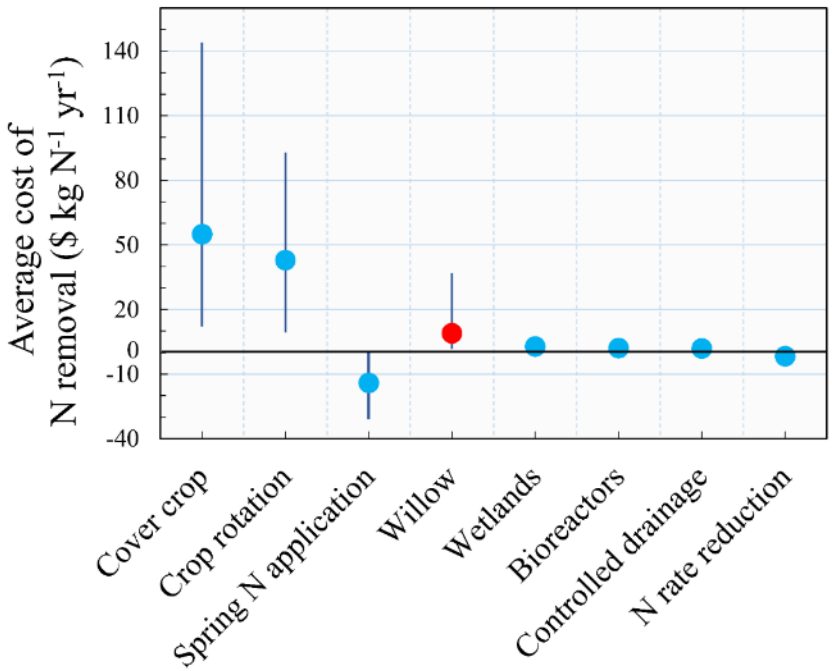
Ssegane et al., 2016

COST OF N REMOVAL – COMPARING CONSERVATION PRACTICES

Bioenergy buffers - cost competitive as a conservation option and GHG-sparing



Adapted from Christianson L, Tyndall J, Helmers M. (2013)

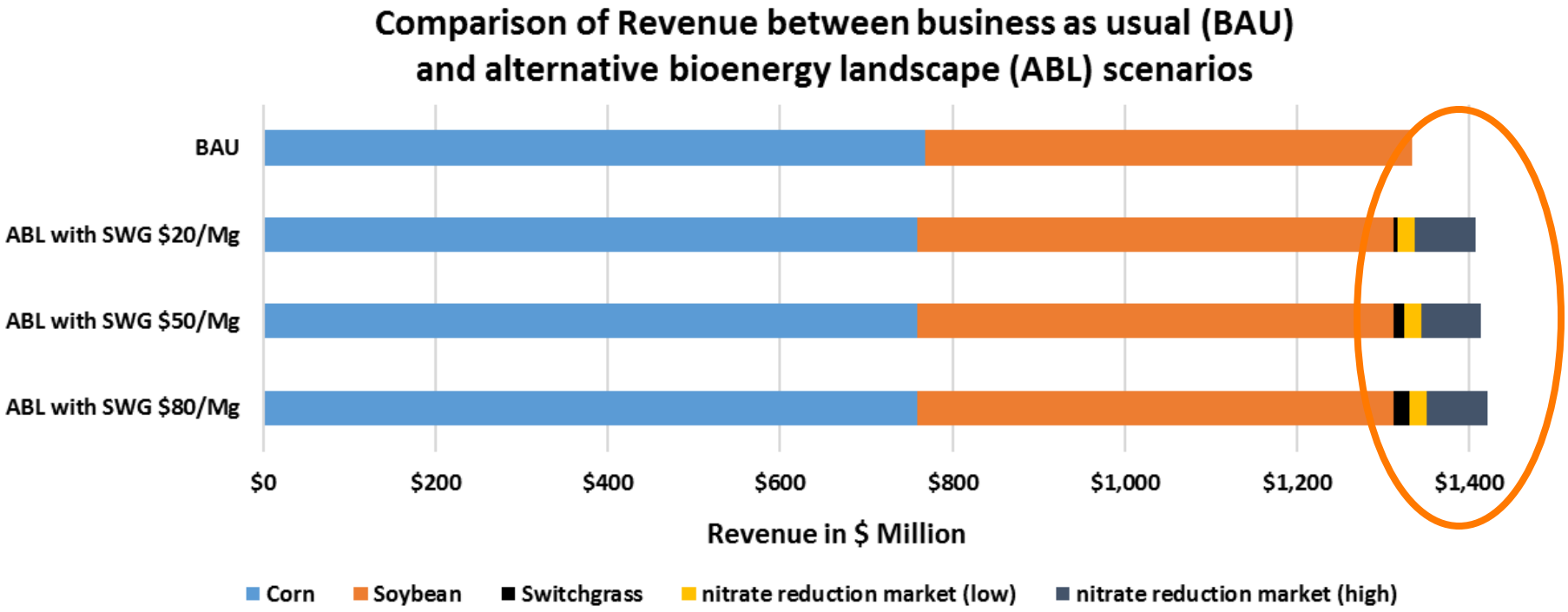


GHG emissions from producing willow on marginal land were less than half of those from producing corn on that land.

- Most benefit is due to less fertilizer, energy, agrichemicals in willow plots
- Sensitivity analysis: results most sensitive to willow yield

H. Ssegane, C. Zumpf, M. C. Negri, P. Campbell, J. Heavey, and T.A. Volk (2016) -**The Economics of Growing Shrub Willow as a Bioenergy Buffer on Agricultural Fields. A case study in the Midwest Corn Belt**. Biofuels, Bioproducts and Biorefining. DOI: 10:1002/bbb.1679.

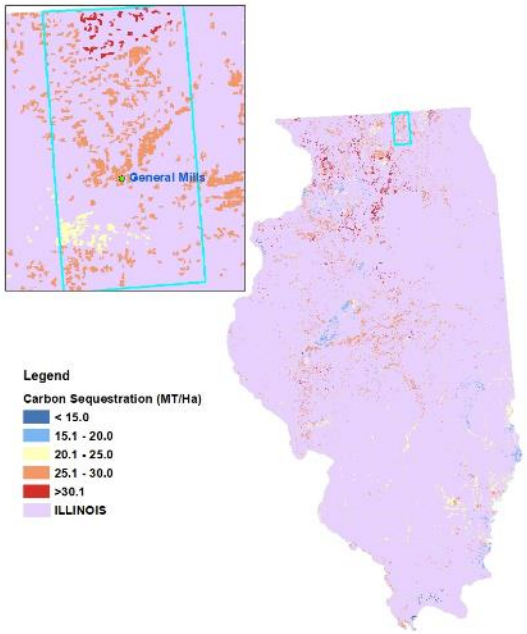
RESULTS FOR UPPER VERMILION WATERSHED

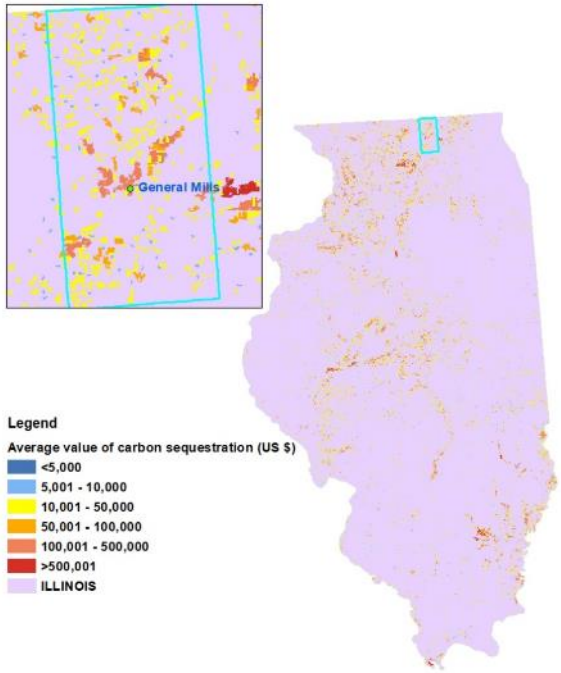


- Replacement of commodity crops in marginal land by switchgrass results in slightly decreased overall value for the commodity crops
- However, inclusion of ES valuation could change situation to a positive
- Value of reduced nitrate *alone* would create a net gain of $20 to $90 million, depending on market for nitrate reduction. (others examined: nitrate loss reduction, erosion/sedimentation, GHG, water-based recreation, wildlife viewing, hunting, and pollinator services)

Mishra et al., (2019) https://onlinelibrary.wiley.com/doi/abs/10.1111/gcbb.12602

CARBON SEQUESTRATION AND ITS ECONOMIC VALUE
ACROSS THE MARGINAL LAND OF ILLINOIS – PRELIMINARY ANALYSIS





- Total marginal land in the state of Illinois - 2 million ha.
- Out of 1.3 million ha of marginal land >10 ha plots, corn or soy is grown in 0.7 million ha.
- Replacing the corn and soy by switchgrass can produce a total of 9 million metric tons (MT) of biomass.
- The quantity of production and distribution across the state ranges from less than 100 MT per plot of marginal land to 20,000 MT per plots.

By converting the row crops in marginal land to switchgrass,

1. Carbon can be sequestered at a range of 15 to 30 Mg/ha.
2. Potential for total carbon sequestration is estimated at 18 million Mg in marginal lands of Illinois.

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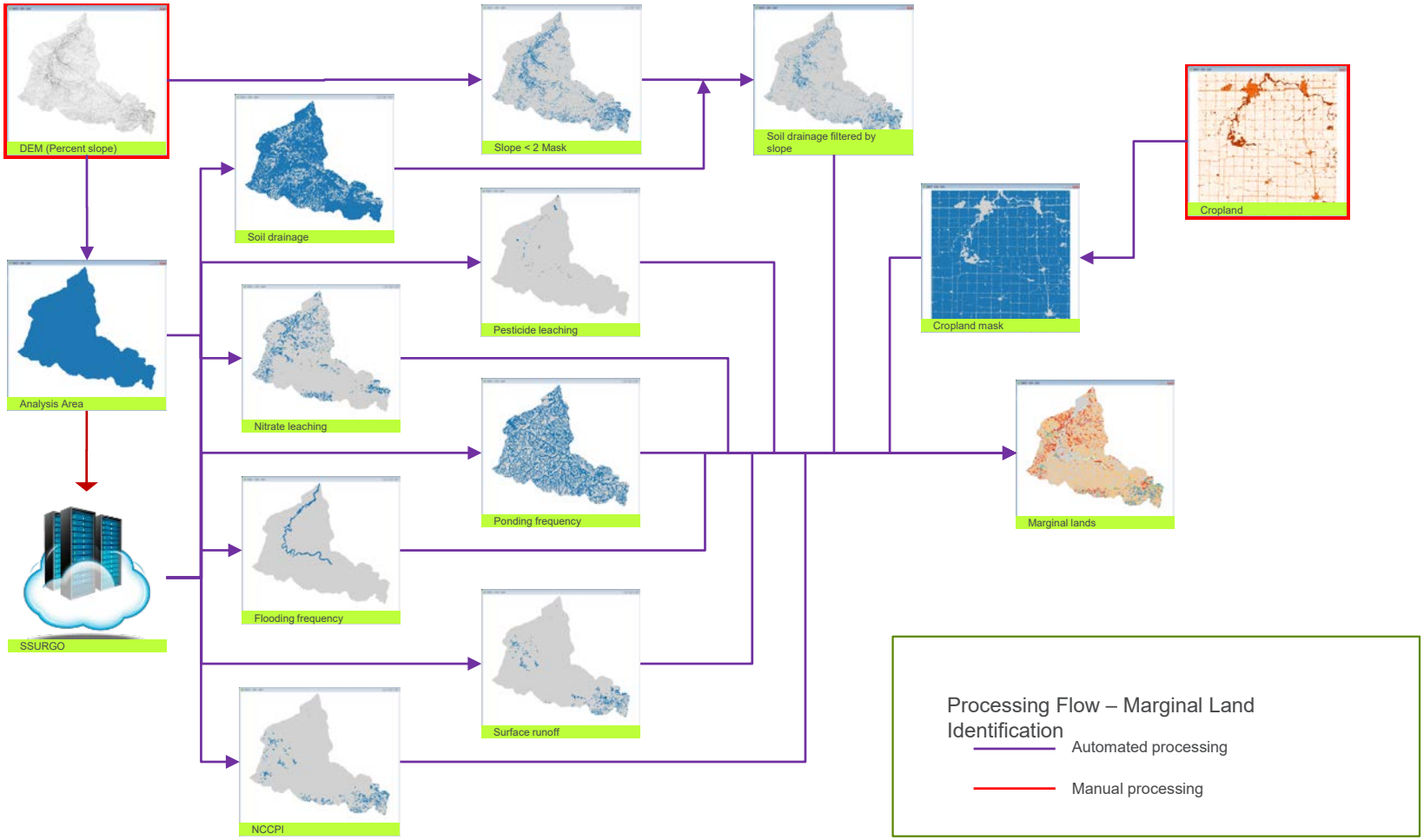
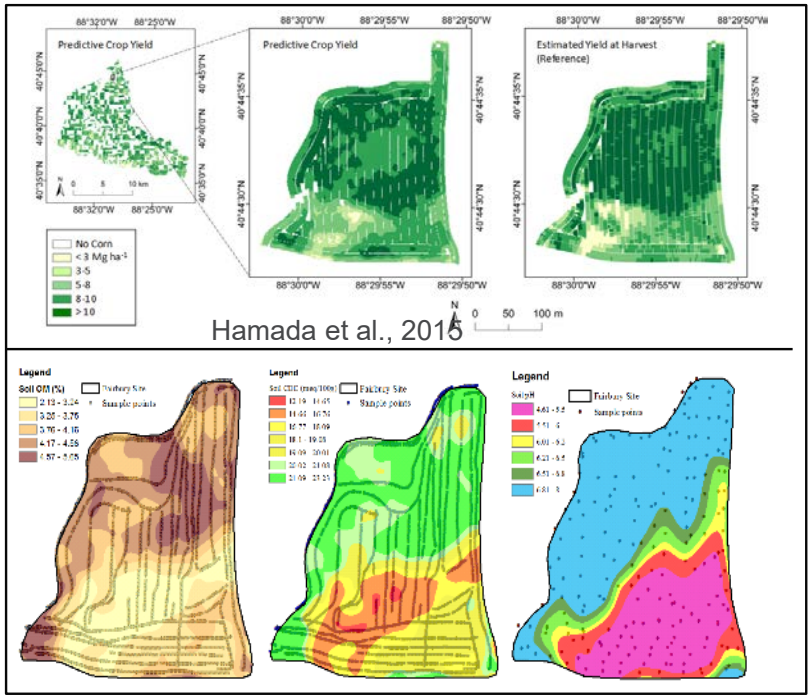
PATH FORWARD 1:
MAKING SCALING UP FASTER AND EASIER



PATH FORWARD 2: SENSORS AND DATA
THE CONCEPT OF OBSERVATORY FOR SYNERGISTIC RESEARCH

- Strength is in the numbers: data, data and more data
- Remote sensing, proximal sensing, distributed sensing, and edge computing
- Observatory concept allows for more leveraging of research investments, larger opportunities for meta-studies – learning from existing examples to bring bioenergy field trials together.

Source: Argonne National Laboratory



Hamada et al., 2015