CLIMATE VARIABILITY, MANAGEMENT PRACTICES AND CORN YIELD IN THE MIDWEST US: ADAPTATION AND MITIGATION STRATEGIES TO CLIMATE CHANGE

Dumont, B., Basso, B.
Michigan State University, East Lansing, MI, USA

INTRODUCTION

To assess and evaluate the impact of the complex interactions occurring between soil, climate, management and genotypes on yields and environmental outcomes, a systems approach is required. In this study, we developed a methodology to simulate, at a fine spatial resolution, crop yield, soil organic carbon and nitrogen leaching across the Midwest US. Within the framework of CSCAP Objective 3, we also aimed to identify the best adaptation and mitigation strategies to projected climate variability and change using different climate and management scenarios.

RESULTS

- Corn yield are expected to decrease with climate change by 17% (mean value for Midwest under RCP 2.6) to 40% (RCP 6). This decrease is steady across the management scenario.
- N-NO_3^- leaching is expected to increase under climate change, but can be greatly decreased by including cover crop and extended rotation.
- Projected SOC decrease under climate change is expected to be mitigated under scenario SC4-SC7.

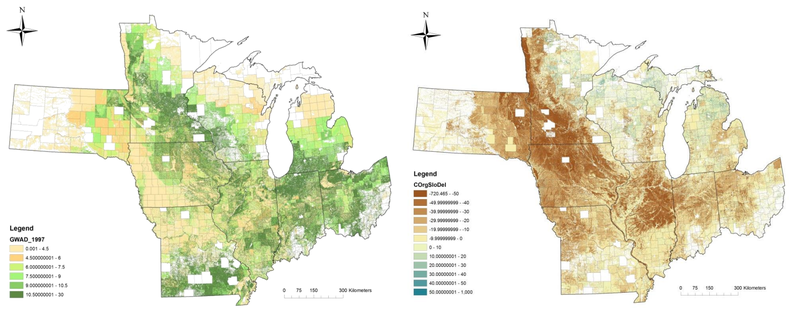

Figure 3: Example of 1997 corn yield [ton.ha^{-1}]
Example of Soil Organic Carbon slow pool changes [ton.ha^{-1}]

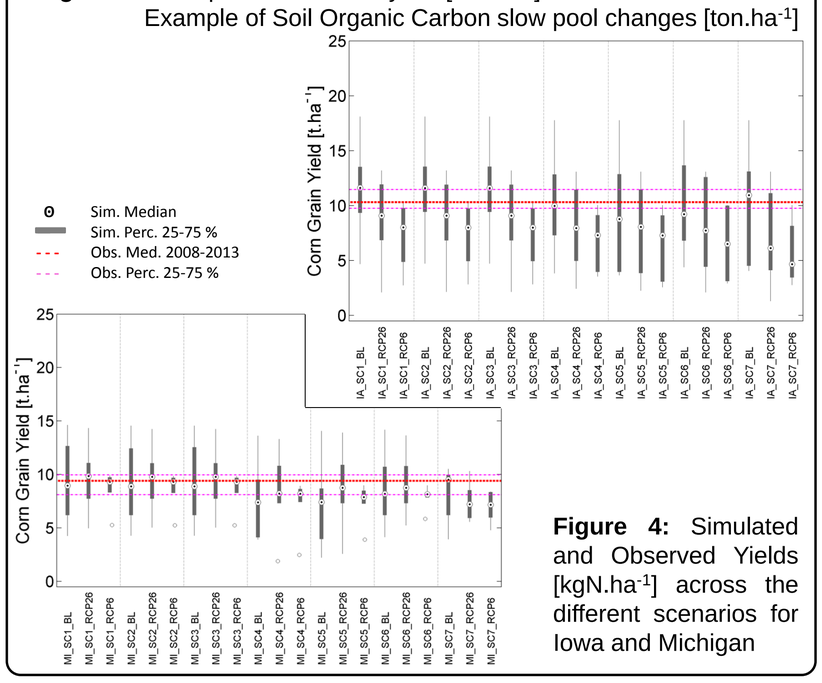

Figure 4: Simulated and Observed Yields [kgN.ha^{-1}] across the different scenarios for Iowa and Michigan

MATERIAL AND METHOD

Management scenarios

Seven management scenarios were defined, with increasing complexity and progressive integration of sustainable practices.

Table 1: Management scenarios

Scenario description	*Rotation*	*Manure*	*N fertilization*	*Tillage*
SC1	Continuous Corn	Fall manure	Inorg. N: 200kgN/ha (@ planting)	Conv. Till.
SC2	Continuous Corn	No manure	Inorg. N: 200kgN/ha (@ planting)	Conv. Till.
SC3	Continuous Corn	No manure	Inorg. N: 50-150kgN/ha (Plt -V6)	Conv. Till.
SC4	Continuous Corn	No manure	Inorg. N: 50-150kgN/ha (Plt -V6)	No Till.
SC5	Continuous Corn + CC	No manure	Inorg. N: 50-150kgN/ha (Plt -V6)	No Till.
SC6	Corn/SB + CC	Fall manure	Inorg. N: 50-150kgN/ha (Plt -V6)	No Till.
SC7	Corn/SB/WW + CC	Fall manure	Inorg. N: 50-150kgN/ha (Plt -V6)	No Till.

Climate change scenarios

Projected climatic change scenarios (RCP 2.6, RCP6) were simulated, considering seasonal modifications around the baseline (1979-2013).

Table 2: Seasonal climate change scenarios

Scenario	Season / Variable	DJF	MAM	JJA	SON
Baseline (BL)	----------	NCEP – NARR		1979-2013	
RCP2.6	Precipitation	1.1	1.1	0.95	1
	Temperature	---------- +3 dC ----------			
	CO_2	---------- 400 ppm ----------			
RCP6	Precipitation	1.2	1.2	0.90	1
	Temperature	---------- +6 dC ----------			
	CO_2	---------- 540 ppm ----------			

Soil and climatic databases

The SSURGO (Soil Survey Geographic) data of nine Midwest states (IA, IL, IN, MI, MN, MO, OH, SD, WI) were extracted to parametrize soil characteristics at the fine spatial scale. The NCEP-NARR (North American Regional Reanalysis) weather files were analyzed to account for the driving climatic variables at the county level.

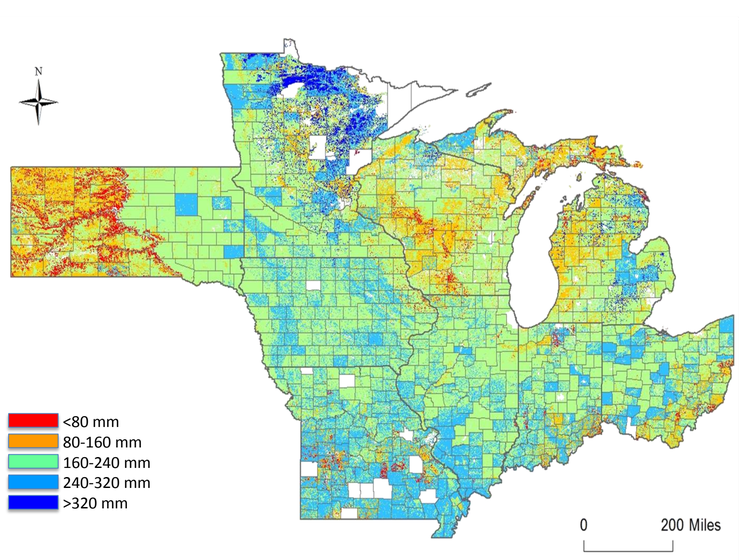

Figure 1: Derived soil extractable water from SSURGO data

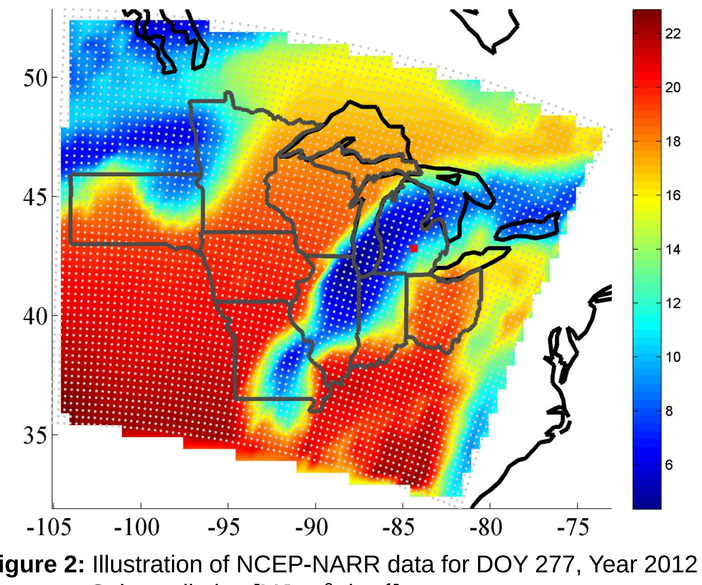

Figure 2: Illustration of NCEP-NARR data for DOY 277, Year 2012
Solar radiation [MJ.m^{-2}.day^{-1}]

Crop model and state specific crop management

The information collected by the USDA-National Agricultural Statistics Service (www.nass.usda.gov) was used to define state specific management itineraries. The SALUS soil-crop model (http://salusmodel.psm.msu.edu/ - System Approach to Land Use Sustainability) was used to simulate crop growth and soil changes over the Midwest US.

CONCLUSIONS

- Corn yield are expected to decrease across the Midwest, with slight increase in MI and WI. The impacts of climate change and management practices on corn yield varies greatly from one site/state to another with opposite effects between sites.
- The gain in SOC and the reduction in N-leaching when using improved management are greater under RCP2.6 compared to BL and even higher under RCP6

RECOMMENDATIONS

- Addition of manure, cover crops, extended rotation have a great impacts on mitigating and reducing N-NO_3^- leaching and SOC losses, but not sufficient to reverse the negative effects on yield caused by climate change.
- The negative impact of increasing temperature and more frequent extreme events, such as flooding and drought, can be mitigated using adaptive in-season management strategies, new genetics, and variable rate application of agronomic inputs.

MICHIGAN STATE UNIVERSITY

This research is part of a regional collaborative project supported by the USDA-NIFA, Award No. 2011-68002-30190 “Cropping Systems Coordinated Agricultural Project (CAP): Climate Change, Mitigation, and Adaptation in Corn-based Cropping Systems” sustainablecorn.org

SUSTAINABLE CORN.ORG
CROPS, CLIMATE, CULTURE AND CHANGE

USDA
United States Department of Agriculture
National Institute of Food and Agriculture