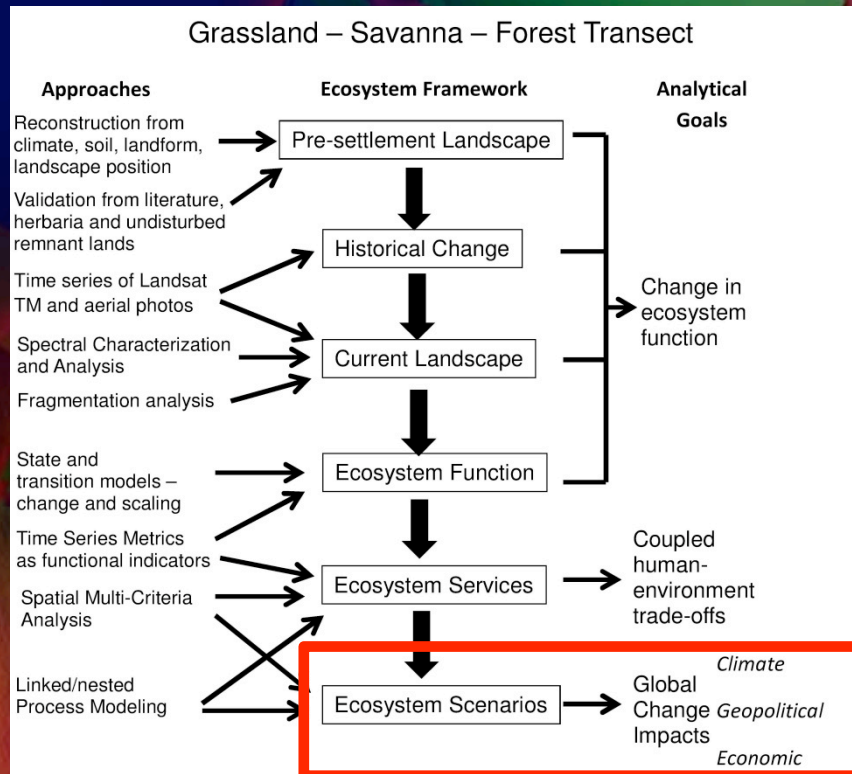


WCRP Open Science Meeting, Denver, October 2011

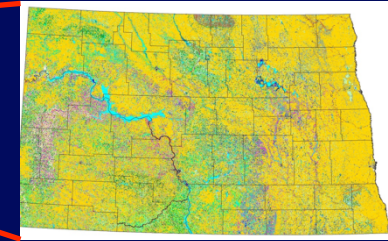
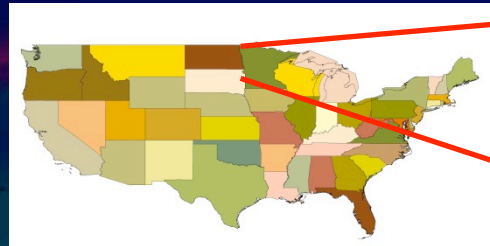
A Global Change Scenario Analysis for North Dakota: potential future trade-offs between agriculture, energy and grassland/ wetland conservation



Michael J. Hill, Rhonda Olson and Andrei P. Kirilenko
Department of Earth System Science and Policy
University of North Dakota, Grand Forks, ND,
58202, USA
Email: hillmj@aero.und.edu

Acknowledgements: Lorilie Atkinson, Rebecca Romsdahl, Seth Fore, Kate Overmoe, Anduin McElroy

North Dakota



- Part of one of the **great global granaries**
 - Major **oil and gas** extraction boom (Bakken Formation)
 - Significant potential for **renewable energy** – wind, biomass
 - Contains significant **conservation value**
 - National **Grasslands** (Little Missouri, Sheyenne)
 - **Prairie Pothole** region (waterfowl, biodiversity)
 - microcosm of trade-offs faced globally in savannas and grasslands
 - **resource exploitation and food production**
 - VS
 - **maintenance of ecosystem function and services**
 - Case study: explore under plausible future global scenario
- Commodity economy

Concept (GLP association)

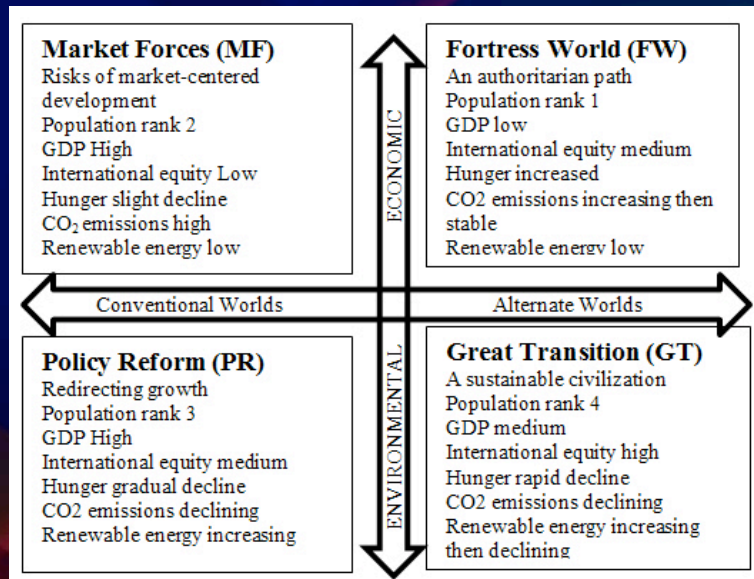
- Interested in the broad impacts of **Global Change** – not just Climate (**interaction** of climate with various outcomes for **global food security** and **national energy security**)
- Using MCAS-S – a **spatially explicit Multi-Criteria Analysis Shell** for visualization of complex land system problems. Designed for **stakeholder interaction and decision support**
- Specific **focus on grasslands** in the landscape and ecosystem (and incidentally in **associated wetlands**)
- Concerned with current and future global and national demand for food and energy as **threats or stress factors on grassland habitats**

Approach

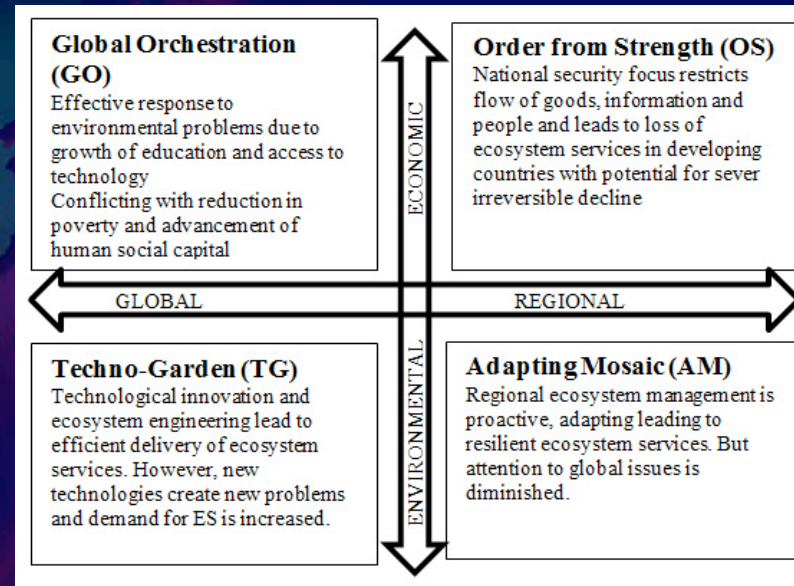
- **Combine published global scenarios** for overall development (Rosen et al., 2010), oil security (Johnston, 2010), emissions (SRES; Nakićenović et al., 2000) and care of the environment (MEA, 2005)
- Construct a **comprehensive spatial database** describing ND agriculture, grassland, wetlands, energy resources and future climate
 - **WorldClim data** under **SRES scenarios** (2071 – 2100) from HADCM, CCCMA and CSIRO GCMs
 - 300 m spatial resolution
- Develop rules for **scaling** global scenario effects to ND
- Challenges
 - **inference step** – global scenarios to potential local land use effects
 - capture of **climate effects** that are **enterprise relevant**

Global Frameworks: for linking

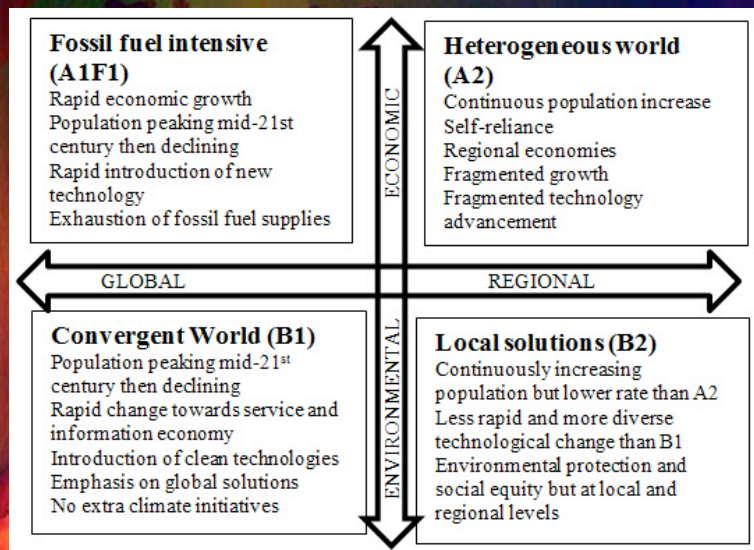
Global Development (Rosen et al., 2010)



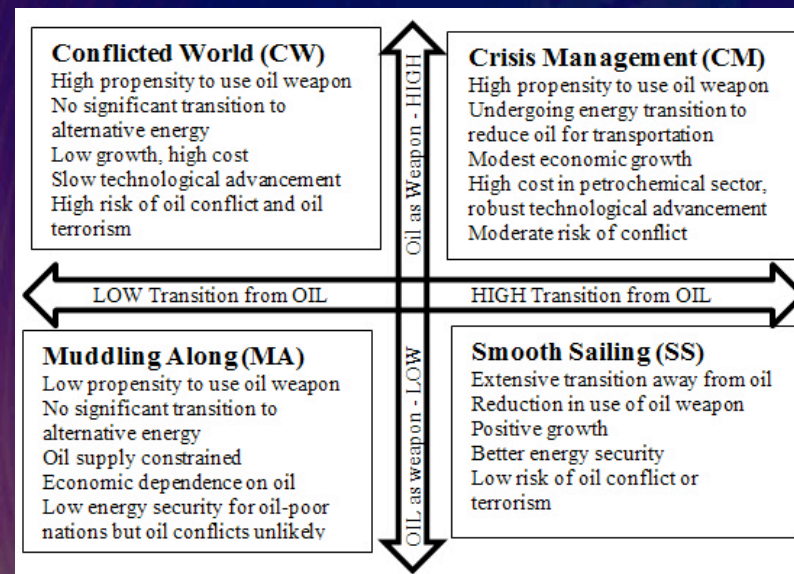
Millennium Ecosystem Assessment(MEA, 2005)



Special Report on Emissions Scenarios (IPCC, 2000)

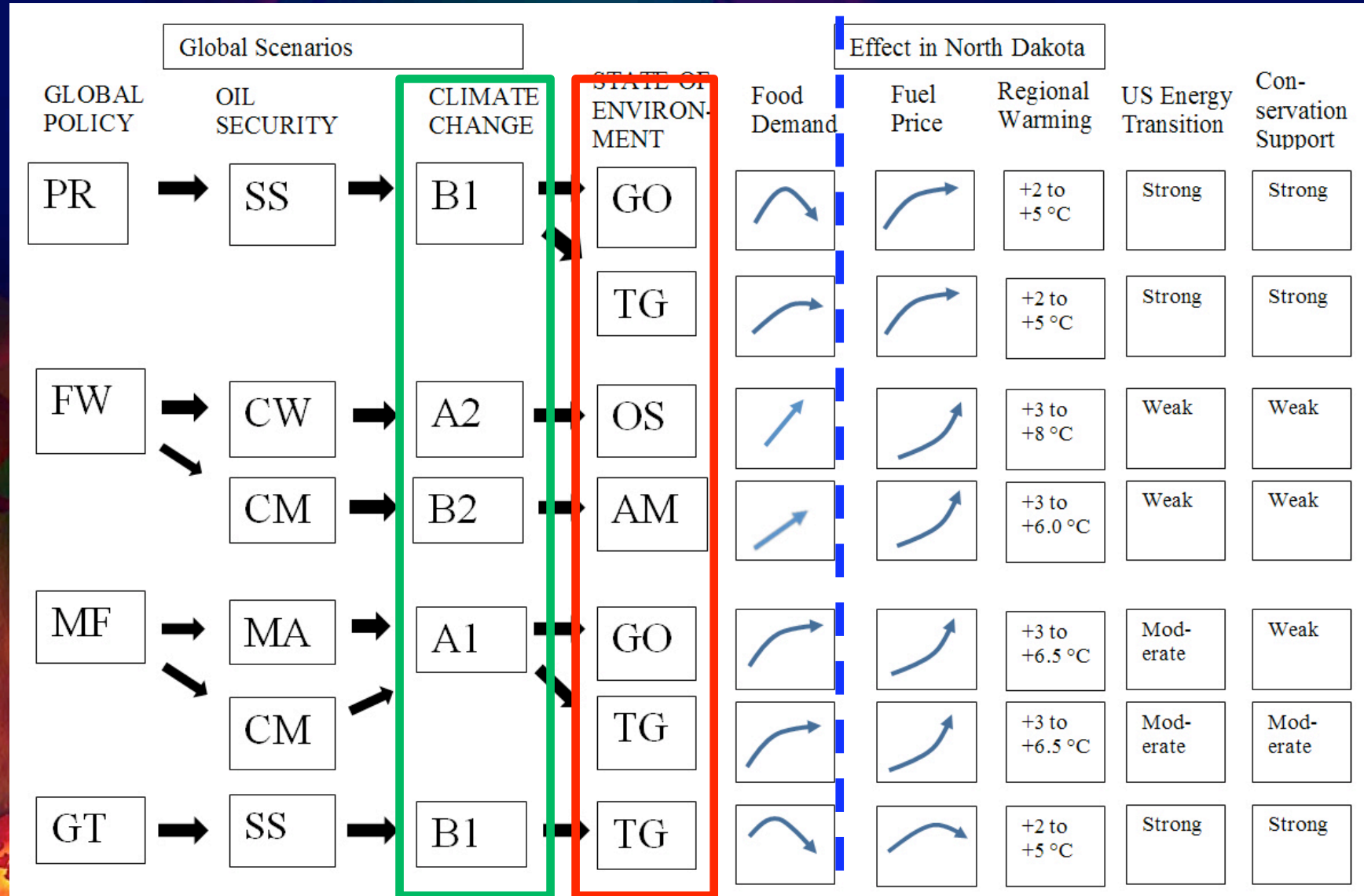


Oil Security (Johnston, 2010)



Nominal Linked Global Scenarios

with suggested global, national and regional consequences



Regional Factors and Features

- Complex history of **responses at State level** to historical events, changes to public sentiment, federal policy, and economic and technological changes

(dust bowl, “Silent Spring”, New Deal, CRP, oil prices, cattle prices, advanced agriculture, soybeans, ethanol subsidy, etc)

- Influence of US **incentives** for grassland and wetland conservation

- **subsidies** for biofuel production

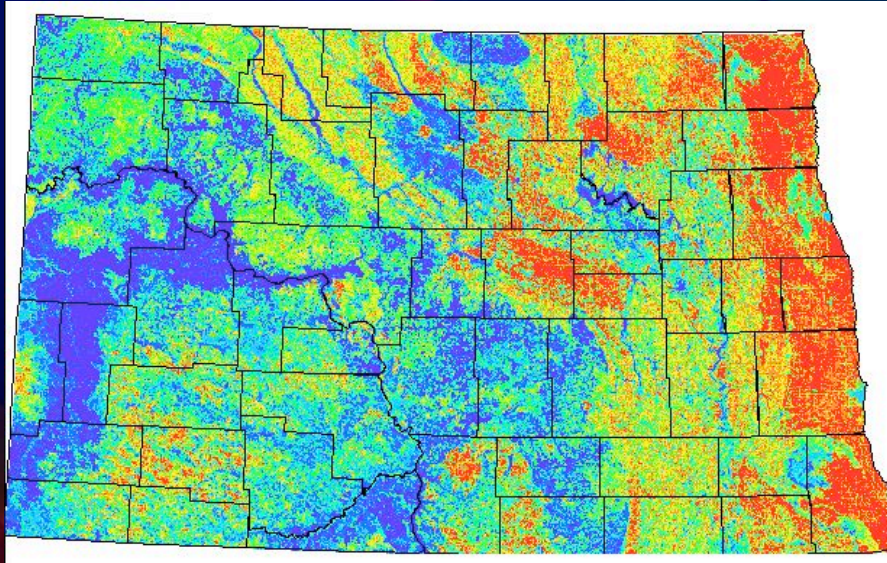
- **emphasis on private land utility and private access to public land in ND**

Turns out that these local factors and tendencies are really important and we are still working on a comprehensive analysis in relation to grassland conservation

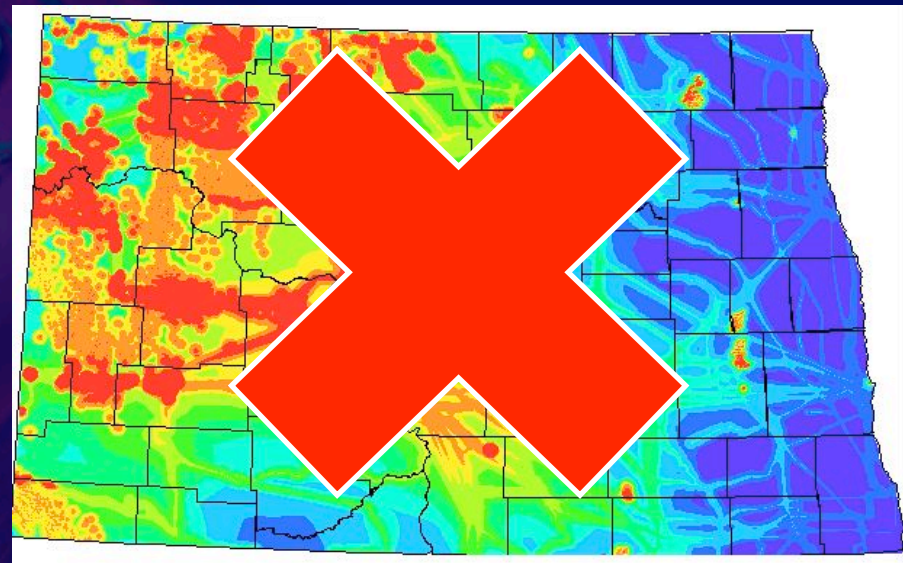
Note: CRP = Conservation Reserve Program

Agriculture, Energy, Grasslands and Wetlands

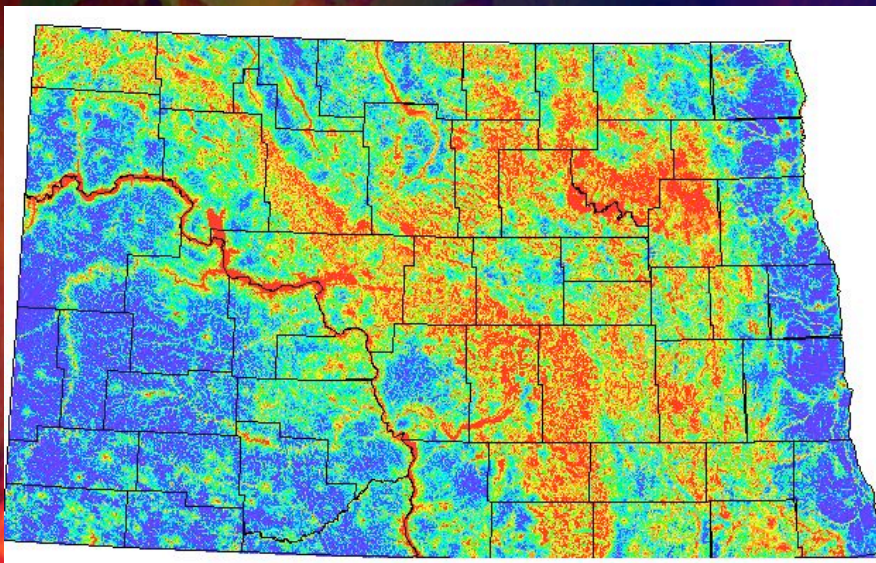
Agricultural Capability



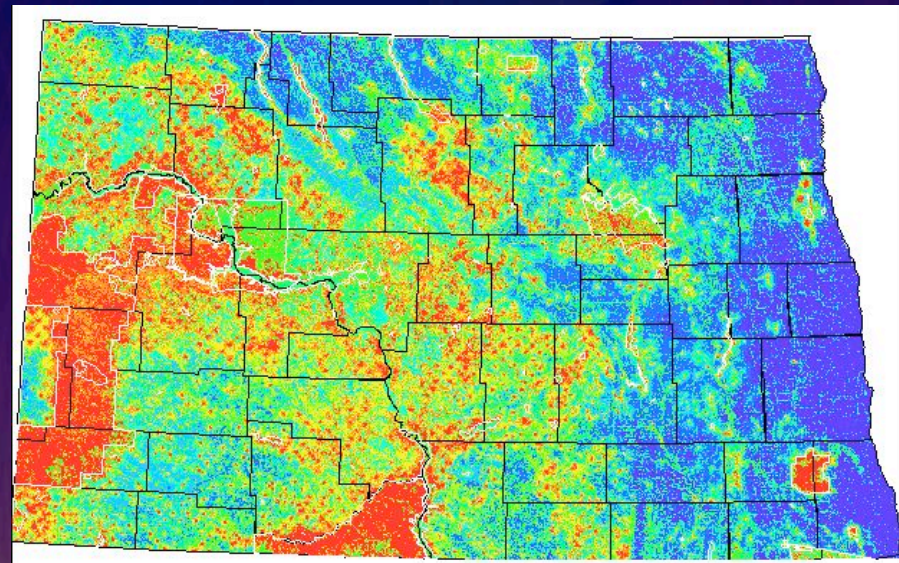
Current Energy



Wetland "Strength"



Grassland "Strength"

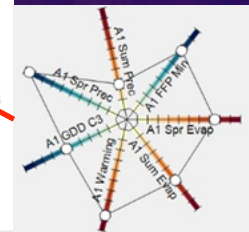
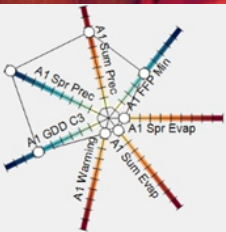
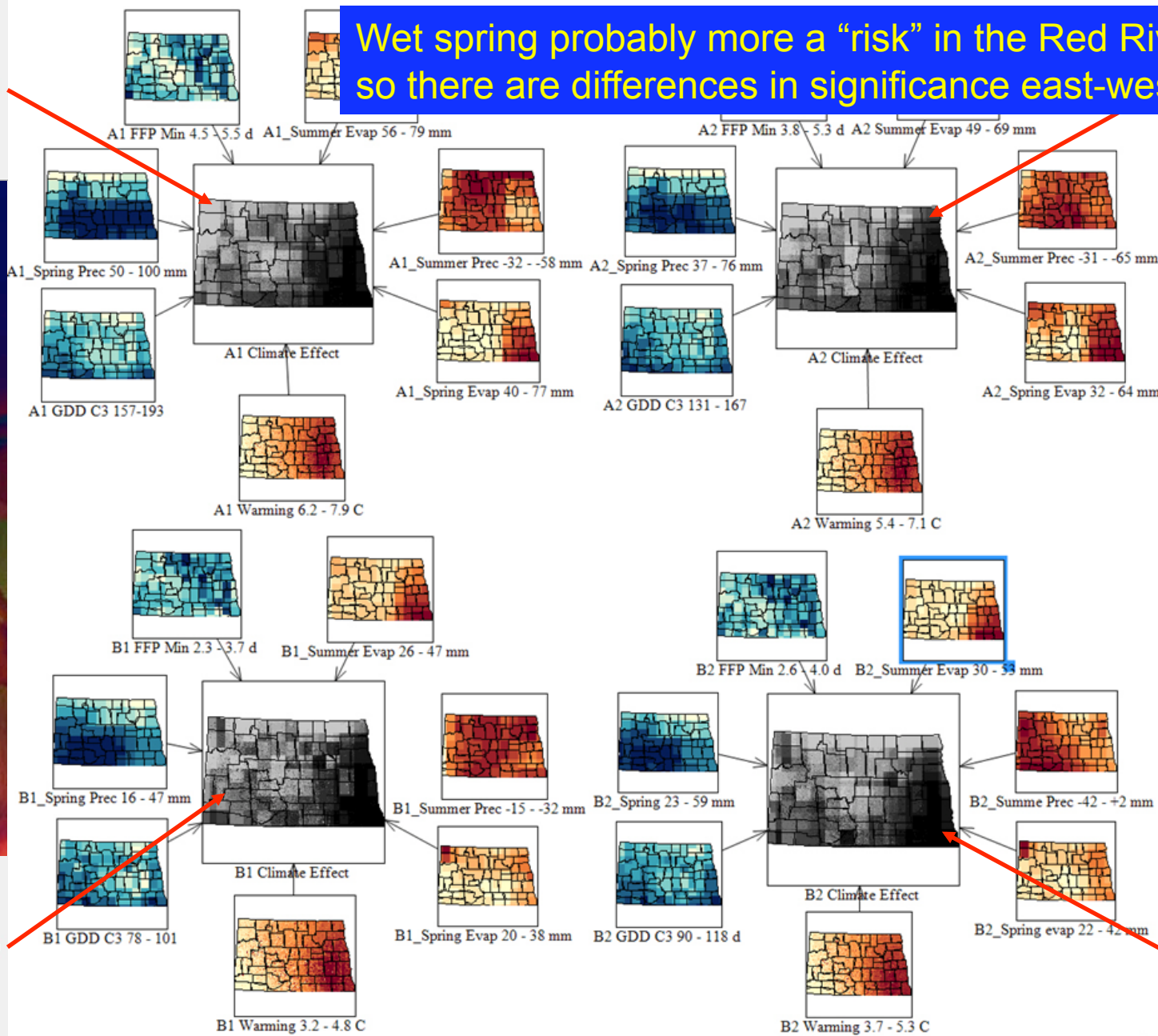


Major Climate Changes (WorldClim Data)

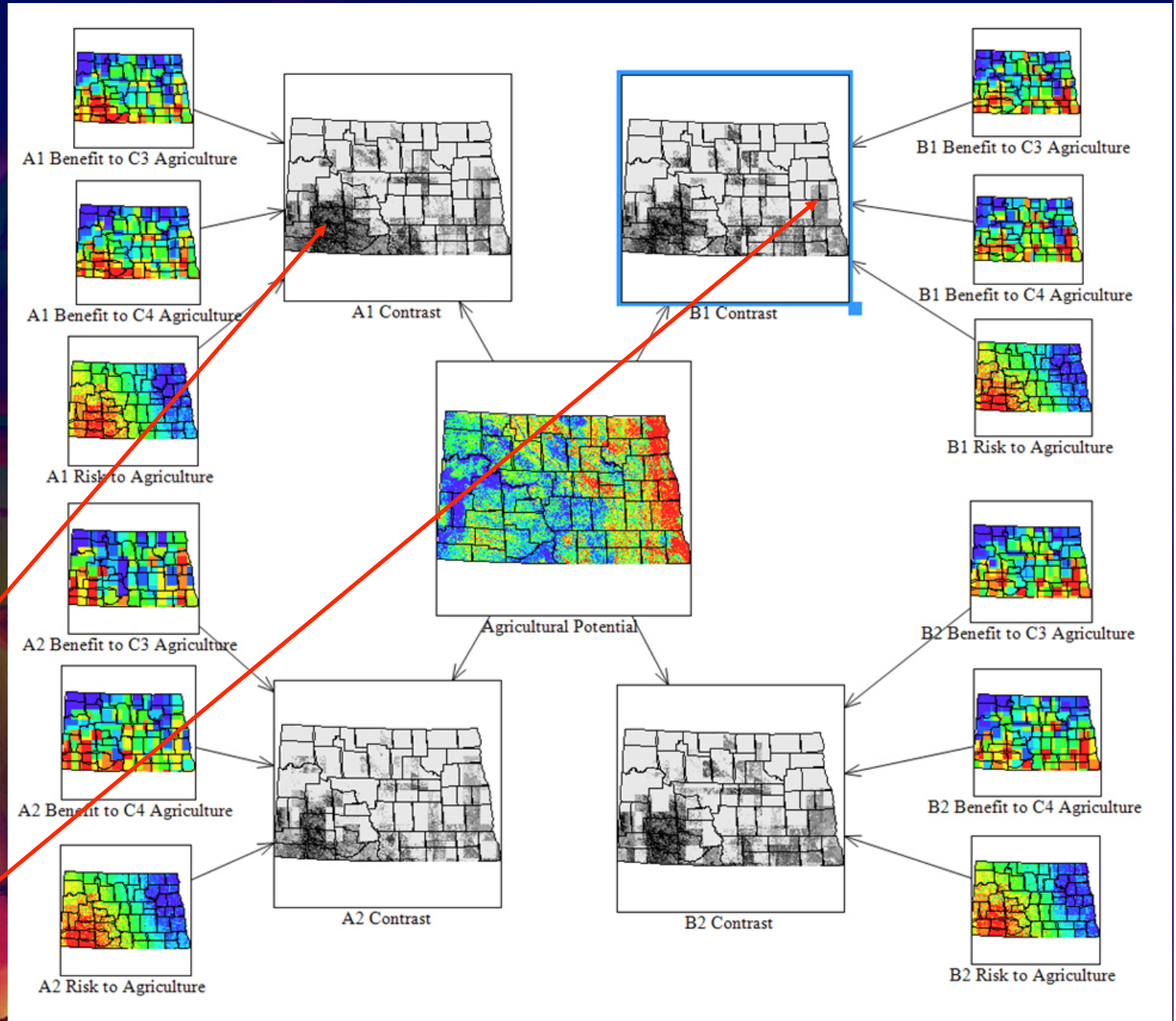
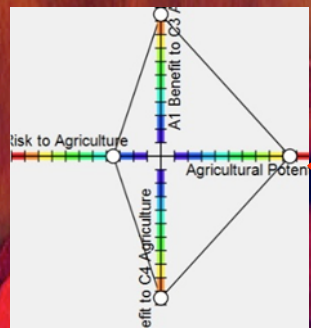
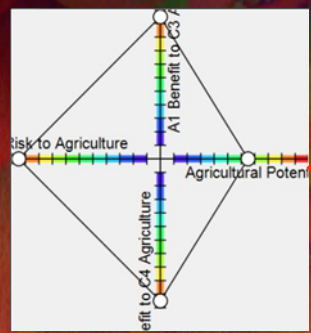
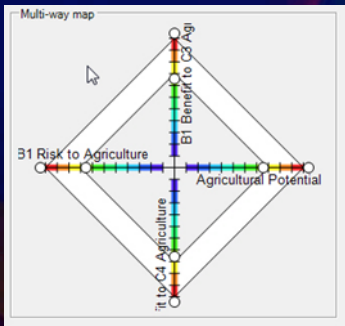
Wet spring probably more a "risk" in the Red River Valley so there are differences in significance east-west!

FFP – frost free period
GDD – growing degree days

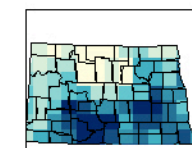
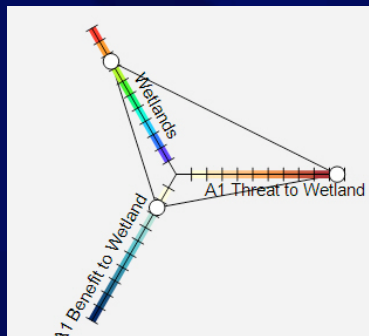
Blue color scale – more blue more benefit;
orange color scale - more orange more risk
Combined to create benefit and risk composites



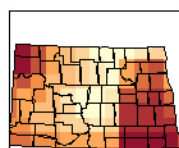
Climate vs Agriculture - response envelope: high benefit, high risk, high Ag potential



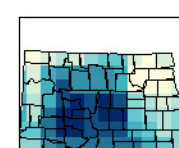
Climate vs Wetlands



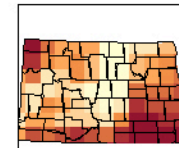
A1 Benefit to Wetland



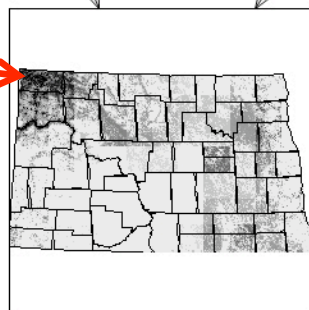
A1 Threat to Wetland



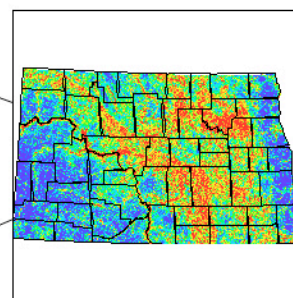
A2 Benefit to Wetland



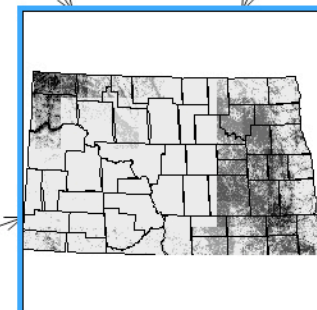
A2 Threat to Wetland



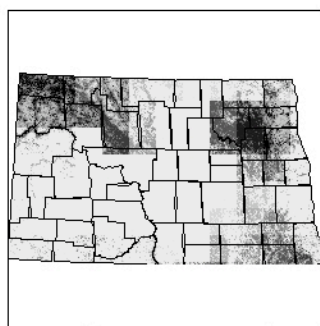
A1 Wetland Impact



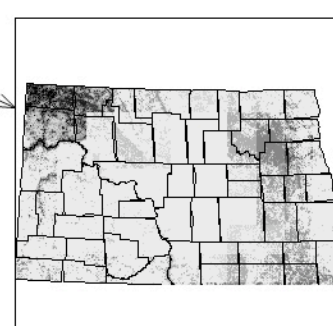
Wetlands



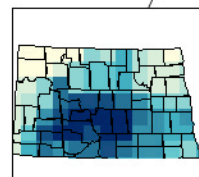
A2 Wetland Impact



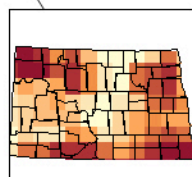
B1 Wetland Impact



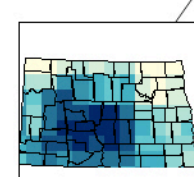
B2 Wetland Impact



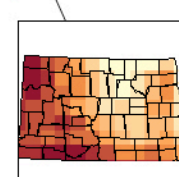
B1 Benefit to Wetland



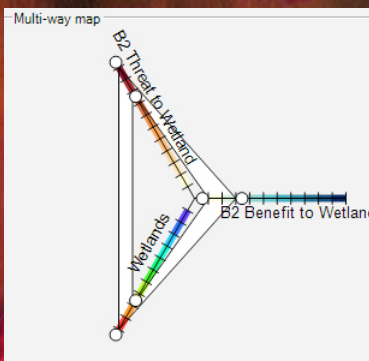
B1 Threat to Wetland



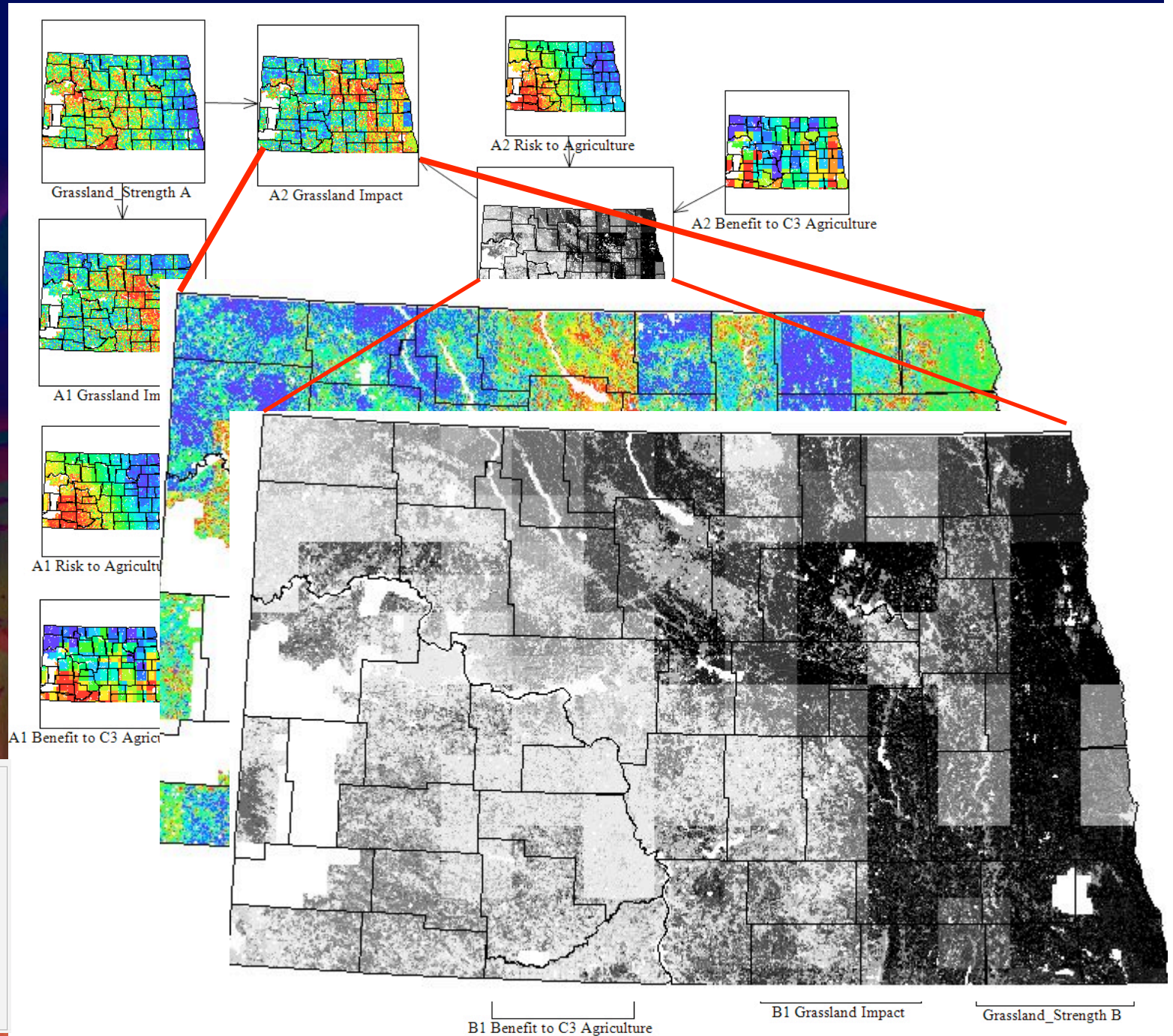
B2 Benefit to Wetland



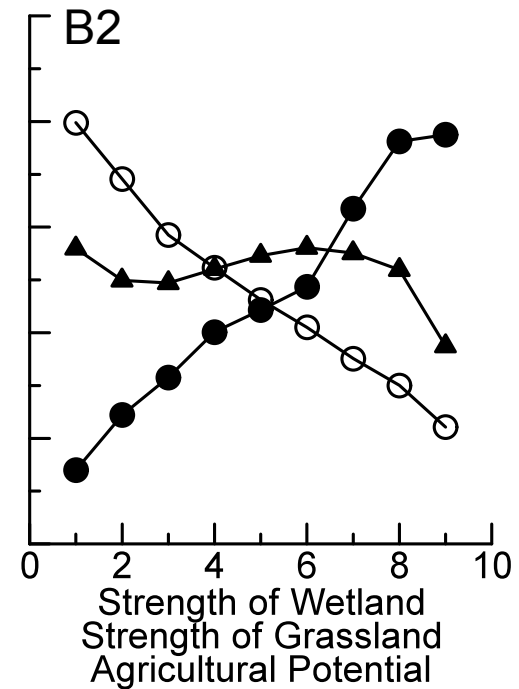
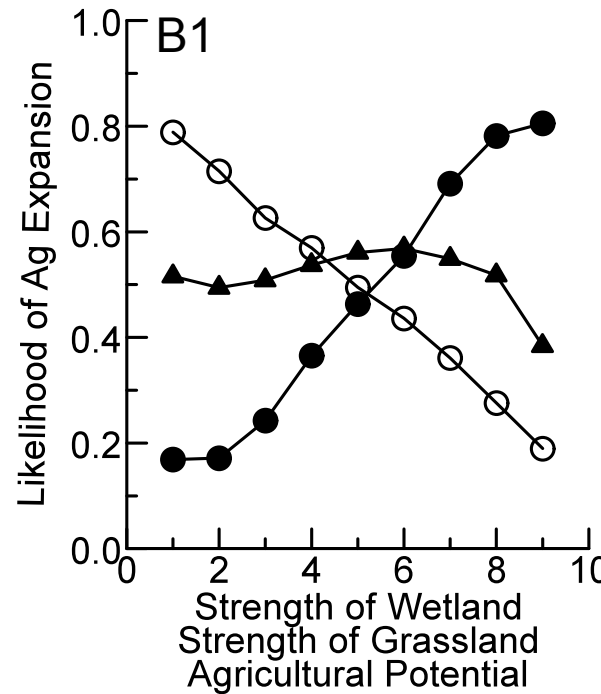
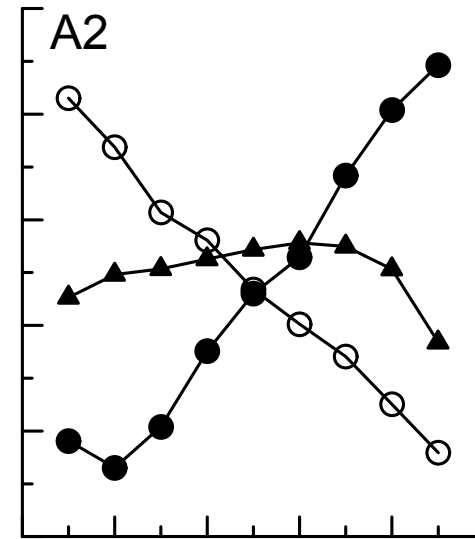
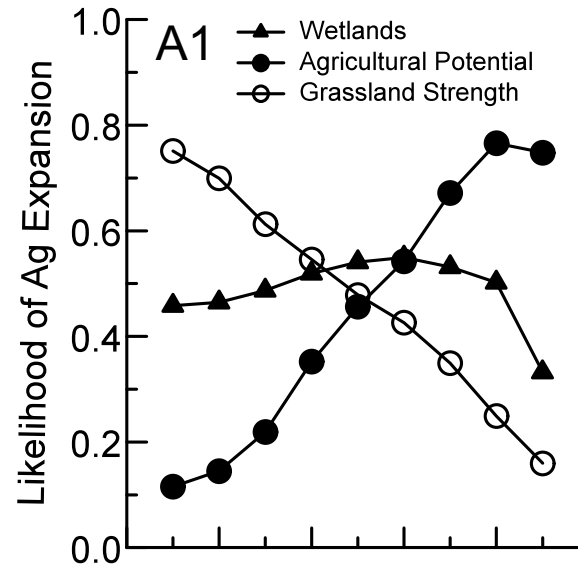
B2 Threat to Wetland



Agriculture vs Grassland



Likelihood of agricultural development vs grassland, wetlands and agricultural potential



Major Potential Effects

- Major impacts on agriculture with potential benefits in the SE (although wet springs may limit this) and serious increase in drought risk in the SW.
- Potential pressure on the current CRP and remnant grasslands from agricultural expansion in eastern and central ND
- Multiple risks to prairie pothole wetlands from drier summers and conversion of dried-up intermittent wetlands to agriculture accelerated by global food and national biofuel demand
- Potential fragmentation issues in western grassland with expansion of oil and gas extraction but with considerable uncertainty about extent and life of this resource

Issues

- What are the consequences for ecosystem function?
- In what way can/ does such scenario analysis lead to or deliver “actionable science”? **Can we take this to the “people”?**
- Need to represent uncertainty/probability of effect
- Agriculture is very responsive to price and climate changes, but natural systems – particularly species at risk from habitat decline are another thing altogether.
- How will “events” shape sentiment and policy at national and State level? A well formed scale connection awaits.