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

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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
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)
- Market Forces (MF)
  - Risks of market-centered development
  - Population rank 2
  - GDP High
  - International equity low
  - Hunger slight decline
  - CO2 emissions high
  - Renewable energy low

- Fortress World (FW)
  - Authoritarian path
  - Population rank 1
  - GDP low
  - International equity medium
  - Hunger increased
  - CO2 emissions increasing then stable
  - Renewable energy low

Millennium Ecosystem Assessment (MEA, 2005)
- Global Orchestration (GO)
  - Effective response to environmental problems due to growth of education and access to technology
  - Conflicting with reduction in poverty and advancement of human social capital

- Order from Strength (OS)
  - National security focus restricts flow of goods, information and people and leads to loss of ecosystem services in developing countries with potential for severe irreversible decline

- Fossil fuel intensive (A1F1)
  - Rapid economic growth
  - Population peaking mid-21st century then declining
  - Rapid introduction of new technology
  - Exhaustion of fossil fuel supplies

- Heterogeneous world (A2)
  - Continuous population increase
  - Self-reliance
  - Regional economies
  - Fragmented growth
  - Fragmented technology advancement

- Convergent World (B1)
  - Population peaking mid-21st century then declining
  - Rapid change towards service and information economy
  - Introduction of new clean technologies
  - Emphasis on global solutions
  - No extra climate initiatives

- Local solutions (B2)
  - Continuously increasing population but lower rate than A2
  - Less rapid and more diverse technological change than B1
  - Environmental protection and social equity at local and regional levels

Oil Security (Johnston, 2010)
- Conflicted World (CW)
  - High propensity to use oil weapon
  - No significant transition to alternative energy
  - Low growth, high cost
  - Slow technological advancement
  - High risk of oil conflict and oil terrorism

- Crisis Management (CM)
  - High propensity to use oil weapon
  - Undergoing energy transition to reduce oil for transportation
  - Modest economic growth
  - High cost in petrochemical sector
  - Robust technological advancement
  - Moderate risk of conflict

- Muddling Along (MA)
  - Low propensity to use oil weapon
  - No significant transition to alternative energy
  - Oil supply constrained
  - Economic dependence on oil
  - Low energy security for oil-poor nations but oil conflicts unlikely

- Smooth Sailing (SS)
  - Extensive transition away from oil
  - Reduction in use of oil weapon
  - Positive growth
  - Better energy security
  - Low risk of oil conflict or terrorism
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 initiatives, and economic and technological changes (dust bowl, “Silent Spring”, National Grasslands, CRP, oil prices, cattle prices, advent of canola, soybeans, ethanol subsidy, etc)

• Influence of US Farm Bill in terms of incentives for grassland and wetland conservation

• Influence of subsidies for biofuel production

Note: CRP = Conservation Reserve Program

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

private land utility and private access to public land in ND
Agriculture, Energy, Grasslands and Wetlands

Agricultural Capability

Current Energy

Wetland “Strength”

Grassland “Strength”
Wet spring probably more a “risk” in the Red River Valley so there are differences in significance east-west!
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
A3 Threat to Wetland
A1 Wetland Impact
A2 Wetland Impact
B1 Benefit to Wetland
B1 Threat to Wetland
B2 Benefit to Wetland
B2 Threat to Wetland

Wetlands
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.