Economic and Environmental Co-benefits of Carbon Sequestration in Agricultural Soils: Retiring Agricultural Land in the Upper Mississippi River Basin

H. Feng, L. Kurkalova, C. Kling, and P. Gassman
CARD, Iowa State University

Presented at the Third USDA Symposium on Greenhouse Gases and Carbon Sequestration in Agriculture and Forestry

March 22-24, 2005; Baltimore, Maryland

For those who were at my previous presentation in this room

- What is new in this presentation
  - Focus and issues are different
  - Policies assessed are different
  - Only one environmental model is used here
- What is not new
  - Study region: both are conducted for UMRB
  - Based on similar methodology for the estimation of land retirement cost

Co-benefits from Carbon Sequestration Policies in Ag

- Effects on other environmental goods
- Effects on income support
- Effects on overall social welfare through market responses
- Effects that arise from the potential substitution of carbon sequestration for outright reductions in carbon emission
  - There are co-damages from carbon emissions

Environmental co-benefits of carbon sequestration policies

- Many conservation practices produce multiple benefits.
- Sound policy would aim to maximize the value from all benefits.
- Complication: the social values of many benefits are unknown
  - Most of these benefits are non-market goods
  - Difficult to assess environmental improvements in physical quantities

The importance of co-benefits--water quality as an example

- A large amount of expenditures on conservation in ag is meant for water quality;
- Many studies have shown that people are willing to pay for water quality improvement (contingent valuation models, and damage based analysis);
- The National Needs Survey indicates that a large amount of funding may be needed to meet the water quality needs.

Literature on environmental co-benefits

- Plantinga and Wu (2003)
  - The size of co-benefits is in the same order of magnitude as the costs of sequestration policy
- McCarl and Schneider (2001)
  - Increasing levels of co-benefits as carbon prices increase.
- Elbakidze and McCarl (2004)
  - The magnitude of co-benefits from sequestration is comparable to the magnitude of co-costs from carbon emissions.

Our focus—co-benefit in terms of income support

- Our definition of economic co-benefit: It is the amount of revenue received by the farmer or landowner in excess of the full opportunity cost of a new practice or land use.

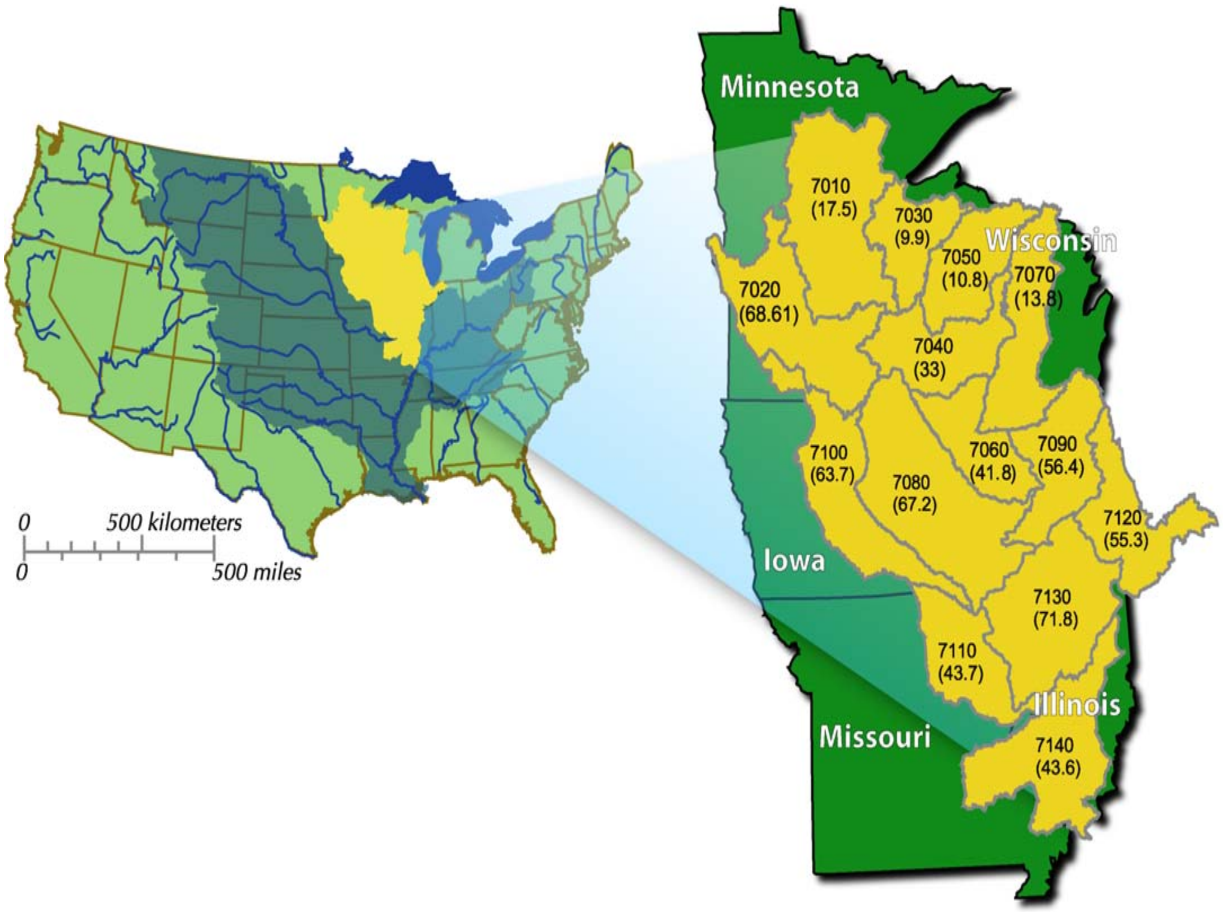
Why do we need to understand co-benefits

- The magnitude of co-benefits will affect program design.
- The heterogeneity of co-benefits will also affect program design
- Political support for a carbon sequestration policy may be strongly linked with co-benefits, particularly economic co-benefits.

Alternative policies considered

- Policies: producers are offered a uniform payment based on per unit of some benefit (carbon, erosion and nutrient loss reduction).
- Assuming policies are designed to max benefits at a given budget, then fields with the highest benefits per dollar can participate.
- For any field, if the program payment is greater or equal than cost, then it will be enrolled in the program

Study region



Some stats on the study region

- covers 189,000 square miles in seven states,
- is dominated by agriculture: cropland and pasture together account for nearly 67% of the total area (NAS),
- has more than 1200 stream segments and lakes on EPAs impaired waters list, highest concentrations of phosphorous found in the world (Downing),
- is estimated to be the source of nearly 40% of the Mississippi nitrate load discharged in the 1980- 1986,
- contains over 37,500 cropland NRI points

Main data and simulation model

- National Resource Inventory (NRI) (over 40 thousand points)
- Estimated cost for land retirement for each point based on corn yields at each point and county level cash rental rate
- the Environmental Policy Integrated Climate (EPIC) model, version 3060 (Izaurralde et al. 2005) is used.

Aggregate result—given one budget level

	Benefit Targeted				
	Carbon	**Erosion**	**N Runoff**	**Leaching**	**Area**
Area (mha)	1.5	1.7	1.3	1.6	3.1
Carbon (mmt)	3.2	0.8	0.6	1.0	1.3
Erosion (mmt)	7.4	40.5	14.1	9.7	27.1
N Runoff (tmt)	2.8	5.1	11.7	2.8	6.1
N Leaching (tmt)	10.0	6.4	5.6	30.6	15.3
Transfer (mill. $)	158.1	209.9	256.2	216.9	147.7

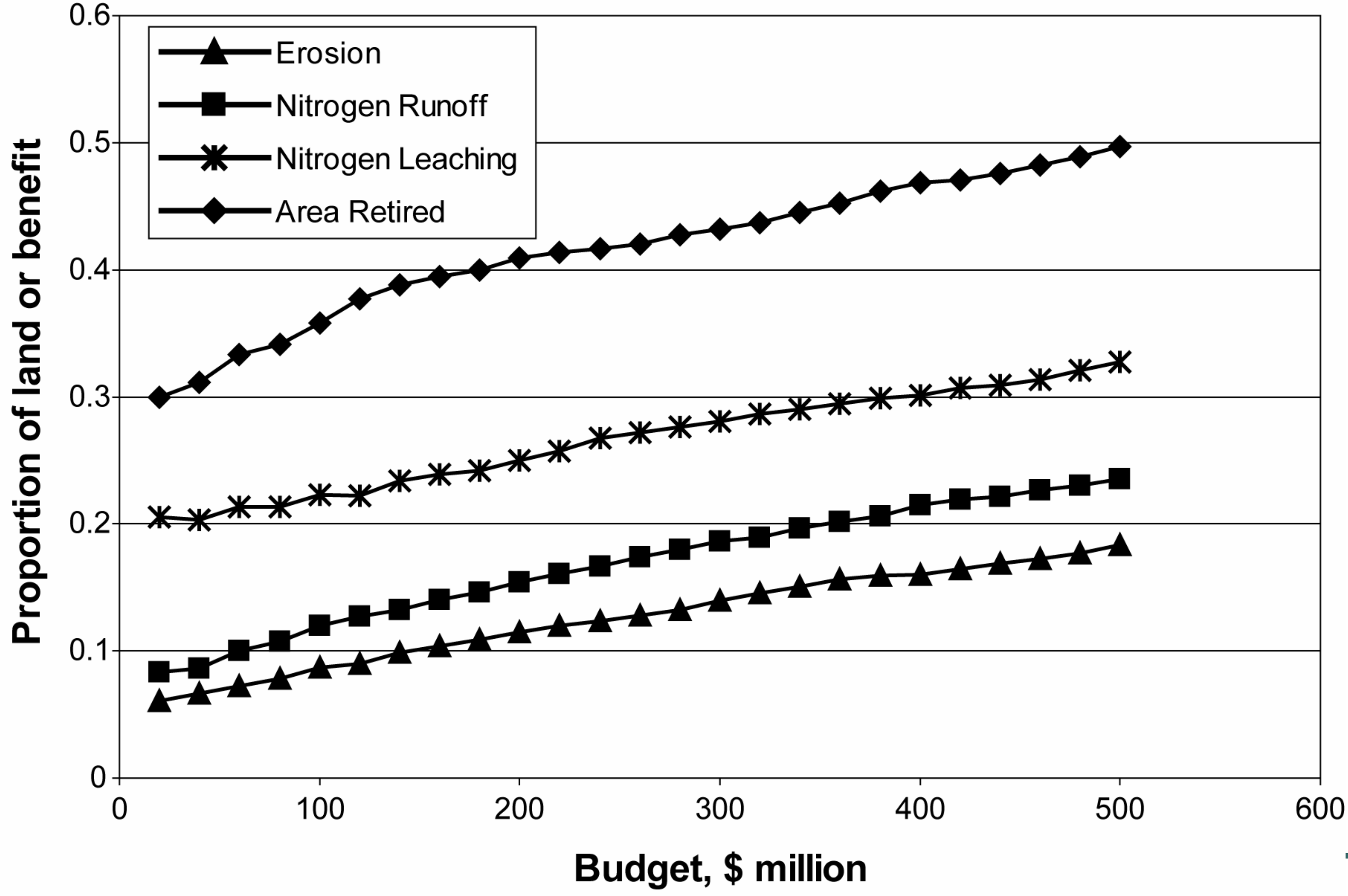
Put #s in perspective

- If the benefits from reduced erosion are about $5 per mt;
- Targeting carbon: the benefits from erosion reduction alone would be about $35 million, or about 7% of program cost (or about 10% of program cost minus transfer).
- However, targeting erosion, the benefits from erosion reduction would account for about 70% of program cost excluding transfer.
- In addition, if the carbon price is lower than $5 per mt, then the combined benefits from carbon and erosion would be higher under any policy considered than under the policy targeting carbon.

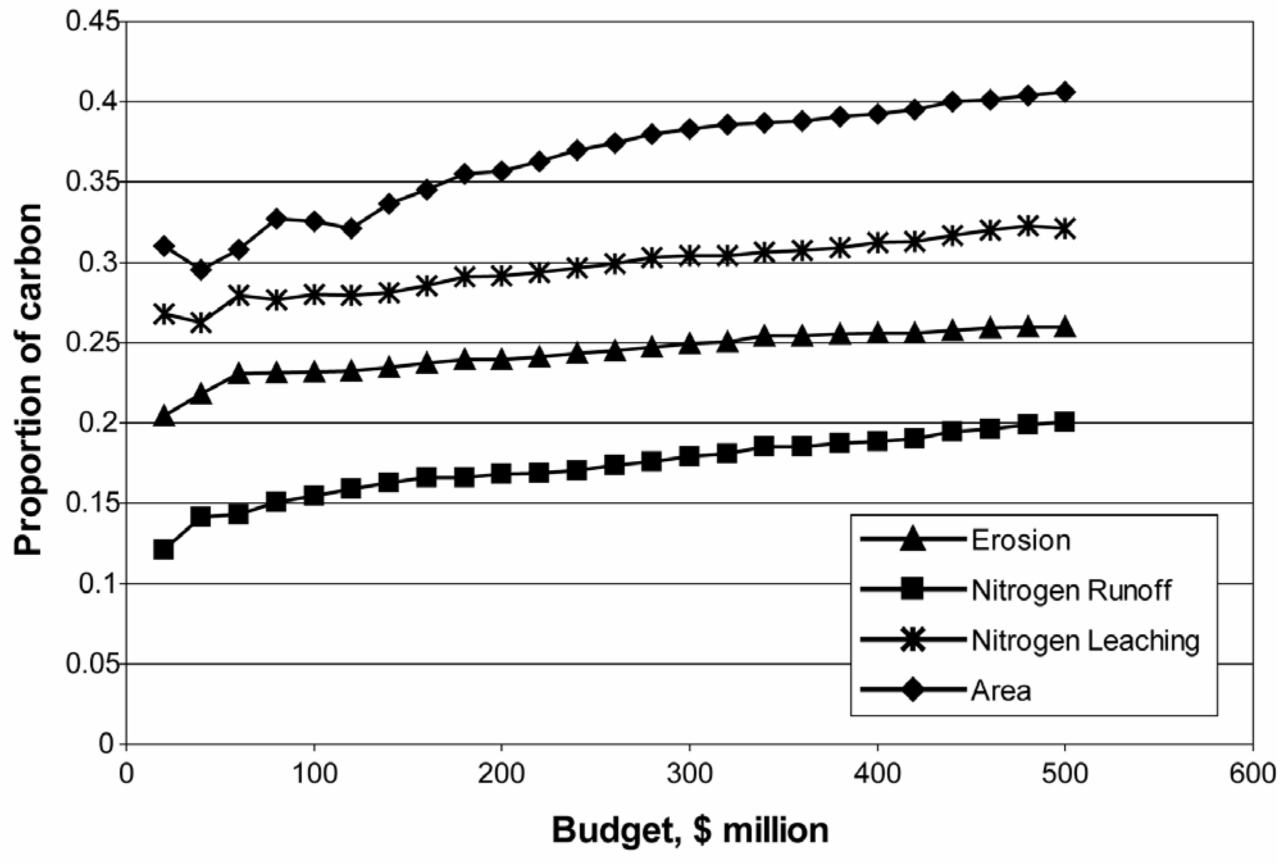
Environmental Lorenz Curve

- The Lorenz curves depict the proportion of the benefit obtained under a targeting scheme relative to the benefit obtainable when the indicator itself is targeted, for varying levels of budget.

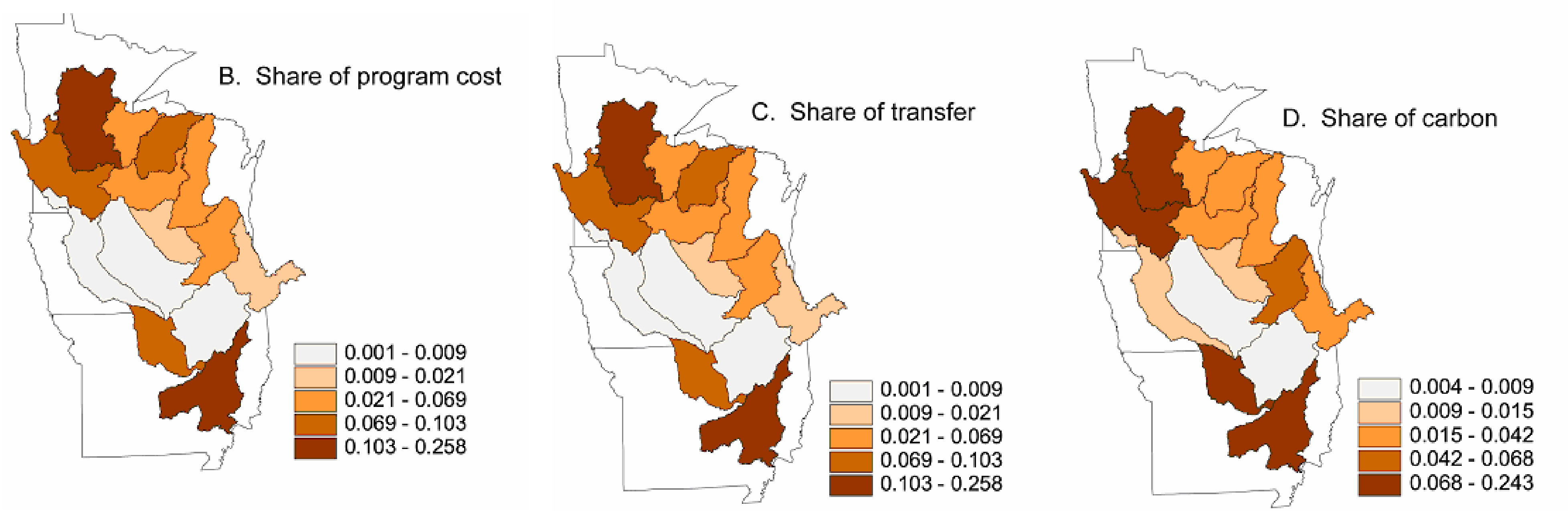
Aggregate result on other indicators when targeting carbon



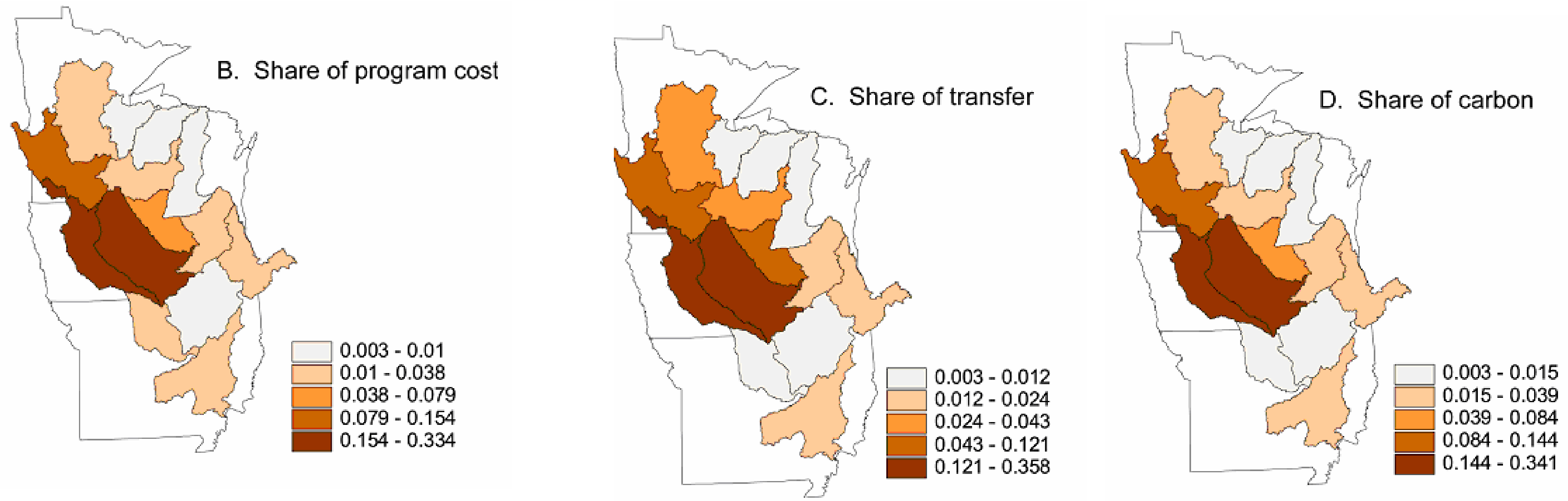
Aggregate result on carbon when some other indicator is targeted



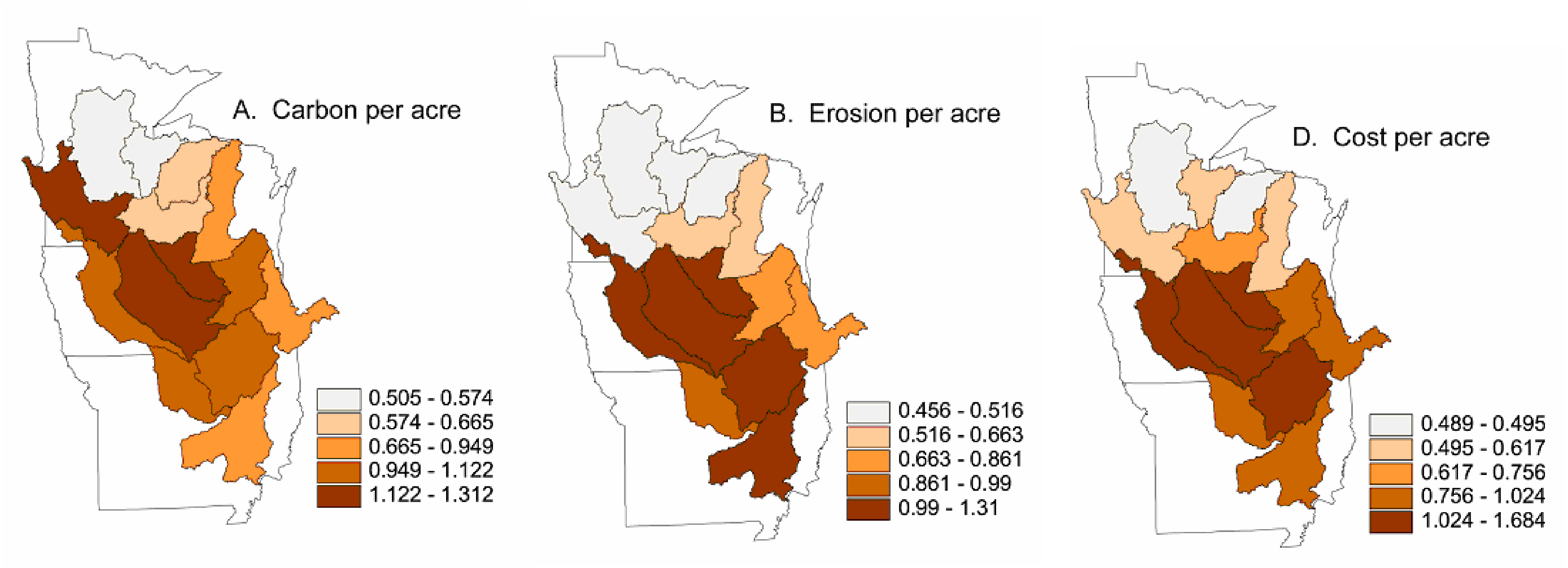
Distribution of some outcomes when fields with lowest costs are selected



Distribution of some outcomes when fields with highest C benefit are selected



Distribution of some outcomes when fields with highest erosion benefit are selected



The numbers are normalized by the overall average of the region

Concluding remarks

- For the region of the UMRB, the co-benefits are likely to be sizable in absolute magnitudes
- Those magnitudes are highly dependent upon the design of the policy (i.e., the choice of indicator to target).
- The co-benefits are likely to be highly variable across the sub-regions of the Basin.
- Implications
  - A carbon market or conservation policy that solely focuses on carbon sequestration will not be efficient.
  - Co-existence of conservation programs and C markets?