Regional Economic Impacts of a Watershed Planning Process to Reduce Erosion and Stream Sedimentation

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Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Montreal, Canada, July 27-30, 2003

Introduction

Nationally, locally led watershed planning has become one of the primary vehicles for enhancing water quality, reducing nonpoint-source pollution, and for implementing the Clean Water Act's Total Maximum Daily Load (TMDL) plans. The implementation of watershed planning often results in changes in land use and managerial practices by farmers. Farmers, however, are part of a larger agri-ecological system as well as the agricultural and rural economies. The purposes of this study are to identify and measure these extended consequences. Specifically, the economic impact of two policy prescriptions, soil erosion held to T and the establishment of riparian buffer strips, will be analyzed. Through the study we demonstrate the usefulness of linking the results of a spatial decision support system (SDSS) developed to estimate farm-level and watershed-wide land-use changes to a regional input/output model. Through this linkage, not only can the economic impacts at the farm-level be determined as well as the location of these impacts in the watershed, so too can the regional economic impacts. Consequently, policy makers can assess the effects of conservation policies not just in terms of farm-level land-use and economic changes but also the effects on the larger farm and nonfarm regional economy.

The Study Area

The Cache River watershed encompasses 751 square miles of southern Illinois near the confluence of the Mississippi and Ohio Rivers (Figure 1). The unique and diverse plant and animal communities have led to designating 58 sites as Natural Areas by the Illinois Dept. of Natural Resources, and two sites as National Natural Landmarks by the U. S. Dept. of Interior. The wetlands associated with the Cache River have led to the area being designated a RAMSAR site by the United Nations - - one of only 14 such sites in the US. This study focuses on the Big and Cypress Creek subwatersheds of the Cache River. The two subwatersheds encompass 85 square miles, or about 11 percent of the Cache River watershed.

The ecological integrity of the Cache River ecosystem is threatened by: (1) loss and fragmentation of natural habitats as a result of agricultural activities and timber harvest; (2) dramatically altered hydrologic systems caused by drainage and channelization; (3) sediment deposition in wetlands causing deterioration of water quality and alteration of habitat conditions; and (4) land use and economic activities that are incompatible with long-term maintenance of ecological functions (Beck et al., 1993). Moreover, the predominantly rural 5-county area has an impoverished economy with minimal infrastructure and weak linkages to the surrounding region.

The economy of the five county region, as presented in table 1, primarily depends upon services, government employment, manufacturing and construction. Agriculture is an important component but not the dominant economic sector. Given their importance to this study, the more detailed ranch-fed cattle, feed grains, hay and pasture, and oil-bearing crops subsectors has been disaggregated from the agricultural sector. This data, for a 1995 base year, obtained from the U.S. Census Bureau, Bureau of Economic Analysis of the U.S. Dept. of Commerce, and the U.S. Dept. of Agriculture have been compiled for regional input/output modeling by the Minnesota IMPLAN Group, Inc (University of Minnesota, 1989). As demonstrated, the manufacturing sector accounts for $703 million in industrial output while the services and governmental sectors are the dominant employers. The agriculturally related sectors account for 5% of industrial output, 1.8% of employee compensation (hired labor on farms), and 10% of property income.

Agricultural Policy and Land-use Decisions

During the 1980s, there were a number of policy changes at both the federal and state level to address soil erosion and the off-site damages it causes. The Conservation Reserve

Program (CRP) and the Wetland Reserve Program (WRP) encouraged changes in land-use patterns to mitigate the impacts of soil erosion and wetlands losses. More recently, the CRP and WRP have spawned variants such as the Conservation Reserve Enhancement Program (CREP) in Illinois where state funds are used to augment USDA funding for CRP and WRP contracts. Additionally in 1980, Illinois Soil and Water Conservation Districts were charged in the "T by 2000" mandate with the task of reducing sediment loss from all crop fields to a "tolerable" level (T) by the year 2000 (Illinois Dept. of Agriculture, 1980). Tolerable soil loss (T) is defined as the maximum amount of topsoil that can be eroded per acre without a reduction in long-term soil productivity. This value is determined empirically for individual soils in the US by the Natural Resources Conservation Service (NRCS) and the Agricultural Research Service (Walker and Pope, 1983). Programs similar to "T-by-2000" were implemented in other midwestern states.

The consequences of these policies for landowners/users is specification of a changed set of opportunities for producing income as well as constraints on their farming operations. Ultimately, any changes in farming practices will affect integrated biological, hydrological, and socio-economic systems and trade-offs among them may result. For example, the trade-off to improving environmental quality may be economic costs as changes in land management affect farm income and, in turn, impact the regional economy. Spatial Decision Support Systems (SDSS) (Densham, 1991) are designed to help understand such interconnectedness. An SDSS links models together within a spatial context so that the farm-level consequences of farm management decisions and production practices can be combined with the ecological and hydrologic repercussions at the watershed level, as well as in this case, to the regional economy

Methods – Spatial Decision Support System

The underlying structure of the SDSS developed to estimate watershed level impacts of policy initiatives has been reported in greater detail (Bennett et al., 2001; Sengupta et al., 2000; Beaulieu et al., 1998). In general, a spatially explicit linear programming model is developed by extending a representative farm model (Kraft and Toohill, 1984) within the framework of an SDSS linked to a Geographical Information System (GIS). The output is a GIS coverage of the watershed that represents the optimal land-use pattern given the objective to maximize economic returns, defined as gross margin (i.e., the return to the farmer's management and the capital invested in the business) and a user defined set of managerial activities and prices as well as constraints on allowable-levels of erosion, labor availability, and machinery capacity.

Linear Programming (LP) has a long tradition in developing whole farm management plans in both an academic setting (Beneke and Winterboer, 1973 and Agrawal and Heady, 1972) and as an advisory tool in farm extension (Dobbins et al., 1992). Users of LP can investigate, among other questions, how enterprises change with crop prices, how changes in labor availability affect enterprise selection, and/or how changes in acreage will affect machinery needs and farm profits (Carter, 1963; Kraft and Toohill, 1984). The linkages between farm decisions and their impacts on the environment have been modeled using LP. For example, Taylor and Frohberg (1977) considered the economic impacts of banning herbicides and insecticides, Miranowski and Bender (1982) analyzed the impact of erosion control policy on habitat quality, and Bretas and Haith (1990) focused upon groundwater contamination. One limitation of these uses is that modeling has been upon a representative farm basis–an artificial farm developed to "represent" the average characteristics of the farms of interest (see Carter, 1963; Becker, 1963; Plaxico and Tweeten, 1963). Given the spatial heterogeneity of soils, topography, farming practices and farm characteristics this approach may cause biased results as they are "scaled up" from the farm level to the watershed in order to represent processes that occur at the landscape level. The SDSS developed here recognizes the importance of this heterogeneity.

Special tabulations of returns from the 1987 and 1992 Censuses of Agriculture for farms in the Cache River (Kraft and Pemberthy, 2000) resulted in statistics required as part of the necessary economic input. In particular, frequency distributions of farm size (e.g., acres operated). A GIS clustering routine was used to aggregate contiguous blocks of land to create 96 different farming units in Big Creek and 93 in Cypress Creek watersheds (figure 2). The average acreage of these farms was 245 acres (range of 56 to 716 acres). In 1992, the actual average Cache farm size was 256 acres.

Crop type, tillage practice, and timing of farm activities are among the economic decision variables considered by farmers as well as the SDSS. Conventional, conservation, and no-till production of corn, soybean, wheat, double crop soybean/wheat**,** and hay/alfalfa comprise the set of alternative tillage practices. A livestock (calf-cow) operation was allowed. Twenty percent of non-forested land was idled consistent with the existing land use in the watershed. Highly erodible lands were eligible for CRP. In total, the cropping, tillage and timing alternatives resulted in over 90 possible cropping activities for each soil type.

RKLS-factors from the universal soil loss equation (Walker and Pope, 1983) were developed for each soil-mapping unit. R represents the erosion potential inherent in the rainfall patterns in a particular area. K reflects the fact that different soils erode at different rates because of physical characteristics such as texture and organic material. The LS-factor reflects the erosive potential of a particular combination of slope length and steepness. The multiplication of these factors yields the amount of soil loss annually without consideration of cover, tillage operations, rotation, or conservation practices. To determine the erosive potential of different crop and tillage practices two additional factors are needed. The crop management factor, C, varies based on tillage operation, crop, and timing of tillage activity. The C factors for corn, for example, are estimated at 0.38 for conventional tillage fall-plowed, 0.18 for conservation tillage fall plow, and 0.05 for no-till. The conservation factor, P, reflecting the reduction in erosion from implementing conservation practices, was held constant at 0.85 across all soil types. This reflects a minimum level of conservation on the part of farmers. Survey data of farmers from the area indicate this is the case. The multiplication of all factors yields the average annual soil loss for a particular crop and set of tillage practices on a particular soil type. There were 90 distinct soil types mapped in the subwatersheds. As can be seen in Table 2, both crop yields and soil loss differ dramatically. For example, corn yields may range from 125 bu/ac. on Wakeland Silt Loam (soil mapping unit 333) to 75 bu/ac. on the relatively steeper sloped and more erosive Hosmer Silt Loam (soil mapping units 214C3 and 214D3). Additionally, for these same soils an acre planted to conservation tillage corn would result from 1.87tons/ac. to 37.05 tons/ac of annual soil loss. On some smaller farms there were fewer than five soil types, on larger farms in excess of fifteen soil types was common.

An average price level for commodities for southwestern Illinois was estimated for the 10 year period ending in 1996. Corn was priced at $2.40 per bushel, wheat at $3.20 per bushel, soybeans at $6.25 per bushel and mixed hay/alfalfa at $74 per ton. CRP rental rates were held equal to the average 1997 signup bid of $68.00 for the region. Beef returned $73 per cwt. Scenarios reflecting no constraint on per acre soil loss and scenarios that limited soil loss to 1T, as well as a 100% implementation of filter strips were modeled at these prices. Filter strips along riparian areas were mapped to be 100 feet wide. Existing land-use based on Landsat imagery was used to determine which land in the riparian areas were eligible for filter strips.

Methods–Regional Input/Output Modeling

The economic changes at the farm level reveal only part of the overall economic impacts. As changes take place in enterprises on individual farms, there are consequences for the regional economy. The results of the SDSS analysis in conjunction with regional input/output analysis (Miller and Blair, 1985; Beck et al., 1999) can be used to assess the primary, secondary, and induced regional economic impacts of the land-use changes resulting from alternative policy prescriptions. Specifically, shocking the baseline regional economy (table 1) for each of the land-use scenarios results in estimates of the impacts on regional economic activity.

Regional data were used to hybridize the IMPLAN regional Input/Output model (University of Minnesota, 1989) with technical coefficients and purchasing patterns appropriate for the region. Technical coefficients reflect productive relationships among sectors, and the extent to which buyers of intermediate and final goods and services were willing to purchase them regionally. Hybridization refers to the use of superior, local data to more accurately specify regional economic relationships. Such data were derived from surveys of farm operators, special tabulations of the 1987 and 1992 Censuses of Agriculture, and Illinois Dept. of Revenue municipality sales tax data. The greater the extent to which such local data can be incorporated into the IMPLAN model, the more reliable and accurate will be estimates of the total, direct and indirect economic impacts for an individual sector.

The structure of IMPLAN and the development of the IMPLAN model for the study region were described in detail in Beck et al. (1993). Beck et al. (1999) used ecological (erosion, sedimentation, and landscape structure) and economic (personal income, industrial output, employment, and population) criteria to evaluate implementation for a regional economy of large-scale habitat restorations, riparian filter strips, and alternative agricultural practices. In the present study IMPLAN permits the tracking of farm-level production changes resulting from conservation policies to their net effect on the economy.

Farm Level Impacts of Policies

The varied impacts that policy initiatives may have on individual farms is demonstrated in figure 3. Both farms are drawn from the cluster of farms depicted in figure 2. The farm in the upper part of the figure is an upland farm characterized by more highly erodible soils and topography. This farm does not border a creek. The lower farm is located in the lower part of the watershed. The soils are less highly erodible and as is typical of these areas, are divided by Big Creek. In the unconstrained solutions, the upland farm exhibits a tillage pattern that generates a USLE soil loss equivalent to 224.8 percent of T. A gross margin of $14,940 is generated. Limiting USLE soil loss to T results in a 7.8% decline in gross margin as no-till tillage practices are employed and acreage is moved into the CRP. As this farm does not border a creek, riparian buffer strips are not employed under the second policy initiative and the tillage practices, and hence, gross margin is identical to the unconstrained scenario. The lowland farm exhibits a tillage pattern that generates a USLE soil loss equivalent to 54.6 percent of T in the unconstrained soil loss scenario. Only a minor adjustment in tillage practices is necessary as USLE soil loss is constrained to T on individual soil types, however the introduction of riparian buffer strips reduces gross margin by 7 percent as 18 acres formerly in corn production are placed in buffers. Payments through CRP for the riparian lands would help compensate for this loss. The average loss per acre converted to riparian uses of $80.69, however, exceeds the average rental rate of $68 offered for seeded land through the CRP. This difference is frequently covered by higher rental rates for lands in riparian buffers. Across all modeled farms in the watersheds acres shifted to riparian uses incur an average loss of $117 or about $49 over the

CRP rental rate.

A sampling of the impacts across the watershed is demonstrated in figure 4. In this figure a cross-section of 19 modeled farms is depicted. Implementation of the policy that limits USLE soil loss to T results in an average per farm decline in gross margin equivalent to about $100 and a decrease in conservation tillage of 244 acres. These acres are shifted to the less erosive no-till tillage, hay/alfalfa, or enrolled in the CRP. However, the impacts are not uniform across the watershed–some areas experience greater or smaller affects on income. When fully extended to the watershed level, this location specific depiction would assist watershed planners in targeting best management practices and cost-share funding appropriate to comply with policy initiatives.

Watershed Level Impacts of Policies

Summary statistics at the combined, Big and Cypress Creeks subwatershed level, for the gross margin and tillage practices resulting from the policy scenarios are presented in table 3. Over $3.84 million in aggregate gross margin results when soil loss is unconstrained. On average this is $20,352 per farm. This income is generated from an average of about 98 cropped acres (40% of average farm size), 52 acres (21% of average farm size) of hay/alfalfa and 37 acres of CRP (15% of average) the remaining acres are used for grazing or left idle. Of the 7,074 acres in CRP in the study area, 63 percent, or about 4,500 acres are located in Cypress Creek. This suggests that Cypress Creek is inherently more erosive and the $68 CRP rental exceeds potential crop income. Constraining soil loss to T or requiring filter strips comes at a cost of about $537, about 2.5%, and $708, about 3.4%, on average per farm for the T and filter strip solutions, respectively. Although the T and filter strip scenarios result in similar total income declines, tillage practices and income losses are distributed quite differently. The T soil loss solution is characterized by the introduction of 4,060 acres of no-tillage crops and an increase in

CRP of just under 1,000 acres to 18% of watershed acreage. The filter strip cropping pattern replicates the unconstrained pattern, although on **a** smaller number of acres. Of the 189 modeled farms**,** 90 farms would require the establishment of filter strips. Most of these farms are in the Big Creek subwatershed, where for 65 farms acreage in crop production declines an average of 9.9 acres. In the Cypress Creek subwatershed, 25 farms require riparian land to be placed in filter strips.

As demonstrated in figure 5 the economic cost of compliance with a T policy is distributed across all farms, with the majority of the farms losing less than 3%, while the economic cost of riparian buffer strips is more highly concentrated. This is especially evident in the Cypress Creek subwatershed where 64 of 93 farms experience no loss in income if buffer strips are implemented. In contrast only 35% of the 96 Big Creek farms are unaffected if filter strips are required. In general, the decline in income is less in Cypress Creek than Big Creek for both the 1T and filter strip scenarios. For example, 31% of Cypress Creek farms experience more than a 1% decline in income if a T policy is implemented. In contrast, 71 % of Big Creek farms experience a decline in income greater than 1%. This difference is due to the predominance of CRP in the Cypress Creek unconstrained soil loss scenario.

The gross margin generated and estimated USLE sediment loss resulting from the different land-use scenarios for the subwatersheds is presented in table 4. A level of T implies USLE soil loss equivalent to an annual 100,620 tons in the Big Creek Watershed and an annual 85,614 tons in Cypress. The 126.2% for the unconstrained Big Creek scenario therefore represents a potential soil loss of about 127,000 tons annually. USLE estimated soil loss declines to 55% of T, or 55,340 tons annually, in the Big Creek watershed if a policy requiring that land uses result in T soil loss is implemented. In Cypress Creek, USLE estimated soil loss declines from 93.8% of T in the unconstrained scenario to 52.7% in the T scenario. Alternatively, in Big Creek, given that gross margin declines by $66,135 in total from the unconstrained scenario, the average cost of achieving a T soil loss is about $1.08 per ton. In Cypress Creek, the average cost of achieving a T soil loss is $1.15 per ton. As a percentage of T, the average USLE soil loss increases in the filter strip scenario in both watersheds. In general, the low lands removed from production for filter strips along each creek are potentially less erodible than other areas.

Regional Economic Impacts of Land-use Changes in the Watershed

The results presented above demonstrate that watershed planners can estimate likely impacts of changes in conservation policies at the farm and watershed levels as well as identifying areas within a watershed that bear a disproportionate amount of the impact. However, these changes reveal only part of the economic impacts as there are also consequences for the regional economy.

Using the data generated by the unconstrained scenario (Table 3), the regional economic impact was determined. The upper panel in table 5 demonstrates that the combined $7,260,598 in corn, soybeans and hay/alfalfa sales result in a total regional output of $8,213,799. Of this total, $1,255,144 in nonfarm (i.e., mining, construction, etc.) output results. In addition, employment of 283 persons, hired employee compensation of $727,614, property income in excess of $2.5 million, and $294,970 in indirect business taxes are generated. This unconstrained agricultural economy accounts for 0.4 percent of the five county region's total output, 1.3 percent of the region's employment, 0.9 percent of other property income, or what is seemingly a modest contribution to regional economic activity of the five-county area. The Big and Cypress Creeks subwatersheds, however, represent only 11 percent of the Cache River watershed.

The lower panels of table 5 present the total (direct, indirect, and induced) impacts of the changes to the Big and Cypress Creeks' agricultural area as a consequence of shifting from an unconstrained scenario to scenarios in which soil loss is constrained to T or riparian filters are established. The total loss in the value of industrial output to the five county region is about $325,000 for both. This total loss exceeds by roughly five times the total losses incurred by the individual farms as a result of the policies. However, there are other changes in the regional economy that distinguish the two policy prescriptions. Constraining soil loss to T primarily impacts the feed grain sector as the value of output declines in excess of $440,000 and full-time equivalent employment within the sector declines by 8 persons. Property income in this sector declines by $150,000 as commodities produced and tillage practices are shifted toward less erosive, but less income generating, uses. Gains in hay and pasture employment offsets the loss in feed grain employment, leading to an overall increase of about 2 individuals. However, the losses in the total output and property income are not offset as they decline by $335,000 (about 4%) and $122,000, respectively. Non-farm related output declines by $47,000.

The impacts of establishing riparian filter strips are more evenly distributed. In each of the major agricultural sectors; feed grains, hay and pasture, and oil bearing crops, the value of output declines by about $90,000. This decline is associated with an eleven individual loss in area employment as land is retired from production. The employment loss, about four percent is concentrated in the agricultural sectors. The losses generated in the non-farm sectors are similar to those generated when soil loss was constrained to T and the total loss in the value of output is again about four percent.

Summary

The debates over the commodity and conservation provisions of the 2002 Farm Bill underscore that the trade-offs resulting from the implementation of conservation policy must be fully recognized if their impacts are to be understood. This study demonstrates the usefulness of linking the results of an SDSS developed to estimate farm-level and watershed-wide land-use changes to a regional input/output model. Through this linkage, not only can the economic impacts at the farm-level be determined, so too can the regional economic impacts.

From this study, the farm and watershed level results indicate that the economic impacts of conservation-orientated changes vary across the landscape of these watersheds while the regional economic changes seem modest. Nonetheless, farmers in certain spatial areas across the watershed bear a disproportional share of the farm-level economic costs. These are the farm operations that might require targeted assistance in terms of technical support, cost sharing of practices, or payments for environmental stewardship. Additionally, the Big and Cypress Creeks' subwatersheds represent only 11 percent Cache River watershed, it is likely that the regional economic impacts would be more substantial as these and similar policy initiatives are implemented throughout the entire watershed.

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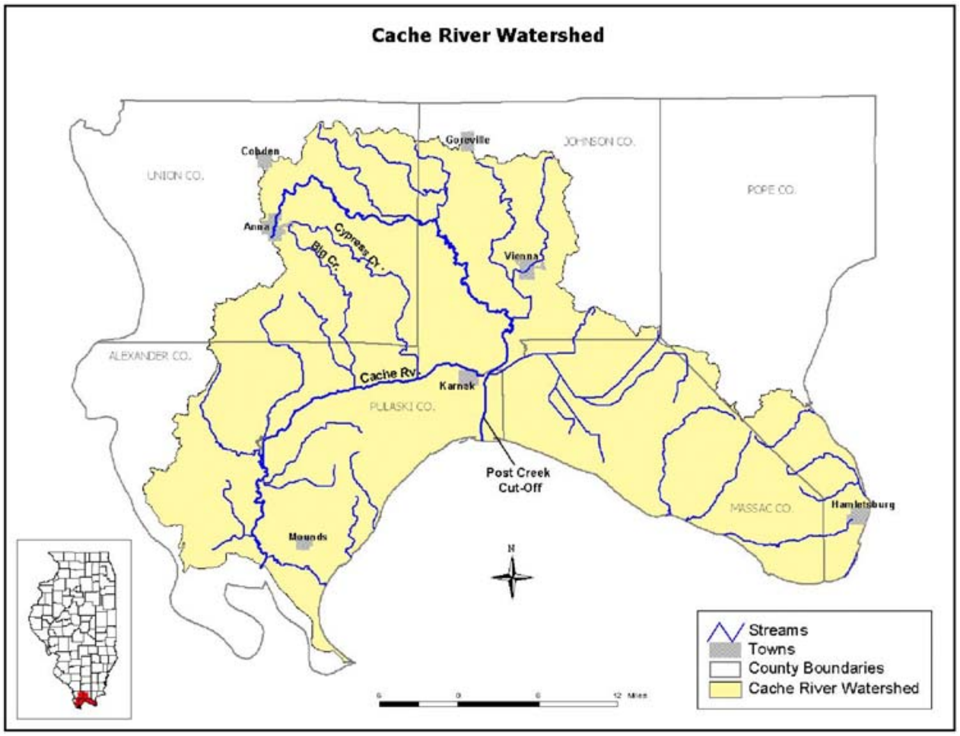


Figure 1. Map of the Cache River Watershed

Table 1. State of Southern Illinois Five County Economy

Sector	Industry Output[a]	Employment[b]	Employee Compensation[a]	Property Income[a]	Indirect Business Tax[a]
Agriculture	25.52	515	4.43	5.27	0.59
Ranch Fed Cattle	7.36	180	0.63	0.55	0.17
Feed Grains	24.08	450	0.91	8.60	0.36
Hay and Pasture	7.13	479	0.31	2.01	0.15
Oil Bearing Crops	32.72	753	2.68	12.00	1.10
Mining	38.90	208	8.09	9.35	1.64
Construction	110.38	1,413	30.72	4.05	0.69
Manufacturing	703.42	2,082	86.10	43.93	8.65
Transportation & Utilities	227.85	1,108	42.48	69.77	18.68
Trade	156.31	3,934	56.80	15.11	27.15
Finance	155.71	920	16.88	79.75	19.10
Services	254.96	5,657	100.96	19.12	4.32
Government	177.28	5,376	154.48	18.09	0.00
Other	-0.38	312	2.10	-2.48	0.00
Total	$1,921.23	23,387	$507.57	$285.11	$82.59

[a]Millions of dollars
[b]Number of persons employed

Table 2. Representative Soils, Crop Yields and Soil Loss Characteristics for Big Creek Farms

	Crop Yield						Soil Loss Per Planted Acre (in tons/ac)			
Soil Type[a]	Corn	Soybean	Wheat	Alfalfa (tons/ac)	T-Value	RKLS	Conservation corn	No-Till corn	Conservation soybean	No-Till soybean
333	125	44	50	4.1	5.00	10.38	1.87	0.52	1.66	0.62
308D3	105	37	42	3.4	4.00	177.13	31.88	8.86	28.34	10.63
308C2	110	38	44	3.6	5.00	99.63	17.93	4.98	15.94	5.98
308B2	120	42	48	4.0	5.00	36.67	6.60	1.83	5.87	2.20
214D3	75	26	27	2.5	3.00	205.86	37.05	10.29	32.94	12.35
108	107	35	44	3.8	5.00	12.06	2.17	0.60	1.93	0.72
214B	105	37	47	3.4	4.00	37.79	6.80	1.89	6.05	2.27
308E3				3.0	4.00	199.27				11.96
214C3	75	26	34	2.5	3.00	94.08	16.93	4.70	15.05	5.64
5308D	85	33	38	2.8	5.00	44.32	7.98	2.22	7.09	2.66

[a]Soil Type Legend

108 - Bonnie silt loam
333 - Wakeland silt loam
308D3 - Alford silt clay loam, 12-18% slope severely eroded
C2 - Alford silt loam, 6-12% slope, eroded
B2 - Alford silt loam, 2-6% slope, eroded
E3 - Alford silt loam, 18-30% slope, severely eroded
214D3 - Hosmer silt clay loam, 12-18% slope, severely eroded
B - Hosmer silt loam, 2-6% slope
C3 - Hosmer silt clay loam, 6-12% slope, severely eroded
5308D - Alford soils, karst, 2-6% slope

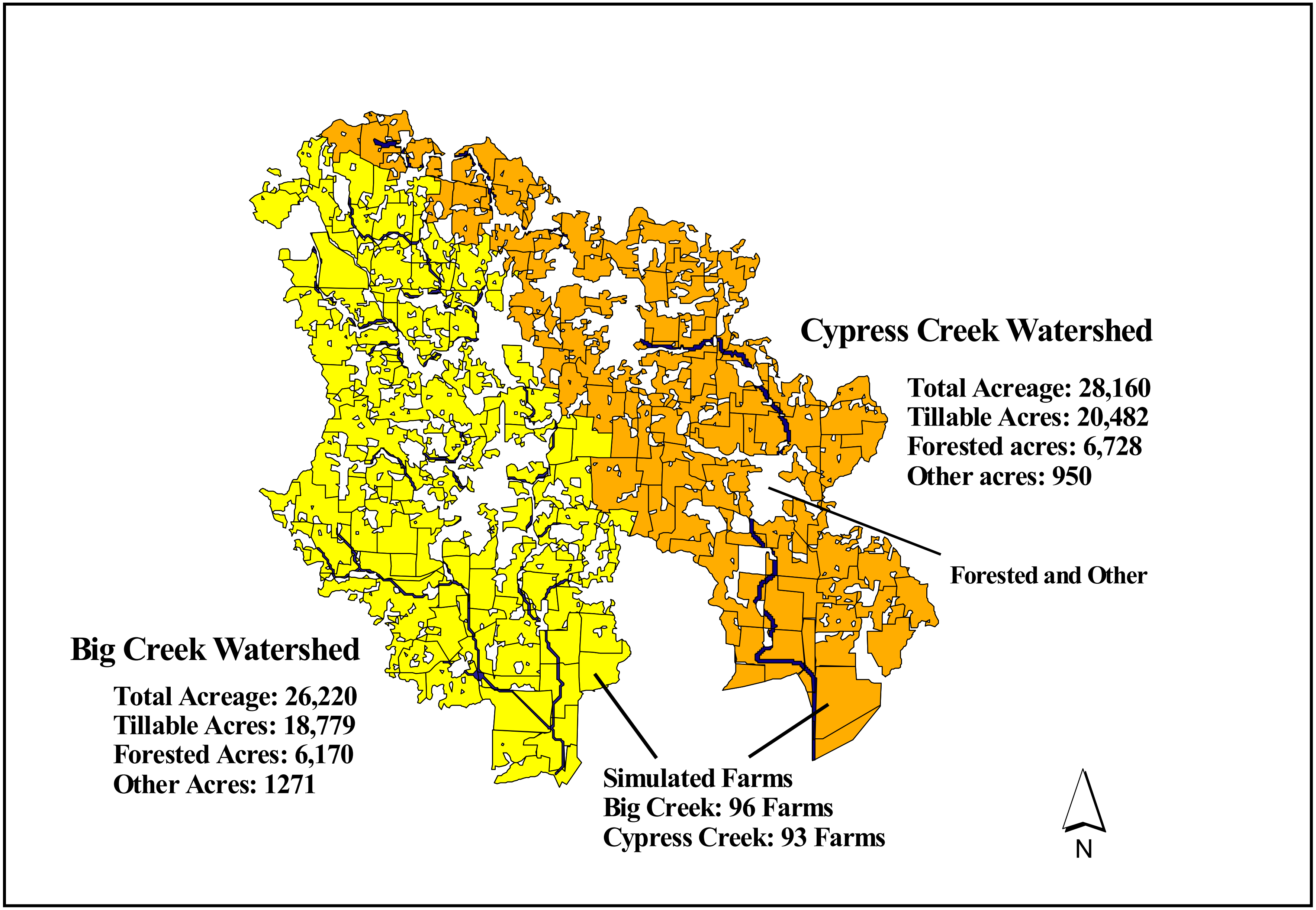


Figure 2. Simulated Farms in Big and Cypress Creek Watersheds

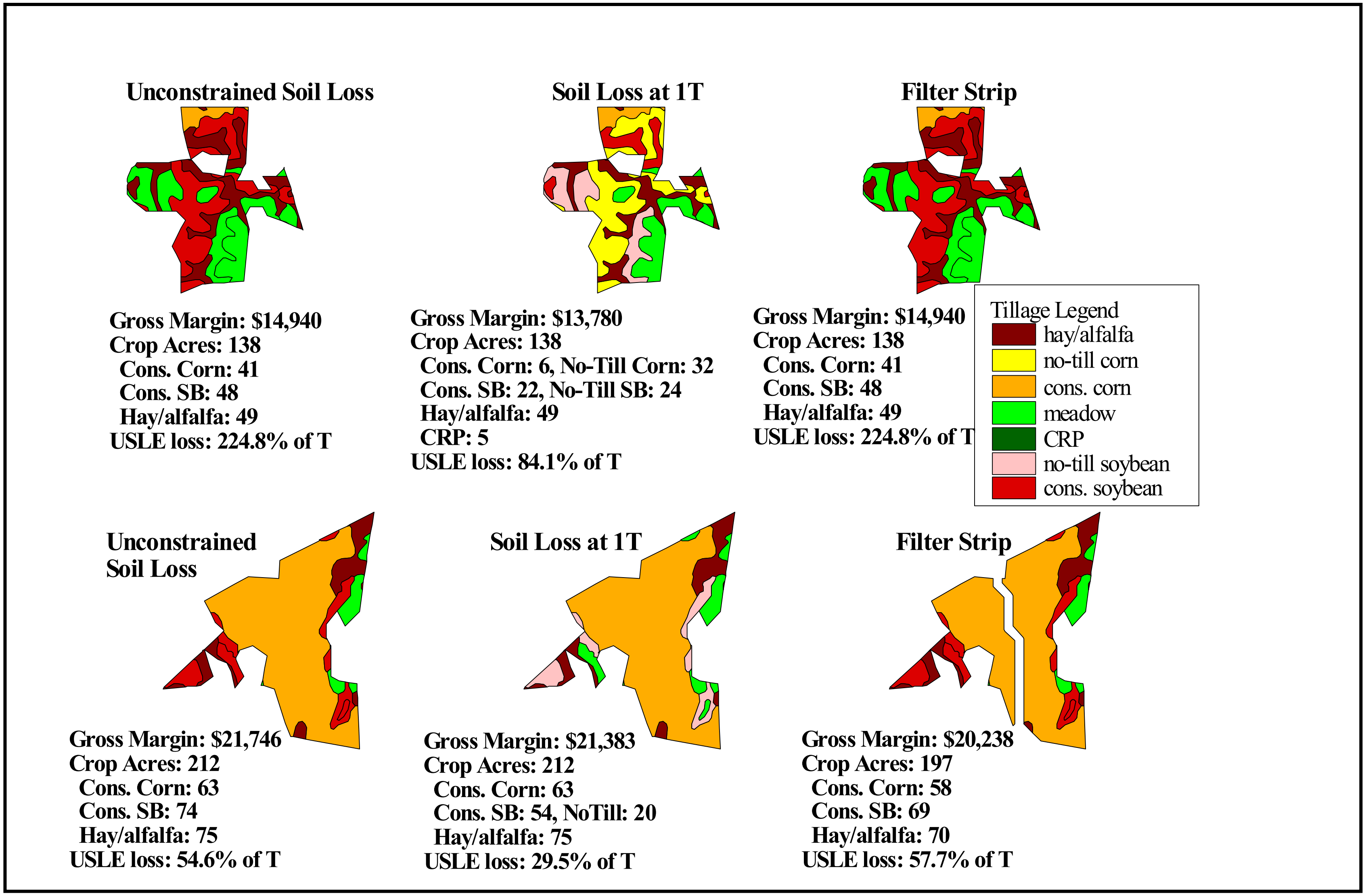
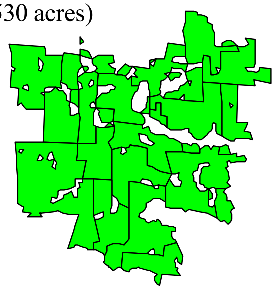


Figure 3. Policy Impacts on Two Representative Farms

Cross-Section of 19 Farms
(4,530 acres)



	Unconstrained Soil Loss	Soil Loss Constrained at 1T
Gross Margin ($ per farm)	$18,415	$18,316
	(acreage)	
Conservation tillage	1,496	1,292
No till tillage	32	123
Hay/Alfalfa	855	968
CRP	1,189	1,239

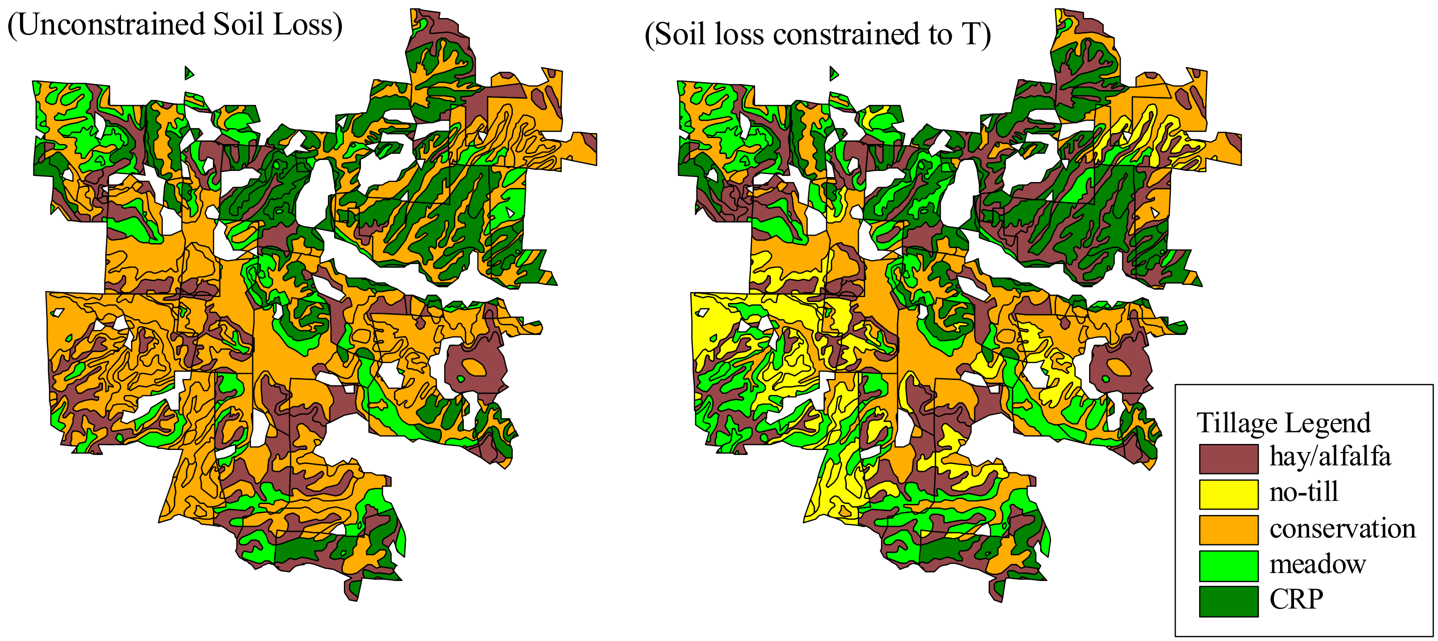


Figure 4. Policy Impacts on Multiple Farms

Table 3. Selected Income, Crop Acreage, and Production Statistics

	Soil Loss Constraint Scenario		
	Unconstrained	1T	Filter Strip
GROSS MARGIN			
watershed total	$3,846,446	$3,745,065	$3,712,710
average per farm	$20,352	$19,815	$19,644
$ Total Sales	$8,713,796	$8,432,581	$8,446,612
CROP ACRES			
corn, soybean, wheat	18,687	16,684	18,042
hay/alfalfa	9,896	10,921	9,574
CRP	7,074	8,050	7,070
unpaid meadow	6,292	6,292	6,121
SOYBEAN			
Harvested acres	9,997	9,653	9,657
conservation	9,884	7,159	9,632
no-tillage	113	2,493	25
Production (bu.)	371,124	370,904	357,707
$ Soybean Sales	$2,319,526	$2,318,150	$2,235,670
CORN			
Harvested acres	8,690	7,032	8,385
conservation	8,170	4,833	7,998
no-tillage	520	2,199	386
Production (bu.)	899,182	714,417	863,460
$ Corn Sales	$2,158,036	$1,714,602	$2,072,303
HAY/ALFALFA			
Production (ton)	37,612	39,822	36,293
$ Hay/Alfalfa Sales	$2,783,260	$2,946,856	$2,685,666
CRP RENTAL	$481,042	$547,423	$480,773
LIVESTOCK			
beef cwt	8,637	8,637	8,637
$ sales	$630,486	$630,486	$630,486
cull cwt	1,920	1,920	1,920
cull $sales	$96,000	$96,000	$96,000

Table 4. USLE Sediment Loss as a percentage of T

	Soil Loss Constraint Scenario		
	Unconstrained	1T	Filter Strip
	- - - - - - - - BIG CREEK - - - - - - - -		
Gross Margin			
watershed total	$2,044,885	$1,978,750	$1,967,190
average per farm	$21,301	$20,612	$20,492
USLE Sediment Loss			
Percentage of T	126.2%	55.0%	128.4%
% of farms			
<100% of T	45.8%	100.0%	46.9%
100%T to 200%T	42.7%	0.0%	39.6%
200%T to 300%T	11.5%	0.0%	13.5%
>300% of T	0.0%	0.0%	0.0%
	- - - - - - CYPRESS CREEK - - - - - -		
Gross Margin			
watershed total	$1,801,561	$1,766,314	$1,745,521
average per farm	$19.372	$18,993	$18,769
USLE Sediment Loss			
Percentage of T	93.8%	52.7%	95.3%
% of farms			
<100% of T	73.1%	100.0%	73.1%
100%T to 200%T	20.4%	0.0%	18.3%
200%T to 300%T	5.4%	0.0%	8.6%
>300% of T	1.1%	0.0%	0.0%

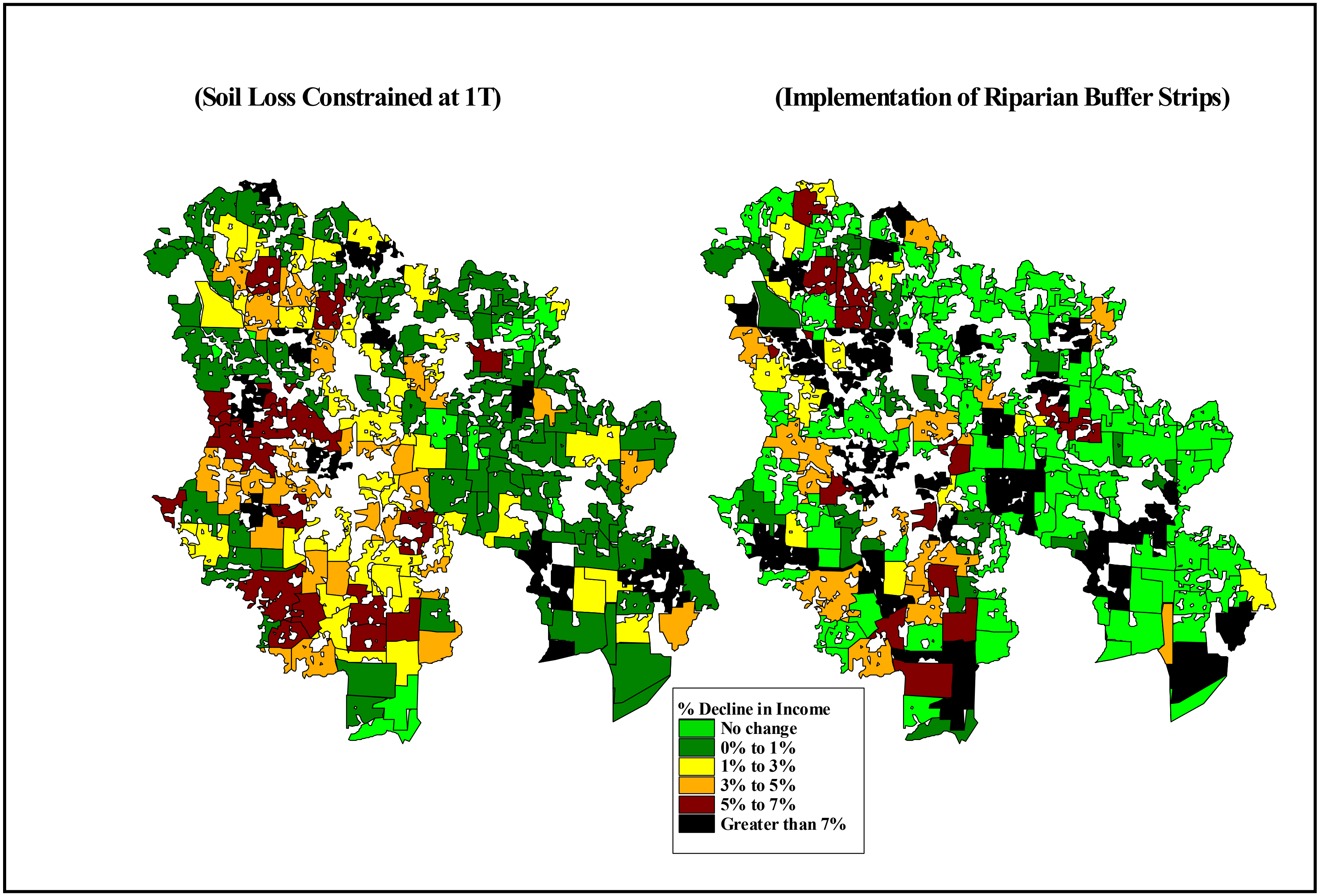


Figure 5. Policy impacts on watershed income distribution

Table 5. Regional Economic Impacts of Changes in Watershed Land Use

Sector	Industry Output	Employment	Employee Compensation	Property Income	Indirect Business Tax
Regional Economic Contribution: Unconstrained Soil Loss Solution					
Agriculture	102,042	4.1	43,018	14,290	3,457
Ranch Fed Cattle	4,892	0.1	417	369	111
Feed Grains	1,960,342	36.6	74,290	699,884	29,309
Hay and Pasture	2,576,695	173.2	110,738	726,805	54,862
Oil Bearing Crops	2,314,685	53.3	189,516	848,913	77,613
Non-farm Sectors	1,255,144	15.2	309,633	226,334	129,619
Total	$8,213,800	283	$727,612	$2,516,595	$294,971
Regional Economic Impact of Constraining Soil Loss to T					
Agriculture	- 4,263	-0.2	-1,798	-596	-144
Ranch Fed Cattle	- 202	0.0	-17	-15	-5
Feed Grains	- 444,513	-8.3	-16,845	-158,701	-6,646
Hay and Pasture	163,198	11.0	7,014	46,033	3,475
Oil Bearing Crops	- 2,966	-0.1	-243	-1,088	-99
Non-farm Sectors	- 46,760	-0.6	-11626	-8,103	-4641
Total Change	-$335,506	1.8	-$23,515	-$122,470	-$8,060
Regional Economic Impact of Implementing Filter Strips					
Agriculture	- 4,054	-0.2	-1,709	-568	-137
Ranch Fed Cattle	- 194	0.0	-17	-15	-4
Feed Grains	- 86,695	-1.6	-3,285	-30,952	-1,296
Hay and Pasture	- 97,938	-6.6	-4,209	-27,625	-2,085
Oil Bearing Crops	- 86,048	-2.0	-7,045	-31,558	-2,885
Non-farm Sectors	- 49,502	-0.6	-12,216	-8,906	-5,100
Total Change	-$324,431	-11.0	-$28,481	-$99,624	-$11,507