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Land Use Planning and Open Space Preservation: Economic Impacts of Low-Density Urbanization and Urban Sprawl[1]

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Abstract

In the United States, dispersion of low density residential areas is typically observed at the urban fringe adjacent to metropolitan areas. It is associated with a depopulation of urban centers and an underutilization and decay of the physical and service infrastructure of central cities. In many metropolitan regions this dispersed growth pattern is, increasingly, an important policy concern due to the permanent conversion of prime and unique farmland and its long-term economic implications. A study was conducted to assess the impact of permanent land use conversion and, specifically, the resulting economic impact of agricultural production loss for the Lansing metropolitan region. Based on 2001 commodity prices, the total Annual Agricultural Production Loss (AAPL), without value-added implications, amounted to a combined total of about $8,628,000. If the additional back and forward linkages of agricultural production are considered, the overall economic impact is conservatively estimated to amount to more than $22 million per annum, for the Tri-county area alone. The near-term trend of revenue loss may easily exceed $30 million per year if prevailing commodity price increases for 2007 are an indication. Controversial policies that create multiple incentives for increased corn production for ethanol (production increased from 0.175 billion gallons in 1980 to 4.9 billion gallons in 2006) and a current import levy of $ 0.54 per gallon[2] on ethanol will further effect the actual economic impacts. This research seeks to ascertain the cost and real long-term implications of the conservation of highly productive farm land. It raises the fundamental question of whether residential development should be directed to urban and peri-urban areas with existing service capacity, facilitating more cost-effective service delivery while reducing environmental impacts and preserving the agricultural economic vitality of rural areas.

[1] The research support from Isuru Saizen, Visiting Scholar form Kyoto University and Lisa Szymecko, Ph.D. Candidate, Michigan University, is gratefully acknowledged.

[2] Brazil is the world's other main producer of ethanol (made from sugarcane, unlike the US corn-based product) but its exports to the US face a 2.5 percent ad valorem tariff and a second duty of 54 cents per gallon.

Introduction

Many cities in both Europe and Japan define the *compact city model* as a desirable community structure in that it favors the efficient delivery of public services and cost-effective development of the physical and service infrastructure. Japan, for example, is approximately the size of California. It has a population of approximately 130 million people residing within an area contained by a mountainous topography, which dominates almost 70% of the landscape. Many communities compete for surrounding farm land that is suitable for development. Here, urban and rural planning legislation plays an important role in land use allocation and the preservation of open space for agricultural and forestry uses. Although significant competition among land-intensive economic activities has shaped the complexity of the landscape in many metropolitan areas, land-use master plans are developed and inspired by the layering of several zoning regulations based on multiple levels of legislation that limit the urbanization of rural areas and discourage encroachment on forest and productive farmland (Saizen et al., 2005).

In Northwestern Europe, countries such as the Netherlands have evolved policies to preserve large open green space near urban agglomerations. For instance, the preservation of the "green heart" of the western provinces, surrounded by major cities such as Amsterdam, Rotterdam, The Hague and Utrecht, has become the paradigm for open space preservation, safeguarding long-term agricultural production vitality, ecosystem integrity and outdoor recreational opportunities. In comparison, U.S. cities and metropolitan areas are typified by expansive, low-density development, commonly referred to as "urban sprawl". While the term *urban sprawl* has no accepted uniform definition, it refers to low-density, often residential development at the urban fringe or even beyond the border of suburban development. The U.S. Environmental Protection Agency (EPA) defines sprawl as residential development at a density of three dwelling units per acre or less (1993). Thus, sprawl can occur within the boundaries of municipal development, though it is more likely to develop on urban fringes where vacant land exists or beyond the fringes in the form of ribbon or leapfrog development.

Sprawl also encompasses commercial and light industrial uses and the relationship between different types of land use. For this reason, Ewing (1994) prefers to define sprawl in terms of accessibility between related uses. He notes that poor accessibility, and thus sprawl, "may result from a failure to concentrate development and/or mix land uses." Some also define sprawl as investment at the urban fringe in relationship to disinvestment in the urban core. The Southeast Michigan Council of Government (SEMCOG) notes that urban sprawl is ultimately a two-part process with "sprawling low-density growth at the suburban fringe and the concurrent disinvestment and abandonment of older/urbanized communities" (SEMCOG, 1991).

One measure of sprawl in the United States is a comparison of relative population densities between cities in the advanced industrial nations of Europe and Asia. With the exception of New York City, residential densities in the United States are below 20 persons per hectare, compared with 50 persons per hectare for major European cities and 150 persons per hectare for Asian cities (Newman and Kenworthy, 1989). Consequently, land is “consumed” in great quantities, and increasingly so. For instance, in the Chesapeake Bay watershed between 1950 and 1980, the population grew by 50 percent, but the amount of land used for commercial and residential purposes grew by 180 percent (EPA, 1993). In Philadelphia, where the population of the metropolitan area increased by 2.8 percent between 1970 and 1990, the developed land area increased by 32 percent (Greenspace Alliance, undated).

Sprawl clearly reflects the housing preferences of a majority of new homeowners in search of smaller, safer communities with quality schools and amenities typically lacking in the inner city or older U.S. suburbs. It also reflects a lack of coordinated planning, which fails to remedy these concerns and promotes new developments rather than revitalization of established settlements.

Sprawl is a process that, in the U.S., began largely after World War II. This process resulted from a demand for improved housing conditions emerging from the years of the Great Depression, typified by low family formation and home construction rates. It was facilitated by technological advances and business and marketing strategies that caused demographic shifts and altered consumption preferences in favor of personal choices, privacy, local control, and flexible personal transportation (primarily the use of the private automobile and the development of the interstate freeway system). Federal, state and local policies equally encouraged low-density development in the suburbs by promoting job creation and housing opportunities in the suburbs. This process began to fuel itself – attracting more residents who migrated out of urban centers, attracting more business investments, expanding local tax revenue and public services, creating more jobs, attracting more residents, and so on. In addition, the removal of sustained investments in the central city, eroded its tax base, reduced the quality of schools and public services, increased crime rates, accelerated demand to explore housing options, and so forth.

In the US particularly, the problem of *urban sprawl* has become a controversial policy issue in today's land use and economic development debate. Sprawl produces and is easily recognized by its noticeable effects: low density urban and commercial development; increasingly larger home sites at the urban edge and beyond; widespread strip commercial development along major arterial roads; physically and economically segregated subdivisions; newer, wider roads and utility network expansion/extension (financed by all taxpayers and not only by the primary beneficiaries); dependence on private modes of transportation; increasing commute distance, travel time, road congestion and, therefore, travel costs; and segregated rather than functionally integrated land uses by zones.

In Michigan, it reflects the trend of land conversion: commercial agricultural land converted to 40- or 10- acre house sites in rural areas or the development of low-density subdivision in rural areas. This low-density subdivision usually occurs within a 1-3 mile radius of smaller towns, most of which boast educational and other service facilities perceived as superior to those of “urban” areas. By isolation distance from urban service boundaries, this residential development is typified by private wells and sewage disposal systems that pose long-term environmental threats: groundwater withdrawal rates that exceed recharge rates in some areas and the risk of ground water contamination by disposed nutrients, chemicals and surface runoff.

The shift toward significantly lower population densities, its distribution and associated land development densities is at the core of sprawl. As we enter the 21st Century, new development is dominated by such low-density residential and commercial construction on formerly unoccupied green space, with relatively little in-fill development or redevelopment occurring in already built-up areas. By and large, new development is rapidly occurring over what was once open space and rural landscapes that once provided valuable biodiversity services and land to grow food. This land formerly sustained the employment and income flow for rural communities and value-added manufacturing opportunities with associated tax revenue.

Study Area

The Tri-county (Ingham, Eaton, and Clinton) area surrounding Lansing, Michigan was chosen for this study in order to assess the dynamics associated with land use transformation and its consequent impact on the loss of agricultural production. This may be considered representative for the agricultural land use dominating the southern part of Michigan’s Lower Peninsula. The selected area includes the Lansing metropolitan region (Clinton, Eaton and Ingham counties), which has a total land area of 1,096,532.6 acres (Fig. 1). This metropolitan region (Fig. 2) is located in the southern part of Michigan with total population of 432,674 in 1990 and 448,344 in 2000 (U.S. Census Bureau). This Tri-county area has seen economic changes similar to other urbanizing regions in the state, with a structural adjustment of its manufacturing and service sectors.

The population growth for the ten-year period of 1990-2000, is almost 3.6% for the Tri-county region. This slight population increase is largely reflected in the totals for Clinton and Eaton counties, with an increase of 12.3% and 11.9% respectively, while the relative rural population increase in Ingham County is off-set by a larger decrease of the Lansing and East Lansing city populations (Table 1). The population of the capital city, Lansing, in 2000 was 119,128 persons - a decrease of more than 8,000 from 1990 – while many smaller incorporated cities (and surrounding townships) show an increase (Table 2). This characterizes the population growth and urban sprawl for the Tri-county region: a population decrease in the largest urban areas contrasted with residential growth in the rural townships and smaller cities.

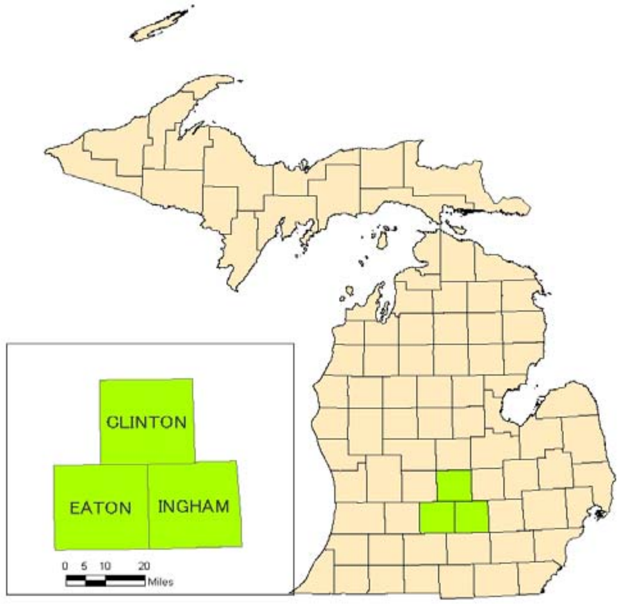

Fig.1. Relative location of the study area (Tri-County; Clinton, Eaton and Ingham) in Southern Michigan. (Source: Michigan Geographic Data Library)

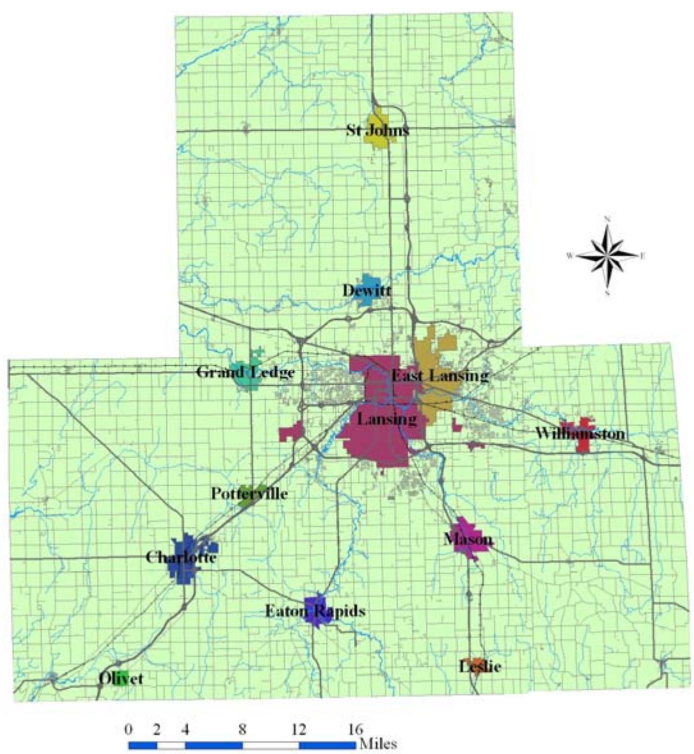

Fig.2. The Tri-county Region with Lansing, minor cities, urbanizing townships, major road network and surface drainage pattern. (Source: Michigan Geographic Data Library)

Table 1. Population trend for the U.S.A, Michigan and Tri-county area (Source: U.S. Census Bureau)

	U.S.A	Michigan	Tri-county area			
				Clinton	Eaton	Ingham
1990	248,709,873	9,295,297	432,674	57,883	92,879	281,912
2000	281,421,906	9,938,444	448,344	64,976	103,915	279,453
Rate of change	13.2%	6.9%	3.6%	12.3%	11.9%	-0.9%

Table 2. Population by major city of Tri-county area (Source: U.S. Census Bureau)

	1990	2000	Rate of change
Charlotte	8,083	8,389	3.8%
De Witt	3,964	4,702	18.6%
East Lansing	50,677	46,525	-8.2%
Eaton Rapids	4,695	5,330	13.5%
Grand Ledge	7,579	7,813	3.1%
Lansing	127,321	119,128	-6.4%
Leslie	1,872	2,044	9.2%
Mason	6,768	6,714	-0.8%
Olivet	1,604	1,758	9.6%
Potterville	1,523	2,168	42.4%
St Johns	7,284	7,485	2.8%
Williamston	2,922	3,441	17.8%

In spite of the population decline of the major urban centers, Table 3 shows that the Tri-county region had created 31,282 jobs during the same ten-year (1990-2000) period in areas such as “Construction”, “Transportation public utilities”, “Retail trade”, “Finance, insurance, and real estate” and “Services”. Most of these sectors are service-oriented and require higher skills associated with higher compensation. The increase of almost 38% for the construction sector implies that this sector leads job growth in the Tri-county area. The “Services” sector represents, by far, the largest employment division in the Tri-county region, with jobs increasing by a total number of 18,332 during the period. “Retail Trade” and “Manufacturing” are the next largest sectors in terms of total number of jobs generated in 2000. The

“Services” sector makes up 29.2 percent of all jobs throughout the region, totaling 80,949 jobs. The “Retail trade” and “Manufacturing” industries made up 17.3 and 10.6 percent of the total jobs, respectively (Fig. 3 and 4).

Manufacturing saw the largest absolute loss of employment between the years 1990-2000. The industry lost a total of 2,624 jobs during the period, or 8.2 percent of sector employment. Manufacturing employment losses made up 50.1 percent of employment losses in the Tri-county region. “Farm Employment” lost a total of 535 jobs during years 1990-2000, which made up 10.2 percent of the employment deficit. After Mining, the “Agricultural services, forestry, fishing, and other” category represented the largest percentage job loss with 43.7 percent of the total unemployment in this sector. In combination, the 1,746 jobs in the natural resources-based sector represent about 33.3% of the job regression.

Table 3. Employment by industry in the Tri-county region (Source: U.S. Department of Commerce - Economics and Statistics Administration - Bureau of Economic Analysis)

Components by Type	Number of Jobs (1990)	Number of jobs (2000)	Number of change (1990-2000)	Rate of change (1990-2000)
Farm Employment	5,172	4,637	-535	-10.3%
Ag. serv., forestry, fishing, and other	1,802	1,014	-788	-43.7%
Mining	649	226	-423	-65.2%
Construction	9,920	13,675	3,755	37.9%
Manufacturing	31,890	29,266	-2,624	-8.2%
Transportation and public utilities	6,875	8,451	1,576	22.9%
Wholesale trade	9,147	9,389	242	2.6%
Retail trade	43,172	47,838	4,666	10.8%
Finance, insurance, and real estate	18,675	22,312	3,637	19.5%
Services	62,617	80,949	18,332	29.3%
Federal, civilian	3,414	3,010	-404	-11.8%
Military	1,777	1,312	-465	-26.2%
State and local	54,487	54,913	426	0.8%
Total Employment	249,597	280,879	31,282	12.5%

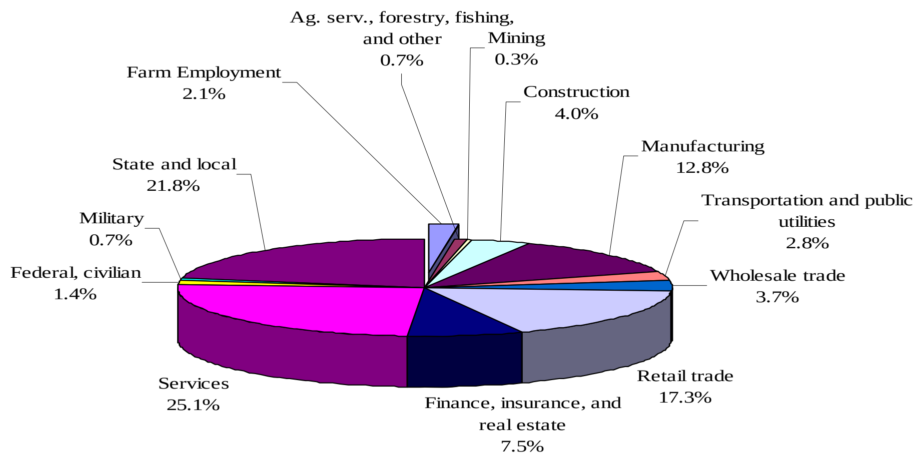

Fig. 3. Percentage of jobs by economic sector in the Tri-county region (Source: U.S. Department of Commerce - Economics and Statistics Administration – Bureau of Economic Analysis, 1990).

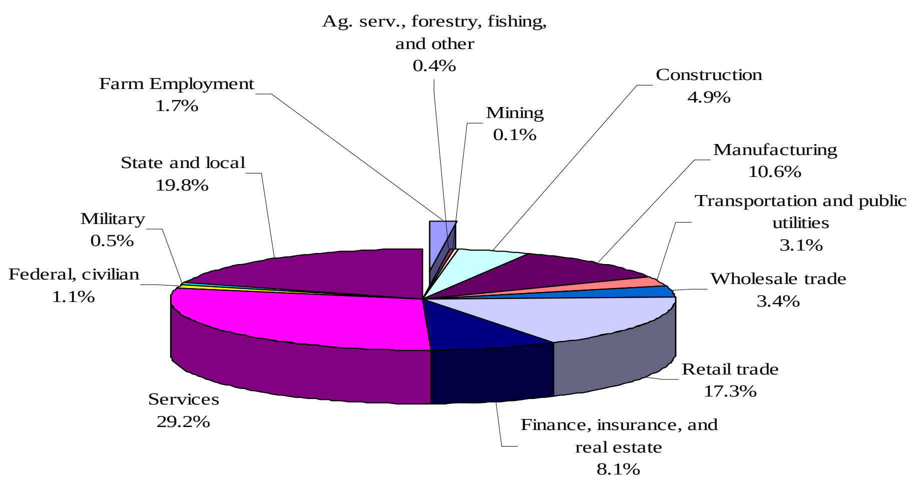

Fig. 4. Percentage of jobs by economic sector in the Tri-county region (Source: U.S. Department of Commerce - Economics and Statistics Administration – Bureau of Economic Analysis, 2000).

Farmland Loss and Impacts caused by Urbanization

Michigan, as many other Midwestern states, faces profound questions about its growth patterns that will ultimately affect the state's economic vitality and quality of life for future generations. One of the most fundamental questions is whether Michigan can sustain the pattern of urban and suburban development, sprawl, which has characterized its growth since World War II. Unchecked sprawl now threatens to inhibit sustainable growth (development of a cost-effective physical and service infrastructure and its associated service delivery) and degrade the characteristics that many view as desirable aspects of the "quality of rural life". There is no question that this pattern of urban growth has enabled millions of Michigan citizens to realize the enduring dream of home ownership. However, it is also clear that sprawl has created enormous environmental and economic costs that may not be sustainable. The key question is: should Michigan move beyond the current pattern of sprawl and rethink future growth policies, functions, and forms? This is not a new concern, but it is one that has never been more critical or urgent. Many planning professionals and community leaders feel that Michigan's traditional development patterns indeed are unsustainable. Urban employment opportunities have decentralized, shifting to the suburbs. New housing tracts have moved into prime agricultural lands and environmentally sensitive areas. Reliance on private modes of transportation and expanded infrastructure continues to rise. The acceleration of sprawl has introduced social, environmental and economic costs that until now have been hidden, ignored, or quietly absorbed by society. The burden of these costs is increasingly becoming clear and is also reflected in the higher costs of goods and services, and taxes. As a result, these factors have contributed to a business climate that has become less attractive than that of some surrounding states. Some argue that this plays a key role in the out-of-state migration of many metropolitan area residents. Another consequence is that suburban residents pay a heavy price in taxation and automobile expenses, while residents of older cities and suburbs lose access to jobs, social stability, and political power. In concert, the future viability of the agricultural production base, the socioeconomic viability of rural communities, and vital ecosystems are equally threatened. As we review the urbanization trend in the Lansing metropolitan region, we see that urban land uses (Fig. 5a and b, below identified in red) have increased from 57,443.6 acres in 1992 to 91,852.2 acres in 2001 (Table 4a and b, below).

Thorp et al. (1996) reports that land classified as farmland -which includes cropland, woodland and permanent pasture categories - declined in the Great Lakes basin by more than 1.8 million hectares (4.5 million acres) in the 10-year period from 1981/82 to 1991/92. Much of this land conversion surrounds metropolitan areas and increasingly includes their rural hinterlands with small communities. For example, in Michigan, 70 percent of the converted farmland acres between 1982 and 1992 were located near three urbanized areas— the metropolitan areas surrounding Detroit, Grand Rapids, and Kalamazoo. The total 345,000-hectare (850,000-acre) decline in Michigan farmland during the decade included 121,500 hectares (300,000 acres) of cropland, much of it with a *prime soils* classification. A Governor's Task Force estimated that this impact represented a potential loss of $60 million to $120 million in gross sales per year (Schultink, 2005). If significant levels of farmland conversion continue unabated in the Great Lakes basin, the agricultural production base will decline and, likewise, future farming opportunities. Given the fact that nearly two-thirds of Great Lake basin cropland is located within a 50-kilometer (about 30 mile) radius of medium-sized cities and large metropolitan areas, efforts to preserve farmland may also help contain sprawling development and maintain the long-term viability of the agricultural sector with its value-added economic opportunities.

As in Michigan, the most significant land use issue in the Great Lakes basin and surrounding region is the continuing growth and development of major metropolitan areas and the virtually uncontrolled expansion of low-density residential areas and associated retail and service centers. Its consequences are increasingly well-known and understood: reduction of open space, pollution, higher energy use and cost, encroachment on and conflict with agricultural land use,

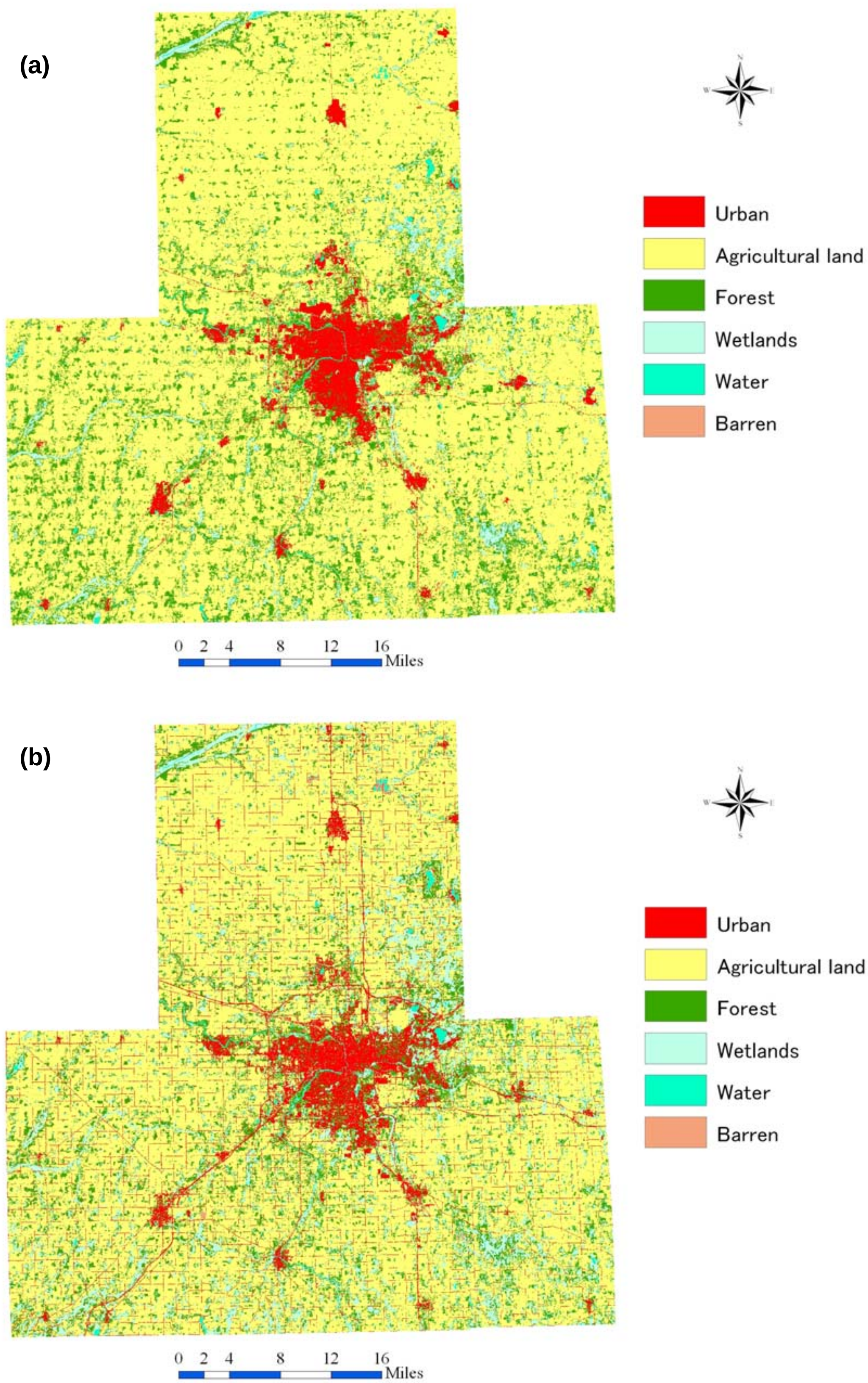

Fig. 5a and 5b. Major land uses in the Lansing Tri-county area in 1992 and 2002 (Source: Michigan Geographic Data Library).

Table 4a. Acreage and percentage of land use in Tri-county area (1992)*

	Acreage	Percentage
Urban	57,443.6	5.2%
Agricultural land	809,967.9	73.9%
Forest	170,191.5	15.5%
Wetlands	51,683.7	4.7%
Water	6,943.0	0.6%
Barren	323.4	0.0%

Table 4b. Acreage and percentage of land use in Tri-county area (2001)*

	Acreage	Percentage
Urban	91,852.2	8.4%
Agricultural land	729,959.5	66.6%
Forest	143,655.7	13.1%
Wetlands	121,504.3	11.1%
Water	6,954.5	0.6%
Barren	2,637.9	0.2%

*****Derived from Michigan Geographic Data Library.

environmental impacts on natural areas (especially wetlands), and an expensive and expansive physical infrastructure promoting an unsustainable future.

This development is characterized by a decentralizing of manufacturing, retail and service functions along urbanized corridors between urban cores surrounded by low-density development. It is also typified by private transportation; poor public transportation options; interstate truck transport; one-story schools, service and industrial buildings; sprawling office parks, retail centers and parking lots; and large-lot housing with individual wells and on-site septic disposal.

In the Tri-county area, urban land use increased from 5.2 to 8.4 percent (3.2%) of the total land area, a relative increase of more than 61 percent! At the same time, this represents an absolute decrease in agricultural land of 73.9 to 66.6 percent (7.3%) and a relative decrease of 9.8 percent in 9 years. While these satellite-derived land use statistics may reflect various degrees of classification accuracy, due to its data sources and automated classification algorithm (such as evidenced in the wetland acreages specifically subject to classification error due to seasonal fluctuations of spectral data and its associated classification error), they clearly demonstrate a dramatic increase over a 9-year period.

For this study, the origin of the agricultural acreage converted to urban uses was evaluated using general USDA land quality standards: including prime farmland, prime farmland when drained, farmland of local importance, and non-prime farmland. It was calculated that 77 percent of the land, converted to non-agricultural use with adequate drainage, can be considered prime farmland (Fig. 6).

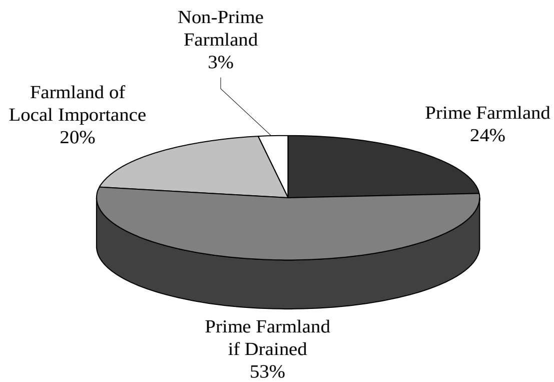

Fig.6. Origin of Land Converted from Agricultural Land to Urban (1992-2001) by Major Soil Productivity Classification (as designated by USDA Farmland Classes).

Quantification of Agricultural Land to Urban Use by Soil Type.

A schematic overview is provided of the first analysis conducted to extract data for further analysis (Fig. 7).

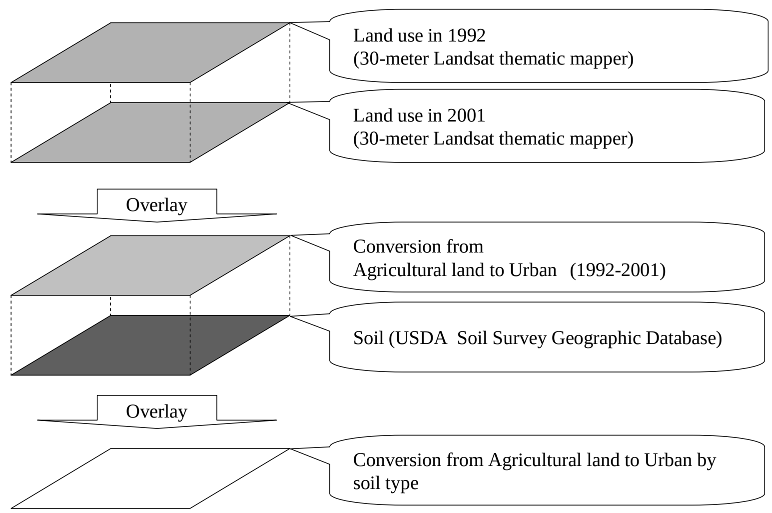

Fig. 7. The GIS-based sequence of spatial analysis extracting conversion from Agricultural land to Urban by soil type.

First, the satellite-derived land cover/use maps for 1991 and 2001 were analyzed to quantify land cover/use change by type for that period. Then, the number of actual acres converted to urban uses during that period was compared with detailed soils data for the 3 counties. Based on this analysis a determination was made of the actual acreage converted by soil type and quality, using the USDA soil textural, physical and prevailing chemical characteristics. The latter step permitted the subsequent transformation of acreages converted to actual crop yield losses based on prevailing soil productivity ratings, as shown below.

Calculation of Annual Economic Production Loss Associated with Farmland Conversion

This phase of research involved the actual conversion of acreage loss to annual productivity loss. Four steps, as outlined below, are involved.

Soil Productivity Ratings

First, the actual soil productivity ratings, as reflected in the USDA soil classification, were used to correlate soil productivity with prevailing crop types grown and grassland used for hay production. These ratings are largely based on physical soil characteristics such as soil texture (particle size) and its resulting ability to retain and release soil moisture to plants during the growing season – to encourage plant growth. The actual soil ratings are referenced in Appendix A.

Typical Crop Mix

The next step involved the conversion of crop productivity ratings based on prevailing agricultural crops or pasture use in Central Lower Michigan. This conversion is reflected below (Table 5).

Table 5. Typical Crop Mix for Clinton, Eaton and Ingham Counties (2001, USDA National Agriculture Statistics Service)

(a) Clinton County

	Corn	Corn silage	Oats	Winter wheat	Soybeans	Hay All (Dry)	Total
Planted All Purposes (Acres)	70,000	16,000	800	21,500	83,000	21,000	212,300
Harvested (Acres)	53,600	16,000	700	21,400	83,000	21,000	195,700
Typical crop mix	33.0%	7.5%	0.4%	10.1%	39.1%	9.9%	

(b) Eaton County

	Corn	Corn silage	Oats	Winter wheat	Soybeans	Hay All (Dry)	Total
Planted All Purposes (Acres)	60,000	2,100	650	17,000	68,000	15,000	162,750
Harvested (Acres)	57,200	2,100	500	16,900	68,000	15,000	159,700
Typical crop mix	36.9%	1.3%	0.4%	10.4%	41.8%	9.2%	

(c) Ingham County

	Corn	Corn silage	Oats	Winter wheat	Soybeans	Hay All (Dry)	Total
Planted All Purposes (Acres)	52,000	4,500	0	14,500	56,000	18,000	145,000
Harvested (Acres)	47,100	4,500	0	14,400	56,000	18,000	140,000
Typical crop mix	35.9%	3.1%	0.0%	10.0%	38.6%	12.4%	

Commodity Price

Based on the typical crop mix grown in the region, soil productivity and resulting biomass production (reflecting crop yields) were then converted into actual dollar ($) values using the prevailing commodity prices for 2001 (see Table 6).

Table 6. Commodity price for major crops in Michigan (2001). Source: USDA

	Corn	Corn silage	Oats	Winter wheat	Soybeans	Hay all (Dry)
Harvested (thousand acres)	1,900	-	55	510	2,130	1,150
Yield (bushel)	105	-	64	64	30	3
Production (thousand bushels)	$199,500	-	$3,520	$32,640	$63,900	$3,610
Value of production (thousand $)	$584,250	-	$6,336	$79,315	$285,633	$253,510
Commodity Price	$1.97 ($/bu)	$25.00 ($/ton)	$1.80 ($/bu)	$2.43 ($/bu)	$4.47 ($/bu)	$70.50 ($/ton)

Note: The commodity price of corn silage is derived from average price of corn silage during the period 1996-2001.

Calculating Annual Economic Productivity Loss

The final multiplication of cropping totals and commodity prices was summed for all counties, resulting in the total annual economic production loss for the Tri-county area of $8,628,992.99, again based on prevailing commodity prices in 2001. The total production function is summarized, below (Fig. 8).

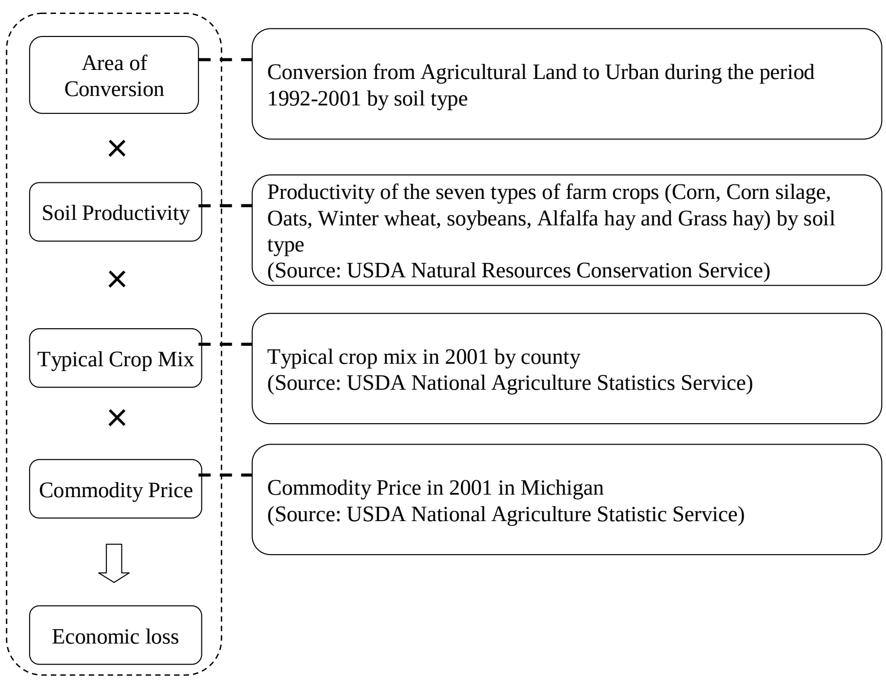

Fig. 8. Economic Production Function of Total Annual Production Loss Associated with Farmland Conversion

The competing uses of corn – for feed and for alternative fuel have increased current and future corn prices. Based on the MSU Market Outlook Report, corn prices will range between $2-$5/Bu (Hilker, 2007). Michigan, in the short-term, is facing an in-state corn supply limitation for ethanol production (Peterson et al., 2006). With increased prices and decreased availability of farmland for corn production, the Tri-county area has lost, and will increasingly lose, this economic opportunity.

With the recent and dramatic increase in commodity prices, associated with increased demand in ethanol production for bio-energy (e.g. for corn to about $3.30 per bushel), an additional production loss can be estimated for 2007. Conservatively assuming the same (non-corn) commodity prices as in 2001, a corn price of $3.30 in 2007 and a 35% constant land production allocation to corn in the region, an increase of about $5 million based on 2007 prices is justified, bringing the resultant total direct production loss to about $13.6 million.

Total Economic Loss by Major Farmland Classification

The actual economic loss associated with agricultural production loss should also be referenced by farmland classification (Fig. 9). Only 4 percent of the total loss of farmland occurred on land not classified as either “Prime Farmland” (75%) or “Farmland of Local Importance” (21%). This is a clear indication that current master plans and zoning ordinances in the region do not sufficiently recognize the importance of Prime Farmland preservation.

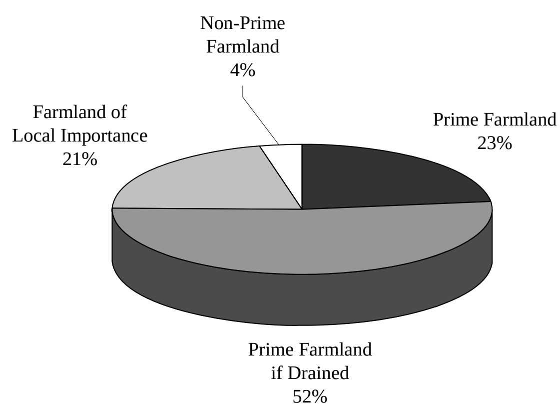

Fig.9. Agricultural Land (1992) by Major Soil Productivity Classification

Economic Impacts of Production Loss

To assess the overall economic impact associated with the annual agricultural production loss, it is imperative to include the value-added impact associated with both back- and forward-linkages. Ferris (2000) addresses these multipliers for various commodities linked to the agricultural sector. In this study the relative general importance of the impacts of these linkages is referenced in the form of *employment* and *output* multipliers. The *employment* multiplier for the Michigan agriculture industry is estimated to be about 1.668, meaning that for every full-time equivalent job in production agriculture about 0.668 jobs exist in industries that supply agriculture in the form of inputs, such as fertilizer, pesticides, fuel, and insurance. The *output* multiplier is nearly identical at 1.678, meaning that for each dollar a farmer generates (receives), 67.8 cents are in backward-linked industries, such as livestock, including “induced” effects associated with the income and expenditures of households. If more commodities were linked to food processing, the aggregate general multiplier could be as high as 2.577.

Assuming that a factor of 1.6 is a conservative -but realistic- multiplier, the $13.6 million dollar value (based on the productivity loss referenced in section 5.4) should be transformed to an *estimated direct economic impact of agricultural production loss of almost $22 million per year.*

Implications of Bio-energy Production for Future Commodity and Food Prices

A more recent significant increase in the use of corn for ethanol production has dramatically shifted future commodity price scenarios. A further conversion to corn production, based on price preferences, will increase this estimate further. While corn prices have doubled over the last year, wheat futures are trading at their highest level in 10 years; and other commodities prices, such as rice, are rising also. In addition, soybean futures have risen by 50%. (Earth Policy News, 2007). Commodity markets analysts note that the soaring use of corn for fuel ethanol is creating unintended consequences throughout the global food market (Fig. 10).

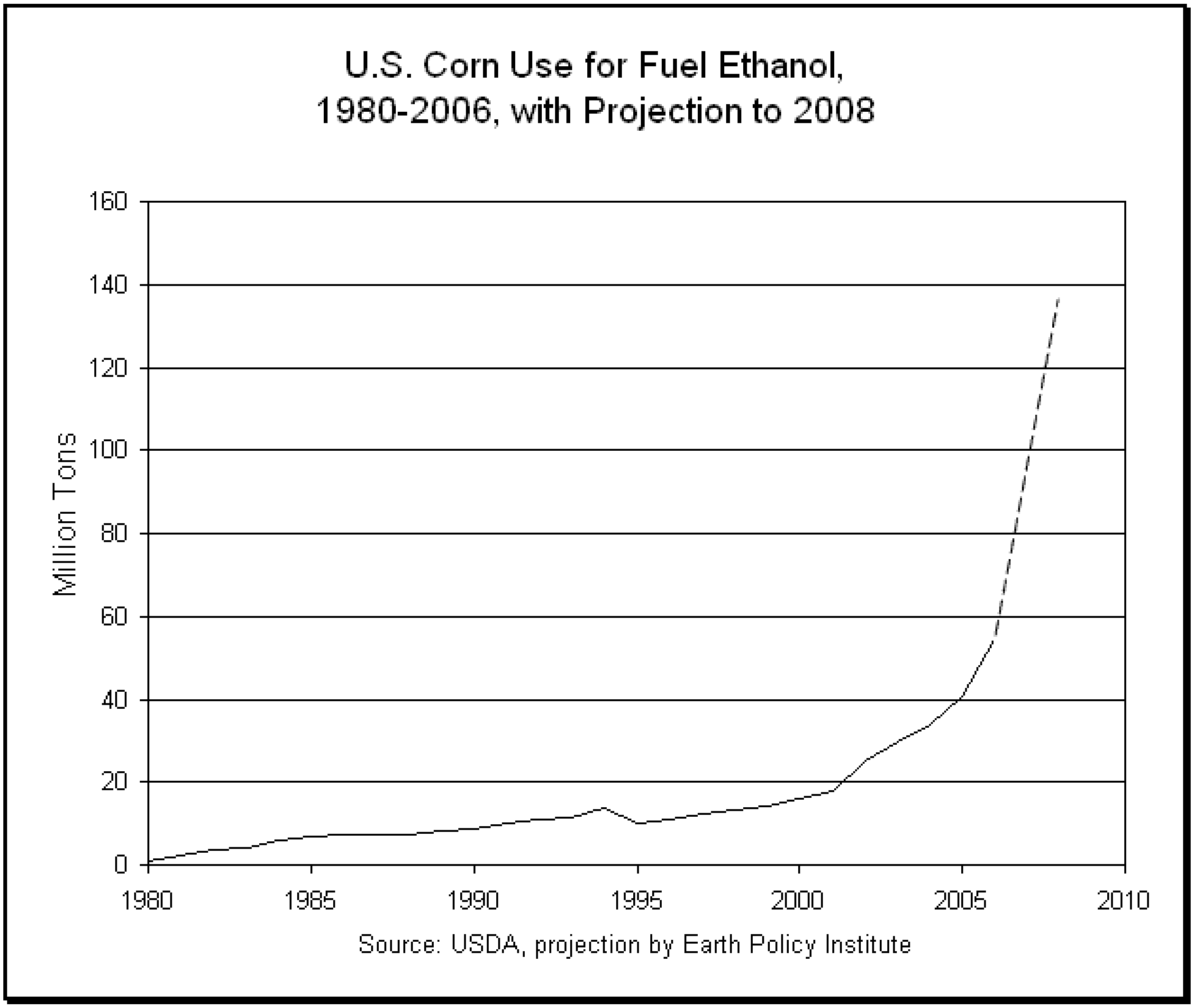

Figure 10. Trend and Projection Corn Use for Ethanol

Countries especially hit by rising food prices are those where corn is the staple food, such as the Latin America region. In Mexico, one of more than 20 countries with a corn-based diet, the price of tortillas is up by 60 percent, resulting in street protests and a demand for government price controls.

Food prices are especially increasing in countries with the largest populations, such as China, India, and the United States: countries that together contain 40 percent of the world's people. While relatively little corn is directly consumed in those countries, a large percentage is consumed indirectly in the form of meat, milk, eggs, and corn-derived food products. Grain and soybean prices are forcing increased meat and egg prices in China. Pork prices were up 20 percent in one year, eggs were up 16 percent, while beef (which is less dependent on grain in that part of the world) was up 6 percent (Earth Policy News, 2007). The U.S. Department of Agriculture projects that the average annual wholesale price of chicken in 2007 will increase by 10 percent, a dozen eggs will be up 21 percent, and milk will be 14 percent higher.

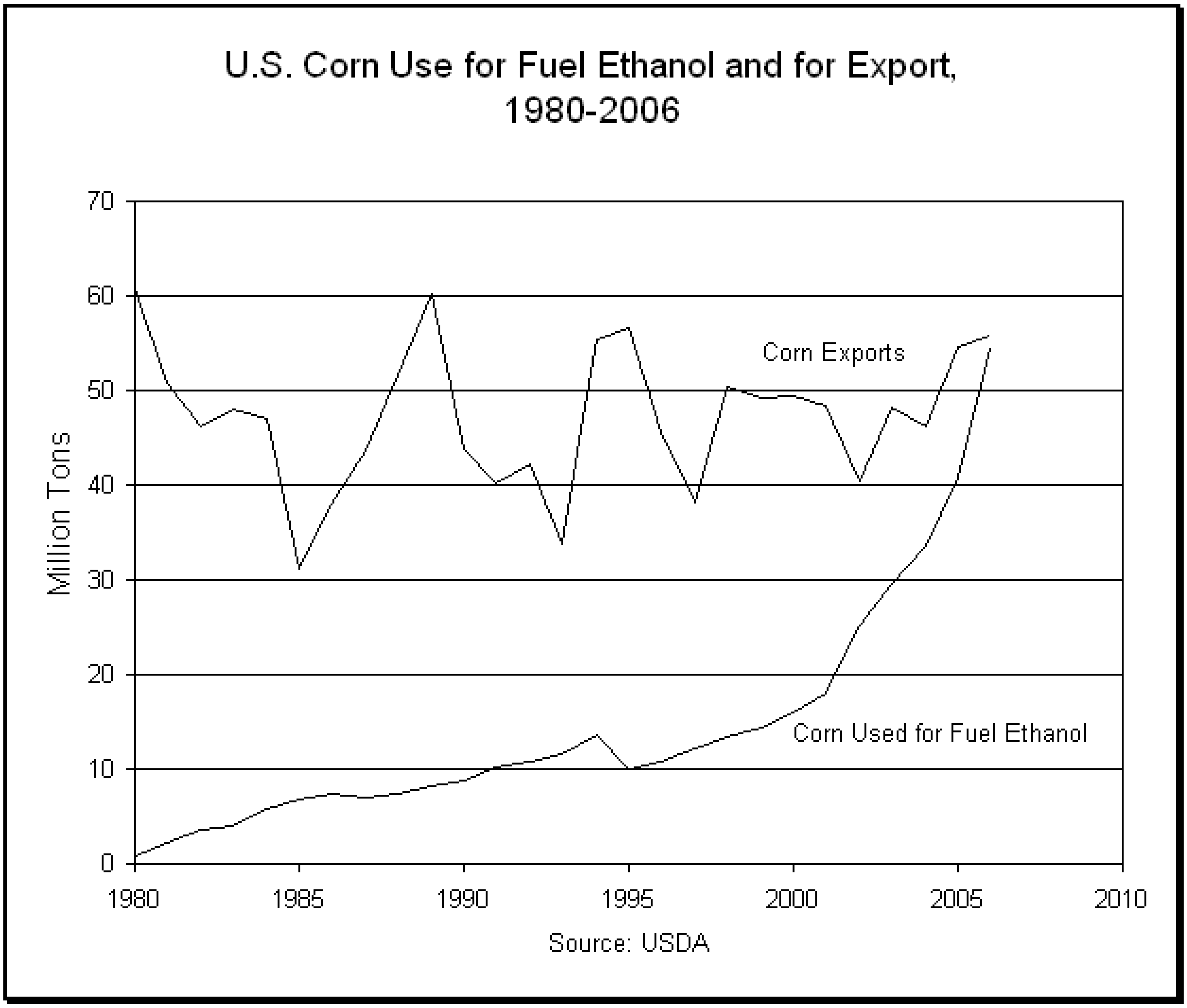

Fig. 11. Trends of Domestic Use of Corn for Ethanol and Exports

In 2006, about 16 percent of the US grain harvest was used to produce ethanol. With a large number of ethanol distilleries now under construction, enough to more than double existing ethanol production capacity, nearly a third of the 2008 grain harvest is destined for ethanol production. It can be expected that if the rapid expansion of fuel ethanol distilleries continues, world grain prices will move toward their oil-equivalent value in what appears to be the beginning of a long-term increase in prices. Given the mounting energy dependence of agricultural production, the food and energy economies are increasingly merging. This means that if the *fuel* value of grain exceeds its food value, market demand will use it primarily as an *energy commodity*. Therefore, the world price of oil will dictate the price of food.

While this impact on future food prices may be one significant concern, another is the use of corn for domestic energy production, which will reduce US exports and increase the current trade deficit. The potential cost savings on fossil fuel imports as a result of corn use are very limited, due to the energy-consuming and inefficient production and distillation of corn (corn processing is about 3-4 times less energy-efficient than the production and conversion of sugar cane), especially when subsidized by direct and indirect price supports and import tariffs (e.g. the current US import duty of 54 cents per gallon of ethanol). While US ethanol production is subsidized and protected by import tariffs, European producers of biodiesel (typically a mixture of rapeseed, soybean and sunflower oil with diesel oil) are complaining that US export producers receive about a 20 Eurocents subsidy per liter (about $US 1.01/gallon at March 2007 exchange rates), even when first imported from foreign sources such as Malaysia and Brazil[3].

The use of traditional agricultural commodities for the production of biodiesel seems to be accelerating in the United States. David Niles (Biodiesel Magazine, Sep. 2006) reports that the U.S. retail (biodiesel) market grew from 300 refueling sites in 2005 to more than 950 sites in 2006. Public consumption, however, still lags behind Europe, where biodiesel represents 2 percent of total on-road fuel consumption and is expected to reach 6 percent by 2010, according to Thurmond (2006). He expects more biodiesel production to come online as long as gasoline prices remain near $2.50 per gallon, and if the Federal biodiesel tax credit is extended beyond 2008.

Biodiesel production is also expected to expand overseas. Brazil, especially, will play an important role as an international biodiesel supplier. In fact, due to its agricultural capacity, Brazil is expected to be one of the world's biggest biodiesel suppliers by 2020. Trends also indicate that China and India will become large-scale producers and users of biodiesel over the next decade, possibly even overtaking Europe. While Europe is currently a leading biodiesel producer, future expansion will be difficult due to land capacity limitations. Future biodiesel feedstock sources may be changing. Thurmond (2006) indicates that within five years soy oil may start being replaced by biodiesel created from algae or imported palm oil, as is already the case in Europe.

Economic Loss from Nonproductive Use

Developing Prime Farmland into nonproductive use has caused much debate. Determining the economic factors surrounding the valuation of agricultural land -as it receives pressure from urbanization- has been well studied (Drozd, 2004; Shi, 1997; Hardie, 2001). Both productive and nonproductive losses should be considered when farmland is converted. (See Figure 12)

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[3] US biodiesel exports to Europe have increased to 30,000 tons in the month of January, 2007. The EU produced 4.5 million liters of biodiesel in 2006, about 70% of the world production (Dutch Press Agency).

Most simplistically, farmland is converted to non-farm uses when the expected net value of an alternative use is higher than its agricultural use. From 1992-2002 the average percent change in land value in the Southern-Lower Peninsula (including the Tri-county area) was 6.1%; 4.9% and 6.6% for field crop (tiled and non-tiled) and irrigated, respectively (Hanson 2002). With land value increasing, the Tri-county area has also seen an increase in the value/rent ratio. A higher value/rent ratio (a direct function of the future cash flows expected to be generated by the land) can signify a higher likelihood that agricultural land will be transformed to alternative or non-farm uses (Hanson 2002).

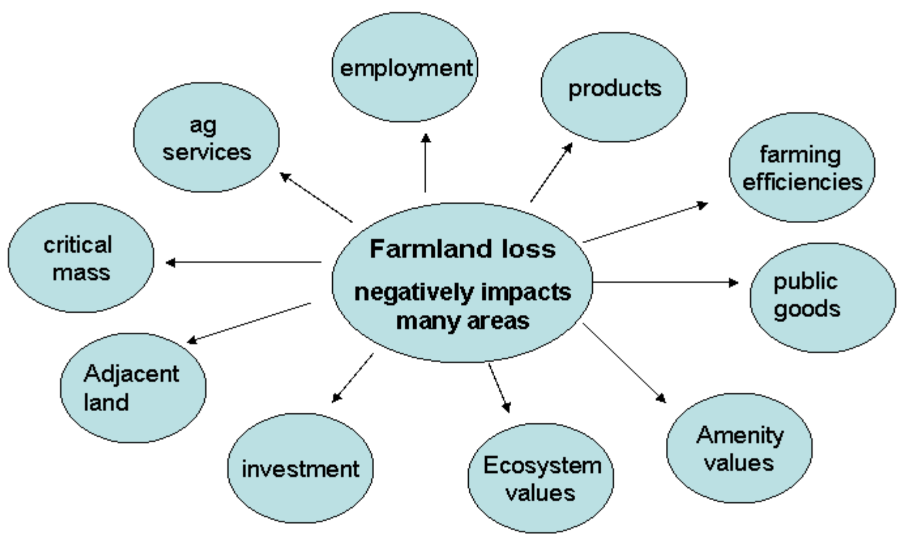

Figure 12. Productive and Non-Productive Losses of Farmland Conversion

As this study indicates, most parcels in the Tri-county study that were converted to nonproductive uses were considered Prime Farmland. This urbanization of Prime Farmland may require lower quality land to be put into production. Such farmland conversion reduces certain public goods associated with undeveloped land, such as flood conveyance, ground water recharge, and preservation of ecosystems values and amenity values associated with open space. Amenities associated with open space include: use values, such as hunting and fishing; indirect uses, such as reading books about open space-related resources; and nonuse values, including both an option value (willingness to pay to use resource in the future) and an existence value (willingness to pay to maintain a resource)(Fausold, 1999). Many of these benefits can be calculated from surveys using contingent valuation or other non-market valuation methods. Lopez (1994) considered the amenity benefits of agricultural land and found that agricultural land often yields significant positive externalities. In fact, he found that the socially optimal solution for land allocation often required a higher proportion of agricultural use. The preservation of agricultural land as an important social amenity value is one of the major considerations in land use planning in north-western European countries, such as the Netherlands. Here, innovative land management agreements are made between the land owner (farmer) and (non)government entities to compensate landowners for the environmental services their land provides, to restrict certain management practices (e.g. delay of the first hay cut to accommodate the nesting cycle of meadow birds) or to reduce agricultural inputs (e.g. minimize fertilizer or pesticide loadings). Other methods to determine the value of natural systems include the calculation of the cost of public expenditures required to construct infrastructure to replace the loss of functional values of these systems.

Rural economies depend on agricultural industries for employment. In the Tri-county area, from 1990-2000, farm employment losses were 10.3 percent and “Agricultural Services, Forestry, Fishing, and Other” job losses were 43.7 percent. The conversion of farmland makes most of these losses permanent. Short-term construction and infill development may provide additional employment over time, but there still is a question of how much agriculture land is needed to be economically viable. The continued loss of farmland erodes the base and reduces the *critical mass* of land needed to sustain a viable agricultural sector (Brabec, 2002). Various reports have tried to quantify this value by computing threshold acreage; however, a study of Michigan farming sectors has not been completed (Lynch, 2003). One factor increasing the loss of critical mass is the “impermanence syndrome”, in which farmers believe that urbanization will absorb the farm in the near future. Nelson (1992) states that for every acre of prime farmland that is urbanized, up to another acre becomes idle. In addition, conversion of farmland to residential use also affects adjacent agricultural land in many probable ways, including the potential for nuisance claims (Lynch, 2003).

Over the study period of 1992-2002, the Michigan Land Values survey showed that the most important non-agricultural factor influencing Michigan land values was the demand for home building sites, followed by the demand for “Farms/Ranchettes of 10 acres or so” (Hanson, 2002). This demand for low density residential or ranchettes can create a “checkerboard distribution” or *parcelization* of agricultural land. This parcelization can cause issues with field surveillance and pest control, as well as inefficiencies in the movement of farm equipment (Pfeffer and Lapping, 1995). This latter negative economic impact of historical land fragmentation is widely recognized and, in some countries such as the Netherlands, is reversed by expensive land consolidation schemes.

The existence of open space has “enhancement value” that positively affects adjacent property. As open space and farmland decrease, the enhancement value increases; and, there is often an increase in the surrounding property values (Fausold, 1999). Farmland, however, provides many types of values. A more thorough understanding of the value of farmland will help inform decision makers and the public at large, and may provide for a more sustainable rural economy.

Discussion and Conclusion

The assessment of economic impact, as discussed, is based on the simplifying assumption that residential land use is the primary (non-productive) use to which agricultural acreage is converted. As such, it assumes that no direct monetary benefits result from changing agricultural land to residential use. In reality, societal benefits accrue from converting agricultural land to "urban uses" especially if these uses result in the more cost-effective delivery of manufacturing and service functions. However, most typical agricultural land conversion primarily results in low-density residential land use. Most of this need could be accommodated by developing high quality neighborhoods through urban revitalization, filling in underutilized capacity in the central city, and developing higher-density subdivisions with open space amenities (green design) and direct (lower cost) access to water, sewer and utilities (reducing environmental impacts). The same can be said for clean manufacturing and service functions that can be accommodated by the development of *brownfields* (old industrial sites), urban infill, and mixed land uses.

Based on findings in this study, principal agricultural production losses associated with farmland conversion in the Tri-County area are estimated to be about $22 million per year, taking into account prevailing 2007 commodity prices and considering value-added linkages. Near-term, expected commodity price trends and an increase in the proportion of corn production, associated with incentives for ethanol production, could easily approximate $30 million per year for the Tri-county area. The economic loss of such a substantial potential revenue stream will significantly undermine the economic vitality of many rural communities and Michigan's agriculture as a whole. If this impact is multiplied – considering other urbanizing regions in Southern Michigan (e.g. Grand Rapids/Holland, Muskegon, Benton Harbor, Kalamazoo/Battle Creek, Jackson, Ann Arbor, Greater Detroit, Flint, the Tri-cities of Saginaw Bay, etc.) – the combined economic impact directly associated with agricultural productivity loss and with the conclusions stated above, could easily surpass the $300 million per year by 2010.

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