SNR-FM-1-99

AMERICA'S FARMLANDS: A LAND RESERVE FOR SOCIETAL EXPANSION OR A NATURAL RESOURCE CROWN JEWEL?

BALANCING CONSTITUTIONAL PROTECTIONS OF PRIVATE RIGHTS AND SOCIETAL INTERESTS IN AMERICA'S HIGH QUALITY AGRICULTURAL LANDS

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PREAMBLE

"Man - despite his artistic pretensions and his many accomplishments - owes his existence to a six-inch layer of topsoil and the fact that it rains."

Old Chinese Proverb

"The fabric of human life is woven on earthen looms - it everywhere smells of the clay."

J.H. Bradley, 1935

"...man's relation to the land...is still strictly economic, entailing privileges but not obligations."

Sand County Almanac, Aldo Leopold, 1949

CONTEXT

Many of society's greatest challenges lie at the interface of ecology, natural resource sustainability, and ecosystem integrity on the one hand and individual-societal interests and economic forces on the other. Nowhere are these challenges more exemplarily portrayed than in the clash of interests and values over land and how much societal control can or should be exercised in protecting both individual and societal rights and interests in land.

In a democratic society with constitutional protections of rights in privately held land, case law has been relied upon to define and locate the fulcrum point supporting the delicate and off-polarized balance beam upon which the rights of land owners and the land-related interests of society are weighed and apportioned. Compounding the complexity and difficulty of locating this fulcrum point for each case is the fact that our nation's constitutional protections are uniformly overlain on a landscape matrix, the components (e.g., soils, geologic substrata, varying ecosystems) of which are not equally suited to or capable of accommodating the many uses proposed for and imposed upon this landscape quilt.

As the density of occupancy and ownership of America's landscapes has increased with the nation's expanding population, there is a growing social undercurrent supporting some level of obligatory land stewardship and better land use planning. The calls for smart growth, protection of unique ecosystems and species, and "pricing" those amenities such as aesthetics, water quality, air quality, and quality of life issues that are not commonly marketable or accounted for through economic indicators, are being heard with increasing frequency and shrillness (Baden, 1996; Diamond and Noonan, 1996; Kunstler, 1993; Platt, 1996).

This amalgam of forces and factors is manifested in the question of whether or not to intervene in the market place to protect some of America's highest quality farmlands and croplands. And perhaps most importantly, should such interventions be deemed appropriate, are there adequate data bases and tools to guide such interventions and do we have the will to use them within the constitutional provisions to protect private rights in land from being physically or economically taken?

INTRODUCTION

Trend Toward More Rational Land Use Driven by a Growth-Impacted Society

Figure 1 illustrates some of the forces and constraints acting on the goal of rational land use, i.e., well-planned land use or "smart growth" and land uses that are commensurate with the capacity of the land and environment to accommodate these uses. While the land use decision-making process is often far from rational, increasing population density on the land coupled with a more informed and growth-impacted public have led to society being an increasingly powerful force in determining how land shall be used.

This growth impact on people demonstrates itself in many forms such as through overwhelmed infrastructure resulting in traffic congestion and other impacts, failure of soil-landscape ecosystems to assimilate the waste loads imposed upon them, increased damage from flooding, spiraling taxes and the realization that the costs of lax planning are indeed substantial, fragmentation of agricultural land, blighted landscapes overrun by strip development and mind-numbing sameness, and a loss of community character and sense of place. These societal forces, often heavily value-laden, will continue to increase, thereby requiring "full disclosure" from public officials as to the real and oft-hidden or unaccounted-for costs and impacts of proposed land uses.

Documenting Land Use Dynamics: The Data Dilemma and Stupefaction Syndrome

If ever there was a complex and confusing issue, trying to decipher the confounding data bases and writings regarding land use dynamics would be close to 'ground zero' of stupefaction. Various data bases often deviate from each other or are misinterpreted because of 1) different data sources and sampling protocols, 2) different definitions of land use categories and changes in definitions over time, 3) different time periods over which land use is measured, 4) adjustments in data from one reporting period to the next, and 5) differences in data sets resulting from using the 50 state land base vs. the 48 contiguous state land base.

Confounding this stupefaction syndrome even more is the proliferation of papers, articles, and reports as well as the tendency toward multisecond media bytes addressing land use issues that do not recognize either the significant or subtle differences among these data bases. Not to disparage the excellent literature on land use dynamics, there are, nevertheless, many cases where these subsequent assimilations and interpretations of data do confuse the literature which, when cited and tweaked by others, further enhances the stupefaction syndrome. This syndrome is what Mark Twain must have had in mind when he commented that "the researches of many commentators have already thrown much darkness on this subject, and it is probable that, if they continue, we shall soon know nothing at all about it."

Having set myself up, perhaps, for more rigorous scrutiny than usual, it is my objective to at least not shed any more darkness on this subject while being mindful of the old adage; "if you torture numbers long enough, they will confess to anything." Table 1 provides a sampling of data from different sources illustrating the disparity between numbers from different periods, sources, and variations on the definitions of similar, yet different land use categories. It has not been uncommon to see reporters and authors mistakenly interchange land use categories and/or numbers as if there was no distinction between agricultural land, farmland, and cropland or developed land, urban land, and urban and built-up areas. Simple questions such as what are the trends in US farmland and cropland over selected periods, how much land is devoted to US farmland and cropland in different decades, or how much farmland and cropland are converted to developed uses each year, can lead the innocent into a morass of confounded data, different interpretations, and answers that can coagulate the cerebrum.

The Magnitude and Complexity of Land Use Changes

The Matrix of Political-Individual Land Use 'Controllers': There are about 3100 counties and tens of thousands of other political jurisdictions in the US, most of which regulate or control land use to some extent. Within this matrix of political jurisdictions are many millions of privately held land parcels, the owners of which have their own ideas and aspirations about how these variable soil-landscapes should be used. Their individual goals may or may not mesh with the greater interests of society, or with the suitabilities of the variable soil-landscapes they occupy and utilize (Figure 2).

This complex of sociopolitical and individual interests in and ownership of highly variable landscapes (Figure 2) coupled with the dynamics of land use changes that play out daily makes the issue of land use dynamics difficult to track and quantify. About two-thirds of the 1.9 billion acres of land in the 48 contiguous states is privately owned. On any given day, there are thousands of land ownership transactions. Many of these transactions result in land use changes, amounting to an average of more than five million acres annually (USDA, 1994).

Trends in Farmland Changes: Figures 3a and 3b show land use trends for farmland and cropland in the US and Ohio over the 52-year period following WWII. While the dynamics that have driven these trends and land use changes over time are significant, i.e., some land is converted to other uses while other lands are brought into farmland and cropland each year, the net cropland base for both the US and Ohio have not changed dramatically over this period compared to the rates of decrease in the amount of farmland (Figure 3).

Putting numbers on the trends depicted in Figure 3, the amount of US land (48 states) in farms decreased by about 182 million acres over the 52-year period following WWII. This acreage reduction works out to an average decrease in US farmland of approximately 3.5 million acres per year (Tweeten, 1998). Looking just at the 15-year period 1982-1997, the net annual rate of US farmland converted to other uses was about 3.7 million acres (1992 and 1997 Census of Agriculture).

Trends in Cropland Changes: Cropland accounts for 24 percent of the nation's 48 state land area (USDA, 1997; Daugherty, 1995). Unlike farmland, there has not been much net change in US cropland over the 1945-1997 period, although land is constantly shifting into and out of cropland from and to other uses. In fact, there are about 10 million more US cropland acres in 1997 than in 1945, although the actual cropland used for crops is 26 million acres less, the difference being cropland idled and cropland used for pasture, both totalling 35 million acres more than in 1945 (USDA, 1997; USDA, 1999).

These numbers illustrate the dynamics of land shifting into and out of cropland and cropland categories (idled cropland, cropland used for pasture, cropland harvested) over this time frame driven by such forces as government set aside programs, weather, commodity price fluctuations, marginal lands converted to other uses, urban consumption and other factors that convert lands into and out of cropland. Considering just the 1982-1997 period, US cropland decreased by an average rate of approximately 547,000 acres per year (USDA, 1999), compared to a decrease of 920,000 acres per year during the 1982-1992 period (Tweeten, 1998; USDA, 1994). These rates of cropland reduction are only a fraction of the corresponding rate of US farmland loss (Figure 3a).

Trends in Ohio: Ohio's farmland and cropland acreages have followed the national trend, although Ohio's cropland acreage has decreased at a greater rate than the national average. Ohio's farmland acreage declined during the 1945-1997 period at an average annual rate of nearly 152,000 acres (Tweeten, 1998; USDA, 1999). To illustrate the volatility of these farmland loss rates from one time frame to another, the 1992-1997 period recorded an average annual farmland loss rate of 29,000 acres compared to an annual rate of cropland decline for the 1982-1992 period of 115,600 acres (USDA, 1999).

Switching to cropland, Ohio's annual average cropland acreage decreases over the 1945-1997, 1982-1992, 1987-1997, and 1992-1997 periods were 31,900 acres, 29,600 acres, 57,900 acres, and 37,600 acres, respectively (USDA, 1999; US Dept. of Commerce, 1994; Tweeten, 1998). Using the NRI database (USDA, 1994) for the period 1982-1992, Ohio's cropland reduction averaged 51,800 acres per year compared to Census of Agriculture (USDA, 1999) data which yields an average cropland decline of 29,600 acres per year for this same period. This difference in data sets and definitions of cropland results in a 1.75-fold differential for the same land use category and time period!

Land Converted to Developed Land and Urban Uses

Land converted from other uses to developed land and urban uses varies by data source; definitions of developed land, urban land, urban areas, and urban and built-up uses; and whether data are reported on a 48 vs. 50 state or other bases (Table 1).

Developed Land: 'Developed land' has several connotations. Such variations result in a lack of consistency in the literature. Tweeten (1998) defines developed land as urban areas, transportation, wildlife, and military areas, citing the AREI (USDA, 1997) data which includes these land use categories plus miscellaneous farm uses in a category defined as 'special uses.'

The AREI report (USDA, 1997) indicates that urban land in the nation's 48 states totaled 58 million acres in 1992, accounting for 3.1 percent of the 48 state land base. 'Special uses,' including urban land, totaled 194.4 million acres in 1992, accounting for 10.3 percent of the 48 state land area (USDA, 1997). Tweeten (1998), using the more restricted definition of 'developed land' from the AREI report's (USDA, 1997) special land uses category for 1992, arrived at the figure of 188.2 million acres of developed land, accounting for just under 10 percent of the 48 state land area.

'Special uses' of land reported by the Bureau of the Census and land management-conservation agencies (Daugherty, 1995), unlike the AREI (USDA, 1997) definition and data, do not include urban land uses. Yet, these 1992 data sources report a 48 state total of 136 million acres in this 'special uses' category, consisting of transportation uses, national-state parks, wilderness and primitive areas, wildlife areas, military and industrial uses, and farmsteads, farm roads and lanes. When Alaska and Hawaii are included, this 'special uses' category, the area balloons to 281 million acres. Alaska accounts for more than half of the nation's 'special uses' of land using the data sources above as reported by Daugherty (1995).

The NRI summary report (USDA, 1994), on the other hand, uses a still more restrictive definition of 'developed land,' accounting for nearly 5 percent of the nation's land area, excluding Alaska[1]. This database reports a total of 92.3 million acres of 'developed land' in 1992, having increased at the rate of 1.41 million acres per year during the 1982-1992 period. The concept of 'developed land,' therefore, is inconsistent among data sources, with numbers varying as much as two-fold (e.g. Tweeten, 1998; USDA, 1997; USDA, 1994).

Urban Land: Urban land uses, and urban and built-up areas present equally confounding data sets. In 1992, the Bureau of the Census (Daugherty, 1995) reported 57.8 million acres of 'urban area' in the 48 contiguous states (58.8 million acres including Alaska and Hawaii) based on trends in urban population and land per capita in urban areas. In contrast to the commonly cited 1992 Census figure of 58 million acres of 'urban area' in the 48 state land area, the NRI (USDA, 1994) data summarized in the AREI report (USDA, 1997; Table 1.1.11) for the same 48 state land area, show that 'urban and built-up' land totaled 65.4 million acres in 1992.

Again, these numerical discrepancies are caused by differences in definitions of 'urban area,' 'urban and built-up' land, and other urban related land use categories. Among these differences in definitions is the fact that 'urban and built-up' lands include some agricultural land encompassed within this land use category. Nevertheless, the development and urbanization of America's land area, although relatively small percentage-wise, has increased four-fold since WWII while the US population has doubled.

Rate of Land Converted to Urban Uses: The rates of conversion of various land uses to urban-related uses also is fraught with a maze of dissimilar numbers and land use definitions (Table 1). Tweeten (1998) using AREI (1997) data for the 48 contiguous states, reported an annual average increase of 1.94 million acres of developed land (urban areas, recreation, transportation, wildlife, and military uses) during the 1982-1992 period. Using the urban land definition in the AREI (1997) 48 state data base for the same period, 840,000 acres of US land were reported converted annually to urbanized land. Heimlich and Bills (1997) reported a 50 state-based figure of 978,000 acres annually converted to urban and built-up areas during the 1982-1992 period.

Vesterby et al. (1994) estimated that 740,000 acres were annually converted to urban uses during the 1970's compared to the 50-state Census data (Fry and Hexen, 1985; Daugherty, 1995) which reported 1.3 million acres annually converted to urbanized areas for the same period. During the 1980's, the annual average conversion of land to urban areas amounted to 900,000 acres, increasing to 1.4 million acres per year during the 1990-1992 period (Daugherty, 1995). Other estimates of the rate of urbanization based directly on changes in land use have ranged as low as 726,000 acres per year during various segments of the 1970-1992 period (Vesterby et al., 1994; Daugherty, 1995). These figures illustrate once again the data discrepancies when different sources, definitions, and periods are compared.

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[1]It must be kept in mind that, unless specifically stated otherwise, the NRI database is not exactly comparable to the contiguous 48 state land area. Although the NRI database does not include Alaska, it does include Hawaii, Puerto Rico, and the US Virgin Islands in addition to the contiguous 48 state land area.

Rate of Cropland Converted to Urban Uses: The amount of cropland converted to urban land during the 1982-1992 period varies from about 273,000 acres per year (Heimlich and Bills, 1997) to approximately 600,000 acres per year (USDA, 1997). These differences are due largely to what is included in cropland. The NRI report (USDA, 1994; USDA, 1992 NRI Highlights, 1994) arrived at the figures (based on two methods of calculation) of about 420,000 acres per year and 400,000 acres per year being converted out of the nation's cropland base to 'developed land' during the 1982-1992 period. If cropland pasture is included in the definition of cropland for this period, then the conversion rate of cropland to urban development totals about 600,000 acres per year (USDA, 1997). Tweeten (1998) reports that 377,400 acres of cropland per year were converted to actual urban development during the 1982-1992 period for the 48 contiguous states.

Rate of Prime Land and Prime Cropland Converted to Urban Uses: US cropland accounts for about 24 percent of the 48 contiguous states' total land area. Prime agricultural land comprises 24 percent of rural non-Federal land but makes up 48 percent of US cropland (USDA, 1997). Of the land converted to urban uses, 28 percent is prime agricultural land so that urban conversion takes prime land in a slightly greater proportion than its overall occurrence. However, prime cropland, making up 48 percent of US cropland, is converted to urban uses at about the same rate as nonprime cropland (USDA, 1997). Thus, one could make the argument that urban uses consume cropland, prime land, and prime cropland disproportionately to their overall occurrence and composition (prime cropland) in the total cropland base. Heimlich and Bills (1997) put the urban consumption of prime cropland, at 39 percent vs. approximately 50 percent set forth in the AREI report (USDA, 1997).

Trends in Ohio: Ohio has followed the national trends for land converted to developed and urban uses. Ohio's expansion of developed land during the 1982-1992 period was 52,000 acres per year (Tweeten, 1998). Between one fourth to one third of this developed acreage came from Ohio's cropland.

The Case for Considering Cropland in Land Use Planning

The US reserve cropland consists primarily of nonprime cropland. Therefore, once prime cropland is consumed, there is little margin for cropland expansion except on those lands that, while productive, do not meet the criteria of prime land for the most part. We must remind ourselves that cropland has already been carved out of the nation's best and limited lands including a disproportionate share of prime land. Yet these best agricultural lands are being consumed for irreversible uses at rates that are disproportionate to their occurrence even though the US endowment of croplands is ample enough to guarantee our nation's food security well into the future. But do we really want to forfeit a portion of our agricultural technology and production efficiency on lower quality lands which are also more vulnerable to leave larger environmental footprints?

Compounding the development phenomenon is the fact that the rate at which land is converted far exceeds population growth - a reflection of larger amounts of land converted to urban-developed uses on a per capita basis. During the period 1945 to 1992, the population of the US nearly doubled. However, the amount of land urbanized nearly quadrupled. Figure 4 illustrates this phenomenon for four major metropolitan areas. The combination of larger lot sizes, wider highway rights-of-way, expansions of airports, park systems, etc. account for this increase in per capita consumption of land. During the period 1960 to 1990, Ohio's urban land area increased by 64 percent while the state's population grew by only 13 percent.

Matching Land Use To Soil-Land Ecosystems' Capacity To Accommodate It

Many of these land use changes result in situations where these new land uses are not commensurate with the capabilities of these soil-land ecosystems to accommodate the proposed uses or to assimilate the waste loads imposed upon these soil-ecosystems. Poorly drained and impervious soils result in wet basements and failed on-site waste disposal systems. Flooding, expansive or unstable soils, contaminated water, and a host of other problems confront those land users who, for whatever reasons, failed to take into account the physical limitations of their site or the ramifications of their ecological footprints. The annual estimated cost (National Research Council, 1987) in the US for damage associated with expansive soils alone amounted to six billion dollars during the 1980s, - the nation's most costly natural hazard that goes mostly unnoticed due to its ubiquitous and local nature.

The Social Costs of Ill-Planned, Uncontrolled Land Use

Aside from the natural resource-related problems of land use, there are other issues and costs associated with ill-planned, uncontrolled land use. The urban-suburban plight of traffic congestion and long travel times, air pollution, crime, flooding, mind-numbing strip development, and the lack of any sense of community aesthetics and character are but a few of the social costs that accrue from the lack of will to embrace "smart" growth. Furthermore, the "escape"-driven mentality to leave these problems behind exacerbates ill-planned land use and its associated problems even more as out-migration occurs beyond the rural-urban fringe into areas and political jurisdictions unprepared for this juggernaught and/or unwilling to plan and control it until it is too late to significantly alter the outcome.

Such timidity results in both financial costs and the uglification of the landscape. Many of OSU's international students and visitors who travel throughout Ohio comment about how ill-planned, uncontrolled, and ugly (their words) many areas of the state seem to be. The social costs of such uncontrolled and ill-planned land use usually accrue into the future when politicians are then forced to expand road systems, extend utilities at costs that far exceed what would be necessary for better planned and controlled land use, construct dikes or flood walls to protect developments on flood plains, dredge streams and reservoirs that become choked with sediment, and other costly actions that would be unnecessary or spread over longer periods with better planned and controlled land use.

Land Use Conflicts Drive Policy Change and Need For Resources

As the frequency of land use changes and population density increases, conflicts arise. The local political jurisdiction usually takes the brunt of this conflict. And such conflict usually forces something to change. New policies or policy changes often are born out of such conflict, but often after the fact or after a situation can no longer be tolerated. Local jurisdictions require resources to deal with resolving conflicts and to establish guidelines, standards and policies for better planning. For most areas, there are adequate resources to guide development in a "smart growth" mode. Soil surveys and geologic, topographic, and hydrologic maps and other resources are available to local planners and agencies to assess hazards and evaluate landscapes for their potential to accommodate various kinds of development when overlain with current land use, population density and diversity, zoning and other maps and databases pertinent to the drivers of land consumption and land use changes.

SOME AXIOMS TO BE UNDERSTOOD AND TO ABIDE BY

Having reflected briefly on the magnitude of land use change, the frequent mismatches that occur between certain land uses and the capacities of soil-land ecosystems to accommodate these uses, and the conflicts and costs of these mismatches and ill-planned land use, we now turn our attention to those factors, forces, and tools that allow us (society) to make better land use decisions. Following are a number of self-evident truths or principles in the form of axioms that summarize the focus of this paper.

AXIOM NO. 1 Variability in Nature is the Norm, Not the Exception

Anyone observing people at a public event or at a busy shopping mall cannot help but be impressed by the physical and cultural diversity that has arisen from our human gene pool. Similarly, the animal and plant kingdoms are characterized by an enormous spectrum of biodiversity. Likewise, the physical character of our planet consists of great diversity, ranging from climatic and weather variability to geologic and soil diversity. This spatial diversity of soils across the landscape occurs in predictable patterns related to landscape position, the geologic substrata and parent material from which the soil was derived, the climatic regimen in which the soils formed, and other factors.

These soil patterns yield transitional boundaries and discontinuities between soils that allow them to be mapped. But these map units, while providing much information about soil properties and behavior, are not pure owing to the fact that nature rarely provides a homogeneous physical medium or mappable unit. Just like an accurate road map is a valuable tool to get from Point A to Point B, it does not tell you where the potholes, speed traps, and every hill and curve are located. Yet it is valuable for what information it does portray. Other maps and resources are necessary if a more comprehensive assessment of traveling from Point A to Point B is to be made. So too with land use assessment.

AXIOM NO. 2 Our Human Well-Being Is Predicated on the Sustainability of Our Natural Resources and Ecological Processes

The landscapes derived from this physical and biological diversity constitute the ecosystems in which our human settlements and activities occur. It is these landscapes and their compliments of ecosystem processes[2] and natural resources that nurture and sustain our human welfare through biological systems and related natural resource-dependent enterprises (e.g., agriculture, forestry, fisheries, wildlife management, recreation-tourism, etc.) as well as our economy, social infrastructure and social stability. As Jane Lubchenco stated recently (Jasanoff et al., 1997), the sustainability of the biosphere is now seen to be inseparably bound up with issues

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[2] Ecological processes include:

* Solar energy flux, heat dissipation, climate modulation
* Hydrological flux, hydrological cycle, soil functioning as "living filter" - water quality
* Biological productivity, food source, O_2 generation, CO_2 sequestration-balance
* Biogeochemical cycling, storage, maintenance of N_2, O_2, CO_2 cycles and of air-water quality
* Decomposition, weathering, soil formation-stability, soil quality
* Biological diversity, species propagation, pollination
* Absorbing, buffering, diluting, detoxifying pollutants-xenobiotics

of economic development, social equity, and international peace and security. In essence, our human well-being is inextricably tied to our natural resource base and the health of those ecosystems we occupy and draw from i.e., we are dependent upon these ecological processes and natural resources for our food as well as our affluence.

AXIOM NO. 3 The Concept of Land and Its Qualities Vary with the Beholder

The concept of land and the values ascribed to it are not universally agreed upon, but vary with the beholder. Following are several conceptual views and valve systems held be different "beholders" of land:

- Native Americans - source of sustenance with a spiritual component.
- Ecologists - land is provider of ecological processes and services.
- Terrestrial Scientists - analyze, characterize that portion of earth above water.
- Economists - a resource as a factor of production, commodity.
- American Law - land as property and everything that can be annexed to it.
- Private Owners - "their" property with rights and privileges.
- Farmers - their most expensive resource; source of economic sustenance and well-being.
- Developers - a requisite resource on which to invest and build what America demands.
- Conservationists - espouse responsibility, accountability, and ethical dimensions.
- Society - land provides amenities, services; when should "public trust" doctrine be invoked?

Of course, within each of these groups that view land differently, there is also a spectrum of value systems. For example, individual land owners view land with a variety of values ranging from absolute ownership (get the H___ off and don't tell me how to use it!) to a sense of obligatory stewardship as if temporarily occupying a piece of God's earth that is borrowed from future generations to be left without any scars or irreconcilable environmental footprints. In a pluralistic society, therefore, a spectrum of often competing and incompatible values accompany many, if not most, land use decisions. Thus, land use decisions in our American culture are driven by combinations of individual objectives, social needs, economic opportunities, and a host of differing value systems where land attains the status of a marketable commodity to some and a natural resource with nonmarketable amenity values to others.

AXIOM NO. 4 Populating Land Gives Rise to Cultural Landscapes and Ecological Footprints

The American landscape was populated by people fleeing feudalism and having a strong desire to control their own destiny and own land. As America was settled and subdivided, its natural landscapes were converted to cultural landscapes, the character of which was determined by individual land owners imposing their own will and use upon the land with varying degrees of stewardship and ecological footprints. Figure 5 illustrates an example of an ecological footprint or landscape response over time as measured by soil erosion and sediment flux. As land use changed over time, the landscape response also changed. Similar response reactions can be plotted for nutrient discharges, soil organic matter losses, soil carbon losses to the atmosphere, and others, many of which have off-site impacts or externality costs.

AXIOM NO. 5 Land Uses Vary With Respect To Their Soil-Landscape Requisites

Agriculture is predicated upon certain land attributes such as quality soils, certain topographic limits, adequate water, and suitable climates. As a general rule, the world's most productive agricultural ecosystems are located on soils derived from relatively young parent materials (e.g., glacial till, alluvial deposits, volcanic ash, and wind-blown silts or loess). Thus, soil quality and other natural landscape attributes loom large in determining where agriculture is located and whether it is sustainable. Figures 6 and 7 illustrate how these soil-climatic attributes relate to biological productivity and how they are priced in the market place.

For other land uses such as certain industrial, commercial, and urban uses, the physical and biological properties of land become less important as proximity to economic centers becomes the driving economic force (location x 3!) that dictates how land is used. Thus, all land use decisions are not arrived at or weighted equally with respect to the factors that determine their feasibility and landscape compatibility. A high value commercial building can be sited on a problematic soil and geologic substrata with appropriate engineering and architectural design that overcome the hazards whereas other land uses cannot accommodate the costs associated with such natural limitations, thus giving rise to Axiom No. 6.

AXIOM NO. 6 You Cannot Do Everything Equally Everywhere

Every farmer knows that the soil-landscape variation across his/her farm results in uneven yields and that dissimilar soils respond differently to management inputs. Precision farming or site-specific management has arisen out of 1) the fact that soils-landscapes vary in both their spatial and temporal dimensions and 2) the availability of technologies capable of accommodating this variability with matching inputs.

Likewise, urban and commercial development across landscapes with their inherent variability results in all manner of potential and real problems. Just as crop yields differ across soil-landscapes caused by their natural variability, so too do nonagricultural land uses respond differently when overlain across these soil-landscapes. For example, certain sections of a subdivision's on-site waste disposal systems work just fine while others fail. Some areas are prone to flooding or poor drainage, others are not. Some soils and substrata are prone to expansion or failure when loaded, others are not. Some soils accommodate underground utilities very well while other soils may result in accelerated corrosion reactions. Slope stability varies with soil and substrata conditions. The depth to hard, dense bedrock varies across landscapes. Soils and substrata differ with respect to their capacity and potential to assimilate wastes, accommodate roads or as material for earthen dams.

These and many other land use problems related to the soil-landscape's variability and failure to adequately accommodate numerous kinds of land uses result in billions of dollars expended annually by the unsuspecting home owner, land user, or governments that are forced, too often via legal action, to retrofit corrective actions. Many, if not most, of these land use problems were both predictable and correctable prior to the proposed land use had those individuals and government officials responsible for approving the land use consulted existing resources available to them and required appropriate planning and engineering designs to overcome the soil-landscape limitations. Thus, the annual outlay of millions of dollars coupled with thousands of land use conflicts litigated through the court system are monumental reminders that, because of the natural variability of soils and landscapes, everything cannot be done equally everywhere (Bouma, 1994).

AXIOM NO. 7 Land Use in America is Driven by an Amalgam of Pluralistic Forces, Values, and Conceptual Paradigms Overlying Highly Variable Soil-Landscape Ecosystems

This axiom predicts conflict. The Twentieth Century philosopher and historian Isaiah Berlin (Schlesinger, 1997) argues that pluralism results in an irreducible collision of values. Choosing one value sacrifices another value. He posited that the tragedy of choice becomes an argument for compromise and trade-offs.

Nowhere is this philosophical concept more evident than in those conflicts which arise out of land use decision-making in the US. The premise undergirding Axiom No. 3 is that a spectrum of values and paradigms are attributed to land as a physical entity and natural resource which ultimately results in conflicts over how land is to be used and managed. Compounding this conflict even more is the challenge of trying to balance the rights and interests of private land owners against the interests of society. And underlying these drivers of land use conflict is a soil-landscape so inherently variable that its proposed uses must be tempered with the landscape's capability to accommodate the proposed uses - thus Axiom No. 6.

In our American legal and economic systems, we have overlain the concepts of 1) the rights and privileges of private land ownership, 2) land as a commodity, 3) land as a resource of production, and 4) public interests in land on top of the natural landscape with its inherent variability, hazards, and limitations in accommodating all land uses. Adding to this already complex brew are numerous amenity values (e.g. aesthetics, historical values, habitat values, etc.) that fall outside the traditional marketing-pricing system, yet which carry great weight among many stakeholders. Various scenarios driven by this complexity of forces play out daily in the form of conflict resolution both in and out of the courts as proposed uses of land encounter limitations and hazards imposed by nature, restrictions imposed by society to protect society's interests, and conflicts over competing amenity values. The refrains echoing from these scenarios are well known to us all: "What do you mean I can't build here, locate my on-site disposal system there, have to abide by your silly regulations, etc.?!" "You can't despoil this land!" "How dare you desecrate this ancestral and sacred place?!"

As population density, land use intensity, and conflicting land uses increase, the greater are the pressures to plan and control the use of land and to weigh more heavily the limitations of land, the interests of society, and those amenity values that do not lend themselves to the traditional market place. The boundary between the interests and rights of society and the interests and rights of private land owners is not a sharp one, thereby resulting in various degrees of contentiousness and litigation. Thus, much land use case law, policies, and land use control strategies are born out of this conflict over private vs. public interests and the limitations or potentials of variable landscapes that do not accommodate all land uses equally or in an environmentally benign manner.

AXIOM NO. 8 Prime Farmland Is A National Asset and Requisite Resource To Accommodate the Challenges Of America's Agriculture in the Next Millennium

We as a Nation have set aside ecosystems such as the Badlands of the Dakotas, the Grand Canyon, Death Valley, the Great Smokies and other unique ecosystems as national parks, wildlife preserves, refuges, and monuments, as well as numerous state and local parks. The rationale for these ecosystems being placed in the public domain as part of our national heritage is, in part, due to their unique physical and biological assets, their beauty and other amenity values. While these national treasures provide us with recreation, spiritual, and aesthetic sustenance, they provide very little in the way of food and fiber - being insignificant from the standpoint of having any potential or capability for agricultural use and food production.

Contrary to these unique ecosystems being protected as part of our country's public trust, virtually all of our Nation's nearly one billion acres of agricultural land and its 460 million acres of cropland are privately owned and managed by approximately two million private citizens. These individual owner-operators under the free enterprise system have generated a virtual cornucopia which has allowed the US to feed more than 275 million people plus export the equivalent of 25 to 35 percent of our land-generated commodities which contribute significantly to our foreign balance of payments. And while this privately held land has served this Nation well, the interests and objectives of these two million farm owner-operators are not always synchronous with society's interests and objectives. These valuable and unique agricultural ecosystems cannot be replaced when withdrawn from our cropland base and converted to irreversible uses - now occurring at the rate of about one average-sized Ohio county each year. Whether society should or should not intervene in this free market allocation of these valuable agricultural resources is a debatable question. This question, however, does not hinge on whether or not our future food security is in jeopardy.

The greatest challenges American agriculture faces as we cross the threshold of the next millennium are to 1) continue increasing production per unit of land in order to remain cost-efficient and competitive in the global market place, 2) reduce the environmental leakages and impacts from our production systems, and 3) sustain those ecological processes[1] that undergird the productivity of our agricultural land. These challenges can only be met when technology is implemented on those soils and ecosystems best suited to agriculture. Not only are these agriculturally-adopted ecosystems best suited for efficient production, they are also best suited to accommodate and ameliorate production inputs (e.g. fertilizers, pesticides, animal wastes) that are vulnerable to loss and leakage. Thus, we must be conscious of not taking our agricultural lands for granted.

It is a Faustian bargain to think that we can continue to appropriate these unique ecosystems for nonagricultural uses and to encroach upon these lands in an unplanned and fragmented manner, then simply expect agriculture to move elsewhere on less productive ecosystems. Although current technologies can mask the lower production potential of such agricultural areas, there is a loss of production efficiency when such technologies are applied to poorer soils and marginal ecosystems. While agricultural census data may reveal no significant net loss of cropland area, these data do not relate indicators of soil quality. Yes, with enough energy and resource inputs, we could grow crops on the Badlands or the Moon - but with far less efficiency than we can produce our food on prime agricultural ecosystems. These soil-ecosystems are, indeed, a National asset that produce a variety of valuable ecosystem services in addition to our daily sustenance.

AXIOM NO. 9 Prime Farmland Is Also Prime Land For Development

Over a quarter century ago when Maryland was proposing its farmland preservation program, this author witnessed more than once, during the many open forums leading up to this initiative, developers holding up soil surveys and pointing out that these documents pointed to the best farmland as the most suitable areas for development. As noted earlier, both experience and data indicate that the best farmlands and croplands are also ideal for development. Because of the qualities of agricultural lands which lend themselves to a variety of other uses, these cropland areas will continue to be converted to urban-related uses, now occurring at the rate of about 400,000 to 600,000 acres per year for the 1982-1992 period (USDA, 1994; USDA, 1997).

AXIOM NO. 10 The Rationale For Preserving Farmland Is Broader Than Just Saving Farmland

The US has been disproportionately blessed with extensive areas and a broad spectrum of young geologic materials (i.e., glacial deposits, alluvium, loess, volcanic material) from which its soil resources developed. Coupled with an agriculturally-suitable climate, these extensive soil resources have provided the US with a natural resource base that sustains its annual food cornucopia. With only 4.5 percent of the world's population, the US accounts for approximately 16 percent of the world's cropland. As a basis for comparison, China contains 22 percent of the world's population in an area that accounts for only eight percent of the world's cropland. On a per capita bases, this difference equates to an 8.5-fold advantage for the US - about 1.7 acres of cropland per capita for the US compared to approximately 0.2 acres per capita for China (WRI, 1998).

A recent wire service (Knight Ridder, Feb. 21, 1999) headline stated that "China threatens death penalty in bid to save farmland." This rather Draconian policy is aimed at illegal developers who build on China's scarce farmland without obtaining an extensive and hard-to-get series of permits. Each year, China loses about 750,000 to 800,000 acres from its limited cropland base in order to accommodate its growing population and their infrastructure needs. Clearly, China's objective in preserving cropland is to protect the agricultural sustenance it provides.

But for the US and other developed countries, particularly in Europe, the rationale for preserving farmland and protecting agricultural land consists of a variety of objectives. Aside from the obvious objective of ensuring food security and maintaining the local services that undergird agriculture, other reasons to save farmland include:

- Maintain, enhance economic viability and social well-being of rural America.
- Maintain character and ambiance of rural landscape; support tourism.
- Maintain a way-of-life, as in independent family farms.
- Maintain the capacity to produce food locally and offer choices to consumers.
- Maintain open agricultural space and plan future development around this space, allowing local governments to plan and invest in infrastructure that will guide planned growth rather than respond to unplanned growth which is far more costly.
- Protect the natural resource base and those ecological processes and services vital to a community, such as maintaining aquifer recharge areas and natural water filtration where agriculture and forestry are compatible with such services.
- Protect society against natural hazards such as earthquake-prone areas where deep alluvial valleys well-suited to agriculture can amplify shock waves and render such areas vulnerable to severe structural damage; protect flood plains, wetlands and other natural ecosystems that are compatible with agriculture but not with urban development.

These and other reasons to save farmland will be determined locally - one jurisdiction will justify its rationale on one set of objectives, another jurisdiction will select others. One size does not fit all circumstances.

States and local jurisdiction have developed a variety of tools and strategies to save farmland. All 50 states have established right-to-farm laws, 270 jurisdictions have agricultural protection zoning. Purchase of development rights or purchase of agricultural conservation easement (PACE) programs have been established in 20 states and even more counties. At least 20 counties have transferable development rights (TDR) programs as another mechanism to preserve farmland, yet keep the cost within the private sector. Table 2 summarizes the farmland protection strategies by state as of 1997. Ohio has recently passed enabling legislation to allow counties to proceed, if they choose, to establish agricultural protection programs. To date, 59 of Ohio's 88 counties have decided to move in this direction.

AXIOM NO. 11 Conflict in the Countryside: The Life-Style of Farming Is Not Always Synonymous with the Business Enterprise of Commercial Agriculture

One of the uniquenesses that characterizes American agriculture is that it is both a business enterprise and a life-style. This agricultural dichotomy results in all manner of conflicts over values and goals. The crescendo of this conflict has intensified as agriculture has accommodated the advances in science, technology, and business management as have all other segments of today's industries and businesses. This conflict pits those who question the wisdom of agriculture paralleling other industries in pursuit of this technology-driven agricultural industrialization revolution, its implications for family farms, rural communities, stewardship of the land, and an independent way of life against those who see the future viability of agriculture as a business enterprise being driven by the same axioms, principles and forces that govern other businesses. With most Americans now being more than two to three generations removed from agriculture, their knowledge of, or at least their sentiments about, American agriculture are probably reinforced as much by Currier and Ives prints on their holiday cards as by their fragmented knowledge about today's agriculture and the technological-industrial revolution that is changing both its character and structure.

Because of its extensiveness, agriculture is highly visible. The American public does not drive through and live amongst Microsoft, General Motors, or Merrill Lynch. But because both rural and urban America look out their "cultural windows" daily at "their" agriculture, often seeing it nostalgically, if not as their last touchstone with the American frontier, American agriculture is forced to march to the cadence of two very different drummers. One drummer beats the "cadence of capitalism", i.e., efficiency, substitution of resources to lower costs, competitiveness, and maximization of profits. However, as if in a chorus of contradiction simultaneously directed by Thomas Jefferson, Jeremy Rifkin, and Earl Butz, American agriculture is expected to perform to the multiple cadences of efficiency, tradition and a spectrum of strongly held values and world views ranging from family farm traditions and a viable rural America to those views espousing animal rights, organic farming, local production, rejection of certain technologies (e.g., genetic engineering, synthetic hormones), and respect for spiritual connections to land.

These various world views of agriculture each have their proponents, the numbers of which may be larger than the populous of American farmers themselves. As Berlin (Schlesinger, 1997) argues, however, adoption of any particular world view often compromises other values and world views. This roster of world views and their corresponding interests and agendas, coupled with agriculture's dependence on the forces of nature and compounded by an unusual mode of doing business, i.e., buying retail and selling wholesale, result in a tyranny of tensions and continuous conflict in the countryside. These forces and tensions play out daily as farmers, their neighbors and interested parties position themselves along the spectrum defined by economic viability, life-style choice, and environmental-ecological compatibility.

The image of agriculture as portrayed in pictures hanging in the homes of many Americans is quite different than the view one sees driving through America's heartland or California's San Joaquin Valley. As Nassauer (1997) points out, the popular image of the countryside as a visual metaphor for human harmony with nature has enormous public appeal, making it hard to reconcile the coexistence of the business enterprise of commercial agriculture with societal expectations and imagery of the lifestyle of agriculture as a gemstone in rural America. In fact, one could probably stratify the American public as to which of the last dozen decades they'd like to fast-freeze American agriculture as their favorite parlor portrait. As noted earlier, Currier and Ives have probably had as much influence in shaping the image of American agriculture as the American Farm Bureau, Monsanto and John Deere. Suburban America and food consumers will ultimately dictate American farm policy, not USDA and agriculture's support groups.

Thus, society's expectation of agriculture to be environmentally benign as well as hold to certain social norms (e.g. family farms vs. industrial enterprises, etc.) imposes very significant pressures on agriculture that most other business enterprises do not have to bear, at least to the same degree. These pressures result in a schizophrenia-like trap for agriculture, contributing to constant conflict which is being exacerbated by the latest trend toward consolidation and industrialization of agriculture.

Critiques of this genomic-industrialization revolution range from Greenpeace to Jeremy Rifkin (1998), challenging everything from corporate bigness to both real and potential dangers as well as the ecological ramifications (Soule and Piper, 1992) of intensified agriculture and the ethical conundrums raised by genetic technologies (Krimsky, 1998). A recent volume edited by Lockeretz (1997) speaks to the social implications of agriculture's revolutions and the place of amenity values in whatever future American agriculture takes, including the future of the family farm.

The various agricultural revolutions of this century, while not completely scale-neutral, were nevertheless rather easily accommodated by the American family farm. Thus, despite the magnitude of changes these revolutionary forces wrought, the American family farm was able to survive, albeit in a different form than its Greenfield Village Museum counterpart.

Thomas Urban, speaking before the International Agribusiness Management Association in Caracus, Venezuela in 1994, reflected on the American family farm of the future as it accommodated itself to the juggernaught of the oncoming genomic-industrialization revolution. He envisions this new family farm being focused as much on financial management skills and contract marketing as on production and agronomic know-how. Family farmers will need to become general managers rather than just production managers. The paradigm shift will be one of considering the farm as a producer-manufacturer of biological attributes rather than bulk commodities. Tomorrow's production agricultural axiom will be "contract and sell the attribute, then produce it" rather than the traditional approach of producing bulk commodities and then marketing them at whatever price is established by national-international commodity markets.

Consistent with the impacts of earlier revolutions on the American family farm, the genomics-industrialization revolution will continue to drive increased farm size and capitalization as the requisite for competitiveness demands the spreading (reduction) of fixed costs over the largest possible acreage and/or span of control by a manager. While the principles of economics are straight-forward in driving increased farm size and span of managerial control, they also exact a price on the human dimensions of this new agriculture and 21st century family farm as the managerial intensity is racheted upward.

Aside from those farmers an others who are critical of these new trends, even those farmer-managers who have embraced these technology-driven revolutions are beginning to realize the managerial implications as manifested by demands and stresses on their time, energies, and their life-style. Some of these new mega-farmers are beginning to wonder whether they will become beholden to their integrated "life science" conglomerate contractors much like coalminers became economically tied to the "company store." Nevertheless, the trends toward increasing farm size and the industrialization of agriculture continue - at least for the time-being.

AXIOM NO. 12 There Are Social, Economic, and Environmental Costs to Uncontrolled Land Uses That Will Eventually Come Due

The right to hold land in fee-simple, private ownership is a cornerstone of our American democracy and culture. As many would argue, this right is non-negotiable and should not be "messed with."

But, in fact, those visionary framers of our Constitution and Bill of Rights did see the necessity to "mess with" this concept over 200 years ago. They foresaw the need to vest some rights in how land is used and controlled with society, for example, through the power of eminent domain. After all, some of those involved in authoring our Constitution, when travelling hundreds of miles via horse and carriage to their homes from Philadelphia, had to cross private land and roads. They paid a fee or toll to have the owner open the gate or turn the pike that blocked the road, thus the derivation of the term "turnpike."

There was also the early notion of a village green or "common" that was public land, owned by no one, but was part of the public domain. Our local, state and national park systems grew out of this early philosophy that not all land should be owned and controlled by individuals - and so did the more recent concept of the "Tragedy of the Commons" (Harden, 1968).

The conversion of America's natural landscapes to cultural landscapes in the 1800's resulted in an agrarian society. Aside from a few cities, most of the young nation's population was rural in character. Even by 1900, 40 percent of the nation's population was still agriculturally-oriented. The landscape was sparsely populated. Low population density tends to dilute the degree of land-water degradation as well as limit land use conflicts. But as population density increases, not only does the need for land increase to accommodate housing demands, but also the need for services and social infrastructure to support this higher density population. These drivers of land use, coupled with the fact that more people result in a larger mix of values as to how land should and should not be used, give rise to conflict. The result is that more constraints and regulations are put on privately owned land as the density of the landscape increases and people's use of land conflicts with the interests of their neighbors as well as the interests of society.

Aside from natural hazard-related costs (e.g., flooding, expansive soils, soil failure under loads, etc.) of increasing population density, there are other costs of development that are exacerbated even more if growth is left uncontrolled and unplanned. Diamond and Noonan (1996) point out that the aftershocks of the explosive post-WWII growth have registered in America's hinterlands and in the agricultural communities and rural horizons that once defined the American experience. Theses authors posit that the vast American countryside, the fountainhead of national myth, memory, and identity, is beginning to lose its distinctiveness, including its beauty, quality of the landscape, and the social well-being of its people.

There have been a number of studies looking at the cost of growth at the rural-urban interface (Diamond and Noonan, 1996; American Farmland Trust, 1997). For example, in Loudoun County, Virginia, officials in 1994 estimated that a new home had to sell for $400,000 to bring in sufficient property taxes to cover the cost of all the local services provided by the county. But like most other communities, the average home sold for far less than this $400,000 "break-even" amount. It does not take a rocket scientist to understand why taxes continue to increase in the face of rapidly growing communities. Such communities are often headed by mayors or leaders who espouse that continued growth will increase the tax base for the community, leading to some future economic utopia.

But the fact of the matter is that the cost of servicing (e.g., schools, roads, utilities, parks, etc.) this growing population far out-paces the revenue generated by residential property taxes. Except in cases where large industrial-commercial tax bases occur, the only recourse is to increase everyone's property and other taxes to fuel this growth. And when such growth is ill-planned, the economic cost is exacerbated even more as are the social and environmental costs. Figure 8 summarizes the findings of 40 cost-of-community service studies verifying that the cost of suburban-community infrastructure exceeds the tax revenue generated by this housing growth compared to servicing farmland and commercial-industrial development.

Communities that have studied their own growth patterns have concluded that planned, higher density development not only results in lower economic costs and fewer demands on the land and environment but that it also reduces harder-to-quantify personal and social costs. The American Farmland Trust study of Loudoun County, Virginia determined that net public costs were approximately three times greater at a density of one unit per five acres compared with a density of 4.5 units per acre.

In a poignant letter to the editor of the February 21, 1999 issue of the Columbus Dispatch, Steve Stolte, Union County, Ohio engineer, responded to a previous article entitled "Citizens Pull Reins on Growth" about the voters in a particular township turning down a "high density" residential development proposal, opting instead for the status quo of larger lot zoning. Mr. Stolte offers a different perspective on this situation which speaks to the issue of the economic and social costs of development. He states:

> "Farmland owners generally believe that clustering housing growth on smaller lots, coupled with the construction of streets, waterlines and sanitary sewers, is much better than the kind of haphazard housing growth (this township) has experienced in the last 20 to 30 years.
>
> Existing through roads in the township are lined with houses set on lots of 2 to 20 acres. Each has its own driveway leading to these through roads - roads that the public counts on to move traffic. Each has its own mailbox, its own well, its own septic tank and leach field. Ask a farmer about negotiating farm equipment on these through roads around mailboxes, around joggers or walkers, around kids on bicycles. Ask an environmentalist about the effluent from a malfunctioning leach field. Ask a resident of this township about the poor quality of the well water. Ask a civil engineer about the economic feasibility of providing public water and sanitary-sewer service to haphazard growth along through roads vs. planned clustered developments. Ask a traffic engineer about the safety of numerous driveways along through roads.
>
> In recent years, we've heard much talk about farmland preservation and the need to control urban sprawl. While urban sprawl may be a problem, in this county and in many other counties the problem is rural sprawl. I define rural sprawl as the creation of building lots along existing through roads. These lots use up large amounts of farmland - much more than a "high-density" development such as the one that this township's voters rejected. In one year, 1,600 acres were lost to 250 building lots. For the development that was rejected, 247 acres would have been lost to 490 building lots over 10 years. If urban sprawl is 490 lots on 247 acres in 10 years and rural sprawl is 250 lots on 1,600 acres in one year, I'll take urban sprawl."

Regardless of whether or how local jurisdictions choose to address future development, one common requisite should be required, namely, full disclosure to their stakeholders of the ramifications and costs of their actions and policies, including the policy of doing nothing. For regardless of how this cloth is cut and stitched into the resultant pattern of the land use quilt, there will be both benefits and costs. The public deserves to know what it gets for its investment in policies and controls, or lack thereof.

AXIOM NO. 13 Fragmentation of Agricultural Land Is More of a Threat to Agriculture than the Amount of Land Actually Withdrawn from Farmland

While it is a relatively straight-forward exercise to document the amounts of farmland and cropland converted to development (about 400,000 to 600,000 acres of cropland per year, depending on the definition of cropland), documenting the fragmentation of agricultural lands is more elusive. Yet it is this fragmentation of farmlands that poses a greater threat to agriculture than the amount of land actually converted to development. These fragmentation impacts often manifest themselves in the form of disrupted drainage and irrigation networks, conflicts with new nonfarm neighbors, the potential for restrictions on normal agricultural husbandry practices, increased traffic and hazards for farmers to negotiate, collapse of the necessary critical mass of agriculture to sustain certain agriculture support industries, changes in the character of agricultural landscapes and others.

AXIOM NO. 14 There Are Landscape "Roadmaps" That Indicate Nature's Pitfalls and Potentials

In Charles Lutwidge Dodgson's "Alice's Adventures in Wonderland" written in 1865 under the pseudonym of Lewis Carroll, Alice asked Cheshire Cat which fork in the road she should take. Cheshire responded that it depended on where she wanted to get to. Alice answered "I don't much care where," at which point Cheshire retorted "then it doesn't matter which way you go." Similarly, with no plan, you're sure to arrive some place, but with a high probability that it will not be where you want to be.

Many communities, faced with the problems and blight of uncontrolled and ill-planned land use, have opted to reject the notion that society's interests are best served when individual land owners are left unrestricted to their own interests and values. These communities are choosing future paths over which they can exercise some control in guiding future land use in a more orderly fashion in the interests of both society and private land users. In order to consider various future land use scenarios and outcomes, information is needed.

There is considerable information that can be displayed spatially via maps and other modes. Once overlain on landscape segments, this geographic information system (Figure 9) can provide decision-making tools and "roadmaps" for various land use scenarios, showing the landscape's limitations as well as potentials for each land use being considered.

With the advent of geographically digitized maps that can store and retrieve information specific to geographic segments of the landscape, individuals as well as political jurisdictions can now access, where available, virtual soil surveys and other data bases specific to their needs. Available geographic information, whether digitized or not, is often adequate to assess and predict the soil-landscape's probable response to proposed land use changes. Even though these data sets are usually not site-specific, they are, nonetheless, valuable information sources and planning tools. Even though a road map does not show where each pothole is located or how fast each curve can be negotiated, it does provide valuable information when needing to get from point A to point B.

As geographic analytical methods become more sophisticated, geographic maps will be more refined and quantitative. Figure 10 illustrates an example of how the application of geostatistics can provide information about the probability of virus decay rates in soils and substrata. It is one thing to locate on-site waste disposal-treatment systems on soils and substrata with adequate percolation rates, but it is quite another matter to assess whether the soil-substrata material through which this potentially pathogenic brew must travel is adequate to the task of filtering-adsorbing the effluent constituents and providing hydraulic conductivity rates that allow for adequate decay rates to occur before reaching the groundwater. These kinds of quantitative data can then be used, not only for guiding development onto suitable soil-landscapes but also, for designing criteria to protect public health and ecosystem contamination.

AXIOM NO. 15 Land Use Problems Are Caused By Both Soil-Landscape and Institutional Failures

Despite the sophistication that geographical information systems might attain in the future, the fact remains that the way we plan and use natural landscapes will still be greatly influenced by the spectrum of values that people bring to the land use decision-making table. Society, through its own participation in the process coupled with that of its local officials, will still need to make judgements as to how these conflicts among competing values will be settled and compromised on the landscape.

Baden (1996) points out that good intentions, scientific and business know how, and dedicated people are necessary but not sufficient conditions for promoting the rational and sustainable use of land. The critical factor often ignored by policy-makers is getting the incentives right through careful institutional design. Baden argues that our past experience in government-driven resources management policies has not worked. He argues that this failure has resulted in the degradation of ecosystems, and an inefficient emphasis on resource extraction, and has separated those best positioned to care for land from responsibility for outcomes, thus the necessity to align action with accountability.

But difficult as these actions are, society need not be blind-sided or encumbered by the lack of awareness or understanding about the physical attributes and capabilities of the soil-landscapes on which their decisions are to be implemented. Land use problems and the resultant economic costs and human suffering often occur as a result of both soil ecosystem and institutional failures. Today, there is no excuse for the former and there need be no reason for the latter.

EPILOGUE

The axiom that one cannot do everything equally everywhere (Bouma, 1994) applies to both the land's incapacity to accommodate all uses proposed for it and society's and individual's multiple interest in the use of land. Society continues to struggle with this issue of how to balance societal interests in land coupled with the need to better plan the uses of our finite landscapes within the land's potentials and constraints to accommodate the multitude of proposed uses driven by individual self-interests while simultaneously honoring the constitutional protections of private property rights.

Responses to this issue range from acquiescence to the comfort zone of timidity to act or barely tinkering at the margins of planning and controlling land use to sound comprehensive land use planning backed by strong land use controls and strict enforcement standards such that a planning document does not become a template for the purpose of allowing variances. Regardless of where political jurisdictions arrive at along this continuum, every land use change becomes the threads that forms the fabric from which the jurisdiction's land use quilt is fabricated, whether planned or unplanned. Indeed, Bradley's (1935) observation still holds true today in that the fabric of human life is very much woven on earthen looms - it everywhere smells of the clay.

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Table 1. A sampling of land use data and sources illustrating both the subtleties among land use catagories and the differences among references using different data sources and time periods.

Land Use Categories	Acres x10^6	% of US Land 48 States	% of US Land 50 States	Date-period	Data source
Land used for agricultural purposes[1]	1,200	63	53	1992	Daugherty, 1995; MLUS[2]-Census
Land used for agricultural production[3]	1,040	55	46	1992	Daugherty, 1995; MLUS-Census
Land in farms	950	50	42	1992	1992 Census of Agri., 1994
Annual reduction of land in farms	3.50	0.18	-	1945-92	Tweeten, 1998; 1992 Census of Agric.
Annual reduction of land in farms	3.70	-	0.16	1982-97	1997 Census of Agric.
Total cropland[4]	542	29	-	1992	NRI, 1994
Total cropland	460	24	20	1992	1992 Census of Agric., 1994; AREI, 1997
Total urban land	56	2.96	2.47	1990	Daugherty, 1995; MLUS-Census
Total urban land	58	3.06	-	1992	AREI, 1997
Total urban area	59	3.12	2.61	1992	Daugherty, 1995
Total urban and built-up land[5]	65	3.43	-	1992	AREI, 1997
Total developed land	92	4.86	-	1992	NRI, 1994
Total developed land	188	9.94	-	1992	Tweeten, 1998; AREI, 1997
Land developed annually[6]	1.94	0.10	-	1982-92	AREI, 1997; Tweeten, 1998
Land urbanized annually	0.84	0.04	-	1982-92	Tweeten, 1998; AREI, 1997
Land converted annually to developed land	1.41	0.07	-	1982-92	NRI, 1994
Land absorbed annually by urban areas	1.30	0.07	0.06	1970-80	Fry and Hexen, 1985; Daugherty, 1995
Land absorbed annually by urban lands[7]	0.90	0.05	0.04	1980-90	Daugherty, 1995; MLUS-Census
Land absorbed annually by urban areas	1.30	0.07	-	1982-92	AREI, 1997
Land absorbed annually by urban areas	1.40	0.07	0.06	1990-92	Daugherty, 1995; MLUS-Census
Land absorbed annually by urban development[8]	0.73	0.04	0.03	1980's	Vesterby et al., 1994; Daugherty, 1995
Land absorbed annually by urban development	0.74	0.04	0.03	1970-80	Vesterby et al., 1994; Daugherty, 1995
Rural land converted annually to urban uses	0.98	0.05	0.04	1950-90	Vesterby et al., 1994
Land converted annually to urban-built up uses	0.98	0.05	-	1982-92	Heimlich and Bills, 1997
Cropland converted annually to other uses, incl. CRP	3.95	0.21	-	1982-92	NRI, 1994
Cropland-pasture; annual net decrease	1.01	0.05	-	1982-92	AREI, 1997
Cropland; annual net decrease	0.92	0.05	-	1982-92	Tweeten, 1998
Cropland; annual net decrease, not incl. CRP	0.55	0.03	0.02	1982-97	1997 Census of Agric., 1999
Cropland converted annually to urban uses	0.33	0.02	0.01	1950-90	Vesterby et al., 1994
Cropland converted annually to developed land[9]	0.42	0.02	-	1982-92	NRI, 1994
Cropland converted annually to developed land[9]	0.40	0.02	-	1982-92	NRI Highlights, July, 1994
Cropland-pasture land converted annually to urban development	0.60	0.03	-	1982-92	AREI, 1997; NRI, 1994
Cropland converted annually to urban development	0.38	0.02	-	1982-92	Tweeten, 1998; MLUS-Census
Cropland converted annually to urban and built up uses	0.27	0.01	-	1982-92	Heimlich and Bills, 1997
% of urban development coming from cropland and pasture		46%	-	1982-92	AREI, 1997
% of prime land in rural non-federal land		24%	-	1992	AREI, 1997
% of prime rural non-federal land converted to urban use		28%	-	1982-92	AREI, 1997
% prime land in cropland - pasture		48%	-	1992	AREI, 1997
% of cropland converted to urban uses classified as prime		50%	-	1982-92	AREI, 1997
% of cropland converted to urban uses classified as prime		39%	-	1982-92	Heimlich and Bills, 1997

Footnotes to Table 1

[1]Includes forest and some nonforest land used for grazing plus land in farmlands, farm roads and lanes not included in land in farms.
[2]MLUS = Major Land Use Series conducted by USDA, ERS coinciding with the Census of Agriculture.
[3]Includes cropland and nonforested grazing land.
[4]NRI sampling protocol picks up more land in cropland pasture and harvested cropland than MLUS-Census.
[5]Includes more parcels of urban and built-up-encompassed rural land than MLUS-Census data.
[6]Includes urban, recreation, wildlife, transportation and military uses.
[7]Includes both urbanized and agricultural land encompassed by urban development.
[8]Based on actual changes in land use.
[9]Based on same NRI data, but different figures arrived at from two different methods of calculation.

Table 2. Farmland protection strategies by state.

State	Agricultural Districts	Agricultural Protection Zoning	Circuit Breaker	Differential Assessment	PACE	Right-to-Farm*	TDR
Alabama				▲		▲	
Alaska				▲		▲	
Arizona				▲		▲	
Arkansas				▲		▲	
California	▲	◆		▲	▲◆	▲	◆
Colorado		◆		▲	▲◆	▲	◆
Connecticut				▲	▲◆	▲	◆
Delaware	▲			▲	▲	▲	
Florida		◆		▲	◆	▲	◆
Georgia				▲		▲	
Hawaii		▲		▲		▲	
Idaho		◆		▲		▲	◆
Illinois	▲	◆		▲		▲	
Indiana		◆		▲		▲	
Iowa	▲	◆	▲	▲		▲	
Kansas		◆		▲		▲	
Kentucky	▲			▲	▲	▲	
Louisiana				▲		▲	
Maine				▲	▲	▲	
Maryland	▲◆	◆		▲	▲◆	▲	◆
Massachusetts	▲			▲	▲	▲	◆
Michigan		◆	▲		▲◆	▲	
Minnesota	▲◆	◆		▲		▲	◆
Mississippi				▲		▲	
Missouri				▲		▲	
Montana		◆		▲		▲	◆
Nebraska		◆		▲		▲	
Nevada				▲		▲	
New Hampshire				▲	▲	▲	
New Jersey	▲			▲	▲◆	▲	◆
New Mexico				▲		▲	
New York	▲		▲	▲	◆	▲	◆
North Carolina	▲			▲	◆	▲	
North Dakota		◆		▲		▲	
Ohio	▲	◆		▲		▲	
Oklahoma				▲		▲	
Oregon		◆		▲		▲	
Pennsylvania	▲	◆		▲	▲◆	▲	◆
Rhode Island				▲	▲	▲	
South Carolina				▲		▲	
South Dakota		◆		▲		▲	
Tennessee	▲			▲		▲	
Texas				▲		▲	
Utah	▲	◆		▲		▲	◆
Vermont				▲	▲	▲	◆
Virginia	▲◆	◆		▲	◆	▲	
Washington		◆		▲	◆	▲	◆
West Virginia				▲		▲	
Wisconsin		◆	▲	▲	◆	▲	
Wyoming		◆		▲		▲	
TOTAL	16	24	4	49	20	50	15

▲ State Program
◆ Local Program

Source: American Farmland Trust, 1997

Figure 1. Schematic representation of the forces and constraints impacting the goal of rational (wise) use of land.

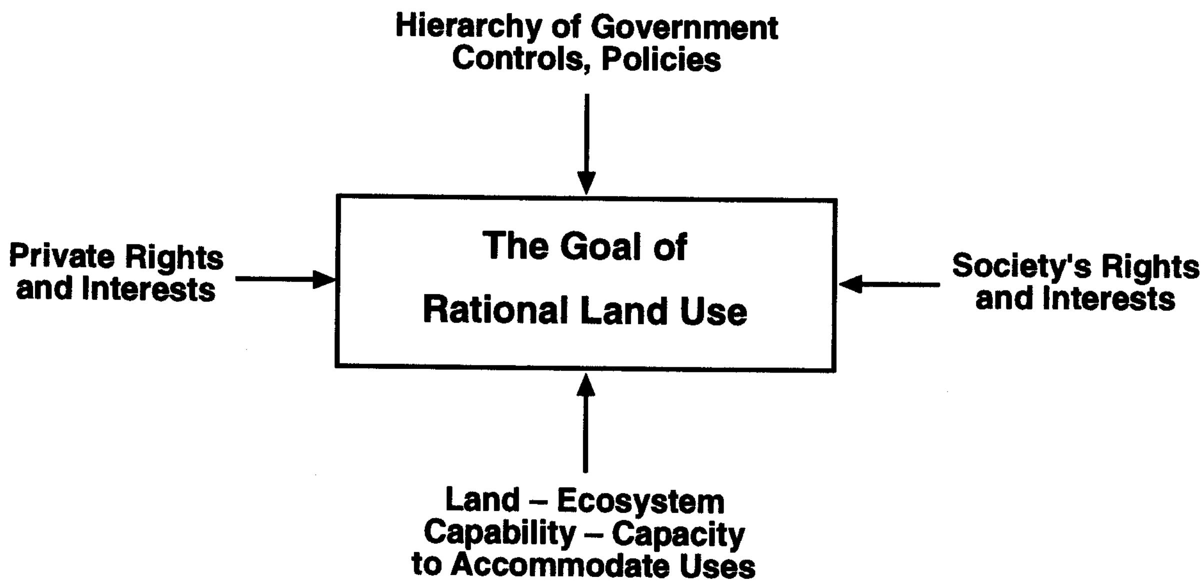
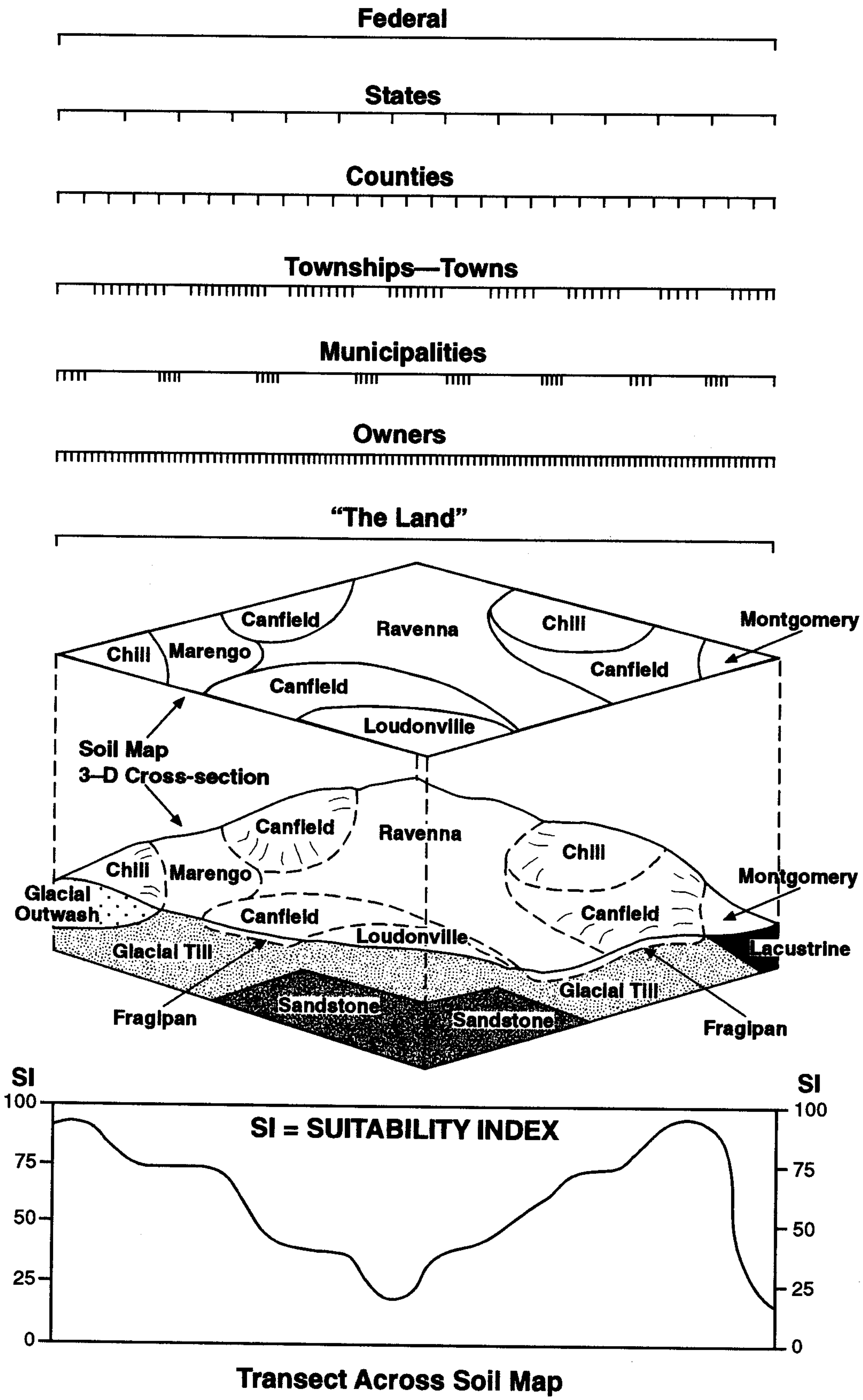


Figure 2. Hierarchy of land use decision-makers and managers overlying variable landscapes with differing land use suitability indices.



Source: modified and expanded by author from Platt, 1996

Figure 3a. Land in farms and cropland, U.S., 1945-1992.

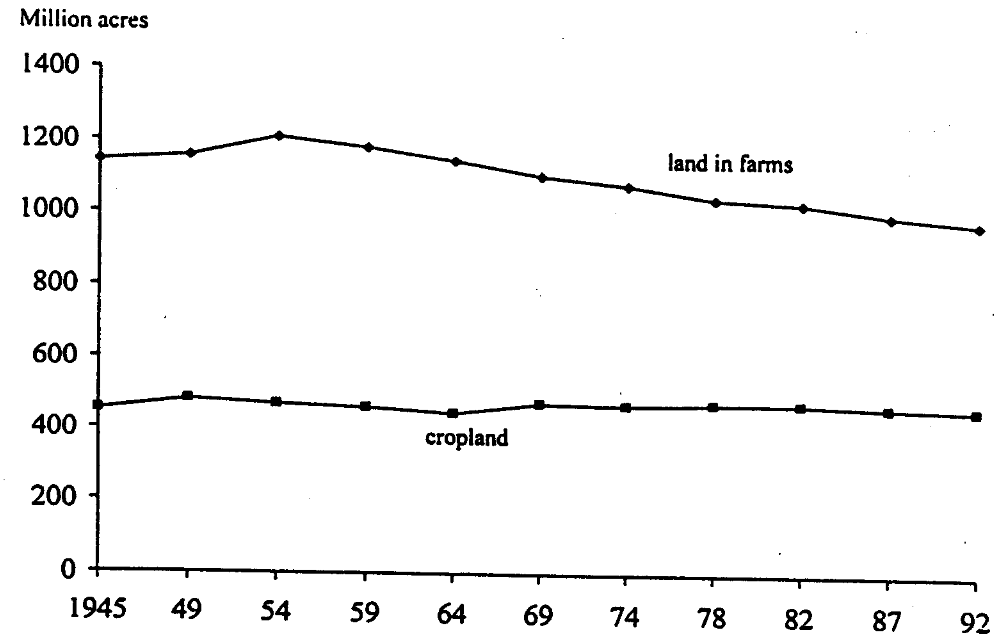
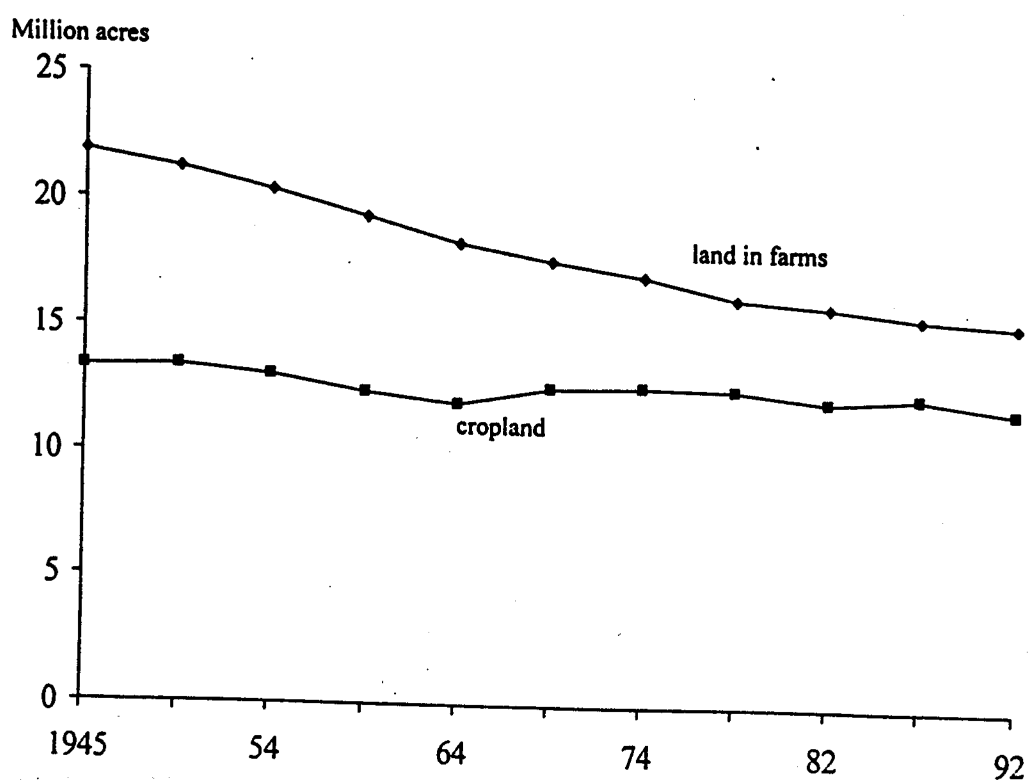
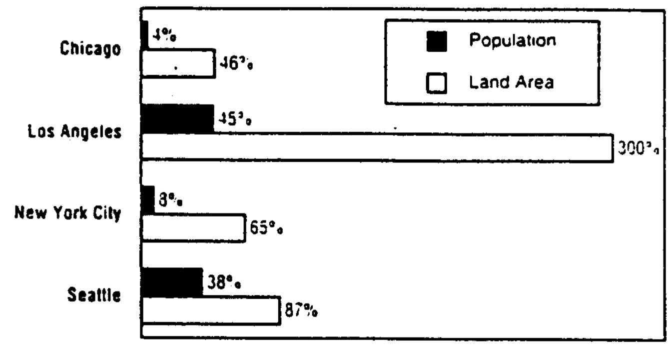


Figure 3b. Land in farms and cropland, Ohio, 1945-1992.



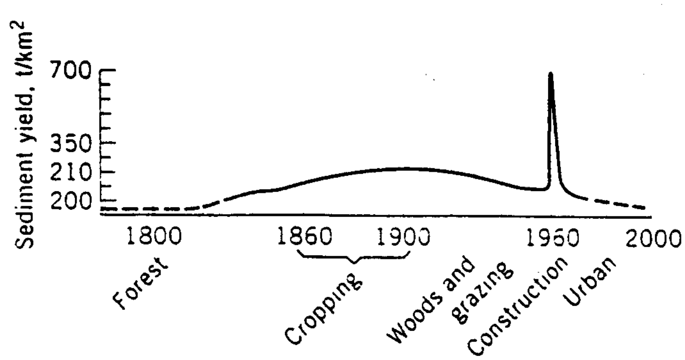
Source: U.S. Dept. of Commerce, 1994. 1992 Census of Agriculture. After Tweeten, 1998.

Figure 4. Expansion in population and land area for selected metropolitan areas, 1970–1990



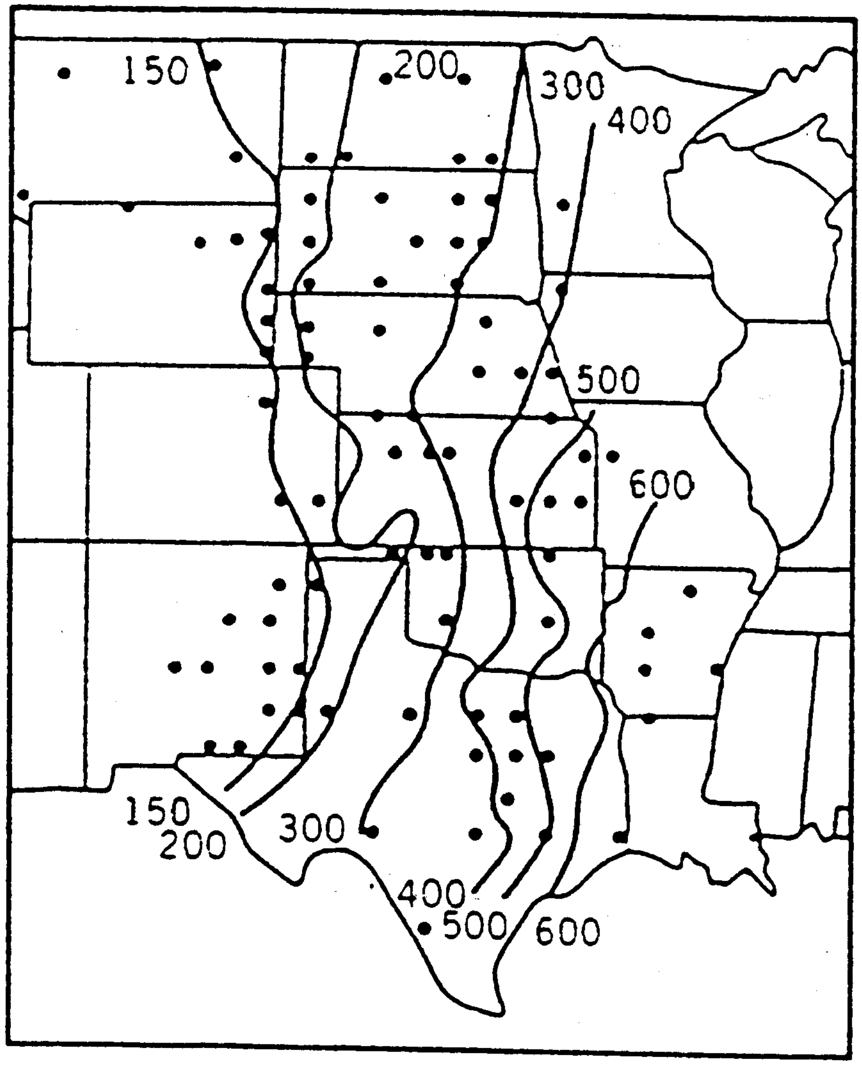
Source: Diamond and Noonan, 1996

Figure 5. Schematic sequence of land use and sediment yield from a fixed Mid-Atlantic area landscape



Source: Wolman, 1967

Figure 6. Above-ground net primary production (grams per square meter) during years of average precipitation



Source: Kormondy, 1995

Figure 7a. Relationship of crop production per unit of cropland compared to annual average precipitation

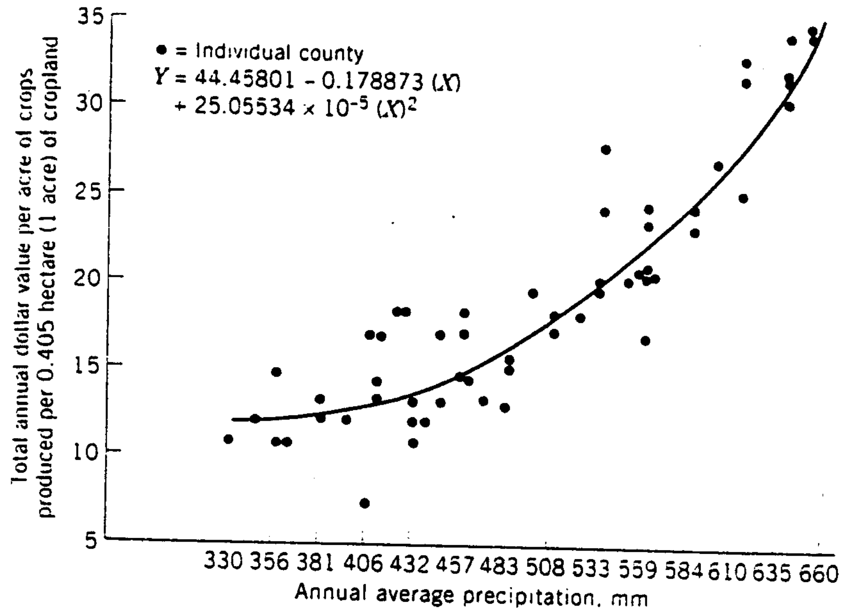
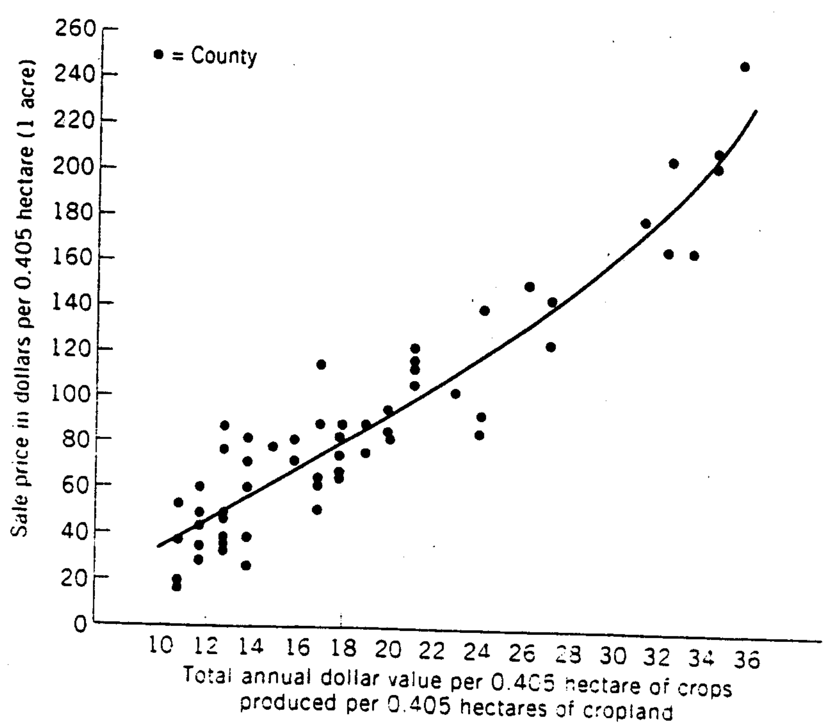
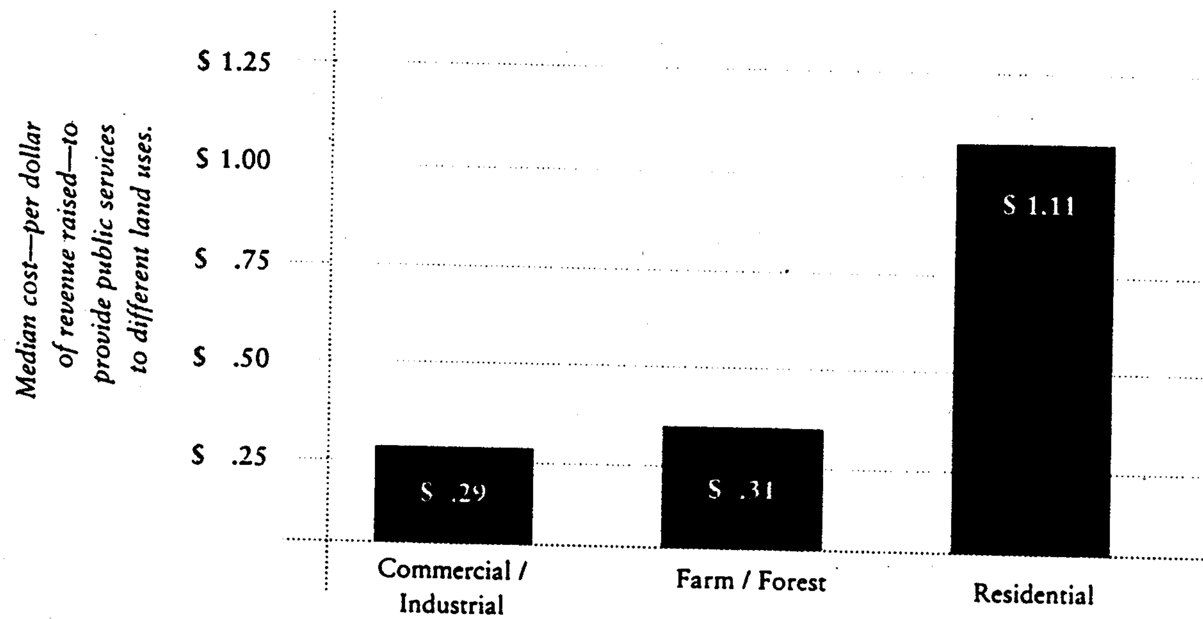


Figure 7b. Relationship of dollar-value produced per unit of land to sale price of land



Source: Westin et al., 1973

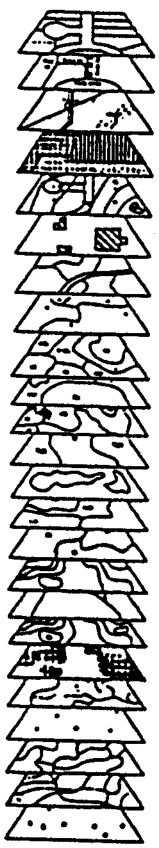
Figure 8. Summary of cost-of-community studies



Source: American Farmland Trust, 1997

Figure 9. Concept of a national digital spatial data base (1:24,000)

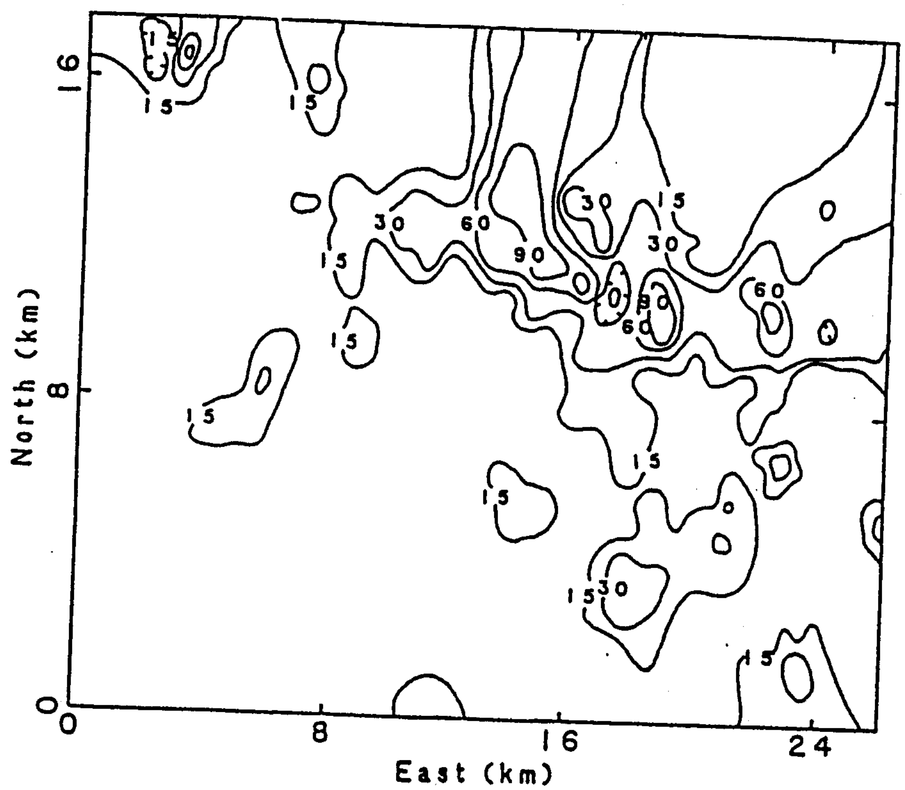
GIS LAYERS



THEME	RESPONSIBLE AGENCY
NDCDB Topography Transportation Hydrography Land Use (15 Layers)	USGS – NMD
GEOLOGY	USGS – GEOLOGY
CENSUS DIVISIONS	BUREAU OF CENSUS
SOILS	NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL PARKS	NATIONAL PARK SERVICE
FORESTS	FOREST SERVICE
WETLANDS	FISH AND WILDLIFE SERVICE
COASTLINES AND BATHYMETRY	NATIONAL OCEAN SURVEY
GEODETIC CONTROL	NATIONAL GEOGEDIC SURVEY
OTHER	OTHER

Source: Mapping Science Committee, 1990

Figure 10. Application of geostatistics by combining kriged estimates of virus decay rates in groundwater with Darcy's Law; separation distances (m) required between wells and septic systems to maintain seven logs of virus inactivation in Tucson area



Source: Yates et al., 1986