Economics and the Land Use-Environment Link

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INTRODUCTION

The use of land as an economic activity has long been a central theme in economics. From issues of land as a productive input and scarce resource to property rights and the role of institutions, the question of land use has spawned a vast and diverse portfolio of research and economic thought. In analyzing the connections between land use and the environment, this chapter takes a different approach from much of this literature. The focus is not land use, *per se*, but how economists have thought about land use *change*, specifically in the context of the link between land use and the environment.

A narrow interpretation of the land use–environment link would consider only the question of how the amount and pattern of land use affects ecological systems. We take a broader perspective by also including a discussion of the characteristics of land use pattern that are directly valued by individuals, such as open space and other landscape amenities. While consideration of such landscape amenities does not necessarily have an ecological basis, the two perspectives are so intimately intertwined in policy motivation and modeling as to be effectively inseparable. The breadth of our discussion on land use change is quite limited in other ways, however. The literature that relates to land use is voluminous, as is the list of policies that affect land use decisions either purposefully or unintentionally. Here we restrict our attention to the land use–environment literature relevant to the U.S. and Europe, with obvious weight given to the former. We focus on what we see to be the most pressing current problems, and limit our discussions to the policies and the literature of the last 10 or 15 years. Our treatment of the problem is tailored to highlight a few themes that have emerged from the recent literature. These are themes that we believe will likely influence land use research over the next several years.

Land Use and Ecological Systems

Land use/land cover change is generally considered to be the single most important factor affecting ecosystem health (Hunsacker and Levine, 1995). Changes in land cover alter the fluxes of mass and energy in the ecological system, which has consequences for ecological structure, functioning, and the flow of ecological goods and services. The existing scientific literature on the connections between the amount and pattern of land use and the functioning of ecosystems is extensive. Here we briefly summarize the principal links and refer to some general sources that can provide greater depth.

Before proceeding, we draw an important distinction between land use and land cover. The former denotes humans' employment of the land, e.g. crop production, grazing, logging, urban development, while the latter denotes the physical and biotic characteristics of the surface, e.g. forest, homogenous or heterogeneous vegetation, asphalt, ice (Meyer and Turner, 1992). Land *cover* is considered the essential determinant of ecological structure and function,[1] but land *use* determines land cover to a large extent. In addition, land use is important in assessing ecological impacts because it signals the nature of the human interaction with the environment. Even the very act of land use change can have systematic effects. Examples include biomass burning, which generates air pollution and greenhouse gas emissions, and clearing and excavation, which contribute to soil erosion and sedimentation.

One of the primary connections between land use and ecological impacts is the discharge of nutrients, toxics, or other substances that are generated by a specific use of the land. Agricultural land, at least in developed countries, is often associated with discharges into surface and ground waters of pesticides and herbicides, high levels of nutrients from fertilizers and manure, and fecal coliforms, as well as discharges of methane and N_2O into the air. Frequent cultivation of agricultural land provides a natural transport of chemicals and nutrients through soil erosion and sediment transport. This process leads to sedimentation of streams and changing hydrology. Where agriculture is fed by irrigation systems, salinization can result in serious soil degradation. Agricultural irrigation represents the principle source of water loss from the natural system and can

[1] Climate affects land cover change and vice versa, but it is often argued that land cover rather than climate has the most effect on the ecology of the planet (Dale, 1997).

lead to arid conditions downstream as well as groundwater depletion (Riebsame, Meyer, and Turner, 1994).

Likewise, urban land is associated with discharges of nutrients and fecal coliforms from sewage, and of toxics and heavy metals from industry and transportation infrastructure. Urban systems are characterized by impervious surfaces that prevent precipitation from infiltrating soils and collect such contaminants as petroleum products from vehicles and chemicals used in winter road treatment for direct deposition into surface waters. Also, irrespective of the contaminant flows, extensive paved surfaces alter the hydrological regime, increasing the variance in stream flow. The latter leads to soil bank erosion and to alterations in the aquatic habitat.

Both urban and agricultural systems have obvious impacts on the abundance and diversity of flora and fauna. Both landscapes are notably inhospitable to a broad range of wildlife and vegetation. Where vegetation exists, it is often monoculture or non-native, placing high water and nutrient demands on the system. Where human engineered landscapes exist, natural ones do not. Intensive urban and agricultural land uses come at the expense of forest, grasslands, and wetlands, and each of these provides functions of value to the broader ecosystem. Forests play an important role in carbon cycling and nutrient removal. Wetlands and other riparian areas have been identified as some of the most productive areas of the planet. Riparian areas support an unusually diverse array of species and environmental processes. Small scale variations in topology and soils are exacerbated by the natural variation in water levels and stream flows, making these areas extremely heterogeneous and complex over small geographical extents. Riparian and wetlands areas serve as sediment traps and, in doing so, can reduce contaminant discharges into streams and coastal areas. Natural riparian areas help maintain stream flows and stabilize shorelines, providing storm and flood protection. Human interventions through damming and drainage or direct elimination have simplified these systems and reduced their ability to perform these functions (Naiman, DeCamps, and Pollock, 1993).

It is not just the land use or land cover *per se* that determines ecological impacts. The ecological consequences of human activities are also determined by the pattern, and not just the amount, of land use/land cover. The field of landscape ecology, which studies the relationship between landscape *pattern* and ecological *processes*, treats landscapes as spatially heterogeneous, environmental mosaics (Turner, 1989). The ecological processes of a system are in part determined by its landscape pattern, e.g. the flow of matter and nutrients across the landscape is a function of its spatial pattern. For example, consider the interaction of natural and agricultural landscapes. Since natural vegetation can remove nutrients from a system, the spatial coupling of natural and agricultural landscapes within a watershed can significantly reduce the adverse effects of the latter.

Spatial pattern also affects regional abundance, movement, and distribution of species. Patch size and shape, as well as habitat connectivity, dictate which species will survive in a region. Interconnections are undisturbed corridors through which species can and will move. They can be supplied by something as simple as a hedgerow and destroyed by a pipeline or road. Habitat connectivity determines the ability of many species to move between desirable habitat patches and, as a consequence, has an effect on the survival of some populations. Different species are differentially dependent on these corridors and thrive in different types of habitat mosaics, depending on such factors as amount of contiguous natural habitat and edge-to-interior ratios.

Likewise, the relative magnitudes of the various problems caused by urban development depend on the pattern of development. For example, low density sprawl may not involve substantial increases in impervious surfaces, but will generally be serviced by septic fields rather than sewage treatment, increasing per capita nutrient loadings and fecal coliform discharges. Because it generally occurs in areas well outside urban centers, low density sprawl implies long commuting distances, a high number of vehicle miles, and consequently air quality degradation. In addition, low density sprawl fragments the landscape in ways that will be detrimental to some species and beneficial to others, but those that benefit are rarely among the endangered or threatened.

Landscape Amenities

The ecological services and functions that are affected by land use/land cover have obvious if not always direct impacts on humans. These effects include climate change, air and water quality, water quantity, storm and flood protection, soil productivity, biodiversity, and wildlife abundance. These are not the only ways in which land use/land cover affects humans, however, and they are not the only motivations for the policy interventions that will be discussed in the next section. The spatial arrangement of people relative to each other, to sites of human activity, and to natural landscape features has enormous effects on the quality of life in a region. Different landscapes afford different recreational experiences – both in type and in quality. They also embody different levels of aesthetic value and reflect, in differing amounts, a people's cultural heritage. Lastly, urban settlement patterns can generate a host of positive and negative spillover effects themselves that may influence an area's quality of life. Some spatial configurations of urban development generate positive spillover effects by fostering a sense of community while others degrade the character of the community or produce congestion.

The fact that people might be willing to pay for increases in landscape amenities and pay to avoid increases in disamenities makes these landscape features of importance to economists. The fact that landscape amenities and disamenities are often interrelated with environmental factors make them important for this chapter. In the remainder of this section we review some of the economics literature that provides evidence of people's willingness-to-pay for different landscapes. We give special attention to those studies designed to measure the value of landscape amenities in the context of agricultural land, for reasons that will become clear in our policy discussion.

The literature that links locally undesirable land uses with depressed property values is extensive (for a recent review, see Farber, 1998). While the fact that the effect on housing prices can be documented empirically is certainly important to our argument, the types of land uses addressed in this literature are specific facilities such as landfills or chemical plants. For a number of reasons it will not be these "point sources" of environmental and amenity effects that will be of most interest to us in this chapter. but rather the pattern of land use and the interaction of that pattern with the environment. Far fewer studies have tested whether the *pattern* of land use in the neighborhood of a house affects its property value, although a growing number address this question (e.g. Bell and Bockstael, 1999; Bockstael and Bell, 1998; Garrod and Willis, 1992a; Garrod and Willis, 1992b; Geoghegan, Wainger, and Bockstael, 1997; Leggett and Bockstael, 1999). The evidence from these papers is inconclusive. Garrod and Willis test whether different types of forests affect neighboring housing prices and find evidence that this is so. The study is limited for our purposes, since it does not reveal whether woodlands relative to other land uses are valuable as neighbors. The remaining papers investigate the determinants of housing prices for different purposes, but in the process explore whether, in the immediate vicinity of a housing parcel, the proportions of surrounding land in each of different land use categories (agriculture, forest, low density residential, high density residential, commercial/industrial) affect price. The results are mixed and depend on whether the houses are in predominantly urban, suburban or rural areas, since marginal additions to surrounding open space may be valued highly in suburban areas, but not in rural areas. The hedonic model is problematic for determining the value of different surrounding densities of development because of an inherent endogeneity problem. Even if open space is a desired amenity, open space will be rare in areas where development values are high because in these areas open space will have a high opportunity cost.

Landscape amenities do not accrue solely to immediate neighbors. City and suburban residents may have high values for agriculture or wooded land in their region. To test for this, several authors have investigated, in a more direct way, whether individuals value features of the landscape. In a series of papers, Kline and Wichelns (1994, 1996a, 1996b) examine agricultural preservation programs in the northeast U.S. Citizens were found to be willing to support these preservation programs for several reasons, including (in order of importance): protecting groundwater, wildlife habitat, and natural places; providing local fresh produce; preserving rural character and scenic beauty; slowing development: and providing public access. The authors found that support for farmland preservation programs was greatest in those counties experiencing the largest increases in population and in housing and property values.

This result is borne out by contingent valuation studies used to estimate the amount people would be willing to pay to preserve land in agriculture. Halstead (1984) and Beasley, Workman and Williams (1986) estimated significant bids that rose to about $150 per household from about $50 when the replacement for agriculture was hypothesized to be high density rather than low density development. Two other studies report considerably lower values for farmland protection. Bergstrom, Dillman, and Stoll (1985) estimate an average willingness to pay per household of only $5 for protecting half the prime agricultural land in a county in South Carolina, and Ready, Berger, and Blomquist (1997) an average per household per farm preservation bid of less than 50 cents for horse farms in Kentucky. In both these cases, the current development levels were not as high as in the northeast and the density of the hypothetical new development was not specified in the contingent instrument.

A few studies in Europe have explored preferences for preserved agricultural land, but here the alternative is either an alternative agricultural method or abandonment and re-growth in natural vegetation. Pruckner (1991) found that tourists in the mountainous areas of Austria visited the areas for "environmental and countryside" reasons, but their bids per day of travel to preserve the farmland landscapes rather than have these farms abandoned were quite small. In contrast, Drake estimated average bids of 541 SEK ($70) per person to prevent half of all Sweden's agricultural land from returning to dense spruce forest. Faced with a choice among agricultural methods, individuals valued the traditional sparsely wooded pasture of Sweden more highly than cultivated pasture and the latter more than cropland. Motives for support included (in order of importance): nature conservation, aesthetics, recreation, and cultural-historic values.