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A publication of the Agricultural & Applied Economics Association

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Improving Public Policy Surrounding Land Use Changes

Stephan J. Goetz

It is critical for U.S. policy makers to have sound information on how their policy decisions affect land use changes (Goetz 2007) and how urbanization interacts with agricultural production. This is true even as the current economic decline coupled with recent spikes in crude oil prices may have temporarily dampened enthusiasm for urban expansion (e.g., Cortright 2008). Further, access to food remains an issue not only in the United States, but worldwide. Recent experiences make it clear that low and stable food prices cannot be taken for granted indefinitely. Land use policy directly affects one of the most critical issues to be addressed in meeting growing demands for food, feed and fuels.

This theme issue features public policy–related papers on the subject of land use changes prepared by leading experts in the area. The topics include economic, social and environmental impacts of land use changes and their implications for policymakers; methods for valuing the multiple functions and amenities provided by farmland, and what these mean for land preservation programs; the impact of urbanization on agriculture and the policies available to mitigate such impacts; and the application of market–based mechanisms to address water quality problems resulting from land use changes.

In the first paper, JunJie Wu examines the effects of recent reductions in total natural land areas associated with urbanization across the United States. Wu distinguishes among economic, social and environmental consequences of land use change, and he points out that environmental costs or "externalities" are often excluded from benefit–cost calculations. This leads to market failures, which in turn justify public sector intervention. A key conclusion of this paper is that the stakes involved are very high, and that land use regulators must walk a fine line between balancing the public interest with private property rights.

Articles in this Theme:

Joshua Duke, in the second paper, picks up on the some of the issues identified by Wu and examines specifically the types of environmental amenities that are provided by one important category of land use—that of farmland—but that are not normally included in benefit–cost analyses. This is also a form of market failure. Two contributions of Duke's paper are that he presents estimated per acre values of farmland amenities and that he outlines how policymakers should use such values. In particular, he cautions that amenity values should not be viewed as "indisputably objective" even though they are sometimes presented as such. Any decision to use such values should include input from local stakeholders and political bodies.

Building on these first two papers, Lori Lynch outlines the host of public policy instruments that are available in a community to influence land use changes. These range from outright regulatory techniques such as agricultural protection zoning (APZ) and right–to–farm laws to incentive–based techniques such as impact fees, use–value assessments and circuit breaker taxes. Another set of instruments involves participatory techniques such as fee simple purchase and purchase of development right (PDR) programs.

A final category consists of hybrids of these instruments. Lynch concludes her paper by drawing policy implications for agriculture and future urbanization.

In the fourth paper, Charles Abdalla examines a problem that knowledgeable observers believe will become even more important in the future, namely that of water quality as impacted by alternative land uses. He describes how market–based incentives can be used to address specific water quality problems, and presents selected examples from Oregon which are contrasted with the situation in the Northeast United States.

For More Information

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Guest editor Stephan J. Goetz (sgoetz@psu.edu) is a Professor of Agricultural and Regional Economics at Pennsylvania State University, and the Director of the Northeast Regional Center for Rural Development.

This theme issue draws in part on a set of policy briefs based on a Transatlantic Land Use Conference hosted by the Northeast Center in September 2007.

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Land Use Changes: Economic, Social, and Environmental Impacts

JunJie Wu

JEL Classifications: Q24, Q28

Major land–use changes have occurred in the United States during the past 25 years. The total area of cropland, pastureland and rangeland decreased by 76 million acres in the lower 48 states from 1982 to 2003, while the total area of developed land increased by 36 million acres or 48%. What are the potential economic, social, and environmental impacts of land use changes? How does land use change affect agriculture and rural communities? What are the important economic and environmental implications for commodity production and trade, water and soil conservation, open space preservation, and other policy issues? This article addresses some of these issues and their policy implications.

Socioeconomic Impacts

Land is one of three major factors of production in classical economics (along with labor and capital) and an essential input for housing and food production. Thus, land use is the backbone of agricultural economies and it provides substantial economic and social benefits. Land use change is necessary and essential for economic development and social progress.

Land use change, however, does not come without costs (see Table 1). Conversion of farmland and forests to urban development reduces the amount of lands available for food and timber production. Soil erosion, salinization, desertification, and other soil degradations associated with intensive agriculture and deforestation reduce the quality of land resources and future agricultural productivity (Lubowski et al. 2006).

Urbanization presents many challenges for farmers on the urban fringe. Conflicts with nonfarm neighbors and vandalism, such as destruction of crops and damage to farm equipment, are major concerns of farmers at the urban fringe (Lisansky, 1986). Neighboring farmers often cooperate in production activities, including equipment sharing, land renting, custom work, and irrigation system development. These benefits will disappear when neighboring farms are converted to development. Farmers may no longer be able to benefit from information sharing and formal and informal business relationships among neighboring farms. Urbanization may also cause the "impermanence syndrome" (i.e., a lack of confidence in the

Table 1. Socioeconomic Impacts of Land–Use Changes

- Conversion of farmland and forests to urban development reduces the amount of land available for food and timber production
- Soil erosion, salinization, desertification, and other soil degradations associated with agricultural production and deforestation reduce land quality and agricultural productivity
- Conversions of farmland and forests to urban development reduce the amount of open space and environmental amenities for local residents
- Urban development reduces the "critical mass" of farmland necessary for the economic survival of local agricultural economies
- Urban development patterns not only affect the lives of individuals, but also the ways in which society is organized
- Urban development has encroached upon some rural communities to such an extent that the community's identify has been lost
- Suburbanization intensifies income segregation and economic disparities among communities
- Excessive land use control, however, may hinder the function of **market forces**
- Land use regulations that aim at curbing land development will raise housing prices, making housing less affordable to middle– and low–income households
- Land use regulation must strike a balance between private property rights and the public interest

stability and long–run profitability of farming), leading to a reduction in investment in new technology or machinery, or idling of farmland (Lopez, Adelaja, and Andrews, 1988).

As urbanization intensifies, agricultural and nonagricultural land use conflicts become more severe. This may lead to an increase in local ordinances designed to force farmers to pay for some of the negative impacts generated by agriculture. As the nearest input suppliers close because of insufficient demand for farm inputs, a farmer may have to pay more for inputs or spend more time to obtain equipment repairs (Lynch and Carpenter, 2003). Competition for labor from nonagricultural sectors may raise farmers' labor costs. When the total amount of farmland falls below a critical mass, the local agricultural economy may collapse as all agricultural supporting sectors disappear.

Urbanization also presents important opportunities to farmers. The emergence of a new customer base provides farmers new opportunities for selling higher value crops. For example, Lopez, Adelaja, and Andrews (1988) found that vegetable producers tend to receive higher prices in urbanized areas. The explosion of nurseries, vegetable farms, vineyards, and other high–value crop industries in many suburban areas illustrates how quickly agricultural economies can evolve. Many farmers have shown remarkable adaptability in adjusting their enterprises to take advantage of new economic opportunities at the urban fringe. They farm more intensively in areas with high population density (Lockeretz 1988). More than half the value of total U.S. farm production is derived from counties facing urbanization pressure (Larson, Findeis, and Smith 2001).

Urbanization has changed rural communities in many places. In some rural areas, urban sprawl has encroached to such an extent that the community itself has been lost. In other areas, the lack of opportunities has turned once–viable communities into ghost towns. Urban sprawl intensifies income segregation and economic disparities between urban and suburban communities (Wu, 2006). Cities tend to gain lower–income residents and lose upper–income population. Between 1969 and 1998, the share of low–income families in central cities grew from 21.9% to 25.5% compared with a decline from 18.3% to 16.6% for high–income households (U.S. Department of Housing and Urban Development 2000). The change in income mix led to a smaller tax base and the need for more social services in urban communities.

Suburbanization brings urban and rural people and problems together. Most land areas are rural, most watersheds are in rural places, and most of the atmosphere exists above rural space. Urbanites and agencies have legitimate concerns about the use and condition of rural natural resources, just as rural populations have legitimate concerns about urban–based pressures on the natural world. These shared interests in the natural environment have important economic, social, and political implications, which may profoundly impact society in the future.

In response to the increasing urbanization, many local governments have imposed strict land use control. Some of the efforts have been quite successful in slowing down development. For example, Wu and Cho (2007) found that local land use regulations reduced land development by 10% in the five western states between 1982 and 1997, with the largest percent reduction occurring in Washington (13.0%), followed by Oregon (12.6%), California (9.5%), Idaho (4.7%), and Nevada (2.8%). A potential consequence of land use regulation is higher housing prices, which make housing less affordable to middle– and low–income households. There is sufficient evidence to support the linkage between land use regulation and housing affordability. Two recent Harvard University studies found that land use regulation reduces housing affordability in the Greater Boston Area (Glaeser and Ward 2006; Glaeser and Gyourko 2002). Cho, Wu and Boggess (2003) analyzed the causes and consequences of land use regulations across counties in five western states and found that land use regulation increased average housing prices between 1.3 and 4.7%, depending on the intensity of land use regulations in a county.

Land use control must strike a balance between private property rights and the public interest. Oregon ballot measures 37 and 49 highlight the difficulty and controversy of the balancing act. In an attempt to protect private property rights from regulatory taking, Oregon voters passed Measure 37 in 2004. Measure 37 provides that the government must compensate the owner of private real property when a land use regulation reduces its "fair market value". In lieu of compensation, the government may choose to "remove, modify or not apply" the regulation. Measure 37 was ruled unconstitutional by a lower court, but was upheld by the Oregon State Supreme Court. By October 19, 2007, 6,814 claims had been filed, requesting almost $20 billion in compensation (Oregon Department of Land Conservation and Development 2007). In an effort to reverse or modify Measure 37, Oregon voters approved Measure 49 on Nov. 6, 2007 to "ensure that Oregon law provides just compensation for unfair burdens while retaining Oregon's protection for farm and forest land uses and the state's water resources" (ODLCD, 2008). Measure 49 essentially modifies Measure 37 by replacing "waivers" of regulations with authorizations to establish a limited number of home sites.

In sum, land use change provides many economic and social benefits,

but comes at a substantial economic cost to society. Land conservation is a critical element in achieving long–term economic growth and sustainable development. Land use policy, however, must strike a balance between private property rights and the public interest.

Environmental Impacts

Land–use change is arguably the most pervasive socioeconomic force driving changes and degradation of ecosystems. Deforestation, urban development, agriculture, and other human activities have substantially altered the Earth's landscape. Such disturbance of the land affects important ecosystem processes and services, which can have wide–ranging and long–term consequences (Table 2).

Farmland provides open space and valuable habitat for many wildlife species. However, intensive agriculture has potentially severe ecosystem consequences. For example, it has long been recognized that agricultural land use and practices can cause water pollution and the effect is influenced by government policies. Runoff from agricultural lands is a leading source of water pollution both in inland and coastal waters. Conversions of wetlands to crop production and irrigation water diversions have brought many wildlife species to the verge of extinction.

Forests provide many ecosystem services. They support biodiversity, providing critical habitat for wildlife, remove carbon dioxide from the atmosphere, intercept precipitation, slow down surface runoff, and reduce soil erosion and flooding. These important ecosystem services will be reduced or destroyed when forests are converted to agriculture or urban development. For example, deforestation, along with urban sprawl, agriculture, and other human activities, has substantially altered and fragmented the Earth's vegetative cover. Such disturbance can change the global atmospheric concentration of carbon dioxide, the principal heat–trapping gas, as well as affect local, regional, and global climate by changing the energy balance on Earth's surface (Marland et al. 2003).

Urban development has been linked to many environmental problems, including air pollution, water pollution, and loss of wildlife habitat. Urban runoff often contains nutrients, sediment and toxic contaminants, and can cause not only water pollution but also large variation in stream flow and temperatures. Habitat destruction, fragmentation, and alteration associated with urban development have been identified as the leading causes of biodiversity decline and species extinctions (Czech, Krausman and Devers 2000; Soulé 1991). Urban development and intensive agriculture in coastal areas and further inland are a major threat to the health, productivity, and biodiversity of the marine environment throughout the world.

Table 2. Environmental Impacts of Land–Use Changes

- Land use and land management practices have a major impact on natural resources including water, soil, air, nutrients, plants, and animals
- Runoff from agriculture is a leading source of water pollution both in inland and coastal waters
- Draining wetlands for crop production and irrigation water diversions has had a negative impact on many wildlife species
- Irrigated agriculture has changed the water cycle and caused groundwater levels to decline in many parts of the world
- Intensive farming and deforestation may cause soil erosion, salinization, desertification, and other soil degradations
- Deforestation adds to the greenhouse effect, destroys habitats that support biodiversity, affects the hydrological cycle and increases soil erosion, runoff, flooding and landslides.
- Urban development causes air pollution, water pollution, and urban runoff and flooding
- Habitat destruction, fragmentation, and alteration associated with urban development are a leading cause of biodiversity decline and species extinctions
- Urban development and intensive agriculture in coastal areas and further inland is a major threat to the health, productivity, and biodiversity of the marine environment throughout the world

Policy Implications

Land use provides many economic and social benefits, but often comes at a substantial cost to the environment. Although most economic costs are figured into land use decisions, most environmental externalities are not. These environmental "externalities" cause a divergence between private and social costs for some land uses, leading to an inefficient land allocation. For example, developers may not bear all the environmental and infrastructural costs generated by their projects. Farmland produces both agricultural commodities and open space. Although farmers are paid for the commodities they produce, they may not be compensated for the open space they provide. Thus, market prices of farmlands may be below their social values.

Such "market failures" provide a justification for private conservation efforts and public land use planning and regulation. Private trusts and non profit organizations play an important role in land conservation. For example, the American Farmland Trust claims that it has helped to protect more than one million acres of America's best farm and ranch land. The Nature Conservancy has protected more than 117 million acres of ecologically important lands. However, some have questioned whether private conservation efforts crowd out or complement public efforts for land conservation.

Land use regulation can take many different forms. The traditional command and control approach often involves zoning, density regulation, and other direct land use controls. Although these policies can be quite effective as regulatory tools, they could lead to substantial social welfare loss in the form of higher housing prices, smaller houses, and inefficient land use patterns (Cheshire and Sheppard 2002; Walsh 2007).

Incentive–based policies are increasingly used to influence private land use decisions. These policies may include development impact fees, purchases of development rights (PDRs), preferential property taxation, and direct conservation payments. From 1998 to 2006, voters approved 1,197 conservation initiatives in local and state referenda in the United States, providing a total $34 billion for land and open space preservation (Trust for Public Land 2007). The implementation of locally based, long–term conservation plans has been touted as a critical element in achieving "smart growth" (U.S. Environmental Protection Agency 2007).

The incentive–based approach has many advantages over direct land use control. For example, a development impact fee can be used to achieve both the optimal pace and pattern of land development, a shortcoming of zoning regulations (Wu and Irwin, 2008). However, zoning may be preferred from a practical viewpoint as well as in cases where the environmental costs of land conversion are highly uncertain. In situations where the natural and human systems interact in complex ways, thresholds and nonlinear dynamics are likely to exist, and the environmental costs could be very high and sensitive to additional development. In such cases, zoning may be preferred. The policy challenge, however, is to know when the system is in the neighborhood of such thresholds.

While federal spending on land–related conservation programs has increased substantially over the last twenty five years, the federal government has yet to articulate a clear vision of how land use should be managed (Daniels, 1999). Most land use controls are in the hands of local governments in the United States, and the level of control varies considerably across counties and municipalities. Some local governments have few land use controls, while others are actively involved in land use planning and regulation.

Land use regulation is a contentious issue in many communities, particularly those facing rapid urbanization. Proponents argue that land use planning protects farmland, forests, water quality, open space, and wildlife habitat and, at the same time, increases property value and human health. Conversely, uncontrolled development will destroy the natural environment and long–term economic growth. Critics of land use regulation call those fears overblown. They argue that urban development is an orderly market process that allocates land from agriculture to urban use, and that governments tend to over regulate because they rarely bear the costs of regulation. The stakes are high in this debate. Any policy measures that aim at curbing urban development will ultimately affect a key element of the American way of life, that is, the ability to consume a large amount of living space at affordable prices. Policymakers must resist the temptation to attribute all "irregular" land use patterns to market failures and impose stringent land use regulations that may hinder the function of market forces. They should try to identify the sources of market failures that cause "excessive development" and address problems at their roots. Land use regulation must strike a balance between private property rights and the public interest.

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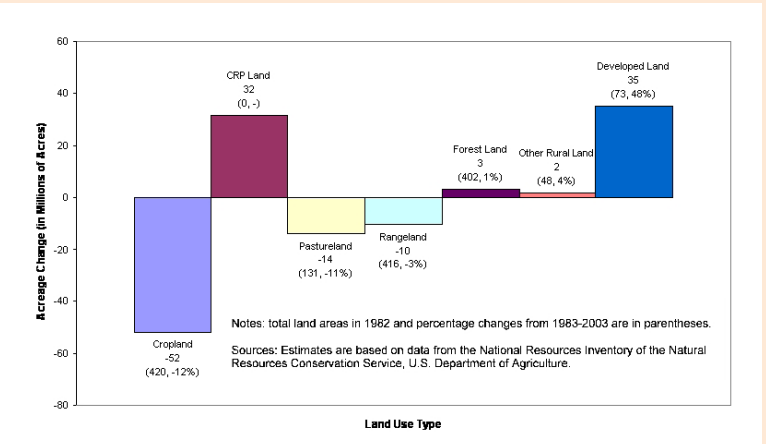
JunJie Wu (junjie.wu@oregonstate.edu) is the Emery N. Castle Professor of Resource and Rural Economics in the Department of Agricultural and Resource Economics at Oregon State University.

Figure 1. Changes in Major Land Cover/Use in the Contiguous United States 1982–2003



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Estimating Amenity Values: Will It Improve Farmland Preservation Policy?

Joshua M. Duke

JEL Classifications: Q18, Q28, Q51, Q58

There is a growing awareness that farmland provides a host of nonmarket services, or amenities. Amenities are external benefits of farmland, i.e., beyond commodity production revenues, accruing to all types of residents (or "amenity consumers") in rural, suburban, and urban areas. Farmland amenities may include aesthetically pleasing views, habitat provision, groundwater recharge, and a lack of development (Irwin, Nickerson and Libby 2003). Although not necessarily amenities, farmland also provides closely related environmental benefits such as flood control and carbon sequestration (Legg 2007). The term "multifunctionality" reflects all of these services from active farmland: commodities, amenities, and other environmental services.

Land–use change threatens future amenity provision. At the rural–urban fringe, high–value development often outbids agricultural land uses. The public perceives conversion as too rapid, or poorly planned, and worries about reduced amenities. Strong political support exists for policy solutions, and some policies make cash payments to landowners in exchange for amenity provision. But are the benefits of preservation policy larger than the costs? An important step in assessing and improving the policy process is the proper *valuation* of amenities.

Figure 1. Conservation Easements

Conservation easements are legal instruments that restrict landowners from pursuing developed land uses—typically, the wholesale conversion from agricultural and natural land uses to residential and commercial uses. Legally, conservation easements are "negative" easements in that they prevent the easement seller (the landowner) from using his or her land in a specified manner. Conservation easements do not give the easement buyer (governmental agencies, land trusts, etc.) the right to use the easement seller's land; they only prevent uses. The easement seller thereby retains all other use rights typically associated with agricultural and natural land ownership.

At least 28 different types of policies exist to retain agricultural land use in the United States (Duke and Lynch 2006). Some of these policies simply alter zoning, changing land–use rules to encourage farming or to discourage development. Governments use incentive–based policies to subsidize agricultural uses (use–value tax assessment) or to penalize conversion activities (impact fees and exactions). The public is likely most familiar with participatory policies, through which governments enter land markets to expand demand for agricultural land use. The purchase of agricultural conservation easements (PACE) is the flagship participatory policy. Under PACE, governments buy negative easements to prevent development and, in effect, create market demand for amenities where little or none existed before. By 2004, over $1.6 billion had been spent in the United States on PACE (American Farmland Trust 2004).

The Economic Union (EU). also has an extensive set of policies that affect amenity provision (Bell 2007). Unlike the U.S., the EU has more unified multifunctional policies that address both soil/water management and land preservation, and also may include rural development provisions (Bell 2007; von Haaren and Bills 2007). Yet in both the United States and the EU policymakers face the challenge of balancing regulatory restrictions with payments to landowners and find that existing policies are not always perceived to be effective by the public (von Haaren and Bills 2007). U.S. and EU policies are somewhat difficult to compare because U.S. policies that directly affect amenity provision tend to emanate from the state and local levels. The EU has cross–compliance standards in their agri–environmental policies and other norms that allow for systematic comparisons of policy effectiveness, especially regarding pollution prevention but also related to amenity provision (Brouwer and Jongeneel 2007).

Unfortunately, in the United States and the EU there appears to be a large disconnect between research and

Figure 2. Key Research Findings on Farmland Amenities

What are the key research findings on amenity values? Irwin, Nickerson and Libby (2003) report that demand for farmland amenities:

- Rises with income levels.
- Increases with educational attainment levels.
- Increases with population growth, especially near the rural–urban fringe.
- Increases as agricultural land becomes scarcer.
- Decreases when other nonfarm, rural lands are abundant.
- Is higher for those located near preserved parcels, except when too many nonagricultural residences are nearby.

Figure 3. How Large Are Amenity Values?

Duke and Johnston (2007) calculate farmland amenity values for Delaware residents and for an assortment of land uses. The following are examples for parcels in Delaware at high risk of development and where preservation is conducted using a state–purchased conservation easement:

- Forest providing moderate levels of public access $131,881 per acre
- Cropland with no public access $54,691 per acre
- Nursery providing moderate levels of public access $117,598 per acre

Duke and Johnston (2007) also find that amenity values differ when parcels are at a low risk of development.

- Cropland with no public access $2,233 per acre
- Cropland with high levels of public access $65,132 per acre

policy regarding the measurement and use of amenity values. It is useful to clarify exactly what amenity valuation research can and cannot provide to policy makers. This paper summarizes both research results and remaining research challenges, and it guides policy makers in interpreting research results. The impact of research on policy is the exclusive focus of the concluding section.

Research on Amenity Values

The market price of a land parcel does not capture its amenity value. Economists view such situations as market failures because society's demand for amenities does not affect the price of land when a farm is sold for development. Nonmarket valuation measures amenity value using revealed preference and stated preference techniques. Revealed preference studies use transaction data on market goods, which are associated with a nonmarket good, to infer amenity values. Stated preference studies use formal survey protocols to estimate amenity values directly, typically targeting amenities that have public good characteristics and thus are independent of observed market choices. This article focuses on evidence from the latter, and does not address complications associated with negative impacts from agriculture (see Poe 1997; Bell 2007; Legg 2007).

A recent review finds that amenity values are affected by parcel size, local scarcity of farmland, development pressure, land productivity, the intensity of farming, and whether food is produced for human consumption (Bergstrom and Ready 2009). In a *Choices* article on amenity values, Irwin, Nickerson and Libby (2003) argue that some farmland–preservation benefits are unrelated to farming. Indeed, the public values the continuation of farming and long–term food security, but it also values the provision of wildlife habitat, groundwater protection, and growth controls. These benefits tend to vary by location. Hence, in some locations the highest amenity value lands may be the most productive, or "prime," farmland, while in others they will be more marginal but with more rural or environmental amenities (Irwin et al. 2003; Duke and Johnston 2007). Even urban areas may deliver high–value amenities and lower value, lower acreage production (Adelaja, Lake and Colunga-Garcia 2007).

Challenges and Alternative Approaches

Accurately measuring amenity values is important for developing effective policy, especially when these values are used to justify payments to landowners. This section describes current research challenges in terms of accuracy of valuations and in explaining spatial and other preference patterns.

Do We Have Accurate Measures of Amenity Value?

Research on amenity values offers many results and relentlessly refines its methods to test and improve survey instruments and statistical techniques. However, measurement accuracy remains a persistent challenge. Recent studies are the most accurate because they better capture current conditions and are most likely to have used the most recent techniques. Choice experiments provide a good example of the latter claim. Choice experiments are a generalized form of contingent valuation in that they allow one to measure the separate contributions to amenity value of a host of land attributes, such as parcel land use, parcel size, and growth pressure. The results of choice experiments increase the diversity of parcels to which estimated amenity values can be applied.

Do We Understand How Amenity Values Vary across Space?

Explaining how amenity values change across the landscape challenges current methods. Studies using "distance–decay" find evidence about

how values decline as residents are located farther from the preserved site (e.g., Bateman and Langford 1997). Using voting data, Bell (2007) also finds a distance impact. These and other studies suggest that amenity values may often extend beyond the boundaries of the political unit proposing preservation—a potential complication to policy (e.g., Loomis 2000). For instance, if Connecticut is proposing to fund the preservation of 10,000 acres of farmland but the benefits extend to residents of Rhode Island and Massachusetts, then preservation may be undersupplied because Connecticut will tend to only fund a program that meets its own needs. More effective policies must reflect the entire population holding values for preservation.

Do We Understand Patterns in Amenity Value?

Other research suggests that patterns are more complicated than just distance. Land preservation amenities have many public–good characteristics. Once supplied, these services are supplied to everyone (without diminution) and no one can be precluded from enjoying them. This is especially true when a "nonuser" enjoys the amenities, i.e., one who values, say, knowing that groundwater quality is protected but never anticipates using that water (Duke and Johnston 2008). Some nonuser values are found to decay with distance while others appear immune to such decay. This complicates efforts to identify fully the population enjoying amenities and to measure, correctly, the spatial patterns of value. Policy makers thus will have difficulty identifying the full set of beneficiaries associated with preservation.

Are Amenity Values Valid beyond the Locality Where Data Were Collected?

Some inconsistencies in amenity–value patterns have been documented (Irwin, Nickerson and Libby 2003; Bergstrom and Ready 2009), and this seems to suggest that amenity values are highly site–specific (Legg 2007). This is intuitive—the housing market is driven by the maxim, "location, location, location," so the amenity market should be, too. Population characteristics, geography, and local scarcities in land use will affect values measured at different locations. Residents in Rhode Island may value habitat provision from farmland preservation more than those in Delaware, whose interests are tied to water protection and perpetuating farming as a way of life. Similar stories could explain why values vary between local regions, states, or even countries.

However, this complicates the use of amenity values because it limits the broader applicability of applied research. Valuation research is a reasonably expensive undertaking, and efforts would have to be increased by many orders of magnitude if all existing preservation programs required amenity valuation measures of their own. One possible solution to this policy problem is "benefit transfer," or adapting existing research results to new contexts (Rosenberger and Phipps 2007). This research suggests that transferring values will be most accurate when the preservation sites are similar, i.e., the data were collected on a parcel sharing land market, population, and geographic characteristics with the parcel of unknown amenity value (Rosenberger and Phipps 2007). In addition, the likelihood of accurate transfer likely increases when the scale of preservation is similar, i.e., a community in one state was studied and values are being transferred to a similarly sized community.

Do Amenity Values Reflect the Variety of Preferences?

A recent methodological advance, mixed logit econometric analysis, allows for amenity–value estimation that reflects the variety of preferences in a population. The main advantage of mixed logit is that the researcher can still examine the importance of various drivers of preference (i.e., the parameters) while also testing for heterogeneity in those drivers (i.e., the standard deviation of the parameters). For instance, researchers now can estimate, say, that 70% of the population holds a positive value for dairy farm amenities, while 30% holds a negative value. Policy makers will increasingly find researchers reporting these more nuanced, more accurate, characterizations of amenity value. It will be a challenge for policy makers to determine how best to use these results to design policies.

Implications for Policy

The preceding section clarifies the current state of amenity valuation research and offers some ideas for bridging the research–policy gap. This section explores the question, "What is to be done with amenity values?" This question has received minimal treatment from researchers, but with a proper understanding policy makers can appropriately employ amenity value measures to improve policy.

How Should Amenity Values Be Used in Benefit–Cost Analysis?

Amenity values are typically presented as the benefits of preserving an acre (or hectare) of farmland with certain attributes (land use, risk of development, etc.), i.e., $\$X$/acre. Economists probably anticipate that policy makers will then conduct a single–parcel, benefit–cost test. With preservation costs of $\$Y$/acre, preservation is efficient if benefits exceed costs ($\$X > \$Y$).

However, many policymakers want to know how much land should be preserved in total, across the jurisdiction, and amenity value research cannot offer much guidance. Amenity value estimates are applicable to the next few parcels preserved. Large preservation efforts involving many parcels will generate amenity values, per parcel, that are less than the research calculated. The law of demand

tells economists to expect these lower values, but economists have little or no understanding of how fast they will drop. There are several implications for policy. First, amenity values are best used for benefit–cost tests or prioritization. Second, additional measurement should be conducted after any major preservation effort has been implemented.

What Preservation Policy Should Be Used?

Amenity values should not automatically direct policymakers to PACE. There is an urge to do so, probably because per–acre benefit measures are so easy to compare to the per–acre cost estimates for PACE with which policymakers are familiar. But there are economic and philosophical problems with this.

Economically, research finds that people also may value the preservation policy process itself (Johnston and Duke 2007). Amenity values may depend on whether they are delivered via PACE, by outright purchase of the land, or by conservation zoning. Amenity values may also depend on whether governments or private land trusts provide preservation. Although conservation zoning tends to generate the lowest preservation benefits, it will also tend to be the least expensive (Johnston and Duke 2007). In addition, Seidl, Ellingson, Magnan and Mucklow (2007) show that achieving preservation with three different tax policies and a zoning policy can have very different, important financial impacts on communities. Policy makers thus should carefully evaluate the various means of reaching preservation goals and not automatically exclude the possibility of using regulations.

Philosophically, there is a danger that policymakers will treat amenity values as indisputably objective simply because they are precise and generated through a complicated, statistical process. Yet amenity values are calculated using a process with subtle value judgments. Valuation researchers pose survey questions in terms of a respondent's willingness to pay for amenities because it has been shown to be the best way to ask about hypothetical market behavior. However, this does not mean that the public should be buying amenity services in all circumstances. Some policies, such as PACE, imply that development is a landowner's property right (Duke and Lynch 2006; Legg 2007). Actual land–use decisions, however, are largely directed by zoning. Zoning laws dictate permissible land uses at a given time—they do not necessarily define property rights.

It is a value judgment whether or not the public should take on a buyer–type role (PACE, fee simple) or a seller–type role (impact fees) in preservation transactions (Duke and Lynch 2006; Legg 2007). Similarly, it is a value judgment whether current land–use rules should be altered via rezoning. Policymakers are advised to seek the guidance of local political bodies and stakeholders in making these judgments. Amenity values from economists can help suggest priorities, but should not automatically and uncritically be used to dictate a specific policy process.

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Joshua M. Duke (duke@udel.edu) is a professor in the Departments of Food and Resource Economics and Economics, and in the Legal Studies Program, at the University of Delaware.

The author thanks Stephan Goetz for guidance and the Northeast Regional Center for Rural Development for supporting this work.

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Desirability, Challenges, and Methods of Protecting Farmland

Lori Lynch

JEL Classifications: Q24, Q28, R14

For many Americans, loss of farmland and forestland ranks as a significant land use problem. The amount of U.S. farmland has declined by an estimated one million acres annually over the last 60 years. Population increases, a desire for larger lots in less urban settings, and advances in communications and transportation have increased the demand for low density housing. The number of acres consumed per person for new housing have almost doubled in the last 20 years, and in metro areas such as Washington, DC the rate at which land is being consumed exceeds population growth by almost 2.5 times. Since 1994, residential lots larger than 10 acres have accounted for more than half of all land developed (Heimlich and Anderson 2001). Thus farmers in many areas of the country face a loss of farmland and other farmers, on the one hand, and new nonfarm neighbors next door, on the other.

Is Retaining Farmland Desirable?

Should farmland retention be a goal of local communities? The U.S. population is growing, and people have to live somewhere. Moreover, technological advances in agriculture have increased per acre yields, requiring less farmland to produce the same amount of food and fiber. Economists ask "What is the market failure in the conversion of this farmland? Why do we need a policy to prevent conversion?" If conversion occurs because people are willing to pay more for land for residential and commercial structures than a farmer can earn by growing a crop on it, then conversion appears optimal (Lynch 2005). Of course, other policy interventions such as transportation policies, educational policies and school quality, banking regulations, and crime prevention or lack thereof all affect development patterns and may contribute to the retention of less farmland than society would find ideal. Nonmarket values or willingness to pay for the multifunctionality of farmland derive from the desire to preserve the amenity values of open space and rural character, to slow suburban sprawl, to provide wildlife habitat, to provide local food supply and food security, and to improve water quality. People report a willingness to pay to retain land as farmland for amenity and environmental reasons. Much of the information on what society desires to preserve and how much it is willing to pay for these multifunctional attributes is presented in the accompanying article by Duke.

Reasons for Farmland Conversion

To ensure that any program or policy introduced actually does retain farmland, we must try to understand the forces that result in its conversion. In certain periods and some areas of the country, net returns to farm activities have been negative and farmers may abandon the land or let it return to forest. For example, in 266 counties in the six Mid–Atlantic States, out of the 1,330 county/decade combinations over the last 50 years, 418 (31%) counties lost agricultural land even when the county's population was not increasing. But what people seem to find most disconcerting is the conversion of farmland to housing and commercial developments. Forces driving this conversion range from demand for land for housing and commercial development that raises the price of land for these uses far above those for agricultural uses, lack of competitiveness in international trade, speculation in the land market (investors earn higher returns buying land than equities), decreasing relative returns from agriculture in urbanizing areas, difficulties with nonfarm neighbors, and inability of farm families to diversify their income sources with off–farm employment in some areas. Some of the forces stem from macro–economic factors (interest rates, value of the dollar internationally, trade agreements) beyond the scope of local and state governments. However, local land–use planning and policies impact others. We address these factors.

Challenges from Land–Uses Patterns

While adapting to surrounding urbanization is crucial for farmland owners, the pattern of land conversion can result in lower profits on remaining farmland, as spillover effects from nonfarm neighbors can decrease the relative net returns for producers. As nonfarm homeowners move closer to agricultural operations, they often discover unexpected and unpleasant odors, dust and farm waste disposal. These new residents have bought their dream home in the country without understanding why they are awakened at 5 a.m., or have to experience fly invasions on hot summer days. And although every state has passed some type of "right–to–farm" legislation to protect farmers from these types of complaints, these laws may provide a false sense of security for farmers.

Fragmentation of the agricultural landscape by mushrooming housing developments also alters farmers' costs. Farming many scattered fields limits an operation's ability to achieve an efficient scale of operation. Moving equipment from field to field is time–consuming and creates conflict with cars on the road. Close proximity to nonfarm neighbors often results in increased vandalism, theft, litter, trespassing and stressed farm animals. Teenagers may think that riding their bicycles and off–road vehicles across an open field has no effect on the soil. Children and household pets may enter pasture land to pet cows, horses, geese or chickens unaware of the dangers involved or the stress caused to the animals. The increased cost to prevent or rectify these behaviors is usually borne by the farmland owner.

These spillover effects from low density developments to farmers may reduce farm profits. But just as importantly, the operational difficulties cause uncertainty about the long–run profitability of the farm sector as more homes are built nearby. This creates an impermanence syndrome, in the sense that farmers see no long–run future in farming in the area and invest less in both physical and human capital (Gardner 1994). They may stop adopting the newest technologies that could increase their yields or decrease their costs.

As farmers exit the industry in a local area, fewer operations remain to support the input and equipment businesses, and veterinarians. Similarly, product marketing firms and food processing plants may disappear. As the farmer travels further to buy inputs or sell outputs, costs increase and profits decline. This loss of a critical mass of farmers has social and political as well as economic consequences. The overall effect is a decrease in the profitability of the farm and an increase in the relative attractiveness of selling the farm for housing development. In some sense, the impermanence syndrome becomes a self–fulfilling prophecy.

In addition, the increased demand for land often prices farmland out of reach of existing farmers who may need to expand their operations to achieve efficient scale. And because the farm population is aging, escalating land values may hinder the long–term continuation of the farm sector as fewer farmers can buy into the sector. Other than individuals who inherit farmland, younger farmers seeking to enter the industry in an urbanizing area will find buying the main input, farmland, to be too expensive. These so–called urban influences affect about 17% of the nation's agricultural land and real estate investors often purchase the appreciating land to achieve high investment returns.

Benefits of Farming Near the City

While problematic in many ways, metropolitan farms can succeed if they take advantage of the opportunities that proximity provides. Many metropolitan farms grow high value crops (fruits and vegetables, bedding plants and other horticultural products, compost and others) and sell to consumers directly. The growing slow and local food movements provide support for farm locations close to population centers. State and local support has resulted in expanding farmers' markets for direct sales to a variety of consumers including those receiving food stamps. The growth in community supported agriculture groups provide a growing number of outlets to reduce income risk and provide consumers locally produced products. Restaurants and schools seek fresh produce as well. These approaches allow some farmers to obtain top dollar for their commodities while providing consumers with a source of locally grown fresh food.

Agri–tourism ventures can also succeed when people from nearby cities come out to the farm. Agri–tourism is a subset of "nature tourism," which is the fastest growing segment of the tourism industry, averaging a 30% annual increase each year since 1987. In the United States., nature tourists spend more than $7.5 billion annually on travel alone. Many of these people would consider visiting a farm or a forest setting for their recreational experience. Also, the equine industry has grown at the rural–urban fringe as farmers realize that boarding horses, riding rinks, and riding trails can earn them higher returns and guaranteed buyers for their hay and alfalfa.

Metropolitan farms also benefit from the proximity of off–farm employment opportunities to increase their family income. Off–farm work provides income during the slow seasons and has resulted in farm income being greater than non-farm income in recent years. As the farm operation changes with the changing economic environment, off–farm income can also aid in any transition from full–time to part–time employment. For labor intensive farm enterprises, the metropolitan proximity also provides

a seasonal labor supply. Thus, although population growth and closeness to metropolitan areas can create an impermanence syndrome and create spillover impacts, farmland loss is not inevitable if the farm sector shifts to new commodities and enterprises more suited to this environment.

Methods for Retaining Farmland

Given that society continues to express a desire to retain farmland and change the pace and pattern of development, what would an optimal preservation strategy be? A farmland retention policy should seek to do three things:

1. Enhance the profitability of farming in the region,
2. Decrease the obstacles to productive farming such as nonfarm neighbors adjacent to productive farms, and
3. Slow or end housing development in the farming area itself and redirect development to nonagricultural areas.

A policy may accomplish these goals by protecting farmland from conversion and/or redirecting new development to desirable nonrural areas. Both regional and local planning is an important and fundamental first step to choosing the right protection techniques and deciding where farmland retention is desired and where development is acceptable. Planning efforts can be aided by ecosystem models that capture space and time dimensions, and balance population growth, consumer tastes and preferences for housing and open space, and land conservation. Regional planning efforts are imperative to ensure farmland protection in one area does not spill over and create conversion problems for adjacent areas.

Farmland preservation policies can be categorized as regulatory, incentive–based, and participatory, with a fourth category being a hybrid of two of the other three types (see Table 1; this section on techniques draws from Duke and Lynch 2006). Each category impacts the land market differently and may have challenging implementation issues. Issues of funding, administration, and equity also come into play. Farmland can be retained either through outright prevention of development or when the price of farmland properly reflects the social value it provides to the community.

Regulatory Techniques

Regulatory techniques such as agricultural zoning, right–to–farm laws and urban growth boundaries make rural areas "off–limits" by changing the rules in the agricultural land market to both protect agricultural land and redirect development. They rely on the state's authority to mandate a socially beneficial behavior and thus require very little tax revenue to retain productive agricultural land. They also can be designed to preserve large contiguous blocks of land, preventing spillover impacts and allowing farmers to operate without constraints. Regulatory techniques can target areas where farms are considered most productive and retain a critical mass of farmland. In areas with a strong and viable agricultural base, agricultural zoning may be supported but only if agricultural landowners believe they have sufficient political capital to alter the zoning at a later date and be able to sell for development (Esseks and Long 2001). However, in areas where the urban influence has increased land value dramatically, limiting the land–use options on farmland without compensation could be seen as a regulatory taking by the farmland owners and thus may not be politically feasible or may result in lawsuits against the local government.

Another concern with regulatory techniques is that they are not permanent. Variances are permitted in

Table 1. Categories of Agricultural Land Retention Techniques

Regulatory techniques	Incentive–based techniques	Participatory techniques	Hybrid
Agricultural protection zoning	Impact fees, exactions, and mitigation ordinances	Fee–simple purchase or negotiated sale	Eminent domain with right of first refusal (ROFR)
Cluster zoning	Mortgage assistance	Eminent domain	Pension plan with purchase of development rights (PDR)
Right to farm laws	Recapture or rollback penalty	Land banks	Transfer of development rights (TDR) with protection zoning
Urban growth boundaries	Use–value assessment	Purchase of development rights or of agricultural conservation easements. (PDR/ PACE) programs	Agricultural districts
Growth management regulations	Circuit breaker tax	Term easements	Capital gains reduction or state income tax reduction/or bargain sales with PDR
State executive orders	Transfer tax	ROFR	Installment payments with PDR
Mandatory real estate disclosure		Land leasing	Point systems with PDR

many cases. Zoning regulations and urban growth boundary lines can be changed with each new set of elected officials. In fact, sufficiently unpopular zoning regulations have lead to a whole new slate of officials being elected. Local communities are also concerned that regulatory tools may drive up the cost of housing by restricting the amount of land available or the number of houses permitted (Glaeser and Ward 2006). The technique of cluster zoning may not be suited to consumer preferences and thus find few purchasers. In addition, cluster zoning still permits housing within an agricultural area and thus does not prevent negative spill–over impacts.

Incentive–Based Techniques

Incentive–based techniques reward the land–use decisions that most benefit society and penalize those individual decisions deemed costly. These techniques can be coercive, i.e., increase the cost of undesirable land uses, or rewarding, i.e. subsidize the cost of desired land use. Compensation is paid or higher agricultural returns are ensured within the same land market but landowners receive more benefits from continuing an agricultural use. Therefore, landowners are relatively more likely to choose a land use that provides the highest benefits to society.

Many of these techniques are voluntary and thus generate less opposition, but others are more costly in terms of tax revenues expended or not collected, than regulatory techniques. Many local governments do not have enough funds to ensure a sufficiently high level of participation to prevent housing development within agricultural areas. If the relative land price in a nonagricultural use increases sufficiently, landowners will convert the farmland from the agricultural use. Therefore, incentive based techniques are more likely to slow farmland conversion rather than achieve a critical mass of retained productive farms.

In addition, governments have rarely targeted these types of techniques to certain places, i.e., farmland in all areas of a county receives use–value assessment. Therefore, these techniques cost more than if they were targeted to a particular area. For example, conversion penalties such as transfer taxes would have greater impacts on those parcels most likely to convert—thus targeting the most threatened parcels. Limited targeting means some landowners, such as real estate investors and wealthy "hobby" farm owners, cannot take advantage of use–value assessment and this increases the cost of speculation. Techniques such as circuit–breaker taxes can limit benefits based on some family or farm income threshold. Incentive–based techniques can be altered relatively easily and thus will depend on the political will and the resources available.

Participatory Techniques

The government may also "participate" in the land market by buying or selling parcels of land or lesser rights in land. For example, the government may purchase land, use eminent domain, purchase partial rights such as the right to build houses and restrict the land with an easement, or use a right of first refusal approach to ensure the retention of farmland. Other than eminent domain, participatory techniques are voluntary and often the creation of these programs is relatively simple and faces little opposition.

Participatory techniques allow more spatial targeting and directed efforts by which only parcels contributing to the desired goals are enrolled. Purchase of Development rights (PDR) programs appear to be achieving their goals and slowing the rate of farmland conversion (Lynch and Musser 2001; Liu and Lynch 2006). However, because the government enters the land market to buy rights, these techniques are more costly from a tax–payer perspective than either the regulatory or the incentive–based techniques. And thus, they often cannot enroll sufficient acres to achieve all of their goals. Because the government acquires rights in the land and easement restrictions are placed on the deed, these techniques operate as a permanent means of preserving the agricultural land. Eminent domain could be used in targeted areas to enroll hold–out landowners. Public access can be permitted on those parcels owned fee–simple while private rights against trespassing can be protected on those for which the government holds lesser rights. Term easements are a temporary technique and would simply slow the rate of conversion rather than permanently retain the land. These could be beneficial to prevent conversion of farmland when the government has insufficient funds to buy more permanent rights but these found little support among stakeholders (Duke and Lynch 2007). As a further complication to the financing side of participatory techniques, several studies have found that adjacency to preserved farmland increases one's land value (Geoghegan, Lynch and Bucholtz 2003). Right of first refusal found a high degree of support among stakeholders in part because governments are not forced to have money up front but can respond to an actual conversion threat (Duke and Lynch 2007).

Hybrid Techniques

Hybrid techniques often combine the best characteristics of two of the techniques listed above into a single technique enabling policymakers to take advantage of synergies. For example, hybrid tools can stress targeting through a regulatory approach but also provide some compensation to current landowners to generate political support for the proposed program. Transfer of development rights programs often use agricultural zoning in a sending area where farmland preservation is desired but allow landowners to sell the rights to develop to

another area, where development is desired, as compensation. Landowners donating development rights receive tax benefits through a charitable tax deduction using a participatory tool (PDR) at a lower direct cost to the government. By using combinations of techniques, most hybrid tools lead to permanent preservation. Agricultural districts delay conversion and provide protection from nonfarmer complaints similar to agricultural zoning but usually for only a specified number of years, as in the case of term easements.

Communities can support farmers' adaptive behaviors on the rural–urban fringe. Farmers have adapted to the changing environment in quite diverse ways whether by changing commodity mixes or taking advantage of urban opportunities to market directly to the consumer. Recent evidence suggests that the farm community has been resilient to large losses of farmland over time and in some cases per acre returns have actually increased (Lynch and Carpenter 2003). Efforts to encourage these adjustments may facilitate farmers' transition and success. Requiring mandatory real estate disclosure of normal agricultural practices for potential rural residents and implementing right–to–farm laws may aid in these endeavors.

Implications for Agriculture, Urbanization, and Policy

The widespread impact of recent housing development on water quality, air quality, loss of open space, wetlands, and wildlife habitat and the stagnation of many inner cities and suburbs suggests a new approach to land use is needed. A do–nothing approach will result in ongoing sprawl and fragmentation in rural areas. Regulatory, incentive–based and participatory policies along with regional and local planning can all play a role in achieving a more socially beneficial land use pattern given the anticipated population growth and tastes and preferences of housing buyers. Judicious use of these policies can enhance the profitability of farming in the region, decrease the obstacles to productive farming such as nonfarm neighbors, and slow or end housing development in the farming area allowing the agricultural sector to survive.

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Lori Lynch (llynch@arec.umd.edu) is Professor of Agricultural and Resource Economics at the University of Maryland.

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Land Use Policy: Lessons from Water Quality Markets

Charles Abdalla

JEL Classifications: Q24, Q25, Q53

Public policies for land use and water quality are increasingly interrelated. Diffuse nonpoint sources of water pollution, such as farming and forestry, have been difficult to address, and remain the most significant unresolved portion of water quality. Market–based approaches, such as pollution credit trading, are being promoted by many academics as well as government and nongovernmental organizations as mechanisms to help meet water quality standards. In areas where economic growth and land use changes have been occurring, attempts are being made to address nonpoint source water pollution or broader environmental concerns by allowing "trades" or offsets between municipalities under water quality regulatory constraints or seeking opportunities for further growth. Several national and state governmental agencies have developed policies or guidance to support this approach (Abdalla, Borisova, Parker and Saacke Blunk, 2007).

Two experiments using market–like concepts are being tested at the watershed or river basin scale in northwest Oregon. The Willamette River basin contains diverse land uses and has significant economic, ecological and cultural resources. The region currently contains about 3 million people or three–fourths of the state's population and is expected to undergo significant future growth (Vickerman, 2008).

In the Willamette River basin, two experiments with market–based concepts are underway. The first was initiated about five years ago and is coordinated by a water service district—Clean Water Services. Its focus is on water temperature in the Tualatin River basin. This basin is located adjacent to the rapidly growing Portland metropolitan area. The second was started in 2005 and is being coordinated by the Willamette Partnership, a coalition of municipal, conservation, industrial, agricultural, development, policy and other interests in the Willamette River basin. This project is broader than the Tualatin River experiment, both geographically and in its goals. The partnership has been attempting to use market concepts to achieve other environmental performance goals, including improving watershed health and sustainability, in addition to improving water quality.

Little systematic information has been available concerning performance of water quality programs using market–based concepts and what are critical ingredients for successful programs. This paper fills some of this knowledge gap by assessing available information about the two experiments in Northwest Oregon. Specifically, the key activities and outcomes will be described, along with a number of observations and conclusions. The findings are discussed with an eye toward identifying broader lessons about the performance of land and water public policies that rely on market–based concepts.

Why Consider Markets for Water Quality and Ecosystem Services?

Water degradation from rural land uses including farming and forestry is an important problem. Markets are being considered because addressing these nonpoint sources has not been feasible through regulatory or other policy approaches. Reasons for this include the lack of or unclear jurisdiction of the federal Clean Water Act over the rural land uses that are the predominant pollution sources. Also, for many states important issues remain about property rights and the role of government to influence decisions on private land. Market–based approaches have been increasingly considered as it has been recognized that available financial (cost sharing) and technical assistance to farmers or other rural landowners will be insufficient to meet water pollution control and conservation needs.

Water quality issues in Oregon in many ways mirror the national picture described above with several exceptions.

First, Oregon's land use policies, which utilize urban growth boundaries to encourage growth near cities and discourage rural land development outside these boundaries, are among the strongest in the nation. Second, the Northwest United States and Oregon's environmental policies emphasize protection of endangered species and fish and wildlife habitat. For example, 90% of the Total Maximum Daily Loads (TMDLs) regulations written in Oregon are for water temperature (Bjorn–Hansen, 2007). Third, there has been growth in human population and land development near high value agricultural areas, including counties close to the city of Portland.

Recent Economic Work on Water Quality Trading

Economists have long championed market–based approaches over regulatory "command and control" approaches for addressing environmental problems. Despite its theoretical appeal in terms of realizing cost savings and success reducing the costs of achieving improvements in the air quality, relatively little success has been achieved in the water quality and agricultural land use contexts (Abdalla, Borisova, Parker and Saacke Blunk, 2007). It is useful to look at market–based programs and specifically trading from the vantage point of potential supply and demand for water quality "credits" (King, 2005). Recent changes in conditions that affect the potential supply of and demand for water quality credits suggest a need to reevaluate the challenges that confront trading programs. Among the key challenges to market based approaches that have been identified are: difficulties in setting pollution caps; difficulties in establishing allowable pollution limits (baselines); complexities in establishing credits and associated risks with agricultural credits; transaction costs; enforcing contracts and liability issues; and the scale of the trading program (Abdalla, Borisova, Parker and Saacke Blunk, 2007).

Market–Based Water Quality and Land Use Management Experiments in Oregon

These two experiments using market–like concepts to affect water quality or other environmental outcomes by affecting rural land uses in northwest Oregon provide valuable lessons for land use policy. The assessment of these experiments draws upon information from secondary sources and interviews with program managers and stakeholders.

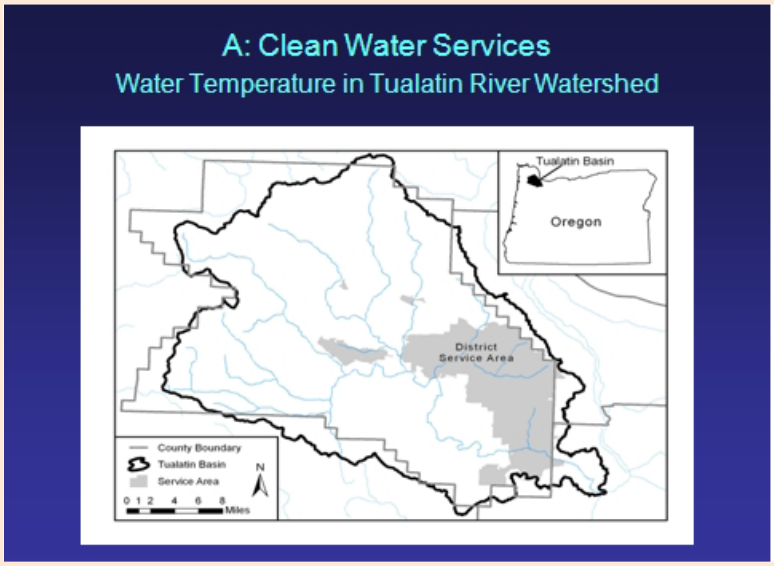
Water Temperature in the Tualatin River

The first market–based experiment is coordinated by a water service district—Clean Water Services (CWS)—and focuses on water temperature in the Tualatin River watershed. This basin is primarily in Washington County, directly west of Portland, and has been increasingly surburbanized. However, it remains an important agricultural area especially for high–value commodities such as nursery and greenhouse crops (Washington County Extension Service, 2008).

Figure 1.

A crop of strawberries was tilled under in the fall before planting the Tualatin River riparian buffer (Fall 2005).

Figure 2.



Source: Roll, et al, 2008

In 2001, CWS faced a federal Clean Water Act requirement (Total Maximum Daily Load- TMDL) to reduce the temperature of effluent from its wastewater facilities. The district considered installing "chillers" at significant costs, estimated at $60 million in capital costs and an estimated $2.5 million to $6 million in operations and maintenance costs (O&M) per year, to meet the requirement. Instead, under authority of a permit negotiated with the Oregon Department of Environmental Quality (DEQ), CWS elected to implement nonstructural methods that included planting of riparian land areas to achieve shade tree credits (Bjorn–Hansen, 2007; Oregon DEQ, 2004)

The elements of CWS's riparian shade tree credits program included: a capital improvement program; a "Tree–For–All" program for cities; and an "Enhanced Conservation Reserve Enhancement Program" (ECREP) for rural areas. Extensive efforts at quality assurance were made by CWS through close work with local Conservation Districts, tree suppliers and contractors to ensure consistency of trees, plantings, maintenance and monitoring.

Once riparian areas are planted, analysis is conducted to estimate the amount of thermal credit generated by each location. Performance measures and performance goals were defined (Table 1) and are monitored. Success rates are calculated each year based on the ability of each program to meet its established performance target.

In the ECREP, CWS pays farmers with riparian land annual lease payments. In return, the contracted farmers allow CWS, through two local soil and water conservation districts, to plant and maintain riparian areas on the farmers' enrolled lands. These riparian restoration projects are financed from two sources: federal and state funds distributed through the USDA's Conservation Reserve Enhancement Program (CREP) and from CWS's sewer and water service rate–payers. The funds from the district were equivalent to the existing USDA Conservation Reserve Enhancement Program (CREP) lease payment rate, essentially doubling the lease rates per acre to farmers (Bryant and Fenn, 2007). Previous to this program, USDA's CREP rental payments were insufficient to induce any farmer to participate in CREP (Vickerman, 2008).

The performance of CWS's riparian tree shade credits program can be measured in quantitative and qualitative terms. Roll, et al. (2008) have done this for the first four years of the five year program. The following discussion draws heavily on their analysis. According to its federal National Pollution Discharge Elimination System (NPDES) permit, the district must have 35 miles of riparian land shaded by tree plantings over five years. Four years into the program, almost 30 miles have been planted, with about 10 miles coming from rural riparian lands enrolled in ECREP. While not required by permit, CWS monitors the program. This has revealed that 82% of the best management practices of tree planting for the ECREP program were meeting performance goals.

Attention to quality assurance and monitoring performance measures has allowed CWS to increase its emphasis on quality over time in ECREP. As a result, the district has become more discriminating in farmer selection. It now uses criteria (e.g., riparian condition, fish habitat, north–south orientation, nutrient filtration potential, habitat connectivity, and potential for water right transfer to in–stream use) to identify land with greatest potential ecological benefit (Roll, et al., 2008).

The outcomes of the ECREP part of CWS's water temperature trading program can be summarized as follows. The major benefits were a change in farmer behavior leading to 250 acres of riparian farmland being enrolled in ECREP and 10 miles of

Table 1. Tualatin River Watershed Project Performance Monitoring Parameters

Parameter	Measure	Performance Target
Native Tree and Shrub Density	Tree and Shrub Counts	60% of tree and shrub target stocking density by Year 5. Stocking density rates are unique to each plant community type.
Invasive Species Cover	Visual estimation of aerial cover	Target species are placed in cover categories and evaluated to ensure cover does not increase over time.

Source: (Roll, et al., 2008).

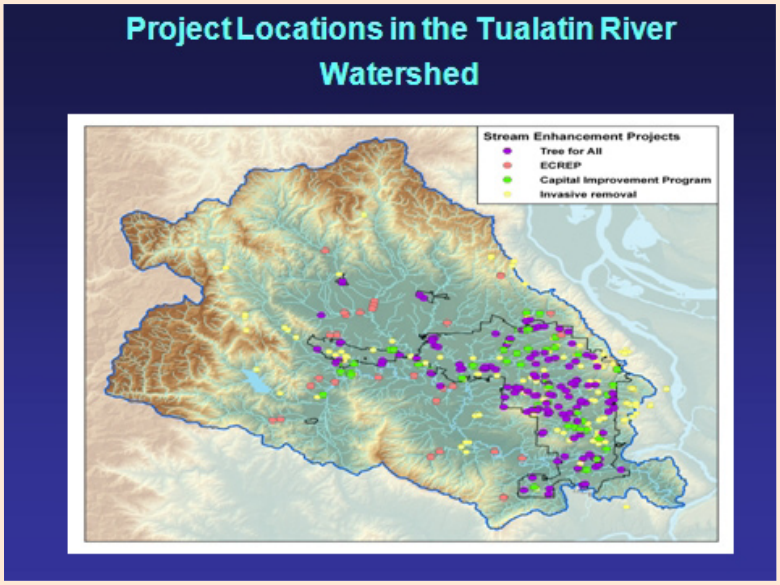
Figure 3.

Native grasses were seeded in early spring between the rows of trees to control weeds and soil erosion in the Tualatin River Watershed. (Spring 2006).

Figure 4.

One year after planting the native vegetation is thriving in the Tualatin River Watershed. (Summer 2007).

Figure 5.



Source: Roll, et al, 2008.

Figure 6.

As the vegetation grows, the buffer will shade out the blackberry and protect the Tualatin River stream bank. (Summer 2008).

riparian areas toward a 5–year goal of 35 miles of such land (Roll et al., 2008). The annual program costs for soil rental & other incentive payments to landowners, planting materials, contracted labor and program staff was $3,693/acre (projects in their 1st year) and $2,707/acre (projects during years 2–5) (Bryant, personal communication, 2008).

The direct benefits of the program to CWS were the avoided capital expenses ($60 M) and O&M ($2.5 million to $6 million/year) associated with achieving the temperature reduction through chillers. Another benefit was the added ecosystem services associated with creating shade along stream banks and the river's tributaries, such as preventing stream bank erosion and creating natural habitat for other species. These added benefits would not have been received by using chillers and they were important to CWS and other stakeholders in the region who supported this program (Vickerman, 2008). This led to broader recognition by environmental groups and other stakeholders of the potential for how ecosystem services might be achieved through market–based schemes.

However, the initial benefits from the trading program should be viewed cautiously. The temperature benefits from riparian shading do not occur at the same time (i.e. the trees must mature to provide full shade), or with the same degree of certainty as the structural option of the chillers. CWS's quality assurance and monitoring programs are increasing the likelihood that the temperature trading program achieves a high success rate.

Ecosystem Services Marketplace in the Willamette River Basin

The Willamette Partnership is coordinated by a coalition of largely non-governmental organizations in the large and diverse Willamette River basin. Most members had worked

together earlier under the Willamette Restoration Initiative (Primozich, 2005). This newer effort is broad and ambitious in its goals. It is attempting to use market forces to achieve multiple environmental performance goals, including restoring watershed health (Vickerman, 2008).

The Willamette Partnership has focused its efforts on developing an ecosystem marketplace for environmental investments in the river basin. While the effort was initially driven by the need to meet a temperature Total Maximum Daily Load (TMDL), it was broadened to include other environmental performance goals, including ecological resiliency, watershed health and sustainability (Primozich, 2005; Vickerman, 2008). The partnership is exploring other land use changes, such as wetland expansion, retiring flood–prone farmland, and restoring the hyporheic zone along more urban river banks, for their potential to generate temperature reductions.

In 2005, the Willamette Partnership obtained a three–year Environmental Protection Agency (EPA) grant to build the tools to develop and implement the ecosystem marketplace concept within the river basin (Primozich, 2005). Additional funds and in–kind resources were used to implement this project. The coalition's overall goal was to use the marketplace to drive investments that provide the greatest return to the watershed. Specific means proposed for achieving this overall goal include trading, credit banking, and development of types of ecosystem "currencies."

In this EPA-funded project, temperature credit trading was seen as an initial way to reduce costs by allowing some dischargers greater flexibility to meet their responsibilities under the temperature TMDL. Credit banking has been proposed to allow parties to document performance related to the TMDL and provide a product that could attract resources in a marketplace where other watershed projects and priority projects not in the TMDL could be addressed.

In addition, several other credit units or "currencies" have been proposed by the project's leaders, including pollution units and environmental services (e.g., habitat restoration) to meet regulatory requirements from other agencies. Over time the program plans to develop a common currency to be used in assessing the relative benefits of different projects (Primozich, 2005).

Over the past three years the Willamette Partnership developed several important tools, including a synthesis map that brought together previously disparate data, and established conservation priorities intended to foster the development of an ecosystem market place (Vickerman, 2008). Numerous activities, including workgroups, taskforces and conferences, have occurred and tools have been made available to potential users. These actions represent an important focal point for creative study and action around the possibility for market concepts to achieve water quality and ecosystem benefits in the basin. Despite these important steps, the central goal of the partnership to meet the terms of its EPA grant—to complete a temperature trade to help reach the temperature–based TMDL for the watershed—was not reached by mid–2008

Perspectives about the reasons for the lack of achievement of a trade in the Willamette basin differed among agencies and interest groups involved. Lawsuits had been filed against the Oregon DEQ relating to the issuance of the TMDL as well as specific load allocations (Nomura, personal communication, June 2008). Frequently identified barriers included the lack of acceptance of the science behind the TMDL and the perceived lack of fairness of the load allocations to different dischargers in the TMDL. The overall effect of these disagreements was to increase uncertainty and increase the transaction costs to trading. This barrier of high transaction costs has been frequently identified as a barrier in the water quality trading literature (Abdalla, Borisova, Parker and Saacke Blunk, 2007).

Policy Implications

Market–based approaches are being attempted to address the difficult challenge of nonpoint source water pollution by allowing trading between municipalities under water quality regulatory constraints and farm or forest landowners. Based on an assessment of available information from two ongoing experiments with market concepts in Northwest Oregon, several policy implications can be drawn.

Federal/State Flexibility, Risk–taking & Resources Matter

A necessary condition for innovative market–based approaches is a supportive organizational environment and resources. EPA Region 10 and the Oregon DEQ were flexible in terms of their regulatory approach to issue water quality permits and willingness to take risks with an unproven market–based experiment to address water quality degradation. The USDA and a number of other federal and state/regional agencies and organizations provided resources and technical assistance that significantly contributed to the Tualatin River program's achievements.

Allowing staff the time and flexibility to explore such innovative approaches is one key to success. Innovative projects are typically considered by state agencies as something to do in one's spare time or a luxury to be funded in better budget times. To overcome this, the initial grant that funded the Tualatin River pilot program allowed Oregon DEQ to devote staff time to fostering and developing this project (Bjorn–Hansen, 2007)

Activities May Not Generate Anticipated Results

Significant resources have been put into the water temperature trading program coordinated by Clean Water Services in the Tualatin watershed and the proposed ecosystem services marketplace coordinated by the Willamette Partnership. In both cases, a significant amount of activities occurred. But only in the case of the Clean Water Services program have on the ground land use changes occurred and some intended outcomes been realized. Moreover, it is critical to discern between program activities and actual behavioral, land use or water quality outcomes achieved when assessing market–based experiments in environmental protection.

Scale, Complexity and Heterogeneity of the Watershed Matter

Much greater success was achieved in the Tualatin watershed, which was geographically smaller and contained fewer, generally more homogeneous municipalities and land uses relative to the more diverse and complex Willamette River basin. In addition, the program run by Clean Water Services in the Tualatin focused on the water quality parameter of temperature and observable best management practices that were correlated to water improvements and their associated benefits to fish and wildlife. One should remember though that the Tualatin pilot project has been in existence for three years longer than the Willamette Partnership.

Existence of Conflict among the Parties Matters

Disagreements about science and regulatory issues increase uncertainty and transaction costs and thereby act as a barrier to market–based approaches. In the case of the Tualatin watershed, important stakeholders, including environmental groups, did not challenge the science behind Total Maximum Daily Load (TMDL) numbers. In the Willamette River basin, important stakeholders have disagreed about scientific, legal or fairness issues related to the TMDL for the river basin, leading to considerable uncertainty and increasing transaction costs.

Leadership, Resources, and Organizational Capacity Really Matter

Some observers have pointed to the leadership, financial and organization capacity of government agencies as the ingredients for the achievements of the Tualatin watershed temperature trading program.

Federal and state regulatory agencies clearly play a critical role in fostering innovative market based projects. They need to strike a balance between holding the municipal or other permit holder accountable to meet the environmental program's goals and being flexible enough to accommodate the learning experience which will inevitably occur as the projects are implemented.

At the local level Clean Water Services' willingness to take a leadership role and persistence in bearing the significant transaction costs of trying a new approach were a key reason for the project's success. In addition, the special district's organizational and technical capacities and willingness to innovate and learn were evident, especially in its efforts in quality assurance and follow–up monitoring and evaluation. Clearly, paying attention to implementation details and learning from mistakes is critical to making market–based programs work. These needed follow–up steps can be costly. Clean Water Services had the organizational capacity and committed the resources to pay attention to these necessary program ingredients to ensure that the intended outcomes would be realized. Others considering market–based programs need to be acutely aware of the realities of implementation, monitoring and learning, and to ensure that some organization is committed to "follow through" and evaluation.

For More Information

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Charles Abdalla, (CAbdalla@psu edu) is Professor of Agricultural and Environmental Economics, Department of Agricultural Economics and Rural Sociology, Pennsylvania State University, University Park, PA.

Appreciation is extended to Autumn Bryant, Landowner Incentive Program Manager, Tualatin Soil & Water Conservation District, Hillsboro, Ore. who provided the photos used in this article.