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Research Paper

Integrating ecosystem services and local government finances into land use planning: A case study from coastal Georgia

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HIGHLIGHTS

- Forested wetlands generate relatively little revenue, but have very high ecosystem service value.
- Forest lands overall contribute much more in revenue than they receive in services.
- Residential properties cost more in services, than they generate in revenue.
- Ecosystem services benefits, hazard reduction, and lower costs result from floodway buffers.

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ABSTRACT

This work presents a novel approach to assessing the impact of future growth in rural regions faced with rapid growth. We investigate one of the most rural counties on the eastern coast of the U.S. (McIntosh County, Georgia) from the dual perspective of (1) ecosystem services and (2) costs assumed by local government. As land cover in our focal locality is overwhelmingly forest or wetland, we compiled estimates from multiple sources to map the value per ha/year of (1) timber sales and recreational leases to private landowners and (2) a suite of non-market public amenities: rare species habitat, carbon sequestration, flood control, pollution treatment, water supply, and storm protection. We then quantified, based on county budgets, expenditures and revenues deriving from major land use categories (residential, commercial/industrial, agricultural/open-space). Results indicate that (1) forested wetlands generate relatively little revenue to either private landowners or in taxes to the county from extractive uses, but have very high value relative other land cover types in the provision of ecosystem services, (2) forest lands contribute much more in revenue than they receive in services, whereas residential properties cost more in services, than they generate in revenue, and (3) significant gains in both ecosystem service preservation, hazard reduction, and in lower costs to the county in municipal services could be achieved by restricting new development from within the Federal Insurance Rate Map (FIRM)-determined 500 year floodplain.

1. Introduction

In a process echoed in many other parts of the world, over the last 60 years, a major driver of land use change in the United States has been suburban and exurban development. Prior to 1950, land use moved typically from wild land where resources were extracted to agriculture then finally to suburban or urban uses. Since 1950, low-density housing (6–10 homes/km^2) set within a landscape of native vegetation has become the fastest growing form of land use (Brown, Johnson, Loveland, & Theobald, 2005; Hansen et al., 2005). Low-density development is often welcomed by rural and suburbanizing counties/municipalities for its perceived benefits to the local economy and to municipal level tax revenues, and because of the returns to politically influential landowners from subdividing and selling land. As it has spread and been replicated across many regions, low-density development patterns resulting from the conversion of forest and agricultural lands to primarily residential uses, often dubbed "sprawl", has come under attack from planners and environmentalists.

On the fiscal side, critics have often made the case that the economic benefits of low-density residential development in the form of tax revenues to local communities may be significantly outweighed by the costs of providing municipal services such as roads, schools, police and fire protection to newcomers. Furthermore, the burden of funding infrastructural improvements or expansion of services is often borne by current rather than incoming residents

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(e.g. Carruthers & Úlfarsson, 2008). A second set of concerns relate to the loss or impairment of natural amenities such as water quality, wildlife habitat, and recreational opportunities with increased development, and the concurrent decline of traditional economic activities such as agriculture, forestry, and fishing. (See Pejchar, Morgan, Caldwell, Palmer, & Daily, 2007; Real Estate Research Corporation, 1974, for a detailed introductions to both sets of critiques.)

Cost of Community Service (CCS) studies have been used to estimate the fiscal impact of development. The American Farmland Trust (AFT) first developed the CCS methodology in the mid-1980s, following two seminal publications, The Fiscal Impact Handbook (Burchell & Listokin, 1978) and Cost of Sprawl (Real Estate Research Corporation, 1974), which demonstrate the importance and cost-effectiveness of land-use planning. The CCS approach partitions land uses into three classes: residential, commercial/industrial, and agricultural/open-space, and then allocate expenditures and revenues from the municipal budget to each category. Although the specific assignment of funds may differ among CCS studies, the final result is always a ratio of expenditures to revenues for each of the three land uses. For example, a ratio of 1.2 for residential land means that for every $1.00 of revenue raised from these areas, that $1.20 is spent (Dorfman, 2006).

The issue of lost environmental amenities as a countervailing cost to the expected benefits of development has received increasing attention with the emergence of ecosystem services as an organizing principle. As a concept, "ecosystem services" addresses the need to adequately represent the value to humans and human society of vital functions performed by natural systems when, for example, making decisions that determine future land use. How ecosystem services are defined has evolved over the last two decades as various frameworks have been developed (Boyd & Banzhaf, 2006; Brown et al., 2007; Costanza et al., 1997; de Groot et al., 2002, Daily, 1997; Fisher & Turner, 2008; Millenium Ecosystem Assessment, 2005; Wallace, 2007). Broadly, we may define ecosystem services as products of nature that directly benefit humans. Practically, estimating the value of ecosystem services often faces a crucial limitation in the availability, format, and quality of relevant data. Furthermore, the availability, format, and quality of socioeconomic data from which valuation must ultimately be inferred (Polasky, Nelson, Pennington, & Johnson, 2011). Deriving values for ecosystem services in such a way that they can be compared in similar units to the fiscal gains and losses stemming from development is most straightforward when the services are directly linked to markets as is the case with timber, fisheries, or agricultural products ("provisioning services" in the MEA scheme). Estimating values is much more challenging when the services of interest, such as biodiversity or maintenance of water quality, cannot be readily linked to markets (Barbier, 2007; Mangi et al., 2011; Mendelsohn & Olmstead, 2009; Polasky & Segerson, 2009). Whereas increasing intensity of use leads, it is generally believed, to reduced flows of regulating ecosystem services (e.g. climate change mitigation by carbon sequestration, absorption of flood waters) (de Groot et al., 2010), we often lack information on "production functions" or the relationship between changes in land use and these flows (Polasky et al., 2011), and, importantly, whether such functions may exhibit non-linear or threshold responses to land-use changes (Barbier et al., 2008; Koch et al., 2009). In addition, we often do not have a means for handling potential trade-offs among ecosystem services (Polasky et al., 2011), e.g. between conservation of biodiversity and carbon sequestration. The challenges above notwithstanding, existing valuation approaches allow land use changes to be broadly assessed in terms of likely gains or losses in specific services.

However, an additional issue relates to the potential mismatch between opportunity costs and benefits of ecosystem services that are often managed at a local scale yet valued more at statewide/regional, national or global scales (Hein, van Koppen, de Groot, & van Ierland, 2006). For example, the protection of nursery habitat for fisheries may require local planning efforts, but the value may accrue to a larger regional or statewide group of stakeholders. Therefore, while attention may focus on the value of natural amenities to stakeholders defined broadly, these benefits may not be sufficient to influence local policy or development decisions which are often determined by vested interests, and incentives or benefits (perceived or actual) that apply locally. To the extent that these differences in local versus regional to global valuation have been addressed by policy-makers, a system of payments for environmental services (PES) may be incorporated into taxes or other policy tools. PES schemes are economic incentives to landowners or resource managers that take a variety of forms from tax relief to direct payments but seek to increase the flow of ecosystem services (see Farley & Costanza, 2010; Jack, Kousky, & Sims, 2008 for an overview of PES schemes and issues related to them). Thus, to effectively guide land use decisions such that ecosystem services are optimally preserved, constraints and incentives at the local level need to be accounted for (Polasky et al., 2011).

In this study, we focus on McIntosh County, a rural county on the Georgia coast. Because the county lacks large industries or major towns and a sizeable portion of the land-base is in public ownership, McIntosh is currently one of the least developed on the east coast. As with many coastal communities, the area faces development pressures as scenic and recreational amenities attract retirees, second-home buyers, and exurban commuters. The rapid connection via Interstate-95 to nearby communities and workplaces has spurred population growth in the county over the last two decades (http://www.rupri.org/Profiles/Georgia2.pdf, http://georgiastats.uga.edu/counties/191.pdf). The hiatus in growth following the crash of 2008 affords an opportunity to plan more comprehensively for future growth by evaluating different scenarios in terms of both fiscal and ecological impact. In this paper, we combine a CCS survey with measures of a set of ecosystem services toward the goal of identifying where outcomes have the potential to both maintain ecosystem service flows and limit municipal costs. We first categorize both local revenue sources and local government expenditures as flowing from rural versus commercial/industrial versus residential sources, and summarize the values for each class. Then, for forested lands and wetlands, the two major classes of rural land in McIntosh County, we map and sum the value of a set of ecosystem services as a means of identifying portions of the county landscape with high value for either commodity production or the provision of non-market ecosystem services, and therefore, candidate sites or features for development restrictions such as buffers, easements or overlay zoning.

Motivated by these results, we consider, in terms of fiscal gains and the value of ecosystem service flows, the potential impact of preserving critical elements of the landscape as "green infrastructure". Green infrastructure is an approach to conserving these components not only as natural amenities, but as features essential to ecological functioning and long-term sustainability (e.g. riparian buffers promote water quality and wildlife habitat) (Benedict & McMahon, 2002, 2006). To investigate likely differences in the cost of providing municipal services and in the value generated by natural systems in the form water quality/waste assimilation, carbon sequestration, timber production, wildlife habitat/biodiversity, and storm protection, we apply values from the relevant literature on land-use patterns, municipal expenditures, and ecosystem services to metrics derived from geographic models with and without green infrastructure. Our goals are to demonstrate how growth in McIntosh County can be best managed to maintain the provision of ecosystem services and limit the growth in costs to county