Connecting Green Infrastructure with Transportation Planning

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Introduction

The development of green infrastructure planning is increasingly espoused by landscape, conservation, and metropolitan planners as an effective way to create a network of ecological functionality in regions that are otherwise highly impacted by anthropogenic changes. The most common condition is one of expanding metropolitan growth transforming cultivated and natural landscapes into developed ones. Despite its promise, several critical problems arise with green infrastructure planning. We will consider three. The first is that the definition of green infrastructure within the public realm remains highly variable if not embryonic. The second is green infrastructure is a long-term investment whose effects will not be able to be measured until years after implementation, yet there are very few cases of green infrastructure planning that have actually resulted in adopted and implemented plans, which can be used as models of success. And third, although the public benefits of green infrastructure are positive, other forms of regional scale planning have more dominant influence and impacts, most notably transportation planning.

Concerning this last point, our thesis is that green infrastructure and transportation infrastructure have important interactions. Furthermore, transportation infrastructure potentially degrades green infrastructure networks through fragmentation, ecosystem impairment, and loss of connectivity. Mitigating the impacts of transportation infrastructure could potentially be an important asset to green infrastructure planning. Coordination of transportation and green infrastructure holds promise for sustainable development across regional landscapes. We address this thesis by assessing the landscape significance of both green and transportation infrastructure planning and presenting a case study from Maryland, USA.

The case study indicates that there are numerous logical connections between the two types of plans, some of them conflicting. However, it also indicates that there is much research still necessary on green infrastructure, especially in the areas of implementation and efficacy.

Background

Green infrastructure is a critical component of landscape planning for sustainability. However, while landscape planning is a core integrative concept (Selman, 2006), green infrastructure is a sectoral interest that deals with ecological services as well as ecosystem function and adaptation. Benedict and McMahon (2006, 281) define green infrastructure to be "an interconnected network of waterways, wetlands, woodlands, wildlife habitats, and other natural areas; greenways, parks, and other conservation lands; working farms, ranches, and forests; and wilderness and other

open spaces that support native species, maintain natural ecological processes, sustain air and water resources, and contribute to the health and quality of life for communities and people." Other definitions are less inclusive. The US-EPA considers green infrastructure to be primarily concerned with stormwater runoff. For this analysis, we will define green infrastructure as a network occurring at the landscape, regional, or continental scale, of natural and semi-natural areas, that protects and enhances ecosystem services, regenerative capacities, and ecological dynamism over long time frames. (There is a meaningful discussion of site-level design elements as green infrastructure, but these are outside of the scale of this discussion.) Landscape ecology is essential in designing green infrastructure alternatives. In order to facilitate sustainability, green infrastructure, must have a long view that includes adaptation to climate change.

Transportation infrastructure is another sectoral interest within landscapes and regions directed at moving goods and people efficiently. Historically, financial investment in transportation infrastructure has been orders of magnitude greater than green infrastructure. Furthermore transportation structures along with other forms of "hard" or "gray" infrastructure, such as energy or water distribution, induce land development.

Green infrastructure in Maryland ensures valuable ecosystem services that are necessary for the continued functioning of ecosystems as well as promoting overall wellbeing for its residents. The state has moved towards protecting its green infrastructure. The Maryland State Data Center projects that populations are expected to continue to increase by 26 percent between 2000 and 2030, increasing the probability of natural lands to succumb to the pressures of development (Maryland Department of Planning 2009b). State data center projections also assert that between 1997 and 2020 urban land uses will increase by over 25 percent while forest cover and agriculture are expected to decrease approximately nine percent (Maryland Department of Planning 2009a). As this rate of development increases, much of the state's wildlife and migration corridors are lost, ecosystem functionality is increasingly disturbed or destroyed, and water quality has be degraded throughout many of the state's streams and rivers as well as the highly productive Chesapeake Bay (Weber, Sloan, and Wolf 2006, 94-110). In 2003, Maryland conducted its first assessment of statewide green infrastructure to provide consistency in the evaluation of land conservation, restoration and protection efforts (Maryland Department of Natural Resources 2003a).

Goals and Objectives

The goal of our research is to understand the potential interaction between hard infrastructure planning and green infrastructure planning as a means to leverage the former to have better outcomes for the latter. In order to do this, our objectives are to understand the definitions and concepts that various agencies use for green infrastructure; look for points of overlap and conflict; and examine how mitigating impacts of hard transportation infrastructure can enable implementation of green infrastructure.

Methods

We address these objectives by looking at a particular case study. In particular, we review the plans for two counties in Maryland, United States, which are at the forefront of green infrastructure planning. We also examine Maryland's statewide green infrastructure assessment. Then we examine the Final Environmental Impact Statement for the Intercounty Connector, a highway project under construction crossing Prince George's and Montgomery Counties. We focus on how the term "green infrastructure" is used throughout the various documents.

Results

The Maryland Green Infrastructure Assessment (GIA) is a statewide effort aimed at identifying the state's most important natural lands. The Maryland Department of Natural Resources conducted the assessment, which heavily utilized geographic information science (GIS) technology coupled with the theories present in landscape ecology and conservation biology to help identify an ecological network. In 2000, the Department of Natural Resource's Chesapeake and Coastal Watershed Service spearheaded the GIS analysis through the use of satellite and aerial imagery, land use cover maps, and environmental and biological databases developed within the state's Natural Heritage Program, the Maryland Biological Stream Survey, and the Forest Service (Conn 2009). Maryland currently has only two million acres of ecologically significant land that is not affected in some way by development. It is estimated that approximately 70 percent of this green infrastructure is unprotected (Maryland Department of Natural Resources 2003a). The primary step in the process employed in Maryland's GIA was the establishment of hubs, which typically consist of unfragmented areas that range from several hundreds to thousands of acres in size and are viewed as being critical components to the maintenance of the state's ecological integrity. Based upon the GIA model used by the state, it identified that the average size of all hubs in the state was approximately 2,200 acres (Maryland Department of Natural Resources 2003b).Upon the establishment of area hubs, the identification of corridors commonly aligns as the second step in the process of network design. The state identifies corridors as linear remnants of natural lands that are used to connect similar hubs.

The state government was very involved in making a case for green infrastructure conservation and in 2003, then Governor Erlich institutionalized green infrastructure in state land conservation planning efforts and added a set of comprehensive ecological indicators that were to be used to expand the state's land preservation purchases. This initiative allowed for the state Rural Legacy and Open Space conservation programs to prioritize conservation activities based upon the state's designated green infrastructure (Greenprint 2009). As Maryland has embraced green infrastructure as a valuable form of long range conservation planning, tools have been developed to assist in this strategy. One such tool is presented through the state's "Smart, Green and Growing" efforts, which is Governor O'Malley's GreenPrint initiative (Maryland Office of the Governor 2008).

The adoption of a green infrastructure approach by the state of Maryland has ultimately led to the creation of various countywide plans throughout the state. These plans tend to follow similar methodologies for network design but are conducted at a finer scale and involve numerous stakeholders throughout the planning process. The plans are an extension of the statewide GIA and commonly provide goals, objectives, policies, and recommendations for successful implementation. The plans are often intended to align with other county or state plans and aim to maintain consistency with other planning efforts. The two counties that make up the area located along the ICC, Prince George's and Montgomery, have both created their own countywide green infrastructure plans and are overseen by the same planning agency.

In Prince George's County, planning is administered by Planning Department. The Planning Department prepares the general plan, which serves as a comprehensive plan for the entire county. The most recent general plan was adopted in October 2002 and set forth recommended goals for the environmental areas suggesting the creation of a green infrastructure plan. The process used to develop the plan was later used by Montgomery County in their planning efforts. There was an extensive participatory component both with citizen stakeholder groups as well as other government agencies. In 2005, Prince George's formally approved and adopted as county policy the Countywide Green Infrastructure Functional Master Plan. This plan is an extension of the statewide GIA but was constructed at a finer scale and accounted for all countywide areas of environmental significance (Prince George's County Planning Department 2010).

In 2001, the Montgomery County formally began a ten year $100 million initiative to complete a countywide network comprised primarily of areas of open space, protected farmland, ecological reserves, and green space preserves (Maryland Office of the Governor 2008). The current green infrastructure plan is a part of this initiative and will be implemented as a functional master plan that will bear equal weight as other county plans including transportation plans. The Montgomery County green infrastructure plan has not been completed, but draft maps of the proposed network have been created. In 2006, the Montgomery County Planning Board approved the publication of the Purpose and Outreach Strategy Report, which initiated the planning process. This collaborative process allowed for the creation of maps, which resulted in conceptual maps of the county's desired green infrastructure network. An extensive public participation component has been included in this planning process and the plan must still undergo approval by the county planning board and county council.

The Washington D.C metropolitan area of Maryland has experienced a great deal of growth in recent decades. Changes to the areas transportation infrastructure have become critical to managing the growth seen in this region. The Intercounty Connector (ICC) project is a multi-modal east-west highway that connects northwestern Prince George's County with central and eastern portions of Montgomery County (Maryland State Highway Administration 2003). The aim of the project is to link existing and proposed development areas between I-270 and I-

95/ US 1 corridors throughout both counties. The project has been planned and studied for over 50 years as part of the creation of an outer freeway known as the Outer Beltway. It wasn't until 1979 that the Maryland State Highway Administration (SHA) initiated the first planning studies for the ICC. In 1983 and 1997 the SHA issued a Draft Environmental Impact Statement (DEIS) and began holding public hearings for the project. In both instances no decision was reached and a third DEIS was issued in 2004. Upon approval in 2005, construction on the ICC began in late 2007. Currently the project is projected to be completed in 2012 (Maryland Department of Transportation State Highway Administration 2009).

As planned, the ICC is 18 miles and contains eight interchanges. The project consists of five contracts and contains 16 miles in Montgomery County and two miles in Prince George's County. Total costs for the project are estimated at $2.566 billion and will be funded by various entities including bonds, general funds and tolling revenues (Maryland Department of Transportation State Highway Administration 2009).

The ICC's Final Environmental Impact Statement (FEIS) definition of green infrastructure is consistent with the definition presented in the Maryland GIA and contains various similarities. Although the FEIS identifies the statewide GIA as another effort to evaluate forest loss and habitat areas, the Maryland DNR commented within the FEIS that the ICC project may fragment many of the existing hubs within the green infrastructure network and ultimately lead to loss in connectivity between various hubs (Maryland State Highway Administration, Maryland Transportation Authority, and Federal Highway Administration 2006, 614).

Upon review of the ICC FEIS the term 'green infrastructure' appeared 12 times throughout various sections of the document. The statewide GIA was noted for consistency purposes but there were no direct references made to the Prince George's Green Infrastructure Plan, which was adopted in 2005. The ICC FEIS does include an assessment analyzing the potential impact of development on identified green infrastructure hubs and corridors and grouped these impacts based upon watershed and subwatershed. Three watersheds including the Middle Potomac River, Patuxent River, and Washington Metropolitan watersheds were analyzed and broken down into 11 subwatersheds (Maryland State Highway Administration, Maryland Transportation Authority, and Federal Highway Administration 2006, Appendix P-3).

Other references to green infrastructure were made throughout the secondary impacts section, particularly in the comparison of different design alternatives for the highway. It was noted that the secondary impacts to identified green infrastructure hubs varied depending on the design alternative. It did not appear that this assessment affected decisions on altenatives.

Discussion and conclusion

The potential for green infrastructure to be included in the ICC environmental assessment is high, considering that the state has embraced this concept and both counties located within the project area have, or are in the process of creating, their own green infrastructure plans. It appears that green infrastructure may be included in documents such as EIS's to address possible mitigation efforts. As the FEIS we analyzed stated that mitigation sites were to be consistent with restoration needs identified in the statewide GIA, it does not account for the areas lost that are directly associated with the construction of the project. The mitigation they suggest is for areas already identified as green infrastructure, in need of restoration. This approach does not follow the notion that both green and hard infrastructure hold equal importance and suggests that the hard infrastructure is being given the lead in determining what ecological areas deserve restoration and how this aligns with the goals of the transportation plan.

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The FEIS identifies that the probability of fragmentation and habitat loss occurring within the remaining forestland is increased and that these impacts will make the area less suitable for many species living within the project area (Maryland State Highway Administration, Maryland Transportation Authority, and Federal Highway Administration 2006, 804). By recognizing the potential impact of this project it becomes important to analyze the relationship between the green and hard infrastructure associated with this type of planning endeavor. The importance of maintaining the integrity of the ecological system through maintaining connectivity and limiting fragmentation could be guiding efforts for how and where the hard infrastructure will be situated. This is not to say that green infrastructure takes precedent over gray infrastructure but rather that the two should be analyzed concurrently.

Using green infrastructure plans as a guide for hard infrastructure requires that green infrastructure assessments be carried out in advance. Then the green infrastructure can be used as a support tool rather than a barrier for transportation development. For one, the greenway elements of a green infrastructure may be able to serve as a

nonmotorized vector of travel, particularly for bicyclists. Furthermore, by overlaying green and transportation networks, points of conflict can be identified and alternative solutions laid out. Both green infrastructure and transportation plans are affected by proximate land use decisions and, in turn, may induce changes in land use decisions. But while transportation systems can be altered on the order of decades, regenerating effective green networks may require a higher order of magnitude.

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