Greenways in Strategies of Mitigation and Adaption to Climate Change: Case Study of State of Maryland, USA

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Introduction

This paper, using the State of Maryland, USA as a case study, draws connections between greenway contributions to the Greenprint Program in MD and the rapidly expanding work on the use of green infrastructure to address climate change. It focuses on recent initiatives that could support the role of greenways in mitigating and adapting to climate change. Maryland established the Climate Change Commission in April 2007 by executive order to develop a plan for reducing the state's vulnerability to sea level rise and other impacts of climate change. The Maryland Climate Change Commission's Climate Action Plan documented forty-two mitigation strategies and nineteen adaptation strategies through the development of an implementation plan (Maryland Climate Change Commission (MCCC), 2008). Implications for mitigation and adaption of climate assessments impacts have also been recently published (Boesch, 2008). How can greenways contribute to these mitigation and adaptation strategies? How can greenways contribute to carbon reduction as a mitigation strategy? Emerging markets and systems for carbon sequestration (e.g., Chicago Climate Exchange and The Climate Registry) might be possible opportunities for greenway landscapes. What are the possible management and policy implications for greenways? The Greenprint Program also provides a framework to increase the role of greenways in addressing climate change.

Background

Current impacts of climate change on species populations and ecosystems are mounting (Kalr, et.al, 2009). Changes in animal migratory patterns, species phenological responses to temperate changes, and increases in pest infestations are among documented changes. In addition, future predictions of consequences of climate change include a wide range of impacts resulting from changing temperature and moisture regimes. One response has been the promotion of adaptive management strategies to deal with these impacts (Heinz, 2008). Greenways, and connected greenway network systems, have long been advocated as a landscape type that can support and accommodate multiple biological and conservation goals (Ahern, 1995; Fabos and Ahern, 1995; Hellmund and Smith, 2006). Bryant (2004) and Gill et.al. (2007) document the role of greenways and green infrastructure in their contribution to urban and metropolitan biodiversity and the roles that they might contribute to global climate change.

Goals

The goals of this inquiry are to 1) document selected strategies for mitigating and adapting to the impacts of climate change in as established by the MCCC (2008); 2) explore where the design, planning, establishment, and management of greenway systems might coincide with and support these strategies, and; 3) consider the possible contributions and limitations of greenways in mitigating and adapting to climate impacts. How can greenways and associated greenway systems contribute to these mitigation and adaptation strategies?

Methods

The author reviewed the literature to find existing strategies for mitigating and adapting to climate change impacts with a focus on literature specific to Maryland and the region. Other strategies not specific to Maryland were also investigated (Heinz, 2008). Each strategy from the MCCC (2008) was reviewed in relation to greenway systems and the author made a judgment as to the relationship between the strategy and the possible role that either an existing or proposed greenway system might be able to address the specific mitigation or adaption strategy.

Results

Expected changes to Maryland as a result of climate change are in part due to its unique physiographic character dominated by the Chesapeake Bay.

> *"With over 3,000 miles of coastline, Maryland is poised in a very precarious position when it comes to the impacts of climate change. Maryland's coast is particularly vulnerable to both episodic storm events, such as hurricanes and Nor'easters, as well as chronic problems associated with shore erosion, coastal flooding, storm surge, and inundation. Problems such as these are both driven by and exacerbated by climate change and sea level rise*." (MCCC, 2008, p. 5)

Mitigation Strategies

The Climate Action Plan (MCCC, 2008) provides forty-two policy options focused on mitigating the predicted impacts of climate change. These options are organized into five groups: 1) Cross-Cutting; 2) Residential, Commercial & Industrial; 3) Energy Supply; 4) Agriculture, Forestry & Waste; and, 5) Transportation & Land Use. While many of these options might have some relationship with greenways, Table 1 indicates the policy options selected that were judged to have the strongest relationships with greenway and greenway systems.

Table 1: Selected Mitigation Options adapted from MCCC (2008)

Six of forty two mitigation options / strategies that were identified that had a strong relationship with greenways	Lower Emission Reduction / Easier Implementation	Higher Emission Reduction / Harder Implementation
Agriculture, Forestry & Waste		
Forest Management for Enhanced Carbon Sequestration	■	
Managing Urban Trees & Forests	■	
Afforestation, Reforestation & Restoration of Forests & Wetlands	■	
Protection & Conservation of Agricultural Land, Coastal Wetlands & Forested Land	■	
Nutrient Trading with Carbon Benefits	■	
Transportation & Land Use		
Bike & Pedestrian Infrastructure		■

All forty two options were further categorized by the MCCC (2008) into four "bins', characterizing the level of emission reduction and ease of implementation, each in two categories (two are noted in Table 1). Of the selected six strategies in this report, five strategies are categorized into the bin of "Lower Emission Reduction / Easier Implementation". This suggests the limitations that greenways can contribute to carbon emission reduction relative to higher emission reduction strategies (e.g., Low-Cost Loans for Energy Efficiency) whether they are hard or easy to implement. Contributions to mitigation that core greenway systems can offer include carbon sequestration and the development of urban tree programs as part of connecting rural and exurban greenways to more interstitial urban green structure. Mitigation benefits may also accrue where greenways serve as core areas for the targeting of afforestation, reforestation and the restoration of forests and wetlands. Existing greenways already contribute significantly to the conservation of coastal wetlands and forested lands. Additionally, it is possible that greenway systems may be perceived and used as receiving landscapes for nutrient trading with carbon benefits. Only one option, Bike & Pedestrian Infrastructure, was selected under the category "Transportation & Land Use". This option was also classified in the bin of "Higher Emission Reduction / Harder Implementation", suggesting that carbon reduction from this policy might be a focus of greenway planners. Unger's et.al, (2010) study of the contribution of atmospheric warming, now and in the near term by societal sector, indicates that motor vehicles are the greatest contributor. Markatos (2009), using the East Coast Greenaway as an example, suggests that greenways can achieve most of United States President Obama's 2020 climate goals. These goals would be met by an increased usage of greenways for daily transportation. This suggests that greenways that facilitated greater integration between jobs and dwellings might meet mitigation strategies. These efforts are in competition and cooperation with traditional transportations systems and more recent initiatives of high speed rail,

transit-oriented development, and light rail systems now being developed in many cities. Again, limitations noted by MCCC (2008) suggest that while the development of bike and pedestrian infrastructure provides high carbon reduction benefits, these systems will be harder to implement in relation to other strategies that were identified.

Adaptation Polices

While mitigation strategies seek to reduce carbon emissions, adaptive polices focus on strategies to adapt to predicted impacts of global warming. Due to Maryland's extensive coast line, sea level rise and impacts from coastal change are significantly highlighted in the adaptation strategies. All adaption policies are noted Table 2 and the degree of the relationship is suggested. While all strategies are noted to inform the reader about the diversity and complexity of strategies and the integrative nature of polices, only the polices with the contribution to greenway were noted in full. It was beyond the scope of this paper to outline the complexity of many of the adaptation strategies that are organized on scenarios of sea level rise or temperature change. Nineteen priority policy options were developed (Table 2). Like mitigation, integrated planning of existing or new greenways has the potential to provide greater resilience to changes in temperature and coastal dynamics. Maryland greenways can be organized as focused on ecological, recreational and economics contributions. Greenways offer some possible potential contributions to the policy "Resource-Based Industry Economic Initiative". Recreation and wildlife related activities that occur in greenways would support this policy. Most of the adaptation polices are organized under "Natural Resource Protection". The identification of high priority protection and restoration actions, retention and expansion of forests and wetlands, and the promotion and support of sustainable shoreline and buffer areas all coincide with goals of existing and potential greenways. Another policy opportunity identified is "Public Awareness, Outreach, Training and Capacity Building" and "Monitoring". As a contributor to this policy, greenways can play an important role in providing information about adaptation and mitigation information to help educate users of trail systems. The Appalachian Trail (AT) MEGA-Transect project is an example where the Appalachian Trail Conservancy (ATC) and National Biological Information Infrastructure (2010) are using the users of the AT to document changes. The program also seeks to educate trail users about the impact of climate change as well as promoting the availability of mass-transit and other low carbon transportation alternatives for travel to trailheads. Last, greenways offer very real benefits to protect human health in urban areas, where most people now live. Kalr, et.al, (2009) reports that extreme heat and declining air quality are likely to pose increasing problems for human health, especially in urban areas. Gill (2007), using a modeling approach, suggest that increases of ten percent in urban greenspace could ameliorate the expected increase in urban temperatures. Kirshen et.al, (2005) also notes the public health benefits of greenways in response to warming in metropolitan Boston.

Table 2: Selected Adaptation Polices adapted from MCCC (2008).

■ modest potential ■■ moderate potential ■■■ most potential

Reduction of Impact to Existing and Future Growth and Future Growth	
1. Integrated Planning: Require the integration of coastal erosion, coastal storm and sea level rise adaptation and response planning strategies into existing state and local policies and programs.	■■■
2. Adaptation of Vulnerable Coastal Infrastructure	
3. Building Code Revisions and Infrastructure Design Standards	
Financial and Economic Well-Being	
4. Resource-Based Industry Economic Initiative: Develop and implement long-range plans to minimize the economic impacts of sea level rise to natural resource-based industries	■
5. Climate Change Insurance Advisory Committee	
6. Develop a Maryland Sea Level Rise Disclosure and Advisory Statement	
7. Green Economic Development Initiative	
Protection of Human Health, Safety and Welfare	
8. Inter-Agency Coordination	
9. Health Impact Assessments	
10. Vector-borne Surveillance and Control	
Natural Resource Protection	
11. Natural Resource Protection Areas: Identify high priority protection areas and strategically and cost effectively direct protection and restoration actions.	■■■
12. Forest and Wetland Protection: Develop and implement a package of appropriate regulations, financial incentives, educational, outreach, and enforcement approaches to retain and expand forests and wetlands in areas suitable for long-term survival.	■■■
13. Shoreline and Buffer Area Management: Promote and support sustainable shoreline and buffer area management practices.	■■■
Adaptation and Response Toolbox	
14. Integrated Observation Systems	
15. GIS Mapping, Modeling and Monitoring: Update and maintain statewide sea level rise mapping, modeling, and monitoring products.	■■
16. Public Awareness, Outreach, Training and Capacity Building: Utilize new and existing educational, outreach, training and capacity building programs to disseminate information and resources related to climate change and sea level rise	■■■
Future Steps and	
17. Local Government Planning Guidance	
18. Adaptation-Stat	
19. Future Adaptation Strategy Development: Pursue the development of adaptation strategies to reduce climate change vulnerability among affected sectors, including agriculture, forestry, water resources, aquatic and terrestrial ecosystems, and human health.	■■

Implementation

In terms of the implementation of greenways' contribution to mitigation and adaptation policies and strategies, the Greenprint Program offers a possible avenue to have a broader citizen-focus input. The Greenprint Program, reorganized in 2008, is a first-in-the-nation web-enabled map showing the relative ecological importance of every parcel of land in the State of Maryland. (Maryland Department of Natural Resources, 2009). While the successful development of the current nationally known greenway system has been a complex combination of the state agencies, county planning entities, and other stakeholder initiatives, the Greenprint Program offers a additional model and means where public openness and transparency may enable a broader coalition of citizens to be more active in the design, planning, management, and use of greenways. The Greenprint Program offers potential to support specific mitigation and adaption polices.

Discussion

Maryland offers one example of a state-led effort to develop strategies and polices to deal with mitigating and adapting to climate change. Greenways and greenway networks offer the potential to contribute to these policies and strategies. Some of these polices offer a greater contribution to carbon mitigation while some of these policies are more difficult to implement to achieve results. In adapting to climate change, greenways can play a significant role in providing core landscapes on which to build more significant ecological networks. The increasing important of ecological networks (Jongman, et.al., 2004) and the greenways that are often a component provide a foundation for integrating climate change polices and greenway development. Strategies to support both climate mitigation and adaption include increasing the amount of protected area, restoration initiatives and other strategies that address redundancy and resiliency functions. It will be useful for those involved in greenway development to play as positive and substantive role as possible in using greenways in adapting to and mitigating global climate change.

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