Tying Local Policy, Management, and Institutional Arrangements to Environmental Outcomes: The Role of Urban Forests in Municipal Sustainability Initiatives

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Introduction

The traditional urban objective of achieving a "sanitary city" is transitioning to that of a "sustainable city" (Grove 2009). Urban forests are important in this regard because of the ecosystem services they generate. In addition to aesthetics and increased property values, urban trees improve local air quality, slow storm water runoff, regulate heat island effects, reduce energy use, and sequester carbon dioxide. Numerous studies have documented the ecological utility of urban forests and several have analyzed their management structures, but the relationship between them remains under-examined.

Research Objective

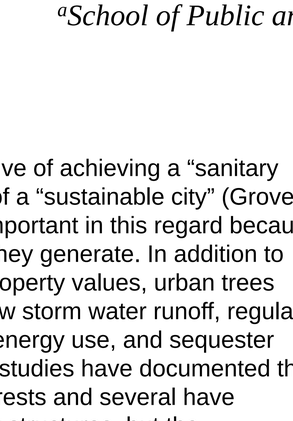
This research considers the relationship between municipal and community management, ecosystem services, and overall forest sustainability. Cognizant of the many outside and natural factors that may influence forest function, it seeks to determine if local urban forestry policies translate into a substantive bio-physical impact.

Data and Methods

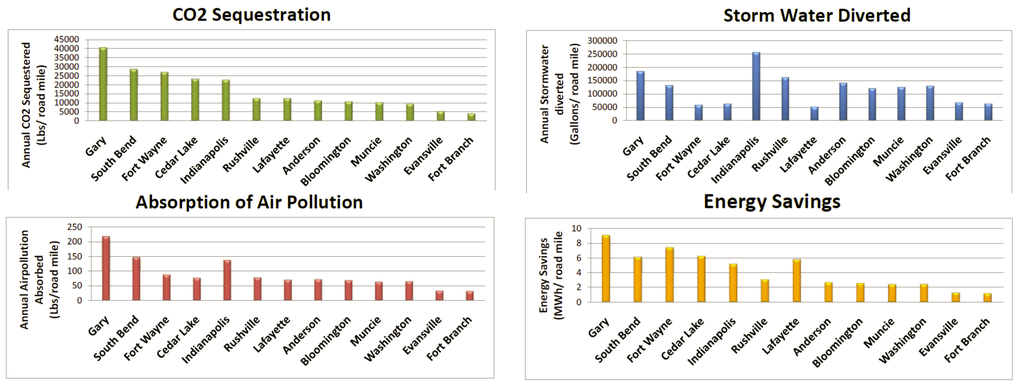
Bio-physical data and management practices characterizing ***street trees*** are used. Street trees are located along roads and in the public right-of-way. Their public nature should allow the impact of municipal management practices to be felt more clearly than for urban forests as a whole.

Ecosystem Services

Data quantifying street tree ecosystem services comes from the Sample Urban Statewide Inventory (SUSI) commissioned by the Indiana Department of Natural Resources in 2008. SUSI estimates are based on the number, size, age, condition, and species of street trees in each city. SUSI inventories were conducted for 23 Indiana cities. Here, we focus on 13: four cities characterized by high levels of net ecosystem services, five by medium levels and four by low levels.



Ecosystem Services Provided by Street Trees in Indiana Cities



A cross-section of Indiana cities are considered, ranging in size from Fort Branch (population 2,550) to Indianapolis (population 798,400). To make ecosystem values comparable across cities, we standardize them by miles of roadway located within each municipality's borders. Subsequent sections of this poster focus on CO2 sequestration.

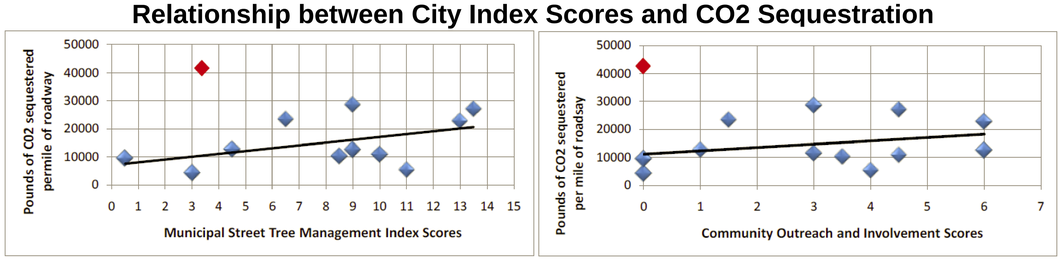
Institutions and Management Data

Information on local institutions and management practices were obtained from two primary sources: (1) A web-based questionnaire completed by the person in charge of each city's urban forestry (2) Relevant local documents and web-pages containing formal rules and ordinances.

Management and Community Involvement Indices

We develop indices to quantify the strength of ***comprehensive municipal management*** (CMM) and ***community support*** (CS) in each city. Indices are additive: a city receives 1 point each time it has a particular practice or institution in place that the urban forestry literature suggests is beneficial. The CMM index ranges from 0 – 14.5 and includes financial, human resource, and planning components. The CS index ranges from 0 – 6.5 and is comprised of indicators of community involvement in street tree care and management, including citizen membership on tree boards and the presence of urban forestry focused volunteer organizations.

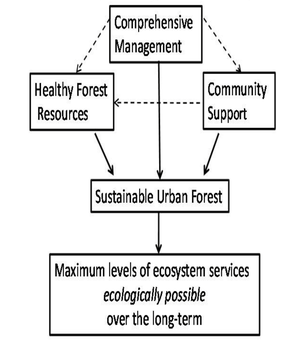
Relationship between City Index Scores and CO2 Sequestration



The above plots generally confirm the hypothesis that higher levels of ecosystem services are found in cities with more comprehensive forestry management and community involvement. However this relationship is far from exact, particularly in the case of Gary, IN (represented in red and excluded from the scatter analysis). Clark's (1997) urban forestry sustainability model helps make sense of these non-linearities.

Sustainability Assessment Results

Sustainable Urban Forest Model
Based off of: Clark, Matheny, Cross & Wake, 1997



According to Clark (1997), comprehensive management, community support, and healthy vegetative resources are ALL needed for urban forest systems to be sustainable. If any one is compromised, forests will fail to yield their maximum benefits over the long term. Based on their index and ecosystem values the cities in the first half of the table below are characterized as sustainable and those in the bottom half are currently unsustainable. Cities with less sustainable forests tend to be small and resource poor. The cities of Gary and Evansville additionally offer interesting case studies. Gary is experiencing significant economic decline and recently eliminated its previously active forestry program. Evansville was about 8 years into building its program when the ecosystem service inventory was conducted. We predict a significant shift in their respective levels of services over time.

Sustainability Characterization

Indiana Cities with **sustainable** urban forests			
City	Management	Community	Ecosystem Services
Anderson	9	3	11348
Bloomington	10	4.5	10742
Fort Wayne	13.5	4.5	26928
Indianapolis	13	6	22692
Lafayette	9	6	12480
Muncie, IN	8.5	3.5	10226
South Bend	9	3	28645
Indiana Cities with **UNsustainable** urban forests			
City	Management	Community	Ecosystem Services
Fort Branch	3	0	4217
Cedar Lake	6.5	1.5	23315
Evansville↑	11	4	5331
Gary↓	3.5	0	40465
Rushville	4.5	1	12522
Washington	0.5	0	9425

Policy Implications & Future Research

Urban forests contribute to several dimensions of urban sustainability. Despite the numerous outside influences, municipal and community management appear important to forest health and ecosystem services. The next phase of this study will consider the local factors that lead to improved municipal and community management.

Citations

Grove, M.J. (2009) Cities: Managing Densely Settled Social-Ecological Systems. *Principles of Ecosystem Stewardship*, 2: 281-294.
Clark, J.R., Matheny, N.P., Cross, G. and Wake, V. (1997). A model of urban forest sustainability. *Journal of Arboriculture*, 23(1): 17-30.