JOURNAL BRIEF: Hotspot Analysis and Strategic Siting of Green Infrastructure to Maximize Ecosystem Service Provision


Study Intent and Research Question
Ecosystem services are the social and ecological benefits that are provided to humans by the natural environment. Where should cities strategically locate green infrastructure (GI) to address the needs of areas with specific ecosystem service provision deficits? Where should GI be located so that it addresses multiple ecosystem service provision deficits at once? City-wide spatial modeling of ecosystem service needs using the GIS-based ‘Green Infrastructure Spatial Planning’ (GISP) tool can help identify hot-spot areas ripe for investment based on different service provision goals, including the goal of providing multiple ecosystem services at once.

Key Background Information
GI is commonly associated with the provision of six specific ecosystem services:
1) Storm-water management (Jaffe et al., 2010)
2) Improved air quality (Pugh et al., 2012)
3) Urban heat island mitigation (Tzoulas et al., 2007)
4) Reduced social vulnerability (Cutter & Finch, 2008)
5) Access to green space
6) Landscape connectivity (Mitchell et al., 2013)

The spatial data needed to run a GISP model similar to the one deployed in Detroit are identified in the table below. These are commonly available GIS layers for most cities.

<table>
<thead>
<tr>
<th>Ecosystem Service</th>
<th>Spatial Attribute</th>
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<tbody>
<tr>
<td>Stormwater Management</td>
<td>Average runoff coefficients based on Rational Method and CSO outfall location data</td>
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<tr>
<td>Reduced Social Vulnerability</td>
<td>Social Vulnerability Index</td>
</tr>
<tr>
<td>Access to Green Space</td>
<td>Estimate of tract population without access to parks</td>
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Key Findings
Due to varying ecosystem service needs across a city, the impact of GI installations are not felt equally in all areas. For example, some areas of a city are more in need of GI’s air pollution mitigation benefits than other areas (i.e. areas with poor air quality). Similarly, other areas are more in need of GI’s stormwater abatement benefits than others (i.e. areas that experience regular flooding).

Within a given city, there will be GI siting synergies—where the optimal siting to maximize the impact of one eco-system service simultaneously supports enhanced impact of other ecosystem services. Within that same city, there will also be GI siting tradeoffs—where the optimal siting to maximize the impact of a particular ecosystem service detracts from the ability to maximize the impact of other ecosystem services.

SYNERGIES
In Detroit, GI siting decisions to maximize stormwater management, reduce urban heat island effects, and improve air quality are all positively related, meaning that siting decisions to advance one of these service priorities, in effect, advances all of them.

TRADEOFFS
In Detroit, GI siting to maximize landscape connectivity is negatively related with siting to address stormwater abatement, to reduce urban heat island effect, and to improve air quality. This means that optimal locations for GI to increase landscape connectivity will not be optimal for maximizing...
stormwater abatement, urban head island regulation, or improved air quality benefits.

**HOTSPOT ALIGNMENT**

Expert stakeholders in Detroit identified storm-water management, reducing social vulnerability, increasing access to green space, and improving air quality as ecosystem service priorities. Current siting of GI in Detroit aligns with ‘hotspot’ areas for increasing access to green space, but does not align with ‘hotspot’ areas for storm-water management needs, reducing social vulnerability, or improving air quality.

**Policy and Practice Implications**

GISP models can identify hotspots ripe for investment based on city-specific ecosystem service provision priorities. This type of analysis can be run for any city with the requisite spatial data layers (see table 1). The referenced paper can provide greater detail on methodology for city practitioner’s interested in performing this type of analysis.

Hotspot analysis can be customized to identify siting locations that address different priorities. For example, siting can be optimized to maximize the impact of an individual ecosystem service by siting where that service is most needed. Alternatively, siting can be optimized to prioritize multi-functionality by locating investments only in areas where multiple service provision priorities overlap.

GISP can help decision makers evaluate whether current and planned green infrastructure installations align with articulated service provision goals and policy priorities. In the event that investments are not aligned with these goals and priorities, hotspot analysis can help to guide investments so that they better align.

**Further Reading and References**


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**About the Sustainable Healthy Cities Network**

The Sustainable Healthy Cities Network is a U.S. National Science Foundation supported sustainability research network focused on the scientific advancement of integrated urban infrastructure solutions for environmentally sustainable, healthy, and livable cities. We are a network of scientists, industry leaders, and policy partners, committed to building better cities through innovations in infrastructure design, technology and policy. Our network connects across nine research universities, major metropolitan cities in the U.S. and India, as well as infrastructure firms and policy groups to bridge research and education with concrete action in cities.

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