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Research Paper

Understanding urban neighborhood differences in willingness to implement green infrastructure measures: a case study of Syracuse, NY

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HIGHLIGHTS

- No relationship between socio-demographics and knowledge of green infrastructure.
- High willingness to implement green infrastructure under two hypothetical scenarios.
- Knowledge, efficacy, aesthetics, and cost influence implementation.
- Lived experiences a main driver of high levels of green infrastructure knowledge.
- Citizen's receptivity essential for green infrastructure policy implementation.

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ABSTRACT

Green infrastructure is increasing in use in many major cities of the United States as a measure of stormwater control. Policy makers have opted for the use of green infrastructure measures as they add both aesthetic and functional value to the landscape. There is a need to understand the view of the public regarding the use of green infrastructure in their neighborhoods, specifically the factors that influence the public's willingness to implement green infrastructure on private properties. This study utilizes a door-to-door survey to examine citizens' knowledge and willingness to implement green infrastructure technologies within two neighborhoods in Syracuse, New York. Results indicate that residents have high levels of knowledge regarding the use of green infrastructure methods for stormwater control, with no differences in socio-demographic variables affecting such green infrastructure knowledge. There is also strong willingness to implement green infrastructure measures whether provided free or whether a savings is accrued with implementation. Additionally, key factors affecting citizens' willingness to implement green infrastructure are efficacy, aesthetics, and cost. This study indicates that perhaps a targeted approach can be taken for implementing green infrastructure measures. The profile of the most likely person to target includes those that are low income, desire to improve the overall aesthetic of their community and their personal space, and those whose financial commitments will not be strained. The study therefore provides valuable information for policy makers interested in using urban private properties to expand green spaces.

1. Introduction

The United States Environmental Protection Agency (USEPA) and Clean Water America Alliance (CWAA) define green infrastructure as "a set of techniques, technologies, management approaches, and practices that can be used to eliminate or reduce the amount of stormwater and nonpoint source runoff including water and pollutants that run into combined sewer overflow systems" (CWAA, 2011, p. 8). Green infrastructure and low impact development (LID) systems and practices may use or mimic natural processes (e.g. rain gardens) and may include hard or grey infrastructure as well (e.g. concrete inflow structures and treatment wetlands). In this paper, we explore the use of

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rain barrels, trees, permeable pavement, and rain gardens, for individual property owners and for larger municipal projects best management practices such as curbside extensions.

The overall goal for using green infrastructure in Syracuse is to reduce the amount of stormwater runoff that flows out of combined sewer overflows (CSO) and directly into receiving water bodies that eventually lead to pollution in Onondaga Lake. The major benefit of green infrastructure is stormwater and pollution reduction. Other indirect benefits include providing more urban green spaces and thus improving microclimate, and neighborhood quality of life and aesthetics. Addressing CSOs is a major issue for northeastern American and Canadian cities bordering the Great Lakes (Podolsky & MacDonald, 2008), as well as a national issue of concern in the United States (National Research Council ((NRC), 2008).

There is continuing debate around how to assess values and functions of green infrastructure measures (Lovell & Taylor, 2013) for urban runoff reduction. Jaffe (2011) has suggested "that green infrastructure strategies are cost effective when compared to conventional stormwater management approaches, even when evaluated in terms of their direct costs and savings over their useful lives" (p. 357). He further asserted that there are methodological problems with assessing indirect benefits and values such as ecosystem services. A prior study (Barnhill & Smardon, 2012) of the same Syracuse areas investigated in this study indicated that residents do not understand green infrastructure or ecosystem services. Tzoulas et al. (2007) have performed an exhaustive review of green infrastructure non-economic benefits to ecosystems and human health in urban areas, while Beauchamp and Adamowski (2013) reviewed both European and North American green infrastructure and LID systems development and administration. Both studies indicated a potential for human physical and psychological benefits from green infrastructure but identified possible barriers to implementation.

Previous literature highlights the positive aspects of green infrastructure functions and values; however, this paper explores how stakeholders perceive green infrastructure functions and values as well as perceptual barriers. According to an NRC study (2008), there are three major barriers to urban stormwater-related green infrastructure—institutional, technological, and perceptual. Additionally, the CWAA (2011, p. 2) reported common themes interwoven with technical and physical barriers to green infrastructure implementation including:

- "Lack of understanding and knowledge of what green infrastructure is and the benefits that it provides;
- Deficiency of data demonstrating benefits, costs and performance;
- Insufficient technical knowledge and experience; and
- Lack of design standards, and best management practices".

This paper focuses on the first barrier—understanding and knowledge of what green infrastructure is and its benefits, in addition to community barriers to implementation in two micro-neighborhoods in Syracuse, New York.

Specific public perception issues with green infrastructure and CSO abatement include: "making the connection between unmanaged stormwater and environmental degradation; appreciating the role of the individual citizen or neighborhood–level actions in ameliorating this problem; and becoming familiar with and accepting green infrastructure within the community" (Keeley et al., 2013, p. 1103). Further Keeley et al. (2013) emphasize the public may not perceive stormwater is a problem and may assume it is already taken care of by government and existing infrastructure. This specific case study runs contrary to Keeley et al.'s (2013) theory: Syracuse residents are knowledgeable about stormwater problems because of a countywide initiative "Save the Rain" campaign, which has extensive outreach messaging (Barnhill & Smardon, 2012; Millea et al., 2011).

A second challenge to green infrastructure implementation is to determine the most effective methods, economic incentives, and public education programs to encourage best management practices on private property. Australia (Brookes, Brown, & Morrison, 2011; Thurston, 2006; Thurston, Goddard, Szlag, & Lemberg, 2003), Chicago (Ando & Freitas, 2011), Portland, OR (Shandas, Nelson, & Arendos, 2009), and Cleveland, OH (Keeley, 2007) all utilize economic and outreach programs to encourage green infrastructure. For example, incentives included providing free rain barrels or offering reduced cost and technical assistance for installing rain gardens. Prior research in Syracuse found that lack of maintenance of green infrastructure is a potential barrier for some individual property owners (Barnhill & Smardon, 2012). Understanding the incentives and barriers are crucial for the successful implementation of green infrastructure on private properties.

Finally, policy managers may have mixed opinions about taking public perception of green infrastructure and stormwater management into consideration for decision-making (Keeley et al., 2013). Discrepancy between policy managers' and general public opinion on the value of green infrastructure was noted as a major issue in Australia (Brown, Farrelly, & Keath, 2009; Mitchell, 2006), Germany (Nickel et al., 2013), Ireland (Lennon, 2014), South Africa (Schaffler & Swilling, 2013) as well as the United States (Carlet, 2014). Research has found that for policy managers, green infrastructure is positive for community outreach (Shandas & Messer, 2008; Shandas et al., 2009) and development (Dunn, 2010). On the other hand, there may be public uncertainty about green infrastructure costs and benefits (Barnhill & Smardon, 2012; LaBadie, 2010; Shandas et al., 2009). Further issues of public safety (Keeley et al., 2013; Olorunkiya, Fassman, & Wilkinson, 2012) and environmental justice (Jennings, Gaither, & Gragg, 2012; Perreault, T., Wraight, & Perreault, M., 2012; Pincetl & Gearin, 2005) must also be addressed with green infrastructure initiatives.

Even though many studies state that public involvement is needed, few outline processes for gauging neighborhood public perceptions regarding green infrastructure knowledge and receptivity toward individual property or neighborhood implementation of green infrastructure projects. One of the few green infrastructure and CSO abatement projects that have considered public perceptions is in Point Breeze neighborhood in South Philadelphia. Montalto et al. (2012) utilized agent-based modeling to explore two scenarios regarding green infrastructure implementation in the Point Breeze neighborhood. In scenario 1, household green infrastructure adoption considered only economic self-interest plus the physical compatibility of each green infrastructure technology with lot characteristics. In scenario 2, adoption rules were enhanced based on the insights into the behavior of property owners, as intuited by the green infrastructure designers over a 2-year period. This project underscored the importance of stakeholder decisions in the ultimate effectiveness of watershed-scale green infrastructure programs.

Another example is the community-based watershed stewardship program in Portland Oregon (Shandas & Messer, 2008), which occurred over a 12-year period. The stewardship program has increased citizen trust in government, fostered participant's ecological understanding, filled gaps between what public institutions can achieve and what the community needs, and used co-production activities to create ownership of the landscape (Shandas & Messer, 2008).

Given the limited studies examining neighborhood public perceptions about green infrastructure knowledge and receptivity, the objective of our study is to answer the following: what factors affect urban residents' perceptions and decisions about green infrastructure implementation? Using the case study of two