Landscape and Urban Planning 136 (2015) 1–12

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Research Paper

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

April Karen Baptiste[a,*], Catherine Foley[b], Richard Smardon[b]

[a] *Colgate University, Hamilton, NY, USA*
[b] *State University of New York, College of Environmental Science and Forestry, Syracuse, NY, USA*

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.

ARTICLE INFO

Article history:
Received 16 April 2014
Received in revised form 7 November 2014
Accepted 14 November 2014
Available online 11 December 2014

Keywords:
Environmental concerns
Environmental knowledge
Green infrastructure
Syracuse.

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

* Corresponding author at: Oak Drive, Hamilton, NY 13346, USA. Tel.: +1 315 228 6740; fax: +1 315 228 7038.
E-mail address: abaptiste@colgate.edu (A.K. Baptiste).

http://dx.doi.org/10.1016/j.landurbplan.2014.11.012

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 urban communities in Syracuse, NY, the study examines whether socio-demographic variables, knowledge, or positive and negative barriers influence urban residents' willingness to implement green infrastructure measures. Specific to implementation of green infrastructure, the study seeks to understand how urban residents might respond under two hypothetical scenarios: free provision of green infrastructure or with the potential of a savings being accrued. Following these study objectives, the paper explains the research design and describes the main findings of the study. The paper then discusses the findings and concludes with the broader implications of this study.

2. Method

2.1. Study area

The study area focused on two urban neighborhoods in Syracuse, NY, known as Strathmore and Near West Side (see Fig. 1). The neighborhoods are socio-economically distinct from one another: Strathmore is characterized as a more affluent, less diverse neighborhood, while Near West Side is a working-class ethnically diverse neighborhood. The Strathmore neighborhood is 26.6% renter occupied, compared to the 76.8% renter occupied Near West Side neighborhood. Thirty-four percent of the Near West Side is Hispanic. In contrast, Strathmore is only 6.3% Hispanic (U.S. Census Bureau, 2010).

2.2. Sample

The survey sample is based on the Near West Side and Strathmore neighborhood census tracts values for the total number of occupied housing units, with the exception of government owned apartment complexes. Specifically, we approached detached and semi-detached housing units that could be owner-occupied or rental units. There was an assumption that those in privately owned (rather than publicly owned) properties had more autonomy for making long-term changes, bearing in mind that renters would have less autonomy than owners. The 2010 census data places the total occupied housing units for Strathmore at 1036 and Near West Side at 307 making the study population $N = 1343$. The minimum sample size was calculated using the finite population correction described by Rea and Parker (2005) with a 90% confidence level and a $\pm 5\%$ margin of error acceptance, where $p = 0.5$. The minimum significant population size is 226. Proportional allocation was done to determine the sample size for each neighborhood: Strathmore = 175 and Near West Side = 52.

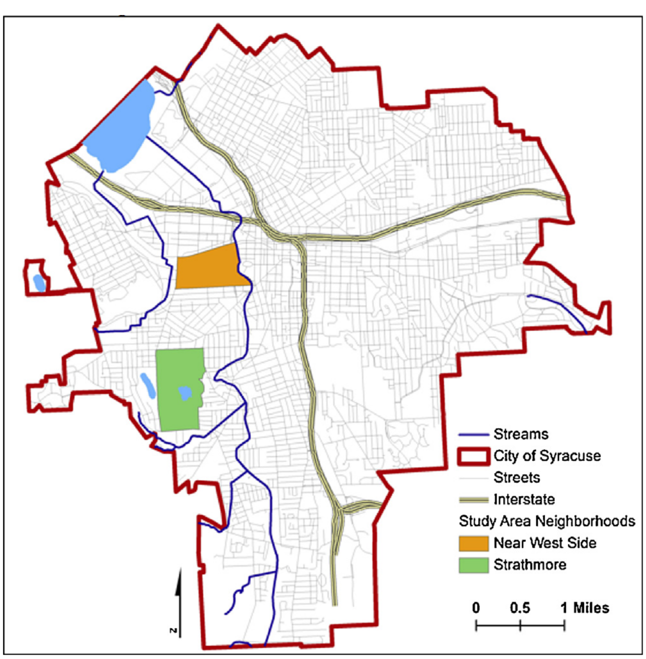

Fig. 1. Syracuse area map showing location of Near West Side and Strathmore sampling areas.

2.3. Survey

This paper aims to answer:

- What are the varying levels of knowledge and efficacy regarding stormwater control among different demographic groups?
- What are the positive and negative influence factors, in terms of aesthetic, cost, and health values that affect green infrastructure implementation decisions among demographic groups?
- What are the strongest predictors of willingness to implement green infrastructure measures given two hypothetical scenarios for the sample?

The survey used closed-ended questions and was divided into multiple sections to determine knowledge (both general and specific), influence factors affecting implementation of green infrastructure, willingness to implement green infrastructure measures given two hypothetical scenarios, and demographic characteristics of respondents. The levels of environmental knowledge and efficacy were evaluated using six different statements.

General environmental knowledge was determined by asking respondents to indicate on a 5-point Likert scale (1 = strongly disagree, 3 = neutral, 5 = strongly agree) their level of agreement or disagreement with the following statement: "There are enough ways to handle stormwater run-off in Syracuse." This general environmental knowledge question was used to determine whether a respondent felt that stormwater management was a problem for the Syracuse area. With reverse coding, higher scores indicated higher levels of environmental knowledge that Syracuse has a stormwater management problem.

Personal efficacy to address stormwater management in Syracuse was measured using the proxy question, "There are many things that I can do to help *minimize* stormwater run-off." This was measured using a 5-point Likert scale similar to the environmental knowledge question. Higher scores indicated higher levels of efficacy regarding assisting with stormwater management.

Specific environmental knowledge was measured using five statements that examined a respondent's level of agreement or disagreement with the following statements: "_____ will help to reduce stormwater run-off" where the blank was filled with the five green infrastructure measures of interest (rain barrels, trees, rain gardens, porous driveways/sidewalks, curbside extensions). The level of agreement or disagreement was measured using a similar Likert scale to that for general environmental knowledge. Specific environmental knowledge was used to determine whether a person was knowledgeable about the use of green infrastructure measures to control stormwater. Higher scores indicated higher levels of knowledge regarding whether green infrastructure measures can assist with stormwater management.

Respondents were provided with 25 influence factors, both positive and negative to determine the extent to which these factors affect their decision to implement green infrastructure. Specifically, these influence factors examined the extent to which themes related to cost factors (e.g., cost of implementation, effect on property values), aesthetics, maintenance, ecological disturbances, and safety influenced the decision to implement the specific green infrastructure measures. Levels of influence were measured on a 5-point Likert scale where 1 = no influence, 2 = very little influence, 3 = neutral, 4 = some influence, and 5 = great influence. Higher scores indicated a greater potential for that factor to affect the implementation decision of green infrastructure.

Willingness to implement green infrastructure measures were determined for two hypothetical scenarios: free provision of GI or savings was accrual due to GI implementation. Respondents were asked to indicate their level of agreement or disagreement with the following statement: "How likely are you to use each of the following green infrastructure measures if _____", where the blank was filled with either "provided for free" or "it provides a savings on your water bill." A 5-point Likert scale was used where 1 = very unlikely, 2 = unlikely, 3 = neutral, 4 = likely and 5 = very likely. The higher the score, the more likely a respondent was willing to implement the specific green infrastructure measure. It is important to note that for this study all green infrastructure measures with the exception of curbside extensions were being considered in the private rather than public context, hence the choice of phrasing stated above. However, for curbside extensions, which were being considered as a measure implemented by the government, residents were asked, "How likely are you to support a curbside extension in your community?" Responses were measured on a 5-point Likert scale where 1 = very unlikely, 2 = unlikely, 3 = neutral, 4 = likely and 5 = very likely. No question was asked for curbside extensions under the savings scenario, as this was not applicable to private residents.

Given that the work in Syracuse is one of the first of its kind, there are limited studies that have used similar measures for the factors that are reported in this study. However, the construction of the measures were based on an iterative process using interview and focus group data (Barnhill & Smardon, 2012) in addition to one previous survey conducted in the region but with different communities (Baptiste, 2014).

Trained survey volunteers, high school, and college students executed the survey during Fall 2010, Spring 2011, and Fall 2011, under the supervision of one of the main researchers of the project. For quality control, high-school students were paired with college students for interviewing. Additionally, interviewers checked in with the main researchers of the project every two to three hours to address major concerns. Surveyors were given a script that included example photographs of the green infrastructure measures in question. Surveyors approached households between the hours of 10 am–3 pm on weekends and 3–8 pm on weeknights in order to collect surveys door-to-door. If there was no answer at a household, surveyors marked the lack of response and returned to the household at a different time and date. During the introduction of the survey to respondents, surveyors gave respondents the opportunity to voluntarily withdraw from taking the survey. Surveyors marked whether households voluntarily withdrew from the survey and placed the household on a "do-not-approach" list. Each household was approached twice except for the aforementioned "do-not-approach" households, or if the household completed the survey on the first approach. Before survey completion, surveyors asked respondents to a sign a waiver form. The survey was administered in English and Spanish, when appropriate.

2.4. Analysis

A conceptual diagram is provided to show the relationships between the variables that are used in this study and the corresponding inferential statistical tests performed (Fig. 2).

Descriptive statistics were used to determine the measures of central tendencies and frequencies for those that responded to the questions for general and specific levels of knowledge. For general environmental knowledge, reverse coding was used to allow for levels of agreement to match with the increasing scale. Hence, those that disagreed with the statement were interpreted as those with higher levels of general knowledge regarding the stormwater

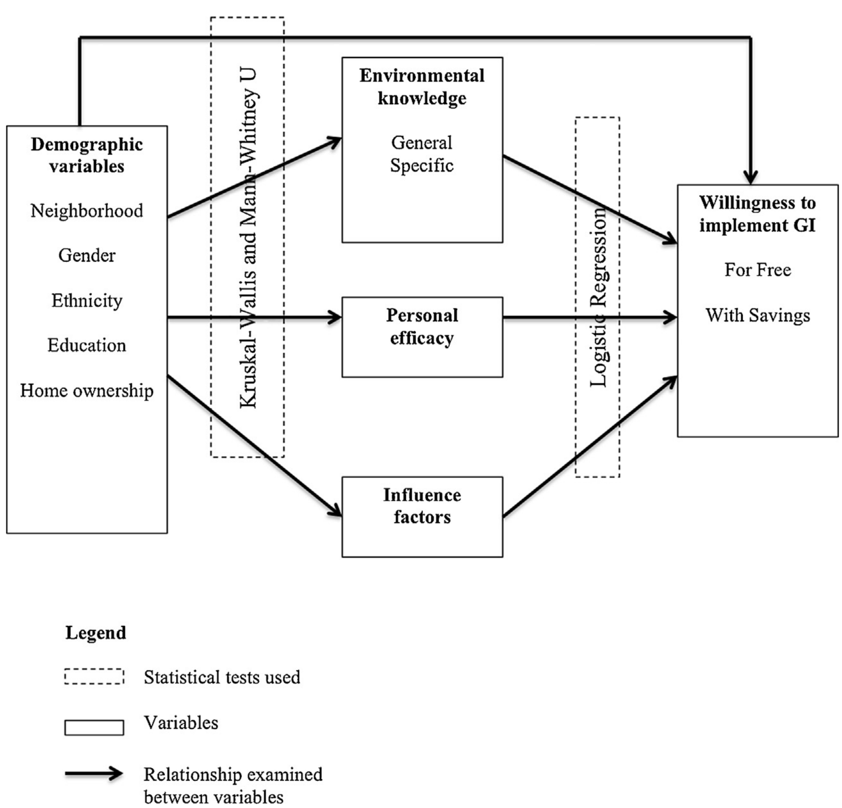

Fig. 2. Conceptual diagram of the inferential analysis used to assess the variables in this study.

management in Syracuse. As such, increasing scores on the 5-point Likert scale corresponded with higher levels of general environmental knowledge.

An overall construct for environmental knowledge was developed using the five questions about use of green infrastructure to reduce stormwater. The scale had a high level of internal consistency (Cronbach's alpha = 0.870). The mean for the aggregate knowledge score was 3.98 (SD = 0.91) where higher scores indicated higher levels of specific environmental knowledge.

A new variable for efficacy was created by recoding the responses into a binary variable where 1, 2, 3 on the 5-point Likert scale = 0 = low personal efficacy and 4, 5 on the 5-point Likert scale = 1 = high level of personal efficacy. Chi-square test of associations (Rea & Parker, 2005) was used to determine the relationships between efficacy and demographic variables of gender, ethnicity, educational level, and home ownership. For the variables, expected cell frequencies were less than 5.

A principal components analysis (PCA) was run on 25 questions that measured factors that influence a person's willingness to implement green infrastructure measures for 229 respondents from the neighborhoods. The suitability of PCA was assessed before analysis. Inspection of the correlation matrix showed all variables had at least one correlation coefficient greater than 0.3. The overall Kaiser–Meyer–Oklin (KMO) measure was 0.829 with individual KMO measures all greater than 0.7, classifications of 'middling' to 'meritorious' according to Kaiser (1974). Bartlett's Test of Sphericity was statistically significant ($p < 0.0005$) indicating that the data were likely factorable.

An aggregate score was determined for willingness to implement green infrastructure measures if provided free using the five variables for willingness to implement specific green infrastructure. Cronbach's alpha for this scale is 0.839. Similarly, an aggregate score for willingness to install green infrastructure if savings accrued was determined using the four variables for willingness to implement specific green infrastructure. Willingness to implement curbside extensions was not used in this scale, as the savings will not be accrued to individual property owners if implemented. Cronbach's alpha for this scale is 0.900.

Kruskal–Wallis and Mann–Whitney *U*-tests were determined as the most appropriate non-parametric tests for assessing the relationships between aggregate knowledge, efficacy, influence factors, willingness to implement green infrastructure, and demographic variables (Corder & Foreman, 2009). Distributions of appropriate variables were examined via visual inspection for the Mann–Whitney *U*-test to determine whether they are similar or dissimilar. Where appropriate, Dunn's pairwise comparisons procedure with a Bonferroni correction for multiple comparisons were used for Kruskal–Wallis tests.

The aggregate scores for willing to implement green infrastructure if free and willingness to implement green infrastructure if savings accrue were recoded into new dichotomous variables. All values ≤ 3 were labeled as 0, that is, not willing to implement under the specified condition and values ≥ 3.1 through the highest are labeled 1, that is, willing to implement under the specified condition. Two separate logistic regression models were run to determine factors that had the most significant predictive effect on willingness to implement green infrastructure under the specified conditions. The independent variables in the models were the variables that were statistically significant from the chi-square, Kruskal–Wallis, and Mann–Whitney *U*-tests from the relationships with environmental knowledge, efficacy, influence factors, and demographic variables. The dependent variables in the models were willingness to implement green infrastructure under the specified scenario. Assumptions for linearity were met when tested.

3. Findings

3.1. Sample demographics

There were 229 respondents in the sample. Of this 75.5% ($n = 173$) of respondents were from the Strathmore neighborhood–response rate = 16.7%, while 24.5% ($n = 56$) of respondents were from the Near West Side neighborhood, with a response rate of 7.5%.

Using chi-square tests of independence, when the distribution of the sample was compared to that of the census tract data for available demographic variables, the sample can be considered representative of the overall population (Table 1). However, the results for some specific variables may be limited. This limitation applies particularly to males in Near West Side, African Americans in Strathmore, and homeowners and those in the other category of home ownership in Near West Side. Hence, wide generalizations of the results for these variables may not be possible.

There were more males than females for both the total sample and for Strathmore, while there were more females represented in Near West Side. White was the most represented ethnic group for the overall sample and for the Strathmore neighborhood, while African American was the most represented ethnic group for Near West Side. For the overall sample, graduate school was the most represented educational group, which was true for Strathmore. However, for Near West Side, high school was the most represented

Table 1
Comparison of representativeness of sample with census data for Strathmore and Near West Side using demographic variables.

Strathmore						Near West Side				
p	df	χ^2	Census (%)	Sample (%)	Variable	Sample (%)	Census (%)	χ^2	df	*p*
					Gender					
0.821	1	0.051	46.7	48.9	Male	29.5	53.3	6.841	1	0.008*
0.439	1	0.599	53.3	45.6	Female	65.5	46.7	3.15	1	0.076
					Ethnicity					
0.014*	1	6.05	21.0	7.8	African American	37.7	47.7	1.171	1	0.279
0.311	1	1.025	72.3	85.0	White	27.9	32.6	.365	1	0.546
0.056	1	3.654	6.3	1.1	Hispanic	26.2	34.2	1.06	1	0.303
0.888	1	0.02	6.6	6.1	Other	8.2	7.6	.023	1	0.879
					Home ownership					
0.284	1	1.147	65.0	77.8	Owners	44.3	9.4	22.682	1	0.000*
0.108	1	2.582	26.6	16.1	Renters	54.1	76.8	3.937	1	0.047
0.546	1	0.365	6.6	6.1	Other	4.9	0	9.665	1	0.002*

* $p < 0.05$.

Table 2
Descriptive statistics for the demographic variables of gender, education level, home ownership status, and ethnicity for the respondents in two researched neighborhoods of Near West Side and Strathmore in Syracuse, NY.

Variable	Total	Neighborhood	
		Strathmore percentage (n)	Near West Side percentage (n)
Gender			
Male	46.5 (101)	51.2 (84)	32.1 (17)
Female	53.5 (116)	48.8 (80)	67.9 (36)
Ethnicity			
Caucasian	70.3 (161)	85.4 (146)	26.8 (15)
African American	14.7 (36)	8.2 (14)	39.3 (22)
Hispanic	7.0 (16)	1.2 (2)	25 (14)
Other	6.1 (14)	5.3 (9)	9 (5)
Education level			
Graduate school	36.2 (83)	48.2 (81)	3.7 (2)
4-year college	21.4 (49)	26.8 (45)	7.4 (4)
2-year college/trade/vocational	16.2 (37)	13.7 (23)	25.9 (14)
High school	18.8 (43)	10.7 (18)	46.3 (25)
Elementary	4.4 (10)	0.6 (1)	16.7 (9)
Home ownership			
Owners	69.9 (160)	82.3 (135)	45.5 (25)
Renters	25.8 (59)	17.7 (29)	54.5 (30)

Note: n values are indicated in parentheses. Some of the total values for n may not be equivalent to the total value of the sample, as some respondents did not respond to some of these questions.

educational group. Finally, there were a larger number of owners than renters among respondents for the total sample. This distribution was the same for the Strathmore neighborhood but the opposite was true for Near West Side (Table 2).

3.2. Knowledge

3.2.1. General knowledge and efficacy on stormwater control

General knowledge, as indicated in the methods section, was determined by asking respondents whether they believed there were adequate measures in place to control stormwater. This was measured on a 5-point Likert scale with higher scores indicating that respondents believed that stormwater management was a problem. Overall, both neighborhoods believed that stormwater management is a problem in the community (M = 3.88, SD = 1.17) indicated by 63.5% (n = 143, those respondents who answered 4 and 5 to the question) of sample respondents. A similar trend was seen across both neighborhoods where Strathmore had a mean of 3.99 (SD = 1.06, n = 172) and Near West Side had a mean of 3.51 (SD = 1.41, n = 53).

Overall, the mean level of personal efficacy was 0.60 (SD = 0.49) which was measured on a 0 to 1 scale, where 0 = low level of personal efficacy and 1 = high level of personal efficacy. The mean score indicates that the sample was leaning slightly to a high level of personal efficacy among respondents. This means that within the sample, respondents believed that they are able to assist in alleviating the problem of improper stormwater management. This trend holds for both neighborhoods: Near West Side (M = 0.57, SD = 0.49), and Strathmore (M = 0.61, SD = 0.49). When comparisons were done between the socio-demographics and personal efficacy only one out of the four variables, ethnicity, revealed a statistically significant relationship.

Chi-square tests for associations indicate there was a negligible association between gender and personal efficacy ($\chi^2(1) = 0.303$, $p = 0.582$, $V = .038$) and home ownership and personal efficacy ($\chi^2(1) = 0.030$, $p = 0.863$, $V = 0.012$). Both were not statistically significant. Similarly, there was a weak association between educational level and personal efficacy, Cramer's $V = 0.135$, though the association was not statistically significant ($\chi^2(4) = 3.980$, $p = 0.409$).

There was a moderate association between ethnic background and personal efficacy, Cramer's $V = 0.191$ that was statistically significant ($\chi^2(3) = 8.167$, $p = 0.043$). Post hoc analysis of a Kruskal–Wallis test revealed statistically significant differences in personal efficacy scores between Hispanic (M = 0.81, SD = 0.40) and Other (M = 0.36, SD = 0.49) ($p = 0.011$) ethnic groups. This pattern was also seen between African American (M = 0.50, SD = 0.51) and Hispanic ethnic groups ($p = 0.036$) and between Other and White (M = 0.62, SD = 0.49) ($p = .054$) but not any other combinations. This indicated that of all the groups, Hispanics showed the highest levels of personal efficacy regarding addressing stormwater management in Syracuse.

3.2.2. Specific knowledge about the effectiveness of green infrastructure for stormwater management

Overall respondents in the sample (n = 229) believed that rain barrels (M = 4.03, SD = 1.15), trees (M = 4.13, SD = 1.11), and rain gardens (M = 4.12, SD = 1.04) are effective measures for treating stormwater. The mean scores for porous driveways (M = 3.90, SD = 1.17) and curbside extensions (M = 3.71, SD = 1.16) indicate that perhaps respondents also believe that these are effective but have less knowledge about the effectiveness of these measures.

Kruskal–Wallis and Mann–Whitney U-tests were performed between aggregate knowledge scores about the effectiveness of green infrastructure to control stormwater and demographic variables. No statistically significant associations were found between these variables as illustrated in Table 3.

3.3. Influence factors

Principal component analysis (PCA) was used to categorize the 25 influence variables into components (Table 4). PCA revealed seven components had eigenvalues greater than 1 and explained 24.9, 12.9, 8.9, 6.1, 4.6, 4.1, and 4.09% of the total variance, respectively, as well as met the interpretability criterion. However, visual inspection of the scree plots and based on the simple structure criteria, using a varimax orthogonal rotation, four components were retained (Cattell, 1966; Thurstone, 1947).

The four-component solution explained 53% of the total variance. The interpretation of the data was categorized into four

Table 3
Kruskal–Wallis and Mann–Whitney *U*-test results between aggregate knowledge about effectiveness of green infrastructure measures to control stormwater (dependent variable) and demographic variables (independent variables).

Variable	*M* (*SD*)	Mean rank (*n*)	χ^2	*U*	df	*z*	*p*
Neighborhood				4679.50		−0.184	0.854
Strathmore	3.96 (0.94)	114.05 (173)					
Near West Side	4.02 (0.85)	115.92 (55)					
Gender				5985.50		0.278	0.781
Male	3.97 (0.93)	110.26 (101)					
Female	3.94 (0.92)	107.90 (116)					
Ethnicity			2.436		3		0.487
White	3.98 (0.96)	(160)					
African American	3.84 (0.82)	(36)					
Hispanic	4.15 (0.80)	(16)					
Other	4.09 (0.77)	(14)					
Educational level			2.844		4		0.584
Elementary	4.29 (0.74)	(9)					
High School	3.85 (0.96)	(43)					
Two year college/Vocational	3.97 (0.78)	(37)					
Four year college	4.01 (0.91)	(49)					
Graduate	4.03 (0.94)	(83)					
Home ownership				5015.50		0.790	0.429
Owners	4.00 (0.93)	111.54 (159)					
Renters	3.93 (0.87)	103.99 (59)					

influence factor groups. There were strong loadings of items measuring Component 1 (Fac_Improve)—factors that improve the physical personal space with green infrastructure measures (Cronbach's alpha = 0.833). Additionally strong loadings were seen on Component 2 (Fac_Cost)—factors that relate to cost either financial or human effort with green infrastructure measures (Cronbach's alpha = 0.820). Component 3 (Fac_Degrade)—factors that degrade the physical space with green infrastructure measures (Cronbach's alpha = 0.798), and Component 4 (Fac_Bio)—factors that affect health and ecological values with green infrastructure measures (Cronbach's alpha = 0.775) (Table 4) also had strong loadings.

The original items used to develop the factor components were measured on a 1 to 5 Likert scale where 1 = low level of influence and 5 = high level of influence. Hence, on the factor scales, a higher score meant that the respective factor had a greater influence on the person's implementation decision. The factors that had the greatest influence on a person's willingness to implement green infrastructure were the factors that influence the ability of green infrastructure to improve the physical personal space (*M* = 4.10, SD = 0.80). The factors with the second greatest influence were factors of cost (M = 3.57; SD = 0.88). The factors with the least influence were factors that either degrade physical space (M = 3.09; SD = 0.93) or that affect health and ecological values (M = 3.09; SD = 0.93). For factors that improve the physical personal space, only neighborhood and gender exhibited statistically significant relationships (Table 5). Distributions of the factors that improve the physical personal space score for both neighborhood and gender were not similar as assessed by visual inspection. Therefore, respondents from Near West Side indicated that factors that

Table 4
Rotated structure matrix with Varimax rotation of a four-component solution to the question on the influence factors to implement green infrastructure measures.

	Variable	Rotated component coefficients				Communalities
		Component 1	Component 2	Component 3	Component 4	
1	Rain gardens add beautification to property	**0.787**	0.089	−0.052	0.078	0.374
2	Adds shade or cools home	**0.778**	0.120	0.004	0.079	0.543
3	Helps to prevent water pooling	**0.700**	0.191	0.042	0.077	0.393
4	Trees add beautification to property	**0.684**	0.160	−0.160	0.229	0.404
5	Curbside extensions will slow traffic and keep neighborhood safer	**0.668**	−0.026	0.226	−0.069	0.572
6	Rain barrels will protect the house foundation	**0.598**	0.152	0.052	0.094	0.642
7	Rain barrels will provide water for gardening	**0.593**	0.125	0.077	0.019	0.626
8	Permeable pavement helps to control ice build-up	**0.478**	0.337	0.035	0.143	0.400
9	Cost to plant a tree	0.108	**0.766**	0.081	0.195	0.636
10	Cost to install rain barrels	0.000	**0.731**	0.088	−0.016	0.576
11	Cost to create a rain garden	0.233	**0.690**	0.092	0.195	0.538
12	Cost for permeable pavement	0.288	**0.671**	−0.063	−0.007	0.364
13	Maintenance of permeable pavement	0.214	**0.661**	0.114	−0.023	0.496
14	Time for maintenance of rain barrels	0.052	**0.612**	0.163	0.022	0.535
15	Size of trees	0.284	**0.485**	0.242	−0.160	0.441
16	Personal property space occupied by green infrastructure	−0.056	0.072	**0.812**	0.036	0.503
17	Decreasing visibility from trees and potential for accidents	0.035	0.048	**0.706**	0.264	0.651
18	Possible decrease in property value	−0.014	0.087	**0.673**	0.196	0.597
19	Leaf litter	0.120	0.104	**0.640**	0.123	0.627
20	Neighborhood security and safety	0.128	0.086	**0.571**	0.514	0.449
21	Maintenance cost	−0.106	0.349	**0.538**	0.239	0.480
22	Curbside extensions will reduce street parking	0.326	0.158	**0.485**	−0.273	0.613
23	Invasive species	0.092	−0.011	0.172	**0.783**	0.572
24	Health risks	0.115	0.069	0.270	**0.732**	0.669
25	Soil erosion	0.183	0.109	0.149	**0.728**	0.499

Note: Major loadings for each item are **in** bold.

Table 5
Kruskal–Wallis and Mann–Whitney *U*-tests showing the relationship between influence factors from the principal component analysis (dependent variables) and socio-demographic variables (independent variables).

Demographic variable	χ^2/df	*U*	*z*	*p*
Neighborhood				
Fac_Improve		3829.00	−2.361	0.018*
Fac_Cost		4531.00	−0.728	0.466
Fac_Degrade		3853.50	−2.302	0.021*
Fac_Bio		5397.50	1.292	0.196
Gender				
Fac_Improve		4582.00	−2.773	0.006*
Fac_Cost		4961.00	−1.949	0.051*
Fac_Degrade		5190.00	−1.450	0.147
Fac_Bio		5075.00	−1.707	0.088
Ethnicity				
Fac_Improve	4.069 (3)			0.254
Fac_Cost	1.991 (3)			0.574
Fac_Degrade	7.164 (3)			0.067
Fac_Bio	3.310 (3)			0.346
Educational level				
Fac_Improve	5.473 (4)			0.242
Fac_Cost	5.580 (4)			0.233
Fac_Degrade	5.498 (4)			0.240
Fac_Bio	7.582 (4)			0.108
Home ownership				
Fac_Improve		4680.00	−0.096	0.923
Fac_Cost		4837.00	0.282	0.778
Fac_Degrade		4190.00	−1.276	0.202
Fac_Bio		4686.00	−0.082	0.934

Fac_Improve: Factors that improve the physical personal space with green infrastructure measures. Fac_Cost: Factors that related to cost either financial or human effort with green infrastructure measures. Fac_Degrade: Factors that degrade the physical space with green infrastructure measures. Fac_Bio: Factors that affect health and ecological values with green infrastructure measures.
* $p < 0.05$.

improve their personal space when green infrastructure is implemented had a greater influence on their implementation decision than for Strathmore respondents. Females' decision to implement green infrastructure was more influenced by the factors that improve personal space, than males' decisions. For ethnicity, educational levels, and home ownership, there were no statistically significant differences with scores for factors that improve the physical personal space with green infrastructure measures (Table 5).

There were no statistically significant differences between the demographic variables of neighborhood, gender, ethnicity, educational levels, or home ownership and the cost factors associated with implementing green infrastructure (Table 5).

Only neighborhood showed a statistically significant relationship with factors that degrade physical space (Table 5). Scores for the distributions of the factors that degrade physical space for Strathmore and Near West Side were not similar, as assessed by visual inspection. This indicates that the green infrastructure implementation decision for those in Near West Side was more influenced by factors that will degrade their physical space than Strathmore respondents.

There were no statistically significant relationships between factors that affect health and ecological values and neighborhood, gender, ethnicity, educational level, or home ownership (Table 5).

3.4. Willingness to implement green infrastructure measures under two hypothetical scenarios

On average, respondents indicated a moderate to high level of willingness to implement green infrastructure measures if provided free (M = 4.07, SD = 0.98). When examined against demographic variables, only gender indicated a statistically significant relationship with willingness to implement green infrastructure if provided free (Table 6). Females were therefore more willing than males to implement green infrastructure measures if they were provided free.

In terms of willingness to implement green infrastructure measures if a savings was accrued, on average, respondents indicated a moderate to high overall willingness to implement green infrastructure measures (M = 4.12, SD = 1.03). The relationships between willingness to implement green infrastructure if savings accrued and demographic variables indicated statistically significant associations with two out of the five variables (Table 6). First, scores for willingness to implement green infrastructure if savings accrued for Near West Side was statistically significantly higher than for Strathmore (Table 6). This shows that those in Near West Side were more willing to implement green infrastructure measures if a savings was accrued when compared to Strathmore residents. For educational level, post-hoc analysis revealed statistically significant differences in scores for willingness to implement green infrastructure if savings accrued between 4-year college and elementary/no formal education ($p = 0.009$) (Table 6), but not between any other combinations among the groups of high school, 2-year college, or graduate school. What this indicates is that those with elementary school education were more willing than any other group to implement green infrastructure measures if a savings was accrued.

For homeowners, ethnicity, and gender, there were no statistically significant relationships with willingness to implement green infrastructure if savings accrued (Table 6). Therefore, regardless of whether a person was a homeowner or renter, White, African American, Hispanic, or Other, male or female had no influence on their willingness to implement green infrastructure measures when a savings was accrued.

For willingness to implement green infrastructure if provided free, the logistic regression model was statistically significant (Table 7). The model explained 38.2% (Nagelkerke R^2) of the variance in willingness to implement green infrastructure if provided free and correctly classified 83.4% of the cases. Sensitivity was 93.9%, specificity was 20.0%, positive predictive value was 87.6%, and the negative predictive value was 35.3%. Of the eight predictor variables, three were statistically significant—factors that improve personal and community spaces, gender, and environmental knowledge (Table 7). First, the willingness to implement green infrastructure if provided for free increased by a factor of 3.558 if personal and community spaces improved in appearance with the use of green infrastructure. Additionally, females were 2.777 times more willing than males to implement green infrastructure measures if provided free and with increasing levels of environmental knowledge, a person is 1.911 times more willing to implement green infrastructure if provided for free.

For willingness to implement green infrastructure if savings accrued the logistic regression model was also statistically significant (Table 7). The model explained 30.1% (Nagelkerke R^2) of the variance in willingness to implement green infrastructure if savings accrued and correctly classified 82.5% of the cases. Sensitivity was 95.4%, specificity was 19.4%, positive predictive value was 85.2%, and the negative predictive value was 46.7%. Of the eight predictor variables, four were statistically significant—factors that improve personal and community spaces, factors that affect cost, factors that degrade personal and community space, and environmental knowledge (Table 7). Specifically, the willingness to implement green infrastructure if a savings was accrued increased by a factor of 2.218 if the personal and community spaces improved in appearance with the use of green infrastructure. Additionally, a person's willingness to implement green infrastructure decreases by a factor of 2.611 with each potential increase in cost factors. If, however, the factors that degrade personal and community spaces

Table 6
Kruskal–Wallis and Mann–Whitney *U*-test for relationships between willingness to implement green infrastructure measures (dependent variable) and socio-demographic variables (independent variables) under hypothetical scenarios of free provision and if a savings is accrued.

Demographic variable	*M* (SD)	χ^2/df	*U*	*z*	*p*
Neighborhood			4109.00[a] **3649.00**[b]	−1.728 **−2.869**	0.084 **0.004**[*]
NWS (56)	4.19 (1.06) **4.39 (0.98)**				
Strathmore (173)	4.04 (0.95) **4.03 (1.04)**				
Gender			4809.00 **5155.50**	−2.301 **−1.575**	0.021[*] **0.115**
Male (101)	3.92 (1.01) **4.02 (1.02)**				
Female (116)	4.21 (.92) **4.20 (1.03)**				
Ethnicity		3.288 (3) **6.073 (3)**			0.349 **0.108**
White	4.04 (0.93) **4.05 (1.02)**				
African American	4.14 (1.08) **4.25 (1.15)**				
Hispanic	4.24 (1.12) **4.34 (1.09)**				
Other	4.10 (1.13) **4.39 (0.79)**				
Educational level		3.926 (4) **12.675 (4)**			0.146 **0.013**[*]
Elementary	4.40 (0.98) **4.93 (0.17)**				
High school	4.02 (1.13) **3.95 (1.28)**				
Two year college/vocational	4.14 (0.81) **4.41 (0.65)**				
Four year college	3.84 (1.12) **3.89 (1.05)**				
Graduate	4.18 (0.84) **4.12 (1.04)**				
Home ownership			4306.50 **4207.00**	−1.007 **−1.274**	0.314 **0.203**
Own (160)	4.02 (1.04) **4.05 (1.07)**				
Rent (59)	4.23 (0.81) **4.24 (0.97)**				

[a] These are values for hypothetical scenario of free provision.
[b] These are values for hypothetical scenario of "if a savings is provided".
[*] $p < 0.05$.

Table 7
Logistic regression for predictive variables on willingness to implement green infrastructure measures if provided free and willingness to implement green infrastructure measures if a savings accrued.[a].

Variable	*B*	SE	Exp (*B*)	*p*
Fac_Improve	1.269 (0.796)[a]	0.371 (0.340)	3.558 (2.218)	0.001[*] (0.019*)
Fac_Cost	−0.569 (−0.959)	0.366 (0.334)	2.424 (.383)	0.120 (0.004*)
Fac_Degrade	0.020 (0.702)	0.341 (0.287)	1.021 (2.018)	0.952 (0.015*)
Fac_Bio	0.383 (0.164)	0.244 (0.215)	1.467 (1.178)	0.117 (0.446)
Neighborhood	1.207 (0.734)	0.767 (0.688)	3.344 (2.084)	0.116 (0.286)
Gender	1.022 (−0.144)	0.516 (0.427)	2.777 (.866)	0.048[*] (0.737)
Educational level	0.421 (0.100)	0.228 (0.427)	1.524 (1.106)	0.064 (0.638)
EK (environmental knowledge)	0.648 (0.769)	0.264 (0.214)	1.911 (2.158)	0.014[*] (0.002[*])
Constant	−7.057 (−4.090)	1.806 (1.522)	0.001 (0.017)	0.000[*] (0.007[*])
n	229			
χ^2	50.687 (41.942)			
df	8			

Fac_Improve: Factors that improve personal and community spaces with green infrastructure. Fac_Cost: Factors that affect cost of green infrastructure measures. Fac_Degrade: Factors that degrade personal and community spaces with green infrastructure. Fac_Bio: Factors that affect health and ecological values with green infrastructure.
[a] Values in parentheses indicate willingness to implement green infrastructure if savings accrued.
[*] $p < 0.05$.

increases, the willingness to implement green infrastructure if a savings is accrued increased by a factor of 2.018. Finally, those persons with higher environmental knowledge scores were 2.158 times more willing to implement green infrastructure if a savings was accrued than persons with lower environmental knowledge scores.

4. Discussion

This paper sought to examine the factors that influence a person's decision to implement green infrastructure measures among urban residents in two Syracuse neighborhoods. Fig. 3 provides a summary of the statistically significant relationships found in this

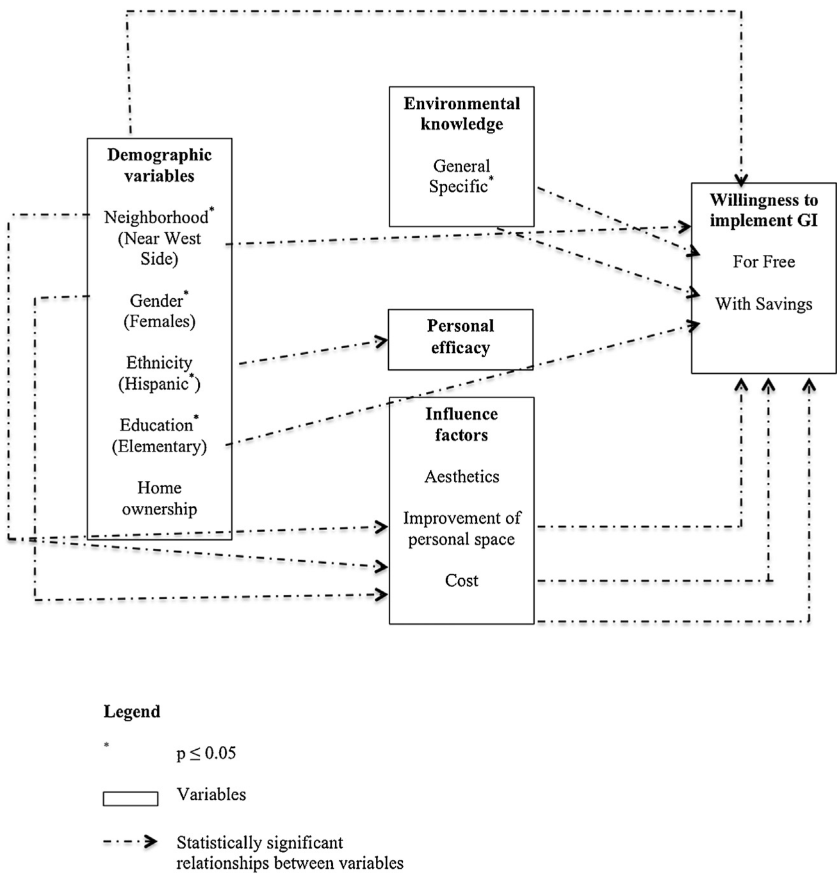

Fig. 3. Conceptual diagram of the summary of the main findings between the independent and dependent variables in this study.

study. The analysis reveals several interesting findings about the neighborhoods and can be used to provide implications for other neighborhoods where green infrastructure is being proposed.

First, no relationship was observed between demographic variables and knowledge. This result is similar to the other studies that have been done in the area that also showed that there was limited variation among the population in terms of levels of environmental knowledge. However, there was an overall high level of knowledge of the problem of stormwater management and use of green infrastructure to control for stormwater (Baptiste, 2014; Peng, 2011). This result also aligns with some of the environmental psychological literature, which indicates that demographic variables often have limited explanatory power for environmental knowledge (Barr, 2007; Dietz, Stern, & Guagnano, 1998; Hovardas & Korfiatis, 2012; Schahn & Holzer, 1990; Stern, 1999, 2000; Van Liere & Dunlap, 1981). There is therefore a need to examine additional drivers of high levels of environmental knowledge other than an individual's socio-demographic characteristics.

Perhaps one of the drivers for the high levels of environmental knowledge may be lived experience. The source of environmental knowledge in this study was specific to stormwater management in Syracuse and the lack of proper handling of CSOs. The high levels of environmental knowledge indicate that residents believe that there is a problem with stormwater management in Syracuse. This could be attributed to many residents experiencing first-hand, the negative impacts of stormwater overflows (Baptiste, 2014). Lived experience can therefore be postulated as a potential driver for the high levels of environmental knowledge in the absence of any relationship to socio-demographic variables.

Second, there is a high level of personal efficacy to address the problem of stormwater management. As defined earlier, personal efficacy refers to a person's belief that one has the ability to plan and execute an action (Meinhold & Malkus, 2005). Hence the greater one's self-efficacy, the more likely one will engage in a particular act. This matches with the high willingness to implement green infrastructure under the two hypothetical scenarios, which may be an indication that the population might be open to implementing these measures on their personal property, or have them within their communities. Stern (1999, 2000) writes about the interactive relationship between information and incentives and that many personal and contextual factors interact to determine environmentally significant behavior (Stern, 1999).

What is more interesting though is the significant relationship between ethnicity and personal efficacy to address stormwater management. Hispanics showed the highest levels of personal efficacy regarding the implementation of green infrastructure measures. African Americans showed the lowest personal efficacy, while Whites were at a moderate level. While some research has indicated that Hispanics are generally positivist in their responses to scale type questions (Van Vaerenbergh & Thomas, 2013), for this study we postulate that the more salient explanation for the high levels of personal efficacy is related to the Save the Rain Campaign. Onondaga County's Save the Rain campaign is a coordinated effort to reduce stormwater runoff utilizing both large municipal green infrastructure projects plus individual voluntary homeowner measures. The campaign includes an extensive outreach to reach sewershed residents about use of green infrastructure to reduce urban runoff. Thus, there may be a relationship with the County's Save the Rain information and residents' willingness to implement green infrastructure, which may have acted as contextual factors, shaping efficacy.

Third, with the influence factors, aesthetic factors play an important role in implementation factors, rather than cost or health factors. Significant relationships were found with factors that improve personal and community physical space and factors that degrade personal and community physical space. In both cases, neighborhood had an influence, and in the case of the former factors, gender played a role. This is understandable in that green infrastructure affects the physical appearance of the neighborhood. This is supported by both a previous focus group study (Barnhill & Smardon, 2012) as well as Palmer's (1984) past study of the area.

Fourth, with the exception of gender (females more willing than males) there were no statistically significant relationships between socio-demographics and willingness to implement green infrastructure if provided free. This finding is supported by the literature that speaks to females being more pro-environment both for larger studies such as Dietz et al. (1998) and Schahn and Holzer's (1990) study of German citizens, plus the more local study by Palmer (1984). For willingness to implement green infrastructure if a savings is accrued, only where a person lives (Near West Side more willing) and level of education (elementary school the most willing) influenced decisions to implement. This makes sense, as these two factors can be surrogates for socio-economic status, perhaps indicating that those with lower socio-economic status were more willing to implement these measures to provide a savings as they are already strained financially in other regards.

Finally, overall influence factors showed that aesthetics, cost, gender (females more willing), and levels of environmental knowledge are the factors that influence willingness to implement green infrastructure under the hypothetical scenarios. This paper postulates that perhaps those in low-income communities, those who desire to improve the overall aesthetic of the community and their personal space, and those whose financial commitments will not be strained should be targeted for these types of green infrastructure initiatives.

However, in order to encourage significant implementation of green infrastructure by private property owners, barriers to implementation must be acknowledged and reduced. Stern (1999, 2000) found many personal and contextual factors (e.g. information and incentives) interact to determine environmentally significant behavior. He notes that these factors may be barriers to change and the most effective intervention is the one that removes the most important barrier (Stern, 1999). As such, taking the implementation of green infrastructure into consideration, removing the most significant barrier involves a combination of information, incentives, social influences, and institutional supports—particularly inclusive participation (Stern, 1999). In the Syracuse Metropolitan area, some of the above-mentioned strategies are in effect with the Onondaga County's Save the Rain campaign. This campaign provides information incentives and institutional support to private property owners interested in implementing green infrastructure on their properties. Our research conclusions provide further guidance for reducing barriers and influencing implementation strategies. Furthermore, our research indicates that most residents are willing to discount negative issues (Thaler, 1980) with green infrastructure implementation if personal space and neighborhood benefits occur.

5. Conclusion

This paper contributes to literature on private property residents' knowledge and understanding of green infrastructure as it affects implementation. The major findings indicate that residents' willingness to implement green infrastructure on their properties is influenced by a number of different factors with limited contribution from demographics. Specifically, the study indicates that high levels of knowledge of the environmental problem of lack of proper stormwater management may be attributed to the lived experience of the residents as suggested by Baptiste (2014). This lived experience can also account for the high levels of personal efficacy that was found among Hispanic respondents, who live in a community that is targeted for the Save the Rain campaign. In terms of benefits and costs, aesthetics and improvement in spaces were the incentives to implementing green infrastructure, while maintenance was not seen as a major issue to implementation.

This study provides management implications regarding appropriate education programs and incentives for implementing green infrastructure on private residences in urban communities. Other studies, such as in Chicago (Ando & Freitas, 2011), Cleveland, OH (Keeley, 2007), Portland, OR (Shandas et al., 2009), and South Philadelphia (Montalto et al., 2012) indicate detailed knowledge of communities targeted for green infrastructure implementation, as well as continued involvement is very important for program success. It is important to understand the levels of knowledge about GI among residents. Further, there must be consideration and increased qualitative studies on the lived experiences of community members as it relates to stormwater management and green infrastructure initiatives in policy development and implementation. A close consideration of these factors can reveal the best target group for these initiatives. For example, this study identifies those in low-income communities, those who desire to improve the overall aesthetic of the community and their personal space, and those whose financial commitments will not be strained as a potential target group.

Acknowledgements

This research was funded by the ULTRA NSF/US Forest Service Project NSF Award ID 0948952 entitled: "Positioning Rust-Belt Cities for a Sustainable Future: A Systems Approach to Enhancing Urban Quality of Life". We would like to thank all the volunteers who assisted with the data collection especially students from State University of New York, College of Environmental Science and Forestry. A special thanks to all the anonymous reviewers for their invaluable comments in advancing this article.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.landurbplan.2014.11.012.

References

Ando, A. W., & Freitas, L. P. (2011). Consumer demand for green technology in an urban setting: The case of Chicago rain barrels. *Water Resources Research*, *47*(12), 1–11. http://dx.doi.org/10.1029/2011WR011070

Baptiste, A. K. (2014). Experience is a great teacher: Citizens' reception of a proposal for the implementation of green infrastructure as stormwater management technology. *Journal of Community Development*, *45*, 337–352. http://dx.doi.org/10.1080/15575330.2014.934255

Barnhill, K., & Smardon, R. (2012). Gaining ground: Green infrastructure attitudes and perceptions from stakeholders in Syracuse, New York. *Environmental Practice*, *14*, 6–16, 10.10170S1466046611000470.

Barr, S. (2007). Factors influencing environmental attitudes and behaviors: A UK case study of household waste management. *Environment and Behavior*, *39*, 435–473. http://dx.doi.org/10.1177/0013916505283421

Beauchamp, P., & Adamowski, J. (2013). An integrated framework for the development of green infrastructure: A literature review. *European Journal of Sustainable Development*, *2*(3), 1–24. http://dx.doi.org/10.14207/ejsd.2013.v2n3p1

Brookes, K., Brown, R., & Morrison, P. (2011, September). A case study analysis of the critical factors influencing a private land developer adopting water sensitive urban design. Paper presented at the 12th International Conference on Urban Drainage, Porto Alegre, Brazil. Retrieved from http://watersensitivecities.org.au/wp-content/uploads/2012/08/PUB14_Brookes_ACaseStudyAnalysis.pdf

Brown, R., Farrelly, M., & Keath, N. (2009). Practitioner perceptions of social and institutional barriers to advancing a diverse water source approach in Australia. *International Journal of Water Resources Development*, *25*, 15–28, 10:1080/07900620802586090.

Carlet, F. (2014). Understanding perceptions and adoption of green stormwater infrastructure (Doctoral dissertation). Virginia Polytechnic Institute and State University, Alexandria, VA.

Cattell, R. B. (1966). The scree test for the number of factors. *Multivariate Behavioral Research*, *1*, 245–276. http://dx.doi.org/10.1207/s15327906mbr0102_10

Clean Water America Alliance (CWAA). (2011). Barriers and gateways to green infrastructure. Retrieved from http://www.uswateralliance.org/pdfs/gireport.pdf

Corder, G. W., & Foreman, D. I. (2009). *Non-parametric statistics for non-statisticians: A step-by-step approach*. Hoboken: Wiley.

Dietz, T., Stern, P., & Guagnano, G. (1998). Social structure and social psychological bases of environmental concern. *Environment and Behavior*, *30*, 450–472. http://dx.doi.org/10.1177/001391659803000402

Dunn, A. D. (2010). Siting green infrastructure: Legal and policy solutions to alleviate urban poverty and promote healthy communities. *Boston College Environmental Affairs Law Review*, *37*, 41–66.

Hovardas, T., & Korfiatis, K. (2012). Effects of an environmental education course on consensus estimates for pro-environmental intentions. *Environment and Behavior*, *44*, 760–784. http://dx.doi.org/10.1177/0013916511407308

Jaffe, M. (2011). Reflections on green infrastructure economics. *Environmental Practice*, *12*, 357–365, http://dx.doi.org/10.1017/S1466046610000475.

Jennings, V., Gaither, C. J., & Gragg, R. S. (2012). Promoting environmental justice through urban green space access: A synopsis. *Environmental Justice*, *5*, 1–7. http://dx.doi.org/10.1089/env.2011.0007

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, *39*, 31–36, http://dx.doi.org/10.1007/BF02291575.

Keeley, M. (2007). Using individual parcel assessments to improve stormwater management. *Journal of the American Planning Association*, *73*, 149–160. http://dx.doi.org/10.1080/01944360708976149

Keeley, M., Koburger, A., Dolowitz, D. P., Medearis, D., Nickel, D., & Shuster, W. (2013). Perspectives on the use of green infrastructure for stormwater management in Cleveland and Milwaukee. *Environmental Management*, *51*, 1093–1108. http://dx.doi.org/10.1007/s00267-013-0032-x

LaBadie, K. (2010). Identifying barriers to low impact development and green infrastructure in the Albuquerque area (Masters project). University of New Mexico, Albuquerque, NM.

Lennon, M. (2014). Green infrastructure and planning policy: A critical assessment. *Local Environment: The International Journal of Justice and Sustainability*. doi: http://dx.doi.org/10.1080/13549839.2014.880411

Lovell, S. T., & Taylor, J. R. (2013). Supplying urban ecosystems services through multifunctional green infrastructure in the United States. *Landscape Ecology*, *28*, 1447–1463. http://dx.doi.org/10.1007/s10980-013-9912-y

Meinhold, J. L., & Malkus, A. J. (2005). Adolescent environmental behaviors: Can knowledge, attitudes, and self-efficacy make a difference? *Environment and Behavior*, *37*, 511–532. http://dx.doi.org/10.1177/0013916504269665

Millea, M., Marngo, B., Marko, M., Fordiani, R., Potts, A., & Wible, D. (2011). Onondaga County's CSO abatement program—Lessons learned and overcoming challenges of large scale green infrastructure deployment. In Water Environment Federation (Ed.), *Proceedings of the Water Environment Federation* (pp. 884–899). Alexandria, VA: Water Environment Federation.

Mitchell, V. G. (2006). Applying integrated urban water management concepts: A review of the Australian experience. *Environmental Management*, *37*, 589–605. http://dx.doi.org/10.1007/s00267-004-0252-1

Montalto, F., Bartrand, T. A., Waldman, A. M., Travaline, K. A., Loomis, C. H., McAfee, C., & Boles, M. (2012). Decentralized green infrastructure: The importance of stakeholder behavior in determining spatial and temporal outcomes. *Structure Infrastructure Engineering: Maintenance, Management, Life-cycle Design and Performance*, *9*, 1187–1205. http://dx.doi.org/10.1080/15732479.2012.671834

National Research Council (NRC). (2008). Urban Stormwater Management in the United States. Washington, DC: National Academy Press. Retrieved from http://books.nap.edu/openbook.php?record_id = 12465

Nickel, D., Schoenfelder, W., Medearis, D., Dolowitz, D. P., Keeley, M., & Schuster, W. (2013). German experience in managing stormwater with green infrastructure. *Journal of Environmental Planning and Management*, *57*, 403–423. http://dx.doi.org/10.1080/09640568.2012.748652

Olorunkiya, J., Fassman, E., & Wilkinson, S. (2012). Risk: A fundamental barrier to the implementation of low impact design infrastructure for urban stormwater control. *Journal of Sustainable Development*, *5*(9), 27–41. http://dx.doi.org/10.5539/jsd.v5n9p27

Palmer, J. F. (1984). Neighborhoods as stands in the urban forest. *Urban Ecology*, *8*, 229–241.

Peng, W. (2011). Map based modeling of people's knowledge, perception and willingness to participate in green infrastructure alternatives: A case study of Syracuse, NY (Masters thesis). SUNY College of Environmental Science and Forestry, Syracuse, NY.

Perreault, T., Wraight, S., & Perreault, M. (2012). Environmental injustice in the Onondaga Lake waterscape, New York State, USA. *Water Alternatives*, *5*, 485–506.

Pincetl, S., & Gearin, E. (2005). The reinvention of public open space. *Urban Geography*, *26*, 365–381, http://dx.doi.org/10.2747/0272-3638.26.5.365.

Podolsky, L., & MacDonald, E. (2008). Green Cities Great Lakes: Using green infrastructure to reduce combined sewer overflows. Toronto: EcoJustice. Retrieved from http://www.blue-economy.ca/sites/default/files/reports/green%20cities.pdf

Rea, L. M., & Parker, R. A. (2005). *Designing & conducting survey research: A comprehensive guide* ((3rd ed.)). San Francisco, CA: Josey-Bass.

Schaffler, A., & Swilling, M. (2013). Valuing green infrastructure in an urban environment under pressure: The Johannesburg case. *Ecological Economics*, *86*, 246–257. http://dx.doi.org/10.1016/j.ecolecon.2012.05.008

Schahn, J., & Holzer, E. (1990). Studies of individual environmental concern: The role of knowledge, gender and background variables. *Environment and Behavior*, *22*, 767–786. http://dx.doi.org/10.1177/0013916590226003

Shandas, V., & Messer, W. B. (2008). Fostering green communities through civic engagement: Community-based environmental stewardship in the Portland area. *Journal of the American Planning Association*, *74*, 408–418. http://dx.doi.org/10.1080/01944360802291265

Shandas, V., Nelson, A., & Arendos, C. (2009, October). Integrating education, evaluation and partnerships into large-scale sustainable stormwater management programs. Paper presented at the North American Association for Environmental Education, Portland, OR. Retrieved from http://web.pdx.edu/~vshandas/NAAEE_ConservationEducation.pdf

Stern, P. C. (1999). Information, incentives, and pro-environmental consumer behavior. *Journal of Consumer Policy*, *22*, 461–478. http://dx.doi.org/10.1023/A:1006211709570

Stern, P. C. (2000). Towards a coherent theory of environmentally significant behavior. *Journal of Social Issues, 56*, 407–424. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=3997994&site=ehost-live

Thaler, R. (1980). Toward a positive theory of consumer choice. *Journal of Economic Behavior and Organization*, *1*, 39–60.

Thurston, H. W. (2006). Opportunity costs of residential best management practices for stormwater runoff control. *Journal of Water Resources Planning and Management*, *132*(2), 89–96. http://dx.doi.org/10.1061/(ASCE)0733-9496(2006)132:2(89)

Thurston, H. W., Goddard, H. C., Szlag, D., & Lemberg, B. (2003). Controlling stormwater runoff with tradable allowances for impervious surfaces. *Journal of Water Resources & Planning*, *129*(5), 409–418. http://dx.doi.org/10.1061/(ASCE)0733-9496(2003)129:5(409)

Thurstone, L. L. (1947). *Multiple-factor analysis*. Chicago. IL: University of Chicago Press.

Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kazmierczak, A., Niemela, J., & James, P. (2007). Promoting ecosystem and human health in urban areas using green infrastructure: A literature review. *Landscape and Urban Planning*, *81*, 167–178, http://dx.doi.org/10.1016/j.landurbplan.2007.02.001.

US Census Bureau. (2010). 2010 Census. Retrieved from http://www.census.gov/2010census/

Van Liere, K. D., & Dunlap, R. E. (1981). Environmental concern: Does it make a difference how it's measured? *Environment and Behavior*, *13*, 651–684. http://dx.doi.org/10.1177/0013916581136001

Van Vaerenbergh, Y., & Thomas, T. D. (2013). Response styles in survey research: A literature review of antecedents, consequences, and remedies. *International Journal of Public Opinion*, *25*, 195–217. http://dx.doi.org/10.1093/ijpor/eds021