Illinois-Indiana Sea Grant (IISG) Research Project Annual Report

Section A. Summary

• Title of Project
Evaluating the Maintenance and Diffusion of Best Management Practices in the Salt Creek Watershed

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• Abstract
Stormwater best management practices (BMPs) can help local communities alleviate water runoff and reduce pollution in a cost effective way. However, few researchers have examined the adoption of stormwater BMPs in urban-suburban communities. The purpose of this project was to investigate the factors influencing the adoption and maintenance of rain barrels, a commonly promoted urban-suburban BMP, in the Salt Creek watershed in northwestern Indiana. The resulting analysis of quantitative survey data, qualitative interview data, and practice assessment field data indicated that: 1) Economic benefits are a more important motivator for adopting a rain barrel than environmental benefits; 2) Gardeners with the intention of reducing water use in their yard were the most prevalent adopters and should be targeted for future stormwater conservation practices; 3) 35% of practices were discontinued after five years of their adoption.

• Keywords
Best management practices; urban stormwater runoff; non-point source pollution; climate change; watershed-based planning

• Lay Summary
This project found that adopters were more likely to indicate that “reducing water use in their yard” was an important motivation for adopting a rain barrel than to “improve water quality”. This implies that it is necessary for practitioners to conduct education programs that spread

knowledge of conservation practices, especially emphasizing the economic benefits of the practice as well as environmental benefits. Additionally, gardeners who want to reduce water use in their yard could be the most likely potential adopters in the future. Moreover, for good maintenance of the practice, it is recommended that only well designed practices together with all related accessories are sold to adopters..

Section B. Accomplishments

• Introduction

The functions and services furnished by Lake Michigan watershed systems provide for the health, resilience and productivity of agricultural systems, human communities and marine and terrestrial natural ecosystems. The predicted increased prevalence of extreme weather events such as floods and droughts due to global climate change will have wide-ranging impacts on the ability of these watershed systems to continue to provide these functions and services at acceptable levels (Weubbles et al. 2010). Local-level adoption of appropriate and sustainable water resource best management practices (BMPs) have been identified as essential tactics for adaptation to climate change (Semadeni-Davies et al. 2008). Stormwater conservation BMPs, such as rain gardens, rain barrels and permeable pavement offer a means to decrease stormwater volumes and reduce the water quality impacts of the predicted increased water quantity that will result from climate change. While these stormwater conservation practices offer real potential to reduce impacts, they generally have low adoption rates compared to equivalent practices in the agricultural sector. Poor adoption and maintenance could be attributed to several reasons, including more numerous landowners with less property, a lower number of cost incentive programs and fewer formal public education programs than found in the agricultural community. However, there have been few efforts to understand this complex condition and, as a result, there is little information regarding the adoption and maintenance of stormwater BMPs by urban and suburban landowners. This lack of knowledge regarding stakeholder motivations contributes to a high level of uncertainty and may lead to reluctance amongst organizations that might cost-share stormwater conservation.

The long-term goal of this project is to produce results that will contribute to our understanding of the adoption and maintenance of water quality and climate change BMPs in urban and sub-urban landscapes within the Lake Michigan region:

1. To determine what motivates urban and suburban landowners to adopt and maintain stormwater conservation BMPs;
2. To identify how stormwater conservation BMPs spread or diffuse throughout a community;
3. To determine specific watershed management planning recommendations for setting adoption goals and reaching potential adopters for the Save the Dunes environmental non-profit organization working in Salt Creek.

• Project Narrative

Methods

Salt Creek watershed is a Lake Michigan watershed—one of the most industrialized and populated areas in the state, covering 19% of Porter County in northwestern Indiana (Salt Creek Watershed Management Plan, 2008). Porter County's population is projected to increase by 24% from 2014 to 2050 (U.S. Census Bureau 2014; STATS Indiana Tool by Indiana Business

Research Center). Like many similar communities with considerable population growth across the country, the area is struggling to deal with increasing urban impacts to local water quality. As a result, the Salt Creek has been listed on the impaired water bodies list for E. coli since 1998 and impaired biotic communities since 2002 (Salt Creek WMP, 2008). In 2006, the Indiana Department of Environmental Management (IDEM) contracted *Save the Dunes* Conservation Fund (SDCF) to develop the Salt Creek Watershed Management Plan (SCWMP). The SCWMP addresses non-point source pollution problems and other identified issues in Salt Creek. In 2008, SDCF started to administrate a cost-share program to implement the SCWMP, which allowed a portion of the cost to implement urban BMPs. The cost-share programs, which ran between February 1, 2009 and January 31, 2013, funded households, businesses and municipalities in the installation of over 350 practices including rain barrels, rain gardens, bioswales, pervious pavement, green roofs, critical area tree planting, and stream stabilization. To understand what motivates the adoption and maintenance of these BMPs in this watershed, an assessment of both the property owner/manager and the actual practice was conducted. This was accomplished through surveys and interviews of urban residents, as well as fieldwork assessment of rain barrels.

In summer 2014, a social indicator survey was mailed to urban residents who adopted rain barrels in the Salt Creek watershed. The addresses were comprised of all 205 rain barrel adopters from SDCF. The Dillman (2014) Tailored Design Method was used to contact all survey recipients up to five times (advance letter, 1st mailing of paper survey, reminder postcard, 2nd mailing of paper survey, 3rd mailing of a paper survey with a final notification postcard). The response rate was 53.3% (number of respondents: n=90) in the Salt Creek Rain Barrel Adopters survey, excluding the bad addresses, duplicated responses, and invalid responses.

The surveys were designed according to parameters based on the Social Indicators Planning and Evaluation System (SIPES) (Prokopy et al. 2009; Genskow and Prokopy 2011) as well as through discussions with staff at SDCF. The indicators are grouped into four categories: awareness, attitudes, constraints and behaviors. Social demographic information was also collected.

Awareness about local water quality was determined by asking questions about perceptions of water impairments, sources of water pollution, and consequences of poor water quality (4-point Likert scale: 1= not a problem, 4=severe problem). All these awareness questions included a “don’t know” answer option next to the 4-point Likert scale separating by a bold dark line, which would be an important indicator for measuring the knowledge of respondents about water quality (Hu and Morton 2012). Attitudes about the environment were measured by questions related to their agreement or disagreement with specific statements (5-point Likert scale: 1=strongly disagree, 3=neutral, 5=strongly agree). Practice constraints were measured by asking how much given factors complicate continued use of a rain barrel. Behaviors were measured by their experience with rain barrels, including questions about why a rain barrel was obtained, how it was paid for, what the water was used for, and how they learned about the practice, as well as their experience with various other BMPs. Social demographic information included gender, age, income, and education as well as property aspects such as lot size, years in residence, proximity to water bodies, and landscape environment.

Practice assessments of the condition of adopters’ BMPs were based upon established criteria and indicators for on-site assessments of BMP performance and maintenance (Bracmort et al. 2004; Lindsey et al. 1992). In addition, collaboration with staff at SDCF led to the development of a checklist with criteria for evaluating the level of maintenance of rain barrels. Excluding the inaccessible locations, a total of 135 rain barrels in Salt Creek watershed were successfully assessed between June 11 and July 15, 2014.

The assessments documented the following conditions of rain barrels:

- if the rain barrel is present,
- if the rain barrel is connected to a downspout or roof overflow,
- if the rain barrel is installed on a stand,
- if the exit hoses are attached,
- if there are any non-essential holes on the screen or on the barrel,
- if the residents displayed informational signage (see Appendix D) about their rain barrel in their yard (only applicable in the Wabash watershed),
- and an approximation of how full the rain barrel was at the time of assessment.

Each rain barrel received a score on an index from 0 to 3 after completing the assessments. Table 1 displays the criteria to achieve an index score.

Category Name	Category Index Score	Criteria
Excellent	3	Rain barrel installed, fills with water, and is able to be used to its full potential
Acceptable	2	Rain barrel installed and does fill with water, but cannot be used to its full potential
Unacceptable	1	Rain barrel installed, but does not fill with water
Absent	0	Rain barrel not installed

Table 1. Assessment index of rain barrel

Rain barrels with a score of 0 are not installed. These rain barrels either are not present, or are present but not connected to a downspout or roof overflow.

Rain barrels with a score of 1 are installed, but do not capture rainwater. These rain barrels either are connected to a downspout diverter that runs uphill, or have severe holes or cracks that eliminate the barrel’s ability to collect water.

Rain barrels with a score of 2 are installed and can capture rainwater, but limitations exist on the use of this water. For example, rain barrels that are not on a stand exhibit water pressure concerns, and rain barrels with damage to the screen on top of the barrel have the potential to attract mosquitoes. The rain barrels sold by Save the Dunes are designed so that they require the use of “exit hoses” to retrieve water from the barrel; therefore, Salt Creek rain barrels without “exit hoses” receive a score of 2.

Rain barrels with a score of 3 contain all the necessary items to be used properly and without difficulty.

In-person interviews of adopters in Salt Creek watershed were conducted in June and July 2014. All 205 rain barrel adopters in the Salt Creek Watershed were contacted up to three times; 31 individuals agreed to participate in the interview. Of these 31 interviews, 30 were with homeowners and one was with a Porter County government official. The thirty homeowner interviews were coded using NVivo and used for analysis; the interview with the government official helped gain background on stormwater initiatives in the community, but it was not used for analysis since it was not based upon personal experience with rain barrel adoption. The interviews were semi-structured, following the interview guide presented in Appendix B but occasionally adding, omitting, or changing the order of questions as the interview progressed.

Interviews included questions about where they learned about rain barrels, their motivation for installing a rain barrel, maintenance concerns, who they talked to about their rain barrel, and their knowledge of others who implemented rain barrels. Specifically, residents who said they had installed their rain barrel were asked what they use the water in their rain barrel for and how their rain barrel is working. Those who purchased a rain barrel but did not have it installed were asked about why they have not installed their rain barrel.

After a single researcher coded all thirty interviews with a systematic codebook, an inter-coder reliability test was completed. This reliability testing reduces the possibility that researcher bias resulted in the data to be coded overly consistent with the hypotheses. It will also increase confidence that the single coder's coding would be reproducible by other coders (Campbell et al. 2013). After two additional coders examined ten percent of the set of interviews, all three coders compared the results and reconciled areas of discrepancies or confusion. This process was repeated until the level of coding consistency reached a Cohen's kappa coefficient value of 0.7, which has been recommended as a satisfactory level of agreement (Bakeman and Gottman 1986; Gardner 1995).

Results

There were a higher percentage of female respondents than male. More than half of the respondents were aged between 50 and 69 (62.5%, n=87). A large number of the respondents earned a bachelor's degree or higher (63.7%, n=88). Most of the respondents owned their property rather than rented it (96.6%, n=88). See Table 2 for more details.

Gender	Female	62.1%
	Male	37.9%
Age	Mean	58.7
	Range	34~91
Education	High school	15.9%
	Some college	13.6%
	2-year college degree	6.8%
	4-year college degree	36.4%
	Graduate degree	27.3%
Residential Lot Size (unit: acre)	1/4 or less	47.2%
	More than 1/4 but less than 1	34.8%
	1 to less than 5	12.4%

	5 or more	5.6%
Home Property	Own	96.6%
	Rent	3.4%

Table 2. Survey respondents' demographic profile

Over half of the respondents reported that they received their rain barrels at a discounted price from the city, university, or local organization (64.7%, n=68). The majority of respondents said they installed their rain barrel and currently use it (70.5%, n=88). Over half of the respondents who installed a rain barrel (64.4%, n=70) stated they emptied their rain barrel within a week of filling.

When asked about motivations for installing a rain barrel (n=74), a high percentage of the respondents said they used it to "reduce water use for their yard and house" (91.9%). The second top reason reported was "to improve water quality in my area" (47.3%). Over half regarded reduction of water use for their yard and house as the most important single factor driving their acquisition of a rain barrel (62.9%, n=70), while only a small percentage of respondents saw improvement of water quality as the most important factor (12.9%, n=70). Most respondents said they used stored rain barrel water to irrigate a vegetable or flower garden (94.4%, n=72).

All of the interviewees in Salt Creek, regardless of whether or not they installed their rain barrels, were flower and/or vegetable gardeners. Twenty-eight of the 30 interviewees mentioned gardening as a primary reason for purchasing a rain barrel. The two who did not mention gardening as a key motivator did not install their rain barrel. Four interviewees mentioned that having a rain barrel was convenient for them because the rain barrel was closer to their garden than the hose was, and made watering easier. Fourteen interviewees also saw cost as an important reason to purchase a rain barrel. Eight interviewees mentioned the rain barrel was inexpensive, while seven individuals noted that city water was expensive while rain barrels supplied free water.

When asked about special constraints on the continued use of rain barrels, except for equipment malfunction and water pressure, over half of the respondents reported all the other listed constraints as "Not at all". Respondents regarded equipment malfunction (4.4%, n=70) and water pressure issues (4.4%, n=71) as the factors influencing them "a lot". The cost of maintenance was identified as the least constraining factor ("Not at all": 97.2%, n=71). The top five factors respondents identified as constraints (aggregated percentage of "a lot" and "some") are shown in Table 3.

Constraints	
Equipment malfunction (n=70)	21.4%
Concerns with mosquitoes (n=72)	15.3%
Water pressure issues (n=71)	12.7%
Time required for maintenance (n=71)	11.3%
Insufficient water in the barrel (n=70)	8.6%

Table 3 Top five constraints to maintain a rain barrel

The interviewees in Salt Creek talked about diverse maintenance concerns as well. The most common maintenance issues mentioned include hoses clogging or breaking, water overflowing, rain barrel cracking over the winter season, and low water pressure. Inconvenience was also a common concern. Six of the eight interviewees who received an assessment score of 0 mentioned inconvenience as a reason why they do not use their rain barrel. One person who used their rain barrel also mentioned inconvenience. As a result, this person discouraged a friend from getting a rain barrel because of the work required.

135 rain barrels were assessed and assigned an index score. Over half of the practices were recorded as "Excellent". Notably, almost 35% of Salt Creek rain barrels were absent after a maximum of five years in practice.

Category	**Index Score**	**Salt Creek**
Excellent	3	70 51.90%
Acceptable	2	9 6.70%
Unacceptable	1	9 6.70%
Absent	0	47 34.80%
Mean		1.76
Median		3
Mode		3

Conclusions

The research finds that the economic benefits are a more important motivator for adopting a rain barrel than environmental benefits. More adopters indicated that "reducing water use in their yard" was an important motivation than to "improve water quality". From another perspective, adopters care more about water quantity than water quality issues. Moreover, most adopters said they use the stored water to irrigate a vegetable or flower garden and all of the interviewees were gardeners. This characteristic of adopters identifying as gardeners is consistent with previous research (Newburn et al. 2013). It should be noted that while water quantity was not classified as an environmental issue in the humid Midwest, it may very well be considered an environmental issue in other regions, especially in the arid western United States.

This implies that it is necessary for practitioners to conduct education programs that spread knowledge of conservation practices, especially emphasizing the economic benefits of the practice as well as environmental benefits. Additionally, gardeners with the intention to reduce water use in their yard could be the most likely potential adopters in the future. Moreover, for good maintenance of the practice, it is recommended that only well designed practices together with all related accessories are sold to adopters.

Section C. Outputs

One submitted publication:

Gao, Yuling, Nicholas Babin, Allison J. Turner, Cheyenne R. Hoffa, Linda S. Prokopy, Understanding Urban-Suburban Adoption and Maintenance of Rain Barrels, *Landscape and Urban Planning.*

• Undergraduate/Graduate Names and Degrees

Yuling Gao, Ph.D. (In Progress)
Allison J. Turner, Bachelor (Earned) – Undergraduate Honors Thesis, Purdue University, "Understanding Maintenance and Diffusion of Rain Barrels"
Aaron Pape, M.S. (Earned)
Cheyenne Hoffa, BS (In Progress)

• Project Partnerships

Save the Dunes

• Related Projects

USGS, 104(g) funding, "Can There Ever be Enough? Analysis of the Adoption, Penetration and Effectiveness of Urban Stormwater Best Management Practices", 2014-2017, $246,254 (PI: Dr. Laura Bowling)

• Awards and Honors

N/A

• Patents/Licenses

N/A