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Research Paper

Analyzing differences among non-adopters of residential stormwater management practices

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ABSTRACT

This study identifies a profile of households that are likely to have stronger intentions to adopt two stormwater management practices, rain gardens and rain barrels. In particular, this study identifies the characteristics of likely adopters compared to persistent non-adopters. The data is from a survey in Columbia, Missouri with a 44% response rate. Results of multinomial logit models show that being female and living in a suburban area are important demographic factors that increase the likelihood that households plan on adopting both practices. This was also true for having positive attitudes towards the environment and believing that they need to protect water quality. Households that are more aware of the practices and perceive a need for technical knowledge to implement the practices are apt to be likely adopters. Since likely adopters are clearly different from persistent non-adopters, the direct comparison of these groups can facilitate targeted policies and informational campaigns.

1. Introduction

Climate change and increasing urbanization, including the expansion of impervious surfaces in urban areas, have together exacerbated urban stormwater runoff, which can result in more severe flash flooding, soil erosion, and in-stream degradation (U.S. EPA., 2003). Improving stormwater management in urban areas can therefore result in improved water quality and aquatic habitats. Households can help by adopting environmental technologies on their properties such as best management practices for stormwater.

Green infrastructure or low-impact development (LID) can be a potential solution, therefore promoting new practices has become an essential component of sustainable urban stormwater management (Benedict & McMahon, 2006; U.S. EPA, 2003, 2007). The U.S. EPA (2003, 2007) has proposed cost-effective stormwater management practices such as rain gardens, rain barrels, buffer strips, and permeable pavements to improve water quality and to control flooding. This study examines two of these practices; 1) rain gardens, depressions that use plants to filter and infiltrate stormwater, and 2) rain barrels, which collect water flowing from roofs and gutters. These practices can reduce stormwater runoff to waterways as well as flooding in yards (Jennings, Adeel, Hopkins, Litofsky, & Wellstead, 2012) but they have different attributes. For example, a rain garden is more expensive to implement but attractive, while a rain barrel is relatively low-cost to install and allows reuse of collected water, but requires specific equipment (U.S. EPA., 2016).

The adoption rates for stormwater management practices are quite low so an understanding of factors affecting the willingness of households to adopt the practices is necessary for effective stormwater management. The current adoption levels for rain gardens and rain barrels, two of the more common household stormwater management practices, are low in Columbia, Missouri, at 3.1% and 7.5%, respectively (Shin & McCann, 2018). Near the Chesapeake Bay, the adoption levels are similar, 2.5% for rain gardens and 7.6% for rain barrels (Newburn, Alberini, Rockler, & Karp, 2013). This low level of adoption implies that those who have adopted these practices can be categorized as innovators or early adopters (Rogers, 2010), and these early adopters might have different characteristics than those who adopt later. In addition, when adoption rates for the innovation are low (Faiers & Neame, 2006; Woersdorfer & Kaus, 2011) and many potential adopters exist (Caird, Roy, & Herring, 2008), it can be useful to distinguish between types of non-adopters: “potential adopters” who are willing to adopt an innovation eventually, and “persistent non-adopters” or “never adopters” who are not willing to adopt an innovation. The latter may include those who had seriously considered adopting the innovation before deciding against it (Caird et al., 2008).

Moreover, the type of technology can affect the reasons for non-adoption, which can help to distinguish the types of non-adopters. Like

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other environmental practices, rain gardens and rain barrels have both private and public good characteristics (Carlson, Barreteau, Kirshen, & Foltz, 2015), which can hinder the early adoption of stormwater management practices. Potential adopters' perceptions of the on-site or private benefits and costs of specific practices may vary across households, as can the extent to which they care about the off-site or social benefits, and these issues can affect the adoption decision.

Much of the existing literature focuses on the factors affecting adoption, however neither the motivations of non-adopters nor the perceived barriers concerning the characteristics of these practices have received sufficient attention. In addition, many adoption studies focus on current adopters in the early adoption stage, which might provide misleading recommendations for educational efforts and policy to reach the large number of potential adopters. Understanding which factors are associated with greater willingness to try these practices will enable social marketers or policy makers to develop strategies specifically targeted to these households.

Our previous study (Shin & McCann, 2018) focused on the factors affecting adoption of two management practices, rain gardens and rain barrels. Response categories compared to adoption included "Never heard of it," "Somewhat familiar with it" and "Know how to use it." Those spending more than 10 h per month on gardening or yardwork were more likely to adopt both practices as were those with pro-environmental attitudes. Another finding from the study was that including perceived barriers in the model substantially increased its explanatory power. After the adoption/knowledge question and questions on barriers, we asked non-adopters whether they would be willing to try the practices. Given the low adoption rates for these practices, identifying the non-adopters most likely to adopt, as well as those who are unlikely to ever adopt, is important. The current study thus uses the same dataset, a household mail survey conducted in 2014 in Columbia, Missouri, and many of the same explanatory variables but focuses on non-adopters using a different survey question as the dependent variable to examine factors affecting the degree of adoption intention.

We assume that potential adopters can be categorized on the basis of the degree of their stated intention to adopt each practice, which in turn depends on a variety of factors. In particular, the objective of this study is to identify a profile of potential adopters who are likely to have stronger intentions for adopting the two practices based on the following factors: 1) their socio-demographic characteristics, 2) their level of knowledge about specific practices and the environment, 3) their attitudes toward the environment and social norms, and 4) their perceptions of the specific practices.

Based on the answer given by non-adopters to the question "Are you willing to try it?", three categories of non-adopters can be distinguished: high willingness to adopt (Yes), moderate willingness to adopt (Maybe), and no willingness to adopt (No). This unique dataset then enables us to contribute to the existing literature by distinguishing between these three different types of non-adopters by examining individuals' demographic characteristics and attitudes. Additionally, this study identifies how awareness and technical knowledge of specific stormwater management practices affects willingness to adopt. The study also examines how perceived barriers to adoption, which are allowed to vary by practice, affect adoption intensions. The analyses of barriers provide specific information to guide practice design, policies, and educational efforts. The final contribution of the current study is to compare the factors affecting interest in adopting rain gardens versus rain barrels. These results regarding intensions are in turn compared to our previous study relating to adoption (Shin & McCann, 2018).

In the next section, we describe the theoretical background and the previous literature, from which we derive the hypotheses to be tested. Both adoption theory as well as theories related to planned behavior are reviewed. In the section that follows, we report on the research methodology used in this study, including the survey methodology, the measurement of the variables, and the statistical methods that were applied. Next, descriptive and empirical results are presented. The paper ends with a brief summary and a discussion of the theoretical and practical implications of the findings.

2. Adoption theory and hypotheses

2.1. Adoption theory and behavioral intention

Rogers (2010) asserts that we can classify people into categories of adopters. His categories—innovators, early adopters, the early majority, the late majority, and laggards—are determined by the rate of adoption, adoption timing, and innovativeness, which can also indicate people's willingness to change behavior. When the number of individuals adopting is plotted as a cumulative rate over time, this diffusion curve takes an S-shape (Mansfield, 1961; Rogers, 1958). However, an innovation can fail to achieve widespread diffusion (Cooper, 1979) so the maximum may not be full adoption. Moore (1999) identifies a large gap between early adopters of high-tech innovations and the early majority, which is created by the divergent personality traits between adopter categories, implying that the innovation needs to be made attractive to the majority. This suggests that earlier adopters may differ from later adopters based on individuals' preferences about attributes of the innovation, which may necessitate market segmentation. In addition, people who adopt one innovation early may be laggards with respect to other innovations (Pannell et al., 2006). Adoption thus happens in an identifiable progression, the reasons for which depend on characteristics of the individual as well as the innovation. Especially when adoption rates are low, these ideas enable us to distinguish between early adopters and potential adopters (Faiers & Neame, 2006; Woersdorfer & Kaus, 2011).

Understanding the role of intentions can also provide useful insights for the adoption of innovations. One intention model, the theory of planned behavior, has proven successful in predicting and explaining behavior by assuming that an individual's behavior is determined by their intention to perform the behavior (Ajzen, 1991). Many studies confirm that degree of intention is a significant factor in changing an individual's behavior, along with attitudes, subjective norms, and perceived control (e.g. Abrahamse & Steg, 2009; Ajzen, 1991).

This study combines different theoretical approaches into one model focusing on the factors distinguishing potential adopters from persistent non-adopters. Rogers' explanation is important because it shows that adoption occurs in a sequential manner and that the reasons for it vary depending on the characteristics of the adopter and the relative advantage of the innovation. The study of intention helps to understand the decision-making process for environmental management practices. Combining the two approaches results in a more nuanced and complete analysis of adoption intentions. The next subsection examines the literature to develop specific hypotheses regarding determinants of adoption intensions.

2.2. Determinants affecting adoption leading to hypotheses

Although there are a number of studies on the factors that influence adoption of residential energy conservation innovations and agricultural technologies, only a few studies compare different types of non-adopters. In the U.K., Faiers and Neame (2006) examined differences in perceptions regarding the characteristics of solar power systems among early adopters, early majority and sub-groups within the early majority group. Also, Woersdorfer and Kaus (2011) analyzed the profile of future consumers of a solar thermal system in Germany using consumers' plan-to-purchase data. Both studies found that people who are considering adoption may be different from persistent non-adopters.

Baddeley (2011) suggests that those who select 'Maybe' show very weak intentions toward behavior change, so considering them as being willing to change their behavior will yield biased results. We were not able to identify studies which had actually implemented a survey using a 'Maybe' response for stormwater management before conducting our