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Research article

Unbundling household preferences for improved sanitation: A choice experiment from an urban settlement in Nicaragua

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ABSTRACT

Many urban settlements in developing countries still lack access to sanitation services, which puts the environment and population health at risk. The lack of knowledge on household preferences for improved sanitation has been an impediment to extending conventional and onsite sanitation infrastructure. This study implemented a choice experiment to elicit households' willingness to pay for the disposal of different types of waste (i.e. wastewater, excreta, and rainwater) in an urban settlement in Nicaragua. Generalized multinomial logit models were estimated to account for heterogeneity among respondents in both choice behavior and preferences for specific attributes. Findings indicate that households are willing to pay a considerable amount of money for improved disposal of wastewater, excreta, and rainwater. However, households have stronger preferences for wastewater and excreta removal than for disposal of rainwater.

1. Introduction

The lack of sanitation services can have negative environmental and health consequences, especially in urban settlements with high residential densities where the squalor and health risks associated with unimproved sanitation are particularly acute (McGranahan, 2015). Inappropriate disposal of wastewater and rainwater presents considerable health risks for urban settlements as stagnant water is often a breeding ground for mosquitoes that can transmit diseases (Sharma, 2014). Unimproved latrines may also put the population at an increased risk for illness as excreta could reach and contaminate underground water sources (Buttenheim, 2008; Graham and Polizzotto, 2013). Moreover, in urban settlements, space constraints may influence decisions to dig new latrines when old ones reach capacity. Under these circumstances, appropriate disposal of runoff and excreta may have considerable environmental and health benefits for households in urban settlements.

Sanitation infrastructure has been quite effective in fighting diseases in developing countries (Vásquez and Aksan, 2015; Zwane and Kremer, 2007). Yet, the progress in expanding improved sanitation coverage in those countries has been slow (Van Minh and Nguyen-Viet, 2011). For example, out of 191 state members of the United Nations, only 95 met the sanitation target within the Millennium Development Goals framework (United Nations, 2015). As a point of comparison, 147 countries met the drinking water target. Lack of information on household preferences and willingness to pay for improved sanitation services can be an important impediment to the implementation of conventional and onsite sanitation infrastructure. Winters et al. (2014) argue that the demand for enhanced sanitation is less expressed than the demand for other services because citizens are embarrassed to talk about sanitation issues. Improved understanding of household preferences for sanitation services may help in prioritizing public investments in sanitation infrastructure by showing the relative importance of those services to citizens. This is particularly important in developing countries where the needs are multiple and resources are limited. Moreover, unbundling household preferences for appropriate disposal of different types of waste may facilitate selecting among conventional and onsite technologies to extend sanitation services (e.g. septic tanks, ecological latrines and biological gardens).

Choice experiments have been shown to be an appropriate method to elicit household preferences for improved public services in developing countries (Bennet and Birol, 2010). Compared to

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other preference elicitation techniques (e.g. contingent valuation method), choice experiments are more suitable to estimate willingness to pay for different attributes of the public service in question (Birol et al., 2006; Hanley et al., 2001). In the case of sanitation, choice experiments could provide useful insights to design and provide sanitation services that respond to households' willingness to pay for disposing different types of waste (e.g. excreta, wastewater, and rainwater). Few studies have conducted choice experiments to investigate local preferences for improved sanitation in developing countries, and most of those studies have done so in areas where conventional sewerage systems or improved on-site technologies (e.g. absorption pits and septic tanks) already exist (e.g. Birol and Das, 2010; Genius et al., 2012; Woldemariam et al., 2016). Similar information would be useful for urban settlements where basic sanitation is nonexistent as residents may face considerable environmental and health risks. Ndunda and Mungatana (2013), for example, found that farmers living in informal settlements in Nairobi (Kenya) would be willing to pay for improved wastewater treatment primarily because it would increase the amount and quality of water available for irrigation. That study, however, focused on wastewater management thus neglecting other types of waste that may also jeopardize the environment and population health (e.g. excreta and rainwater).

In this study, we have implemented a choice experiment to unbundle household preferences for improved sanitation in the form of proper disposal of wastewater, excreta, and rainwater in the urban settlement of Nueva Vida, Nicaragua. As many other urban settlements in developing nations, Nueva Vida is subject to environmental and health risks due to the lack of sanitation infrastructure. Respondents' choices were analyzed using generalized multinomial logit models to account for two types of respondent heterogeneity: 1) taste heterogeneity (i.e. respondents may value attributes differently), and 2) choice behavior heterogeneity (i.e. some respondents may show more random choice behavior than others). Survey results indicated that households are aware of the environmental and health consequences of current sanitation conditions. Findings also suggested that households are willing to pay a considerable amount of money for disposal of wastewater, excreta, and rainwater. Households, however, had stronger preferences for wastewater and excreta removal than for disposal of rainwater.

The rest of this paper is organized as follows. The next section describes the urban settlement of Nueva Vida, with an emphasis on describing current sanitation conditions in that community. Section 3 explains the survey design including the choice experiment. Section 4 introduces the analytical framework and econometric approach followed to analyze responses to the choice experiment. Section 5 presents the estimation results. Section 6 concludes the paper with a discussion of the results and potential policy implications.

2. Study site

This study was conducted in the urban settlement of Nueva Vida, located in the municipality of Ciudad Sandino at approximately 17 km west of the capital city of Managua, Nicaragua. This settlement was initially formed by households that were displaced by hurricane Mitch in 1998. According to Universidad Centroamericana (2016), the population is estimated at 8085 residents in 1724 households. This settlement currently occupies an area of 2.7 km squared, with a high population density of 2994 people per kilometer squared. The settlement is organized in five territorial zones locally referred to as *etapas*.

Universidad Centroamericana (2016) produced an urban diagnostic of Nueva Vida, which portrayed precarious living conditions, particularly in terms of sanitation. The settlement has a drinking water system in place to which most, if not all, households are connected. In contrast, Nueva Vida does not have a conventional sanitation system to dispose excreta, wastewater, and rainwater. Almost 60% of households use an unimproved latrine and almost 35% use a toilet, although few of them (if any) are connected to a septic tank that can be periodically emptied as those services are nonexistent for the community of Nueva Vida. Stagnant water is another sanitation issue given that Nueva Vida lacks a sewerage system. Although some households have a sort of artisanal absorption pit, a vast majority of households let wastewater flow onto the streets. Because the settlement is located on a relatively flat area, and most streets are not paved, wastewater tends to stagnate. This issue is even worse in the rainy season.

Given the high population density of Nueva Vida, the settlement seems to be rapidly reaching its capacity for digging latrines. Inappropriate disposal of excreta represents a latent source of pollution for the aquifer from which Nueva Vida gets its water. Therefore, it is imperative to provide improved sanitation services that can dispose excreta in an appropriate manner. In addition, stagnant water currently puts the population health at risk as it facilitates the proliferation of bacteria, parasites, and mosquitoes. During our visits to Nueva Vida, we observed several barefooted children having direct contact with stagnant water. According to Universidad Centroamericana (2016), Nueva Vida's inhabitants rank sanitation services at the top of their many needs. Against this backdrop, a better understanding of willingness to pay for improved disposal of wastewater, excreta, and rainwater may be useful to prioritize public investments which, in turn, may have substantial environmental and health benefits.

3. Survey and choice experiment design

An interdisciplinary team of researchers from Fairfield University (United States) and Universidad Centroamericana (Nicaragua) designed a household survey to investigate household behaviors, perceptions, and preferences related to water and sanitation in the community of Nueva Vida. The final survey questionnaire had a total of 38 questions (some of them with multiple parts) organized in six sections. First, respondents were asked about current conditions of water services. In the second section, respondents reported their behaviors regarding the use, storage, and treatment of tap water. The third section measured water users' satisfaction levels and inquired about perceptions of water quality. The fourth section included questions on the water-health nexus. The fifth section elicited household preferences for improved sanitation services using a choice experiment. Finally, the survey gathered respondents' sociodemographic information.

For the survey implementation, Nueva Vida was stratified into five geographical zones and parcels in each stratum were randomly selected from a map that Universidad Centroamericana (2016) had generated as part of an urban diagnostic project in 2016. This map was the best available framework for sampling given that mailing addresses are not used in Nicaragua. A total of 419 households were randomly selected according to a geographically-stratified random sampling strategy, and 398 completed questionnaires were obtained via an in-person interview process implemented in July 2016. Interviewers were instructed to ask for the adult who usually pays the water bill.

Local preferences for improved sanitation services were elicited through an unlabeled choice experiment. This experiment included three binary attributes and an increase in water bills to pay for improved services. We defined the binary attributes representing sanitation improvements in terms of the waste to be disposed rather than based on potential technological projects aimed at disposing those wastes. Those attributes consisted of disposal of