Research Paper

Willingness to pay for VIP latrines in rural Senegal
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ABSTRACT

In 2015, African ministers established the Ngor Declaration to achieve universal access to adequate sanitation and hygiene services and eliminate open defecation by 2030. Realizing this target will require significant public and private investment. Over the last two decades, there has been increasing recognition that sanitation programs should be demand driven, yet limited information exists about how much rural residents in developing countries are willing to pay for sanitation improvements. This paper applies the contingent valuation approach to evaluate how much households in rural Senegal are willing to pay for a ventilated improved pit (VIP) latrine. The analysis uses data from 1,635 household surveys that were conducted in 47 rural communities across four regions in Senegal. The willingness to pay model found that respondents were more willing to pay for a VIP latrine if they had plans to improve their existing latrine, lived in districts located nearer to the capital city of Dakar, were dissatisfied with their existing sanitation service, and were male. The analysis also indicates that the current household contribution of 5% of the costs of constructing a VIP latrine could be increased to 30% with only a modest decline in the number of households willing to pay this amount.

Key words | rural Senegal, sanitation, ventilated improved pit, VIP latrine, willingness to pay

INTRODUCTION

More than 2.4 billion people lack access to an improved sanitation facility, and the majority of these people are poor and live in rural areas (UNICEF & WHO 2015). In Senegal, only 40% of the rural population has access to improved sanitation, with rural sanitation being the only sub-sector in the country significantly below the MDG targets (WSP 2011). Addressing the sanitation challenge will require dedicated public and private resources combined with a strong political will that elevates sanitation in national policies and programs.

In May 2015, the Ministers and Heads of Delegations responsible for sanitation and hygiene in Africa adopted the Ngor Declaration on Sanitation and Hygiene in Dakar, Senegal, to ‘achieve universal access to adequate and sustainable sanitation and hygiene services and eliminate open defecation by 2030.’ (AfricaSan 2015). This outcome aligns with the targets under Goal 6 of the proposed Sustainable Development Goals that also call for ‘the participation of local communities in improving water and sanitation management’ (UN 2014, p. 12). The challenge in realizing these goals in Senegal, and Africa in general, will be to find innovative ways to encourage or enable local communities to participate in improving their access to sanitation services and eliminate open defecation.

Investments in sanitation services have suffered from poorly designed programs that promote technically or culturally inappropriate technologies that households do not use (Mara et al. 2010). Such misjudgments concerning the nature of consumer demand in the sanitation sector of developing countries are frequent and stem from a lack of data on existing levels of services, residents’ priorities, and/or their demand for different sanitation services.
Large-scale sanitation programs often involve a donor or government subsidy. To set the design cost, it is necessary to estimate the amount most households are able and willing to pay for improved sanitation, and the likely level of subsidy available (Cairncross 1992). It is surprising that few studies have addressed existing demand for sanitation in Africa (Whittington et al. 1993; Altaf & Hughes 1994; Jenkins & Scott 2007; Rahji & Oloruntoba 2009; Meeks 2012). The Sanitation Directorate in Senegal established a sanitation promotion policy that includes subsidies and awareness raising, yet there is little data on appropriate subsidy levels (WSP 2011). No research was found on the willingness of rural residents in Africa to pay for sanitation facilities, specifically for ventilated improved pit (VIP) latrines, the topic of this paper. Furthermore, there is little quantitative research on the predictors of latrine ownership in Africa.

Without such research, governments and development organizations must estimate what consumers would be willing to contribute for a particular sanitation service. A program funded by the African Development Bank in Senegal to construct 11,000 family latrines (consisting of either a VIP or pour flush latrine), set the household contribution to participate in this program at 5% of the costs of the facility (African Development Bank 2010). In 2009, the Center for Low Cost Water Supply and Sanitation (CREPA), based in Burkina Faso, estimated the cost of constructing a VIP latrine as 180,870 FCFA ($307) (Niang 2009). Therefore, a 5% contribution towards the construction of a VIP latrine would be around 9,000 FCFA ($15). The conversion rate used in this paper was $1 USD = 590 FCFA. At the time of the fieldwork, the conversion rate was $1 USD = 450 FCFA.

The existing research shows a wide range of willingness to pay (WTP) between countries, and that the demand for improved sanitation depends on a variety of factors such as gender, education, assets owned, income, health practices and knowledge, and social networks (Faisal & Seraj 2008; Van Minh et al. 2013; Thanh et al. 2014; Shakya et al. 2015). This variation means that accurate estimates of WTP should be made at the country or regional level.

This paper describes the application of a contingent valuation (CV) method to estimate household demand for one possible sanitation technology, the VIP latrine, in rural Senegal. It also evaluates household level factors associated with the WTP for the VIP latrine.

METHODS AND DATA

The research presented in this paper was undertaken as part of a larger study on the productive use of domestic water in Senegal funded by the World Bank’s Water and Sanitation Program (WSP). The purpose of the larger study was to examine relationships between the productive use of domestic water, poverty reduction, and sustainability (Van Houweling et al. 2012; Hall et al. 2013; Hall et al. 2014). All of the research was undertaken in compliance with the research protocol approved by Virginia Tech’s Institutional Review Board (Protocol ID: 09-153). In preparation for the fieldwork in Senegal, the research team was asked by the WSP-Senegal to also collect data on the willingness of rural households to pay for a VIP latrine, a technology of specific interest to development organizations working in the country. The large-scale, empirical nature of the research presented a unique opportunity to develop data on rural demand for VIP latrines. The fieldwork in Senegal was conducted over a three-month period from May to August 2009.

Sample framework and methods

Of the eight regions located in the Northern and Central zones of Senegal, four were selected for the study (St. Louis, Matam, Diourbel, and Kaffrine) based on an assessment of the agricultural and livestock activity occurring within the regions and the desire to have some variation among the regions in terms of hydrological, geographic, and climate characteristics. The focus on agricultural and livestock activity was due to the emphasis of the larger study on the productive use of domestic water (Hall et al. 2014). In particular, the study focused on small-scale rural piped water systems that obtain water from deep boreholes fitted with electric-powered pumps.

Within the four study regions, 47 rural piped water supply systems were selected based on variation in the reported levels of productive activity supported by the systems -14 in Diourbel, 12 in Kaffrine, 10 in Matam, and 11 in St. Louis. Prior to the main fieldwork, a pilot study was undertaken to test the surveying instruments and WTP module. No substantive changes were made to the WTP module following the pilot, and the surveyors reported no problems with the administration of this module.
In total, 1,860 household surveys were administered in the 47 systems included in the study. The typical household in our sample had an agricultural livelihood and was composed of 11 people. Education levels were low among the survey respondents, and 86% had no formal education. Household median monthly income was 53,100 FCFA ($90).

The households interviewed were selected systematically. Each team surveying a village started from a central point in the community – such as a mosque or school. From this point, the surveyors walked a transect to the outer edge of the community surveying every second or third household.

Enumerators recorded responses to the household survey using a personal digital assistant (PDA). The survey included a series of modules that collected data on the household’s composition, water use, health, sanitation, income, and assets. The sanitation module consisted of questions concerning the following: where different members of the household defecate; the types of latrines households use; household perceptions of their sanitation situation; plans to upgrade household sanitation; and satisfaction with different aspects of sanitation. These variables were all considered in the logistic regression model to understand household demand for improved sanitation. The final part of the sanitation module contained the WTP questions.

**The WTP module**

One approach to assessing the demand for a good or service is the CV method (Whittington et al. 1990). This method is increasingly used in developing countries to put a value on environmental improvements and other public goods (Cummings & Brookshire 1988). It has been used frequently within the water sector (Gunatilake et al. 2007; Null et al. 2012), and is beginning to be applied more frequently to estimate WTP for sanitation (Fujita et al. 2005; Faisal & Seraj 2008; Van Minh et al. 2013; Thanh et al. 2014).

There are many procedures for eliciting demand using a CV design including an iterative bidding process, open-ended questions, contingent ranking questions, dichotomous choice questions, and payment card method (Gunatilake et al. 2007; Thanh et al. 2014). This study uses the dichotomous choice method for CV elicitation. This method has been shown to provide reliable results in the water and sanitation sector (Whittington et al. 1990; Gunatilake et al. 2007). When using the dichotomous choice method the respondent is expected to answer ‘yes’ or ‘no’ to a given price that is associated with a clearly defined good. The bidding game technique is the most widely used in developing countries, and is considered the most valid and adjustable to potential bias (Van Minh et al. 2013; Thanh et al. 2014).

The CV method used in the household survey consisted of two parts: (1) a description of the service or technology being offered; and (2) a procedure to elicit a respondent’s WTP with minimum bias (Altaf & Hughes 1994).

A clear description of the VIP latrine was given to all respondents in their local language (see the Supplementary Information that is available with the online version). After answering any questions the respondents had, the enumerator asked: ‘If a private contractor was willing to build you a VIP latrine would you be willing to pay X amount for it?’

The bid amount (X) included in the question was randomly selected from five values – 8,000 FCFA ($14), 16,000 FCFA ($27), 32,000 FCFA ($54), 64,000 FCFA ($108), or 80,000 FCFA ($136) – using a random number generator programmed into the PDAs. Prior to this study, the WSP-Senegal had one data point indicating that households would be willing to pay 8,000 FCFA ($14) towards the construction of a VIP. This information was used to anchor the lower end of the price range. The remaining price points were developed in close collaboration with WSP-Senegal staff.

**Statistical methods**

Logistic regression models have been used effectively in WTP studies with binary yes/no data (Altaf & Hughes 1994; Choe et al. 1996). We used logistic regression to predict a household’s WTP for a VIP latrine based on the bid price and various other independent variables created from the household survey (see Tables AI and AII in the Supplementary Information that is available with the online version). We determined the average WTP for all households in our study, and separately for each region, by using logistic regression to estimate the sensitivity of a respondent’s WTP for the bid amount (Gunatilake et al. 2007).
We used a forward-backward stepwise logistic regression variable screening procedure in R (R Core Team 2014) based on the Akaike Information Criterion (AIC) to determine which of the independent variables should be included in the final model (Venables & Ripley 2002). The AIC evaluates how well the independent variables explain the dependent variable of WTP (Akaike 1974).

The independent variables were selected from the household survey data based on a literature review of previous studies and consultations with our local partners. The variables analyzed fell into the following categories: respondent attributes, household socio-economic characteristics, urban proximity, health and hygiene behaviors, and the type and satisfaction with existing household sanitation facilities (see Tables AI and AII in the Supplementary Information that is available with the online version).

The AIC screening method identified seven independent variables that were found to be significant (at the alpha = 0.1 level). These variables were bid, satisfaction with sanitation, household income, plans to improve sanitation, size of household, respondent male, and district. Following Gunatilake et al.’s (2007) guidance on constructing a valid analytic regression model, three more variables were included in the WTP model based on hypothesized relationships between these variables and a respondent’s WTP for a VIP latrine: open defecation, illness in the past week, and respondent’s education.

An analysis and quality check on the survey responses conducted after the data were collected revealed that two of the seventeen enumerators had not asked the WTP questions correctly, as an abnormally high number of their responses were, ‘Yes,’ irrespective of the bid amount. These responses were excluded from further analyses, leaving 1,635 households remaining in the study.

RESULTS

Access and satisfaction with sanitation

One half (50%) of the households surveyed reported using a private or public latrine and 52% reported practicing open defecation (2% of households reported that members used both a latrine and openly defecated). Of those households using a latrine, 69% used a private latrine, 30% used a shared private latrine, and 1% used a public latrine. Over one half of households with a private latrine reported constructing the facility within the past five years. In 92% of cases, the households financed and constructed these latrines. Most private latrines are made with local materials and have mud walls, simple soak pits, and either mud or concrete floors. Development projects installed 6% of the latrines.

In 2015, 34% of the rural population in Senegal had access to an improved facility, 8% used a shared facility, 34% used an unimproved facility, and 24% practiced open defecation (UNICEF & WHO 2015). Thus, the data collected from the surveyed communities is comparable with regards to the use of an improved/shared facility, but a much larger share of respondents reported defecating in the open.

Only 18% of respondents reported being generally satisfied with their sanitation services. Two thirds (66%) of respondents were not satisfied with their existing sanitation situation. Almost all households (96%) that openly defecate reported not being satisfied with their sanitation situation, compared with 56% of households that use a private or public latrine.

The majority of respondents (66%) who were not satisfied stated the lack of a toilet facility within their home/household compound as the main reason for their dissatisfaction (Table 1). The second and third most common reasons were embarrassment associated with open defecation and

<table>
<thead>
<tr>
<th>Reason for dissatisfaction with sanitation service</th>
<th>Not satisfied (n = 878)</th>
<th>Somewhat dissatisfied (n = 245)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No toilet in home</td>
<td>66% (580)</td>
<td>7% (17)</td>
</tr>
<tr>
<td>Embarrassing</td>
<td>40% (354)</td>
<td>45% (111)</td>
</tr>
<tr>
<td>No privacy</td>
<td>34% (299)</td>
<td>31% (75)</td>
</tr>
<tr>
<td>Health concerns</td>
<td>28% (242)</td>
<td>28% (68)</td>
</tr>
<tr>
<td>Too expensive to build toilet</td>
<td>22% (194)</td>
<td>16% (39)</td>
</tr>
<tr>
<td>Smells bad</td>
<td>11% (96)</td>
<td>15% (36)</td>
</tr>
<tr>
<td>Unclean</td>
<td>9% (80)</td>
<td>11% (28)</td>
</tr>
<tr>
<td>Pit is full</td>
<td>5% (44)</td>
<td>19% (46)</td>
</tr>
<tr>
<td>Poor drainage</td>
<td>3% (23)</td>
<td>16% (40)</td>
</tr>
<tr>
<td>Far from home</td>
<td>6% (50)</td>
<td>3% (8)</td>
</tr>
<tr>
<td>Other</td>
<td>5% (40)</td>
<td>13% (33)</td>
</tr>
</tbody>
</table>

*Multiple responses permitted.
the lack of personal privacy. Just under a third (28%) of respondents reported health as a reason for their level of dissatisfaction and only around one quarter (22%) of households identified the high cost of building a toilet or latrine as a main reason for their dissatisfaction. Responses elicited from men and women respondents were found to be remarkably similar across the response categories.

Seventy-one percent of households stated that they planned to improve their sanitation situation in the future. Of these households, 32% wanted to build a VIP latrine, 23% wanted to build a private latrine with a soak pit, 20% wanted to install a pour/flush toilet, 13% wanted to build a traditional pit latrine, and 6% wanted to improve the existing structure of their latrine. These data indicate that the majority of households surveyed were thinking about improving their existing sanitation situation, and a range of sanitation options were being considered.

**WTP for a VIP latrine**

The average willingness of all households to pay for a VIP latrine was 72,300 FCFA ($123), which is nine times more than the existing amount (of 8,000 FCFA or 4.4% of the construction costs) that households were thought to be willing to pay for such a facility. However, this value varies significantly by district. In Diourbel, Kaffrine, Matam, and St. Louis the average WTP was 103,500 FCFA ($175), 76,500 FCFA ($130), 58,800 FCFA ($100), and 55,800 FCFA ($95), respectively.

The majority (94%) of respondents presented with a required contribution of 8,000 FCAF ($14) towards the VIP latrine were willing to pay this amount. Further, 88, 79, 56, and 45% of respondents presented with contribution amounts of 16,000 FCAF ($27), 32,000 FCAF ($54), 64,000 FCAF ($108), and 80,000 FCAF ($136) were also willing to pay the stated amount, respectively.

The WTP model identified five variables that are statistically significant predictors of a respondent’s WTP for a VIP latrine (Table 2). First, the bid value was important. The higher the bid, the less willing a respondent was to pay for a VIP latrine (p < 0.001). Second, if a household had plans to improve its sanitation situation, respondents from these households had 2.7 greater odds of being willing to pay for a VIP latrine than respondents from households without such plans (p < 0.001). Third, households in Diourbel and Kaffrine were more willing to pay for a VIP latrine than in Matam and St. Louis (p < 0.001), even though households in Matam and St. Louis have a higher average monthly income. Fourth, respondents who were somewhat dissatisfied (odds ratio = 2.07, p < 0.01) or not satisfied (odds ratio = 1.76, p < 0.05) with their sanitation situation were more willing to pay for a VIP latrine than respondents who were generally satisfied with their sanitation situation. A higher level of dissatisfaction was also found to be highly correlated with a household’s plans to improve their sanitation facility (p < 0.001). And finally, male respondents were more willing to pay for a VIP latrine than female respondents (odds ratio = 1.52, p < 0.01).

**DISCUSSION**

The average willingness of all households to pay for a VIP latrine was 72,300 FCFA ($123), although this value varied significantly by district. Given that the median monthly

<table>
<thead>
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<th>Table 2</th>
<th>Results of logistic regression predicting WTP for sanitation</th>
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<tbody>
<tr>
<td></td>
<td>Odds Ratio</td>
</tr>
<tr>
<td>(Intercept)</td>
<td>4.60815</td>
</tr>
<tr>
<td>Bid</td>
<td>0.99996</td>
</tr>
<tr>
<td>Plans to Improve Sanitation</td>
<td>2.73111</td>
</tr>
<tr>
<td>District–Kaffrine</td>
<td>1.0535</td>
</tr>
<tr>
<td>District–Matam</td>
<td>0.37919</td>
</tr>
<tr>
<td>District–St. Louis</td>
<td>0.31968</td>
</tr>
<tr>
<td>Open Defecation</td>
<td>1.17693</td>
</tr>
<tr>
<td>Satisfaction with Sanitation–Satisfied</td>
<td>2.07002</td>
</tr>
<tr>
<td>Satisfaction with Sanitation–Somewhat satisfied</td>
<td>1.76311</td>
</tr>
<tr>
<td>Illness in Past Week–Yes</td>
<td>1.15389</td>
</tr>
<tr>
<td>Household Income</td>
<td>1.00039</td>
</tr>
<tr>
<td>Size of Household</td>
<td>1.01591</td>
</tr>
<tr>
<td>Respondent Education</td>
<td>1.22634</td>
</tr>
<tr>
<td>Respondent Male</td>
<td>1.51564</td>
</tr>
</tbody>
</table>

Significance codes: ‘***’ p < 0.001; ‘**’ p < 0.01; ‘*’ p < 0.05; ‘.’ p < 0.1.
household income was 53,100 FCFA ($90) and the lowest district-level average WTP for a VIP latrine was 55,800 FCFA ($95), these values could be treated as a conservative upper bound to what the majority of households would be willing to contribute towards the construction of a VIP latrine. Thus, households may be willing to contribute much more than the estimated 5% of the costs of constructing a VIP latrine and perhaps as much as 30% of these costs.

The majority of the variables found to be associated with a WTP for the VIP latrine aligned with the authors’ expectations and the results of previous studies. Proximity to urban centers makes sense as a predictor of WTP because it entails greater access to sanitation markets, increased exposure to sanitation and hygiene campaigns, potentially higher incomes, and stronger networks with other people who already have latrines (Shakya et al. 2015). The variation of WTP between regions in Senegal may also be explained by other factors such as livelihood differences and remittance flows. The implication of these findings is that VIP latrine programs dependent on household contributions are likely to experience greater uptake in those districts located nearer to the capital city of Dakar.

Although few studies consider gender – e.g., see Van Minh et al.’s (2013) study in Vietnam and Fujita et al.’s (2005) study in Peru – this research found that men were more willing to pay for sanitation than women. This finding does not necessarily imply that women are less concerned with sanitation, and might instead be related to the fact that women in rural Senegal typically do not make the major household decisions or have access to household finances (Van Houweling et al. 2012).

There was some association between open defecation and WTP for a VIP latrine, but this relationship was not statistically significant (odds ratio = 1.18, p > 0.1). Open defecation was highly correlated with dissatisfaction (p < 0.001). Thus, a household’s level of satisfaction with their sanitation service and their motivation or plans to build a latrine is likely to be a more useful predictor of their WTP for a VIP latrine than their existing sanitation practices.

Households with a larger number of family members (odds ratio = 1.016) that reported an illness in the past week (odds ratio = 1.15), and that had a respondent who had at least a primary school education (odds ratio = 1.23), were more willing to pay for a VIP latrine, but these findings are not statistically significant (p > 0.1). Thus, respondents either did not make an association between their sanitation practices and family health, or other factors such as their general dissatisfaction with their sanitation situation were driving their decision process.

Household income had a positive relationship with WTP, though it was only statistically significant at the alpha = 0.1 level. It is surprising that there was not a stronger association between some level of economic status and WTP, considering the wide range of income and asset based variables tested in the model and the strong association found in other countries (Seraj 2008; Rahji & Oloruntoba 2009; Van Minh et al. 2013). Along with the higher than expected WTP found among respondents, this result indicates that cost is not the primary constraint for the majority of households surveyed in Senegal to improve their sanitation services.

Research by Guiteras et al. (2015) in rural Bangladesh revealed how subsidies covering 75% of the cost of a latrine led to a 22% increase in latrine ownership compared to no statistically significant increase from a supply-side market access intervention or a CLTS-inspired (community-led total sanitation) community motivation and information program. If Senegal’s Sanitation Directorate were to continue its sanitation promotion program and target subsides at VIP latrines, our research indicates that a significant proportion of households may be willing to pay 30% of the construction costs of the latrine. Further, around three quarters (71%) of the households surveyed in Senegal stated a desire to improve their sanitation situation, which highlights the potential demand for a subsidy program targeting a range of latrine options. However, there may still be groups within communities who cannot afford to contribute to the cost of a latrine and full subsidies may be necessary for these poorest households.

**Study limitations**

In presenting these results, the authors acknowledge the extensive literature critiquing WTP studies (Cummings & Brookshire 1986; Blamey et al. 1999; Merrett 2002; Hensher et al. 2005). For this study, efforts were taken to reduce the impact of information and hypothetical bias by training the enumerators to clearly and consistently describe the
VIP with the support of images. Further, the dichotomous choice method was selected for its relative simplicity and ability to elicit a WTP value with limited bias. However, the authors recognize the potential problem of strategic bias, whereby respondents answer with the intention of influencing a future investment or policy, and ‘yea-saying,’ where respondents answer based on what they think the enumerator would like them to say. In the latter case, two enumerators' data were removed from the dataset due to a concern that they had been leading the respondent–i.e., all their respondents had accepted all of their bids.

Another limitation of this study is that it only provided respondents with one option: the VIP latrine, a selection that is more technologically advanced (and expensive) than most existing private latrines. National latrine promotion programs should offer households a range of options, including latrine designs that can be built making use of more local materials to increase adoption and reduce the likelihood of affordability constraints. Notwithstanding these concerns, we believe the results from this study provide a good indication of the factors that shape WTP for a VIP latrine in the study districts and can inform the design of sanitation programs in these regions.

CONCLUSION

Existing data in Senegal indicated that rural households would be willing to pay 8,000 FCFA (or approximately 4.4% of the construction costs) towards the installation of a VIP latrine. This study found that the majority of households surveyed may be willing to pay up to 50% of the costs of constructing a VIP. While many factors must be considered when establishing the level of household contribution towards a sanitation program, this finding suggests households could bear a greater proportion of the construction costs, which could extend the reach of available funds for a national sanitation program. This study also contributes some key factors that explain a household’s WTP for sanitation. Respondents were more willing to pay for a VIP latrine if they had plans to improve their existing latrine, lived in districts (Diourbel and Kaffrine) located nearer to the capital city of Dakar, were dissatisfied with their existing sanitation service, and were male.

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