The Last Mile Challenge of Sewage Services in Latin America and the Caribbean

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1 // *The authors would like to thank Jorge Oyamada, Marcello Basani, Nicolás Rezzano y Anastasiya Yarygina from the Inter-American Development Bank for their valuable comments and suggestions.*

Abstract

Access to piped sewage in Latin America and the Caribbean (LAC) cities has been on the rise in recent decades. Yet achieving high rates of end-user connection between dwellings and sewage pipelines remains a challenge for water and sanitation utilities. Governments throughout the region are investing millions in increasing access to sewage services but are failing in the last mile. When households do not connect to the sewage system, the full health and social benefits of sanitation investments fail to accrue, and utilities can face lost revenue and higher operating costs. Barriers to connect are diverse, including low willingness to pay for connection costs and/or the associated tariffs, liquidity and credit constrains to cover the cost of upgrades or repairs, information gaps on the benefits of connecting, behavioral obstacles, and collective action failures. In contexts of weak regulation and strong social pressure, utilities typically lack the ability to enforce connection through fines and legal action. This paper explores the scope of the connectivity problem, identifies potential connection barriers, and discusses policy solutions. A research agenda is proposed in support of evidence-based interventions that have the potential to achieve higher effective sanitation coverage more rapidly and cost-effectively in LAC. This research agenda must focus on: i) quantifying the scope of the problem; ii) understanding the barriers that trigger it; and iii) identifying the most cost-effective policy and market-based solutions.

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1
Introduction

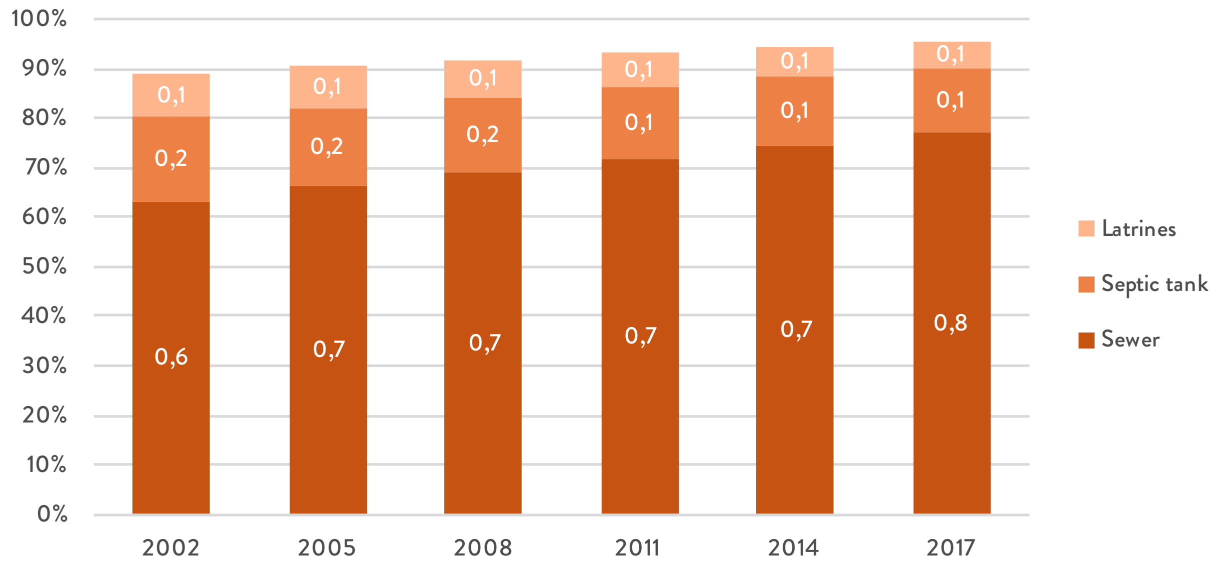
It is estimated that more than 450 million people in Latin America and the Caribbean (LAC) lack access to safely managed sanitation services[2], including the 15.6 million who still practice open defecation (WHO and UNICEF 2020). Due to high urbanization, 72% of those without access (327 million) live in urban areas. Sustainable Development Goal 6 (SDG6) includes ambitious and comprehensive targets aiming at ensuring the availability and sustainable management of sanitation services for all. Target 6.2 aims to achieve, by 2030, access to adequate and equitable sanitation and to end open defecation, while Target 6.3 aims to halve the proportion of untreated wastewater by 2030. Achieving these targets require significant investments. It is estimated that at least US$10 billion annually needs to be mobilized solely to cover the capital costs associated with expanding and improving sanitation services in LAC (Hutton and Varughese 2016). If the full benefits of investments in sanitation services, particularly, sewage systems and wastewater treatment are to be achieved, ensuring that households are connected to the systems is of critical importance.

The proportion of the urban population with access to sewage services in LAC increased from 62.4% in 2002 to 77.1% in 2017 (WHO and UNICEF 2020)[3]. Much of this expansion has taken place in peri-urban neighborhoods where local utilities install and operate sewer networks, but households are ultimately responsible for the end-user connection. Connecting dwelling's bathrooms, kitchen and other wastewater sources to sewer pipes requires financial investments in home upgrades, as well as time and effort. In the absence of sewerage, by 2017, almost 13% of the urban population in the region relied on individual basic sanitary solutions through septic systems and another 6% through latrines (WHO and UNICEF 2020). Even when there are sewer networks nearby, households all too often continue to rely on these individual on-site sanitation options, even though they can be prone to leaks, spills, and in some contexts are only a step above open defecation. In countries with weak legal and regulatory frameworks, options for local governments and system operators to enforce end-user connections are often limited. In this context, the short-run costs of connecting to a newly installed sewer system may outweigh the private benefits, leading some households to delay connecting or decide not connecting at all.

2 // *Safely managed sanitation service means using hygienic toilets from which wastes are treated and disposed of safely.*

3 // *The paper focuses exclusively on urban populations as sewage systems are typically built, for technical and financial reasons, only in urban and peri-urban areas. In rural areas, sanitation solutions are typically on-site solutions such as improved latrines or ecological bathrooms.*

FIGURE 1 Urban population using sewage systems, septic tanks, and latrines in LAC



Source: WHO/UNICEF Joint Monitoring Program for Water Supply and Sanitation.

Low connectivity has negative implications for a number of reasons. First, when households fail to connect, the full health and environmental benefits of sewer infrastructure investments are not materialized. Individual sanitation solutions, when not properly constructed and maintained, are prone to leaking wastewater (water contaminated with feces) into the environment through surface run-off and ground water contamination, leading to increased morbidity and mortality (White, Bradley, and White 2002; Esrey et al. 1991; Fewtrell et al. 2005; Zwane and Kremer 2007; Bancalari and Martinez 2017). Second, the financial sustainability of the sewer system depends on many users contributing to the operation and maintenance costs[4]. Finally, sewer lines and wastewater treatment plants require a minimum flow of wastewater to function properly. Low wastewater volume reduces the plant's efficiency to remove contaminants. Also, if very low volumes of wastewater enter the system, sediments can clog sewer networks, requiring costly maintenance and, in extreme cases, rendering the sewer line and wastewater treatment plant inoperable. In 2017, only 37% of the urban population in region had access to a sewer network with adequate wastewater treatment. This proportion represents an increase of 22 percentage points from 2002 (WHO and UNICEF 2020).

Demand-side barriers can lead to connection rates that are lower than the socially, financially and technically optimal. These barriers are diverse and differ from context to context. For low-income households, liquidity constraints and

4 // *The financial sustainability argument is less relevant under some regulatory frameworks where utilities charge sewerage services when systems start operating, regardless of whether households have connected or not.*

imperfect credit markets result in financial limitations to cover the cost of home repairs. Households may also face non-financial constraints including behavioral barriers, information gaps about the benefits and costs of connecting, as well as collective action problems. In such cases, even households with the financial means to connect may delay doing so. Behavioral barriers include present bias, where a homeowner intends to connect, but perpetually delays the activity, such as searching for a plumber, under the false impression that his or her "future self" will take the necessary actions at a future date. Under the status-quo bias, households maintain their current on-site sanitation solution (septic tanks or latrines) and fail to visualize the benefits of connecting. Alternatively, information barriers may lead to systematically underestimate the health and environmental risks of failing to connect. Finally, collective action failures can arise if the decision to connect by one household is dependent on the larger collective. For example, households may be unwilling to incur the private costs of connecting until their neighbors also connect, especially when the benefits of a cleaner environment will only materialize with high connection rates.

High quality and representative data on end-user sewer connections for the region is still lacking. Operators tend to report the number of households with access to piped sewerage, rather than effective connections. Household surveys report sanitary infrastructure or place of discharge, but not access. As such, constructing regional measures of connection rates and analyzing trends over time is not feasible with existing data. Nonetheless, purpose specific surveys of connectivity from several cities and sewerage projects throughout LAC suggest that the connectivity challenge is real. Some cities report that sewer connection rates are as low as 50%, implying that despite infrastructure being built a high percentage of households remain unconnected. Low connectivity appears to be especially problematic in rapidly expanding peri-urban areas, where much of the remaining backlog in sanitation infrastructure exists. Available data suggest that connection rates increase over time, but at a decreasing rate, and densely populated urban areas with sewer systems that have existed for a long time may still contain a non-trivial number of households unconnected. This shortage of quality information extends to wastewater treatment. Only 9 of 32 countries in LAC report complete information on wastewater generation, treatment and use (Sato et al. 2013).

This paper discusses the potential scope of the connectivity problem and surveys the theoretical and empirical literature on demand for sewage services. We draw on recent developments in behavioral science and extrapolate lessons from evidence-based solutions in the context of health, education, water, among other sectors, to propose a set of potential interventions to promote sewer conectivity. While the evidence on effective solutions applied to sewer connectivity is very limited, we outline a research agenda to test and adapt promising solutions to the network connectivity challenge. The ultimate objective is to identify a set of cost-effective and evidence-based approaches that utilities and governments can adopt to achieve high connection rates whenever financing a project. These interventions can be embedded in sewer infrastructure projects to alleviate demand and supply side constraints for connecting and help ensure that the full benefits of investments in sewage collection and treatment are achieved.

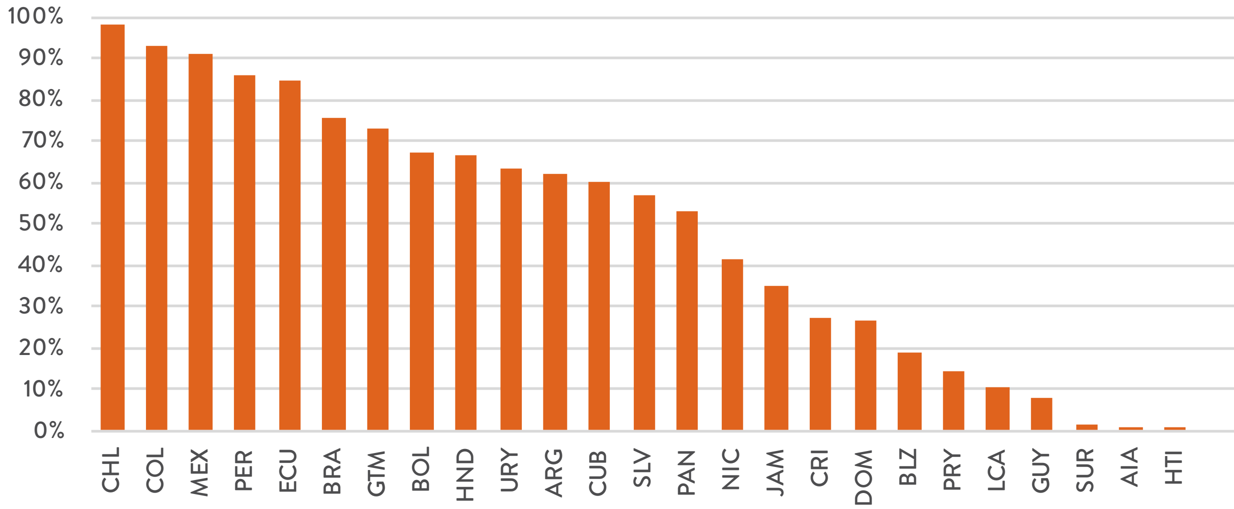
The remainder of the paper is organized as follows. In section 2, we present data on access to sewerage in LAC and describe the scope of the connection problem using data from available case studies. In section 3, we explore potential barriers faced by households. In section 4, we present a series of policy interventions to promote connectivity, linking these interventions to barriers, from subsidies and credits to information and training. Section 5 outlines a research agenda to build empirical evidence and eventually map the cost-effectiveness of different policy alternatives that could inform future sewerage interventions. The final section lays out a series of conclusions around the last mile challenge.

2

Sewage System Coverage in LAC

Despite progress in extending access to sewage services in urban areas, there are huge gaps in coverage across countries, which ranges from 1% of the urban population in Haiti to 98% in Chile (Figure 2).

FIGURE 2 Urban population with access to sewage systems by country



Source: WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation.

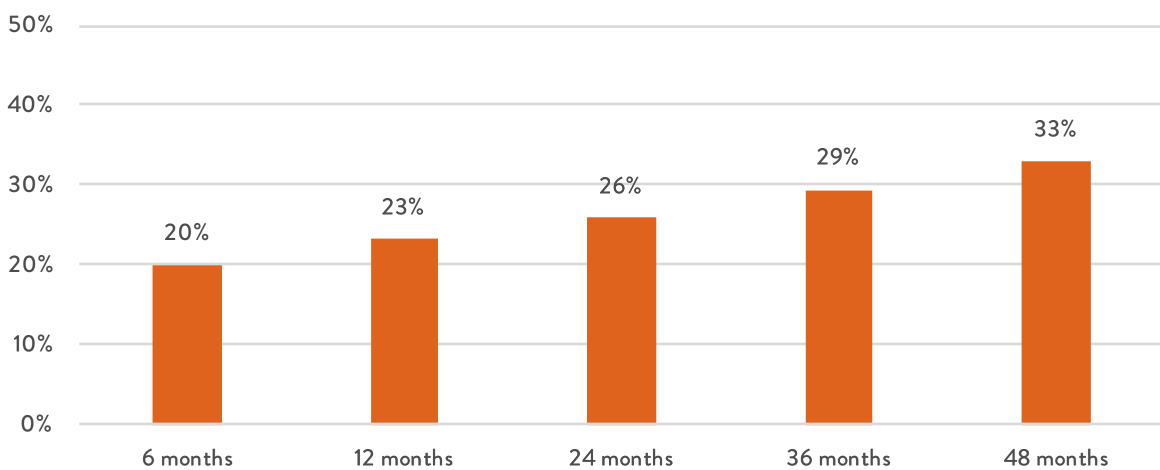
As mentioned, if the full benefits of investments in sewage systems and wastewater treatment are to be achieved, ensuring that households are connected to the system is of critical importance. Unfortunately, representative data on sewage system connectivity in the region is very scarce. Sewer operators tend to measure access (i.e. the number of households that could connect to the sewer line) rather than actual connection rates. On the other hand, representative household surveys tend to measure on-site sanitation infrastructure (i.e. the presence of a bathroom and the place of discharge), or how wastewater is discharged into the environment, rather than measuring access to a sewer line. As such, estimating representative measures of end-user connection at the regional or country level is a major challenge.

For an initial approximation to the connectivity problem, we analyzed information collected from sanitation projects in Argentina, Ecuador, Paraguay, and Mexico that tracked effective connection rates over time in areas with newly installed sewer networks[5]. The data show that 12 months after sewer networks were installed, 23% of households in these areas had connected, while 48 months later the connection rate was 33% (Figure 3). These data also

5 // *It is important to note that the connection rates presented in this section are based on information from specific projects and are not representative of the total urban area of a country or region. Moreover, because these projects are mostly concentrated in peri-urban and usually low-income areas, connections rates are likely to be lower than average.*

suggest that the speed of connectivity diminishes over time, with connections in the first year more than doubling the rate of subsequent years. Appendix 1 provides project level information on connection rates over time in Argentina and Mexico. The data show substantial variation, with areas that surpass 90% after 48 months, and others that reach only 15% over the same period. However, it is important to note that projects with very high coverage tend to be much smaller in terms of the absolute number of households with access.

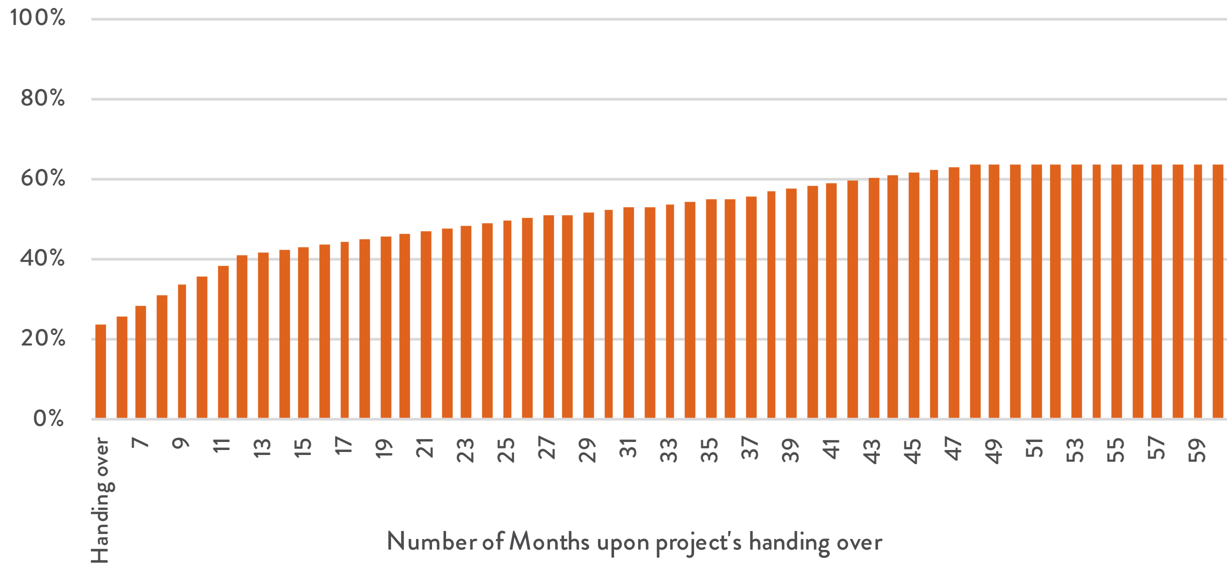
FIGURE 3 Sewage system connection rate over time in selected projects



Source: Authors' calculation using population weighted averages. Data come from sewer projects in Concepción (Paraguay), Mixtla de Altamirano (México), Pénjamo (México), and Tres Isletas (Argentina).

In Guayaquil, Ecuador, monthly connection rates were estimated for a set of 49 sewerage projects constructed between 2000 and 2010 that benefitted 105,552 end-users. For each project, the local water utility, Interagua, analyzed the number of new users that entered Interagua's billing system each month. They later used this information to forecast the connection rate for the next five years (period 2011-2016). Figure 4 presents the estimated monthly connection rates since the sewage services became available until almost five years later. Average connection rates increased to 41% over the first year, and then increased gradually over the next three years, stabilizing at 64% after 48 months. These numbers reveal that connection rates seem to increase at a decreasing rate over time, eventually reaching a steady state at which some proportion of households remain unconnected.

FIGURE 4 Evolution of monthly sewage system connection rates in selected projects in Guayaquil, Ecuador (2000-2010)



Source: Estimations based on a study carried out by Interagua using data from 49 sewage expansion projects carried out between 2000 and 2010 in Guayaquil, Ecuador.

Another sewer connectivity study in 47 of Brazil's 100 largest municipalities (representing 21.2% of the country's population) estimates that 687,268 households (2,2 million individuals) were not connected to the sewer network, despite having access to the service (sewer box outside the household) (Galvão Junior, Baldez Custódio, and Monteiro 2015)[6]. Additional 516,771 households had inactive connections, meaning that while an end-user connection exists, the household is not actively discharging effluents into the system. Together, these two groups of households lacking "effective connection" accounted for roughly 9% of all households with access to sewer systems. The study estimates that the total number of people in the 100 largest municipalities that have access to a sewer network but are not receiving services is 3.6 million. In contrast to the project data from Argentina, Ecuador, Paraguay and Mexico, the Brazilian context includes highly urbanized areas and sewer systems that have presumably existed for much longer.

Overall, the available data on connectivity suggests that the Last Mile challenge in Latin American and the Caribbean is large. For newer projects in peri-urban areas, slow rates of connectivity early in the project's lifetime mean that benefits do not start to accrue in full until many years later, when a critical mass of households have connected. Incomplete connectivity also means that aggregate sewerage coverage rates may be over-estimated, and projects may over-estimate the projected benefits and under-estimate the per-capita costs of piped sewage investments.

6 // *The study focused on 47 of the 100 largest municipalities in Brazil, including Brasília, Campo Grande, Sao Paulo, Belo Horizonte, among others.*

3

Barriers to Connectivity

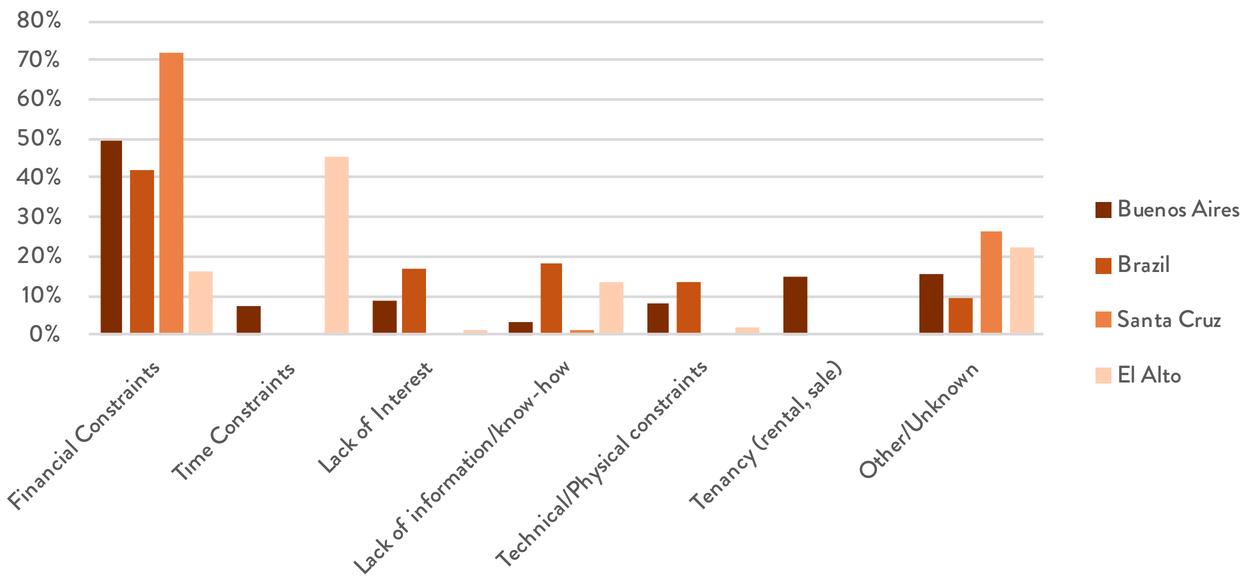
Multiple barriers may prevent households from connecting to the sewer system in a timely manner, and constraints are likely to be different from context to context and even household to household[7]. In this section, we categorize the most common barriers observed in the water and sanitation literature and complement the discussion with lessons from research on service demand and technology adoption in developing countries. We categorize barriers to connectivity into demand-side and supply-side constraints. Conditional on having access to sewerage, key demand-side barriers to connectivity include financial constraints, incomplete information of connection benefits, behavioral constraints, and coordination and collective action failures. On the supply side, we focus on institutional barriers to connectivity, including property rights, bureaucratic obstacles, and availability of skilled service providers.

3 • 1 • Demand-side barriers

To gain an initial understanding of potential demand side barriers and their relative importance, we analyzed self-reported information about the main factors preventing households from connecting to the sewage system in areas with access to services. Using data from selected projects in Brazil, the Metropolitan Area of Buenos Aires, Argentina, and the cities of Santa Cruz and El Alto in Bolivia, the numbers show that, in three out of four cases, factors associated with financial constraints, such as economic difficulties, resistance to pay the tariff or the value of connection, were the most frequent reported barriers to connectivity (Figure 5). Still, in all areas except Santa Cruz, only less than half of the households indicated that financial constraints were the main factor. In Brazil, for example, time constraints, lack of interest or motivation, and lack of information represent almost half of the reasons given by households. Time constraints and lack of information were reported as the main barriers in 59% of households in El Alto, Bolivia. Technical or physical barriers and property rights (particularly for renters) represent another subset of reasons for not connecting. Finally, a non-trivial proportion of households in all four contexts, ranging from 10% to 27%, report other or unknown barriers to connectivity that do not fall into financial, motivation and information, technical or institutional barriers.

7 // *While insufficient service infrastructure is the most important constraint to improving sewerage coverage at an aggregate population level, in this paper we focus on demand- and supply-side barriers that explain people's limited take-up of services conditional on the presence of infrastructure.*

FIGURE 5 Reported reasons for not connecting to the sewage system in peri-urban localities – Selected projects in LAC



Source: Data are from selected projects reporting reasons for not connecting among households in the Buenos Aires Metropolitan Area, 47 Brazilian municipalities, and the cities of Santa Cruz de la Sierra and El Alto in Bolivia. Responses across surveys have been aggregated into comparable categories (see Appendix 2).

Low willingness to pay and liquidity constraints

While self-reported data are informative, households may not reveal full information regarding their willingness to pay for sewage connections and whether liquidity constraints in fact play a primary role in their decision to delay connecting (or not to connect at all). To quantify the magnitude of this potential barrier based on revealed preferences, unconnected households in three peri-urban areas of the Santa Cruz department, Bolivia, were offered financial subsidies to cover the cost of their end-user connection using two alternatives designs[8]. The designs were structured so as to reveal the presence of liquidity constraints as a barrier to connect (see Table 1) Under option 1, households were offered a subsidy equivalent to approximately 40% of the intra-household connection cost, payable in monthly installments (over a 24-month period) through the user's water bill (at a 0% interest rate). Under option 2, households were offered the same financial subsidy, with an additional 7% discount if the connection was paid upfront. The additional discount was set slightly above the market interest rate so that households with available liquidity would be inclined towards option 2, whereas liquidity constrained households would prefer option 1 (use the subsidized credit). Households could also choose to connect on their own (no subsidy). No penalty was imposed

8 // The connection subsidy initiative was implemented in the localities of Cuatro Cañadas, San Jose de Chiquitos and La Guardia by the Bolivian Ministry of Environment and Water as part of the Water and Sewerage Program in Peri-urban Areas, Phase I in Bolivia (BO-L1034/BO-X1004) with support from the IDB. The strategy coordinated national, sub-national and local agencies to promote sewage connections and guaranty the sustainability of services, articulating actions of the Ministry of Environment and Water, municipal governments, local operators, and beneficiary households. The Ministry purchased sanitary devices and sewage materials and transferred them to local Operators. Local governments administered and transferred program funds to operators to purchase additional supplies, and contracted plumbers and construction workers. Operators were responsible for identifying final beneficiaries, purchasing additional materials, and administering the fund created to finance household connections.

on those households that decided to remain un-connected. Additionally, a limited number of households categorized as highly vulnerable based on socioeconomic and demographic conditions (extreme poverty, single parents, etc.) were granted a full subsidy.

TABLE 1 Subsidy options for end-user connectivity

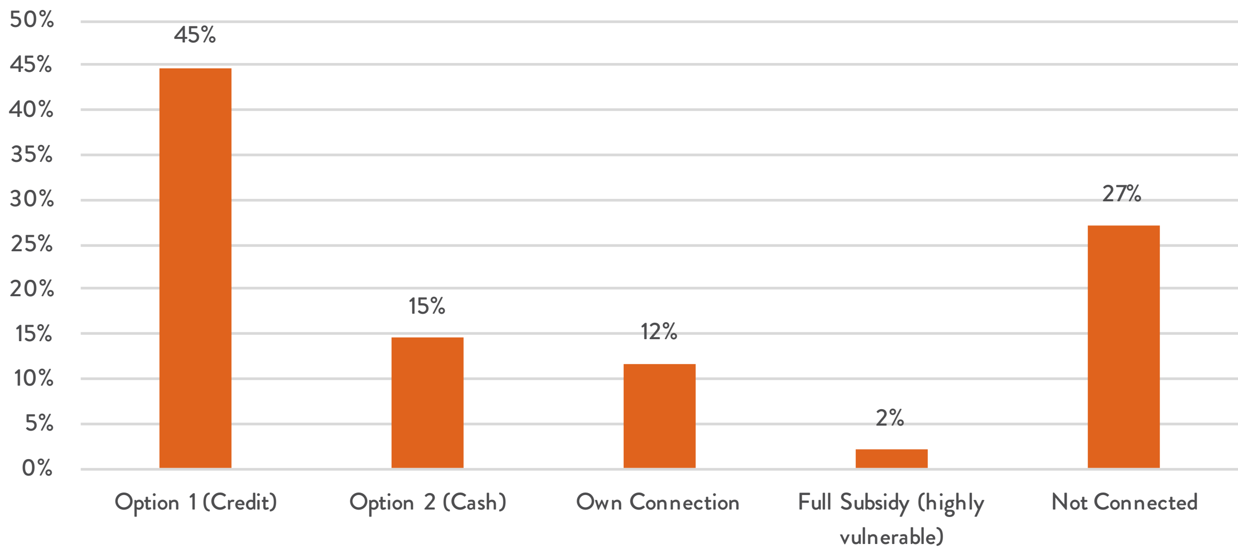
PAYMENT OPTION	DESCRIPTION	AVERAGE DISCOUNT (%)
OPTION 1: Subsidies + credit	Subsidy of 50% of the cost of the inspection chamber. In addition, 20% subsidy of the remaining connection costs (pipes and other materials). The final cost could be paid by the household to the Operator in 24 monthly installments with 0% interest rate.	Approx. 40% of total cost
OPTION 2: Subsidies + extra discount	Subsidy of 50% of the cost of the inspection chamber. In addition, 20% subsidy of the remaining connection costs (pipes and other materials). If the household agreed to pay upfront the full connection cost, there was an additional discount of 7% to compensate the opportunity cost of capital.	Approx. 55% of total cost

Source: Water and Sewerage Program in Peri-urban Areas – Phase I (BO-L1034/BO-X1004).

Baseline data were collected in 2016 from 2,023 households that had not connected to the system 3 years after the sewage systems started operating[9]. After the implementation of the incentives (subsidy scheme), connectivity was monitored using administrative records from local utilities. Data showed that 45% of households selected option 1, indicating willingness to pay for the subsidized connection, but signaling the presence of liquidity constraints to cover the cost. 15% of households chose option 2, suggesting that liquidity constraints at the subsidized rate were not the primary factor in the decision to remain un-connected. Another 12% of households declined the subsidy and instead connected on their own. These households may have identified alternative and lower cost (or higher quality) solutions to their end-user connections and may have benefited from the technical assistance provided by the program in assessing the connection requirements and costs. An additional 2% of highly vulnerable households had their connections fully subsidized; leaving 27% of households unwilling to pay for an end-user connection even in the presence of highly subsidized connection costs (Figure 6).

9 // *Sewage systems started operating in September 2013 in Cuatro Cañadas and in January 2014 in San José de Chiquitos and La Guardia.*

FIGURE 6 Revealed Preferences for Connection Subsidies in Santa Cruz, Bolivia (% households)



Note: Calculation by authors. Baseline and follow-up data from the Bolivian Ministry of Environment and Water through the Water and Sewerage Program in Peri-urban Areas, Phase I program.

These findings are consistent with evidence from the water and sanitation literature that suggests that liquidity and credit constraints are important determinants of connectivity. However, the Santa Cruz case also shows that other factors, apart from liquidity constraints, also play a role. Consistent with the descriptive data on sewer connectivity, non-experimental evidence from Sri Lanka found that while poverty, service price, and connection costs were key determinants for piped water demand, other variables (correlates) such as location, self-provision, water quality perception, and awareness of health issues mattered as well (Pattanayak et al. 2006). In Morocco, larger and wealthier households were more likely to take-up a water connection. However, the cost of the connection had little effect on demand, which contrasts with economic theory. Aspects related to convenience, like the share of water fetching trips by children or the distance to the main public water source increased the probability of investing in a household connection (Devoto et al. 2012).

Low willingness to pay for public services has been documented in numerous contexts, and even small prices can deter the decision to take-up cost-effective services. In the water and sanitation literature, evidence on willingness to pay is limited and results are mixed. Existing studies that measure willingness to pay for environmental quality improvements, including water and sanitation, find low willingness to pay for improved services and low valuations by affected households (Greenstone and Jack 2015). For example, in a water source improvement program in Kenya, researchers found that individuals were only willing to walk 3.5 minutes more to collect water from a protected spring. Using this households' willingness to pay, they then obtained a surprising low valuation of child health gains (in terms of reduction of diarrhea) and a statistical life. Again, this result might indicate that people in poorer settings put a low value on their health or that behavioral factors are at play (Kremer et al. 2011b).

Two experimental studies on water chlorination in Zambia and Kenya evaluate the effect of varying prices on take-up of water disinfectant products. They found similar results indicating that when provided for free, take-up was very high among households, but fell considerably when service charges were introduced even at very low rates (Ashraf, Berry, and Shapiro 2010; Kremer et al. 2011a). Both studies provide indication of low willingness to pay for improved water quality. The high price sensitivity of demand, particularly around a price of zero, suggests that other plausible explanations may include liquidity constraints, understanding costs and benefits, or other behavioral and institutional barriers (JPAL, 2012).

In contrast, other studies suggest that individuals are willing to pay more for better and more convenient services. A study in urban Morocco found that households' willingness to pay for a private connection to the water system was high when it could be purchased on credit. Interestingly, the higher willingness to pay was not associated to the expectation of better health, as people had already access to clean water from public taps, but rather to increases in available time for leisure and reductions of inter- and intra-household conflicts (Devoto et al. 2012). Similarly, a randomized controlled trial (RCT) evaluation of a microcredit program carried out in rural Cambodia showed that even poor households were willing to pay for improved latrine installation at an unsubsidized price if they could benefit from microloans (Yishay et al. 2017).

Even for households willing to pay market price, connecting to the sewage system can involve considerable up-front construction costs, including plumbing materials, labor, sanitation accessories and fees. For households that lack a sanitation facility or require constructing new facilities to gain access to sewage services, the additional cost of installing a new bathroom must be added to the connection cost. Furthermore, some utilities charge a one-time connection fee. To assess the financial commitment required for a connection, Table 2 presents average end-user connection costs for recent sewerage projects in Argentina, Bolivia, and Costa Rica[10]. Projected costs vary between US$204 to US$500 per connection, representing between 10% and 16% of yearly per-capita income for households in the bottom 40% of the income distribution. These costs are limited to the connection and do not take into account other

10 // *In all these projects, regular conventional sewage systems were financed and constructed. None of these projects financed condominial or simplified sewerage, where dwellings are grouped into "blocks" known as condominiums. Connection rates for conventional systems tend to be higher as typically the project is constructed only once a certain percentage of the dwellings commit to connect.*

household remodeling costs that may be required to repair or replace floors, foundations, walls and patios, or to build a new bathroom. Thus, these estimates are lower-bounds, and we expect that full end-user connection costs are likely to surpass 10% of yearly per-capita income for most lower-income households.

TABLE 2 Sewer connection costs in selected projects (US$)[12]

	END-USER CONNECTION COST (US$)	% PER-CAPITA YEARLY INCOME FOR POORER 40%	INCLUDES:		
			INSPECTION CHAMBER	PIPES	LABOR
Argentina	500	16%	Yes	4ml	Yes
Bolivia	204	13%	Yes	20ml	No
Costa Rica	271	10%	Yes	NA	NA

Source: Authors' calculations based on data from selected sewerage projects. Costs expressed in current US dollars.

Based on the evidence presented thus far, for low- and middle-income households, the high upfront costs likely pose a significant barrier when it comes to deciding whether to connect to the sewage system. Furthermore, cost is not limited to only financial considerations. As observed in the context of El Alto, Bolivia, the opportunity cost of time can be a major barrier if households must allocate time, from either work or domestic activities, to arrange for a connection (contracting a plumber, purchasing materials, etc.) or install the connection themselves.

Lack of information, behavioral and other demand-side constraints

Even when households can afford connection costs, they may still decide not to take-up the sewage service. One hypothesis widely acknowledged in the water and sanitation sector is that households have imperfect information and do not fully understand the benefits (costs) of adopting (not adopting) new technologies (Currie and Gahvari 2008; Kar and Pasteur 2005). A lack of understanding of the use or value of sewage services could result in lower willingness to pay for them.

Another set of potential explanations relate to behavioral constraints and preferences. The behavioral economics and behavior science literature has shown

11 // *For more details, a detailed cost breakdown for Bolivia is presented in Appendix 3.*

that individuals often have difficulties making rational choices and are prone to "heuristics" that can lead to cognitive biases (Kahneman 2011). Difficulties are particularly likely when individuals are faced with decisions that involve uncertainty and tradeoffs between current and future costs and benefits. These attributes are relevant to decisions regarding the use of services and technologies that can improve health such as sewerage. Another bias that is particularly relevant to the connection problem includes present bias, when a homeowner chooses not to invest in a connection in the short-term, ignoring long-term costs, or when he or she intends to connect but perpetually delays the action under the false impression that his or her "future self" will take the necessary actions at a future date. On the other hand, the status-quo bias is evident when households prefer things to stay the same and choose to maintain their current on-site sanitation solutions and fail to visualize the benefits of connecting. In the water and sanitation sector behavioral approaches including "nudges" have been adopted to reduce open defecation through community led total sanitation, or CLTS (Neal et al, 2016), and a growing literature explores the demand for water and sanitation products highlighting behavioral barriers (Ashraf, Berry, and Shapiro 2010).

The decision to connect to the sewage service may also be affected by technological externalities which take place if a household is positively (or negatively) affected by another household's decision to use (or not use) the technology (Foster and Rosenzweig 2010). For example, if the health benefits of connecting are a function of both your own behavior and the neighbor's behavior, the individual private benefits from connecting may not outweigh the costs until a certain threshold or "critical mass" is surpassed in terms of the percentage of neighbors who also adopt the technology. This would be the case if contamination from septic tank or latrine runoff pollutes the environment: individual households may be unwilling to connect until their neighbors have connected, leading to a sub-optimal equilibrium of low connectivity.

Identifying those household characteristics that are related to the decision to connect can be relevant to understand what underlying factors affect the demand for sewage services. A study in peri-urban areas in Bolivia estimated models of the propensity to connect based on observable household and individual characteristics. It found that households with more children and where the household head is an independent worker were less likely to connect, possibly because more unpredictable income flows postpone sanitation investments in favor of other priorities (Bancalari, Gertner, and Martinez 2016). Another study in poor peri-urban neighborhoods in Cote d'Ivoire found that low household socioeconomic status and settlement characteristics, including accessibility, were the main factors of poor access to sanitation (Angoua et al. 2018). Following the methodology in Bancalari, Gertner, and Matinez (2016), another recent a study in four urban areas in Uruguay used household survey data and logit models to identify predictors at the household level that are associated with the probability of connecting to the sewage system. The estimated parameters in the model were then used to predict the connection status of households in a fifth area where the sewage system was not yet available. The results showed that household wealth was the most important determinant of sewerage connection, suggesting that, in the context of this study, liquidity constraints can be relevant connection barriers. Other relevant predictors were the age of the household head, property status of the dwelling and having had access to sewerage services in the past (Yarygina, et al. 2020).

3 • 2 • Institutional and supply-side barriers

While the primary objective of this paper is to identify demand side barriers and propose potential solutions, institutional and supply side constraints also play a critical role in preventing access to sewage services.

Investments to connect a house to the sewage system require adequate institutional and legal arrangements. Insecure land tenure, for example, may pose a significant barrier to investments in home upgrades if households are unwilling or unable to connect under uncertain property rights. Using evidence from a natural experiment, Galiani and Schargrodsky (2010) showed that households with allocated land titles were more likely to invest in housing improvements compared to households in a control group without land titles. Renters and temporary migrant households that migrate to urban areas during the agricultural off-season may also lack both the incentives and legal authority to connect when residing on properties that are not owned (J-PAL 2012).

In the presence of a functioning sewer system, households may opt not to connect if the bureaucratic cost involved in processing a connection with the local utility is high. Unnecessary red tape and complex procedures for establishing a connection can increase transaction costs and prevent households from connecting.

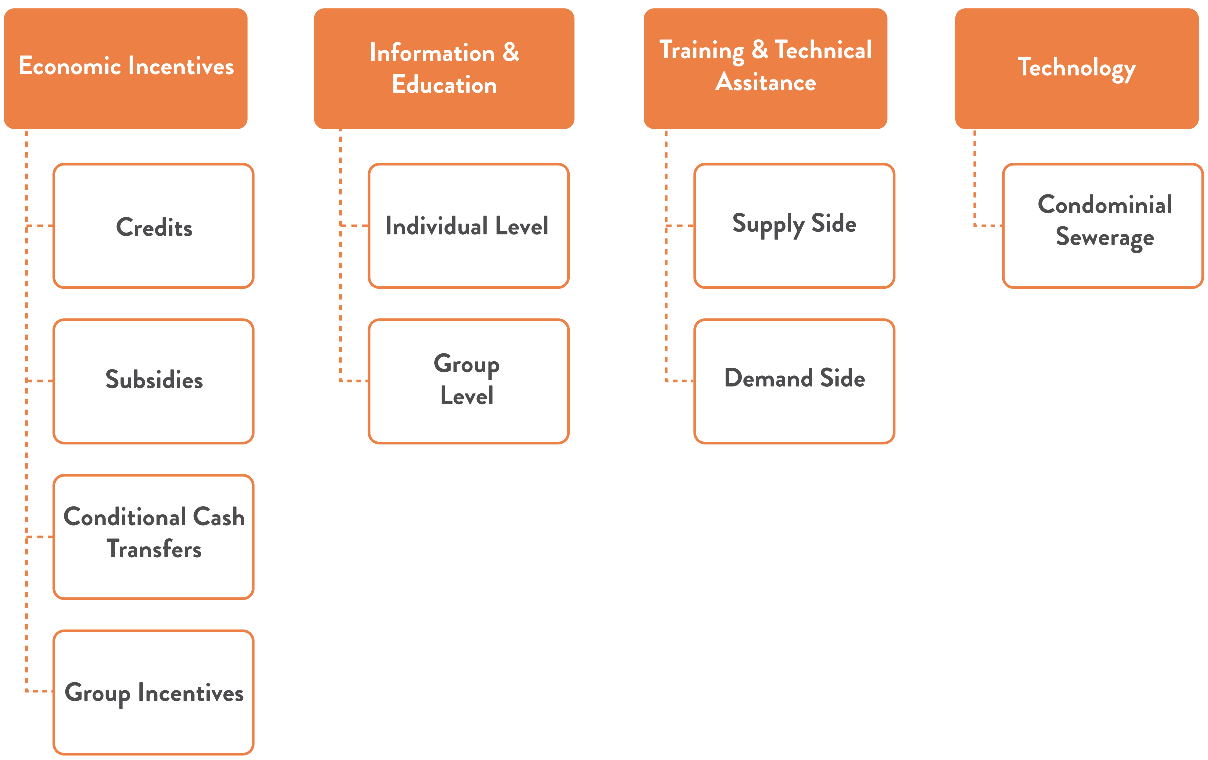
Another potential barrier to adopt sewerage services relates to the (lack of) availability of qualified personnel and materials for installing the household connection. If sewerage is new in a community, local plumbers may lack the skills to install connections under the technical specifications required by the utility. Finally, the technical design of a sanitation system may impose differential costs for connecting. For example, "condominial" sewerage that runs between property lines at lower depth may reduce the cost and complexity of connecting existing sanitary infrastructure vis-a-vis conventional sewer lines installed under the access road in front of the property.

4

Interventions to Promote Connectivity

We discuss four categories of interventions that have the potential to improve connection rates: 1) economic incentives; 2) information and education; 3) training and technical assistance; and 4) technology (Figure 7).[12] The most appropriate alternative for a given context will depend on the prevailing barriers to end-user connections and should be informed through a diagnostic of local conditions, including demand and supply side barriers affecting the population. Also, the approaches can be complementary. Identifying the most cost-effective approaches as well as the right "mix" of interventions is a promising area for future research, further discussed in section 5.

FIGURE 7 Interventions to promote sewage system connectivity



4 • 1 • Economic Incentives

We discuss four economic approaches to promote sewerage connectivity that address some of the financial and behavioral barriers discussed in section 3. These include credits, subsidies, conditional cash transfers and group incentives.

Credits: In contexts where there is low willingness to pay and/or liquidity constraints to cover the capital investments related to the home upgrade,

12 // Fines and other forms of penalties may be an appropriate mechanism to promote end-user connections in strong institutional and regulatory contexts, where system operators or governments have the capacity to credibly impose and enforce fines on households that fail to connect.

microloans may be an appropriate intervention to boost connection rates. Evidence suggests that facilitating access to credit for poor household to finance lump sum investments can significantly increase take-up and willingness to pay. Using an encouragement design, Devoto et al. (2012) show that providing an interest-free loan to cover the cost of the water connection with regular installments in the water bill over three to seven years, increased in-house piped water connectivity by 59 percentage points in the treatment group. Several other recent studies shed light on the impact of liquidity constraints on demand and willingness to pay. Yishay et al. (2017) evaluated a program in rural Cambodia and tested the hypothesis that missing credit markets suppress willingness to pay for sanitation improvements that require large up-front investments. In an RCT setting, they tested the impact of microloans on willingness to pay for hygienic latrines and found that loans significantly raised willingness to pay, with 60% of households in the treatment group willing to purchase a latrine, compared to 25% in the control group. In the context of financing sewer connections, loan repayment could be spread over multiple years and collected through water bills to reduce the transaction costs of repayment. If set up in collaboration with a financial institution, the utility may choose to partially guarantee the credits and/or subsidize rates for the extreme poor. Credit based interventions can also be set up as "rotating funds" that are self-sustaining after an initial capital investment.

Subsidies: Subsidizing the cost of an end-user connection will create deadweight loss but could result in net welfare gains if there are significant positive externalities associated with achieving high connection rates. Subsidies are a particularly controversial intervention in the water and sanitation sector, with practitioners concerned that they may undermine intrinsic motivation or cause dependency (Kar and Pasteur 2005; Currie and Gahvari 2008).

Several studies have tested how lowering the price or subsidizing the cost of investment in sanitation affect uptake. In rural Bangladesh researchers implemented a cluster-randomized experiment in 380 communities to evaluate the effectiveness of alternative mechanisms to encourage investments in hygienic latrines. Communities were randomized to different treatments including: i) a community motivation and health information campaign; ii) information combined with subsidies; and iii) a supply-side market access intervention; then, within "subsidy" communities, vouchers were randomly distributed among eligible poor households. Their findings showed that neither information alone, nor the supply-side mechanism increased purchase of hygienic latrines. By contrast, in communities that received subsidies, access and ownership of a hygienic latrine increased significantly relative to the control group (by 14 to 15 percentage points, or 29 to 36%) (Guiteras, Levinsohn, and Mobarak 2015).

The presence of interlinked decision-making implies that social influences can be an important element to consider when motivating service adoption. Empirical evidence can be found in a sanitation investment program in rural Bangladesh (Guiteras, Levinsohn, and Mobarak 2015). The authors wanted to analyze the extent of demand spillover effects across neighbors in villages that were assigned to a 75% subsidy intervention to purchase hygienic latrines. Within subsidy villages, they randomized the share of lottery winners at the neighborhood level into low (25%), medium (50%), and high (75%) intensity. They found that in neighborhoods where a higher share of households received the voucher, latrine ownership increased, and open defecation decreased more than in neighborhoods with the less intense subsidy treatment. Interestingly, the study also found that, relative to controls, open defecation decreased even for unsubsidized households (lottery losers) in medium and high intensity neighborhoods (by 8.8 percentage points for medium-intensity and 8.1 percentage points for high-intensity). As stated by the authors, these findings give evidence of a potential "virtuous cycle" where the adoption of a new technology triggers further adoption. Based on their results, they conclude that cost-effective "smart" subsidy policies should be carefully targeted to populations where the potential for positive spillovers is maximized.

Evidence also suggests that combining credit and subsidies may have multiplying effects on demand. Guiteras et al. (2016) studied the effect of different time payments plans (micro-loans or dedicated micro-savings) on willingness to pay for a ceramic water filter among 400 households in urban slums of Dhaka, Bangladesh. They found that both willingness to pay and coverage increased substantially with time payments. At an unsubsidized price, coverage is 12% without credit, compared to as high as 45% with time payments. When price is subsidized at 50%, coverage without credit is 27%, compared to as high as 71% with either credit or dedicated savings. Using a simple structural model of time preference, they found strong evidence for the presence of credit constraints, and suggestive evidence of savings constraints.

Conditional cash transfers: In addition to facilitating access to credit and providing subsidies, conditional cash transfers (CCTs) have the potential to help households overcome financial, information and behavioral connection barriers. An extensive literature shows the potential of CCTs to effectively boost demand for services, particularly as they relate to investments in human capital such as health (complying with a recommended health checkup) and education (children attending school) (Fiszbein and Schady 2009; Adato and Hoddinott 2011). CCTs help households overcome liquidity constraints by transferring cash, but they also signal the potential value of a service and can serve as a "nudge" to encourage households to adopt a desired behavior. In the context of the water and sanitation literature, CCTs have been applied to promote toilet use and reduce open defecation (Tilley and Günther 2016) having access to a toilet does not necessarily imply use: infrequent or non-use limits the desired health outcomes of improved sanitation. We examine the sanitation situation in a rural part of South Africa where recipients of novel, waterless "urine-diverting dry toilets" are not regularly using them. In order to determine if small, conditional cash transfers (CCT. In the context of sanitation connections, households could be offered one or more payments conditional on the compliance with the desired behavior, which in this context is simply establishing a functional end-user sewage connection. Conditionalities could establish a specific time frame within which a household must be connected to the system and define verifiable quality standards for the connection to be eligible for the cash incentive. When multiple demand side barriers are present within a population, or the barriers are hard to identify, then CCTs may provide an innovative alternative to credit or subsidies.

Group Incentives: Utilities might also consider group level incentives and collective conditionalities to help leverage social pressure and improve coverage rates. For example, cash or in-kind incentives at the block or neighborhood level conditional on verified connectivity coverage targets within an established timeframe may mobilize local communities to exert social pressure on non-complying households, thus elevating the cost of remaining unconnected.

4 · 2 · Information and education

If households fail to connect because they do not fully understand the benefits of doing so, or underestimate the costs, information campaigns that update beliefs regarding the benefits of connecting have the potential to boost connectivity rates. An example of an information-based intervention model that advocates the role of knowledge and information to encourage demand is the Community-Led Total Sanitation (CLTS) approach. CLTS empowers local communities to stop open defecation and to build and use improved sanitation facilities by informing communities of the problem and monitoring compliance. The model has been widely adopted in south and south-east Asia and Africa (Kar and Pasteur 2005) and, in some cases, it was implemented in combination with other incentives to maintain communities open-defecation free. A cluster randomized impact evaluation of the CLTS Campaign in 80 rural villages in Madhya Pradesh, India, examined the effect of the approach on defecation practices and child health. Researchers found that the intervention increased uptake of improved sanitation facilities by an average of 19% and decreased open defecation among adults by an average of 10% (although no health effects were reported) (Patil et al. 2014). Similarly, social marketing campaigns to raise awareness of the benefits of handwashing and sanitation in Tanzania led to improvements in latrine ownership, reductions in open defecation, and marginal improvements in handwashing behaviors, but did not show detectable effects on final health outcomes (Briceño et al. 2017).

Another innovative approach to communication campaigns is using educational entertainment (*edutainment*) to change social norms and influence people's behavior regarding sanitation. Such approach was implemented the city of El Alto in Bolivia to encourage sewage system connectivity. The national government, in coordination with local authorities, decided to implement a comprehensive communication campaign after a follow up survey showed that only 65% of households had connected to the sewage system after two years of the construction of the sanitation infrastructure (Ministry of the Environment and Water 2018). Using edutainment such as street and school theaters, the communication intervention provided information about the benefits of connecting to the system. In addition, the government organized training workshops with community leaders, neighborhood fairs and home visits aimed at facilitating specific information about how to connect (costs, access to qualified construction workers and material providers). The intervention package was designed to respond to a potential information constraint, as well as to bureaucratic constraints tackled through at-home assistance. Although a randomized evaluation is still under way, preliminary evidence suggests that the intervention was successful in increasing connectivity (see Box 1)

Evidence suggests that the perception of bureaucratic hurdles can have relevant discouraging effects when households make choices about adopting new technologies and services. In the Morocco study, Devoto et al. (2012) found that small administrative barriers had a large impact on take-up. The simple "nudge" of providing information and helping with administrative procedures had a significant effect on the take-up of a loan offered to poor urban households to facilitate in-home water connections. Using an encouragement design, treated households received information and assistance in preparing the loan application, including obtaining pre-approval from authorities, collecting the paperwork, and bringing financial officers to the house to collect the down payment. Control households could apply to the credit as well, but they received neither information nor facilitation. After 6 months, 69 percent of households in the treatment group had taken the loan and purchased the connection, compared to 10 percent in the control group.

Overall, however, the evidence of the effectiveness of information interventions is mixed. In the rural Bangladesh study by Guiteras, Levinsohn, and Mobarak (2015) , communities that received only community motivation and health information did not increase their probability of accessing or purchasing hygienic latrines relative to the control group. When combined with other incentive strategies, however, information became more effective. In the same study, researchers showed that compared to the control group, the community motivation intervention plus subsidies targeted to the poor did increase access to hygienic latrines by 14.3 percentage points. Similar results were found in poor urban areas of Kampala, Uganda (Günther et al. 2016). In this case, the authors implemented a cluster-randomized experiment to test the effects of information, subsidies and credits on private investment in improved latrines. They found no increase in investments in sanitation infrastructure when information was the only intervention.

BOX 1: How an Innovative Communication Strategy Incentivized Families to Connect to the Sewage System in El Alto, Bolivia

Two years after the inauguration of the sewer system in the fast-growing 8th District of El Alto, Bolivia, still 35% of potential beneficiaries were not using the sewage service. A survey carried out in 2017 showed that the main reasons given by families were lack of time to build the connection (49%), financial constraints (18%), and lack of information (13%).

Given this challenge, in 2018, the Bolivian Ministry of the Environment and Water, in coordination with the local government of El Alto and neighborhood organizations, and with support from the IDB (BO-L1034), decided to implement and evaluate an 11-week communication campaign called "Conéctate a la Ciudad Que Queremos" (Connect to the City We Want). The campaign used a comprehensive approach to change perceptions and educate people about the benefits of connecting to the sewerage system. For that purpose, it deployed a combination of communication channels including mass media (radio and TV), group and household level capacity-building activities, and educational entertainment ("edutainment") that included games and competitions in local fairs, street and school theaters, and music performances at the neighborhood level.

To assess the effectiveness of the intervention in incentivizing connection to the sewerage system, the campaign was implemented following an experimental design where 20 neighborhoods were assigned to the treatment group and 11 to the control group. While both groups received information through mass media, only treatment neighborhoods received the edutainment component. Preliminary results from the impact evaluation found that, after 14 months of the communication campaign, households in treatment neighborhoods were 14 percent more likely to connect to the sewerage system, relative to households in the control group. The evaluation also showed positive gains in knowledge about how to adequately maintain the connection to the sewers. Moreover, households in the treatment group reported less problems with the connection than their counterparts in the control group, suggesting better maintenance of the connections.

Overall, these preliminary findings indicate that the edutainment component was an effective tool to promote sewage connectivity and contribute to the growing evidence showing that interventions that deliver educational content through entertainment can be effective in changing people's behavior.

4 • 3 • Training and Technical Assistance

Training and technical assistance for households and/or local service providers could be an effective strategy to promote connectivity if a principal barrier to connecting is the lack of know-how for establishing a connection. On the end-user side, technical assistance could involve assessing alternatives for installing the intra-household plumbing, putting together a cost-estimate, or identifying suppliers of materials and local plumbers. On the supply side, if skilled technicians are in short supply, the program could train local builders and plumbers on the technical requirements for installing intra-household connections.

Training and technical assistance to improve connectivity have been a key component of community-based social strategies implemented in Latin America together with water and sanitation infrastructure projects. The objective of social strategies is mainly promoting participation and empowerment of communities and neighborhoods as main actors for the sustainability of water and sanitation services. A primary goal is that beneficiaries adequately assume their responsibilities as users of the systems for the monitoring of works, the payment of fees and quotas, and the adequate management and use of water infrastructure and services.[13]

4 • 4 • Technology

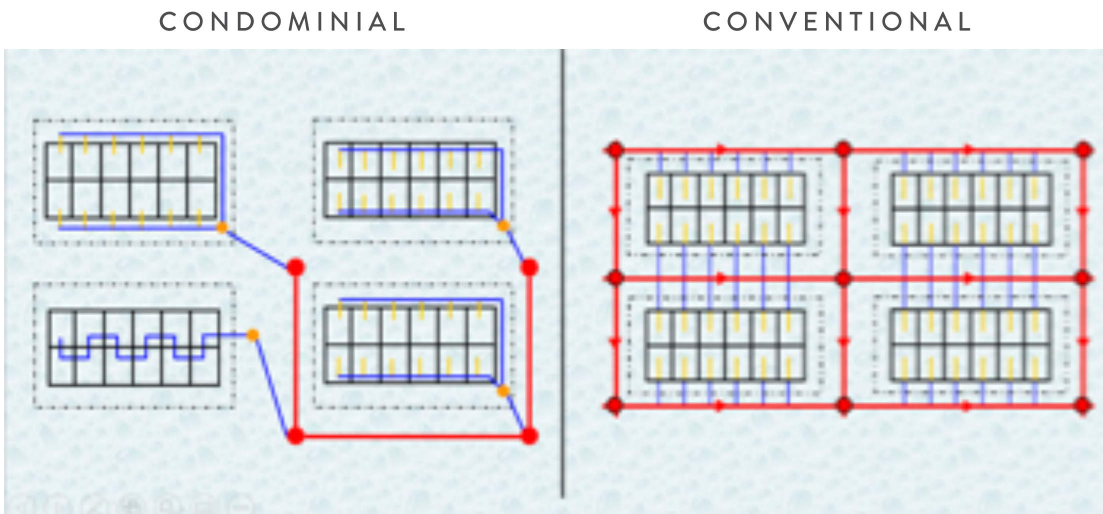
Technological solutions related to the type of sewer infrastructure and installation requirements for households also have the potential to affect connection rates. Traditional (or conventional) sewer lines run along the front boundary of a dwelling's property, requiring the household to extend intra-household connections to the chamber installed by the utility along the front boundary. Alternative sewer technologies, such as condominial sewerage that installs smaller (in terms of diameter) and easier to construct pipes in between household property lines has the potential to reduce the distance and complexity of establishing a connection, lowering its costs (Figure 8).

While randomized studies to evaluate the effect of condominial networked systems on take-up of services would be hard to implement, observational data indicate that this alternative promotes higher household connectivity when compared to conventional sewage systems (Cannelli 2001). Moreover, a key characteristic of the condominial model is that it is combined with active participation of the community in decisions taken during all phases of project implementation. In the pilot project evaluated by Cannelli (2001) in the city of El Alto, Bolivia, the percentage of households connected to the condominial

13 // *Such a strategy has been institutionalized in Bolivia since 2009 to accompany water and sanitation infrastructure projects. The strategy has been innovative and comprehensive by including the development of capacities and mobilization of actors linked to water and sanitation projects, end-users capacity building and training, prevention and managing of conflict, social participation and social monitoring, environmental and health education, technical assistance for connectivity, and socialization of the tariffs and management models.*

system, as well as the percentage of households with a functioning toilet facility was higher in areas where the education and participation components were implemented with more intensity.

FIGURE 8 Condominial versus Conventional Sewage Systems



5

Conclusions

The safe disposal of human waste is key to maintaining a healthy and thriving society, as fecal pathogens are a leading cause of water-borne diseases, including enteric infections and resulting morbidity and mortality (WHO 2017; White, Bradley, and White 2002; Esrey et al. 1991; Fewtrell et al. 2005; Zwane and Kremer 2007). Sewer systems collect and remove sewage through networks of inter-connected pipes leading to a treatment plant where waste can be treated and safely disposed. In areas that still lack access to piped sewage, including rapidly expanding peri-urban neighborhoods, households rely on on-site sanitation solutions such as pit latrines or septic tanks. To operate safely, these systems require proper construction and routine maintenance. When not maintained, individual systems can be prone to spillage of fecal pathogens into the environment, reducing the health benefits from on-site sanitation (Berendes et al. 2017; Bancalari and Martinez 2017). Furthermore, recent evidence from large-scale efforts to improve sanitation coverage suggests that high coverage levels may be necessary to achieve the full health benefits of investments in sanitation infrastructure (Clasen et al. 2014; Patil et al. 2014; Gertler et al. 2015).

There are numerous reasons for promoting high coverage rates between end-users and sewer lines. There are important health and environmental benefits. The collection and treatment of wastewater can reduce contamination of fresh water sources such as rivers, streams and groundwater, and reduces the release of fecal and other pathogens into the environment. An improved sanitary environment, in turn, has important implications for improved morbidity and mortality. For utility operators, high connectivity rates are important for the technical and financial operability of the systems. Some operators charge sewerage fees when the infrastructure becomes available, rather than when households start receiving the service (effective connection to the system), leading unconnected households to go “off the grid” and reducing revenue required for maintenance costs. Furthermore, sewage systems require a minimum flow of effluent or can become plugged with sediment in low-flow conditions. With low connectivity rates, systems can require costly repairs or even become inoperable.

This paper reviewed a series of economic, behavioral and technical interventions that can be adapted to local contexts and tested. While the proposed interventions have been used and tested in related contexts such as water programs, rural saniation and health interventions, their application to the context of promoting sewer connectsion in urban and peri-urban areas of the LAC region are largely unknown and untested. As such, there is enormous scope for generating rigorous evidence of both the magnitude of the problem, as well as the effectiveness of potential solutions.

As funding agencies, governments and system operators seek to address connectivity challenges in their particular contexts, a rigorous research agenda that accompanies these efforts hast the potential to shed light on a number of important questions, and to build evidence- based solutions. A research agenda on sewer connectivity should include at least two core areas. First, the generation of high-quality data to understand the magnitude and causes of the connectivity problem and inform the design of interventions. Second, a complementary research agenda that tests the effectiveness and cost-effectiveness of interventions through rigorously designed experimental or quasi-experimental impact evaluations.

While available data suggest that the connectivity problem could be substantial, a first important step in the sewage connectivity research agenda is to establish more representative and systematic data. Such data are required for a proper quantification of the scale of the problem and for diagnosing the key barriers limiting connectivity for different populations. The gap in connectivity data can be closed by including measures of access and effective connection in representative household surveys and census, and through surveys and routine monitoring systems (administrative data) used by utilities. Data collection efforts are necessary to understand the magnitude of the problem and better diagnose key barriers faced by households. This information will aid the design of interventions and help target appropriate solutions for specific areas and population subgroups.

The next critical step is to rigorously test the effectiveness of different intervention alternatives and compare relative cost per effective connection using cost-effectiveness analysis. Many of the interventions proposed in this paper can be evaluated using randomized control designs, whereby operators randomly assign one or more interventions amongst eligible households, neighborhoods or even cities. For connectivity interventions that are targeted to the poor through income measures or poverty indices, regression discontinuity designs can provide a robust measure of impact by comparing units above and below the eligibility threshold. In contexts where other quasi-experimental methods are more applicable, baseline and follow-up data in treatment and comparison areas could provide a credible estimate of impact. Given that the primary outcome of interest, that is, the effective connection rate, would be common to all interventions, the cost per connection achieved can be compared across alternatives, providing policymakers with valuable guidance on cost-effective alternatives to boost connection rates. For example, the impact of a mass information campaign might be substantially smaller than connection subsidies. However, if information campaigns are also substantially cheaper, they may prove to be more cost-effective.

A research agenda in connectivity would additionally benefit from understanding the potential interaction effects between intervention alternatives. For example, if information and subsidies together are substantially more effective than either alone, utilities could deploy an appropriate mix of complementary interventions that serve to overcome multiple barriers. Another important dimension of the research agenda is the optimal timing and sequencing of connectivity interventions. For example, relatively cheap information campaigns might be used to elevate connection rates early on, and more expensive financial incentives might be offered for households with lower willingness to pay that remain unconnected after a given period. Furthermore, understanding whether different sub-groups respond differently to interventions and the dynamics of collective action regarding group level interventions would allow for better design and targeting of interventions. Understanding the implications of timing and targeting of interventions can help to reduce the potential for moral hazard, whereby households delay connecting under the expectation of receiving incentives or other benefits.

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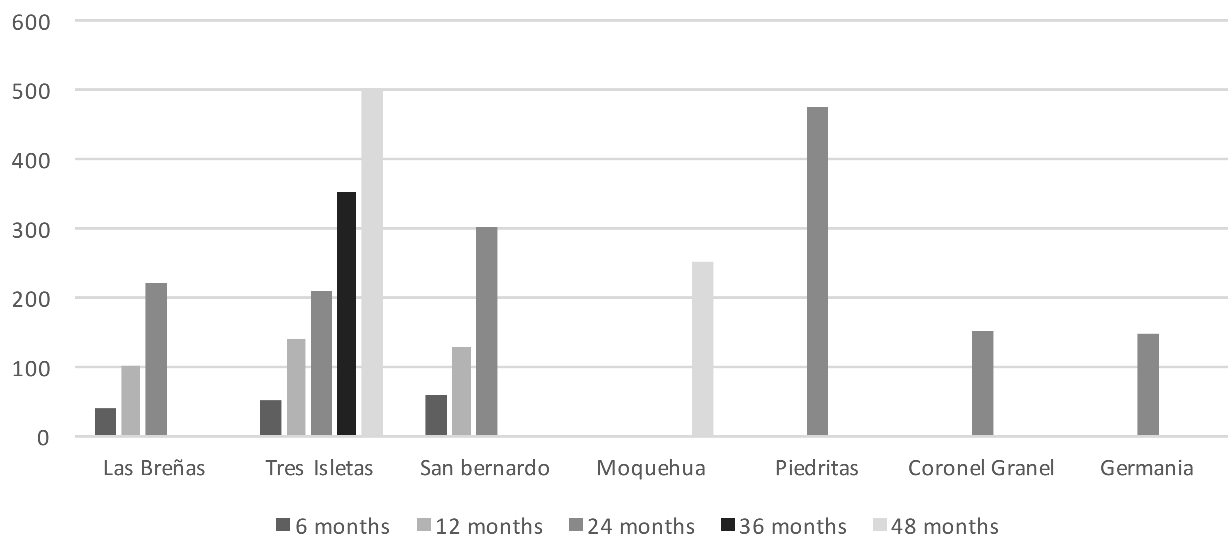
APPENDIX

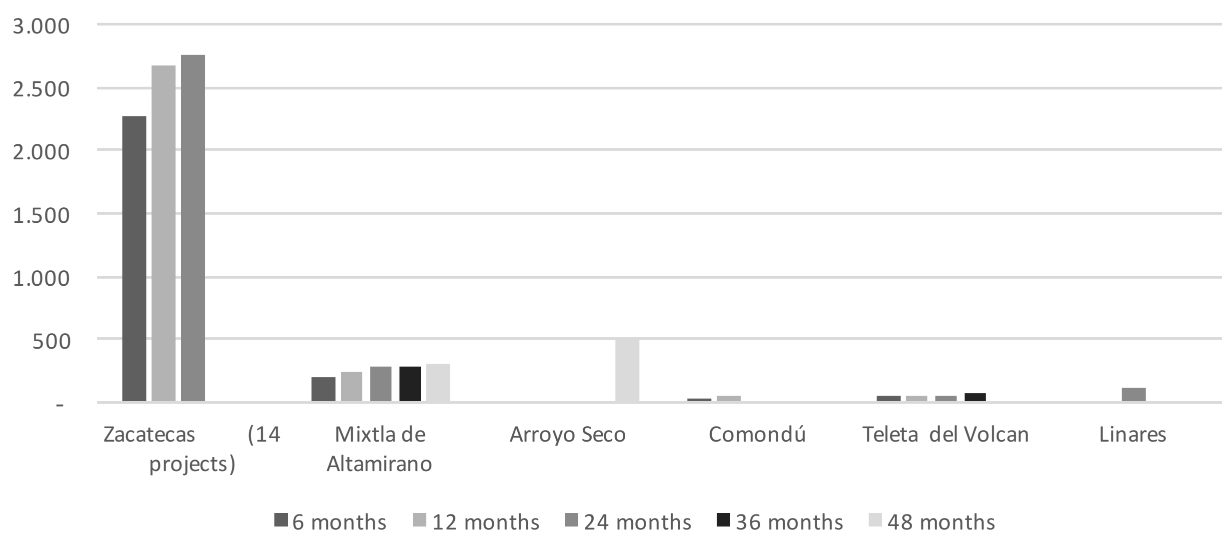
APPENDIX 1:
Project level connectivity rates for select project in LAC

FIGURE A1 Connection rate in 7 localities in the Buenos Aires and Chaco provinces, Argentina (%)



Source: Own calculations based on connectivity surveys, Argentina.

FIGURE A2 Connection rate by period in México (%)



Source: Own calculations based on connectivity surveys, Mexico.

APPENDIX 2:

Reasons for not connecting to the sewage system in selected projects

REPORTED REASON	%	CLASSIFICATION
Argentina: Buenos Aires Metropolitan Area		
Economic difficulties	49.5	Financial Constraints
Unknow	13.4	Other/Unknown
Tenant	11.8	Tenancy (rental, sale)
Not interested	8.6	Lack of Interest
Technical difficulties	7.9	Technical/Physical constraints
Lack of time	7.0	Time Constraints
Not knowing how to do it	3.2	Lack of information/know-how
Other	1.7	Other/Unknown
Agree with neighbors	1.1	Tenancy (rental, sale)
Newly moved	1.0	Tenancy (rental, sale)
Not mark	0.6	Other/Unknown
On sale	0.6	Tenancy (rental, sale)
Brazil		
Resistance to the payment of the tariff	36.0	Financial Constraints
Lack of information	18.4	Lack of information/know-how
Dweller does not want to damage floor	13.2	Technical/Physical constraints
Non-existence of sanctions	13.2	Lack of Interest
Others	7.0	Other
Value of Connection	6.1	Financial Constraints
Lack stimulus program	3.5	Lack of Interest
Stimulation not the interlinking	2.6	Other
Bolivia: Cuatro Cañadas, San José de Chiquitos and La Guardia		
No dwelling in premises	2	Other
Service too expensive	11	Financial Constraints
No money for construction	61	Financial Constraints
No plumbing service available	1	Lack of information/know-how
Other	25	Other
Does not need	0	Other
Bolivia: El Alto City		
Lack of time	45	Time Constraints
Lack of money	16	Financial Constraints
Lack of information	13	Lack of information/know-how
Other priorities	1	Lack of Interest
Construction difficulties	2	Technical/Physical constraints
Some other instruction	8	Other
Other	14	Other

Sources: Argentina: based on information collected by IIED-AL, 2012-2014; Brazil: Galvão Junior, Baldez Custódio, and Monteiro (2015); Bolivia (Cuatro Cañadas, San José de Chiquitos and La Guardia): own calculations based on data from project's baseline household survey, 2016; Bolivia (El Alto): own calculations based on data from a nutrition and sanitation survey, 2017.

APPENDIX 3:
Connection Cost Data in Bolivia

DESCRIPTION	UNIT	QUANTITY	UNIT PRICE (BS)	TOTAL COST (BS)
Intra-household boxes				**741.1**
Inspection Box 60x60 cm		1	741.1	741.1
Installation of 4-inch pipes				**677.2**
4-inch PVC pipe	MI	20	22.25	445
4-inch PVC elbows	Piece	1	12	12
Glue for PVC	Liter	1.4	40	56
Cement Portland	Bag	1	60	60
Cleaning liquid	Liter	1.4	18	25.2
Inspection box + Sink	Piece	0	50	0
2-inch PVC pipe	MI	0	6.25	0
4-inch to 2-inch PVC reducing coupling	Piece	1	8	8
4-inch PVC yee	Piece	0	10	0
2-inch PVC pipe	MI	8	6.25	50
2-inch PVC tee	Piece	1	5	6
4-inch PVC tee	Piece	1	10	10
2-inch PVC elbows	Piece	1	5	5
Total cost (Bs)				**1,418.3**
Total cost (US$)				**203.8**

Source: Water and Sewerage Program in Peri-urban Areas – Phase I (BO-L1034/BO-X1004).

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