How to expand
water and sanitation to keep up with urban growth in Lima

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The purpose of these case studies is for INE to share its work in the region, the problems and challenges it encountered, and the lessons it learned. *How to expand water and sanitation to keep up with urban growth in Lima* was written by Edgar Orellana and Tania Páez of the Water and Sanitation Division and Julio Urdaneta and Benedicte de Waziers, consultants.

Infrastructure for development is led by Olga Morales. It was inspired by Tomás Serebrisky and Ancor Suárez-Alemán. INE is grateful for the collaboration of Anamaría Núñez from the Knowledge, Innovation, and Communication Sector.

How to expand water and sanitation to keep up with urban growth in Lima

Identifying the problem

In the second half of the 20th century, international organizations like the United Nations and the World Health Organization put access to water and sanitation at the center of their global sustainable development efforts. Access to these services became a fundamental right that could "improve health, education and economic productivity of populations."

The world also began to face an inadequate water supply and growing demand, a situation that was spiraling quickly toward a global crisis. After many international conferences and summits to address the problem, the Millennium Summit was held at the United Nations in New York in September 2000. Leaders from 189 countries committed to the Millennium Development Goals, among them, "to halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation."

Even though governments recognize the benefits, such as reducing poverty and improving public health, guaranteeing access to water and sanitation for an entire country is a significant challenge. Like many countries in Latin America and the Caribbean, Peru has undertaken several initiatives and reforms to increase its population's access to water. But it still had a long way to go. According to the Household Survey conducted in 2010, 76.8% of Peruvian homes got their water from the public water system. The system covered 89% of the population in urban areas, but just 40.4% in rural ones. Nationally, sanitation coverage was significantly lower than water coverage: 64.8% total, 83.8% in urban areas and 44.7% in rural ones. The survey results showed the urgent need to close the gap in water and sanitation access, especially in rural areas.

With just over nine million residents in 2010 and rapid population growth, the need for drinking water distribution and waste water management in Lima and the surrounding metropolitan areas was increasing. The capital's environmental conditions make water management difficult. The region has a desert climate and average annual precipitation is just 16 mm (millimeters). In contrast, average annual precipitation in Guayaquil, Ecuador (a coastal city like Lima) is 791 mm. The average in the Atacama Desert ranges from 0 mm to 3 mm. Lima is the second largest city in the world located in a desert (after Cairo). Because of its climate, Lima draws its water supply from nearby rivers, chiefly the Rímac River, which begins in the Andean highlands and empties into the Pacific Ocean.

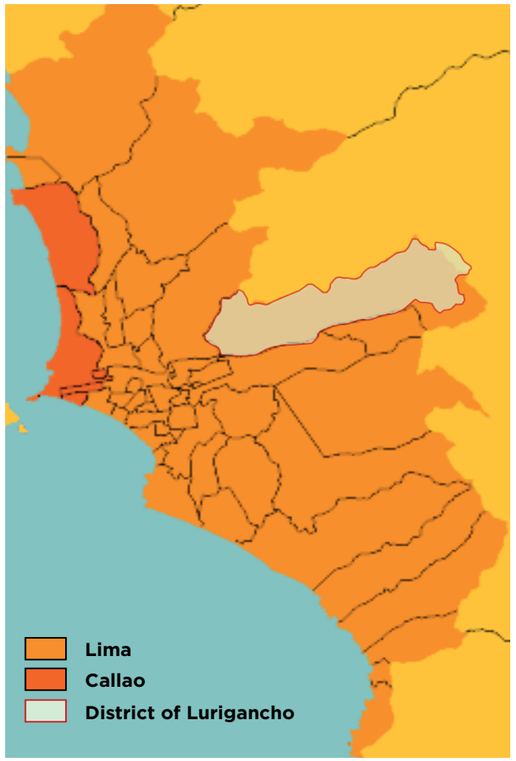
Latin America and the Caribbean is experiencing a new, widespread trend: the rapid and disproportionate growth of poor urban areas. This phenomenon, which is also happening in Lima, frequently goes hand-in-hand with the rise of informal settlements as a result of rural-urban migration. These settlements are often built in hazardous areas, mainly on the outskirts of cities. They pose a new challenge for delivering basic services like potable water, sanitation, and more (electricity, health, education, etc.). This was the reality for residents of Cajamarquilla, Nievería, and Cerro Camote, one of the fastest growing parts of the Lima metropolitan area.

The project area

Cajamarquilla, Nievería, and Cerro Camote are in the district of Lurigancho in the Rímac River Valley, nestled in the foothills of Peru's Cordillera Occidental. According to the National Institute of Statistics and Informatics, the district had 181,500 residents in 2010, most of whom lived in the district's western half where it meets the city of Lima.

Cajamarquilla, Nievería, and Cerro Camote share a pre-Columbian past that has been declared part of the country's national heritage by Peru's Ministry of Culture. Several archaeological sites, mainly those in Huaca-Cajamarquilla, Pedreros, and Cerro Matabuey, have remains from a significant Incan cultural, religious, and trading center dating from the Early Intermediate period (approximately 200 – 700 B.C.).

Because of the area's arid climate, which has long dry seasons and very short (or nonexistent) rains, the region's inhabitants have depended on man-made solutions like aqueducts to carry water to their towns since pre-Columbian times. The soil in these areas is sandy, less stable and fertile, and more prone to erosion and landslides, known locally as "huaycos". These are aggravated by extreme climate phenomena that bring heavy rains, like El Niño.



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Pablo Linde / EL PAÍS

Even so, the population has not stopped growing. In 2010, approximately 74,500 people (more than 41% of the district's population) lived in the project area in precarious settlements with little access to public services. Most are domestic migrants driven by the area's recent economic boom. In 2009, it was estimated that "less than 16% of homes (...)[had] access to the water system and water connections, with barely 1 to 3 hours of service per day."

63% of households in these communities get their water from a tanker truck and 17% from public wells. Lack of access to water has forced them to turn to alternative sanitation options. 50% of the population uses septic tanks, 38% use latrines, and 12% utilize the river or open areas.

All of these alternatives are more likely to contaminate wells or water sources intended for domestic use with bacteria or chemicals and are therefore more likely to affect residents' health. In 2009, communicable gastrointestinal illnesses were the area's third-leading cause of morbidity, with San Juan de Lurigancho Hospital reporting 5,838 cases.

Box I

A septic tank is one of the most-utilized methods for removing excreta and other liquid waste from individual homes, small groups of houses, or institutions in areas where sewer systems do not reach. A septic tank is a sedimentation tank (usually buried) into which all sewage directly flows. "Primary" waste treatment, a simple physical and chemical transformation, takes place inside the tank. However, this treatment must be continued in specialized treatment plants, so the tanks must be emptied regularly.

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https://commons.wikimedia.org/wiki/File:Sickergrube.jpg

Advantages:

- They are easy to build and install.
  There are several prefabricated, economical options.
- This solution is financially sustainable for small, outlying communities.

Disadvantages:

- They require regular maintenance to work properly and avoid overflow, soil contamination, and/or foul odors.

- The accumulated septage must be regularly extracted and properly treated. In urban areas, tanker trucks (public or private) generally empty the tanks and transport the septage to be treated and disposed of. This may be more difficult in rural areas due to lack of infrastructure and qualified labor.

"What happens when the tank is full?", Volvamos a la Fuente blog

Lack of access to potable water and sewage systems was making it more difficult for people in these areas to do basic things like prepare food or bathe. Environmental pollution was rampant, including foul odors and pests. The lack of sanitation increased watershed contamination.

Organic and inorganic waste flowed into the river, not only polluting the water, but filling it with sediment, which made it more likely to flood when the rains came.

Box II

Name: Cajamarquilla, Nievería, and Cerro Camote – Expansion of Potable Water and Sewerage Systems in Sectors 129, 130, 131, 132, 133, 134, and 135 – Districts of Lurigancho and San Antonio de Huarochirí

Borrower: Republic of Peru

Amount: US$163 million
IDB: US$100 million
SEDAPAL: US$63 million

Project start date: November 2011

Project Site: Cajamarquilla, Nievería, and Cerro Camote – Districts of Lurigancho and San Antonio de Huarochirí

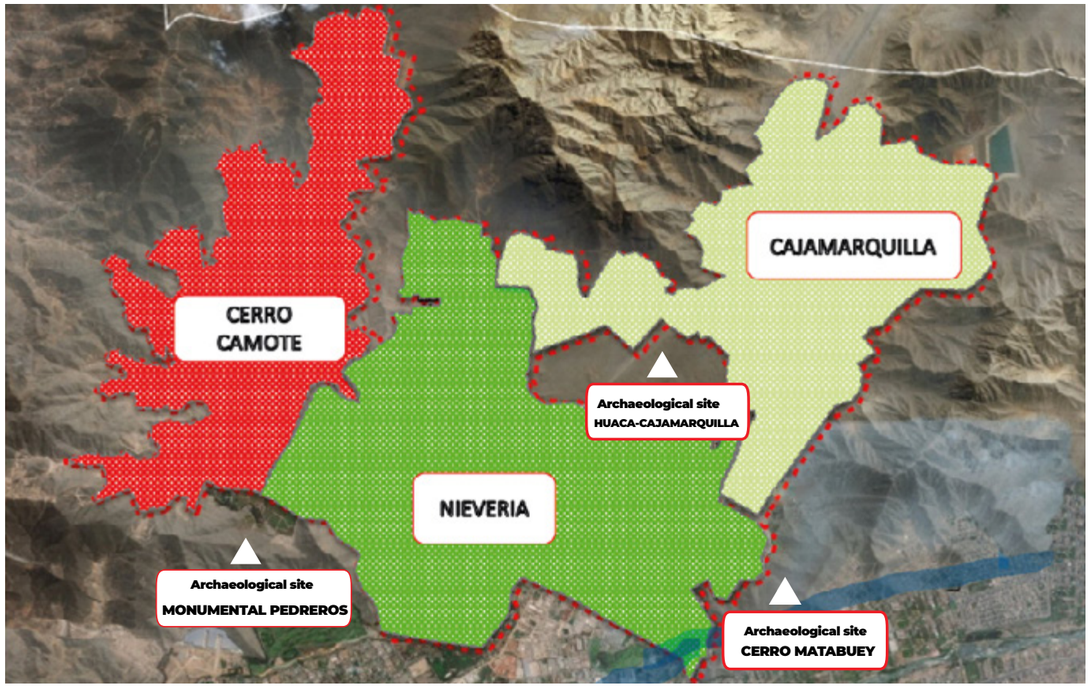
Executing Agency: Lima Water and Sewer Utility Company (SEDAPAL)

SEDAPAL (Lima Water and Sewer Utility Company) is the public entity responsible for providing access to potable water and sanitation services to residents of Lima and surrounding areas, including the province of Callao. SEDAPAL oversees the creation and execution of the plans, programs, and projects needed to reach its efficiency targets for the administration, coverage, and quality of drinking water and sanitation services in 46 districts. Due to the size of the water and sanitation system and population growth in SEDAPAL's coverage area, the company implemented a sector system (marking off areas under 3 km^2) and plans (works and projects) to optimize service conditions and better manage[1] the volume.

In late 2008, SEPAPAL released its 2009-2013 Institutional Strategic Plan and investment program that included the expansion and improvement of water and sanitation systems in Cajamarquilla, Nievería, and Cerro Camote. These areas are part of SEDAPAL sectors 129, 130, 131, 132, 133, 134, and 135.

1. This sector monitoring includes flow volume, chlorine concentration levels for treatment, and required pressure levels for the sector systems.

Map of project area: Cajamarquilla, Nievería, and Cerro Camote



As part of its partnership with the Government of Peru, the Inter-American Development Bank (IDB) approved a loan to confront the water and sanitation challenges in these marginalized areas. The objective of the project was to provide networked water and sanitation systems to the residents of Cajamarquilla, Nievería, and Cerro Camote, and build a Wastewater Treatment Plant (WTP) to treat the sewage generated by the new services and other areas with sewage systems. When completed, this infrastructure was expected to provide water and sanitation services to 88,000 residents, or 17,128 households: a 1% increase in coverage in SEDAPAL's service area.

The WTP would be built in the sector known as La Atarjea and would initially serve 370,000 residents in certain sectors of Lima, including the 88,000 residents from the Cajamarquilla project area. However, it will eventually have the capacity to serve 710,000 residents, with a final design that can process 900 liters per second.

Box III

WHAT IS A WASTEWATER TREATMENT PLANT (WTP)?

A wastewater treatment plant receives wastewater and decontaminates it to eliminate environmental and health risks. Once it is treated, the wastewater can be released into natural bodies (sea, rivers, or lakes) or reused in other activities (irrigation, household cleaning, industry). It is generally not meant for human consumption (drinking and personal hygiene),

Wastewater treatment typically has three steps:

-**Primary treatment:** the mechanical separation (e.g. filters, mesh) of large solids, grease, and sand from human and food waste, soaps, and detergents.

-**Secondary treatment:** the soluble biological content of the wastewater resulting from chemical and organic waste is broken down substantially. Most municipalities use aerobic biological processes for this purpose.

- **Tertiary treatment:** the water quality is improved to the required standard before is it released (to the sea, river, lake, countryside, etc.). A treatment plant may use more than one tertiary treatment process.

Challenges for Implementation

Interrupted oversight

The project encountered its first obstacle as soon as it began, during the design stage.

To ensure the quality of infrastructure projects and minimize possible problems, experience and good practices suggest having robust, concurrent oversight throughout the project, from the design work to the completion of construction, and even possibly until operations begin. Under the project guidelines, the oversight and design contracts were supposed to start at the same time.

However, administrative problems delayed the selection and awarding of the first contract. The team needed a solution that would allow the project to continue. They decided to temporarily oversee the design contract, creating an ad hoc team at SEDAPAL for this purpose. After six months, SEDAPAL finally hired an independent oversight company. The team from this company—highly trained and with experience on similar projects—reviewed the engineering designs, oversaw the project, and managed contractors.

At first, it seemed like the transition would be smooth. However, due to the project's technical complexity, it quickly became clear that the transition needed to be handled with more care. The Bank's project team, to make sure that the project was implemented correctly and to get it back on schedule, held technical meetings with the new oversight company and the SEDAPAL technical team two or three times a week.

Despite these strenuous efforts, the project suffered significant delays. During the handover meetings, the teams identified key issues that had to be corrected before construction could begin. The team had to address flaws in the engineering designs, topographic surveys, and some construction calculations. This experience shows that, when it comes to infrastructure project oversight, continuity is key to achieving the desired goals and executing the project on schedule.

Delays in the construction of the WTP

One of the program components was the construction of the WTP near La Atarjea (on SEDAPAL's property) in the district of El Agustino, between the district of Lima and the Cajamarquilla, Nievería, and Cerro Camote project area. SEDAPAL already had a plant in La Atarjea to treat water from the Rímac River with a capacity of 18m3/s (cubic meters per second) and had selected an 11-hectare site to build the new WTP.

The utility company was initially going to finance the treatment plant on its own. But in 2013, SEDAPAL obtained financing from the German development bank KfW. The SEDAPAL-KfW loan experienced significant delays due to technical and administrative issues, which affected the original timeline. Despite these delays, the project team kept working to move the program along as quickly as possible. In June 2014, the project team conducted an exploratory visit to the proposed construction site. During that visit, they made a surprising discovery: there were archaeological remains at the site! In Peru, archaeological sites are protected by the government because they are invaluable cultural heritage and a legacy of pre-Colombian civilizations. Although SEDAPAL owned the property and had enough space to build the plant, it couldn't build the WTP on a site with archaeological remains in accordance with Peruvian law.

In order to continue the project, the Bank recommended that SEDAPAL immediately hire a local Peruvian company to conduct an archaeological survey of the area to confirm the presence of archaeological remains and determine suitable sites for WTP. This survey would also tell them whether the archaeological areas would be affected by construction and make contingency plans to avoid any damage. Unfortunately, the survey found that the area free from archaeological remains was not large enough to build the WTP, so another site was needed for the ancillary works, which could not be installed on the original site.

Once the site was chosen, the project team conducted a site survey so that construction could begin. Because of the delays up to that point, the plan was to build the plant in stages so that it could begin operations at the same time as the sewage lines in the Cajamarquilla, Cerro Camote, and Nievería project area. Its capacity would be increased in subsequent phases. But in June 2017, the consultant in charge of the La Atarjea WTP's engineering designs said that the plant needed to be built all at once for technical reasons, not in stages as originally planned.

This change, the financing delays, and the issues finding a suitable construction site shifted the timeline significantly. Construction is now expected to conclude in 2021, three years after initially planned.

Financial and educational barriers for new proyects adoption

In September 2018, after most of the water and sanitation network in the Cajamarquilla, Cerro Camote, and Nievería area had been completed, a new obstacle emerged; just 60% of beneficiary families had installed or adapted the fittings needed to connect to the system. Most of the remaining families did not have the financial resources to update their homes and take advantage of the service.

One solution was for these families to take out a loan but getting mortgage or home improvement credit in Peru can be complicated, even more so for low-income people. They are generally not connected to the country's banking and financial system. According to Global Findex, the global financial index created by the World Bank in 2017, just 42.6% of Peruvians have bank accounts, a much lower percentage than other countries in the region like Bolivia (54%), Paraguay and Argentina (both 49%) and Colombia (46%). There are also cultural barriers to overcome. Given that most of these households had little or no access to water and sanitation services prior to the project, many residents had very little education about health and how to use the new systems. The project team needed to improve connectivity levels among beneficiary families in order to meet the program's impact goals.

In October 2018, the team began advising the community through home visits, fairs, and follow ups to provide technical, educational, and financial assistance to unconnected homes. This project component also sought return on investment through potable water consumption, appropriate use of sanitation systems, and creation of a culture of timely payment for services rendered. Another important goal of this exercise was to institutionalize connectivity-related social work within SEDAPAL for future projects.

Outcomes

Based on SEDAPAL's previous experiences (in nearby areas with similar demographics), the expanded water and sanitation system was expected to benefit 88,000 residents (17,128 homes) when completed. However, due to sustained population growth in the project area and project efficiencies, 100,000 residents (20,000 homes) will now receive water and sanitation services in their homes.

The project was also completed under budget. The initial project cost per home without treatment was US$5,200. Allowing for economies of scale and population growth, the final cost per home, including relief sewer works, was US$5,000. The final project cost was US$96.8 million, lower than the US$163 million budgeted.

Relief sewer

Although the planned sewage system was expected to be completed in 2018, delays and changes to the La Atarjea WTP meant that the wastewater from the new system could not be treated.

The project team began to look for alternatives so that communities would not have to wait until the WTP became operational. After some deliberation, the team found an innovative solution that not only solved the problem temporarily, but also increased the infrastructure's capacity and the number of beneficiaries.

In 2017, they mapped out a relief sewer that would collect and carry the wastewater to the Taboada WTP, which was near the project area and had enough capacity to accept the waste during that time frame, for a cost of US$2.5 million. This infrastructure will ensure that the wastewater from the 100,000 residents of the project area and surroundings is properly disposed of. Once the La Atarjea WTP comes online, the relief sewer will continue to operate, collecting wastewater from other parts of the city where SEPADAL operates and diverting them to the Taboada WTP.

Without this solution, the water and sanitation system built for the project area would not have been operational until the La Atarjea WTP was completed (expected 2021), which would have limited the project's impact and put the already-built infrastructure at risk due to lack of use. Thanks to this temporary solution, improper disposal of wastewater can be avoided, as can the negative environmental, health, economic, and social impacts. The water and sanitation service will begin operations in the first half of 2019.

Household connection to services

To make sure that homes could connect to the new network and take advantage of its benefits, the team worked out several socioeconomic and educational solutions with SEDAPAL's social development team. The team developed a campaign to incentivize households to connect to the water and sanitation systems and verify those connections.

They made door-to-door stops at approximately 20,000 homes to check on system connections and sanitary conditions. Working with three local microlenders, they made follow-up visits to homes that didn't meet the sanitary conditions or have a connection to promote specific loan products. The campaign also provided financial education and advice for beneficiary households that had not yet installed connections, and promoted key health concepts like hand washing, how to use the installations, and more.

This campaign was based on the Multilateral Investment Fund's CREDIAGUA program. This program successfully connected residents of marginalized sectors in Lima, Callao, Arequipa, and Cuzco with microfinance companies to make sanitation improvements in their homes, while also creating demand for these basic services and improving hygiene practices.

Increasing the connectivity of homes in Cajamarquilla, Cerro Camote, and Nievería will have several benefits. It will improve the health, environmental, and social conditions of residents by reducing rates of water-borne illness, increasing school attendance, and more. SEDAPAL will also increase its revenue as a result of the new connections, improving its economic return on investment. Financial entities were also able to improve the business market and increase their portfolio of loans with a social objective. The market for products and services related to the potable water and sanitation sector will grow due to increased demand.

Lessons learned

Theory vs. practice:

For large and complex infrastructure projects like this one, applying theory is not always easy or possible. There are several lessons from this project that should be kept in mind for the future.

To successfully implement this kind of project and achieve the desired objectives, having solid oversight mechanisms is crucial. This will allow the team to manage all aspects of the project—administrative, fiduciary, and technical—in a timely manner from start to finish. Because it is such a complex task, executing agencies often hire an independent company with the capacity and experience to oversee their project.

In this case, SEDAPAL had planned from the beginning to hire a supervisory company. However, delays in the hiring process jeopardized the project timeline, pushing back the chance for project beneficiaries to access water and sanitation systems. In order to move forward with the engineering contract, the project team suggested using temporary internal oversight until the contracted oversight company began working and SEDAPAL could hand over the project.

Theoretically, maintaining the same supervision over the course of a project is recommended, but that wasn't possible in this case. There were two supervisory bodies and therefore a transition period. Transitioning from one supervisor to another is very complicated and demands a lot from all parties. Correctly executed, a transition can maintain continuity of oversight for infrastructure projects like this one.

Teams should determine an effective, transparent, and seamless strategy for exchanging information. It should consider the scope of the process and encourage all parties to communicate and make themselves available to one another

for regular and one-off conversations. Keep in mind that during this transition, detailed review of the progress made so far (calculations, designs, contracts, etc.) can uncover errors, which will necessitate corrections and additional work. This review will allow the project team to regroup and avoid problems that could arise later in the process and lead to higher costs. When a new supervisor takes over, thoroughly review everything that was done previously during the transition period and do not assume that there were no mistakes in the previous work.

Finally, it is important to recognize that this project benefited immensely from using the same firm to oversee the design and construction of the infrastructure. This arrangement led to the greatest possible continuity in the process and facilitated the exchange of information between the designers and builders. It also allowed those involved to anticipate problems that needed alternative and innovative solutions (e.g. the relief sewer) so that the program's objectives could be met.

Look at projects holistically

Many infrastructure programs have several components (or subprojects) and they are often interdependent. For one to work, the others must work too. These components are often financed by different institutions, which adds a layer of complexity to program execution.

For this project, the expansion of the potable water and sanitation systems for Cajamarquilla, Cerro Camote, and Nievería were financed by the IDB and the La Atarjea WTP by KfW. Significant delays in the construction of the La Atarjea WTP put the successful expansion of the water and sanitation systems at risk. If the WTP wasn't ready, it would be impossible to treat the wastewater from Cajamarquilla, Nievería, and Cerro Camote, and therefore the new systems could not be used.

The project team addressed the challenges holistically from the beginning, regardless of who funded what, which allowed them to identify problems as soon as possible (like when archaeological remains were discovered at the WTP site) and quickly come up with creative solutions (like the relief sewer). This perspective was vital to the success of the whole program and ensured the greatest benefit to the 100,000 residents in the project area.

This comprehensive view of the program requires all stakeholders to come together (project team, beneficiaries, financing institutions, local and regional governments, contractors, etc.). Everyone must communicate and be fully transparent with each other. All stakeholders should see a project like this one as a whole: a comprehensive solution. This perspective gives them greater flexibility to look for creative solutions and face the challenges that will come up during a project of this scope and size (and do so within the project timeline) with minimal impact on the budget.

Build a close relationship with the community

Because the project team visited the beneficiary families, they understood firsthand that they needed to do more; it was not enough just to install potable water and sanitation systems for the community to use. At the end of the day, the program is for community residents, and they are in the best position to decide what they need. Their voices are essential to ensuring that the investment has positive results and the community can enjoy the benefits of the project for a long time.

Going from house to house within the communities illuminated the financial, technical, and educational barriers that were stopping homes from connecting to the networks. It also allowed the team to find unexpected solutions. Based on this exercise, the project team invited three microlenders to facilitate connections to the system, construction of bathrooms, and sanitation improvements in homes by offering loans.

If the beneficiary community does not have a say in the project, there is a risk that the program will not meet its objectives and have poor financial and economic returns. This experience also generated invaluable knowledge and experience for SEDAPAL about the need for social work in the field to increase connection rates for future projects.

The challenges of sustainability

The population of Lima's metropolitan area will continue to grow, as will the project areas. Domestic and foreign migrants continue to arrive, drawn by the capital's thriving economy and the ease of migrating in Peru. This means that demand for potable water and sanitation will continue to grow.

Expanding the new water and sanitation systems as the population grows and keeping them operational during the expansion process is a priority. As new residents come, it will also be important to continue the community educational, financial, and health programs to ensure that the new arrivals adapt to the project infrastructure.

The ultimate goal is to continue to expand sanitation in SEDAPAL's coverage area and in the rest of the country. The challenges are significant, especially for a country with Peru's socioeconomic, climatic, and geographic features. It won't be easy, but this project, the lessons learned, and the challenges overcome prove that these things are possible in Peru.