Beyond the Faucet

Enchancing Water Accesibility in La Carpio

Abstract

The primary objective of our project was to address the acute water crisis faced by La Carpio, a marginalized migrant community in Costa Rica, by developing and marketing prototypes of a filtration system. This initiative, chosen for its feasibility, targeted households grappling with waterborne illnesses. Through comprehensive surveys, we identified sources of contamination, emphasizing damaged pipes, urban runoff, stagnant water, and poor sanitation practices. Simultaneously, we initiated an awareness campaign, educating residents about water contamination risks and promoting proper sanitation of storage vessels. Overall, La Carpio's water crisis demands a holistic approach, combining technological solutions, community education, and increased political advocacy for lasting change.

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Sponsor

Costa Rica Humanatarian Foundation

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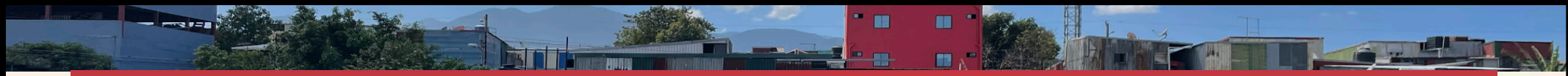

Acknowledgements

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Meet The Team

From Left to Right:
Bryce Illingsworth, Jane Tucker, Lindsey Gorham

Bryce Illingsworth

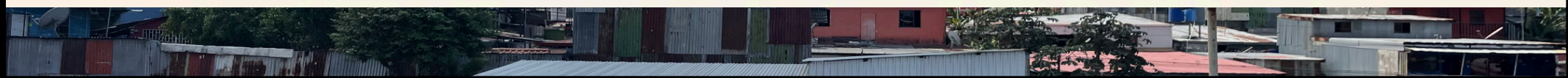
Hi, my name is Bryce Illingsworth, and I am from Southampton, MA and I am majoring in Mechanical Engineering. This project was interesting to me because of its impact on the community of La Carpio, specifically by providing potable water at the household level. While completing this project, I worked on valuable skills such as leadership, communication, and time-management, all of which were essential for the success of our team. This project had a profound impact on the community, demonstrating the hard work and passion of our team.

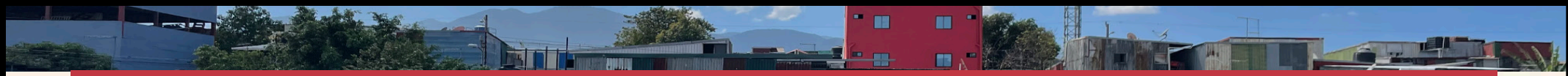
Jane Tucker

Hello! My name is Jane Tucker. I am from Rye NH and I am majoring in Biochemistry with a minor in Biology/Biotechnology. This project was a great experience in advancing my leadership, writing, communicative skills and my spanish speaking ability. This project taught me to focus on the social aspect of places rather than just the science. I developed a great appreication of La Carpio and I am thrilled with the work my team has done to approve the lives of so many in the community.

Lindsey Gorham

My name is Lindsey Gorham, and I am from Stoneham, MA. I am majoring in Chemical Engineering. I was very interested in this project as I have had experience with water filtration projects in the past. This was a unique experience compared to my previous projects because we were able to fully grasp this project from a scientific, as well as a social perspective. Becoming familiar with La Carpio was an incredible experience and I was able to improve my writing, leadership, and research skills.





Executive Summary

Water is arguably one of the most important resources in any civilization. Despite its abundance, 30% of people worldwide struggle to receive adequate portions of water year-round[1]. The UN declares that clean drinking water is a fundamental human right, but many marginalized communities continue to fight for proper access1. Costa Rica, with its tropical and wet climate, is not a country that one would imagine experiences issues with water accessibility. The country receives 170 cubic kilometers of water a year, creating vast networks of rivers, lakes, and aquifers that supply 90% of the country with potable water[7]. Nonetheless, some areas of the country still experience poor water accessibility. An example of this is La Carpio, a low-income district in San Jose. La Carpio is an informal settlement that is mostly inhabited by three generations of Nicaraguan refugees[15]. Since many of the residents lack citizenship and political power, they are mostly responsible for building their own infrastructure, including their water pipes[4]. The pipes were installed decades ago and were siphoned from a pipe owned by A y A (Acueductos y Alcantarillados), a government owned aqueduct company4. The system consisted of underground and above ground PVC pipes. These pipes have been damaged over time and many of the residents intermittently receive piped, contaminated water[20]. Cracks in the pipes expose the water to trash, sediment, and bacteria, causing contamination. The pipes are mostly maintained by the residents; A y A has not updated the system since its installation.

Our project, in collaboration with the Costa Rican Humanitarian Foundation (FHCR), aimed to increase water accessibility in this under-privileged community. FHCR is a non-profit organization that tackles many different projects with the common goal being the development of socially challenged communities in Costa Rica, including La Carpio.

Addressing the Water Crisis

The primary goal of our project was to address the acute water crisis in La Carpio by developing and marketing prototypes of a filtration system. This initiative, chosen for its feasibility, targeted households grappling with waterborne illnesses. To achieve this goal, our objectives were multi-faceted. First, we undertook the crucial task of identifying the source of water contamination, discerning the pollutants involved. By conducting extensive surveys across sectors and consulting with local health clinics, we aimed to home in on specific contamination sources.

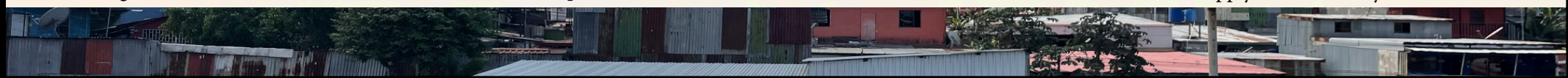
Simultaneously, we surveyed the existing infrastructure in La Carpio to assess damage and identify areas for improvement. By conducting interviews with residents, making visual observations, and collaborating with local organizations such as A y A, our team gained a more comprehensive understanding of the infrastructure damage. Understanding that community-wide infrastructure repair was economically challenging, we strategically shifted our focus to proposing a household-level filtration system. This system is needed to efficiently filter out specific pollutants.

To identify a viable solution, our team considered the community's limitations and needs. We proposed low-cost, highly efficient filtration methods, narrowing down options based on feasibility and compatibility with La Carpio's unique circumstances. The chosen filtration system underwent testing, including further research of our chosen filtration method, exploration of local material and component providers, and the production of prototypes.

In tandem with these efforts, we recognized the importance of raising awareness about poor water quality in La Carpio. We conducted comprehensive polls to gauge the community's current awareness levels, using the data to tailor educational materials. Leveraging FHCR's existing infrastructure and collaborating with their school program, we strategically placed graphics in high-traffic areas. These visuals, designed with the community's low literacy levels in mind, emphasized the risks associated with consuming polluted water and promoted proper sanitation practices. Our holistic approach aimed not only to provide a technological solution but also to empower residents through education, fostering a sustainable future for La Carpio.

Water Availability and Quality

La Carpio's infrastructure, originally designed for 3,000 households, now struggles to accommodate an estimated 5,000 homes[30]. However, 72% of the community members surveyed face irregular piped water availability, leading to severe health issues. Cistern trucks continuously run over exposed water pipes resulting in significant damage and possible infiltration of pollutants entering the water system[20]. These trucks supply water to sectors of La Carpio that have the most issues with water availability. The workers arrive at inconsistent hours and the residents collect the water in buckets that will supply them for a day or more.



Executive Summary

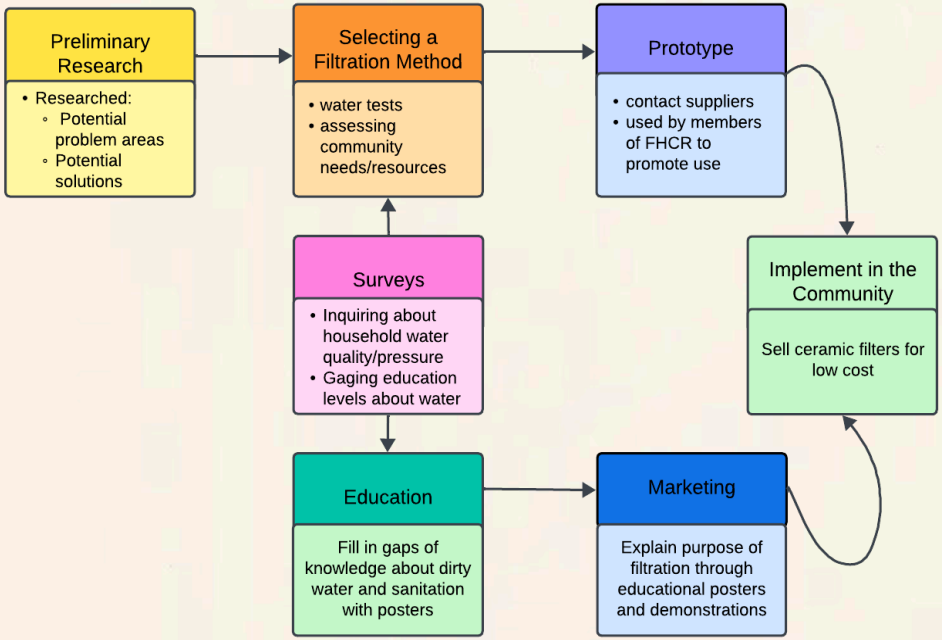


Chart 1: Methods Flow Chart

Sources of Contamination

There were three discovered causes of contamination: damaged infrastructure; stagnant water in holding buckets;, and poor sanitation. Broken pipes, resulting from improper pressure regulations of a water tank and damage from cistern trucks, expose residents to harmful pollutants[5]. Repair responsibilities falling on individual households exacerbate challenges, especially in areas like La Libertad, which experiences the worst water quality due to infrequent piped water and sanitation issues. The infrequency of water forces the residents to store water in buckets that are breeding grounds for bacteria and mosquito larvae. This issue is worsened when the buckets are not regularly cleaned with proper anti-bacterial reagents[5].

Ceramic Filtration Solution

To comprehensively address La Carpio's water crisis, we proposed a viable solution in the form of ceramic filtration. This method effectively targets bacterial and physical contaminants, utilizing abundant clay resources in Costa Rica. Through collaboration with local clay providers, a prototype was developed, incorporating recycled materials to minimize price per unit and aligning with the community's needs for an accessible and sustainable solution.

Education Initiatives

Low community awareness, particularly regarding water quality, underscores the need for educational initiatives. Sixty-three percent of 35 individuals surveyed rated their water quality as good to great. In contrast, 32% of those same individuals described how they or family members have gotten sick from the water. To combat the lack of awareness, purposeful posters and materials were designed for both children and adults. Placed strategically in FHCR sites, health clinics, and schools, these materials aimed to bridge knowledge gaps concerning sanitation practices and encourage the widespread adoption of ceramic filtration systems.

Recommendations

In response to the poor infrastructure, contamination issues, and limited education in La Carpio, our team provided the following recommendations for the residents of La Carpio and our sponsor to overcome these challenges. Residents of La Carpio who use buckets for collecting stagnant water are encouraged to use their containers with the ceramic filtration pots we have suggested. This will filter out bacteria, sediment, and other contaminants. Community members should frequently examine their holding buckets for mosquito larvae, sediment, and possible animal excretion. In addition, our sponsor, FHCR should continue to educate the community using our outlined posters to raise awareness about dirty water, the importance of cleaning holding vessels, and the proposed use of ceramic filtration. Furthermore, proper disposal of trash is an important component to prevent possible infiltration of chemicals and bacteria entering the water system. The people of La Carpio should be consistent about disposing of their trash in proper containers and picking up trash surrounding their property to reduce cross-contamination.

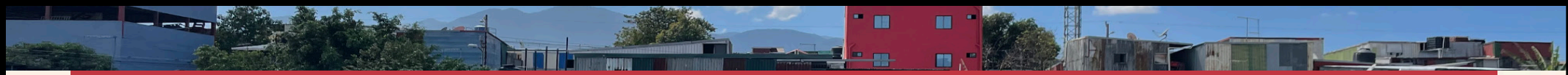
Executive Summary

Our team could not address the dominant issue of consistent water access in La Carpio. The inadequate infrastructure must be addressed by A y A or a government organization. The piping system needs to be completely replaced resulting in a multi-million-dollar project.

Conclusion

Through our two months of research and two months of fieldwork, our team has discovered the intricacies of La Carpio's water cleanliness, and water accessibility. Issues regarding water quality are prominent in nearly all nine sectors of La Carpio. In some cases, E. coli and mosquito larvae infested the holding buckets of community members resulting in devastating health issues. The group was determined to combat this issue with a low-cost easy-to-use filtration system. After extensive hours of research, onsite work, and constructing a prototype, our team was successful in creating a practical, cost-effective system. Our team has hopes that one day the 5000 homes and approximately 45,000 individuals present in La Carpio, will have the ability to drink clean water.

Rio Torres River in La Carpio littered with trash



The Right to Water

Access to clean and safe water is a fundamental human right, yet it remains a pressing global challenge. Of the 7.9 billion people in the world, 2.3 billion live in water-stressed countries, of which 733 million people live in high and critically water-stressed countries[1]. About 4 billion people experience severe water scarcity during at least one month of the year[2]. Water is a finite resource in high demand. As population numbers continue to rise, many developing countries in the 21st century lack the water resources and infrastructure to meet the growing necessity.

Costa Rica's tropical climate, along with its mountainous geography, creates a vast water network of freshwater rivers that cover almost the entire country. As a result, 97.8% of Costa Rica's population has access to water[3]. However, water supplies are consistently endangered during the dry season, especially for low-income communities. La Carpio, an informal settlement populated mostly by impoverished refugees, is an example of a district in San Jose that struggles to receive appropriate amounts of potable water.

The residents of San Jose have often marginalized the occupants of La Carpio due to their refugee status from Nicaragua. The people of this neighborhood have fought for their human rights, such as proper water and electrical infrastructures, since the majority lack citizenship[4]. The piping infrastructure that supplies water to each household is suboptimal due to damage, inadequate water filtration, and frequent failure to supply water to homes at lower elevations. Thus, the people of La Carpio use open holding buckets with stagnant water that collect bacteria and mosquito larvae, both of which are dangerous to this developing community. Contamination also enters the pipes and buckets, causing the people of La Carpio to consistently experience symptoms of water-borne illnesses[5].

The Fundación Humanitaria Costa Rica (FHCR), located in the capital of San Jose, is a non-profit organization dedicated to addressing various social problems in Costa Rica, particularly in low-income neighborhoods of La Carpio. They focus on several programs including health, housing, enterprise, and education[6].

One of their new projects addresses the limited water access and damage to La Carpio's water pipe infrastructure. This project offers solutions for clean water access while also involving and raising awareness about the dangers of poor water quality. Our goal was to create prototypes of a filtration system chosen for its feasibility and market them to La Carpio households experiencing waterborne illnesses through education about poor water quality.

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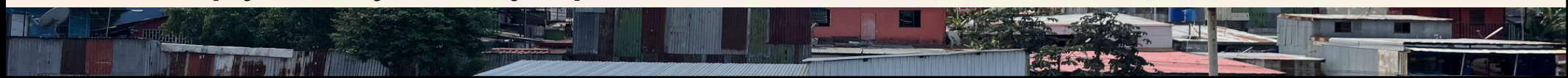
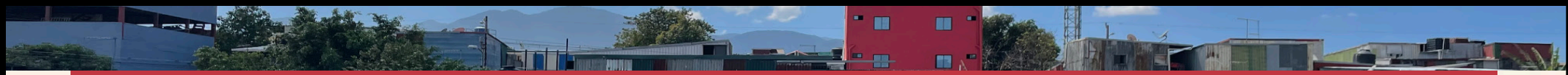




Water Disparities, Contamination, and Solutions

In this section we will introduce watr disparties across Costa Rica, possible contimants entering water systems, and potential solutions to contimination issues.

Water in Costa Rica

Over the last 30 years, public institutions and private sectors of Costa Rica have collaborated to achieve maximum sustainability and provide water to 97.8% of the population[3]. About 75 cubic kilometers of rainwater is collected in rivers and lakes, while 37 cubic kilometers collects in underground aquifers, the primary source of drinking water[7]. The Pacific side experiences dry seasons and contributes to water scarcity in the region. As irrigation, tourism, and population have increased, consumption has also grown, leading to conflicts regarding allocation of resources and issues of water quality throughout the nation[8]. **Figure 1** shows average rainfall in Costa Rica while **Figure 2** shows the dry season average rainfall.

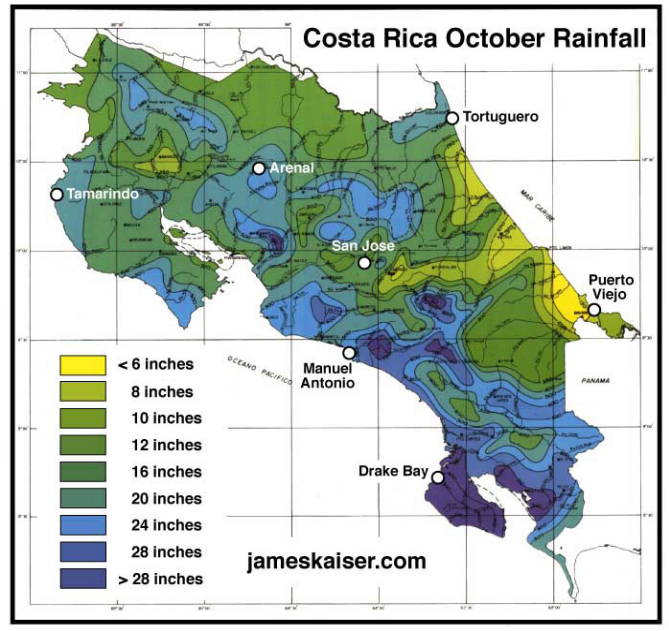


Figure 1: Costa Rica Wet Season Rainfall[9]

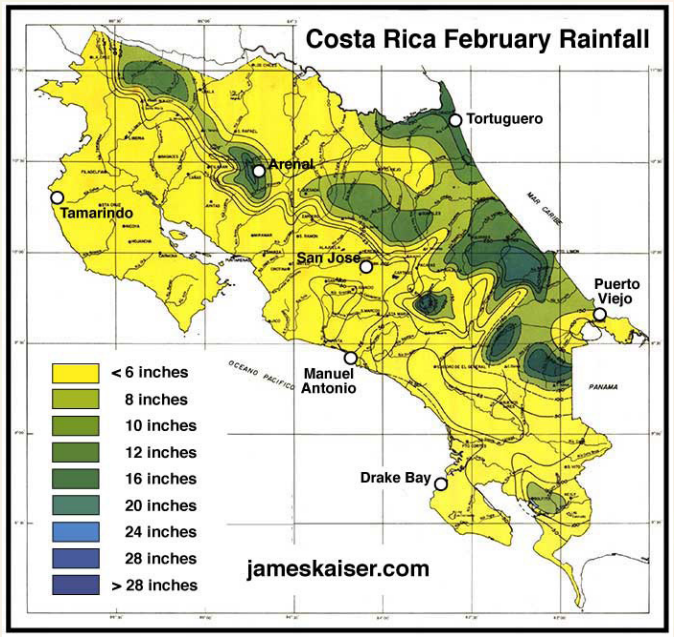
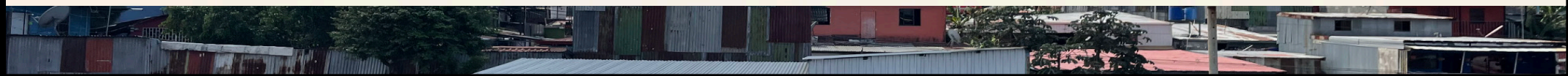


Figure 2: Costa Rica Dry Season Rainfall[9]

Over 90% of the population receives their water from one of the country's 2,145 aqueducts transporting potable drinking water. Ground water in Costa Rica is the primary water source, accounting for almost 90% of agricultural, industrial, and domestic water demands in Costa Rica[7]. There are currently 34 basins present in Costa Rica, 5 of them labeled as the most crucial, for they supply water to majority of the population. However, these five basins are rapidly deteriorating due to contamination and other environmental issues[7]. The most common pollutants contaminating the water are shown in **Figure 3**.

"For many of us clean water is so plentiful and readily available that we rarely if ever, pause to consider what life would be like without it."

Marcus Samuelsson



Water Disparities, Contamination, and Solutions

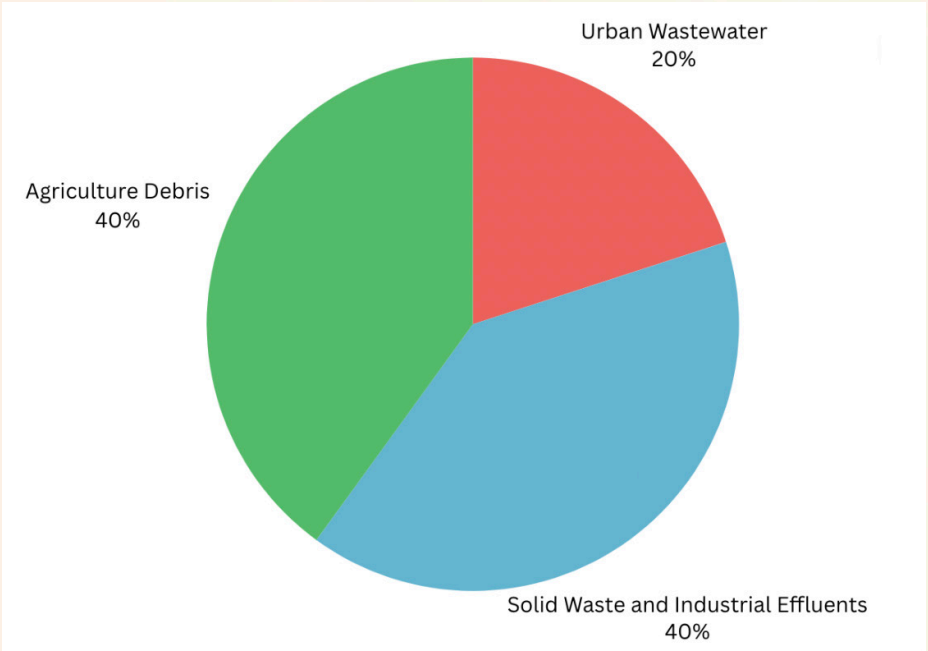


Figure 3: Most Common Pollutants Contaminating Costa Rica's Water. Adapted from Source 7

Despite efforts on sustainability and environmental protection, Costa Rica is still fighting to improve water stability in many communities.

Previous Attempts to Provide Clean Water

Many efforts to improve Costa Rican water systems have been enacted over the last two decades. Specifically, over the past 10 years, governmental agencies, and environmental organizations have joined forces to implement serious measures to reduce water pollution in rivers and water systems. In 2010, Costa Rica was granted with a combined total of a US $320 million loan from various international governments to improve drinking water, sanitation and wastewater treatment "directly benefitting approximately 1,070,000 residents of the San Jose metropolitan area"[10]. Over US $270 million dollars of this budget was designated to improve construction and improvement of sewer networks in the Maria Aguilar and Tiribi river watersheds. Another $14 million financed the construction and rehabilitation of drinking water networks and sewers in low-income districts of San Jose[10]. In 2015, A y A (Acueductos y Alcantarillados), took action to improve San Jose's water treatment institution, wastewater management and financial sustainability. Although ongoing efforts have been dedicated to improving Costa Rica's water systems, low-income communities, including La Carpio, continue to struggle to receive potable water in their households.

Global Examples of Water Filtration in Low-income Communities

Drinking water filtration is a critical process to public health and well-being. With the escalating challenges of environmental pollution and the presence of contaminants in water sources, the need for effective filtration systems has emerged as an important piece of infrastructure. Drinking water filtration involves the removal of impurities, pollutants, and bacterial agents in water, ensuring the product meets quality standards for human consumption. From municipal water treatment plants to individual household filters, the quest for pure and clean drinking water underscores the significance of filtration technologies in safeguarding communities against waterborne diseases and promoting a sustainable approach to water resource management.

Mechanical filtration is a crucial component of drinking water treatment, employed to remove suspended particles and impurities from the water. This process involves passing the water through physical barriers or media that trap and separate solid particles, sediment, and other contaminants[11]. Commonly used materials for mechanical filtration include sand, gravel, ceramic, or synthetic membranes. An example of this technology being used can be found in Cambodia where community-level filtration systems are utilized to treat drinking water[12]. These systems may include mechanical filters such as cloth fibers or sand filters, which are relatively low-cost and can be maintained locally. These simple filters help in reducing impurities and pathogens within water. Mechanical filtration is effective in enhancing the visual clarity of water, reducing the load on subsequent treatment processes, contributing to the overall purification of drinking water.

Water Disparities, Contamination, and Solutions

Slow Sand Filtration (SSF) is an example of a low-cost mechanical filtration method that effectively removes chemicals, bacteria, and physical matter from raw water[13]. This method requires no chemical agents, low energy input, and low material costs. SSF works by using layers of natural filters. Raw water is transported into a tank with layers of sand and gravel. The pore size of each filtration layer increases in size, meaning that the initial layer is composed of fine sand[13]. The bacteria settle on the surface of this layer due to the small pore size. New water is then exposed to the microbial layer which attacks competitor bacteria in the raw water. The water travels through each layer, and bacteria-free water is transported out the bottom. This process does require consistent maintenance to control the microbial layer which can delay the process. This system is unsuitable for single household units, and there is no central location in La Carpio for communal implementation.

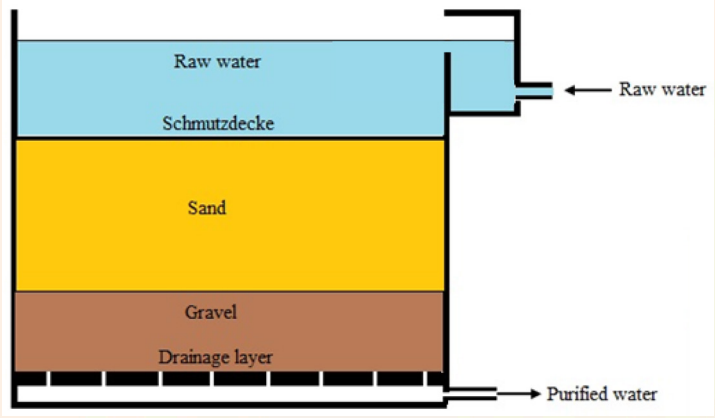


Figure 4: Slow Sand Filtration Mechanism[13]

Historians have discovered that civilizations as early as 2000 BC used sand and gravel in a similar manner to improve their water quality in canals. Today, this filtration method is highly utilized in less-developed communities with warm, tropical climates since bacteria and algae thrive in higher temperatures. For example, a community tested SSF on the polluted Kali Jagir Surabaya River located in Indonesia[13]. After optimizing the design aspects of the SSF system, the filtration method was able to eliminate about eighty-two percent of the water's turbidity. Turbidity is an indication of water purity and is measured by how much light is transmitted through the water. Water with high turbidity is heavily contaminated. In addition, the system also removed fifty percent of the iron and about ninety percent of the solid trash in the river water. The tropical climate of this location makes this case an optimal comparison since Indonesia and Costa Rica are both relatively close to the equator.

Ceramic filtration is a low-cost filtration method in which a clay container is used to filter water. Tiny pores present on the surface of the ceramic surface filter bacteria, sentiment, and chemicals present in the water. In addition, some ceramic filtration systems contain a colloidal silver lining to increase removal of bacteria. According to the U.S. Center for Disease Control (CDC), ceramic filtration is an effective way of improving water quality and removing pathogens[14]. In addition, the CDC reports a 60-70% decline in diarrheal disease when these filtration units are implemented[14]. This water filtration system is commonly used in rural neighborhoods struggling with water quality. In Colombia, the low-income areas in the Choco, Valle De auca, Cauca Cordoba, Antioquia, and Caquetá regions use this water filtration system as a primary method in households. A ceramic filter can be seen in **Figure 5**

Figure 5: Ceramic Filtration Mechanism[25]

In Cambodia, non-governmental organizations (NGOs) began implementing these ceramic filters throughout the country. In 2010, over 100,000 households in Cambodia were recorded using this filtration method for water treatment[12]. In addition, a study to determine the effectiveness of ceramic filters in Cambodia showed a 99% reduction in E. coli and a 90-99% bacteriophage reduction in rainwater and surface water spiked with E. coli and bacteriophage[12].

Adversity in La Carpio

In the next sections we describe the setting of our project and the history of the community in La Carpio. We then discuss the current struggles the residents of La Carpio face with accessing clean water.

Nicaraguan Migration in Latin America

Nicaraguan citizens have sought refuge in Costa Rica since the early twentieth century. Beginning with the Great Depression, a social uprising throughout Latin America due to economic turmoil allowed dictators to gain control of each country except Costa Rica. While many Latin American countries reformed their government in the forties and fifties, Nicaragua remained under the control of a dictatorship. Civil wars, an oil crisis, and natural disasters, such as a drought and a series of earthquakes, drove large numbers of Nicaraguan refugees to Costa Rican land. After the Nicaraguan Civil War, the people were left impoverished, and a high percentage were illiterate[15]. Costa Rica was very appealing for the refugees, and as of 2020, 368,000 Nicaraguans had settled in Costa Rica[16].

Adversity that Refugees Face in La Carpio

The government of Costa Rica struggled with the increased refugee population, and many of the migrants remain impoverished without an issued work permit. La Carpio is a 25 square kilometer district located in West San Jose. **Figure 6** shows an aerial view of the densely populated district. Originally, La Carpio was a coffee plantation destroyed by a volcanic eruption in the 1960s. In the 1990s, thousands of refugees who were desperate to escape poverty settled in this area because of its proximity to San Jose and its undesirable location to Costa Ricans. Three generations have now lived in and renovated the community. The socio-economic status of La Carpio is a hardship the community endures. According to Costa Rica's Mixed Social Aid Institute, the monthly income of La Carpio's families ranges between 60,000 and 75,000 colons (US$130-165), an insufficient salary to cover everyday life essentials[18]. Furthermore, less than half of the population has formal employment and even fewer own land[19]. Poor health conditions exist for the residents of La Carpio, and the neighborhood does not receive government aid since it is categorized as "informal living." The community does not regularly receive adequate or sanitary food and water supplies.

Figure 6: Aerial View of La Carpio with Rio Torres Rio Virllia and EBI landfill[17]

The History of Water in La Carpio

In contrast to the abundant water supply outside of San Jose, La Carpio's history with water access is an uphill battle. Before there was piping, the neighborhood received clean water by entering another district named La Uruca. Traveling outside the community to obtain clean water without access to public transportation was not viable, and many resorted to rainwater. Rainwater was their primary water source for dishwashing, laundry, and showering. Living without access to clean water was no longer an option for the residents of La Carpio. They created their own infrastructure of piping by connecting 1" PVC lines to a water pipe owned by A y A[4]. After the people of Calle Filadelfia made homemade aqueducts, a representative of this company traveled to La Carpio and was met by the

Adversity in La Carpio

passion of its people. The company agreed to leave the infrastructure in place[4]. The piping has never been replaced by the company and the residents are responsible for their own repairs. The current water piping system of La Carpio is old and unstable. The primary water storage is one of the aforementioned aquifers that originates from the province, Heredia, on top of the mountain[20]. From this natural source, water travels through underground six-inch PVC pipes. The water enters La Carpio in one-inch PVC pipes. **Figure 7** and **Figure 8** below show examples of above ground pipes. Above ground water pipes are exposed to dangerous elements.

Figure 7: PVC Water Pipes attached to a home in La Carpio

The pipes are also continuously damaged by trucks and animals[20]. Damage to the pipes can cause infiltration of urban run-off into the water system. Broken pipes also cause leaks that reduce water pressure and limit water availability for lower-elevation homes. A lack of water supply forces residents to store water in open, household water storage containers when water is scarce[20]. Although A y A supplies the water traveling through these pipes, households who do not have direct pipes into their house opt to cut the PVC pipes, creating a tee off it. These tee'd pipes are often done illegally and without sufficient tools or materials. Improper connections result in leaks.

Figure 8: PVC Water Pipes in La Carpio

Sources of Water Contamination

This section will identify possible contaminants that enter La Carpio's water system from the open holding buckets or urban runoff. Runoff water is any uncontained, flowing water. Runoff water can absorb contaminants from multiple sources due to its constant movement.

Waste Management in La Carpio

About 4500 tons of waste are produced daily in Costa Rica and sent to the four main landfills[21]. Despite adamant opposition from the residents of La Carpio, the government installed a landfill next to the neighborhood in 2004. **Figure 9** below shows the proximity of the EBI landfill to the community of La Carpio. This landfill receives fifteen percent of the country's daily waste. Airborne trash from the landfill can be found in the streets of the nearby sector. There are also areas surrounding the district where waste is illegally dumped, further destroying the area's sanitation. EBI, the Canadian company that owns the landfill and regulates the trash system of La Carpio, allocates the job of cleaning trash in the streets to

Adversity in La Carpio

Figure 9: EBI Landfill located in La Carpio, less than 500 meters away from a home

two workers[20]. This is not nearly enough labor to clean the 25 square kilometer district. Chemicals and bacteria from the waste are then diffused into the runoff water.

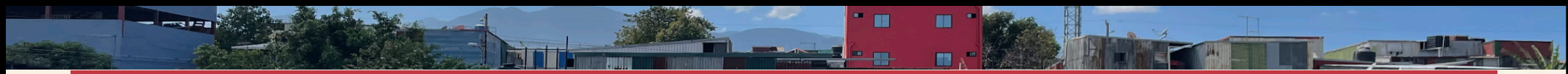
Erosion Contaminants

Erosion occurs when a force, like water, wind, or ice, detaches and abrades soil from one location and deposits it elsewhere. Urban runoff collects sediment and other contaminants that could enter the open, holding buckets or damaged pipes. The residents of La Carpio who do not receive enough piped water collect rainwater in holding buckets. Rainwater collects eroded metals and other materials from roofing. Thus, water quality decreases, and sediments must be manually filtered out of drinking water.

Pathogens and Chemicals in Water.

Costa Rica has prided itself on potable water, according to a 2019 international report involving the U.S. Centers for Disease Control and Prevention (CDC). However, recent data from 2022 reveal a concerning reversal with 10.5% of the population lacking access to piped and potable water - an alarming uptick from 4% in 2021[22]. Regions such as La Carpio, Huetar Caribe, Brunca, and Huetar Norte face the most significant challenges. While fecal matter remains a predominant cause of water contamination, the number of aqueducts contaminated for this reason has decreased, dropping from 45% in 2007 to below 20% in 2019[22]. The Greater Metropolitan Area (GAM) emerges as more vulnerable to fecal matter contamination, emphasizing critical water catchments that could be at risk[22]. Fecal matter in drinking water is an example of bacterial contamination. Over 500 waterborne pathogens, many of which are bacteria, exist on the US Environmental Protection Agency's Candidate Contaminant List[23]. Some types of bacteria thrive in warm, stagnant water. Examples of these types of bacteria are cyanobacteria (algae), E. coli, and Legionella. Viruses and fungi can also grow in warm, still water and cause waterborne illness in a community. Symptoms of bacterial contamination in drinking water include diarrhea, nausea,Ida fever, and stomach pain. Urban runoff in La Carpio could absorb bacteria from fecal matter or decomposing trash and infiltrate the pipes. Households of La Carpio have holding buckets to collect water which are examples of high-risk stagnant water.

In this section, we discussed the background of water accessibility issues in Costa Rica and in La Carpio and possible solutions to the problem that have been attempted in similar communities. In our project, we used this research to find a feasible solution to improve accessibility to clean water in this community. The next section discusses our methods implemented during our fieldwork in La Carpio.



Goals, Objectives, and Approach

The goal of our project was to improve potable water accessibility in La Carpio by creating prototypes of a filtration system chosen for its feasibility and marketing them to households experiencing waterborne illnesses through education about poor water quality and sanitation. Our objectives to achieve this goal were:

1. Determine the sources of water contamination and discern the resulting pollutants that may need to be addressed using a filtration system.

2. Survey the current infrastructure, assess any damage, and ascertain improvements for delivery.

3. Propose a solution while considering the needs of the community and surveying what resources are available.

4. Raise awareness in La Carpio regarding the risks of contaminated water.

Identifying the Sources of Pollution

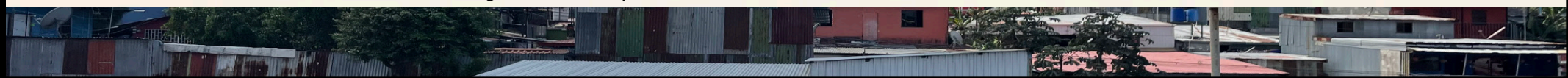
Before we finalized our decision regarding a potential solution most suited to the circumstances in La Carpio, we determined the sources of the water contamination. We were then able to address the resulting pollutants in our solution. Ascertaining where the pollution originates, and the specific contaminants emitted from the source, helped direct our team to the most appropriate filtration system. Our goal was to tailor our system to the pollutants after we determined if they were hazardous chemicals, bacteria, sediments, or other particulate matter. We first asked our sponsor if the source of contamination and where it was entering the system was known. We also contacted A y A to inquire if they had conducted any previous chemical tests on the water. The organization and the company lacked research pertaining to water quality in La Carpio. We then ascertained which sectors received the worst water by surveying residents in seven out of nine sectors. We asked them to rate the cleanliness of their water on a scale from one to ten, ten being completely potable. The survey also asked if the residents or their neighbors had experienced any symptoms of waterborne bacteria or illnesses. The most concerning responses were recorded, and we visited their sectors to see if there was visible cross contamination of any damaged pipes and urban runoff. We also observed their holding buckets for any noticeable sediment, algae, or animal interference.

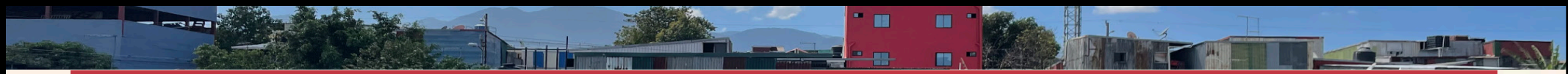
Another method of finding the sources of contamination was interviewing medical personnel at the local health clinic. The team asked the health clinic about their theories of where the pollution was entering the system. Three notable sources were mentioned: urban runoff, stagnant water, and improper sanitation. Since many of the reported symptoms indicated bacterial contamination in stagnant water, our team arranged water quality tests focused on bacteria of holding buckets in the sectors with the most problems pertaining to drinking water. Since the issue of cross-contamination with urban runoff was reiterated, we visited the adjacent landfill and observed other community waste regulations, such as animal waste pickup. Although methods of trash removal have been established, we observed that trash and animal excrement are continuously littered throughout the streets, threatening the quality of potable water. In addition, after learning that improper sanitation was a cause for concern, we also began asking residents if and how they cleaned their holding buckets.

Surveying the Infrastructure

Assessing the current infrastructure in La Carpio was vital to our team's research. After contact with our sponsor (FHCR), our team learned that leaks and inadequate pressure are a common issue throughout the piping system. To navigate the piping system, our team contacted A y A to obtain a visual schematic system of the water piping system below and above ground throughout La Carpio. Additionally, our team conducted an interview with librarians at A y A. Since A y A controls the water system in La Carpio, we inquired about their insights on potential issues with the water delivery system and asked for any documentation regarding water availability in La Carpio.

FHCR provides food for low-income families residing in La Carpio nearly every day. We attended these food distribution events and interviewed residents about how they obtain water. FHCR has a large network of community members open to answering questions about their water. Our survey asked the community members to rate their water accessibility situation from one to ten, ten being consistent water supply. The questionnaire can be seen in the Supplementary Materials file. We asked if they get water from their pipes or if they need to look for other sources, such as the cistern trucks. These questions gave our team insights into specific locations where the infrastructure was damaged. Visual





Goals, Objectives, and Approach

observations of any damage in these specific locations were recorded to generate plausible conclusions about infrastructure or contamination issues.
From interviews with officials of A y A and the local community, our team gained a better understanding of the issues in the infrastructure. We also gathered information regarding who is responsible for fixing the damaged pipes. Since repair was kept on a household level and community-wide repair was too expensive, our team decided to focus on a filtration system that safely stores water rather than improving the delivery system.

Identifying a Potential Solution

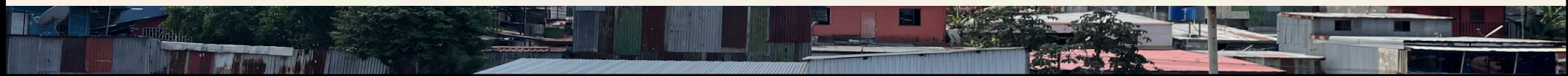
An important consideration when addressing water accessibility in La Carpio were the limitations set by the community. The team's goal was to understand the needs of the residents and provide a low-cost, highly efficient filtration method that could be widely adopted throughout the community. The team provided suggestions on filtration systems that best fit the community's needs based on other low-income communities with water quality issues. The group analyzed the findings surrounding water quality and availability and eliminated our researched filtration systems based on feasibility. Fixing the community's entire water system was not possible with our team's resources and time, so a household level filtration device was the best route for clean water access in La Carpio. We determined the filtration system also needed to filter bacteria, specifically E. Coli.
To test the viability of this system, our team did further research of ceramic filtration regarding clay composition, conditions for firing, and maintenance. We also visited local clay providers to see if any of the sites had the materials and willingness to work with FHCR on this project. We also searched for recycled or cost-efficient materials for the other components of the filter. We began firing initial prototypes at different providers who agreed to take on this project.

Raising Awareness About Poor Water Quality

In addressing the pressing issue of water supply and pollution, it was crucial to implement educational components that raise consciousness of the dangers of polluted water. The first step involved conducting a comprehensive poll within the community to gauge the current level of awareness about water quality as displayed in the Supplementary Materials file. We printed the survey and gave copies to the educators of the FHCR school program and volunteers so we could increase our reach in the community. They recorded responses from the residents, and we organized their data and ours into tables and quantitative data. We were then able to gauge the current education level surrounding bacterial contamination and sanitation.
To understand the most effective method of creating educational material surrounding the topics, we inquired about the organization's current strategy to raise awareness in La Carpio. FHCR has an employee with a background in graphic design who creates graphics that are displayed across the organization's sites. We observed the style of these posters when creating ours. The locations of the poster were chosen to be in the hallway where residents wait for food, the site's school, and the health clinic. These locations were chosen based on traffic levels and targeted audience. By integrating these educational components into the school curriculum, the youth of La Carpio will educate their families and encourage safe and sustainable practices. Almost 100% of the youth in La Carpio is registered in schools. Children are prone to disperse information, and many adults in the community lack education past second grade. We took note of the low levels of literacy in the community while designing the graphics and focused on creating effective visuals. These graphics emphasized the risks associated with consuming polluted water. Educational material surrounding proper sanitation was also implemented to prevent pollution of the water supply. Our initiative aimed to instill proper health practices and empower residents to actively contribute to improved water quality and a sustainable future.

"Water is one of the most basic of all needs - we cannot live for more than a few days without it. And yet, most people take water for granted. We waste water needlessly and don't realize that clean water is a very limited resource. More than 1 billion people around the world have no access to safe , clean drinking water, and over 2.5 billion do not have adequate sanitation service..."

Robert Alan Aurthur



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Water Availability and Quality

La Carpio's infrastructure consists of two main pipeline branches that attempt to supply water to all nine sectors, as shown in **Figure 10**.

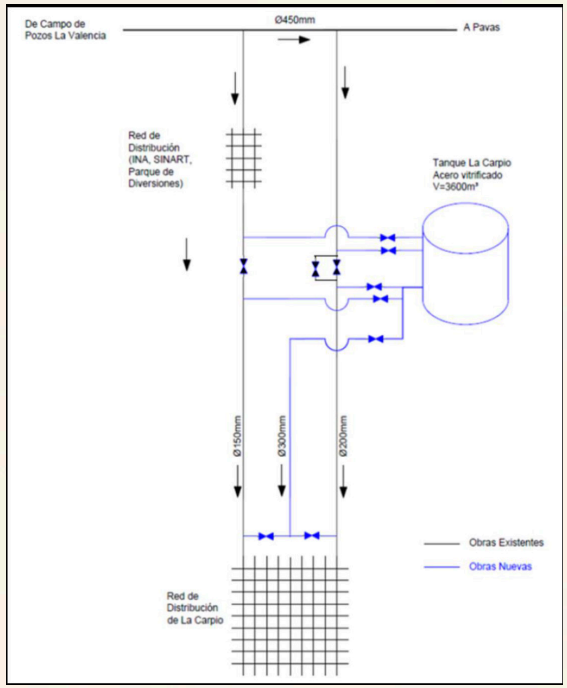

Figure 10: Schematic of La Carpio's piping infrastructure supplied by A y A[25]

According to A y A, the system was originally designed to account for three thousand households containing fifteen thousand residents. The actual population is unknown, but it was found in our fieldwork that most likely somewhere between 40,000 to 50,000 people live in around 5,000 thousand homes. Seventy-two percent of the residents we interviewed reported problems with receiving piped water. When asked to elaborate, water availability was described as infrequent and irregular. Some only received water at night and others went days without water from the faucet. We discovered minimal water accessibility and poor water quality were critical matters in La Carpio. When water was received through pipes, the water was collected in holding buckets to be used throughout the day(s). A y A also sends cistern trucks that distribute clean water throughout the community[25]. Some reported that the trucks only arrived every few days and others said the schedule is sporadic and often clashes with their work or errands. This water is also saved in open buckets or drums. This collected water, an insufficient amount to sustain a family, stands still in buckets, becoming contaminated and non-potable. There were three main causes of contamination found in the infrastructure of La Carpio. These problem areas allowed for the infiltration of two main types of contaminants: physical and bacterial.

Damaged pipes throughout the community allow contaminants to enter the pipes through urban runoff. PVC pipes become brittle with prolonged exposure to UV light and other natural elements. Thus, above ground pipes are susceptible to breakage and are exposed to urban runoff[25]. Urban runoff was observed to collect pollutants such as trash, sediment, chemicals, animal excrement, and bacteria. Crossflow between runoff and damaged pipes exposes the closest households to a plethora of contaminants.

Figure 11: Broken Pipe located in Rio Torres

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The cause for the destruction of the pipes was the installation of an A y A owned water tank located at the top of the hill that La Carpio is built on[25]. The tank became operational about two years ago. The head pressure of the tank was too great for the one-inch PVC pipes and caused many to break. Since then, the residents of La Carpio have reported worse water quality and accessibility. Each household is responsible for their own repairs. Over 50% of residents have a family member, or a neighbor in charge of repairs, 25% of surveyed households have no one repairing their pipes, and renters said that their landlord fixed them. Another element that damages above ground pipes are the cistern trucks that transport potable water to sectors lacking piped water[25].

These large trucks run over the pipes. It was also reported that A y A workers dug holes to observe damage in the underground pipes. This exposes the underground infrastructure to elements of the street such as animal excrement, rainwater, and urban runoff. Some households reported that sediment and silt were regularly found leaving their faucet. One household stated that they stopped receiving water due to a build-up of rocks in their pipes. Cracked pipes allow contaminated water to enter the infrastructure while also causing leakage of potable water. The damage then causes a reduction in pressure and water availability, forcing the people of La Carpio to collect any available water.

Open holding buckets were the observed solution to water accessibility issue of La Carpio. Almost all residents reported that their household receives piped water for a maximum of two to three hours per day. Therefore, the available water is collected in either 5-gallon buckets or 55-gallon drums. These containers are open and lack any filtration system. The local health clinic reported that these containers were the cause of a public health concern[5]. Stagnant water collects bacteria over time. Common symptoms caused by consuming water contaminated with bacteria are diarrhea, stomach pain, nausea, fever, and headaches[5]. These symptoms were reported in four out of the seven sectors that participated in our survey. This past year, 2023, had the most cases of diarrhea and hepatitis, suggesting that the damage caused by the water tank has significantly worsened the infrastructure[5]. The health clinic has tracked many cases of E. coli, Salmonella, and Hepatitis A, which can all be traced back to waterborne bacteria. The results from our water quality tests showed a case of E. coli in a holding bucket in La Libertad.

Due to the infrequent hours of water availability, the holding buckets were often

Figure 12: 5-gallon Holding Bucket in La Libertad showing visible sediment and bugs present in the water (tested positive for E.coli)

used to collect rainwater in the wet season. Rainwater collects silt and other minerals from the roofs. To collect rainwater, the residents do not use covers for their buckets. Animal interference is then another issue presented by the holding buckets. Dogs, cats, and other animals can drink, bathe, or excrete in the water, introducing more bacteria and viruses. A prominent example of this issue is mosquitoes. Mosquitoes lay their eggs in water, and this has been reported frequently in these holding buckets. Mosquitos, as well as their larvae, carry Dengue Fever. This virus causes a high fever, rash, muscle pain, and vomiting[5]. These outbreaks of various illnesses underscore the importance of maintaining the cleanliness of these buckets. Dengue has plagued the community of La Carpio for years. The nurses from the health clinic stated that Dengue Fever was

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significantly more difficult to control than Hepatitis, indicating the severity of the mosquito problem[5]. These outbreaks of various illnesses underscore the importance of maintaining the cleanliness of these buckets.

Figure 13: 55-gallon Holding Bucket in La Libertad

Improper sanitation is another potential cause of water contamination in La Carpio. Infrequent or inattentive cleaning of water storage units or vessels causes the buildup of germs and bacteria. One household in each of the three sectors that experienced the most cases of waterborne illnesses was tested for bacterial contamination. Only one of the tests came back positive. This discovery raised concern for the community's sanitation practices since the other household's water did not contain bacteria. When asked if the holding buckets were frequently cleaned, more than half stated yes. Methods of cleaning varied from using bleach and laundry detergent to wiping the bucket with a previously used rag. The community does not have access to dish detergent. Limited access to clean water and cleaning supplies restricts their ability to thoroughly clean their buckets, jugs, and cups. Each sector reported varying information regarding water accessibility and quality. Sectors that had notable answers are listed below.

La Libertad is one of the poorest communities in La Carpio[25]. This sector rated their water the worst in the community. This sector had the only holding bucket that tested positive for E. coli.

[1] Puede incluir descripciones y condiciones de la muestra ensayada, condiciones ambientales durante el muestreo.
Metodología de análisis y muestreo: "Standard Methods for the Examination of Water and Wastewater", 22da Ed. 2012; Métodos de HACH.

Ensayo	Resultado	Valor Máximo Admisible[2]
Coliformes Totales	Presente	Ausente
E. Coli	Presente	Ausente
pH	7,57	6,00 - 8,00
Olor	Aceptable	Aceptable
Color	0 mg/L (U-Pt-Co)	15 mg/L (U-Pt-Co)
Turbiedad	0,47 UNT	5 UNT
Cloro Libre	0,02 mg/L	0,60 mg/L
Cloro Combinado	0,00 mg/L	1,80 mg/L
Conductividad	128 µS/cm	N/A

[2] Valor Máximo Admisible según el Reglamento para la Calidad del Agua Potable (Decreto Nº 38924-S).

UNT= Unidades Nefelométricas de Turbidez

Resultados únicamente válidos para la muestra analizada.

Figure 14: Water Lab Results

Many households in the upper portion of the community receive piped water every few days. In the lower portion that is adjacent to Rio Torres, the houses receive water daily since they have above-ground tee'd off pipes. The cistern trucks only travel to the upper portion of La Libertad due to insufficient roads.

Maria Auxiliadora also rated their water quality and accessibility very low. Many responded to the survey saying that they had not received water in days. One family stated it had been four days since they had received water from the faucet. There were inconsistencies in the responses which demonstrate the sporadic pipe damage. This sector stated that A y A digs holes to their pipes and does not repair them.

Pequena Gran Cuidad did not report poor water quality, but one side of the

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street did not receive any piped water. The only way that they can get water is through the cistern trucks or from neighbors on the other side of the street. **Sector Central** is a higher-income district where many of the residents rent. Despite having landlords who are responsible for fixing damaged pipes, some people answered yes to symptoms of bacterial consumption.

Sector	Water Quality Rating (1=poor, 10=clean)	Water Accessibility Rating (1=poor, 10=perfect)	Symptoms of bacterial contamination or Waterborne Illnesses
Roble Sur (n=3)	8.7	5.3	Some cases of sickness in neighborhood
Pequena Gran Cuidad (n=10)	10	0	None
Libertad (n=1)	4	5	Diarrhea
Maria (n=17) Auxiliadora	5.3	5.8	Dengue, Nausea, Stomach pain, etc.
San Vicente (n=3)	8	7	None
Rio Torres (n=3)	7	9.7	Stomach pain and fatigue in children
Sector Central (n=6)	8.3	7.3	Stomach pain, Nausea

Table 1: Ratings and Reported Symptoms from Varying Sectors

After discerning the pollutants that contaminate La Carpio's drinking water and their origin, our group began the process of improving clean water accessibility.

Ceramic Filtration

To select a filtration method, our team had to discover which contaminants were present in the water. As explained in the previous section, bacteria, sediment, and other organic material were identified through visual observation and water quality tests. After reviewing our previous research pertaining to low-cost filtration systems, we determined that ceramic filtration would be the appropriate choice. Ceramic filtration is an efficient way to filter out bacteria, physical material, and some chemicals in water. A ceramic pot is created by mixing a small combustible material such as saw dust, or corn meal into clay, firing it, and creating a pot with large enough pores to allow water to filter through. Clay is an abundant material in Costa Rica; mountains contain rich terracotta clay used for pots and artwork. Clay is also a relatively low-cost material. A clay filtration pot costs around US$10 to produce[14]. In addition, our prototype uses recycled water jugs as the collection bucket to cut costs. Our tap mechanism, coming from EPA Costa Rica, is approximately US$1.44. Another benefit of ceramic filtration is that it is used at a household level, ideal for the situation in La Carpio. Since most family homes collect water in open holding buckets, ceramic filters are an easy substitute and provide a safe, closed water container. The easy-to-use mechanism is not a significant change for the members of the community who are already holding water in buckets. Finally, the longevity of the filters is an attractive asset. Ceramic filters last approximately 5 years without visible cracks or leaks[14]. Furthermore, the filters are easily cleaned if visible material is blocking filtration. The choice was clear on which filtration method to use. The low-cost, abundant material, longevity, and easy-to-use system of the ceramic filter was ideal for La Carpio.

Community Implementation

To develop a working prototype our team visited three clay sites. The first clay site was a local businessman located in Santa Ana hand sculpting and selling his clay work to a business down the road. He explained he could not put sawdust or cornmeal into his clay because his clay was too fine causing it to fall apart when fired. However, he created a visual prototype seen in **Figure 15:** for us to use in demonstrations and present the idea to other clay studios.

Figure 15: Prototype Obtained from first Clay Site

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The next clay site was clay brick manufacturing. This company was an industrial site only focusing on brick production. This company was unable to help us due to their large-scale manufacturing only focusing on rectangular bricks. They did not have the equipment to produce clay pots with combustible material in them. The final clay place, located in Santa Ana, was a local business with a variety of ceramic products. When proposing our idea to the head sculptor, he understood immediately. He explained that in Guatemala they have a wide-scale production of ceramic filters. A few migrant workers came to the studio and taught him how to make these ceramic filters. This main sculptor was the key to making our ceramic filter. He said he would have a working prototype done in 22 days. Unfortunately, the projected completion date of March 14th was after we departed from Costa Rica.

Figure 16: Successful Santa Ana Clay Studio Producing a Working Prototype

Educational Components

The results of the survey, seen in our supplemental materials, show many individual ratings of high water quality. Many community members believed the water was exceptionally clean while visible evidence proved otherwise. Most community members did not know what bacteria was and failed to understand how their water could be contaminated. In addition, 63% of 35 individuals surveyed rated their water a 7, 8, 9, or 10. In contrast, 32% of those same individuals described how they or family members have gotten sick from the water. This itself contradicts the water quality rating.

When our team visited a FHCR pre-school, the teachers asked the 20 kids if they had dirty water. Seventy percent raised their hand expressing they had dirty water. Another 60% of those children experienced stomach pain related to water. When given an activity to illustrate their thoughts about water, many drawings depicted contaminated water. Seen in **Figure 17** a child expresses how there is clean water on the mountain but dirty water in La Carpio. In **Figure 18**, a child illustrates what getting water looks like on a day-to-day basis explaining "There are days where there is no water, water, dirty water, and a little water."

Figure 17: A Child's Artwork Between the ages 6-9

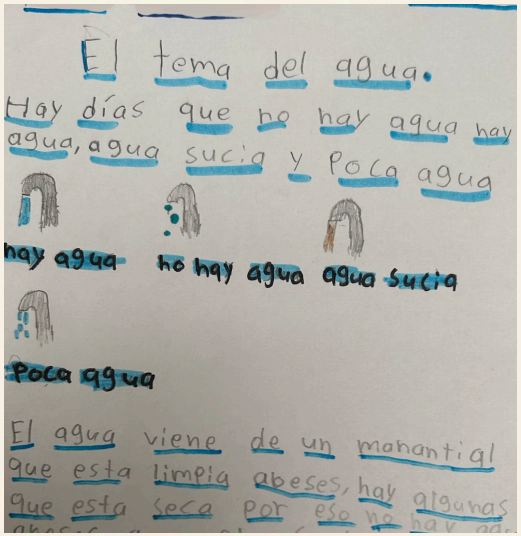

Figure 18: Another Child's Artwork Between the ages of 6-9

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The results from these activities demonstrate that the children knew more about dirty water than the older population, but many were unsure of the origination of the contamination. In addition, nearly 100% of the kids in La Carpio attend school[25]. By implementing our educational components in FHCR preschools, the local teachers can educate the children who will return to their homes and educate their families. Our team cannot reach 5,000 homes to educate on water quality, so putting educational posters in the FHCR school is the best way to reach a larger population in La Carpio.

Figure 19: A Teacher in a FHCR Preschool Demonstrates our Ceramic Filter

To educate the adult community of La Carpio, our team generated educational posters seen in **Figures 20, 21, and 22**. The first poster "Clean or Dirty Water?" illustrates how water may look clean but can be dirty. The second poster "Ceramic Filtration" demonstrates the benefits of a ceramic filter by showing clean water being dispensed at the bottom. This poster was part of the marketing aspect our team designed for community members to be inclined to purchase a ceramic filter. The last poster "Do You Clean Your Buckets?" shows how clean water vessels lead to clean water. The health clinic told us that education regarding proper sanitation was poor and we decided to create this poster to spread awareness. These posters contain limited written components due to the community's literacy rate being significantly low in adults. These posters were placed in FHCRs headquarters where over 20 community members a day from different sectors wait for food distribution. In addition, the posters were placed in the FHCR pre-schools throughout La Carpio where teachers and children will see them. The local health clinic, EBIAS, also hung these posters in their clinic where patients regularly enter daily. By creating and implementing these posters, our team hopes to lower preventable water-related illnesses such as Dengue Fever and promote wellness throughout the community. As the posters were hung up in FHCR, our team received feedback from the teachers and other members of the community. Six teachers were trained to give lessons regarding our posters. Some of the teachers began the lessons and reported that the kids understood the importance of water cleanliness, describing the kid's responses and questions as engaging. A woman in FHCR told our team the ceramic filters were a "clever idea" and will be beneficial in the community.

Figure 20: Clean Water or Dirty Water?

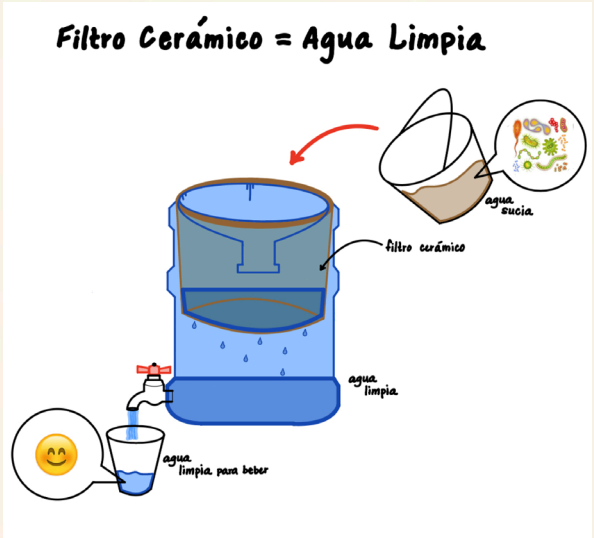

Figure 21: Ceramic Filter Equals Clean Water

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Figure 22: Do You Clean Your Buckets?

Political and Social Aspects of Water in La Carpio

Formerly an abandoned coffee plantation, La Carpio became an undesirable growing location after a volcanic eruption in the 1960s[25]. Nicaraguans, like many other immigrant groups, have migrated to various places for a range of reasons, including economic opportunity, political stability, and seeking better living conditions. Historically, Costa Rica has been more economically stable than its neighbor to the north. For this reason, many Nicaraguans have come to La Carpio in search of employment. Combined with the settlement's proximity to the capital city of San Jose, La Carpio became a hotspot for rural-to-urban migration. Furthermore, many of the early settlers of La Carpio faced economic challenges; the lack of formal housing options and the inability to afford traditional housing in established urban areas contributed to the community's growth. Frequently, migration trends include the reunification of families. Nicaraguans may have been motivated to come to La Carpio by the presence of relatives or acquaintances who were already established in the community, providing a supportive network that influenced their choice to migrate.

The community members in La Carpio have faced challenges in securing government-funded aid. The process of advocating for their rights has been ongoing since the community's establishment in the 1990s[25]. When La Carpio was in its infancy, houses were constructed from cardboard and plastic sheeting. Over time, improvements were made, with cinder block walls and tin roofs creating more permanent structures. Despite advancements in housing, the community lacked government-funded infrastructure, including roads, potable water systems, and sewers[25]. Residents had to travel to La Uruca, a neighboring community, to manually transport water back to their homes in buckets. In the late 1990s, roads were developed to support the growing industry in La Carpio.

One notable industry in La Carpio is EBI, a Canadian-owned waste management company that established a landfill on the outskirts of the settlement. The introduction of this landfill faced resistance from the local residents who were concerned about the landfill and the additional heavy-truck traffic it would bring[25]. In response, community leaders organized protests to represent the growing population of migrants residing in this unclaimed area. However, these protests were met with government intervention, including the use of tear gas to disperse crowds and threats of deportation by Costa Rican authorities if residents did not comply[25].

After these interventions, EBI proceeded to establish the landfill, which accepted 15% of Costa Rica's daily waste at its peak, with all waste transported through the main street, Avenida 61, of La Carpio[26]. Initially, there was an agreement between EBI and the residents that the landfill would be active for a 10-year period and then capped. Additionally, EBI pledged to construct a park at the former landfill site to mitigate its impact on the community. However, as of 2024, the EBI landfill has surpassed the initially agreed upon duration, marking a prolonged challenge for the community of La Carpio.

Another issue of concern in the community revolves around access to water. In the absence of proper roads in La Carpio, characterized by rough dirt paths, residents had to walk to La Uruca to fetch water. The situation saw some improvement with the introduction of paved roads, allowing water trucks to deliver water to residents in a more centralized location. Despite this modest improvement in water accessibility, La Carpio was not officially recognized as its own

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Figure 23: EBI Landfill located less than 500m away from a home in La Carpio

own district by the Costa Rican government. Consequently, the community did not receive additional government-funded aid or infrastructure. In response, some of the community members resorted to tapping into the water supply from the Costa Rican municipal water, Acueductos y Alcantarillados (A y A). This involved connecting 1" PVC pipes to an A y A water main, providing running water to many homes for the first time since the community's inception. However, the makeshift network of PVC pipes introduced unforeseen problems. The A y A waterline was not designed to support an additional community of over 5,000 developments, leading to pressure drops and water shortage for many La Carpio residents[27]. To address this, Acueductos y Alcantarillados installed a large water tank outside the community in 2021[27]. The tank aimed to provide a more stable water supply. Unfortunately, upon its completion and use, it was promptly shut off due to leaks in the makeshift distribution network[25]. The pressure from the tank overwhelmed the 1" lines, leading to another interruption in the water supply. This miscalculation impacted the neighborhood, leaving many without running water; a basic necessity the community had worked hard to secure. Since the tank's introduction in 2021, numerous community members have been left without a reliable water source, resorting to collecting water in buckets from the potable water truck that visits the community two to three times per week. Each household is limited to two 5-gallon buckets, a minimal amount for essential tasks like drinking, cleaning, cooking, bathing, and laundry.

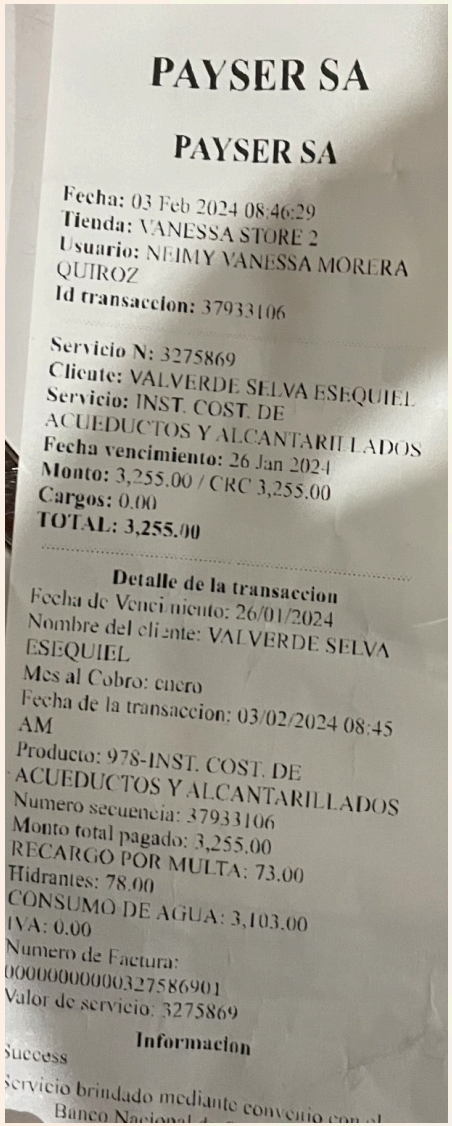
Figure 24: Municipality Truck bringing water to Pequeno Gran Ciudad

As of 2024, water disparities in La Carpio are still a major concern. Despite many parts of the community not receiving a steady supply of water, residents are still required to pay the A y A mandated water bill. An example of a water bill from Acueductos y Alcantarillados can be found in **Figure 25**.

In February 2024, a local community leader and thirty representatives traveled to San Jose to appeal to the President of Costa Rica regarding concerns about the quality and quantity of water in La Carpio. They were met by a senator who addressed their complaints but took no further action. On February 9th of 2024, the same community leader received a document from a politician responding to their complaint with the following points:

1. "Stop bringing people from Nicaragua so there won't be a scarcity of water."

Findings



PAYSER SA

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Fecha: 03 Feb 2024 08:46:29
Tienda: VANESSA STORE 2
Usuario: NEIMY VANESSA MORERA QUIROZ
Id transaccion: 37933106

Servicio N: 3275869
Cliente: VALVERDE SELVA ESEQUIEL
Servicio: INST. COST. DE ACUEDUCTOS Y ALCANTARILLADOS
Fecha vencimiento: 26 Jan 2024
Monto: 3,255.00 / CRC 3,255.00
Cargos: 0.00
TOTAL: 3,255.00

Detalle de la transaccion
Fecha de Vencimiento: 26/01/2024
Nombre del cliente: VALVERDE SELVA ESEQUIEL
Mes al Cobro: enero
Fecha de la transaccion: 03/02/2024 08:45 AM
Producto: 978-INST. COST. DE ACUEDUCTOS Y ALCANTARILLADOS
Numero secuencia: 37933106
Monto total pagado: 3,255.00
RECARGO POR MULTA: 73.00
Hidrantes: 78.00
CONSUMO DE AGUA: 3,103.00
IVA: 0.00
Numero de Factura: 00000000000327586901
Valor de servicio: 3275869

Informacion
Success
Servicio brindado mediante convenio con el Banco Nacional

Figure 25: Receipt from A y A

2. "More water enters La Carpio than in Escazú."

a. Escazú is an affluent district located in the San Jose Province of Costa Rica with around 65,000 residents compared to La Carpio's 40,000 to 50,000 people28. It is renowned for its upscale neighborhoods and luxury residences. Many affluent locals and expatriates choose to live in this area due to its safe and high-quality living standards.

3. "The officials from A y A tell us that nobody pays for water in this community, and they call you thieves because La Carpio does not pay."

4. "La Carpio does not have the right to water because they are a community without titles."

a. Since the people of La Carpio are not citizens of Costa Rica they cannot legally own land. Therefore, they do not own the land where their houses are located.
This response highlights the limited political influence of La Carpio in Costa Rica.
Additionally, based on interviews conducted, every community member paid for water in La Carpio. For instance, a resident in Pequeno Gran Ciudad showed her receipt from A y A but experienced a lack of water when she opened her faucet.

Despite facing significant socioeconomic challenges, La Carpio struggles with persistent difficulties in accessing substantial government aid, emphasizing the need for increased attention and support to address the community's long-standing issues.

Street in Rio Torres, La Carpio

Conclusion

The findings from our study reveal a dire situation regarding water availability and quality in La Carpio. The mismatch between the designed capacity of the water infrastructure and the actual population, coupled with the damage caused by the installation of the A y A water tank, has resulted in a severe water crisis. Contamination from damaged pipes, urban runoff, and inadequate sanitation practices has led to health concerns, with a significant increase in waterborne illnesses in recent years. The community's efforts to access clean water, such as open holding buckets and reliance on cistern trucks, are temporary and exacerbate issues regarding contamination. Our proposed solution, the implementation of ceramic filtration at the household level, addresses the specific contaminants present in La Carpio's water and provides a cost-effective and sustainable option. The educational components introduced in FHCR preschools and throughout the community aim to raise awareness about water quality and proper sanitation practices, with a focus on empowering the residents to advocate for their rights.

Furthermore, the political and social aspects surrounding water in La Carpio highlight the historical challenges faced by the community in securing basic services and infrastructure. The lack of recognition as an official district, coupled with discriminatory responses from authorities, underscores the marginalized status of the residents of La Carpio. The community's appeal to the President of Costa Rica and subsequent dismissive response illustrates the urgent need for increased political advocacy and support to address the water disparities.

In summary, the water crisis in La Carpio is a complex issue intertwined with historical, political, and social challenges. Our proposed solution, combined with community education and advocacy, represents a step towards sustainable change. However, addressing the root causes of the problem requires a concerted effort from both the community and external stakeholders to ensure equitable access to clean water and improved living conditions in La Carpio.

Recommendations

Recommendations to residents of La Carpio

The people of La Carpio should try to keep their streets waste-free. Picking up trash and animal excrement could possibly reduce the dangers of cross-contamination of broken pipes with urban runoff. Another way to reduce cross-contamination is to allocate a percentage of their income to fixing any damage in their piping. They should also consistently wash their buckets, drums, and any kitchenware used in the process of drinking water. This would reduce the spread of germs and the build-up of bacteria. Available and effective cleaning supplies that should be used sparingly are bleach and laundry detergent. The people with holding buckets should consistently check them for mosquito larvae to prevent contracting Dengue.

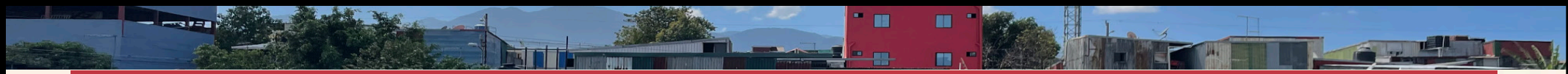
Recommendations to FHCR

Gail Nystrom, the founder of FHCR, should continue to educate the community on the importance of clean water, cleaning holding tanks, and a water filter. Our posters will continue to be shown in La Carpio. FHCR should market the ceramic filters through these educational demonstrations. Our sponsor should continue to train community leaders and teachers about water quality in hopes of reaching a large population of La Carpio.

Once a working prototype has been constructed, our sponsor plans to advertise this water filtration system by offering samples of filtered, potable water to members of the FHCR community. Additionally, our sponsor should test the filtered water from the ceramic filter and report the results and effectiveness to the community. The results, being negative for bacteria and other chemicals, will show visible evidence of the effectiveness of the filters in preventing illness. In addition, our sponsor is planning to construct more ceramic filters by contracting out to the Santa Ana clay site. At first, she plans to make around 10-20 filters and sell them for less than she bought them for, providing an accessible low-cost solution to clean water in the community. Then, she plans to use the profits to re-invest in more filters. However, to reach 5000 homes in La Carpio, our sponsor has identified a donor lined up to finance large scale production of ceramic filters. As a result, numerous filters will be distributed to the people of La Carpio.

The water accessibility problem in La Carpio is a large concern in the community nity. Our team could not address this issue due to the large scale of the problem. For all community members to receive clean piped water in their homes for prolonged periods of time, the piping system in La Carpio must be replaced. This multi-million-dollar project could take months or years but would ultimately lead to water accessibility for all.

A Street in Rio Torres, La Carpio



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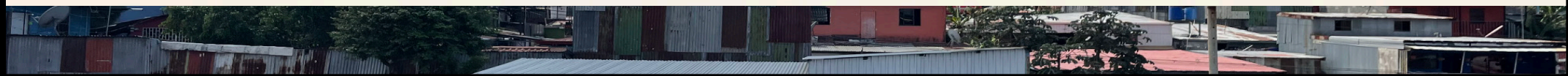

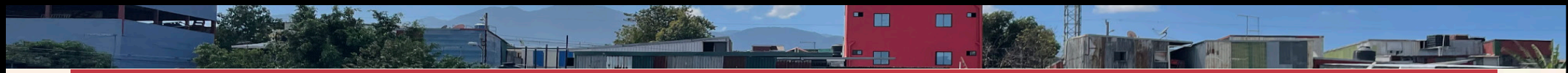

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