Engineers Without Borders - Huamanzaña, Peru

Water Distribution

2009 Summer Implementation Overview

Overview

Engineers Without Borders – Princeton University is a student-run organization dedicated to the sustainable development of suitable technologies to impoverished communities around the world. The Peru Water Distribution project specifically works in the community of Huamanzaña, La Libertad, and is comprised of more than twenty undergraduate and graduate students. During the summer of 2009, between August 5 and August 31, six Princeton students and a professional engineer traveled to the community to:

- Implement a system capable of providing a 24/7 supply of water
- Install two 2,500L tanks into the mainline as an additional reservoir
- Construct and install concrete taps into every household
- Promote better awareness of bacteria and sanitation practices
- Set up a water board to enforce water conservation and system upkeep

Introduction

Huamanzaña, La Libertad, Peru

Huamanzaña is a small town of about 140 people located at the base of the Andes in the district of Chao in northern Peru. An isolated, rural area, the town is characterized by poverty, misuse of natural resources, and abandonment by the central government in faraway Lima. It lacks easy access to healthcare or secondary education, and is highly dependent on an agricultural economy. Almost all of the townspeople are farmers whose only income comes from the crops grown on their fields.

EWB-Princeton has worked with the town of Huamanzaña since 2005, installing a sanitations facility, a solar electric system, and several smokeless stoves. The current project addresses the town's issues with water. The town's water distribution system was constructed by the Peruvian government program FONCONDES in 1999 so that villagers would not have to walk to the spring and transport their water in buckets. Since then, the condition of the system has rapidly deteriorated - of the 14 original taps, only 7 work, and many of these are poorly functioning, with defective valves that waste a large amount of water. Because of these broken taps, the system allowed for only a few hours of water in the mornings, forcing people to collect their daily supply of water in buckets, which then sat stagnant and exposed to potential contamination by insects and animals. Moreover, because the water was piped to communal taps spread out around town rather than individual spigots, the lack of personal ownership led to a tragedy of the commons in which no one took care of the system. While the original technical design was adequate, no provisions were made for its continued maintenance.

A communal tap with collection buckets

After an assessment trip held in January 2009, the EWB-Princeton Peru team spent the academic year designing a new system to solve these problems. The team engineered a design that would provide a 24/7 supply of water by augmenting the system with an additional reservoir and extending the water lines to individual taps at every home. The constant supply of water would eliminate the health hazards of collecting water in buckets, and the individual taps would introduce a personal responsibility to take care of the system.

Water Infrastructure

The first week in Huamanzaña was primarily spent acquiring materials to prep for construction. This entailed several trips to Sodimac, a hardware store located in Trujillo, to purchase valves, adaptors, unions, tees, and other supplies required for the tank foundation and taps, as well as a meeting with the mayor of Chao to make good on an agreement he signed in January in which he agreed to provide a certain amount of sand, rebar, and gravel. Cement and additional tubing and supplies were purchased in various hardware stores around Chao. Without the guidance of the professional mentor, Mohamed Kilany, who would not be arriving until the second week, the team could not begin construction of the tank foundation, which required an assessment of soil conditions, and instead focused on building taps.

A newly constructed tap (personalized by the family)

These taps were meant to be easily constructed and quickly mass-produced. The design was simple – the internal piping was placed inside a plastic mold made out of PVC tubing, which was then filled with concrete. After two or three days to fully cure, the tap was ready to be installed. In this fashion, the team built the entire quota of forty taps in two and a half weeks.

Once Mr. Kilany arrived in Huamanzaña, a town meeting was held to discuss the next steps in the project. When announced that the new tanks would be placed at a location far above the town, almost all the townspeople adamantly objected, expressing concerns about the safety of the tanks if they were placed so far away. Surprised by this unexpected proposal, the Princeton team took the community's opinion into account and measured elevation points with GPS to determine a new location that was closer to town but would still provide enough pressure to power the system. Although at a lower elevation than originally planned, the new site was approved by Mr. Kilany and satisfied the concerns of the people.

Due to Mr. Kilany's late arrival the team was a few days behind schedule, and so worked feverishly to finish constructing the tank foundation. With the help of several members of the townspeople, the team dug out a large, rectangular pit, laid down the wooden molds and rebar frame, and poured the concrete. As a load-bearing structure, the foundation would need a full eight days to cure.

In the meantime, the team began to install the individual taps to each home. On paper, installation was simple – after inserting a T piece into the mainline and laying down the piping from the mainline to the tap location, the pipes were glued into the concrete tap, which was anchored into the ground. However, the team ran into many problems, finding that although each family was instructed to dig a trench from the mainline to the tap location themselves so that the team could come in and quickly lay down the piping, very few houses had trenches dug due to concurrent preparations for the local fiesta in honor of Huamanzaña's patron saint. Moreover, many of the trenches that had been dug were too shallow or did not expose enough of the mainline. Thus the first several days of tap installation went slowly since much time had to be spent making the trenches deeper or digging more around the mainline. Learning from this, in the mornings, the Spanish-speaking members of the team began to visit every family whose taps would be installed that day to remind them to dig their trenches, with very precise instructions on how to do it. Tap installation proceeded more smoothly after that.

The finished tanks

The conclusion of the tap installation phase coincided with the final day of curing for the tank foundation. With the concrete finally

hard enough to withstand the weight of the tanks, the team cut the mainline and inserted the tank piping into the water system. An emergency bypass valve was also installed, in case anything went wrong with the tanks. This valve, when opened, would essentially return the system to how it was before so that the town would always have access to water.

With the successful installation of the tanks, construction of the water infrastructure was complete.

Community

Any engineering project is only successful insofar as the new technology is smoothly assimilated into the local culture. Accordingly, the EWB-PU team tried to involve the townspeople of Huamanzaña as much as possible, believing that doing so would instill in them a greater sense of pride and ownership of the project. Throughout construction, the team worked alongside the villagers, whether it be mixing concrete, connecting the internal pipes for the taps, or cutting the rebar for the tank foundation. Each family was also instructed to contribute to part of the tap installation process by digging the trench from the mainline to their backyards. More than labor, the townspeople also provided all of the meals for the team throughout their entire stay. Through a rotating system set up by the town leaders, one family would provide breakfast, lunch, and dinner. These became times to learn about the town's way of life, share stories, and bond closer with the community, as well as discuss the water project and its implications. The villagers' involvement in the construction of the water system was crucial, for doing so fosters a personal commitment to the project and ensures its sustainability.

Justin working with townspeople to sift gravel

This is especially important because the community has an active stake in the future of their water system. The old system failed because no one took responsibility for the maintenance of the taps. These taps were designed to be shared by the community, but instead begot a tragedy of the commons – because the taps belonged to no one in particular, no one took care of them. Thus, a new water committee, comprised initially of the town leaders and the owner of the land on which the natural spring is located, was established to enforce water conservation and system upkeep. This committee will be community driven, with elections held every two months, and impose a system of taxation on the use of the water system. If the board decides that one household is using too much water or leaving their taps on all the time and misusing the system, it can shut off water to that tap by

turning off its associated control valve. The committee will also organize periodic cleaning of the natural spring source and oversee maintenance of all valves and piping.

Health Improvement

In previous assessment trips, it was determined that the natural spring was clean and that the townspeople were not experiencing diseases borne from the water. However, by making water more readily available, there were now a myriad opportunities to improve the community's health. The EWB-PU team decided to focus on health education, particularly lessons aimed at children about germs. During the summer trip, the team taught a session during school to all of the children, instructing them on the harmful consequences of bacteria and the importance of washing their hands. Using Glo Germ, a glow-in-the-dark lotion designed to simulate bacteria, the team instructed the children to rub the lotion into their hands. Then, members of the team shined a UV light and the children were able to clearly see how their hands were coated with "bacteria" as it fluoresced green under the light. The kids were told to wash their hands and come back to examine them again. Because the lotion was oily, it would not come off easily, so when the children came back to view their hands, they were still able to see some fluorescence as evidence of improper hand-washing technique. Only after thoroughly scrubbing would the lotion come off and the hands not light up under the UV light. Although this demonstration was simple, the visualization of the bacteria had a strong influence on the children and helped drive home the lessons learned during the class session.

Andreas teaching children about bacteria

Results

All planned structures were constructed and installed. Thirty-two taps were placed in every home in the main section of Huamanzaña and all of the piping from the mainline to the taps were connected and laid in. The tanks were installed on top of the newly constructed concrete foundation and connected into the mainline. However, when the system was turned on for the first time with all of the components of the new water distribution system in place, the team was disappointed to find that the tanks were not filling up as quickly as had been previously calculated. The problem seemed to be that water was being withdrawn faster from the tanks than they were being filled. Because the tanks were essentially empty all the time, not

enough pressure was building up, and consequently, not everyone in town was receiving water consistently.

It proved difficult during the summer trip to determine what exactly the culprit of the problem was. A high consumption rate seemed likely but may have been merely due to the many preparations for the fiesta and not have reflected average rates. Other reasons may have been air bubbles caught in the piping that acted against the pressure gain or possible leaks that drained water out of the system. Unfortunately, due to time constraints, the team was unable to pinpoint and fix the problem before having to leave. Instead, at least for now, the town was instructed to close the output valves at the tanks to allow them to fill, and then to release the water whenever they need it, essentially a version of their previous system.

Through recent correspondence with the team's community contact, who revisited the town a week after the summer trip ended, the EWB team happily found that the summer's work did increase the town's access to water – the townspeople report that, through a combination of the old and the new tanks, everyone receives water for about 10-12 hours a day. Moreover, the individual taps seem to have succeeded in instilling a sense of responsibility for the maintenance of the system, as households have taken the initiative to fix any leaks that arise. The taps have also largely eliminated the use of buckets to store the family's daily required supply of water.

Future Plans

Though many of EWB-PU's objectives were met, the project has yet to fully achieve its goals in terms of providing a 24/7 supply of water. Throughout the next year, the Peru project will be fully devoted to getting the new water system fully operational. Through constant communication with Huamanzaña as well as the community contact, the team will work to diagnose the problems and engineer solutions. This will require a focusing on community education as the team tries to curb the town's old habits of excessive water consumption and promote conservation. Drawing from the lessons learned during the summer, the team is confident that the problems will be solved and plans to return to Huamanzaña in January to implement the fixes, as well as assess for future projects.

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