ISEN Report

Hydraulic Ram Pump for Clean Water Delivery in the Philippines

I. The Motivation

The ram pump project strives to provide an undergraduate research and educational experience. This summer, we will make water and sanitation more accessible in the village of Tres Hermanos by installing a low-cost, low-maintenance ram pump system.

Ram pumps deliver the major resource Filipinos need to start growing vegetables and other high-value crops. Beneficiary communities are empowered to increase their own standard of living through improved health, nutrition, and income. Our partner community is Tres Hermanos, a poor rural village of 206 individuals. We hope to relieve women and children of the necessity to carry 40 pound buckets on their heads and backs. As a result of the labor-saving benefits, women will likely have more time to attend household gardens, maintain their health, and assist with their family's education. An increase in school attendance rates has been shown to follow the relief of children from being constantly sick and/or dehydrated, a preventable situation by providing an available source of fresh water.

II. Pump modification

The ram pump uses the natural force of falling water to create pressure in an air chamber that drives a portion of the water uphill to elevations 20 to 100 times greater than the distance of the original fall. Once the water in the delivery pipe reaches the community, it is stored in an elevated tank. Water is then delivered via gravity to tap stands stationed in desired locations throughout the village to provide water for daily applications such as hygiene and agriculture. The system is relatively affordable, long lasting, easy to maintain, and can support multiple families simultaneously. Most importantly, it does not use electricity or any external energy source except for the kinetic energy of water.
In order to investigate the waste valve as well as other parts of the pump, we needed to construct several prototypes made of PVC pipes, safety and release valves, tape, and plastic bottles to simulate the ram pump designs. We experimented with different bottle shapes and designs to see if we could find what would work best for our system. One of the prototypes is shown to the right. Through the creation of our prototypes, we were able to discover that the vertical air chamber provides the best results. In addition, the larger the air chamber, the more efficient the pump. We used computer modeling (MATLAB and CAD) and wet-lab techniques to design and test our ideas.

Our major goal was to make AIDFI’s current design easier to operate by working on a pump body that was sent to Northwestern University. During the operation of the pump, the waste valve should be oscillating on a hinge, allowing water to come out of the system. A major problem with the design is that the waste valve occasionally jams due to high water pressure. Methods that have been used to open the valve include applying external pressure with a hand, foot, or bamboo stick (see image). This is very dangerous and so we built a latch as well as a lever mechanism. The latch was made from welded steel and mounted onto the top of the waste valve plate using heavy bolts. The lever was constructed from metal alloy and cut with a computer guided water jet machine.

III. Outreach

The team is very enthusiastic about the project and gave several presentations to the ESW (Engineers for a Sustainable World) general body. Each presentation consisted of a powerpoint presentation as well as a design component during which the audience would break up into groups and brainstorm ideas for a particular problem. The team found this to be very useful for getting new ideas and recruiting members.

We also gave demonstrations in our work space, Dr. Packman's wet lab. During our meetings, we left the door open and happily showed people our work. Professor Sharon Waller taught a class, CEE364, on Environmental Engineering Applications II: Water during winter quarter, and we gave a demonstration to her class regarding the function and properties of the ram pump.
In April, the team got an invitation to present our work at the Clinton Global Initiatives University Conference in Miami. A large part of the conference was on the future of water, and it was extremely inspiring to hear global leaders to stress the importance of our work as well as other students who were working towards the same goals, to ensure equitable water access around the world. It is important to keep in mind, however, that we must also be good stewards of our resources. It would be unfortunate if we spent great efforts to intervene on the other side of the world and return home only to waste and pollute our own waters, those which eventually flow to other parts of the world.

IV. Implementation of the ram pump

In June 2010, the team is traveling to the Philippines to install a system of two ram pumps (see image below). AIDFI will provide the steel pipes and other components of the system including the sedimentation tank for source water filtration. During the installation, at least two members from the community will be trained as technicians to maintain the pump. Technicians are typically paid 70 pesos/day (just under $2/day) from the community fund to maintain the pump and replace parts as needed. We plan to facilitate workshops with the technicians on how to operate, tune, and maintain the ram pump. Beneficiary households will support the system with a small monetary contribution that will be saved in the community fund. We hope to design a business model that will empower the villagers to better improve their community. Idealistically, funds generated from activities made possible by the ram pump system can be collected in the community fund. This investment can be used for the next project, which will be determined by the community members according to their needs. Eventually, our model may serve as a success story for other initiatives around the world.