How rainwater can meet clean-water needs

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A clinic in the village of Bisate, Rwanda, the yellow building in foreground, was equipped with storage tanks to collect rainwater for use during the area's dry seasons. The corrugated metal roof was fitted with gutters to carry the water to several large collecting tanks, using a 'first-flush' diversion system to separate out the first, dirty water at the beginning of each rainfall. Photo: Christiane Zoghbi

At a remote village called Bisate in the desperately poor nation of Rwanda, a clinic faced chronic shortages of water during the nation's twice-yearly dry seasons. Sometimes there was simply not enough water available even for seriously dehydrated patients to drink, or for health workers to maintain basic standards of sanitation.

Collecting rainwater during the rainy periods was the obvious answer, but figuring out how to do so safely and economically was not a trivial problem: How big should the collection tanks be? And how much water should be diverted at the beginning of each rainfall to avoid

contaminating the supply with the dirt, dust and animal droppings that accumulate on a roof during a dry spell?

Providing answers to those questions became the focus of a master's thesis research project for civil and environmental engineering graduate student Kelly Doyle, who worked with senior lecturer Peter Shanahan. The results of that research have just been published in the *Journal of Water, Sanitation and Hygiene for Development.*

"Certain areas rely almost entirely on rainwater" for clean, potable water, Shanahan says. "Internationally, it's an emerging topic of interest" to find ways of making rainwater-collection systems safer and more reliable.

The field research carried out by the team was done in cooperation with the Dian Fossey Gorilla Fund International, which was working to restore the health clinic in Bisate. The researchers studied three collection systems there: one at the clinic, one at a local school and one at the foundation's field headquarters. The Fossey Fund wanted to provide clean water to the village in order to protect nearby mountain gorillas that were getting parasites and infections from people who went out into the rainforest to gather water during the dry season.

During those dry seasons, Shanahan says, the village "didn't have enough water for people to wash their hands, for basic sanitation or for hydration."

In addition to figuring out optimal sizes and materials for rainwater-storage tanks, Doyle did a detailed analysis of methods for diverting the so-called "first-flush" water away from the tank. The simplest and most reliable system, the team found, consisted of a diverter — an extra length of vertical pipe connected to the gutter system that would fill up first following any fresh rainfall. Once that pipe was filled, any remaining runoff would pass right over it and into the collection tank.

Between rainstorms, a cap on the end of the diverter pipe could be opened to drain the water along with any sediment that it carried, preparing the system for the next rain. The dimensions of the diverter tube would automatically determine how much of the rain from a given roof would be diverted each time.

A study of the local hydrology and geology showed that rainwater harvesting was the only viable option to improve the water supply, Shanahan says. So over a two-year period — aided by some previous work done by Tufts University researchers — the team helped the foundation calculate the right size for large plastic storage tanks for a rainwater-harvesting system, and then added a system to test the amount of sediment and microbial contamination that could be separated out by various sizes of diversion tubes.

The simple diverter-pipe setup, requiring no intervention other than emptying between storms, turned out to make a significant difference: Sediments in the water were reduced by half, and microbial contamination was sufficiently reduced for the water to pass World Health Organization standards for drinking water. Less than 2 percent of the total amount of water collected was lost in the process.

While such diversion tubes had been used previously, Shanahan says, “the effect on supply had never been looked at rigorously.”

Richard Vogel, a professor of civil and environmental engineering at Tufts, says, “Rigorous methods for the design and operation of rainwater-harvesting systems can have a tremendous impact in the developing world, where such systems are commonly the only source of water.” He adds, “I will certainly refer this paper to all my graduate students who are working in this area.”

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