Engineers look into wastewater pollution issues to modernize Caribbean communities

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Mark Widdowson, center, tests Veron's water supply. In Veron, most sewage is disposed of through pipes placed directly into the ground, and groundwater is the sole source of fresh water there.

For the past three years, Virginia Tech civil and environmental engineering students and faculty advisers Mark Widdowson and John Novak, have spent considerable time in the Caribbean but the journeys were not of the recreational variety.

They have been measuring the significant pollution of the well water in Veron, a rapidly-urbanizing community with considerable health issues related to sewage-contaminated groundwater.

Although Veron itself is not a tourist destination, the untreated wastewater for the population of 60,000 threatens the aquifer that the tourism industry of the Dominican Republic depends on, according to the Puntacana Ecological Foundation.

Most of Veron's residents work in the tourist industry.

"Our data has set into motion a solution in the form of a pilot project for one of the worst areas of Veron," Widdowson reported.

Three civil and environmental engineering graduate students, Nick Mason, of Richmond, Virginia, Robert Garrett Wilcocks, of Yorktown, Virginia, and Nicole Abramson, of Irvine, California, have studied the contamination, providing their findings in reports dated in 2012, 2013, and 2014, respectively.

"This is a significant project that is drawing national attention in the Dominican Republic," said Widdowson. "The soils are not suitable for waste treatment and the hydrogeology is not ideal for natural protection of the groundwater supply. This year, our students have been collecting data to benchmark the performance of the wastewater treatment system and the groundwater quality."

In Veron, much of the sewage is disposed of through pipes drilled directly into the ground. Groundwater is the sole source of fresh water in Punta Cana. So when Veron's residents use open fields for defecation or pipe household wastewater into unlined pits in the ground, referred to as pit latrines, concerns have been raised.

"Local residents report that pit latrines very rarely fill up, indicating that waste discharged into pit latrines can freely flow" through the soil that is mostly porous limestone and contaminate groundwater, Mason added.

Other findings include significant contamination in Veron's well water, including E. coli and elevated levels of nitrates.

"E. coli is an indicator of recent contamination by sewage," Abramson wrote in her thesis.

Mason noted that well water in Veron "is not generally used for drinking water, but it is used for bathing, washing clothes, flushing toilets, gardening, and other household needs."

Despite the fact that well water is not normally used for drinking purposes in Veron, Mason said the presence of "fecal matter" remains a threat.

"There are several pathogenic organisms that do not need to be consumed to become harmful…and in Veron, some water–based pathogens have already been causing rashes, skin infections, and sepsis among residents," said Mason.

Fecal bacteria such as cholera are highly infectious even if not directly consumed. Cholera was introduced in the Dominican Republic from Haiti in November of 2010 and by the time of Mason's thesis in 2012 there were 21,432 cases and 363 deaths from cholera.

Punta Cana, the most popular tourist destination in the Dominican Republic with its 30 miles of coastline, also needs to be concerned about the lack of sanitary conditions in Veron because certain pathogens can withstand environmental stresses such as chlorination. An example is giardia that can form hard shell-like formations called oocysts if not

properly filtrated.

Following the 2011 study by Mason, Novak recommended implementing a small-scale wastewater treatment system as a preventative step to improving groundwater quality. Local non-profit organizations, the Punta Cana Foundation and a local Rotary club, began a campaign of fund raising for the construction of a horizontal wetland treatment system for a community within Veron.

Construction of the system began in late 2013 on a plot of land donated by local government and put into operation in June 2014 with the help of civil and environmental engineering students and faculty.

Widdowson said Virginia Tech "has been contributing expertise along the way to support the design and implementation."

In addition to the graduate students, a senior design team of biological systems engineering students developed the initial design of the treatment system. Their goal was to reduce the amount of pathogens that is recharged into the aquifer resulting "in the reduction of waterborne diseases and the protection of tourists from the possibility of disease outbreaks," Wilcocks said.

Wilcocks explained the students suggested the concept of using a vegetated submerged bed wetland, a horizontal flow, gravity-fed system.

The final design was completed by engineers with the U.S. Peace Corps. After the wastewater is treated by the wetland, the treated wastewater is allowed to infiltrate into the soil. The wastewater in a vegetative submerged wetland is maintained below ground surface and a bed liner is used between the wetland and the surrounding soil due to its high permeability.

"This system is sustainable and can be efficient in reducing pathogens, biochemical oxygen demand and total suspended solids. The higher temperature and climate of the Dominican Republic will improve biological activity and thus increase their removal," Wilcocks said.

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