World Water Crisis
- Approximately 1.6 million people die each year due to lack of proper water sanitation.
- Contaminants often include bacterial pathogens, viral pathogens and dissolved arsenic in the form of arsenate and arsenite.
- This problem prevails in impoverished and under-developed areas, where two-thirds of the population earn less than two dollars a day.

“Therefore, the people in these countries require a water treatment system that is inexpensive, easy to construct, and most importantly very effective at providing large amounts of safe drinking water.”

Health Effects Associated with Bacterial Contamination
- Diarrhea
- Typhoid fever
- Paratyphoid fever
- Pulmonary illness
- Gastroenteritis
- Leptospirosis
- Various diseases

Health Effects Associated with Arsenic Contamination
- Cancer (skin, lung, bladder, liver, and kidney)
- Cardiovascular disease
- Peripheral vascular disease
- Arsenic exposure – a crisis
- The system must be operated at various influent flow rates and arsenic concentrations for optimization
- The system must be tested at different influent flow rates and arsenic concentrations for optimization

Research Objectives
- Examining the effectiveness of bio-sand filter for removing pathogenic microorganisms (using E. coli as model microorganisms)
- Studying the mechanism of bacteria (E. coli) removal by the bio-layer (schmutzdecke)
- Testing the efficiency of iron-oxide coated sand filter followed by bio-sand filter for achieving arsenic removal to levels well below prescribed drinking water standards

University of Southern California, Undergraduate Symposium for Scholarly and Creative Work, April 12-14, 2010
Bio-Sand Filters for Removal of Pathogenic Bacteria and Arsenic from Drinking Water in Rural Areas of Developing Countries*

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Experimental Methods for Bacteria Testing
The source water was obtained from Echo Park Lake. The water was inoculated with a known population of E. coli; the bacterial populations were counted before and after bio-sand filtration (see Figure 1).

Experimental Methods for Arsenic Testing
The source water from Echo Park Lake was spiked with 1000 mg/L of arsenic and passed through the iron coated sand filter. The water was then passed through the bio-sand filter for further arsenic removal (see Figure 1). Arsenic concentration was measured before and after the iron coated sand filter, using inductively coupled mass spectroscopy (ICP-MS) analytical technique.

Health Effects Associated with Arsenic Contamination
- Cancer: skin, lung, bladder, liver, and kidney
- Cardiovascular disease
- Peripheral vascular disease
- Arsenic exposure – a crisis
- The system must be operated at various influent flow rates and arsenic concentrations for optimization
- The system must be tested at different influent flow rates and arsenic concentrations for optimization

Future Recommendations
- The bio-sand filter must be optimized for bacterial removal at different influent flow rates and bacterial concentrations
- The combination of iron-oxide coated sand column and the bio-sand filter must be optimized for achieving high arsenic removals
- The performance of the bio-sand filter must be evaluated and optimized for various influent flow rates and arsenic concentrations

Conclusions
- The bio-sand filter was capable of achieving almost complete (> 99.9999%) removal of bacteria
- The combination of iron-oxide coated sand filter and bio-sand filter was effective in reducing arsenic levels below the drinking water standard of 10 µg/L (>99.9% removal)
- The bio-layer (schmutzdecke) alone achieved arsenic and bacteria removals below drinking water standards.

Funding Source
USC Provost’s Undergraduate Research Associates Program

Bibliography