Nutrient recovery through urine separation

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ABSTRACT

Existing water infrastructure is deteriorating and thus demands replacement. This provides an ideal **opportunity** for the **installation of more sustainable water systems**. Human urine contains the bulk of the nitrogen and phosphorus that passes through municipal wastewater treatment plants, while comprising only 1% of the total volume. The environmental and human health implications of using human urine-derived fertilizer are under assessment in the **first two pilot demonstrations of fertilizer production from separated urine in North America** at the Rich Earth Institute (Brattleboro, VT) and the Hampton Roads Sanitation District (Norfolk, VA). Source-separated urine collected with modified porta potties at public events by the Rich Earth Institute was characterized and applied as fertilizer to grow lettuce and carrots. **This research aims to provide design and permitting guidelines to address practical issues related to the implementation of urine separation and collection systems**

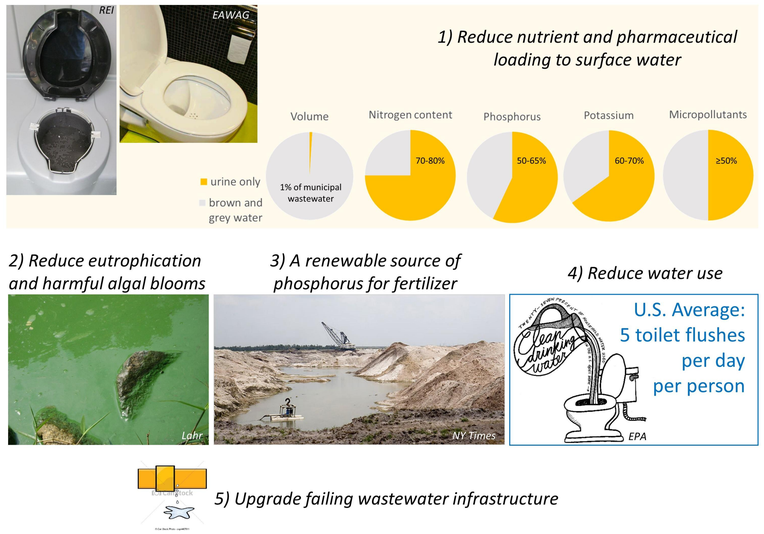

Figure 1. One new treatment technology to target many environmental problems.

INTRODUCTION & OBJECTIVES

Why Does This Matter?

- Source separation of urine and the production of urine-derived fertilizer could account for **a quarter of fertilizer demands in the U.S.** and reduce excess nutrient release into water bodies (Figure 1)[1-3]
- **Specific public health regulations** for urine-derived fertilizers do not exist
- Existing water infrastructure is deteriorating and demands replacement, (opportunity for install of sustainable systems)

Research Objectives

- Provide design and permitting guidelines to address practical issues related to the implementation of urine separation and collection systems
- Understand how urine pretreatments impact pharmaceutical and biological contaminant concentrations
- Compare the efficacy of using natural urine and urine derived product as agricultural fertilizers
- Evaluate the fate of nutrients, pharmaceuticals and biological contaminants following urine product application

APPROACH

The fate of pharmaceuticals, bacteria, viruses, and antibiotic resistance genes are monitored during urine processing and fertilizer use (Figure 2). Urine collection and field site are maintained by the Rich Earth Institute; struvite is produced by the Hampton Roads Sanitation District, Brown and Caldwell, and Ostara; pharmaceuticals are analyzed by University at Buffalo; and biological analyses are analyzed by the University of Michigan (Figure 3).

Figure 2. Pasteurized urine, struvite produced from urine, chemical fertilizers, and no fertilizer were used to fertilize plots of lettuce and carrots. Samples of fertilizers, soil, lysimeter water, lettuce, and carrots were collected for contaminant analyses.

2014 FIELD SEASON

In the first field season, methods were developed and optimized to characterize urine and quantify pollutants in urine, urine-derived fertilizers, plant tissues, lysimeter water. Lysimeters were installed, and a first crop of lettuce and carrots were grown (Figure 4).

Figure 4. Tank lysimeters intercept and store all soil leachate passing through the enclosed soil column. Leachate is periodically collected for contaminant analysis.

Urine collection, storage, agriculture
Rich Earth Institute (Vermont)
Abe Noe-Hays, Kim Nace, Konrad Scheltema, Neil Patel

Struvite production
Hampton Roads Sanitation District (VA)- Charles Bott, **Brown and Caldwell -** Jose Jimenez, **Ostara -** Matthew Kuzma

Pharmaceutical analyses
University of Buffalo (New York)
Diana Aga, Rachel Mullen

Biological analyses
University of Michigan
Heather Goetsch, Rebecca Lahr, Yinyin Ye, Joy Jeyaratnam, Miles Ellenberg, Betsy Foxman, Ting Luo, Kirtana Ramadugu, Krista Wigginton & Nancy Love (PIs)

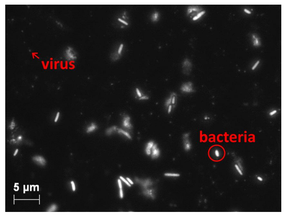

Figure 3. Project team includes a non-profit group, a wastewater treatment plant, consulting firm, private company, and two universities.

FUTURE OUTLOOK

2015 Field Season Research Plan and Anticipated Outcomes

- Determine fertilizer production conditions that minimize biological and pharmaceutical contamination
- Produce urine-derived struvite in a pilot scale reactor at the Hampton Roads Sanitation District
- Apply fertilizer on lettuce and carrots summer 2015 and evaluate the environmental fate of contaminants

This research will provide design and permitting guidelines to address practical issues related to the implementation of urine separation and collection systems.

ACKNOWLEGEMENTS

References. **(1)** Fewless, K. L.; Sharvelle, S.; Roesner, L. A. IWA Publishing: London, 2011. **(2)** Maurer, M., et al. Water Res. 2006, 40 (17), 3151-3166. **(3)** Meinzinger, F., et al. Water Sci Technol 2009, 59 (9), 1785-91.