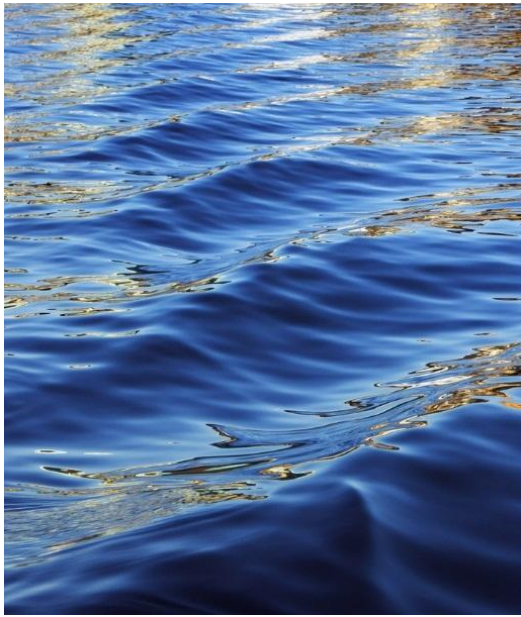
# The Development of a Remediation Approach for the Removal of Bacteria and Toxic Metals for use in Rural Uganda



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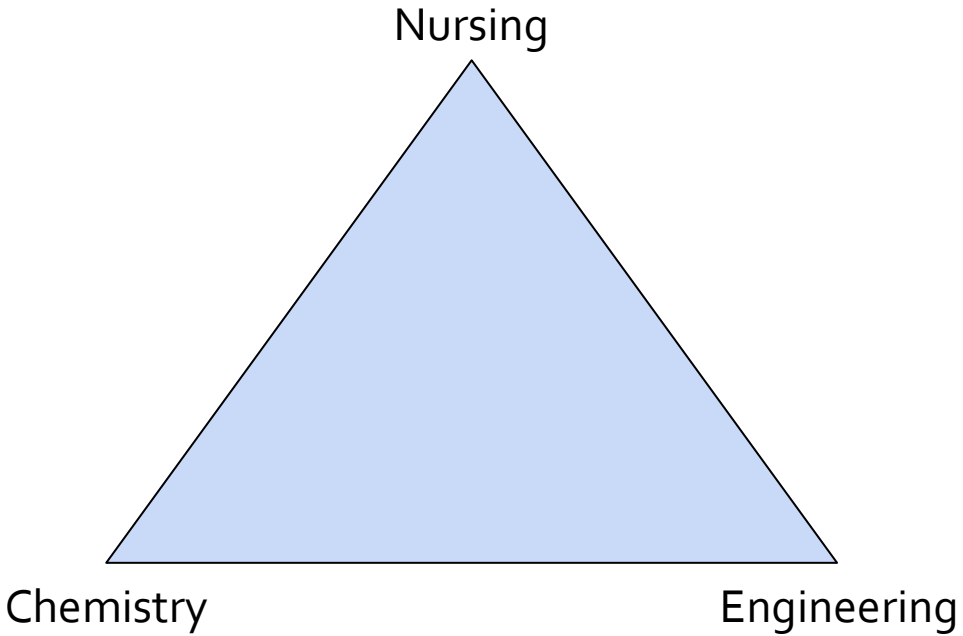
Faculty Mentors: Bryan Cornwall, PhD, PEng, MBA; Martha Fuller, PhD, PPCNP-BC;
Keith Macdonald; James Bolender, PhD; and Frank Jacobitz, PhD

# Introduction to the Project in Uganda




- Project started in response to a need for a children's hospital in Uganda
- Transformed into a project focused on water quality and education

# Background

Ensuring **"access to water and sanitation for all"** is Goal 6 of the United Nations' Sustainable Development Goals (n.d.)

Approximately **30%** of the global population does not have access to "safely managed drinking water services" (United Nations, n.d.)

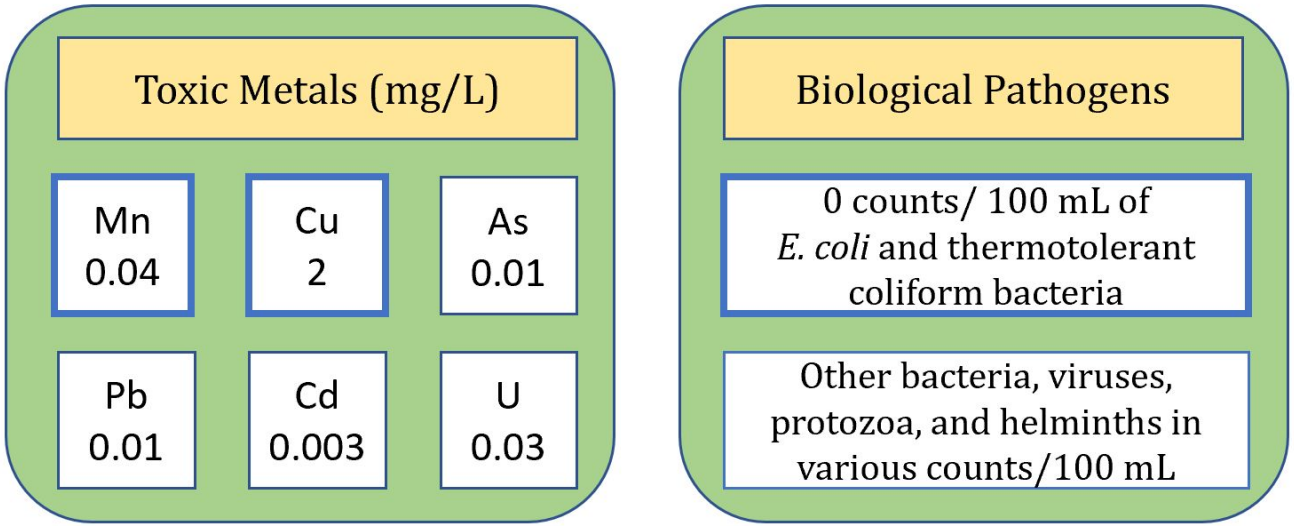
**Key contaminants:**

- Biological contamination
- Toxic metal contamination

According to the CDC, diarrheal diseases were the **6th leading cause of death** in Uganda in 2018.

# Standards for Drinking Water Quality

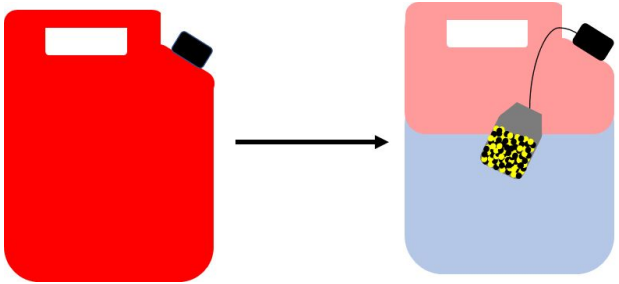
The World Health Organization (WHO) mandated the following contaminant thresholds for drinking water as of 2017 :



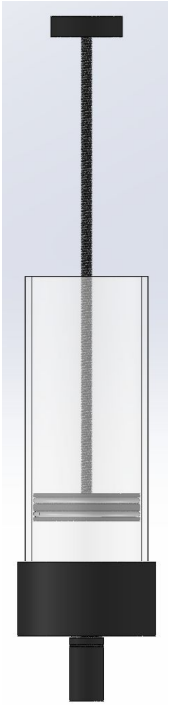
# Timeline of Project

- **Spring 2019:** Started with general research about removal of toxic metals
- **Summer 2019:** Found potential effective solution that Dr. Bolender's Chemistry Lab started testing
- **Fall 2019:** Dr. Bolender's Lab came back with positive results
- **Fall 2019:** Engineering started to work on design for a mechanism to support the removal of these contaminants
- **January 2020:** Trip abroad to Uganda
- **Spring 2020:** Further work on the design with changes based on knowledge gained through January Trip

# Current Design of System



**Step 1:**
Bind and remove select toxic metals using banana peels and activated carbon



**Step 2:**
Trap and remove bacteria using xylem filtration (Particular focus: Eucalyptus tree xylem)

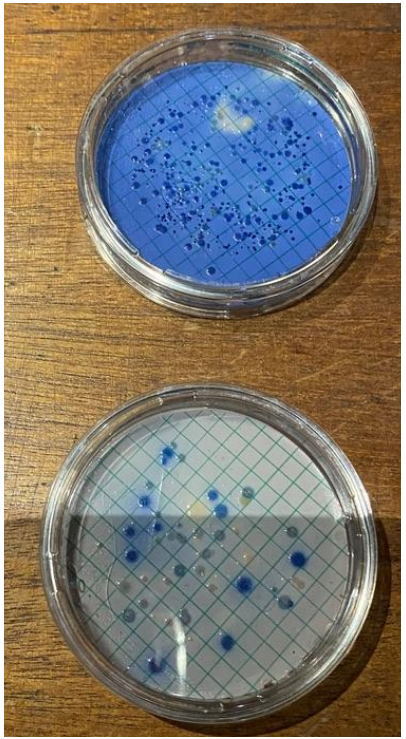
# Subsystem 1: Removal of Toxic Metals

- System Consists of a Tea Bag:
  - Dried Banana Peels
  - Activated Carbon
- Biosorbent : Banana Peels
  - High mechanical strength and large surface area (Annadurai, Juang, & Lee, 2002)
  - Traps toxic metals ions (Annadurai, Juang, & Lee, 2002; Al-Qahtani, 2016)
- Activated Charcoal
  - General purification

# Subsystem 2: Removal of Bacteria

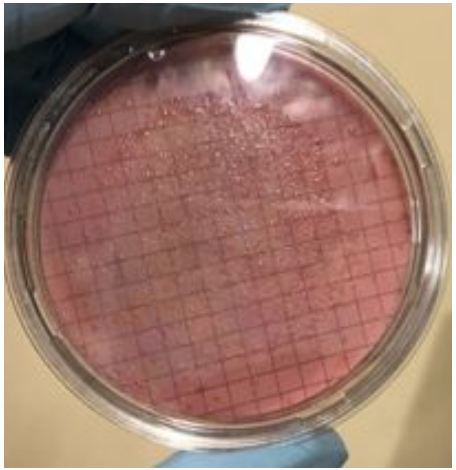
- System Consists of
  - Plant Xylem
  - Piston and Cylinder Set-Up
  - Sealing Mechanism
- Plant Xylem
  - Traps bacteria in the margo pits in the plant xylem cell walls (Boutilier et al., 2014)
- Piston and Cylinder Set-Up
  - Hold water and force water through the plant sample
- Sealing Mechanism
  - Ensure all water travels through the plant cells

# Subsystem 2: Bacteria Testing



Water before Xylem Filtration

- Raised bumps are bacteria colonies
- Raised bumps with a blue pigmentation designate fecal coliform bacteria

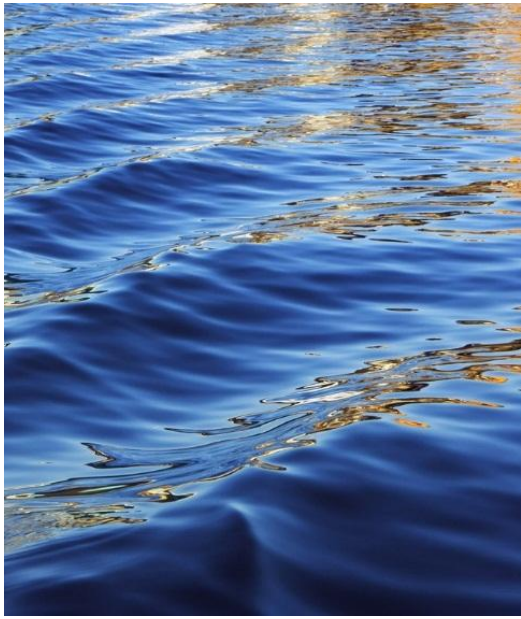


Water After Xylem Filtration through Eucalyptus

# Next Steps

- **Spring 2020**
  - Continue flow rate testing
    - Characterize relationship between applied pressure and flow rate
    - Determine filtration capacity before sample degrades
  - Define filtration capacity per sample of eucalyptus xylem (biological testing)
  - Determine optimal design to scale up device to meet the needs of a family of 5
- **Future Semesters**
  - More extensive biological testing
  - User testing in rural Ugandan communities of interest
  - System implementation (long term goal)

# Thanks for Watching!



# References


- Al-Qahtani, K. M. (2016). Water purification using different waste fruit cortexes for the removal of heavy metals. *Journal of Taibah University for Science*. https://doi.org/10.1016/j.jtusci.2015.09.001
- Annadurai, G., Juang, R.S., & Lee, D.J. (2002). Adsorption of heavy metals from water using banana and orange peels. *Water Science and Technology, 47*(1), 185-190. doi: 10.2166/wst.2003.0049
- Boutilier, M. S. H., Lee, J., Chambers, V., Venkatesh, V., & Karnik, R. (2014). Water Filtration Using Plant Xylem. *PLoS ONE 9*(2): e89934. doi: 10.1371/journal.pone.0089934
- Centers for Disease Control and Prevention. (2019, Jun. 10). *Global Health-Uganda*. https://www.cdc.gov/globalhealth/countries/uganda/default.htm
- United Nations. (n.d.). *Goal 6: Ensure access to water and sanitation for all.* Sustainable Development Goals. https://www.un.org/sustainabledevelopment/water-and-sanitation/
- World Health Organization. (2017). *Guidelines for Drinking-water Quality, Fourth Edition Incorporating the First Addendum.* https://apps.who.int/iris/bitstream/handle/10665/254637/9789241549950-eng.pdf?sequence=1