

Safe and Affordable Drinking Water for Rural Regions of Developing Nations: Process Design and Implementation

Student Researchers: Jay Todd Max and Avril Pitter

Faculty Advisor: Professor Massoud Pirbazari

Astani Department of Civil and Environmental Engineering; Viterbi School of Engineering; University of Southern California



Background: The World Water Crisis

More than 1 billion people lack access to safe drinking water

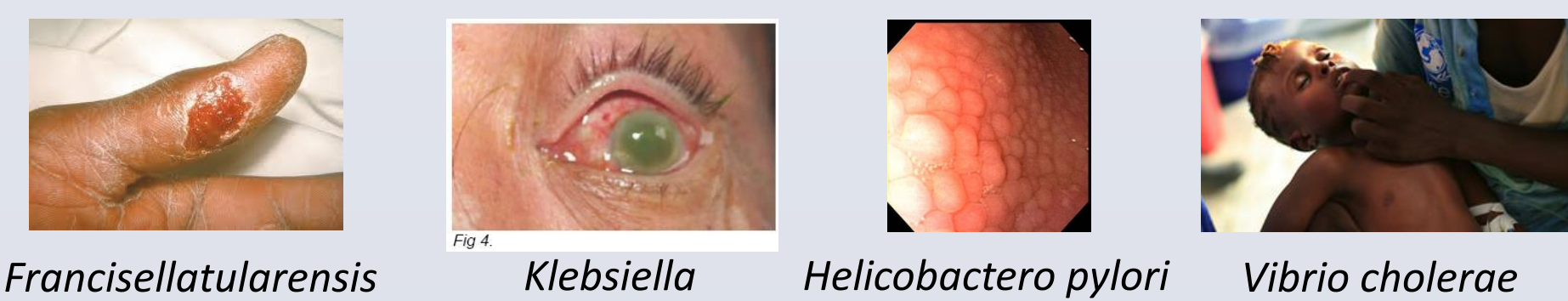
Currently, water in many rural, developing areas is not treated effectively to remove pathogens



Children in Uganda collecting contaminated river water 2007

The following table outlines some of the bacterial diseases commonly contracted through contaminated waterways:

Pathogen	Disease	Treatment	Efficacy
<i>Campylobacter jejuni</i>	Campylobacteriosis	Chlorine, UV	Effective
<i>E. Coli verocytotoxin-producing (VTEC)</i>	Diarrhea (bloody)	Irradiation, sanitation	Effective
<i>E. Coli (STEC)</i>	Enterotoxins	Irradiation, sanitation	Effective
<i>E. Coli (EHEC)</i>	Disease, HUS	Irradiation, sanitation	Effective
<i>Helicobacter pylori</i>	Ulcers, gastritis	Hygiene, clean consumables	Somewhat Effective
<i>Legionella</i>	Legionnaire's disease	Chlorine Dioxide, monitor	Effective
<i>Shigella</i>	Shigellosis	Hygiene, careful food preparation	Effective
<i>Yersinia enterocolitica</i>	Aches, fever	Culinary sanitation and waste control	Effective
<i>Yersinia pestis</i>	Plague	Antibiotics, avoid infected rodents	Somewhat Effective
<i>Vibrio cholerae</i>	Cholera	Chlorine, UV	Effective
<i>Francisella tularensis</i>	Flu-like symptoms, systemic failure	Use insect repellent	Effective
<i>Mycobacterium tuberculosis (resistant)</i>	Weakness, fever, cough	Obey drug regimen	Effective
<i>Mycobacterium avium</i>	<i>M. avium</i> complex (MAC)	Multiple Antibiotics	N/A
<i>Salmonella</i>	Salmonellosis	Antibiotics	N/A
<i>Salmonella enterica serovar Typhimurium</i>	Gastroenteritis	Prevent fecal cross-contamination with water sources	Effective
<i>Klebsiella</i>	Pneumonia	Antibiotics	Effective
<i>Leptospira</i>	Fever, aches	Avoid contacting contaminated water	Effective
<i>Mycobacterium paratuberculosis</i>	Crohn's Disease	UV and Gamma Irradiation	N/A
<i>Burkholderia anthracis</i>	Pulmonary infection	UV	Effective



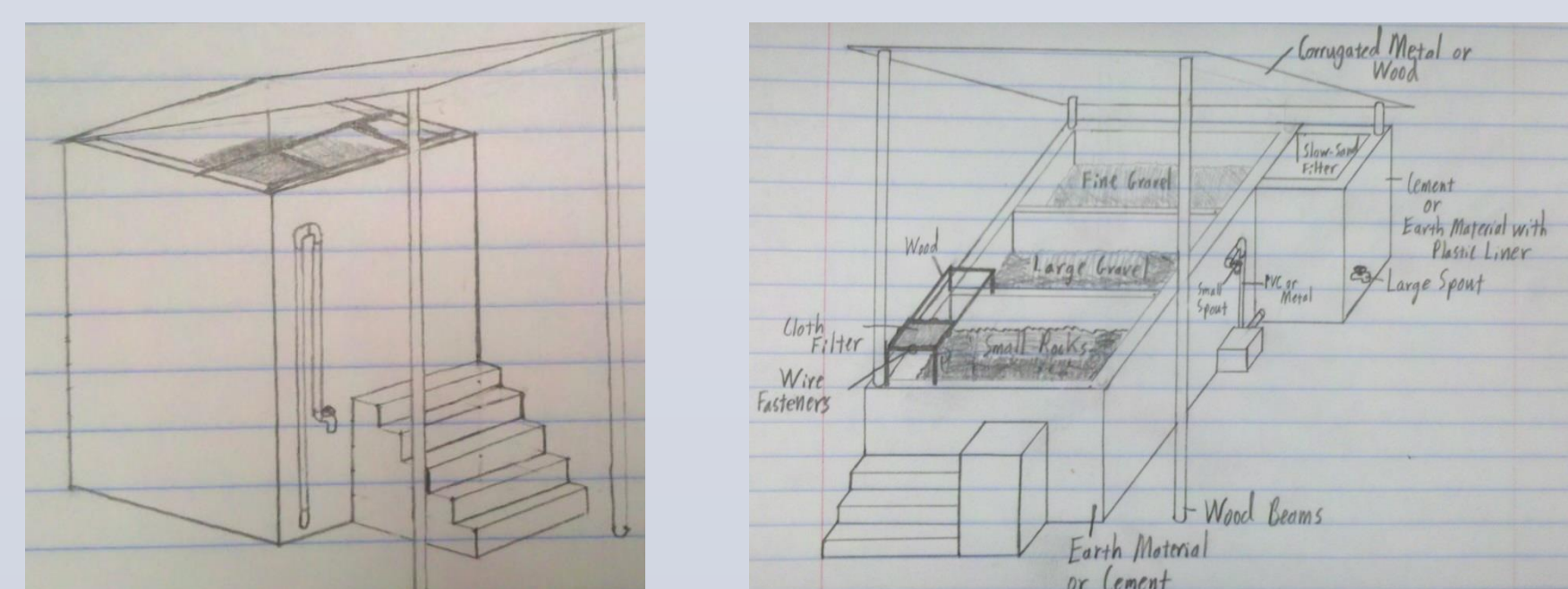
Four typical disease symptoms depicted in the above table

Objective of Research

- Create water treatment systems tailored to rural communities in developing counties.

- Present the designs in a way that potential partners, such as NGOs, may use them as blueprints for implementation.

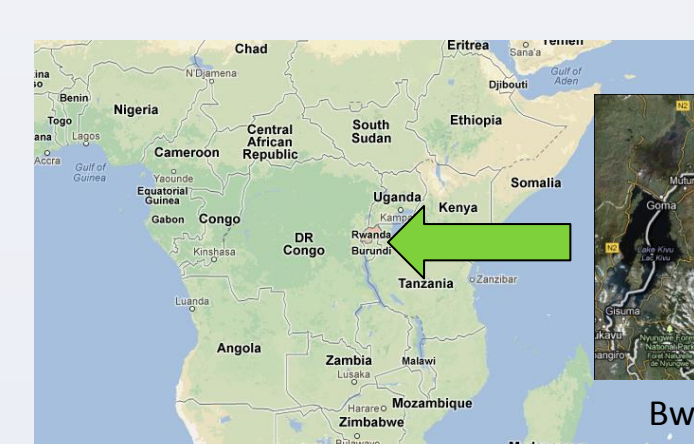
Sketches prepared at site



- Main Design Criteria:
- Made of local materials
 - Water from out-spout only needs simple chlorination
 - Easy to use (for children ages 8+)
 - Simple and infrequent maintenance
 - Robust for most environmental conditions
 - Minimal (or no) use of electricity

Rwanda Field Research

During the summer of 2013 I lived with a host family in rural Rwanda, where I began to understand the difficulties involved in a rural water supply system. We discussed the problems of transportation, illness, childhood dehydration and more. So, together we worked to gather information on all of the troubling aspects of the rural community's water supply, as well as information on desirable traits for a water treatment system. This information forms the body of our research and has been used to produce water treatment systems tailored to rural communities, so that we may return to Rwanda and implement our designs, in conjunction with local organizations.



Rwanda
Location: East Africa, in the Rift Valley
Language: Kinyarwanda
Currency: Rwandan Franc (RWF)
Rural Water Sources: Limited access to surface water



Host Family
Location: Bwana, Eastern Province
Length of Stay: 7 weeks
Accommodations: Host family's house

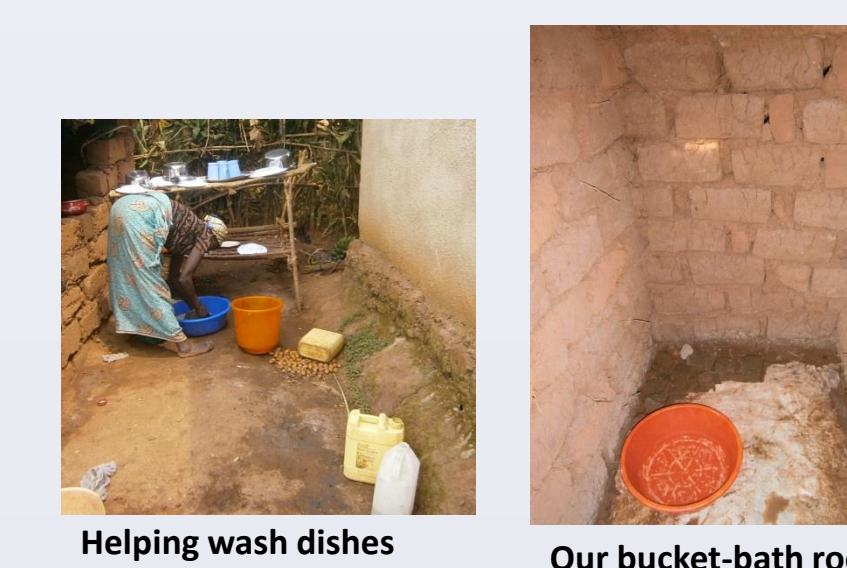
Community Meetings



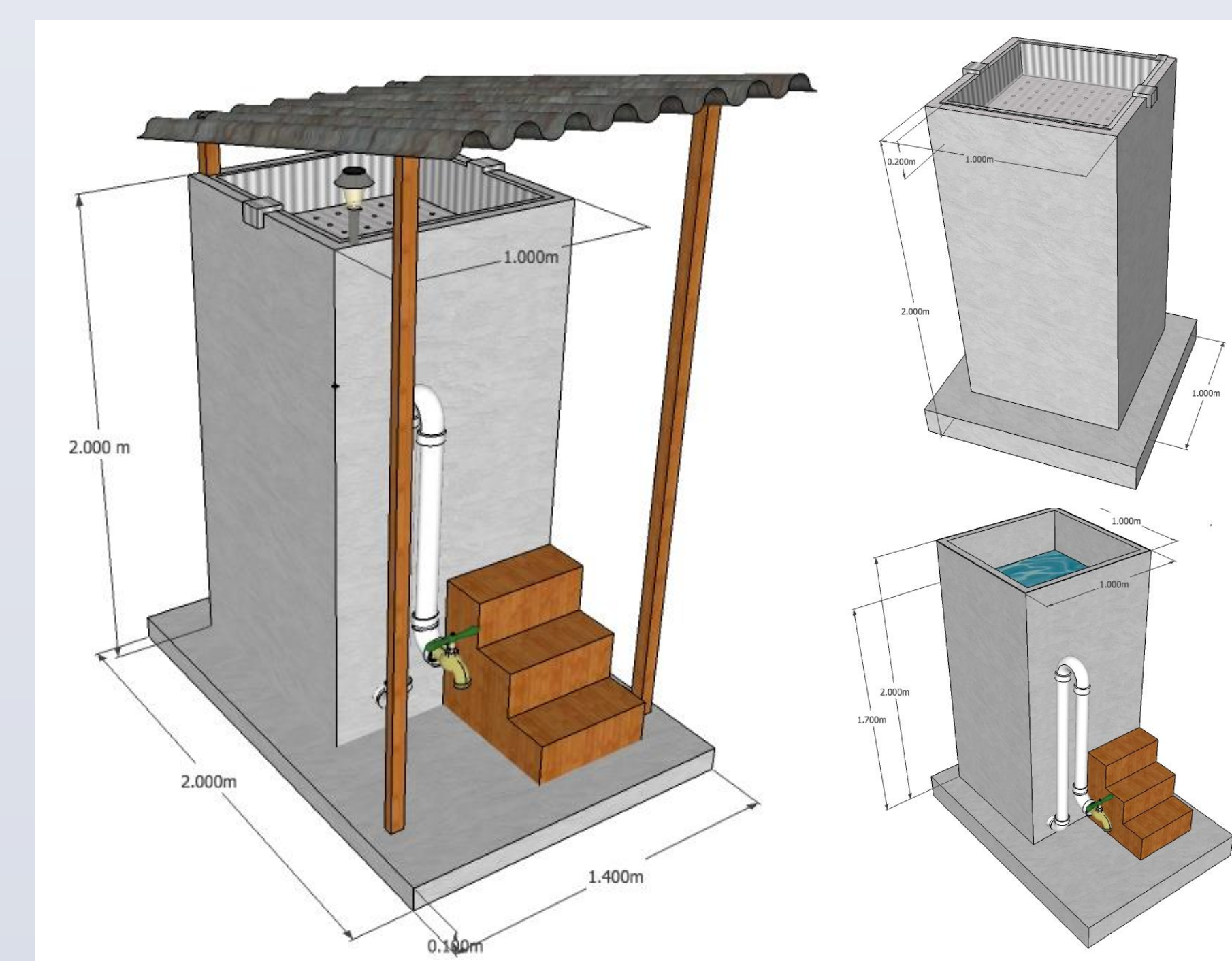
Briefing Translators



Interacting with Water



Water Treatment Process Design



Detail of bio-sand filter process

Bio-sand Filter Process

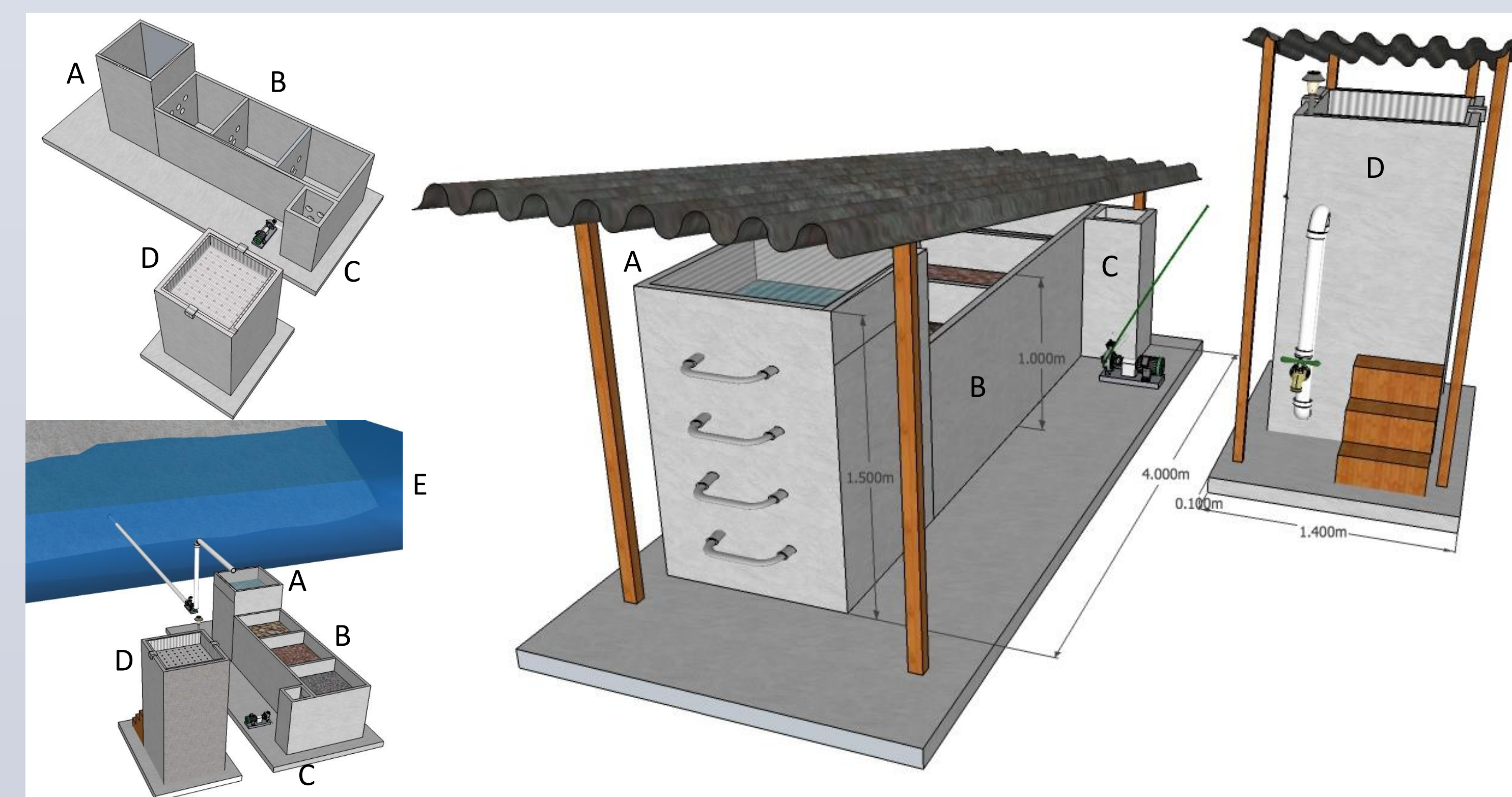
- For visibly clear water
- Treats 60 liters/hr
- Concrete design with corrugated metal roofing and PVC pipe
- Perforated metal plate holds pre-filtering cloth in place
- Biolayer removes contamination

Full Treatment Process (Bio-sand Filter and Horizontal Roughing Filter)

- For high turbidity water
- Roughing filter component removes turbidity
- Water pumped or transferred by bucket to bio-sand filter
- Treats up to 5400/day using three bio-sand filters (requires storage)



Water clarity at different stages of treatment



Detail of full treatment process

Legend

- A: Water Reservoir
- B: HRF Unit
- C: Storage Basin
- D: Bio-sand filter unit
- E: River

Merits of Constructing "Safe Water" Projects

I -The Value of Working with the Local Community to Provide Safe Water

II -The Value of Fostering Life-Long Friendship



Interaction with local communities



My local young supporters: Jean & Karita

Filter recommended for use in southern stretch of Nyabarongo River in Rwanda



Young children should learn that they are an important part of construction of "safe water" projects



Invite young adults to participate in the "safe water" projects



Local leaders should be involved in decision making



Tailor design to specific needs of the community such as population size and needs



Find the most suitable water source for the community

Our Plan of Action

- We plan to travel to Rwanda and use local contacts to work on-site with the local communities and the assistance of organizations such as the following:



Ministry of Trade and Agriculture



Energy Water and Sanitation Authority



water for people



SACCO: Network of Community Banks

- We are currently in negotiation with several NGOs to secure funding for our projects

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SWAN
SAFE WATER FOR ALL

For all references, see SWAN site:

<http://cee.usc.edu/assets/024/85077.pdf>

