An Innovative Approach to Water Quality along the Amazon River Using Biosand Filters

Michigan State College of Osteopathic Medicine
Universidad Cesar Vallejo

MSUCOM Peru Global Outreach

• Began in 2009

• 25+ medical students, 30+ Physicians
  • Family Medicine, Physical Health and Rehabilitation, Radiology, Dermatology, Emergency Medicine, Obstetrics & Gynecology, Pediatrics, Neurology, and Internal Medicine

• Public Health Outreach
  • Water Sanitation
  • Adequate Hygiene
  • Infectious Disease Prevention
  • Safe Household Practices Minimizing Childhood Diseases

• 50+ abstracts published

• $1,000,000+ fundraised
  • Apx. $20,000/year by students
Location of Care

Peru – home of 3 basins

- *Costa* (coastal)
- *Sierra* (highlands)
- *Selva* (rain forest)

The Loreto Region

- The largest of the 25 regions of Republic of Peru
- Located in the *Selva* basin
- No roads connecting to the other basins
- Only accessible by plane or boat
Location of Care

Maynas Province
• 11 districts

Peru Global Outreach
• Locations (1), (2), (3), (4) (Iquitos clinic)
• Locations (6), (8) (Travel Clinic)

Population
(6) Indiana: 163,549
(8) Mazan: 13,977
The Amazon River
The Amazon River

Plenty of water, but…
  Contamination
  Deforestation
  Mining
  Commerce

What resources do they have access to?
- Rock
- Sand
- Charcoal
- Buckets
- Clay
The Biosand Filter

- Cheap
- Natural Resources + Bucket
- Reproducible
- Anaerobic bacteria
  - Compete for resources
  - Develop in response to bacterial competition and available nutrition
  - More effective with greater use
The Biosand Filter
The Biosand Filter

- Supplies for 1 filter
  - 5 gallon bucket (2x)
  - Air tight gasket
  - ½ inch x 1 ½ inch galvanized steel nipple
  - ½ inch CPVC female adaptor (2x)
  - ¾ inch CPVC female adaptor
  - ¾ inch CPVC 90 degree elbow
  - ¾ inch CPVC straight cut into 8 inch long pieces (2x)
  - ¾ inch CPVC boiler drain
  - Washed fine sand x ½ gallon
  - Small gravel x 1 gallon
  - Large gravel x ½ gallon
The Biosand Filter

Schematic
The Biosand Filter

- Prototype
Prototype Results:

Pre-Filtration

<table>
<thead>
<tr>
<th>System Name/Owner:</th>
<th>RED CEDAR RIVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection Address:</td>
<td>2929 HANNAH BLVD, EAST LANSING</td>
</tr>
<tr>
<td>Collected By:</td>
<td>TAYLOR DICKEY</td>
</tr>
<tr>
<td>Township/Well#/Section:</td>
<td>//</td>
</tr>
<tr>
<td>County:</td>
<td>Ingham</td>
</tr>
<tr>
<td>Sample Point:</td>
<td>RIVER</td>
</tr>
<tr>
<td>Water System:</td>
<td>Public System Surface Water</td>
</tr>
<tr>
<td>WSSN/Poll ID:</td>
<td>Source: Surface Water</td>
</tr>
<tr>
<td>Site Code:</td>
<td>RED CEDAR #1</td>
</tr>
<tr>
<td>Collector:</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>Date Collected:</td>
<td>07/29/2016 14:00</td>
</tr>
<tr>
<td>Date Received:</td>
<td>07/29/2016 16:01</td>
</tr>
<tr>
<td>Purpose:</td>
<td>Other</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analyte Name</th>
<th>Result (mg/L)</th>
<th>Date Tested</th>
<th>RL (mg/L)</th>
<th>MCL/AL (mg/L)</th>
<th>Method</th>
<th>CAS #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coliform Organisms per 100 mL</td>
<td><strong>EC POSITIVE</strong></td>
<td>07/29/2016</td>
<td></td>
<td></td>
<td>SM 9223 B</td>
<td>TC-00-B</td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.004</td>
<td>08/02/2016</td>
<td>0.002</td>
<td>0.010</td>
<td>EPA 200.8</td>
<td>7440-38-2</td>
</tr>
<tr>
<td>Chloride</td>
<td>74</td>
<td>08/01/2016</td>
<td>4</td>
<td></td>
<td>SM 4500-CI</td>
<td>7647-14-5</td>
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<tr>
<td>Fluoride</td>
<td>0.18</td>
<td>08/01/2016</td>
<td>0.1</td>
<td>4.0</td>
<td>SM 4500 FC</td>
<td>16948-48-8</td>
</tr>
<tr>
<td>Hardness as CaCO3</td>
<td>462</td>
<td>08/01/2016</td>
<td>20</td>
<td></td>
<td>SM 2340</td>
<td>HARD-00-C</td>
</tr>
<tr>
<td>Iron (automated)</td>
<td>0.2</td>
<td>08/01/2016</td>
<td>0.1</td>
<td></td>
<td>SM 3500 FeB</td>
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<tr>
<td>Nitrate as N</td>
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<td>08/01/2016</td>
<td>0.4</td>
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<td>08/01/2016</td>
<td>0.05</td>
<td>1</td>
<td>10-107-04-2-B</td>
<td>14797-65-0</td>
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<tr>
<td>Sodium (automated)</td>
<td>35</td>
<td>08/01/2016</td>
<td>5</td>
<td></td>
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<tr>
<td>Sulfate</td>
<td>49</td>
<td>08/01/2016</td>
<td>10</td>
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<td>SM 4500 SO4E</td>
<td>14808-79-8</td>
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The analyses performed by the MDEQ Drinking Water Laboratory were conducted using methods approved by the U.S. Environmental Protection Agency in accordance with the Safe Drinking Water Act, 40 CFR parts 141-143, and other regulatory agencies as appropriate.
Prototype Results
Post-Filtration

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<td>Explanation of Coliform Results:</td>
<td></td>
</tr>
<tr>
<td>Not Detected = Coliform and E. coli bacteria were not found</td>
<td></td>
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<tr>
<td>Positive = Total Coliform was found and E. coli bacteria was not found</td>
<td></td>
</tr>
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<td>EC Positive = Coliform and E. coli bacteria were found</td>
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The Biosand Filter

Lima, Peru
The Biosand Filter

Iquitos, Peru
The Biosand Filter

Pucallpa, Peru
The Biosand Filter
Key Points for Successful Installation

- Patient Education
  - “See one, do one, teach one” mentality
- Village Leadership
- Building Key Relationships
- Maintenance & Troubleshooting
- Health Tracking
- Cheap, Easy-To-Find Resources
Survey

Patient ID: | Date Seen:
Age:
Gender: M  F

¿Cuántas veces ha consultado usted con un médico en el año pasado?
0  1-2  3-4  Más que 5

¿Cuánto tiempo necesita viajar para ver un médico?
Menos que 30 minutos  1-2 horas  3-4 horas  Más que 5 horas

Durante los pasados 6 meses ¿ha sufrido de diarrea o nausea?
Sí  NO

¿Está experimentando algún problema cuando orina - dolor, sensación de quemadura, orina más seguido?
Sí  NO

¿Ha notado algún anormalidad con su orina? Por ejemplo, odor fuerte, espumosidad, color abnormal?
Sí  NO

¿Hierve su agua antes de tomarla?
Sí  NO

¿Siente que tiene acceso a bastante agua?
Sí  NO

¿Cuántas tazas de agua toma usted diariamente? (círculo uno)
1-2  3-4  5-6  7-8  Más que un litro

¿De dónde consigue su agua? (círculo uno)
Río  Agua embotellada  Pozo  Agua de la lluvia

¿Ha usado un filtro de agua?
Sí  NO

---

Filter?  YES  NO
Explain:

CC:
Dx:
Weight (kg): ___  BP: ___  HR: ___

Relevant history/physical findings:

Volume status: HYPOVOL EUVOL HYPERVOL

Urine dipstick results:
Color: CLEAR  LIGHT YELLOW  DARK YELLOW  BROWN
pH ___  Spec Gravity ___  Leuk ___  Nitrite ___  Gluc ___  Ketones ___  Protein ___  Blood ___  Bilirubin ___

I-STAT results  

Please turn in completed forms to Katelyn at the end of your shift.
Survey

- How many times within the past year have you seen a doctor?
- How long does it take for you to travel to see a doctor?
- 30 minutes or less 1-2 hours 3-4 hours 5 or more hours
- Within the past 6 months, have you been experiencing episodes of vomiting or diarrhea?
- Are you currently experiencing any problems with urination - pain, burning, increased frequency?
- Have you noticed any abnormalities with your urine? For example, strong smell, bubbles, abnormal color?
- Do you boil your water before drinking?
- Do you feel as though you have access to enough water?
- How many glasses of water do you drink per day?
- Where do you get your drinking water?
- River/Stream Bottled water Well Rain water
- Have you used a water filter before?
Difficulties

- Leaking
  - Moving from a 2 bucket to 1 bucket system
  - Working with MSU-EWB for next year’s prototype

- Suppliers
  - Knowing when and where to ship
Finishing Touches

- 2 installed in Pucallpa, Peru (MSU1 and MSU3)
- 23 finished filters in the process of installation/GPS tracking
- Additional filters continually being installed/tracked
- Results from Renal Function Research Study
- Pre- and Post-filtration water labs
- Biofilm analysis using PCR
Future Potential

- Tailoring the water filters towards the endemic water sources
- Community impact
- Integrated educational component
- Health parameters and filtration efficacy
- Replication of process in other developing nations
Questions?

- Contact Information
  - Taylor Dickey OMS-II
  - Email: dickeyt1@msu.edu
  - Phone: 248-860-6894
  - Websites:
    - https://www.peruglobaloutreach.com/
    - https://www.gofundme.com/MSUCOMPeru/