CIVIL AND/OR ENVIRONMENTAL GROUP
RAPID: Remediation of Earthquake-Impacted Potable Water Sources with Cactus Mucilage

PI: Norma Alcantar
University of South Florida
**RAPID: REMEDIATION OF EARTHQUAKE-IMPACTED POTABLE WATER SOURCES WITH CACTUS MUCILAGE**

The proposed work aims to investigate cactus mucilage-based separation as a viable alternative treatment or rapid water purification in post-earthquake scenarios.

Earthquakes can have severe detrimental effects on the quality of drinking water due to the following:

- **Surface water** is usually impacted by debris and presence of higher microbiological and organic loading in runoff water due to damage to buildings and roads.
- From cadavers when there is a high death toll.
- Ground water can also become contaminated as shifts in the earth may introduce soil (bearing minerals and other solids) as well as bacteria to the water table.

**TASK 1:** Determine water quality and source of contamination. The sources of interest are tap water (distributed from treatment center), well water, surface water, and distributed water (in bottles, water from the tank, etc.).

**TASK 2:** Determine cactus mucilage has effectively cleaned challenge waters. We will determine specific water quality parameters needed for the mucilage treatment to improve drinking water in Haiti, and define the mucilage dosages required for effective treatment of collected water samples.
## Initial Findings

### Haiti RAPID and Research Needs Workshop

**Arlington, VA  Sept 30/Oct 1, 2010**

### Location of sampling sites, a brief description of sampling conditions, and most important findings.

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Collection Date</th>
<th>Time</th>
<th>Location</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2</td>
<td>8/11/2010</td>
<td>4:00 PM</td>
<td>Camp Bredmon/Canape Vert</td>
<td>From a black plastic tank inside the camp</td>
</tr>
<tr>
<td>A3</td>
<td>8/11/2010</td>
<td>4:00 PM</td>
<td>Camp Bredmon/Canape Vert</td>
<td>Water pack/Street vendor/Nationale/ right outside Bredman camp</td>
</tr>
<tr>
<td>B</td>
<td>8/12/2010</td>
<td>10:15 AM</td>
<td>CAMEP Borehole/Rue Theodat Station</td>
<td>Borehole in Cazeau/Approximately 110 ft deep</td>
</tr>
<tr>
<td>C</td>
<td>8/12/2010</td>
<td>11:05 AM</td>
<td>4th Borehole/Pinguin Region</td>
<td>Truck Distribution center</td>
</tr>
<tr>
<td>D</td>
<td>8/12/2010</td>
<td>12:26 PM</td>
<td>Gedèon Camp/Delmas 75</td>
<td>Bladder sample exposed to direct sunlight</td>
</tr>
<tr>
<td>E</td>
<td>8/12/2010</td>
<td>2:00 PM</td>
<td>Tête de L'Eua Chlorination site/Water source comes from up North</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>8/12/2010</td>
<td>2:25 PM</td>
<td>Plaisance Second Chlorination site/Sample source up North</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>8/12/2010</td>
<td>10:15 PM</td>
<td>Hotel Le Plaza Own cistern/Treated by hotel staff</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>8/13/2010</td>
<td>8:50 AM</td>
<td>Constitution Park Camp Bladder/1/4 full/ Filled previous day</td>
<td></td>
</tr>
</tbody>
</table>

### Water Quality Parameters and Other Indicators

<table>
<thead>
<tr>
<th>Water quality parameters</th>
<th>Quality/ contaminant indication</th>
<th>Sources of contaminant</th>
<th>Determination Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbidity</td>
<td>Indicates the presence of suspended solids</td>
<td>Various</td>
<td>EPA Method 180.1⁴</td>
</tr>
<tr>
<td>Total suspended solids</td>
<td>Measures concentration of suspended solids</td>
<td>Various; expected to increase post-earthquake</td>
<td>ESS Method 340.2⁵</td>
</tr>
<tr>
<td>Fecal coliforms</td>
<td>Indirect indicator of pathogens</td>
<td>Human and animal fecal wastes</td>
<td>EPA Method 9221 A⁶</td>
</tr>
<tr>
<td>Biochemical oxygen demand</td>
<td>Indication of organic compound contamination</td>
<td>Waste organic chemicals, or human and animal wastes</td>
<td>EPA Method 507⁷</td>
</tr>
<tr>
<td>Heterotrophic plate count</td>
<td>Measures a variety of bacteria naturally present in water</td>
<td>N/A</td>
<td>EPA 9215 with R2A⁶</td>
</tr>
<tr>
<td>Conductivity</td>
<td>Presence of anions and cations in water</td>
<td>Dissolved metals from industrial effluent</td>
<td>EPA Method 205⁷</td>
</tr>
<tr>
<td>pH</td>
<td>Indicates sources of acids or bases in water</td>
<td>Various</td>
<td>EPA Method 150.2⁷</td>
</tr>
<tr>
<td>Nitrate-N</td>
<td>Presence of nitrogenous wastes in water</td>
<td>Decomposition of organic nitrogen compounds, fertilizer run off</td>
<td>EPA Method 352.1⁷</td>
</tr>
<tr>
<td>Color</td>
<td>Indirect indicator of dissolved and suspended solids</td>
<td>Various</td>
<td>EPA Method 352.1⁷</td>
</tr>
</tbody>
</table>

*Iron Maximum Contaminant Level (MCL) by EPA is less than 300 µg L⁻¹
RAPID: Earthquake Debris Management in Haiti: Data Driven Decision Support

PI: Ozlem Ergun
Georgia Institute of Technology
Debris Management
Reginald DesRoches, Ozlem Ergun, Pinar Keskinocak

• Costly, long, and complicated process
• Use mathematical models to aid in operations
  • Policy analysis for preparedness
  • Decision support during operations

Haiti
• Estimated 20-25 million cubic meters of debris
• Only small fraction collected so far
• Lack of ownership over debris
• Interferes with many aspects of recovery
  • Prevents land use, blocks roadways, health hazards, etc

Debris, Resources, Emergency Supply/Demand

Clearance
  • Prioritize roads during initial response

Partitioning
  • Assign teams to regions for collection considering time to completion

Routing
  • Determine complete set of truck routes to collect debris

Scheduling
  • Feasible scheduling for all trucks during collection

Disposal
  • Evaluate long and short term effects of debris operations

Haiti RAPID and Research Needs Workshop
Arlington, VA    Sept 30/Oct 1, 2010
Initial Findings

• Focus on partitioning model
  • Applicable to current situation
• Use ArcGIS to create road network dataset
• Estimate debris based on percentage buildings down and arc length
• Solve for range of best possible days to completion based on work rate projections

  • Assign debris to three types of teams
    • Heavy, medium, light (Cash for Work)
• Best completion time: 670-1198 days
• Bird’s eye distances: 546-1069 days
• Opening dump site in West: 517-1041 days
RAPID: Assessing the Impact of Internal Refugees on Hospital Water and Wastewater Infrastructure and Its Implications for Future Sustainable Treatment Designs

PI: Stephanie Lansing
University of Maryland College Park
Project Description/Goals
Assessing the Impact of Internal Refugees on Hospital Water and Wastewater Infrastructure and Its Implications for Future Sustainable Treatment Designs
Stephanie Lansing, Andrew Moss, Katherine Strass, Kyla Gregoire
Environmental Science and Technology, University of Maryland

Study Site: Partners in Health (Zanmi Lasante) hospital in the rural Central Plateau


Infrastructure goal: Design and implement a biodigestion system to treat latrine and septic wastewaters, produce energy, and to create fertilizer to enhance crop production.

Research Objectives:
• Quantify the impact of internal refuges on wastewater and energy infrastructure
• Assess post-earthquake wastewater and energy needs of the medical complex
• Create a sustainable and locally appropriate design for meeting wastewater and energy demands in planned refugee communities.
• Implement a flexible and adaptable biodigestion system for meeting increased energy and water demand in a pre-existing medical medical complex.
Initial Findings

Energy Use and Wastewater Production

• Post-earthquake propane use increased 66.7% to $9,375/month (9000 lbs), with 3000 charcoal bags purchased for increased energy needs in Jan 2010 at $18,750.

• Staff increased 57% from pre-earthquake, which is expected to place an increasing demand on water and waste systems.

• Post-earthquake, wastewater increases were not observed due to patients utilizing an open-air pit or the wooded areas.

• Due to overflowing latrines post-earthquake, 67% of clinic patients used the woods in March 2010, 78% in April and almost 100% in August 2010.

Methane Production from Zamni Lasante wastewater

• Cow manure outperformed latrine waste and grey water, with the hospital septic pit exhibiting no methane production nor inherent toxicity. Further testing has shown methane production.

• A waste treatment system was designed combining low-cost digesters, a swirl concentrator and latrine flushing system, with the effluent treated by a trickling filter/wetland connected to an agricultural field drainage system.
RAPID: Supporting Haitian Infrastructure Reconstruction Decisions with Local Knowledge

PI: Franco Montalto
Drexel University
Supporting Haitian Infrastructure Reconstruction with Local Knowledge

Focusing on the city of Léogâne and surrounding areas, this project examines local knowledge and participation in reconstruction of water and sanitation infrastructure.

1. Geotagged 88 water/sanitation/flood features while circulating through area.
2. Conducted a survey using 6 Haitian enumerators who administered 171 surveys.
3. Met with local stakeholders and conducted 20 semi-structured interviews.
4. Conducted full-day participatory workshop + surveys with 76 local stakeholders.
5. Meetings and interviews with DINEPA, the Mayor of Léogâne, Ministry of the Environment, WASH cluster, and NGO’s involved in water and sanitation.

The City of Léogâne, 30km west of Port-au-Prince, was at the epicenter of the earthquake. The map shows areas where we conducted surveys, interviews and geotagging of water & sanitation features. Drexel Team Members: Franco Montalto, Michael Piasecki, Patrick Gurian and Mimi Sheller with assistance of Jennifer Britton.
Initial Findings: Divergent Visions

1. Sample result: city center vs. other areas differ on who should operate water system
2. Mental maps of different actors, based on semi-structured interviews:

<table>
<thead>
<tr>
<th>The DINEPA plan</th>
<th>The NGO approach</th>
<th>Local Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focuses only on provision of piped drinking water in the urban core. The restored system is to be owned by a regional office of DINEPA, national agency responsible for water and sanitation, with management gradually transferred to public or private operators. Users would pay based on metered consumption with revenues remaining at the regional level. No plan for sanitation.</td>
<td>Efforts are piecemeal and vary in terms of focus (drinking water vs. sanitation) and service area (from single settlements to community clusters). Installation and service are usually provided free of charge with no provision for long term operational costs. Learning as they go, but little stakeholder involvement has taken place yet in Léogâne. Development NGOs have a longer-term view.</td>
<td>Suggested multiple solutions customized to the needs of the urban, peripheral, and outlying zones of the city. Recognized need to address protection of source waters and the environment in general, plus develop irrigation, water treatment, public and private drinking and sanitation facilities. Suggested that people are willing to pay for and co-manage services; and are ready to self-organize action.</td>
</tr>
</tbody>
</table>
RAPID: Wind Energy and Rainwater Harvesting Solutions for Sustainable Recovery of Haiti

PI: Catherine Peters
Princeton University

Goal: To advance sustainable technologies for rapid response after a disaster.

4kW wind turbine. Deploys from a 40 ft. shipping container.

Rainwater collection, storage and treatment system. Two 20 ft. shipping containers. Capacity 1200 L.
Initial Findings

Site in Haiti: Camp Mayard near Jacmel

Design challenges for the rapid deployment wind turbine

Wind field simulations over Haiti

Water filtration system using porous ceramic clay pots