Winter 2011 – Choluteca Aquaponics Team

Kristen Frooman
Michael Jewitt
Son Ngo
Ronni Nimps
Amanda Peterson
Drew Pritt
Miriam Simon
Michael Wolfe
Greg Bixler
Roger Dzwonczyk
Dr. John Merrill
Winter 2011 – Choluteca Aquaponics Team

The Team

Son Ngo – Manual Pump Team – Pump Guru, Structure, Siphon System
Ronni Nimps – Solar Pump Team – Structure, Assembly, Gravel Collection, Data Collection
Miriam Simon – Manual Pump Team – Team leader, Electronics, Gravel, Documentation

Greg Bixler – Team Adviser – Structure, Assembly, Sustainability
Roger Dzwonczyk – Team Adviser – Structure, Assembly, Electronics
Dr. John Merrill – Team Adviser – Assessment
Overview of the Project

What is aquaponics:

A system composed of two (or more) tanks, at least one for fish and one for plants.
As the fish expel effluents into the water, this water gets pumped to the plant tank. This water is then ‘consumed’ and cleaned by the plants, and then clean water is sent back to the fish tank.
Overview of the Project

Why is this project needed?

-Larry Overholt – Vocational School in Choluteca

-Low – energy / sustainable system for developing areas
  - Choluteca, as well as other areas in Honduras, experience power outages
  - Families and small communities can benefit greatly from a reliable and low-maintenance food source
  - Aquaponics may provide families and individuals with business opportunities

Our challenge

Build a couple of pump options for an aquaponics system to serve as a model at the vocational school – ‘Escuela Vocacional Estados Unidos de America’
Project Components

Fish Tank

- Rule of thumb: about 1 cubic foot of water / full grown fish
- If we want about 20 fish in the tank at any given moment, we need a 25 – 30 cubic foot tank – about 250 gallons

- Of the water in the tank, we need to pump about 30% of the volume per cycle (75 gallons) in order to maintain the tank safe for the fish
Project components and Implementation

Project Components

Types of Fish Researched:

Barramundi         Catfish         Jade Perch       Tilapia     Trout         Blue Gill

-Most adequate for these conditions: Tilapia

Other Species (for fresh water):

Mussels         Prawns         Crayfish         Crustaceans
Project Components

Plant tank

- About 100 gallons (ideal)
- Filled with gravel/clay
- Able to grow tomatoes, cucumbers, spinach, lettuce, radishes, celery, herbs

Siphon system must return water at a fairly slow rate in order to avoid getting the roots damaged due to dehydration
Project Components

Pumps – 2 options – a solar pump and a manual/mechanical pump

Proposed Structures:
Project Component and Implementation

Project Components
Manual/mechanical Pump – Original Design

Piston Pump Operation

Source: Lifesaver International
Project Components
Manual/mechanical Pump - Modified Design

1) Piston pulls water from lower check valve, upper check valve is closed
2) Piston pushes water through upper check valve, lower check valve is closed
### Project Component and Implementation

#### Project Components

**Manual/mechanical Pump**

- Plant Basin
- Water Basin
- Five 4x4 Posts
- One 2x4 Board
- Siphon (punctured PVC pipe)
- Pump

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
<th>Quantity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 ft (1 1/4&quot;) PVC Pipe</td>
<td>$4.15</td>
<td>1</td>
<td>$4.15</td>
</tr>
<tr>
<td>(1 1/4&quot;) Check Valve</td>
<td>$9.62</td>
<td>1</td>
<td>$9.62</td>
</tr>
<tr>
<td>3 ft all thread bar</td>
<td>$3.09</td>
<td>1</td>
<td>$3.09</td>
</tr>
<tr>
<td>1/4&quot; x 20 Nuts</td>
<td>$0.33</td>
<td>5</td>
<td>$1.65</td>
</tr>
<tr>
<td>1/4&quot; Washer</td>
<td>$0.15</td>
<td>4</td>
<td>$0.60</td>
</tr>
<tr>
<td>1/4&quot; V shape nute</td>
<td>$0.35</td>
<td>2</td>
<td>$0.70</td>
</tr>
<tr>
<td>3/4&quot; Male Straight PVC fitting</td>
<td>$1.75</td>
<td>1</td>
<td>$1.75</td>
</tr>
<tr>
<td>3/4&quot; Female Straight PVC fitting</td>
<td>$2.25</td>
<td>1</td>
<td>$2.25</td>
</tr>
<tr>
<td>1/4&quot; ID, w/ 1&quot; OD Rubber Washer</td>
<td>$1.50</td>
<td>2</td>
<td>$3.00</td>
</tr>
<tr>
<td>1 1/4&quot; ID Tee Fitting</td>
<td>$3.84</td>
<td>1</td>
<td>$3.84</td>
</tr>
<tr>
<td>Oatey All Purpose Cement 8oz</td>
<td>$5.98</td>
<td>1</td>
<td>$5.98</td>
</tr>
<tr>
<td>Oatey Primer</td>
<td>$4.98</td>
<td>1</td>
<td>$4.98</td>
</tr>
<tr>
<td><strong>Grand Total:</strong></td>
<td></td>
<td></td>
<td><strong>$41.61</strong></td>
</tr>
</tbody>
</table>

Beckson 136PF-6 Water and Irrigation 1.75in. Pumps 36x72in. 35 ozs.

You can always buy a longer hose from us later, and you can cut down these hoses if needed. 1-3/4" diameter Pump with 72" flexible hose 4 strokes = 1 gallon 13 gpm ]

Price: $31
Project Components
Solar Pump

Pump Calculations

**Estimated Values**

- Daily time running, $t_{on}$: 6 hours\(^1\)
- Minimum sunlight, $t_{sun}$: 8 hours\(^2\)
- Time without sun (running on batteries): 3 days

**Values to be Decided**

- Power of the pump: $P_{pump}$
- PV panel power capacity: $P_{panel}$

\(^1\) This is based upon the assumption that our pump will run 15 minutes of every hour.
\(^2\) A conservative estimate based on the following website:
http://astro.unl.edu/classaction/animations/coordsmotion/daylighthoursexplorer.html
### Project Components

**Solar Pump**

### Pump Operation and Cycling

<table>
<thead>
<tr>
<th>Ioff, A</th>
<th>toff, %</th>
<th>Ion, A</th>
<th>ton, %</th>
<th>Iavg, A</th>
<th>Hours of Operation/da</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>75</td>
<td>2</td>
<td>25</td>
<td>0.5</td>
<td>24</td>
</tr>
</tbody>
</table>

| Input Variable | Input Variable | Input Variable | Input Variable |

### Power and Energy Calculations

<table>
<thead>
<tr>
<th>Pavg, W (assuming 12VDC)</th>
<th>Ah/day</th>
<th>Wh/day</th>
<th>Days on Battery Power Only</th>
<th>Hours of Sunlight</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>12</td>
<td>144</td>
<td>3</td>
<td>8</td>
</tr>
</tbody>
</table>

| Input Variable | Input Variable |

### System Requirements

<table>
<thead>
<tr>
<th>Battery, Ah</th>
<th>Solar Panel, W</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>36</strong></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</table>

Fournier S et al. The sun shines on the Granite Bay Montessori Shack. QST 2011;95:76-77.
Project Components
Solar Pump

System Specifications

45 Watt Solar Panel Kit – Chicago Electric

Weatherproof solar power center works under all light conditions

Includes 3, 6, 9 and 12 volt DC adapter outlets on charge controller

Easy-to-read LED charge indicator

Includes mounting hardware, lights, 12 volt DC socket and battery clamps
Project Components

Solar Pump

Battery

12 Volt Deep Cycle Marine Battery

Timer

A-TIME ERDI 12v DC
Allows the system to run 15 min. on 45 min. off every hour

Water Pump

Rule 24 Marine Rule 360 Marine Bilge Pump

360 gallons/hour
Project components and Implementation

Electrical System

- Battery
- Charge Controller (Back and Front)
- Solar Panels
- Timer
- Water pump
Project components and Implementation

System Setup

- Manual Pump
- 45 Watt Solar Panels
- Battery & Charge Controller (behind panels)
- Custom-made wooden structure (scrap materials)
Project components and Implementation

System Setup

Overflow protection system

Siphon System

Lower Plant Basin (scrap materials)

Upper Plant Basin (scrap materials)

Son – Manual pump & siphon guru, ninja

Siphon protector (prevents gravel from clogging the siphons)

Fish Basin with solar-powered pump on the inside
## Project Components

### Bill of Materials

<table>
<thead>
<tr>
<th>Part</th>
<th>Price</th>
<th>Source</th>
<th>Pricing for Honduras ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Panel Kit</td>
<td>$196</td>
<td>Harbor Freight</td>
<td>300 *</td>
</tr>
<tr>
<td>Fish Tank</td>
<td>$20</td>
<td>Local Materials</td>
<td>20</td>
</tr>
<tr>
<td>Pump Timer</td>
<td>$64</td>
<td><a href="http://www.backwoodssolar.com">www.backwoodssolar.com</a></td>
<td>Unknown</td>
</tr>
<tr>
<td>Deep Cycle Battery</td>
<td>$0</td>
<td>Local Materials</td>
<td>Included in Solar Kit</td>
</tr>
<tr>
<td>DC pump</td>
<td>$24</td>
<td><a href="http://www.backwoodssolar.com">www.backwoodssolar.com</a></td>
<td>25</td>
</tr>
<tr>
<td>Grow Bed</td>
<td>$0</td>
<td>Local Materials - Scrap</td>
<td>20</td>
</tr>
<tr>
<td>Gravel</td>
<td>$0</td>
<td>Local Materials – Collected at River</td>
<td>0</td>
</tr>
<tr>
<td>Manual Pump &amp; Fittings</td>
<td>$15</td>
<td>Local Materials – Hardware Store</td>
<td>15</td>
</tr>
<tr>
<td>Wood Supports</td>
<td>$0</td>
<td>Local Materials - Scrap</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total Cost:</strong></td>
<td><strong>$319</strong></td>
<td></td>
<td><strong>395</strong></td>
</tr>
</tbody>
</table>

**Target Cost: $400** \[**$81** under budget!\]

* Solar panel kits sold in Choluteca at SOLAIRES – But, units are sold as a lighting kit.
### Implementation Schedule

<table>
<thead>
<tr>
<th>Saturday</th>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday - Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel to Honduras</td>
<td>Beach Day</td>
<td>Vocational School Assessment</td>
<td>Sifter Design and Assembly</td>
<td>Solar and Manual Pump Installation</td>
<td>Travel to Catacamas for Assessment</td>
</tr>
<tr>
<td>Drive to Choluteca</td>
<td>Gathering of plant basins at Larry and Angie's home</td>
<td>Building of Aquaponics Structure</td>
<td>Gather Gravel at the Choluteca River</td>
<td>Stocking System with Plants and Fish</td>
<td>Return to Tegucigalpa</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Preliminary Manual Pump Installation</td>
<td>Siphon Implementation and Testing</td>
<td>Electronics Assembly and Testing</td>
<td>Return to Columbus</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Complete the System and Document</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Teach Larry and Chacho about the system</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Leave for Tegucigalpa</td>
<td></td>
</tr>
</tbody>
</table>
Unexpected Items

- Beach Day = Awesome, but one fewer working day

- Old basins were available at Larry and Angie’s house

- Scrap wood was available at the Vocational School that we could use for structures

- We collected gravel at the Choluteca River using some custom-made sifters

- Items that are available at hardware stores here are generally available in Choluteca as well.
Recommendations for sustaining the system

Monitoring the system
- Make sure pumps are working
- Make sure plants aren’t dehydrated
- Make sure fish are being fed and aren’t dying
- Check the pH level
- Check the nitrite level
- Check the temperature

Make sure siphon is working properly
Make sure system has no leaks
Check the water level on a daily basis

Make sure replacement parts are locally available
Recommendations for sustaining the system

Future Recommendations

- Assess local stores which carry solar panels and pumps. SOLAIRES, a solar panel store in Choluteca, carries panels, but at a high cost (See Documentation).

- Optimize the plant/fish ratio in order to run a truly profitable system.

- Gather feedback from the users (Larry Overholt and Jose “Chacho” Davila) in order to improve the new system based on their recommendations.

- Assess the possibility of incorporating an in-ground pool for the fish basin instead of an above-ground pool. This would help by lowering the cost of the fish basin as well as improving cooling conditions for the fish.

- Acquire a complete listing of materials available (either new or discarded) in the area before going down to Choluteca for the week. This information would have been useful to have before going down to Choluteca, as the availability of the basins was one of our main concerns.
The course’s influence on the project

Roger’s documentation slides – important for keeping track of our work

Guest speakers – Brad, Greg and Dr. Hull
  - Different perspectives and ideas for sustainability, humanitarian work

Citizen Engineer
  - Allowed groups to share ideas about different issues presented in the book. Taught us about different areas that engineers can be a part of service engineering environments.

Previous Documentation
  - Assessment reports from last year were extremely useful in providing initial information about the area and projects
Questions or Comments?