Design Solutions for Seasonal Water Scarcity in the Comarca Ngäbe-Buglé

*Mujeres Fuertes Consultados*

*Michigan Technological University*

*iDesign Panama 2010*

Jacquie Blom, Alye Hannum, Natalie Helms, Sara Maihofer, Beth Shears
## Outline

- Introduction
- Background
- Site Assessment
- Design Alternatives and Analysis
- Cost Estimate and Construction Schedule
- Design Recommendations
Comarca Ngäbe-Buglélé

Erin Kelley

- University of Kentucky
  - Foreign Language and International Economics
- Peace Corps Volunteer
  - Agro-business
- Salto Dupí in the Comarca Ngäbe-Buglélé
- Counterpart: Alvaro Bejerano
Comarca Ngäbe-Buglé

Ngäbe-Buglé People

- Comarca: “reservation”
- Language: Ngäbere and Buglére
- Livelihood: Subsistence farmers, shop owners
- Income: $10/week
- Religion: Seventh-Day Adventist
- Crafts: Chacaras, Naguas
Farming on the Comarca

Quebrado Loro Rainfall

Rainfall, mm

- Average Rainfall
- Maximum Rainfall

Seasons
- Rainy: May – November
- Dry: December – April
- “Famine”: May – July

Farming adversities
- Poor soil
- Steep slopes
Farming on the Comarca

- OPAMO: Organization of Agricultural Producers with Organic Methods
  - mulch
  - compost
  - soil conservation plants
  - plants to slow runoff

- Design Needs
  - Rainwater Collection
  - Rainwater Storage
  - Irrigation
Designing for the Developing 80%

Considerations

- Technical Aspects
  - Construction skills
  - Material availability
  - Maintenance

- Social Aspects
  - Willingness to use the technology and show other farmers the technology

- Economical Aspects
  - Capital and financial management
  - Market opportunities for the produce and pay back time for the technology
Site Assessment

- GPS
  - Coordinates of property line
- Surveying
  - Elevations and distances of vegetable plots and property
Site Assessment

- Plant Identification
  - Photographs for guidebook
- Soil Investigation
  - Characteristics to estimate soil properties: cohesion and unit weight
Design Alternatives

- Dam river
- River water pumping
  - Electric pump
  - Treadle pump
  - Windmill pump
- Rainwater storage
  - Water bladder
  - 50-gallon polyethylene barrel
  - Ferrocement tank

Proposed Design

Developing 80% Considerations

- Economically feasible
- Materials available in Salto Dupí or San Felix
- Minimal technical training
- Adaptable for other farms
- New technology for the area – easily accepted
Proposed Design

- **Rainwater Collection and Storage System**
  - Zinc-coated roof
  - Bamboo gutters
  - 50-gallon polyethylene barrels

- **Drip Irrigation System**
  - Garden hose

- **Rice Terraces**
Proposed Design

- **Upper Garden Plot**
  - Zinc-Coated Roof
  - 50-gallon Polyethylene Barrels
  - Garden Terraces
  - Irrigation Hose
  - Bamboo Gutters
  - Bamboo Structure
Design Analysis

Rainwater Collection System

- Zinc roofing
- Bamboo gutters

![Diagram of rainwater collection system with zinc roofing and bamboo gutters]

Water Collected (Gallons)

Days

Number of Zinc Sheets
1 2 3 4 5 6
Design Analysis

Rainwater Storage System

- 50-gallon polyethylene barrels
- PVC connections
Design Analysis

Drip Irrigation System

- Experiment
  - Determined flow through emitters
  - Various elevation changes
Design Analysis

Drip Irrigation System

- EPA Net 2.0 Model
  - Flow: 0.026 GPM
  - Pressure: 2-4 psi
# Design Analysis

## Rice Terrace Water Budget

<table>
<thead>
<tr>
<th>Month</th>
<th>Irrigation Need (mm/month)</th>
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</thead>
<tbody>
<tr>
<td>May</td>
<td>-116</td>
</tr>
<tr>
<td><strong>June</strong></td>
<td>34.0</td>
</tr>
<tr>
<td>July</td>
<td>-19.6</td>
</tr>
<tr>
<td>August</td>
<td>-186</td>
</tr>
<tr>
<td>September</td>
<td>-33.2</td>
</tr>
<tr>
<td>October</td>
<td>-236</td>
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www.images-photography-pictures.net/China_riceTerraces_terracotta_soldiers.htm
Design Analysis

Rice Terrace Slope Stability Analysis in SLIDE 5.0

![Graph showing safety factors and slope stability analysis in SLIDE 5.0]
Rice Terrace Dimensions

- Height: 2 ft
- Width: 3 ft
- Length: 24 ft
- Number of terraces: 8
- Construction Time: 16 days
## Detailed Cost Estimate for Rainwater Collection, Storage and Distribution System

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total Cost</th>
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<tbody>
<tr>
<td>Zinc Roofing (3.5'x10' sheet)</td>
<td>2</td>
<td>$8.00</td>
<td>$16.00</td>
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<tr>
<td>Nails (box)</td>
<td>2</td>
<td>$2.30</td>
<td>$4.60</td>
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<td>Rubber Sheeting (12&quot;x36&quot;)</td>
<td>1</td>
<td>$17.50</td>
<td>$17.50</td>
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<tr>
<td>Barrels</td>
<td>7</td>
<td>$25.00</td>
<td>$175.00</td>
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<tr>
<td>PVC Pipe (1&quot; diameter) (20 ft)</td>
<td>1</td>
<td>$3.50</td>
<td>$3.50</td>
</tr>
<tr>
<td>PVC Threaded Nipple (1&quot; diameter)</td>
<td>12</td>
<td>$0.50</td>
<td>$6.00</td>
</tr>
<tr>
<td>PVC Valve (1&quot; diameter)</td>
<td>2</td>
<td>$3.50</td>
<td>$7.00</td>
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<tr>
<td>Caulk (1 tube)</td>
<td>1</td>
<td>$4.00</td>
<td>$4.00</td>
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<tr>
<td>Garden Hose (75')</td>
<td>3</td>
<td>$17.50</td>
<td>$52.50</td>
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<tr>
<td>Hose connections</td>
<td>3</td>
<td>$1.00</td>
<td>$3.00</td>
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<tr>
<td>Hose caps</td>
<td>2</td>
<td>$1.00</td>
<td>$2.00</td>
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<tr>
<td>Transportation of Materials</td>
<td>-</td>
<td>$40.00</td>
<td>$40.00</td>
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<tr>
<td><strong>Total Cost:</strong></td>
<td></td>
<td><strong>$331.10</strong></td>
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## Construction Schedule

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<tr>
<th>Activity</th>
<th>Duration (Days)</th>
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<tr>
<td>Site Prep</td>
<td>5</td>
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<tr>
<td>Material Acquisition</td>
<td>14</td>
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<tr>
<td>Roof and Gutter Construction</td>
<td>9</td>
</tr>
<tr>
<td>Storage System Construction</td>
<td>5</td>
</tr>
<tr>
<td>Irrigation System Construction</td>
<td>7</td>
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<tr>
<td>Early Finish</td>
<td>21</td>
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<tr>
<td>Late Finish</td>
<td>39</td>
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Recommendations

- Rainwater collection, storage, and irrigation system
  - Screen collected water before storing
  - Test irrigation system water flow at various elevation changes
  - Cover irrigation lines with mulch
- Maintenance
  - Clean gutters and screen
  - Clean out irrigation lines
  - Clean emitter holes
- Rice terraces
  - Place rocks at water spouts to prevent erosion
  - Plant vetiver to filter waste water
Next Steps

- Maintain communication with Peace Corps volunteer
  - Funding opportunities
  - Materials already obtained
  - Design questions and adaptations
- Follow up with Comarca farmers for design feedback
Acknowledgements

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- Krissy Guzak, *Mentor in Panama*
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<th>Photo Credits: Natalie Helms, Beth Shears, Sara Maihofer, Jacquie Blom, Alye Hannum</th>
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References


