Payments for Watershed Services in the Rimac Basin, Peru

Context and Challenges

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Consultor Aquafondo/FONDAM
Outline

- Quantity & Quality issues
- Aquafondo (The Water Fund)
- Watershed understanding
- Stakeholder desires/Fund interests
- Assessing funding priorities
- Quantifying watershed services
- Framework “strawman”
- Challenges
Quantity & Quality Issues

- Critical water scarcity in Lima
- ~70% imported water from Amazon
- Limited/no wastewater treatment
- Untreated mining/industrial wastes
- Ag irrigation withdrawals
- Hydropower reservoir sedimentation

[Graph showing water volume over time with deficit and surplus periods.]
• Capture and mobilize financial resources from primary water users
• Optimize water usage/promote efficient water management (*water quantity*)
• Recover environmental conditions (*water quality*)
• Fund projects for recovery of hydrological environmental services related to:
  – Management and conservation of water resources
  – Promotion of a new culture of water use
  – Participative management and water governance
30-second Watershed Tour
Watershed Understanding

<table>
<thead>
<tr>
<th>Dam #</th>
<th>Dam Name</th>
<th>(River kilometer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Huampani</td>
<td>(45)</td>
</tr>
<tr>
<td>2</td>
<td>Moyopampa</td>
<td>(55.7)</td>
</tr>
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<td>3</td>
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</tbody>
</table>

### Monthly Average Flow for each Station

<table>
<thead>
<tr>
<th>Gauge Station</th>
<th>Period of Record</th>
<th>Minimum (m³/s)</th>
<th>Maximum (m³/s)</th>
<th>Average (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chosica</td>
<td>1938-1997</td>
<td>15.2</td>
<td>60.1</td>
<td>27.10</td>
</tr>
<tr>
<td>San Juan</td>
<td>1961-1993</td>
<td>3.0</td>
<td>25.2</td>
<td>9.82</td>
</tr>
<tr>
<td>Sheque</td>
<td>1962-1990</td>
<td>3.9</td>
<td>18.7</td>
<td>8.59</td>
</tr>
<tr>
<td>Yurac Mayo</td>
<td>1952-1993</td>
<td>0.6</td>
<td>5.8</td>
<td>2.15</td>
</tr>
</tbody>
</table>

Legend Notes:
- Hydropower dam
- Municipality/Village
- City or village with known water treatment
- Rimac Mainstem Sampling Station
- Tributary Sampling Station
- Flow Monitoring Station (active)
- Flow Monitoring Station (inactive)

River Schematic:
- River flows
- Tributaries
- Dams
- Sampling stations
- Municipalities

Legend Notes:
(Vertical length not to scale)
Horizontal scale: 1 inch = 10 kilometers
(0.0) = River kilometer
- = Hydropower dam
□ = Municipality/Village
□ = City or village with known water treatment
□ = Rimac Mainstem Sampling Station
□ = Tributary Sampling Station
□ = Flow Monitoring Station (active)
□ = Flow Monitoring Station (inactive)
Simplified Understanding of Concerns

Legend Notes:
- (Vertical length not to scale)
- Horizontal scale: 1 inch = 10 kilometers
- (0.0) = River kilometer
- = Hydropower dam
- = Mining Companies
- = Tailing Ponds
- = Non-mining Companies
- = Dumping Areas
- = Domestic Drainage

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<td>Matucana (83.6)</td>
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</table>

Pacific Ocean (0.0)
## Alignment of Aquafondo and Stakeholder Concerns and Goals

<table>
<thead>
<tr>
<th>Highly Aligned</th>
<th>Moderately Aligned</th>
<th>Narrowly Aligned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reforestation</td>
<td>Industrial Effluent Treatment</td>
<td>Drinking Water Distribution</td>
</tr>
<tr>
<td>Aquifer Recharge</td>
<td>Mining Contamination/Tailings</td>
<td>Agri-chemicals</td>
</tr>
<tr>
<td>Erosion Control</td>
<td>Strengthening Water Management</td>
<td></td>
</tr>
<tr>
<td>Irrigation Technology</td>
<td>Increased Regulations</td>
<td></td>
</tr>
<tr>
<td>Infiltration Practices</td>
<td>Public Education</td>
<td></td>
</tr>
<tr>
<td>Bank Stabilization</td>
<td>Pesticides</td>
<td></td>
</tr>
<tr>
<td>Wetland Restoration</td>
<td>Farmland Preservation</td>
<td></td>
</tr>
<tr>
<td>Sustainable Livestock Systems</td>
<td>Dams</td>
<td></td>
</tr>
<tr>
<td>Ag Management</td>
<td>Stormwater Management</td>
<td></td>
</tr>
<tr>
<td>Solid Waste Management</td>
<td>Flood Protection</td>
<td></td>
</tr>
<tr>
<td>Wastewater Treatment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Assessing Options & Prioritizing Outcomes...EXAMPLE

You are thirsty.
You need water.
You have limited funding.
You have several options.

Which option is the most cost-effective for addressing your thirst?

**Metric = litres**

- **Bottle 1**
  - $2.50
  - 1L
  - $2.50/L

- **Bottle 2**
  - $4.50
  - 2L
  - $2.25/L

- **Bottle 3**
  - $3.00
  - 1.5L
  - $2.00/L

*Prioritized Outcome*
Assessing Options/Prioritizing Outcomes

Groundwater recharge projects are needed to increase drinking water supplies. Aquafondo could fund several different types of project options.

Which project option is the most cost-effective for addressing recharge?

<table>
<thead>
<tr>
<th>Project</th>
<th>Cost</th>
<th>Metric (m$^3$.sec$^{-1}$)</th>
<th>Cost/m$^3$.sec$^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project 1</td>
<td>$22,000</td>
<td>4.5</td>
<td>$4,900</td>
</tr>
<tr>
<td>Project 2</td>
<td>$17,000</td>
<td>4</td>
<td>$4,300</td>
</tr>
<tr>
<td>Project 3</td>
<td>$3,000</td>
<td>0.2</td>
<td>$15,000</td>
</tr>
</tbody>
</table>

**Prioritized Outcome**
Quantifying Watershed Services

**Water Quantity Projects**

**Approach**
- Infiltration
- Conservation

**Solutions**
- Reforestation, irrigation improvements, capture, wetlands
- Water reuse, urban water conservation

**Metric**
- m³/s

**Calculation Method**
- Empirical or mass balance
- Mass balance

**PROJECT**
- Project Name
- Location
- Project Type
- Description
- Calculations
- Project Cost
- Unit Cost
- Prioritization
Infiltration Ditch Restoration for Water Harvesting *(Rio Chillon)*

**Project:**
Lining diversion ditch from main channel to infiltrate more water to upland springs for highland Ag irrigation

**Results:**
Cost: $12,000
Flow improvement: $0.35 m³·sec⁻¹ (performance)
Benefit: $34,300/m³·sec⁻¹

1 m³·sec⁻¹ = 1,000 hectares for farming
## Water Quality Projects

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Solutions</th>
<th>Metric</th>
<th>Calculation Method</th>
<th>PROJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediments</td>
<td>Streambanks, buffers, animal exclusion, wetlands</td>
<td>MT/yea</td>
<td>Empirical</td>
<td>Project Name, Location, Project Type, Description, Calculation, Cost, U</td>
</tr>
<tr>
<td>Nutrients</td>
<td>Agricultural management, wastewater treatment</td>
<td>kg/year</td>
<td>Empirical or mass balance</td>
<td>Calculations, Prioritization</td>
</tr>
<tr>
<td>Heavy Metals</td>
<td>Erosion controls, mine tailing covers</td>
<td>kg/year</td>
<td>Empirical or mass balance</td>
<td></td>
</tr>
<tr>
<td>Organic (enrichment)</td>
<td>Wastewater treatment</td>
<td>kg/year</td>
<td>Mass balance</td>
<td></td>
</tr>
</tbody>
</table>
Calculating Watershed Services

Collect site-specific data and information (streambanks)

Channel Erosion Equation

\[ CEE = \text{Length} \times \text{Height} \times \text{LRR} \times \text{soil weight} \]

\[ CEE = 40\text{m} \times 0.7\text{ m} \times 0.2\text{ m/yr} \times 1.762 \text{ t/m}^3 \]

\[ CEE = 9.87 \text{ tons/yr} \]

Annual sediment erosion = 9,870 kg/yr

Future Erosion Control Benefits
9,870 kg/yr sediment reduction

Future Phosphorus Benefits
4.2 kg/yr phosphorus reduction

Future Nitrogen Benefits
8.4 kg/yr nitrogen reduction

Cost-effectiveness
S/tonne or kg
## Chaclacayo Bank Stabilization Project

<table>
<thead>
<tr>
<th>Credit</th>
<th>Reductions</th>
<th>Unit Cost (Nuevo Soles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment</td>
<td>2,150 MT/yr</td>
<td>8,600/MT·yr⁻¹</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>912 kg/yr</td>
<td>20,186/kg·yr⁻¹</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>1,826 kg/yr</td>
<td>10,084/kg·yr⁻¹</td>
</tr>
</tbody>
</table>
A Draft Framework for Aquafondo Implementation
Challenges for Developing Aquafondo Framework

• Understanding who can provide services and who might pay for services
• Simplified & uniform valuation of “watershed service”
  – Quantified benefits using *common metric* (performance-based)
  – Funding *prioritization*
• Appropriate framework