Service Levels Provided by Rainwater Harvesting Systems and Multiple Water Sources: A Case Study from Nicaragua

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A study within a WASH program

- Millennium Water Alliance coordinates a rural WASH program called *Lazos de Agua* in 5 countries in Latin America that is implemented by 6 member NGOs

- Key program areas:
  - Implementation
  - Shared Monitoring, Evaluation, & Learning (MEL)
  - Applied research

Countries where *Lazos de Agua* works in Latin America
# Service Level Ladder MEL System

<table>
<thead>
<tr>
<th>Service Level</th>
<th>Quantity (lpcd)</th>
<th>Quality</th>
<th>Accessibility (distance-to-source)</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>&gt;100</td>
<td>Exceeds WHO Guidelines</td>
<td>Multiple taps flowing continuously</td>
<td>Very reliable (365 days of functionality)</td>
</tr>
<tr>
<td>Intermediate</td>
<td>&gt;50</td>
<td>Meets WHO Guidelines</td>
<td>Less than 100m</td>
<td>95% functionality</td>
</tr>
<tr>
<td>Basic (normative)</td>
<td>&gt;20</td>
<td></td>
<td>100-1000m</td>
<td></td>
</tr>
<tr>
<td>Basic (sub-standard)</td>
<td>&gt;5</td>
<td>Problematic</td>
<td>Greater than 1000m</td>
<td>Problematic</td>
</tr>
<tr>
<td>No service</td>
<td>&lt;5</td>
<td>Significant problems</td>
<td>Greater than 1000m</td>
<td>Unreliable/insecure</td>
</tr>
</tbody>
</table>
Inspiration for the study

1. MWA found it difficult to predict the service levels provided by rooftop rainwater harvesting (RWH) systems.

2. Major question of how to evaluate water supply service levels when multiple sources are in use.

- At $1.2 million, RWH is the largest single water supply budget item and 10% of total budget.
- There has been little analysis of how people use multiple sources simultaneously and there is no standard methodology for doing so.
Purpose

- To generate empirical data to describe how rooftop RWH performs in practice while accounting for all additional water sources households use for domestic supply

- Key aspects of the approach:
  - Adopt the Service Level Ladder from *Lazos de Agua* to evaluate its suitability where multiple water sources are used
  - Provide quantitative data to inform how the program makes decisions about its MEL system and water supply interventions

- *This presentation will focus on the quantity and accessibility aspects of the Service Level Ladder*
Methodology

- Piloted as a case study in one purposefully selected community in the Caribbean region of Nicaragua.
- Step-wise data collection in 2 seasons (April and June 2014):
  1. Demographic survey (20 households)
  2. Map all water sources
  3. *Simplified water diaries
  4. Perceptions interviews
  5. Technical data collection (water quality, rain gauge, water levels in RWH tanks)
Simplified water diaries

- Designed to quantify the volume of water a household uses from any number of water sources
- Consists of a table with the water sources in the columns and the days of the week in the rows
- Respondents were asked to note water collected with a standard 19 L container with an “X” and with other containers with other symbols
- Water collected and brought to the home and water used at the source (such as for bathing and clothes washing) were reported
- Deployed over 4 days in April and 4 days in June
- Researchers visited each household 2 times each day of data collection to discuss with respondents and weigh the water collection containers
Simplified water diaries
Results - Demographics

- Community of approximately 450 people in 72 households
- Average of 6 people per household
- Average self-reported cash income of $0.44/person/day; residents also engage in subsistence activities
## Results – Water sources

<table>
<thead>
<tr>
<th>Source Type</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilled well with hand-pump</td>
<td>1</td>
</tr>
<tr>
<td>Concrete-lined dug well (no cover)</td>
<td>6</td>
</tr>
<tr>
<td>Unlined dug well protected only with a cover</td>
<td>9</td>
</tr>
<tr>
<td>Unprotected dug well</td>
<td>6</td>
</tr>
<tr>
<td>Surface water</td>
<td>7</td>
</tr>
</tbody>
</table>

*Total = 29 (plus 57 RWH systems)*
Results - Mapping

- See Google Earth map of water sources, households, and pathways from households to water sources
Results – Dry season population water usage by source type (liters per capita per day – lpcd)

Average dry season household water use: 37 lpcd
Results – Dry season population water usage by source type (lpcd)

Average rainy season household water use: 41 lpcd
Results – % water usage from multiple sources over 4 consecutive days by household (dry season – in L)
Results – % household water usage from multiple sources over 4 consecutive days by household (rainy season - L)
Results – Total water usage from multiple sources over 4 consecutive days in the same 9 households (in L)

- Dry season:
  - Primary source: 4780 L
  - Other sources: 1782 L
  - Total: 6562 L

- Rainy season:
  - Primary source: 6492 L
  - Other sources: 757 L
  - Total: 7249 L

Water usage by volume:
- Dry season: 27% from other sources
- Rainy season: 10% from other sources
Results – Total water usage from multiple sources over 4 consecutive days in the same 9 households (in L)

- Dry season:
  - Primary drinking water source: 3920 L
  - Other sources: 2642 L
- Rainy season:
  - Primary drinking water source: 6492 L
  - Other sources: 757 L

Percentage breakdown:
- Dry season: 40% primary, 60% other
- Rainy season: 90% primary, 10% other
Results – Total water usage from “improved” and “unimproved” sources in the same 9 households (in L)

- Dry season:
  - Unimproved sources: 4931 L
  - Improved sources: 1631 L
  - Total: 6558 L

- Rainy season:
  - Unimproved sources: 691 L
  - Improved sources: 6558 L
  - Total: 7249 L

- Percentage:
  - Unimproved: 82%
  - Improved: 9.5%
  - Total usage: 9.5%
## Results - Impact of RWH on accessibility

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Dry season</th>
<th>Rainy season</th>
<th>Projected annual average*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average one-way distance-to-source(s)</td>
<td>183 m</td>
<td>94 m</td>
<td>116 m</td>
</tr>
</tbody>
</table>

*Assuming a 9 month rainy season and 3 month dry season during which water use patterns are as observed during fieldwork in April and June 2014
Discussion points

- While many studies have noted the use of multiple sources in many lower-income settings, only a few (Evans et al., 2013, several related to IRC’s MUS approach, MWA program baseline survey) have looked at it in more detail.
- Every household in Kuahkuil had “coverage” of “improved” sources, but usage of them was <100%, especially when RWH water was not available.
- In Kuahkuil, water use and accessibility measurements are significantly affected when all sources instead of only each household’s “primary” sources are considered.
- How important is it to account for water from all sources?
Results – Total water usage from primary drinking and other sources over 4 days in the dry season (lpcd)
Results – Total water usage from primary drinking and other sources over 4 days in the dry season (lpcd)
Key limitations

- Small, pilot scale
- Assumption that water source choice remains as observed throughout each season
- Data collected during the 1st seasons after RWH systems installed
- Some evidence of under-reporting of water use from RWH systems from a water meter installed on one tap
Conclusions

1. Accounting for the use of multiple water sources significantly affects measurements of water supply service levels in the case study community
   - Neglecting to do so would under-report post-intervention water supply service levels, affecting the evaluation of program success

2. Rooftop RWH systems:
   - Are residents’ preferred water source when available
   - Will provide the most water of any source type annually
   - Provide significant accessibility benefits, quantified as saving 1.5 km/household/day for water collection
Case study site – village of Kuahkuil
Recommendations

1. Better characterize the extent of multiple water source usage for domestic supply in *Lazos de Agua* and globally
   - Is it widespread enough to significantly affect global water supply monitoring?
   - MWA and WaterAid are expanding the study in Nicaragua and Mexico to gather more evidence

2. Results suggest continuing to support rooftop RWH in the Nicaraguan Caribbean will help *Lazos de Agua* reach its objectives, as long as the use of other sources is acknowledged in monitoring:
   - Significant accessibility benefit, despite risk of discontinuous service
   - Demonstrated user preference for using RWH systems in the case study community
Questions?


Evans, B. et al. 2013. Public Health and Social Benefits of at-house Water Supplies. Leeds: University of Leeds, University of North Carolina at Chapel Hill, London School of Hygiene and Tropical Medicine, and the University of East Anglia.


Selected Bibliography (3 of 3)
