Drivers of water insecurity for urban households in Tanzania: water supply, quality, and access to piped water

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(1) Social Impact, Inc., (2) Virginia Tech
Objective

- Describe and analyze water use and water insecurity in two cities in Tanzania prior to large-scale water infrastructure interventions
In urban Tanzania, piped water supply is limited and irregular, and often of sub-standard quality.

US Millennium Challenge Corporation (MCC) and the Government of Tanzania entered into a Compact to improve water quantity and quality in Dar es Salaam and Morogoro.

Social Impact contracted by MCC to carry out five-year, rigorous impact evaluation of the Water Sector Project activities.
Water Infrastructure Intervention

- **Dar es Salaam**: Double capacity of Lower Ruvu plant (180 → 270 MLD)
- **Morogoro**: Rehabilitate water treatment plant and improve water transfer (Mafiga and Mambogo WTPs) (4 → 6 MLD)
- MCC $64.2 million investment; 2.8 million estimated beneficiaries
- Estimated completion date: ??
Summary of Impact Evaluation

- **Quasi-experimental design**: Tests cause and effect relationships, using statistical matching technique (generalized propensity score matching, GPSM)

- **Mixed methods**: Qualitative, geospatial, and direct measurement data supplement quantitative data from household questionnaire

- **Considers intervening factors**: Evaluates factors that may influence relationships between MCC interventions and outcomes of interest (e.g. water expenditures, water treatment practices)

- **Integrates process-related questions**: Examines how project implementation may influence project impacts
### Impact Evaluation Scope

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Water supply at the utility level</td>
<td>Consumption patterns of water at household level</td>
<td>Poverty and income</td>
<td>Implemented according to plan?</td>
<td>Unintended results of the project?</td>
</tr>
<tr>
<td>Demand for connections to network</td>
<td>Health (diarrheal incidence among children under 5)</td>
<td></td>
<td>Challenges encountered? How were they addressed?</td>
<td>Likelihood that results will be sustained over time?</td>
</tr>
<tr>
<td>Access to water and availability of water (household level)</td>
<td>Investment in physical and human capital</td>
<td></td>
<td>Lessons learned from design and implementation?</td>
<td>Cost-effectiveness or re-estimated Economic Rate of Return (ERR) based on realized benefits and costs of the project?</td>
</tr>
<tr>
<td>Water quality (source, distribution channel, point of consumption)</td>
<td>Sub-groups including women, children, poor</td>
<td></td>
<td>Variations in this activity worth considering in the future?</td>
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<td></td>
<td>Businesses, schools, health centers</td>
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</tbody>
</table>
Two-stage cluster sampling:
Enumeration Areas listed then households randomly selected

- Urban centers of Dar es Salaam and Morogoro
- Survey of 2504 households in each city, n=5008 (616 EA clusters)
- Electronic data collection using SurveyBe
- Estimates are adjusted for design using two-stage sampling weights
### Sampling & Data Collection

**Phone follow-ups (3x per household),**
- 83% (Dar) and 78% (Mor) full participation
- Both cities ~90% response rate in round 3

**Water quality testing, 500-600 in each city**

**Extensive qualitative component (FGDs, Health, Edu, Vendors, IP), 88+**

**Secondary data (utility monitoring data, TMA rainfall)**

**Geospatial data (public distribution network, kiosks, households)**

#### 2013

<table>
<thead>
<tr>
<th></th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
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<tbody>
<tr>
<td>Listing: Mini-Survey</td>
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<tr>
<td>Mini-Survey</td>
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<tr>
<td>Listing: Full Baseline</td>
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<tr>
<td>Full Baseline Survey</td>
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<td>Water Quality Tests</td>
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<tr>
<td>Phone Survey (3 rounds)</td>
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<tr>
<td>Qualitative Interviews</td>
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<tr>
<td>Geospatial &amp; Secondary</td>
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</table>
Measures

**Water Security**
- Access to piped network
- Water portfolio and use of secondary sources
- Reported shortages
- Reported water shocks
- Reported worry about adequacy of water
- Water quality

**Outcome**
- Time spent hauling
- Water expenditures
- Water consumption

### Water Source Categorization

<table>
<thead>
<tr>
<th>Water source</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Own Tap</strong></td>
<td>Own tap in dwelling or plot</td>
</tr>
<tr>
<td><strong>Other Piped</strong></td>
<td>Neighbor’s tap; kiosk; public tap; tap to a HH-owned or nearby business</td>
</tr>
<tr>
<td><strong>Vendors</strong></td>
<td>Water tanker trucks; mobile water vendors (i.e., push-carts)</td>
</tr>
<tr>
<td><strong>Non-Tap</strong></td>
<td>Borehole; protected and unprotected wells and springs; surface water</td>
</tr>
<tr>
<td><strong>Bottled</strong></td>
<td>Bottled water</td>
</tr>
</tbody>
</table>
Water Security Measures

Access to piped network

Water portfolio and use of secondary sources

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Reported worry about adequacy of water

Water quality

Connection to Public Network, by SES Quintile

- Dar es Salaam
- Morogoro

Quintile 1
Quintile 2
Quintile 3
Quintile 4
Quintile 5
In Dar es Salaam, a fifth of the poorest households obtain drinking water primarily from vendors (3% in Morogoro). ~40% of the poorest in Dar es Salaam use a non-tap source for drinking.

Poor households are more likely rely on sources of lower quality & those that require more time and money (especially in Dar es Salaam).
### Water Security Measures

#### Access to piped network

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#### Water quality

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<table>
<thead>
<tr>
<th>Water Source</th>
<th>Drinking</th>
<th>Cooking</th>
<th>Washing</th>
<th>Cleaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own tap</td>
<td>15%</td>
<td>17%</td>
<td>17%</td>
<td>17%</td>
</tr>
<tr>
<td>Other piped</td>
<td>51%</td>
<td>52%</td>
<td>51%</td>
<td>51%</td>
</tr>
<tr>
<td>Vendors</td>
<td>29%</td>
<td>25%</td>
<td>24%</td>
<td>23%</td>
</tr>
<tr>
<td>Non-Tap</td>
<td>39%</td>
<td>57%</td>
<td>64%</td>
<td>65%</td>
</tr>
<tr>
<td>Bottled</td>
<td>12%</td>
<td>2%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Other</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Water Source</th>
<th>Drinking</th>
<th>Cooking</th>
<th>Washing</th>
<th>Cleaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own tap</td>
<td>57%</td>
<td>58%</td>
<td>58%</td>
<td>58%</td>
</tr>
<tr>
<td>Other piped</td>
<td>52%</td>
<td>52%</td>
<td>51%</td>
<td>51%</td>
</tr>
<tr>
<td>Vendors</td>
<td>8%</td>
<td>8%</td>
<td>7%</td>
<td>7%</td>
</tr>
<tr>
<td>Non-Tap</td>
<td>25%</td>
<td>30%</td>
<td>36%</td>
<td>36%</td>
</tr>
<tr>
<td>Bottled</td>
<td>6%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Other</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
</tr>
</tbody>
</table>
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### Number of sources used by household, for each activity

<table>
<thead>
<tr>
<th>Activity</th>
<th>Dar es Salaam</th>
<th>Morogoro</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>95% CI</td>
</tr>
<tr>
<td>Drinking</td>
<td>1.58</td>
<td>(1.48, 1.58)</td>
</tr>
<tr>
<td>Cooking</td>
<td>1.56</td>
<td>(1.46, 1.56)</td>
</tr>
<tr>
<td>Washing</td>
<td>1.61</td>
<td>(1.5, 1.61)</td>
</tr>
<tr>
<td>Cleaning</td>
<td>1.62</td>
<td>(1.51, 1.62)</td>
</tr>
<tr>
<td>Gardening</td>
<td>0.04</td>
<td>(0.02, 0.04)</td>
</tr>
<tr>
<td>HH Business</td>
<td>0.16</td>
<td>(0.12, 0.16)</td>
</tr>
</tbody>
</table>

![Number of sources used for drinking](chart.png)
**Water Security Measures**

Access to piped network

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**Secondary Source used when Primary Source not available**

- **Dar es Salaam**
- **Morogoro**

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<table>
<thead>
<tr>
<th>Source</th>
<th>Dar es Salaam</th>
<th>Morogoro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own tap</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Other piped</td>
<td>15%</td>
<td>40%</td>
</tr>
<tr>
<td>Vendors</td>
<td>15%</td>
<td>30%</td>
</tr>
<tr>
<td>Non-Tap</td>
<td>45%</td>
<td>40%</td>
</tr>
<tr>
<td>Bottled</td>
<td>10%</td>
<td>5%</td>
</tr>
</tbody>
</table>
Water Security Measures

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No. times in last 30 days got drinking water from secondary source

Dar es Salaam

Morogoro
Water Security Measures

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Water quality

Dar es Salaam:
4.2 days
95% CI [3.8,4.6]
Alternate question,
Phone Round 3

Morogoro:
3.9 days
95% CI [3.8,4.1]
Alternate question,
Phone Round 3
**Water Security Measures**

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**Seasonal shortages**

Perception of rationing frequency, by season

- **Dar es Salaam**
- **Morogoro**

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- **Wet Season**
  - Often: 20%
  - Rarely: 30%
  - Never: 10%

- **Dry Season**
  - Often: 50%
  - Rarely: 20%
  - Never: 30%
A substantial portion of Dar es Salaam (19%) and Morogoro (30%) residents were concerned about the adequacy of water supply in the past 30 days.
Water Security Measures

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Reported water shock as one of top 3 shocks last 2 years, by SES

Dar es Salaam  Morogoro
# Water Security Measures

- **Access to piped network**
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- **Reported shortages**
- **Reported water shocks**
- **Reported worry about adequacy of water**

## Water quality

### Fecal bacteria

<table>
<thead>
<tr>
<th>Fecal bacteria risk rating</th>
<th>Household</th>
<th>Community</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfactory</td>
<td>90</td>
<td>254</td>
<td>344</td>
</tr>
<tr>
<td></td>
<td>73%</td>
<td>65%</td>
<td>67%</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>34</td>
<td>137</td>
<td>171</td>
</tr>
<tr>
<td></td>
<td>27%</td>
<td>35%</td>
<td>33%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>124</strong></td>
<td><strong>391</strong></td>
<td><strong>515</strong></td>
</tr>
<tr>
<td></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

### Dar es Salaam

- Fecal bacteria risk rating:
  - Satisfactory: 90 (73%)
  - Unsatisfactory: 34 (27%)

### Morogoro

- Fecal bacteria risk rating:
  - Satisfactory: 378 (77%)
  - Unsatisfactory: 116 (23%)

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These tables provide a snapshot of the fecal bacteria risk ratings for households, communities, and overall in Dar es Salaam and Morogoro, indicating the percentage of satisfactory and unsatisfactory ratings in each category.
Fecal colony counts among “unsatisfactory risk” (presence of fecal bacteria) water quality tests

<table>
<thead>
<tr>
<th>Dar-es-Salaam</th>
<th>Morogoro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent</td>
<td>Percent</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
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<tr>
<td>5</td>
<td>5</td>
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<tr>
<td>10</td>
<td>10</td>
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<td>15</td>
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<td>40</td>
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<tr>
<td>45</td>
<td>45</td>
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<tr>
<td>50</td>
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</tbody>
</table>

Water Security Measures
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Water quality
**Water Security Measures**

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**Water quality**

- CDC recommends .5 mg/L chlorine threshold for potable water

- Dar es Salaam
  - Lower Ruvu only 1 of 4 samples taken (June-July) met criteria

- Morogoro:
  - Mambogo only 1 of 8 met criteria
  - Mafiga 7 of 8 met criteria

*Chlorination*
Hot Spot Analysis – Assessing clusters of poor-quality water (fecal bacteria)

- Areas closer to the distribution network are generally less likely to be in areas with hot spots of poor water quality, confirming that those with greater access to the piped network, directly or indirectly, may have safer water.
- In Morogoro, significant hot spots of poor quality in the outskirts of the municipality.

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Water quality
Outcome Measures

- Time spent hauling
- Water Consumption
- Water Expenditures

Households using another piped source for drinking spend the most time hauling water in Dar es Salaam

Time spent hauling water is highly seasonal
Outcome Measures

Time spent hauling

Water Consumption

Water Expenditures

Poorest households are more likely to haul water, controlling for other factors, but...

Controlling for other factors, time spent hauling water is not related to household SES
Households using own tap for drinking and bottled water, consume more water/capita/day than those relying on other sources.

Average consumption estimates are below utility estimates (but piped water estimates similar to utility estimates).
Outcome Measures

Time spent hauling

Water Consumption

Water Expenditures
Outcome Measures

Time spent hauling

Water Consumption

Water Expenditures

Expenditures easier to measure from tap sources (from utility bills)

Those using vendors and bottled water pay higher prices relative to others, especially in Morogoro

Overall, seasonal differences are slight, although expenditures slightly higher in dry season
Outcome Measures

Time spent hauling

Water Consumption

Water Expenditures

WEEKLY WATER EXPENDITURES (TZS/CAPITA) BY SOCIOECONOMIC STATUS: DAR ES SALAAM

WEEKLY WATER EXPENDITURES (TZS/CAPITA) BY SOCIOECONOMIC STATUS: MOROGORO
• **Tap water is preferred** and sought out for drinking in both cities

• **Borehole/shallow well water** is much more abundant in Dar es Salaam, but due to its salinity, it cannot be used for all purposes, including consumption

• **Even those connected rely on other sources** due to irregular schedules and frequent rationing experienced through the network

• **Other sources each present distinct challenges** (collection times, mark-ups)

• **Mixed perceptions about public utility**: respondents believe utilities trying to serve the population well, but frustration about billing and erratic rationing persists

"If water increased… I would no longer have to buy water from wells. I spend [1200 TZS] every day on water, therefore if I pay [utility] bills the cost would be lower:"

"…their water flows once a month; how can I wait for water that comes once a month or once in two months? … One asks, where do all these charges come from? … Even when you open the tap and only air comes out, it reads as if water was flowing."
Haba na haba hujaza kibaba
Acknowledgments

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- Respondents in Tanzania

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Thank you!
Asante sana!