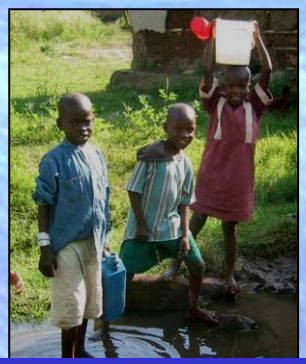


# Kenya Water Project

Michael Pihulic . Suzanne Young . Amber Franz . Brian Loux
Pragnya Alekal . Brian Robinson . Robert Baffrey

Maji, Inc.

Bringing water to the masses

# Kenya


The cradle of civilization

- Population = 31.5 M
- Area = 582,650 sq km (roughly twice the size of Nevada)

Child mortality

**126 deaths per 1000 live births**

http://www.africanaidsaction.org/volunteers.htm

The leading cause

# diarrhea

## a direct result of lack of clean drinking water

**Only 57% of the population has access to an improved water supply**

**30% of the population has to walk over half an hour to get access to water**

# This is the kind of water they get

**There is a solution to Kenya's water crisis…**

**…we want to be a part of that solution**

# MAJI, Inc

- Formed at the Massachusetts Institute of Technology in 2004, in response to the world's water crisis
- A team of highly qualified Environmental Engineers, Scientists and Business Strategists
- Diverse backgrounds, world experience…all committed to finding a solution

*bringing water to the masses*

Maji, Inc.

# MAJI, INC.

## *Overall Goal*

*To aid in Kenya's development and progress towards safe water and sanitation for all.*

# MAJI Focus Areas

- HH Drinking Water Treatment & Storage
  - Filtration: Ceramic filter performance
  - Disinfection: SODIS
  - Storage: Modified clay pots
  - SWS: Technical and Social Evaluation, Implementation
- Program Implementation
  - Household water treatment and storage
- Sanitation
  - EcoSan

# Location

- All over Kenya; mostly Nyanza Province
- 1-5 persons per area
- Collaborations with local NGOs


# Team Projects

1. **AMBER** – Filtration – *Ceramic filter performance*
2. **BRIAN L.** – Disinfection – *SODIS*
3. **SUZANNE** – Storage – *Standardization, Tap Design, and Cost Recovery of modified clay pots*
4. **MIKE** – Storage – *Manufacturing of modified clay pots*
5. **PRAGNYA** – SWS – *Technical and Social Evaluation*
6. **ROBERT** – Program Implementation – *Household water treatment and storage technologies*
7. **BRIAN R.** – Sanitation – *EcoSan*

*(Other Collaborators from Harvard and MIT Sloan)*

# The team “in the field”

# Microbial Filter Study

Amber Franz

# Objective

- Assess the performance of ceramic candle filters that are locally available in Kenya
  - Parameters examined
    - Cost
    - Turbidity Removal
    - Flow Rate
    - Bacterial removal
    - Viral removal

# Filters Studied

- **AquaMaster** (Brazil)
  - $10
- **Doulton Super Sterasyl** (UK)
  - $40
- **Stefani São João** (Brazil)
  - $1.50-$3.00
- **Pelikan** (India)
  - $2
- **Pozzani** (Brazil)
  - $20 ($2.50 in Peru)


# Study Design

- Kenya
  - Test locally contaminated water (Nairobi)
    - Total coliform
    - *E. coli*
  - Test candle filters
    - Turbidity Removal
    - Flow rate
    - Bacterial indicator removal efficiencies
      - Total coliform
      - *E. coli*

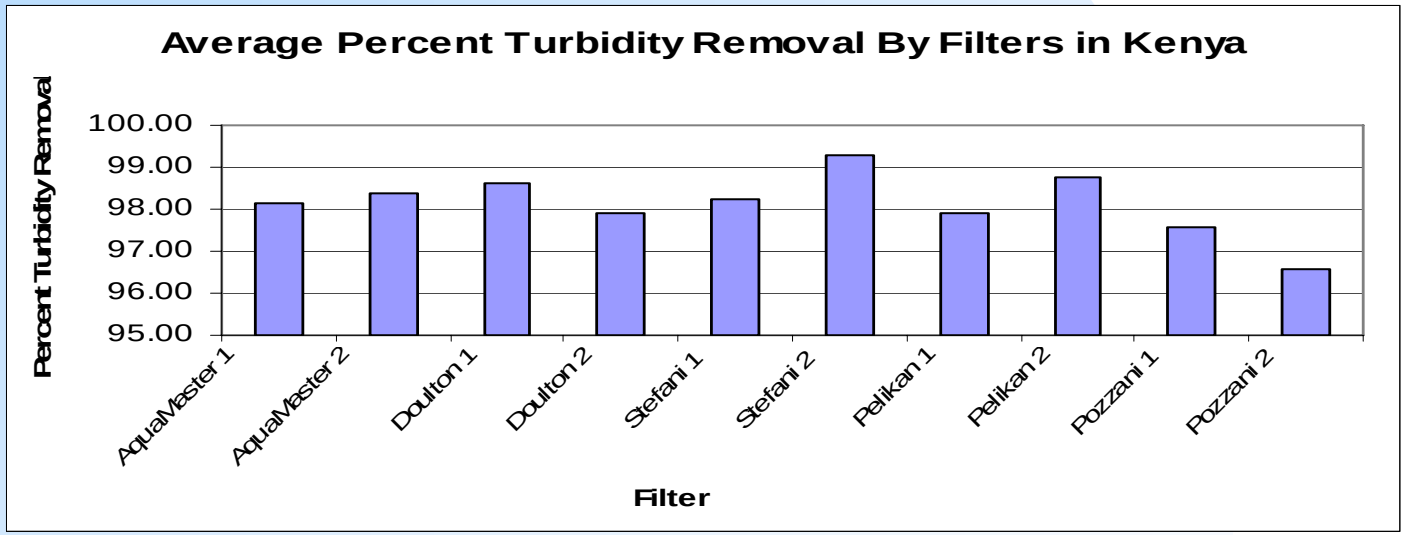
# Study Design

- MIT
  - Test Charles River water
  - Test candle filters
  - Test Pelikan filters
    - Viral indicator removal efficiency
      - MS2 coliphage

# Turbidity Removal Results

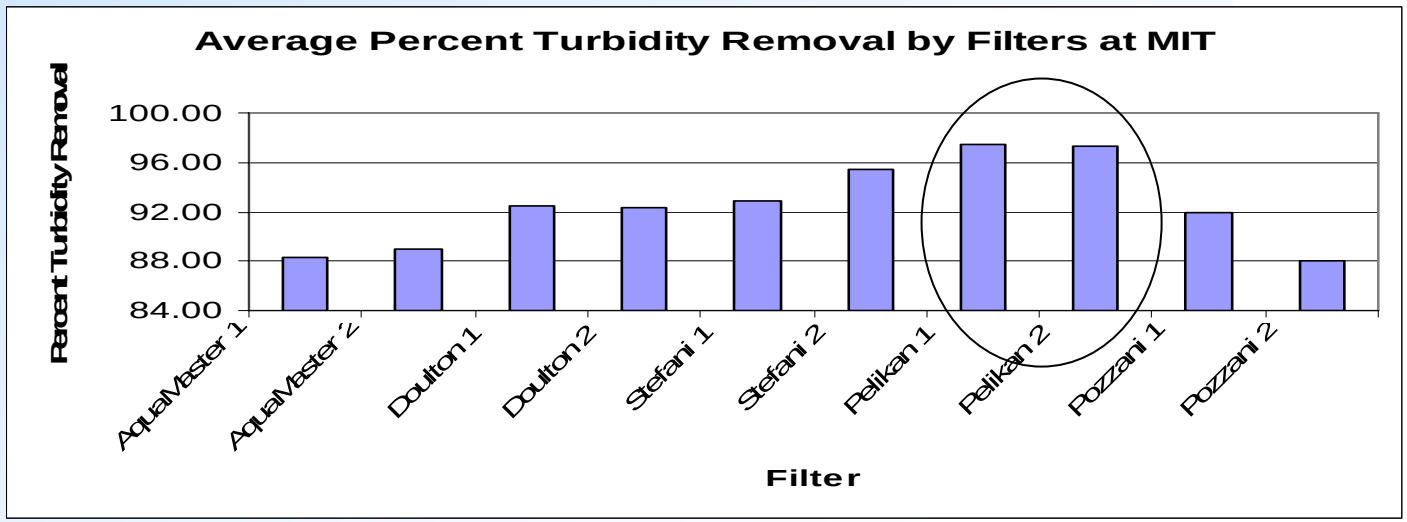
Raw Water Turbidity:

15-31 NTU

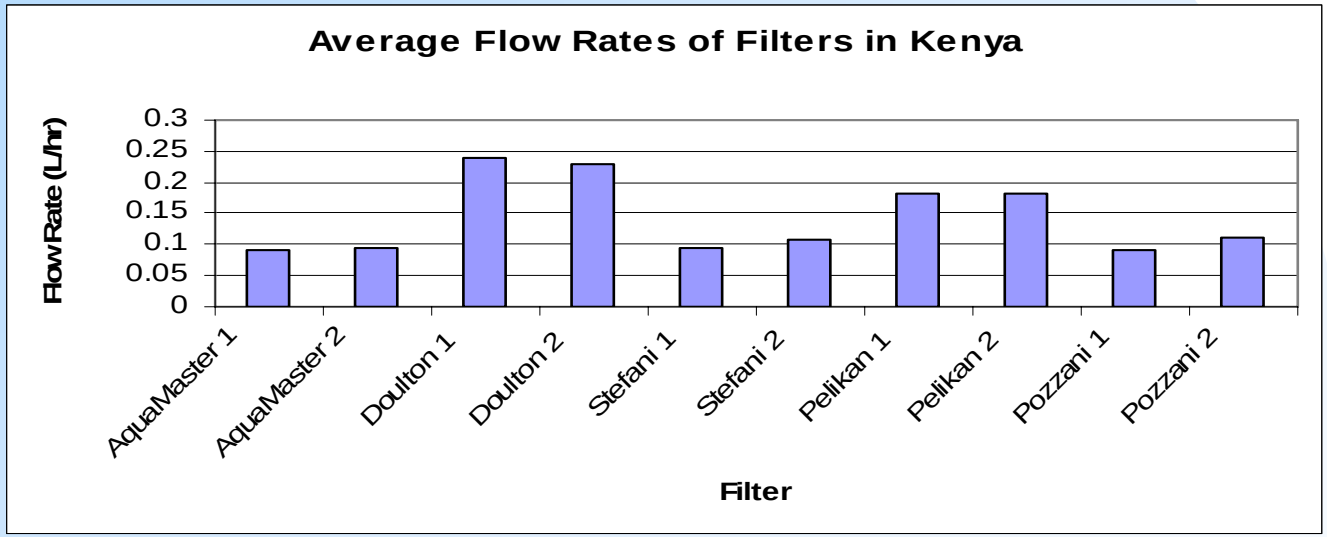


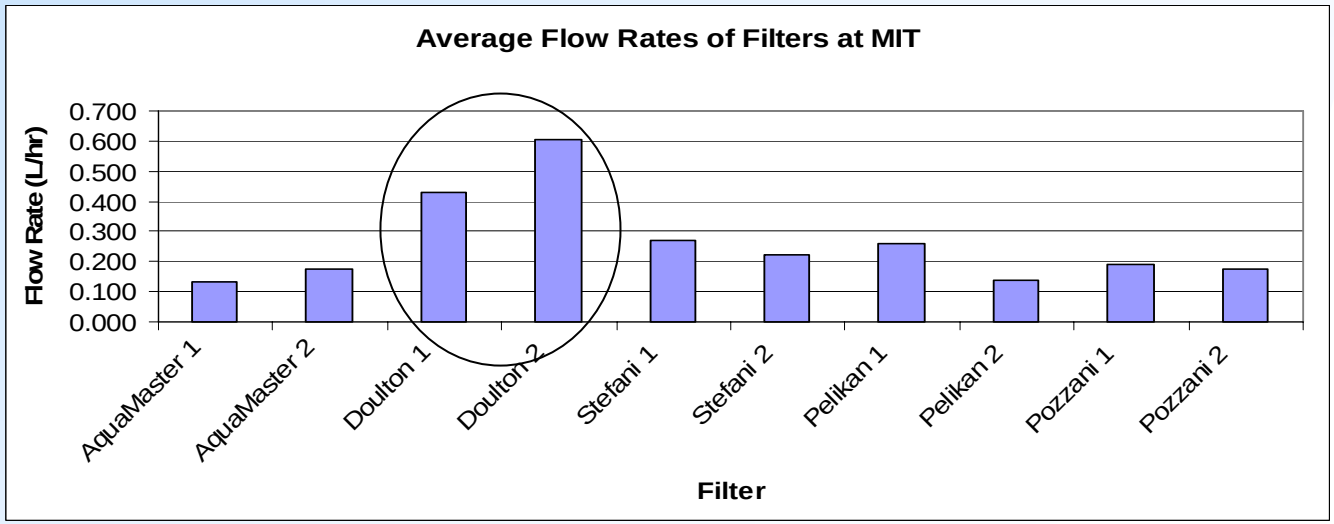

Raw Water Turbidity:

1.8-8.4 NTU



# Flow Rate Results



# Bacterial Removal Results

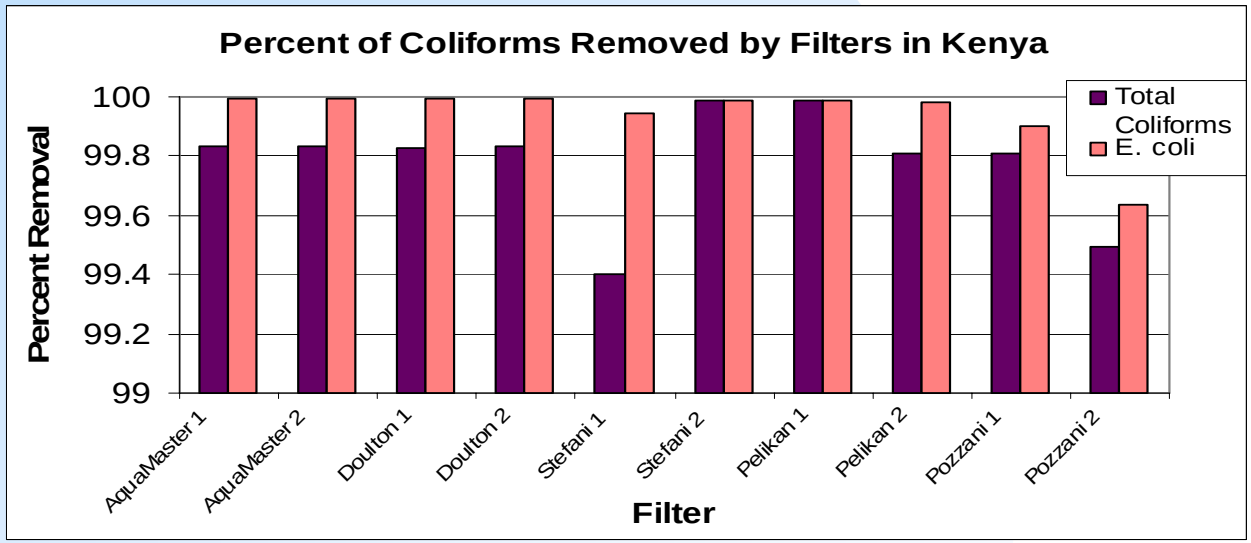
**Diluted Nairobi Source**

***E. coli:***

$2.4x10^4$-$1.2x10^6$ CFU/100 mL

**Total coliform:**

$7.8x10^4$-$1.6x10^6$ CFU/100 mL



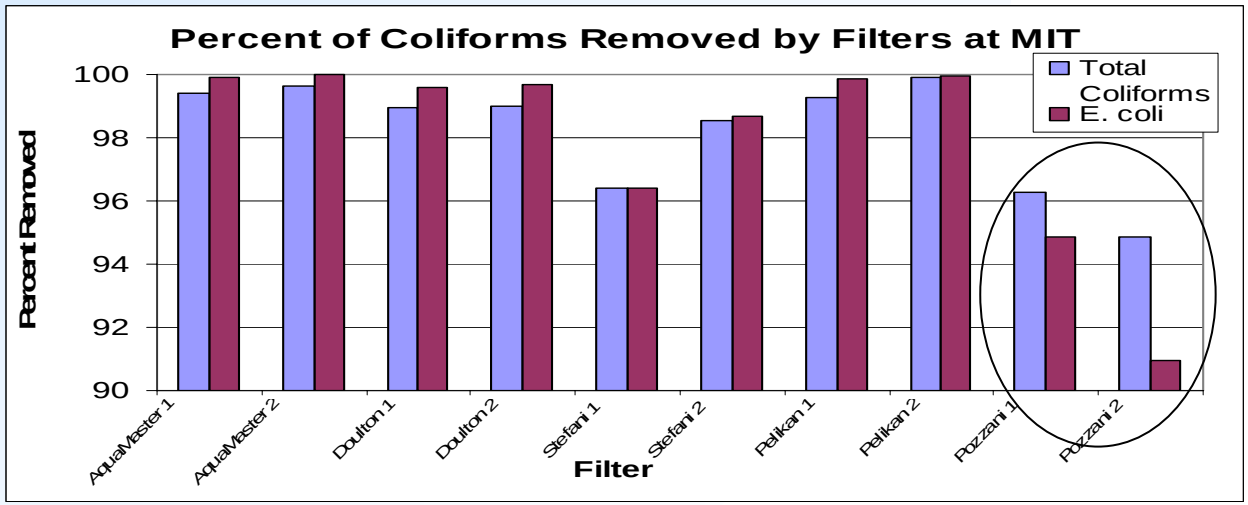

**Charles River Source**

*E. coli:*

$1.4x10^2$-$5.5x10^2$ CFU/100 mL

Total coliform:

$1.4x10^4$-$6.1x10^4$ CFU/100 mL



# Conclusions & Recommendations

- Pelikan filters
  - Good Performance
  - Cheap Price
  - Not effective at removing viruses
- Pre-filtration for turbid waters
  - Sedimentation
  - Coagulation
- Post-filtration
  - Disinfection

# Spirasol: Improvements to Continuous-Flow SODIS

Brian Loux

# Point Of Use Treatment

- Piping Impracticalities
- Questionable Quality
- Hand Contamination

# SODIS

UV irradiation

$OH^- + h\nu \rightarrow {}^*OH^- + e^-$

Heat Pasteurization

Small Amounts

Quantized

Drinking only

# SC-SODIS by Xanat Flores

- Continuous flow
- Straight into home

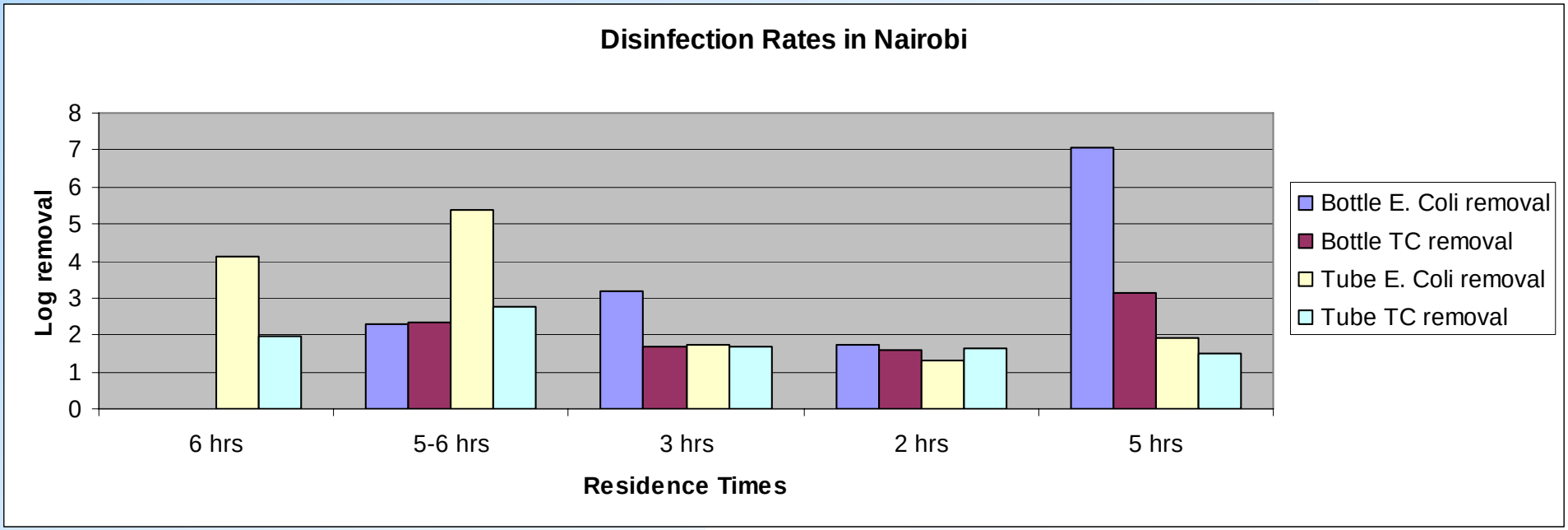
- Multiple pieces
- Potentially expensive
- Difficult to assemble

# Spirasol

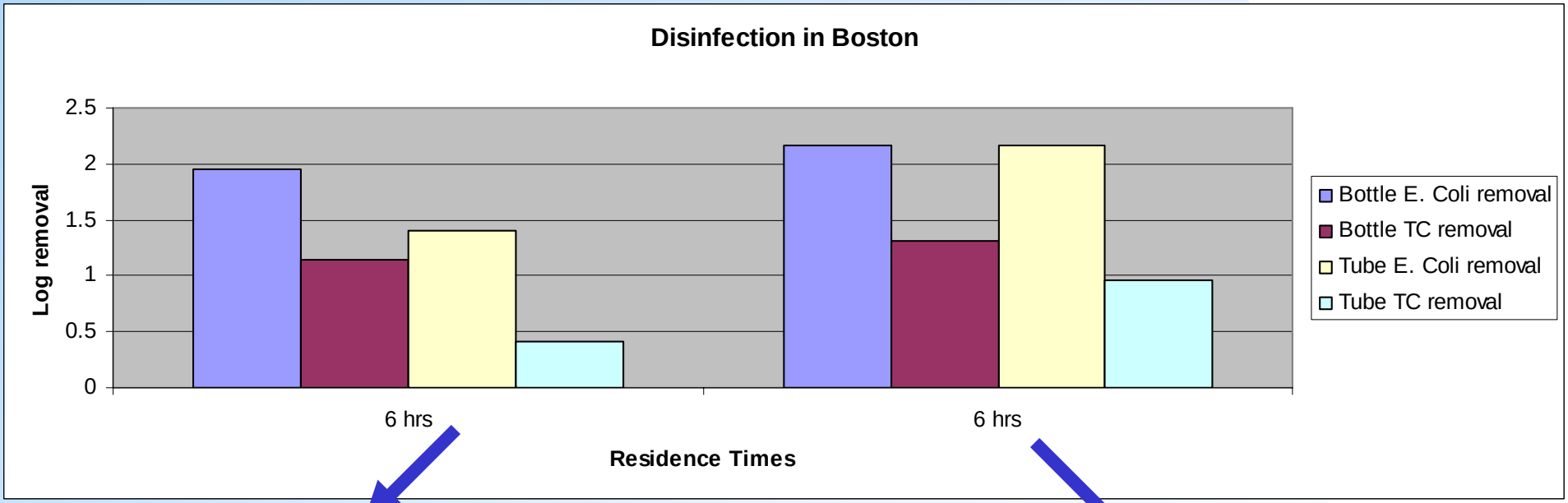
- Compact area
- UV scatter in tube unlikely
- Easy to assemble
- Cheap

# Lab Work

- Compare Spiral Tube to Bottle
- Source: “Nairobi River”
- Membrane Filtration for *E. Coli* and Total Coliform




# Lab Work (continued)





# Future Work

- Efficacy of Plastic
  - Heat, transmissivity, byproducts, strength, etc.
- Oxygen levels
- Flow Control
- Scaled-up applications

# The Modified Clay Pot: Standardization, Taps and Cost Recovery

Suzanne E. Young

# Field Sites


**Asembo:**
**Kinda E Teko Pottery Group**

**Oriang:**
**ORIANG Women's Pottery Group**

**Rangwe:**
**AMILO CBO Pottery Group**



Maji, Inc.

# Modified Clay Pot

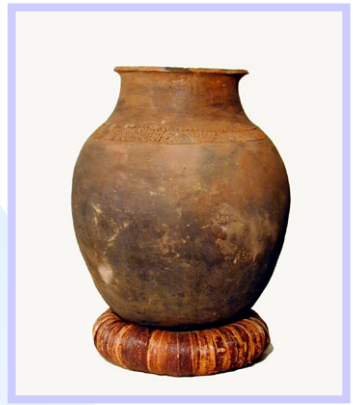
Lid

Narrow mouth

Sediment pouch

Flat base

Metal spigot to access water



Wide mouth clay pot

# Project Goals

- Standardization of pot sizes
  - 20 L , 40 L
- New tap design
- Analysis of cost recovery

# Field Methods

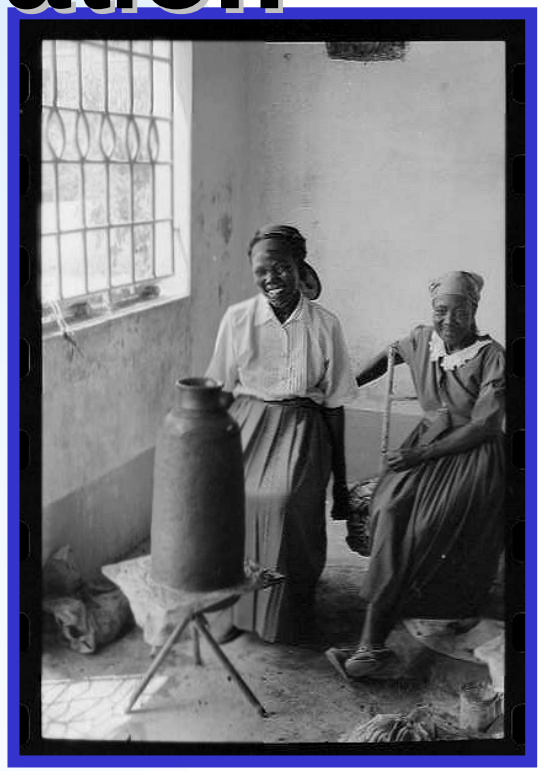
Hard at work at Amilo CBO

- Observation
- Interview
- Trial and error problem solving
- Focus groups

# Results: Standardization

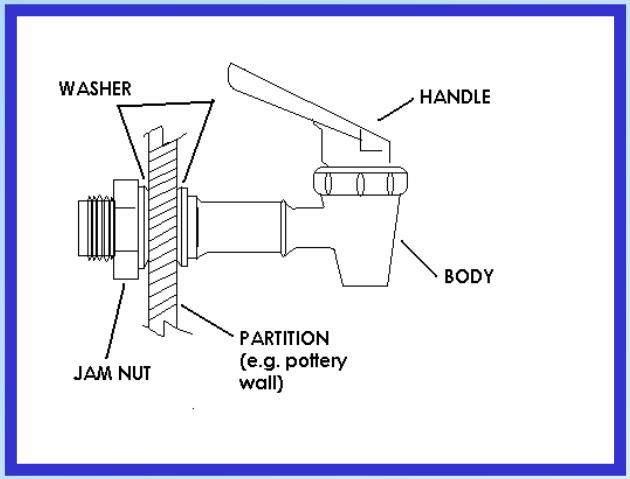
Measuring pots at Amilo CBO: Volume variability +/- 10%

Making pots with metered ropes at Amilo CBO



New shape at Amilo CBO: Cylindrical “milk bottle”

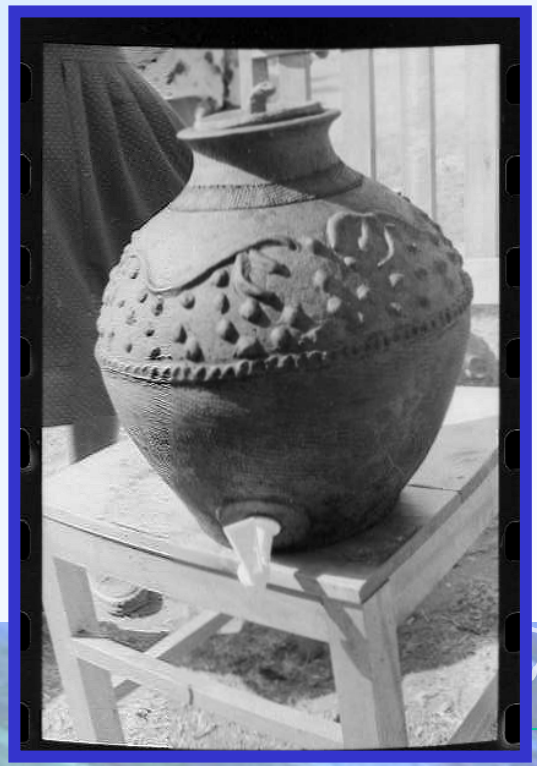
# Results: Taps




Schematic of plastic tap

Attaching plastic tap to unfired pot with flat spot at Oriang

Close up of jam nut used to secure tap on inside of pot at Oriang



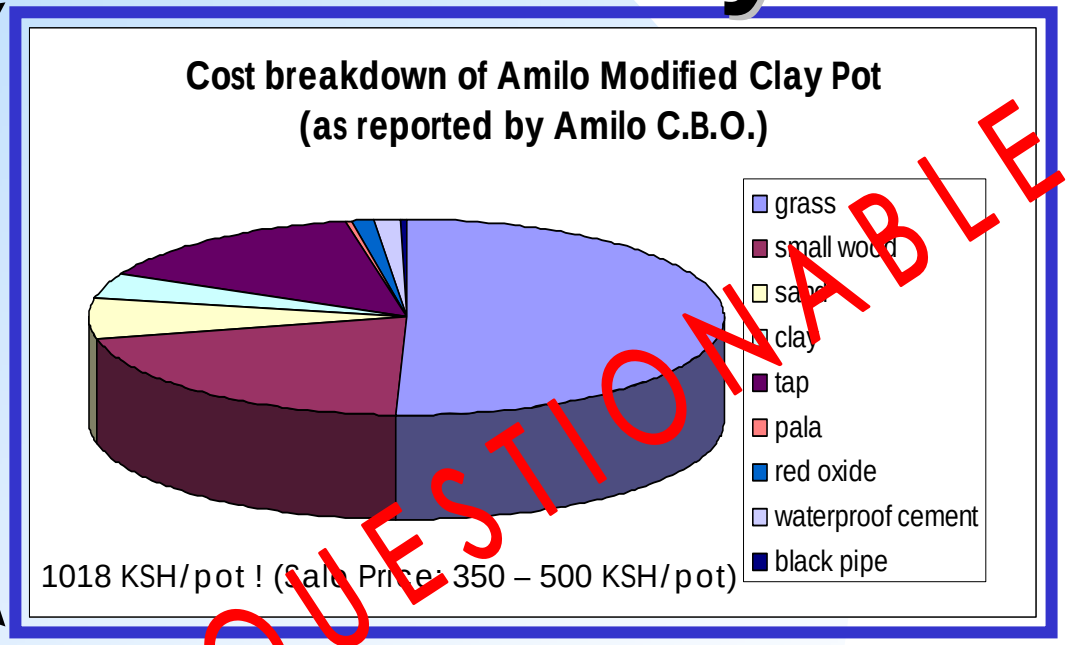
WINNER!

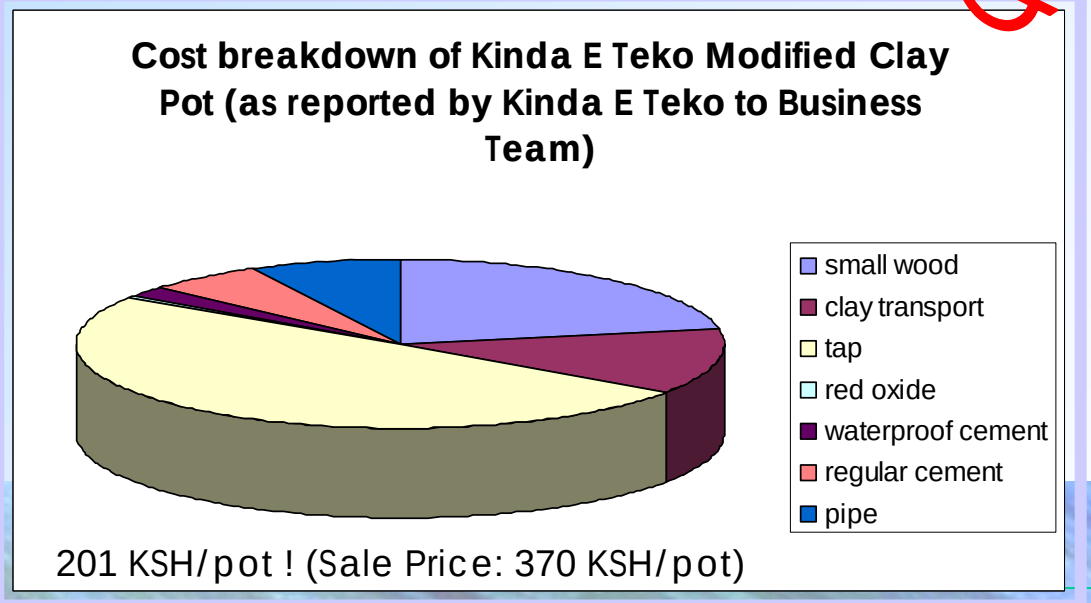
20 L pot with plastic tap at Oriang…

No leaks! ☺

# Results: Cost Recovery

Interview at Amilo C.B.O.




- **Amilo data questionable**
- **Oriang data incomplete**
- **Kinda E Teko data OK**

Maji, Inc.

# Conclusions

- Standardization
  - Volume variability already within 10%
  - Encourage use of tools (e.g. measuring tape, metered ropes) – but account for shrinkage
  - Will cylindrical shape sell?
- Taps
  - Plastic design wins!
  - Next step: Field test
- Cost recovery
  - Need more information / validation

# Production and Manufacture of the Modified Clay Pot

Michael Pihulic

# Objectives

- Observe and Document Manufacturing and Production Process
- Compile Best Practices
- Suggest Improvements

# Methods

- Observed, Photographed, Taped Production Process at Each Site
- Interviewed Potters and Support Organization Staff
- Examine Finished Product

# Production Process

1. Gathering
2. Processing
3. Shaping
4. Decorating
5. Drying
6. Tapping
7. Firing
8. Sealing
9. Tap Preparation
10. Tap Attachment
11. Quality Assurance and Control

# Results

- Production Methods are Variable
- Difficulty Identifying and Isolating Defects
- Little Growth or Experimentation

# Variability in Production

- Group level
  - Materials
  - Funding
  - Techniques

# Variability in Production

- Individual Level
  - Materials
  - Dimensions

# Defects Identification

- Systemic vs. Local
  - e.g. Leakiness of Tap Versus Porosity of Pottery
- Taking Action
  - Eliminating Problems They Have Solutions For
- Quality Assurance and Control

# Experimentation

- No Written Records of Success or Failures
- Limited Sharing of Knowledge Between Groups

# Improvements

- Develop Material Resources
  - Clay Sources
  - Taps
- Develop Tools
  - Standardize Tapping
- Keep Records
- Share Methods
- Quality Assurance and Control

# Evaluation of Water Treatment Options in Nyanza

Pragnya Alekal

Maji, Inc.

# Situation - Water

- Very contaminated
  - morbidity for age 0-5 primarily due to waterborne diseases
- Poor distribution system, if at all
- High turbidity levels, up to 1500 NTU
- Sources include Lake Victoria, streams, springs, ponds, earthpans, boreholes, taps, rainwater, rivers, etc.

# Typical Water Sources

*Photos courtesy of Jody Gibney*

# Situation – socio-economic

- AIDS/HIV infection rate = 25-40%
- High malaria rate
- Life expectancy ~37 years
- Average family income <$0.40/day
- Average family size = 6

# Water Treatment Options


## WaterGuard

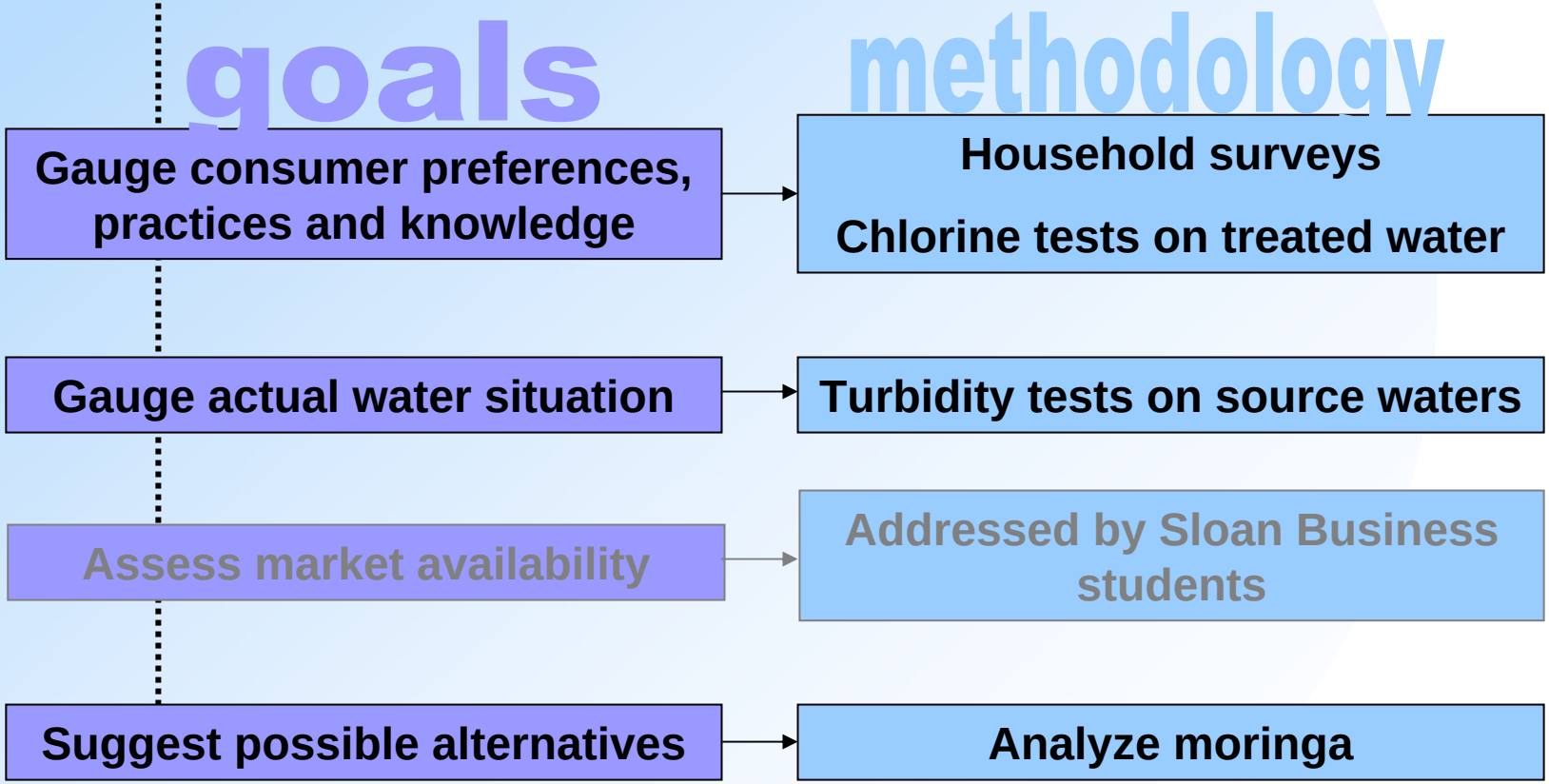
- Developed in conjunction with CDC
- Contains NaOCl
- Only disinfects
- Cost* = $0.56/mo

## PuR

- Developed by P&G
- Contains $Ca(OCl)_2$ and $Fe_2(SO_4)_3$
- Removes turbidity and disinfects
- Cost* = $3.00/mo

* For family of 6

# Evaluate which one is most appropriate…



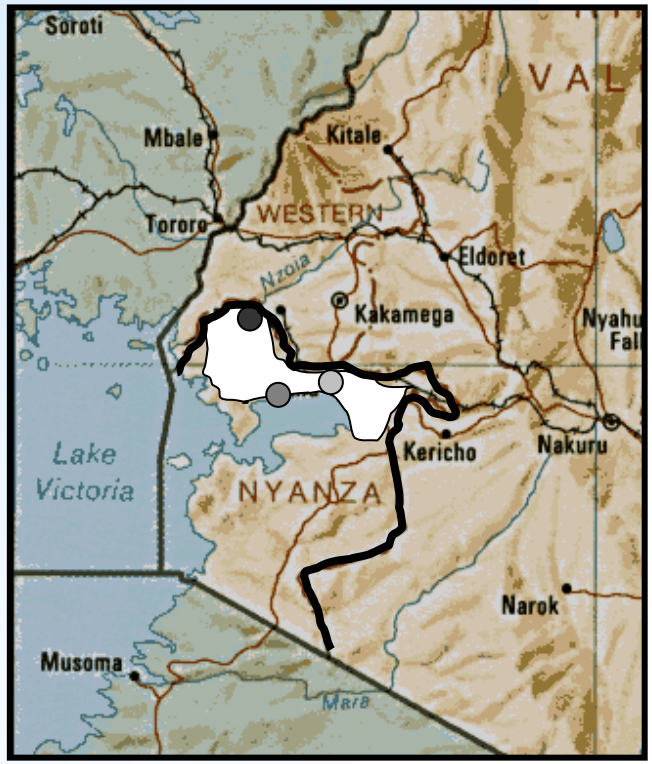
# Analysis: Moringa

| WaterGuard | PuR | Moringa |
|---|---|---|
| By CDC | By P&G | Occurring naturally |
| Contains NaOCl | Contains $Ca(OCl)_2$ + $Fe_2(SO_4)_3$ | Contains bioproteins |
| Disinfects only | Removes turbidity + disinfects | Removes turbidity only |
| Cost* = $.56/month | Cost* = $3.00/month | Cost* = ??? |

*for a family of 6

# Field Work

- 14 communities
- 74 people surveyed



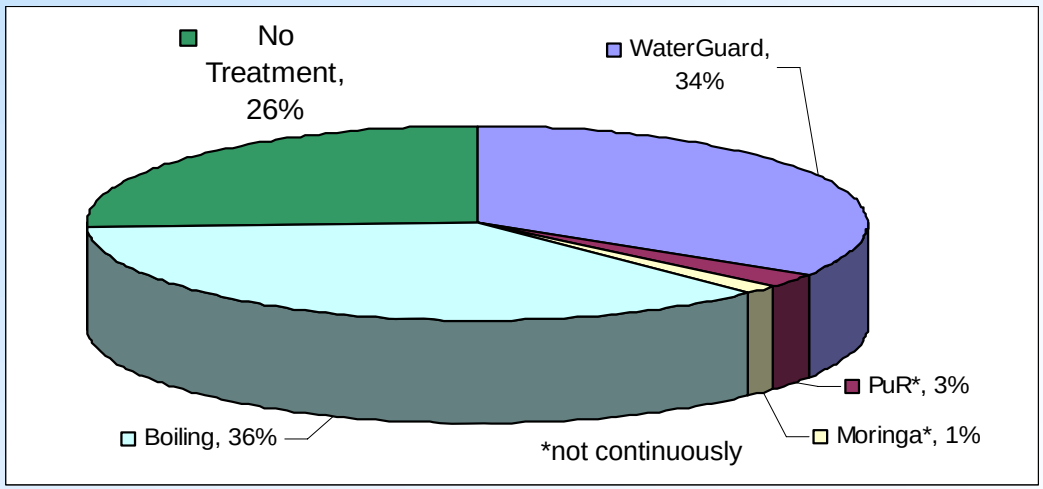
# Results: Source vs Turbidity levels

| Source | Communities (n = 14) | Turbidity (NTU) |
|---|---|---|
| **Tap** | 5 | 0.76 -1.31 |
| **Borehole** | 5 | 0.78 – 95.7 |
| **Pond/Earthpan** | 4 | 8.00 - 42.0 |
| **Rainwater** | 9 | 0.30 – 5.20 |
| **Lake** | 1 | 22.4 |
| **Spring** | 2 | 2.48 – 2.52 |
| **River** | 4 | 7.5 – 59.6 |
| **Tank** | 1 | 25.4 |

- Average measured turbidity = 39 NTU

# Results – Current Practices

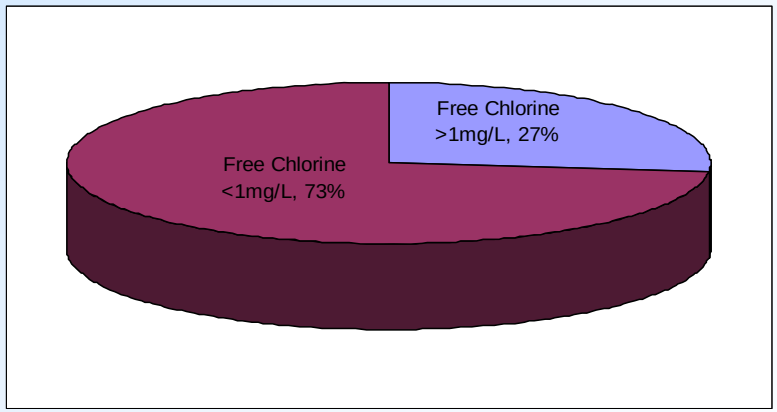
- Product usage




- 52% did not treat or boil rainwater

# Results – WaterGuard Users

- 100% of WaterGuard users reported a stop to stomach-related illnesses
- Safe chlorine levels in Waterguard users:



# Results – observations

- VERY low level of health, product and financial knowledge
- Moringa, in general, is not widely harvested. Moringa Stenopetala has not been studied for water treatment.

# Conclusions - Recommendations

- Conduct education programs
  - on health and water treatment
- If Turbidity
  - < 10 NTU or “looks clear”, use filtration-disinfection
  - 10 < T < 30 NTU or “somewhat clear”, use sedimentation-filtration-single dose disinfection
  - 30 < T < 100 NTU or “not clear” use sedimentation-filtration-double dose disinfection
  - > 100 NTU, or “muddy” use PuR
- Retreatment with WaterGuard every 36 hrs
- Moringa stenopatela needs more research

# Thank You



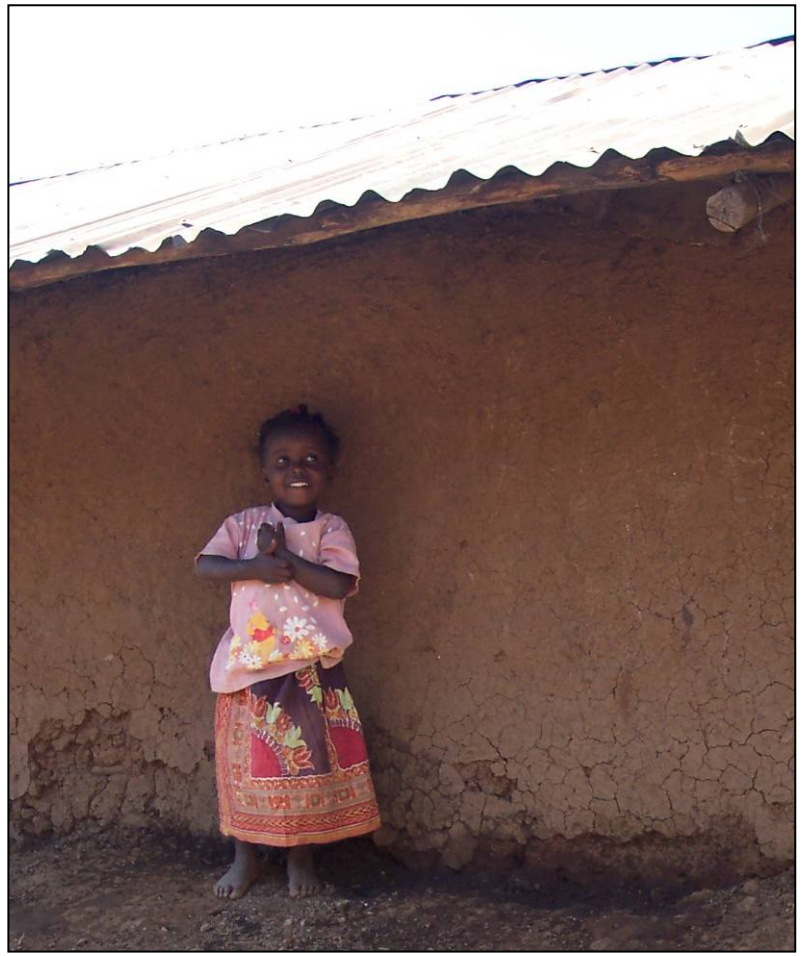

SWAK

Department of Civil and Environmental Engineering

Maji, Inc.

# Program Implementation of Household Water Treatment and Safe Storage Systems

Robert Baffrey



# Goals – The Big Picture

10. Reiteration

1. Problem Awareness

9. Scale-up

2. Problem Definition

8. Implementation

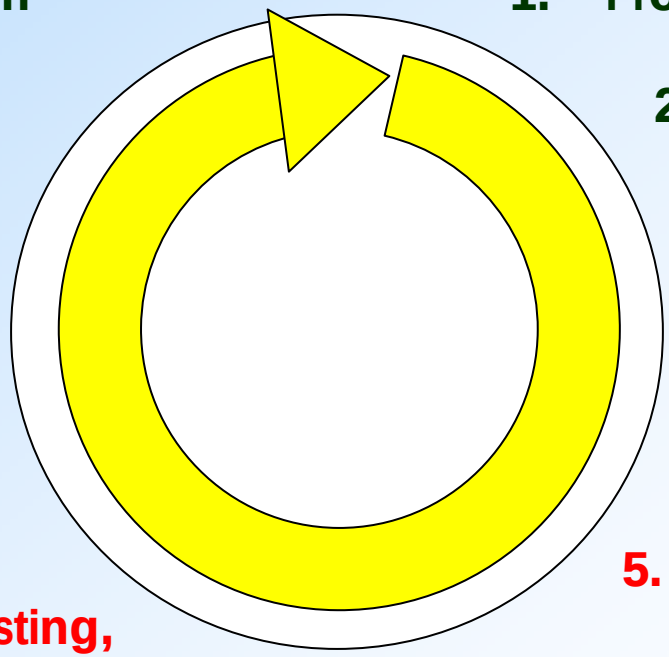
3. Idea Generation

7. Pilot Studies

4. Concept Evaluation

6. Refined Design (Field and lab testing, multiple sites and countries)

5. Field Experience, Fabrication, Experiment, Lab Work



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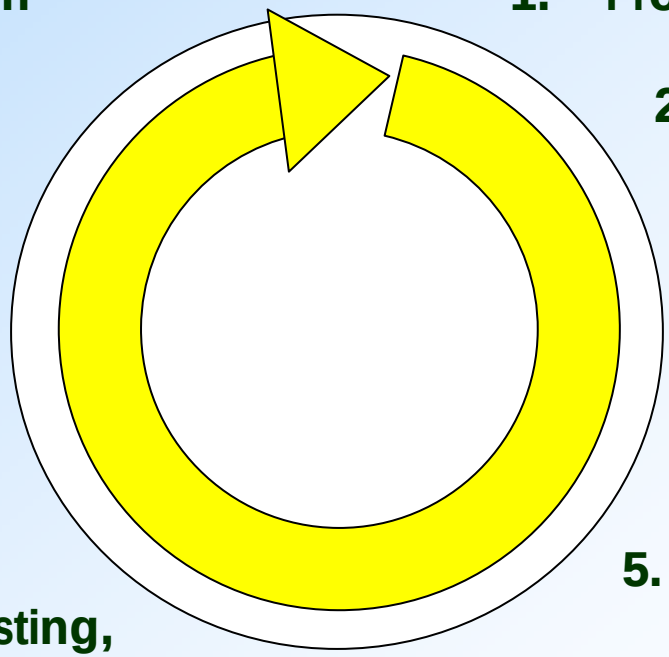


1. Problem Awareness

2. Problem Definition

3. Idea Generation

4. Concept Evaluation

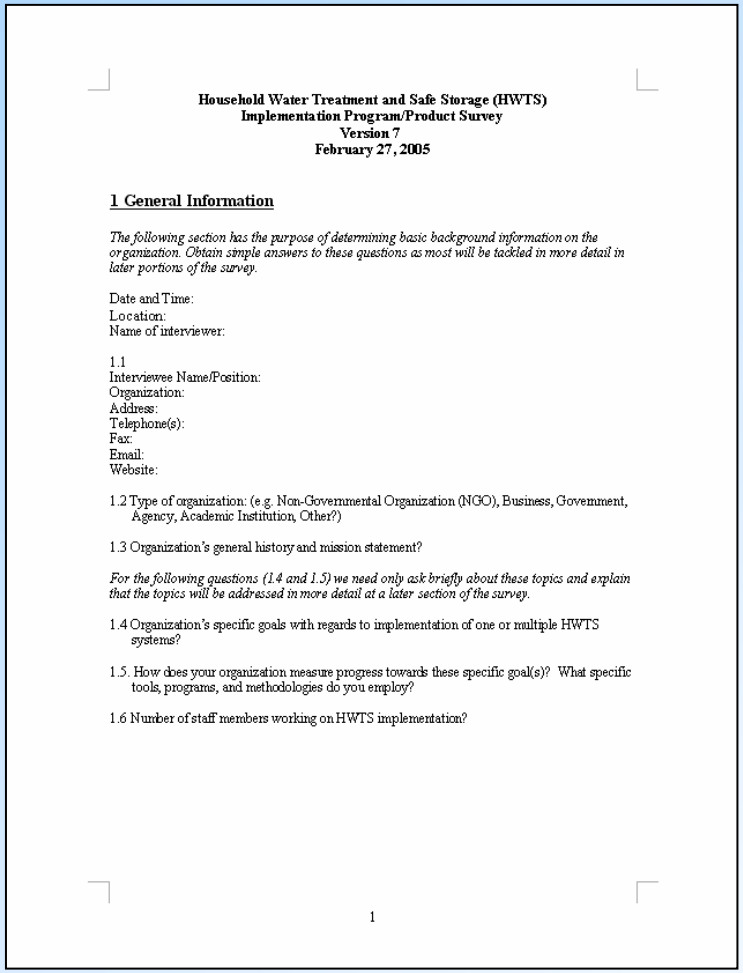
5. Field Experience, Fabrication, Experiment, Lab Work

# Goals – Specific Objectives

- To develop an implementation/evaluation survey to be utilized primarily for evaluating the effectiveness of currently implemented HWTS technology programs.

- To develop a technology selection tool to aid in the selection of appropriate HWTS technologies in local communities of developing nations.

# Methods – The Survey



**Household Water Treatment and Safe Storage (HWTS)**
**Implementation Program/Product Survey**
**Version 7**
**February 27, 2005**

**1 General Information**

*The following section has the purpose of determining basic background information on the organization. Obtain simple answers to these questions as most will be tackled in more detail in later portions of the survey.*

Date and Time:
Location:
Name of interviewer:

1.1
Interviewee Name/Position:
Organization:
Address:
Telephone(s):
Fax:
Email:
Website:

1.2 Type of organization: (e.g. Non-Governmental Organization (NGO), Business, Government, Agency, Academic Institution, Other?)

1.3 Organization's general history and mission statement?

*For the following questions (1.4 and 1.5) we need only ask briefly about these topics and explain that the topics will be addressed in more detail at a later section of the survey.*

1.4 Organization's specific goals with regards to implementation of one or multiple HWTS systems?

1.5. How does your organization measure progress towards these specific goal(s)? What specific tools, programs, and methodologies do you employ?

1.6 Number of staff members working on HWTS implementation?

1

- Length: 18 pages
- Time Required: 1 to 2 Hours
- Target: Organizations Implementing HWTS Programs
- Current Version: 7

# Methods – The Survey

**Sections**

1 General Information
2 Implementation Program / Product Description
3 Target Population and Current Water Use Practices
4 Resource Availability
5 Education and Training
6 Funding
7 Operational Monitoring
8 Target: Health Outcomes
9 Target: Water Quality
10 Target: HWTS System Performance
11 Target: Behavior/Use (Social Acceptability)
12 Costs
13 Other Types of Approaches and Questions
14 Final Thoughts
15 Publications

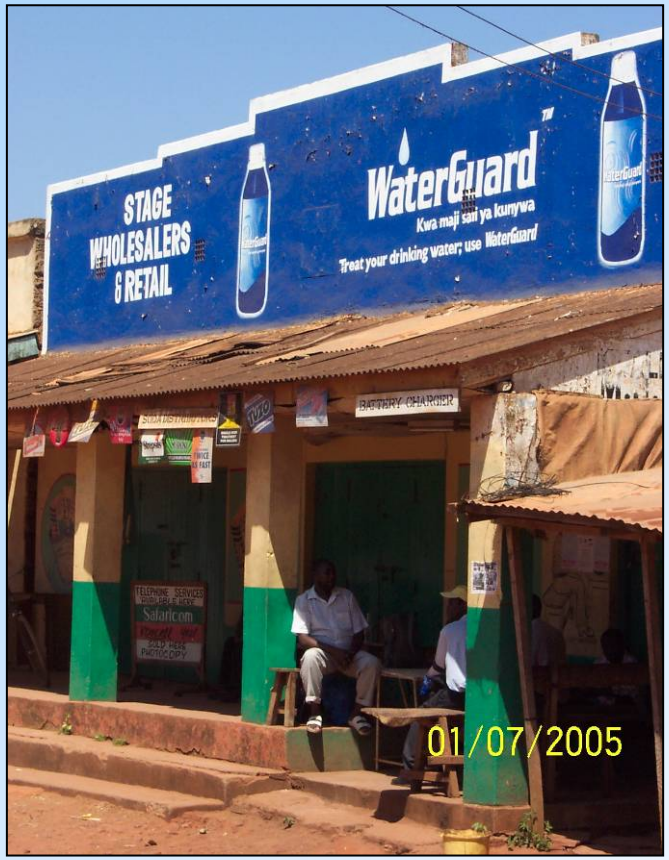
Pre-Implementation

Implementation

# Organizations Visited


- **Nairobi**
  - PSI (Population Services International)
  - NETWAS (Network for Water and Sanitation)
  - KWAHO (Kenya Water for Health Organization)
  - WVI (World Vision International)
  - Ministry of Health
  - Ministry of Water
  - Approtec (Appropriate Technologies for Enterprise Creation)
- **Mombasa**
  - PSI (Population Services International)
- **Machakos**
  - MEDAIR / Bushproof
- **Nakuru**
  - CDN (Catholic Diocese of Nakuru)
- **Mathuru**
  - ACK (Anglican Church of Kenya)
- **Kisumu**
  - PSI (Population Services International)
  - SWAK (Society for Women and Aids in Kenya)
  - KWAHO (Kenya Water for Health Organization)
  - CARE Kenya
  - Women's Pottery Groups

# Organizations Visited





**PSI – Waterguard Chlorination (Mombasa)**

# Organizations Visited


**MEDAIR / Bushproof– BioSand Filtration (Machakos)**

# Organizations Visited


**MEDAIR / Bushproof– BioSand Filtration (Machakos)**

# Organizations Visited




**Catholic Diocese of Nakuru – Bone Char Defluoridation (Nakuru)**

# Organizations Visited



**Anglican Church of Kenya – SODIS (Mathuru)**

# Organizations Visited

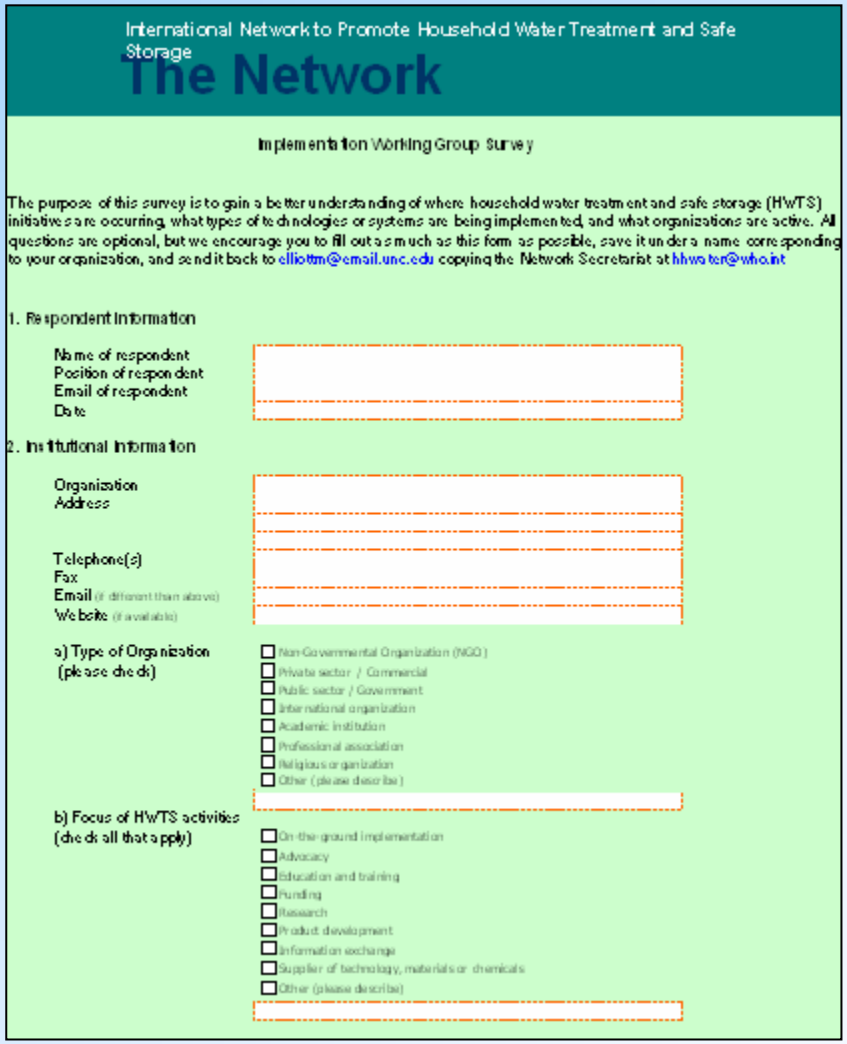



**Society for Women and Aids in Kenya**
**– The Modified Clay Pot (Kenda E Teko Pottery Group, Asembo)**

# Organizations Visited

| Organization | Technology | Location |
|---|---|---|
| Population Services International (PSI) | | |
| Nairobi | Waterguard | Nairobi (Headquarters) |
| Mombasa | Waterguard | Mombasa (Headquarters) / Coast Province |
| Kenya Water for Health Organization (KWAHO) | | |
| Nairobi | SODIS | Kibira District, Nairobi, Nairobi Area |
| Maseno, Western Province | EcoSan Toilets | Maseno, Western Province |
| MEDAIR / Bushproof | Concrete BioSand Filters | Machakos, Eastern Province |
| Network for Water and Sanitation (NETWAS) | Ceramic Candle Filter | Nairobi (Headquarters) |
| World Vision International (WVI) | Safe Water System | Nairobi (Headquarters) |
| Kenya Ministry of Health | - | Nairobi (Headquarters) |
| Catholic Diocese of Nakuru (CDN) | Defluoridation Filters | Nakuru, Rift Valley Province |
| Anglican Church of Kenya (ACK) | SODIS | Eldoret (Headquarters) |
| Society for Women and Aids in Kenya (SWAK) | Waterguard / PuR / Modified Clay Pots | Kisumu (Headquarters) / Western Province |
| CARE | Safe Water System / Modified Clay Pots | Kisumu (Headquarters) / Western Province |
| Appropriate Technologies for Enterprise Creation | Money Maker Pumps | Nairobi (Headquarters) |

# Results – The Survey



International Network to Promote Household Water Treatment and Safe Storage

The Network

Implementation Working Group Survey

The purpose of this survey is to gain a better understanding of where household water treatment and safe storage (HWTS) initiatives are occurring, what types of technologies or systems are being implemented, and what organizations are active. All questions are optional, but we encourage you to fill out as much as this form as possible, save it under a name corresponding to your organization, and send it back to elliottm@email.unc.edu copying the Network Secretariat at hhwater@who.int

1. Respondent Information

Name of respondent
Position of respondent
Email of respondent
Date

2. Institutional Information

Organization
Address

Telephone(s)
Fax
Email (if different than above)
Website (if available)

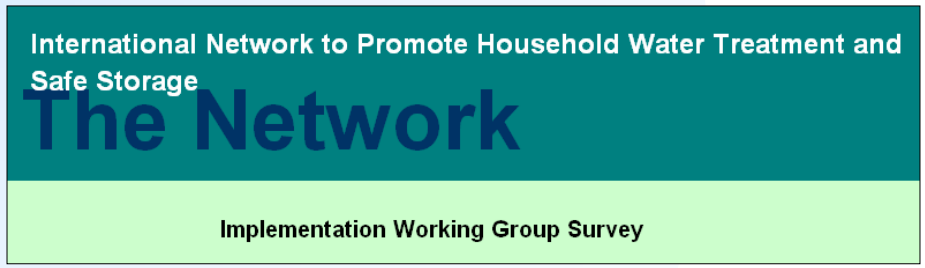
a) Type of Organization (please check)

- ☐ Non-Governmental Organization (NGO)
- ☐ Private sector / Commercial
- ☐ Public sector / Government
- ☐ International organization
- ☐ Academic institution
- ☐ Professional association
- ☐ Religious organization
- ☐ Other (please describe)

b) Focus of HWTS activities (check all that apply)

- ☐ On-the-ground implementation
- ☐ Advocacy
- ☐ Education and training
- ☐ Funding
- ☐ Research
- ☐ Product development
- ☐ Information exchange
- ☐ Supplier of technology, materials or chemicals
- ☐ Other (please describe)

## A Web-Based Collection Tool Being Implemented by the World Health Organization



International Network to Promote Household Water Treatment and Safe Storage

The Network

Implementation Working Group Survey

http://www.who.int/household_water/implementation/en/

# Results – The Selection Tool

- Aims aid in the selection of appropriate HWTS technologies in local communities
- Based on data collected in Kenya.
- Intended for use by implementing organizations and local communities.
- Two versions: electronic and hard-copy.
- Prompts user for information on parameters that are used to compute scores which in turn rank HWTS technologies in terms of applicability.
- Two types of parameters: site-specific and technology-specific.

# Results – The Selection Tool

**Site-Specific Parameters**

| Parameter | Suggested Weight (/1000) |
|---|---|
| Target Population | |
| Size | 40 |
| Density (Urban/Rural) | 40 |
| Average Household Size | 40 |
| Age Demographics | 40 |
| Literacy Rate | 40 |
| Water Source (Type, Turbidity, Microbial Contamination) | 120 |
| Water Use Practices, Access, and Transport | 100 |
| Occurrence of Disease (Prior Studies Conducted) | 100 |
| Local Government (Structure and Involvement) | 60 |
| Presence of Implementing Organizations (NGOs) | 60 |
| Economic Considerations (Family Wealth Information, Willingness-to-Pay, Funding) | 150 |

# Results – The Selection Tool

**Technology-Specific Parameters**

| Parameter | Suggested Weight (/100) |
|---|---|
| **CERAMIC CANDLE FILTRATION** | |
| Resource Availability | 20 |
| Mass Media Presence | 40 |
| Available Local Distributors | 40 |
| **BIOSAND FILTRATION** | |
| Resource Availability | 30 |
| Skilled Labor Availability | 30 |
| Technical Support Availability | 40 |
| **SOLAR DISINFECTION (SODIS)** | |
| Resource Availability | 40 |
| Technical Support Availability | 20 |
| Exposure to Sunlight | 40 |

# Results – The Selection Tool

**Technology-Specific Parameters (Continued)**

| Parameter | Suggested Weight (/100) |
|---|---|
| **CHLORINATION (WATERGUARD)** | |
| Resource Availability | 20 |
| Mass Media Presence | 40 |
| Available Local Distributors | 40 |
| **COMBINED FLOCCULATION / DISINEFECTION (PUR)** | |
| Resource Availability | 20 |
| Mass Media Presence | 40 |
| Available Local Distributors | 40 |
| **BOILING** | |
| Resource Availability | 100 |

# Results – The Selection Tool

## Sample Scoring

**Population Density (Urban/Rural)**

Suggested Weight: 40/1000 (4%)

Information requested:
__ Urban (>500 people/square mile* or >1,300 people/square kilometer)
__ Rural (<500 people/square mile* or <1,300 people/square kilometer)
*Source: United States Census 2000

Suggested Scoring:

| Technology | Urban | Rural |
|---|---|---|
| Ceramic Candle Filtration | 40/40 | 30/40 |
| BioSand Filtration | 30/40 | 20/40 |
| Solar Disinfection | 30/40 | 25/40 |
| Chlorination | 40/40 | 30/40 |
| Combined Floc/Dis | 40/40 | 30/40 |
| Boiling | 30/40 | 40/40 |

# Results – The Selection Tool

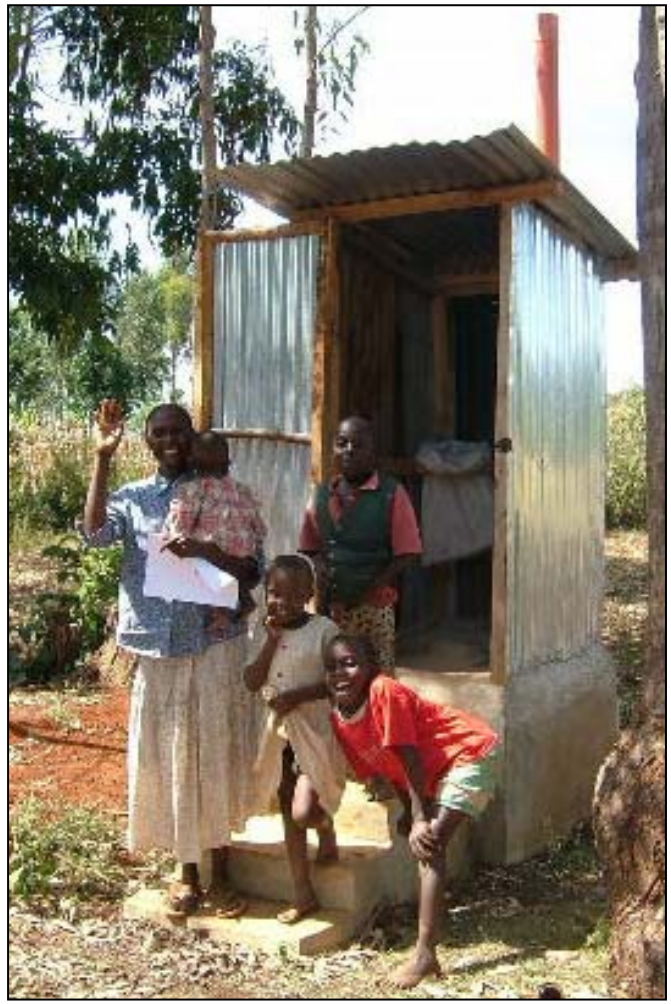
## Sample Scoring – Luna, La Union, Philippines

| Technology | Site-Specific Score | Technology-Specific Score | Total Score |
|---|---|---|---|
| Ceramic Candle Filtration | 665/1000 | 80/100 | 745/1100 |
| BioSand Filtration | 680/1000 | 90/100 | 770/1100 |
| Solar Disinfection | 580/1000 | 70/100 | 650/1100 |
| Chlorination | 720/1000 | 90/100 | 810/1100 |
| Combined Flocculation/Disinfection | 690/1000 | 90/100 | 780/1100 |
| Boiling | 520/1000 | 60/100 | 580/1100 |

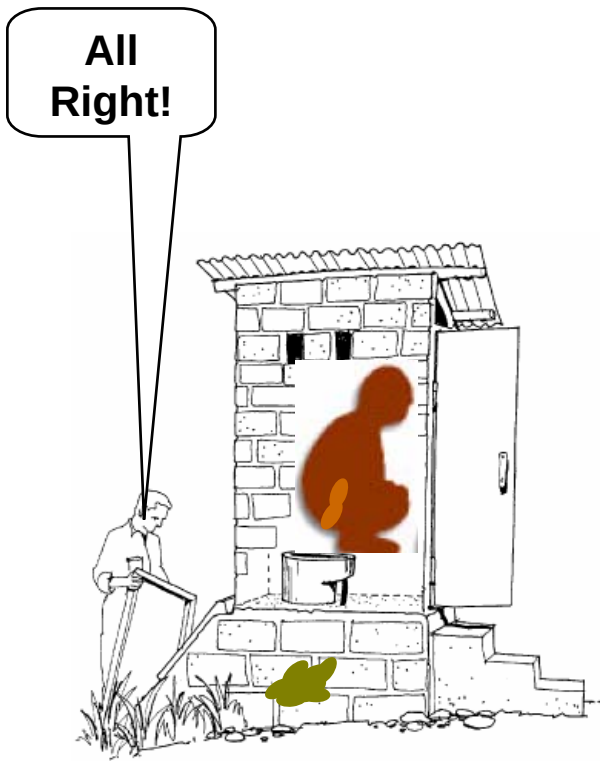
| Technology | Total Score | Rank |
|---|---|---|
| Chlorination | 810/1100 | 1 |
| Combined Flocculation/Disinfection | 780/1100 | 2 |
| BioSand Filtration | 770/1100 | 3 |
| Ceramic Candle Filtration | 745/1100 | 4 |
| Solar Disinfection | 650/1100 | 5 |
| Boiling | 580/1100 | 6 |

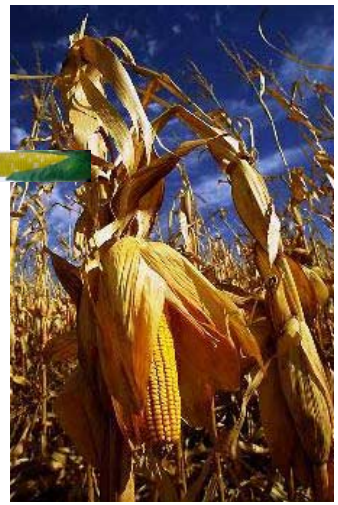
# The Agricultural Potential and Usability of Ecological Sanitation

Brian E. Robinson



# Ecological Sanitation



# Site Background


Town: Kombewa

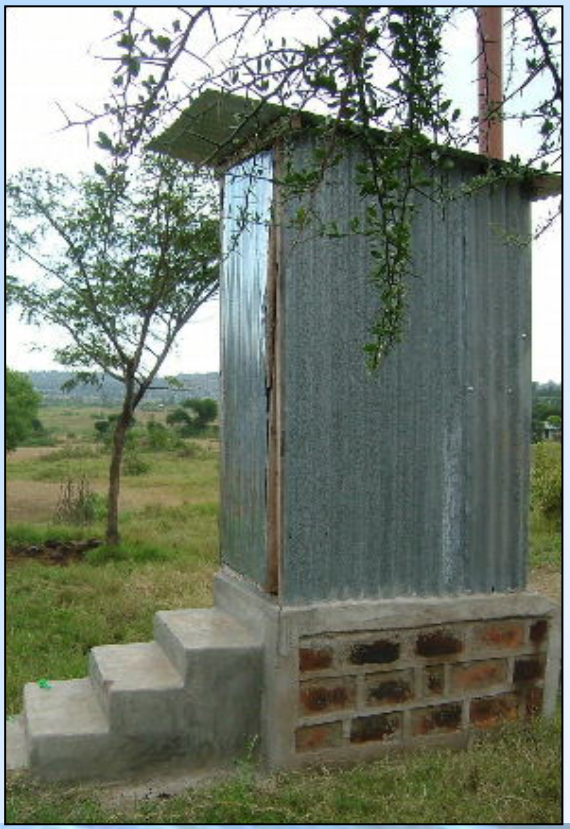
All households:

- Rural
- Practice household agriculture
- Low income

Toilets: 33 urine-diverting Skyloos

# The Skyloo

## Decomposition by Dehydration



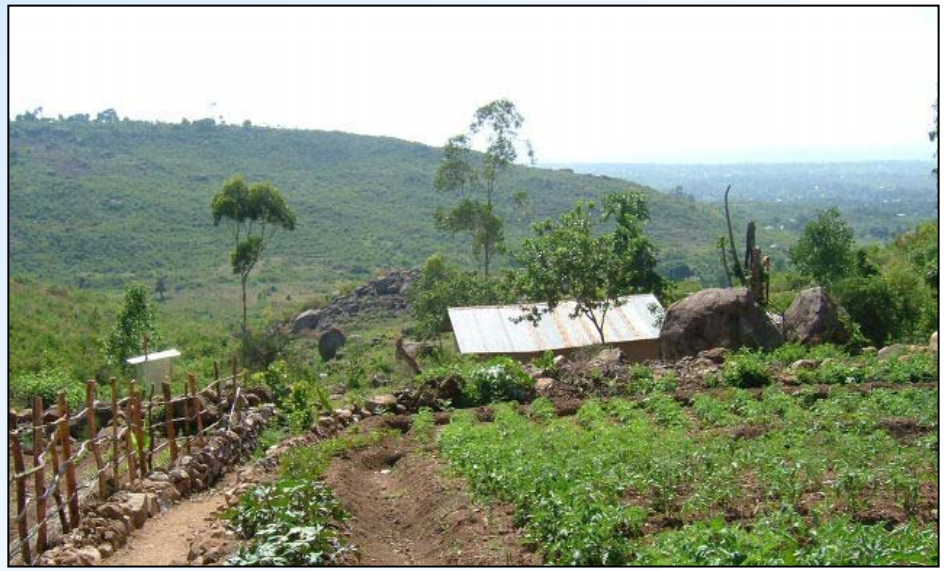
- Dry sanitation
- Add ash, soil, or lime to feces
- Storage: 6-12 months

**Urine diversion** makes drying feces easier!

# Goals

1) Agricultural value of the urine

2) Reuse methods



3) …Other drivers for demand

# Methods

- Laboratory analysis of urine samples

- Interviews with households
- Interviews with organizations

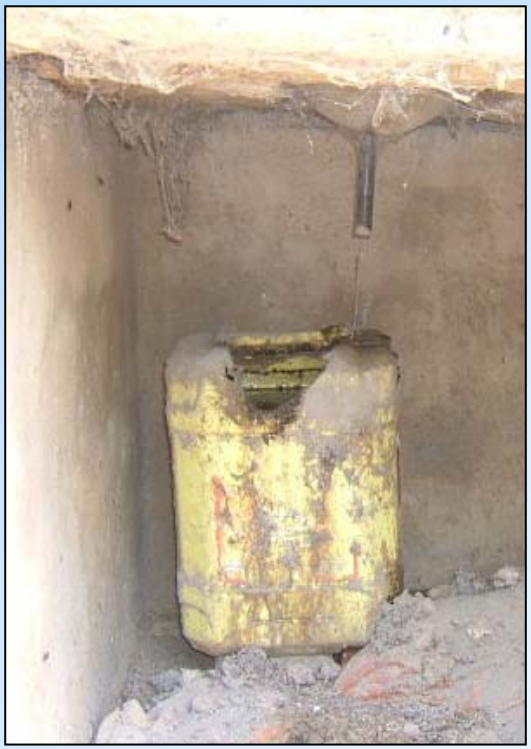
# Analytic Results: Agricultural Value

Family of 4 adults ➔ **~ 3 Kg of N / year**
**~ 0.4 Kg of P / year**

Same nutrients in **a hectare** (10,000 $m^2$) of fresh corn, spinach and watermelon

# Survey Results: Urine Reuse

n=26 people



Urine

- 67% of households claim to reuse the urine in farming
- 33% dump it out

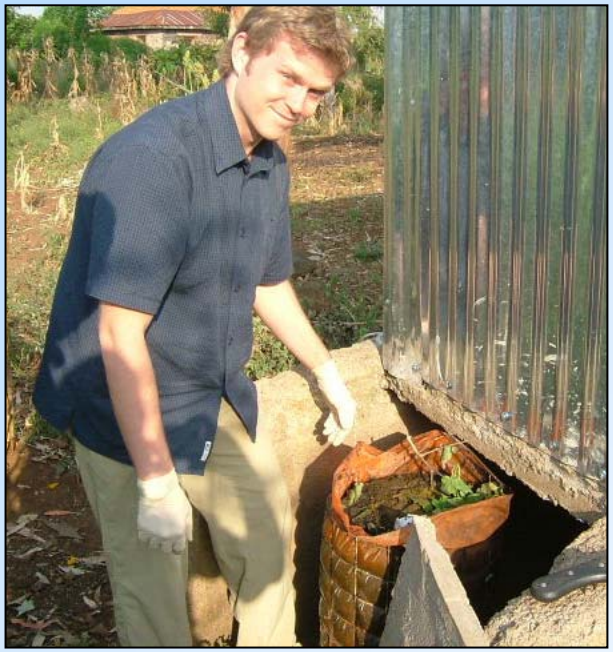
Storage time

Recommended: 1 month

Actual: 2 months (average)

# Survey Results: Feces Reuse

n=26 people



Feces

- 65% reuse the feces
- 28% bury feces

Storage time

Recommended: 6 months

Actual: 4½ months (average)

# Results: Demand Drivers

- **Recycling Process**
  - + "I like my manure"; "This toilet doesn't smell!"
  - – "If you don't have a strong heart, you could vomit"
- **External Factors**
  - + "My pit latrine floods"; " The soil here is too loose"
  - – "Granny can't squat or get up the stairs"
- **Physical Characteristics**
  - + "It adds beauty to my home"
  - – "The chamber is too small"
- **Financial Factors**
  - + "The manure saves me money"
  - – Dependent on NGO-subsidized materials?

# Conclusions

**Why would people want to use this?**

- Urine and feces have direct agricultural value
- Other advantages to the toilet, could they be just "putting up with" the recycling aspects?

**Recommendations**

- Marketing of the toilet can focus on aspects other than just recycling
- Target areas with poor soil conditions
- More training for users (re: storage time)

# Overall Project Conclusions

Individual project contributions

Applications beyond Kenya

Future research

# Individual Contributions

- **Filtration**
  - Identified most effective ceramic candle filters
- **Disinfection**
  - Improved SODIS design
- **Storage**
  - Best Practices for each pottery site
- **SWS**
  - Turbidity-based selection of product; retreatment after 36 hours
- **Program Implementation**
  - Survey and decision making tools
- **Sanitation**
  - Agricultural potential and usability

# Applications beyond Kenya

- **Filtration**
  - Basis of comparison for related and future ceramic candle filter research
- **Disinfection**
  - Spirasol may be more valuable in areas with less solar intensity
- **Storage**
  - Improved modified clay pot may have applications to other African countries, esp. in refugee camps and hospitals
- **SWS**
  - Identified appropriate products for use in various conditions
- **Program Implementation**
  - Evaluation survey and selection tool adoptable by organizations such as WHO
- **Sanitation**
  - People want *nice* toilets in addition to practical/resourceful toilets

# Future Research

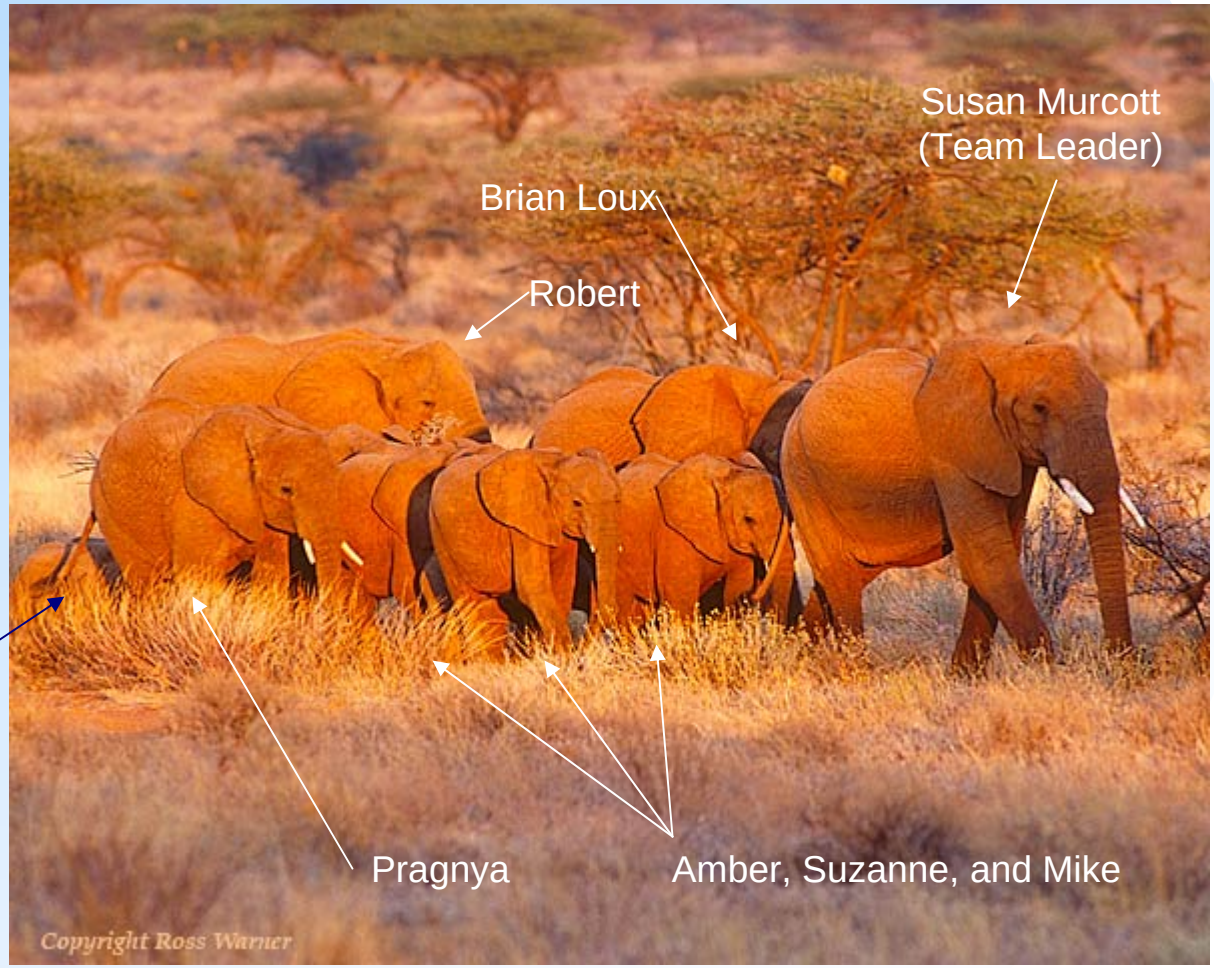
- **Filtration**
  - Further testing , esp. filter performance over time and viral removal, on more ceramic candle filter brands
- **Disinfection**
  - Further testing of SODIS variables; Scale up system; Determine first world applicability
- **Storage**
  - Field test of plastic tap performance
- **SWS**
  - Field-based research for sedimentation, cloth filtration, and chlorine disinfection
- **Program Implementation**
  - Supplement evaluation survey and selection tool with more accurate information; Apply to other programs
- **Sanitation**
  - Field-evaluation of nutrient content of feces; Further evaluation of application methods

# ERO KAMANO

(Thank you in Luo dialect of Nyanza Province)

- Susan Murcott
- Eric Adams
- Teammates: Sloan (Ellen, Mark, Rachel, Jody) Harvard School of Public Health (Jill Baumgartner)
- Organizations
  - Centers for Disease Control (Daniele Lantagne, Rob Quick)
  - NGOs- Kenya Water and Health Organization (KWAHO), CARE-KENYA, Society of Women with Aids in Kenya (SWAK), Population Services International (PSI), Network of Water and Sanitation (NETWAS), Catholic Diocese of Nakuru (CDN), Bushproof, Samitarian's Purse.
  - Kenyan Government (Water Resources Authority, Pollution Control Division)

# Questions?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