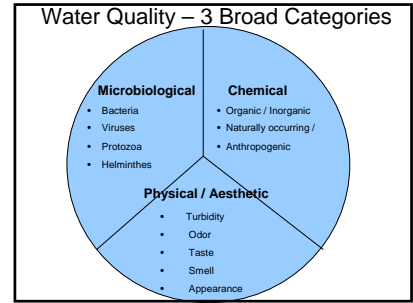


Status of Implementation, Critical Factors and Challenges to Scale up of Household Water Treatment and Safe Storage Technologies

Susan Murcott, Consultant
Academy for Educational Development - Hygiene Improvement Program
May 2006

Water Quality Categories



Microbiological Contaminants

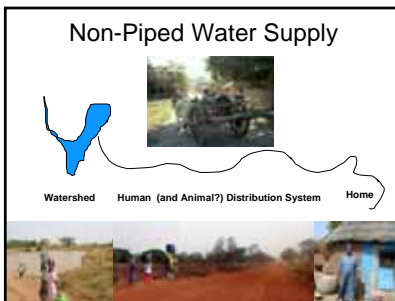
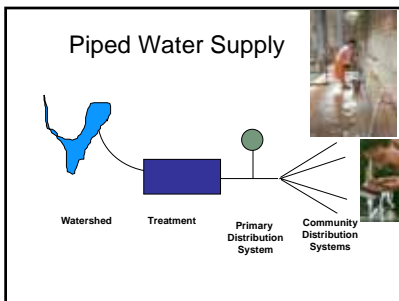
- "Infectious diseases caused by pathogenic bacteria, viruses, protozoa and helminthes are the most common and widespread health risk associated with drinking water."
- (WHO, 2004. *Guidelines For Drinking Water Quality* 3rd Ed. p. 123)

Multiple Barrier Approach: A Watershed-based, Systems Approach to Water Safety

- "Securing the microbial safety of drinking water supplies is based on the use of multiple barriers, from catchment to consumer, to prevent the contamination of drinking water and to reduce contamination to levels not injurious to health. Safety is increased if multiple barriers are in place, including protection of water resources, proper selection and operation of a series of treatment steps and management of distribution systems (piped or otherwise)."
- (WHO, GDWQ, 2004)

Multiple barriers to protect drinking water are applied in various locations

- Watershed (Source) Protection**
- Treatment: centralized and decentralized**
- Piped Distribution: safe distribution to the public standpipe or home compound**
- Non-piped - Community and Household Distribution: safe transport from the source to the point-of-use**
- Storage: reservoirs, community and home storage**



HWTS Technologies (presented in Fact Sheets in Appendix A)

Examples of Household Safe Storage and Water Treatment Processes and Systems

- I. Safe Storage**
 - 1. Plastic or modified clay pot safe storage containers
- II. Disinfection**
 - 2. Boiling
 - 3. SODIS
 - 4. Household chlorination
- III. Particle Removal Technologies**
 - 5. Cloth Filtration
 - 6. Ceramic Filters
 - Carafe Filters
 - Pot Filters
 - 7. Biosand Filters
 - 8. Coagulation/Precipitation Only
- IV. Combined Systems**
 - 9. Coagulation/Precipitation + Chlorine Disinfection (e.g. PUR)
 - 10. Filtration + Chlorine Disinfection (e.g. Gift of Water Filter)
 - 11. Filtration + Disinfection + Aesthetics (Hindustan Lever, Pure-It)
- V. Chemical Removal Systems (not covered in this presentation)**

1 Water Storage

Current Means of Water Transport

CDC Safe Storage Vessel Characteristics

- Standardized volume (10 - 30 liters), with handles shaped to facilitate transport and use.
- Durable, easy-to-clean material.
- Inlet diameter between 6 and 9 cm
- Durable spout or spigot allowing a discharge rate of 1 liter per 15 seconds at outlet.
- Instructions for use, cleaning container and disinfecting its contents permanently attached to vessel.

Safe Storage Products

CDC Safe Storage Vessel Oxfam Safe Storage Modified Clay Pot

Disinfection

2 Boiling

Photo: Jeff Albert, Aquaya

3 Household Chlorination

- Household Chlorination using locally produced and distributed chlorine solution.
- Safe Water Storage in plastic containers with narrow mouths, secure lids and dispensing spigots to prevent recontamination.
- Education: Influence hygiene behaviors and increase awareness about the dangers of contaminated water and waterborne disease.

The "Safe Water System" Approach

Safe Water System Products

This is a simple picture of the actual water treatment solution bottles that are sold under different brand names in 7 countries, Bolivia, Peru, Zambia, Uganda (in yellow), Kenya, India, and Madagascar.

Pros and Cons of Household Chlorination / "Safe Water System" Approach

- | | |
|--|--|
| <ul style="list-style-type: none"> • PROS • Applied properly and with a water that is not excessively turbid, this provides a safe, disinfected water supply • Residual chlorine is simply measured • Clinically proven • Inexpensive | <ul style="list-style-type: none"> • CONS • Chlorine taste and smell • Some customers only use it sporadically, like "medicine" or just for their young children • Must wait 30 minutes before drinking treated water • Chlorine availability • Storage issues |
|--|--|

Cost = about \$7 to \$10 per family per year



4

Solar Disinfection (SODIS)

What is SODIS?

- PET plastic bottles exposed to solar radiation for 1-2 days to disinfect drinking water
- Variations:
 - Exposure time
 - Clear, black or reflective surface

SODIS

- SODIS was invented by Prof. A. Acra *et al.* of American University of Beirut, Lebanon in 1982.
- Researchers at the Swiss Federal Institute of Environmental Science and Technology (ETH-EAWAG/SANDEC) took up extensive studies of SODIS beginning in 1991.
- MIT students have investigated SODIS in Nepal and Haiti since 1999.



Pros and Cons of Solar Disinfection

<ul style="list-style-type: none"> • PROS • Scientifically proven • Highly effective against a wide range of microbial contaminants • PET plastic bottles widely available 	<ul style="list-style-type: none"> • CONS • User acceptance and sustained behavior change? • Weather dependency • Must expose bottles 1 day for safe water • Users in hot climates may reject hot water
--	--

Cost = about \$1 per family per year

Filter

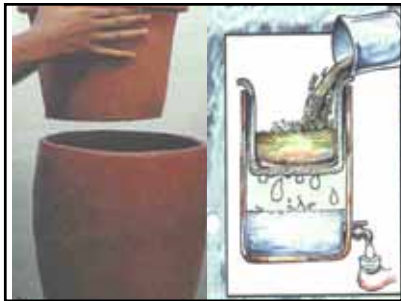
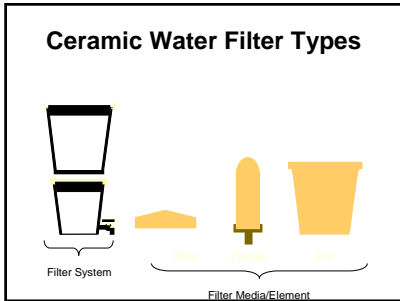
5 Cloth Filtration for Guinea Worm or Cholera Removal



Pros and Cons of Cloth Filters

- PROS
- Effective at removal of guinea worm
- Simple and readily available
- CONS
- Must be kept clean so as not to be a source of other microbial contamination
- Does not address other possible contaminants of concern

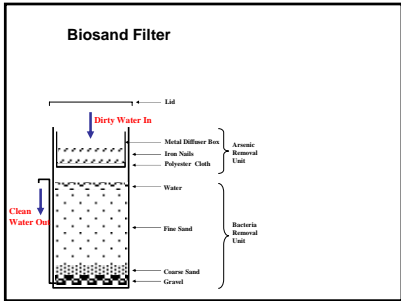
Cost = \$0.10 – 1.00



Pros and Cons of Ceramic Filters

- PROS
- About 90 – 99% removal of bacteria
- Can be constructed of local materials (clay, sand, concrete, plastic) by local producers and create local jobs
- CONS
- Requires regular cleaning once filter becomes clogged
- Flow rates are slow and may not provide sufficient water quantity
- Ceramics can break if handled improperly

Cost = about \$5 - \$40



Pros and Cons of Biosand Filters

- PROS
- About 90 – 99% removal of bacteria
- Can be constructed of local materials (clay, sand, concrete, plastic) by local producers
- Can create local jobs
- High flow rate compared to many other household systems
- Extremely durable
- CONS
- Requires proper maintenance
- Does not provide safe water protection in the first 1-2 weeks of use, while the biological layer develops.
- Must be properly maintained by cleaning about once per month
- Does not provide safe water directly after regular cleaning

Cost = about \$15 - \$75 depending on size and materials

Coagulation



Jar Testing of Coagulants – a standard approach using a flocculator is shown



Photo: Frederick Chagnon, 2003

8 Manual Coagulation (with Alum)



Water Treated through Manual Coagulation with Alum



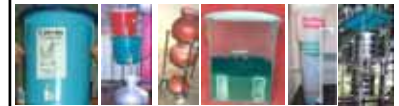
- 30 seconds under ~ 1.5 rotations per second
- 10 minutes under .5 rotations per second
- 30 minutes under 0 rotations per second

Water Treated through Manual Coagulation with Alum



Raw Water Coagulation Regime Settling Time
0 min 30 min

Membrane Processes

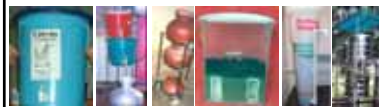


Reverse Osmosis (RO)



Image: <http://www.lenntech.com/images/rofiltration-unit.jpg>

Combined Treatments



9 Coagulation-Disinfection Product

PROS

- Combines turbidity removal with microbial disinfection
- Measurable chlorine residual
- Simple to use
- Visually impressive improvement in water clarity.
- Clinically proven

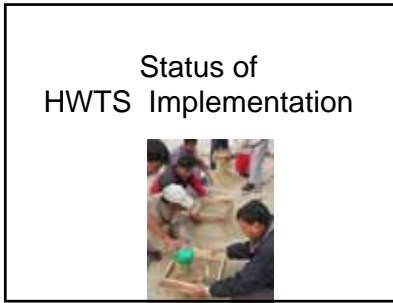
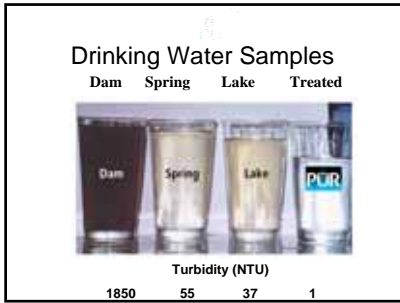
CONS

- Comparatively expensive
- Customers use it sporadically as "medicine" and/or only for young children
- Issues with user acceptance
- Available in limited number of countries



Proctor and Gamble

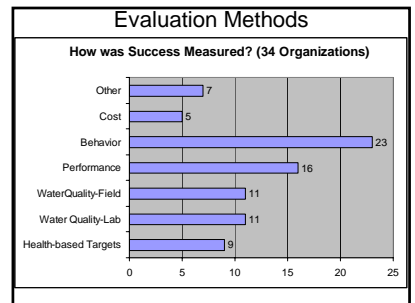
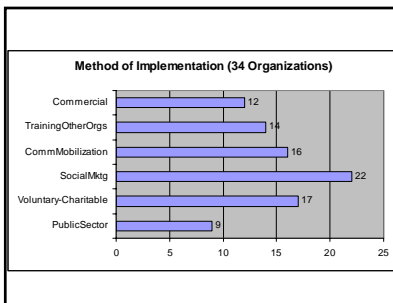
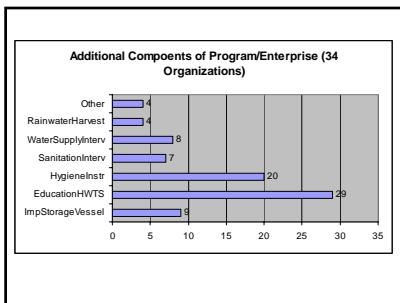
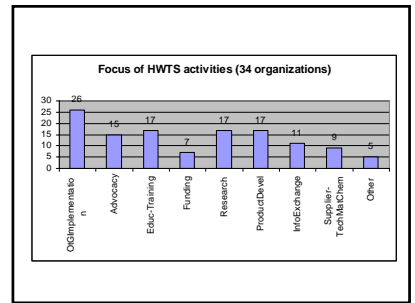
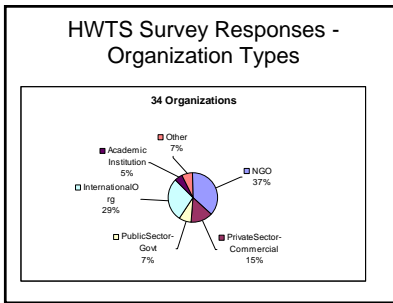
Cost = about \$0.05/sachet or about \$80/year per family depending on use



- ### Summary Statistics on HWTS Mapping
- **36 respondents** from implementing organizations to date representing > 1/2 of the Network's 70+ members
 - **53 countries** with HWTS projects
 - **8 HWTS technologies**

Implementation Organization Survey

- Current Version: 1
- Length: 4 pages
- Target: HWTS Implementation Organizations
- Time Required: 30 Minutes
- http://www.who.int/household_water/implementation/en/





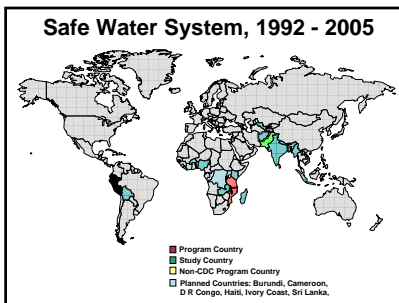
- ### 16 Safe Storage Countries
- Afghanistan
 - Burkina Faso
 - Guyana
 - Haiti
 - India
 - Kenya
 - Madagascar
 - Malawi
 - Mozambique
 - Myanmar
 - Nigeria
 - Rwanda
 - Uganda
 - United Republic of Tanzania
 - Uzbekistan
 - Zambia



- ### 8 Boiling Countries
- Bolivia
 - Brazil
 - Ecuador
 - El Salvador
 - Guatemala
 - Honduras
 - Nicaragua
 - Zambia



- ### 29 Household Chlorination Countries
- Afghanistan,
 - Bangladesh,
 - Bolivia,
 - Brazil,
 - Burkina Faso,
 - Ecuador,
 - El Salvador,
 - Guatemala,
 - Guyana,
 - Haiti,
 - Honduras,
 - India,
 - Indonesia,
 - Kenya,
 - Lao,
 - Madagascar,
 - Malawi,
 - Mozambique,
 - Myanmar,
 - Nepal,
 - Nigeria,
 - Pakistan,
 - Philippines,
 - Rwanda,
 - Tanzania,
 - Uganda,
 - Uzbekistan,
 - Vietnam



- ### 34 SODIS Countries
- Argentina
 - Bhutan
 - Bolivia
 - Brazil
 - Burkina Faso
 - Cambodia
 - Cameroon
 - China
 - Colombia
 - Congo
 - Ecuador
 - El Salvador
 - Ethiopia
 - Guatemala
 - Haiti
 - Honduras
 - India
 - Indonesia
 - Kenya
 - Kingshasa
 - Madagascar
 - Nepal
 - Nicaragua
 - Pakistan
 - Peru
 - Philippines
 - Senegal
 - South Africa
 - Sri Lanka
 - Thailand
 - Togo
 - Uganda
 - Uzbekistan
 - Viet Nam



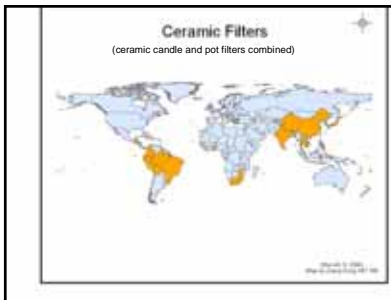
8 Ceramic Pot Countries

- Cambodia
- Ecuador
- Ghana
- India
- Nepal
- Nicaragua
- Thailand
- Vietnam



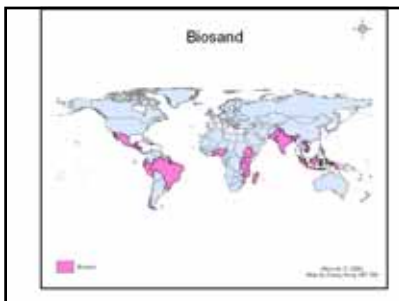
20 Ceramic Candle Filter Countries

- Bolivia
- Brazil
- Cambodia
- China
- Colombia
- Dominican Republic
- Guatemala
- Guyana
- Haiti
- India
- Japan
- Korea
- Peru
- Sierra Leone
- South Africa
- Sri Lanka
- Switzerland
- United Kingdom
- United States
- Zimbabwe



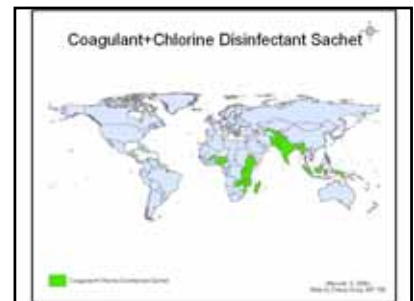
23 Ceramic Filter Countries – All Types

- Bolivia
- Brazil
- Cambodia
- China
- Colombia
- Dominican Republic
- Ecuador
- Ghana
- Guatemala
- Guyana
- Haiti
- India
- Japan
- Korea
- Nepal
- Nicaragua
- Peru
- Sierra Leone
- South Africa
- Sri Lanka
- Thailand
- Vietnam
- Zimbabwe



25 Biosand Filter Countries

- Brazil
- Cambodia
- Dominican Republic
- Ecuador
- El Salvador
- Ethiopia
- Ghana
- Guatemala
- Haiti
- Honduras
- India
- Indonesia
- Kenya
- Lao PDR
- Madagascar
- Mexico
- Mozambique
- Nepal
- Nicaragua
- Nigeria
- Pakistan
- Peru
- Tanzania
- Uganda
- Vietnam



19 Coagulation + Chlorine Disinfection Sachet Countries

- Afghanistan
- Burkina Faso
- Ethiopia
- Haiti
- India
- Indonesia
- Kenya
- Madagascar
- Malawi
- Mozambique
- Myanmar
- Nigeria
- Pakistan
- Rwanda
- Sri Lanka
- Uganda
- United Republic of Tanzania
- Uzbekistan
- Zambia

