



GH₂O
Consultants

Drinking Water Solutions for the Northern Region of Ghana

Final Presentation

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Ghana Background

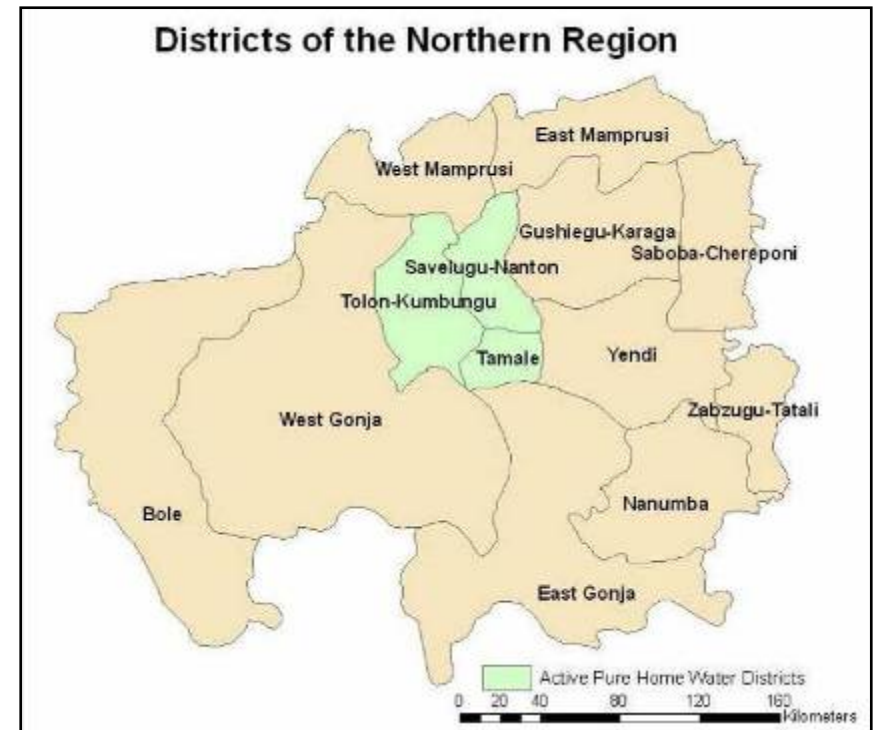


www.ashesi.org/GHANA/map.gif

- Land area of 240,000 km²
- Population of 22.5 million
- Official language is English
- Tropical climate in the south and semi-arid in the north
- In the Northern Region, 1 out of 1.8 million people lack access to an improved water supply

Pure Home Water (PHW)

- PHW's goal is to provide household water treatment and safe storage (HWTS) technologies to people in the Northern Region.
- Two social entrepreneurs run the business in Ghana.
- Last year 3 MEng students and 4 G-Lab business students worked with PHW.



Presence of Pure Home Water in Northern Ghana (Mattelet 2006).

HEALTH AND WATER QUALITY MONITORING OF PURE HOME WATER'S CERAMIC FILTER DISSEMINATION

By Sophie Johnson

Project Goal

To enable PHW to better understand the ceramic filter, its users, and the effectiveness of the new marketing strategy through:

- ▣ Household surveys
- ▣ Water quality testing

Household Surveys



- ❑ Surveyed 41 households
- ❑ Collected baseline data on water use practices, diarrheal prevalence, hygiene practices, and sanitation access
- ❑ Asked about ceramic filter acceptability

Water Quality Tests



- ❑ Collected filtered and unfiltered samples
- ❑ Tested for H_2S bacteria, E. coli, total coliforms, and turbidity.

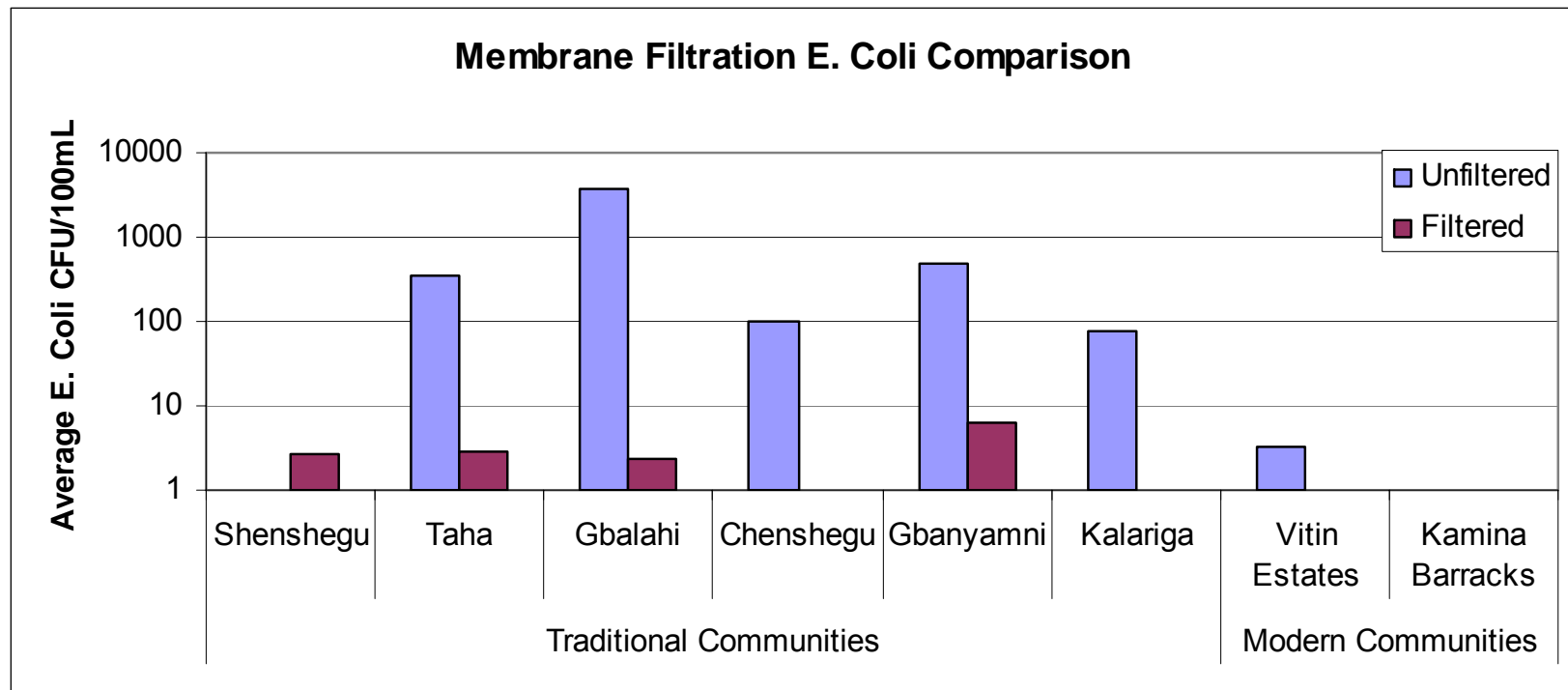
Epidemiology Results from All Households

- Average expenses: US \$8.60 per person per month
- 12% have access to an improved water source
- 4.9% believe water is safe to drink without treatment
- 15% have access to adequate sanitation
- 95% knowledgeable about diarrheal causes

Epidemiology Analysis

- Odds ratio calculations, chi-square tests for statistical significance
- Filter households are 76% less likely to have a member with diarrhea than non-filter households (p-value=0.008)
- In traditional households, people living with a filter are 69% less likely to have diarrhea than people without a filter (p-value=0.035)

Water Quality Results



Water Quality Results:

Filtered vs. Source Water

	Traditional Households	Modern Households
E. coli Reduction	99.7%	85%
Total Coliform Reduction	99.4%	90%
H2S Removal	85%	100%
Turbidity Reduction	92%	68%

Business Results: Quick Look at the 4P's

- *Product* is acceptable to users:
 - ▣ 100% of users said it is easy-to-use, that they use it daily, and that they would recommend it to others
 - ▣ Spigot problems in filters in use >1 year
- *Promotion* channels are effective:
 - ▣ 94% of non-users were aware of ceramic filters in their community
- *Price* is affordable to low-income families:
 - ▣ Non-filter users actually reported a higher monthly income per person than filter users (US \$ 7.60 vs. US \$5.50)
- *Place* of focus is in communities that need the filters the most
 - ▣ 0% of targeted communities have improved water supplies or sanitation

Conclusions

- ❑ PHW is reaching the poorest communities
- ❑ Households with filters have lower rates of diarrhea
- ❑ The filters are effectively removing bacteria and turbidity
- ❑ Variability in filter performance suggests that better quality control and/or user training is necessary
- ❑ PHW is marketing a socially acceptable product



WATER QUALITY AND BUSINESS ASPECTS OF SACHET-VENDED WATER IN TAMALE, GHANA

By Teshamulwa Okioga

Objectives

General Objective

To investigate the quality of sachet-vended water, and suggest strategies for improving the water quality

Specific Objectives

- ❑ Conduct microbial tests on sachet water samples
- ❑ To investigate the handling and distribution practices of sachet-vended water
- ❑ To investigate the 4P's : Product, price, place (distribution) and promotion as they relate to sachet water
- ❑ To analyze the feasibility of marketing PHW's ceramic filter to sachet water vendors

Sachet-Water

- Bagged water
- Two types of sachet-vended water sold in Tamale:
 - ▣ Hand-tied (locally know as ice-water)
 - ▣ Factory-produced (locally know as pure-water)

Factory-produced
sachet water



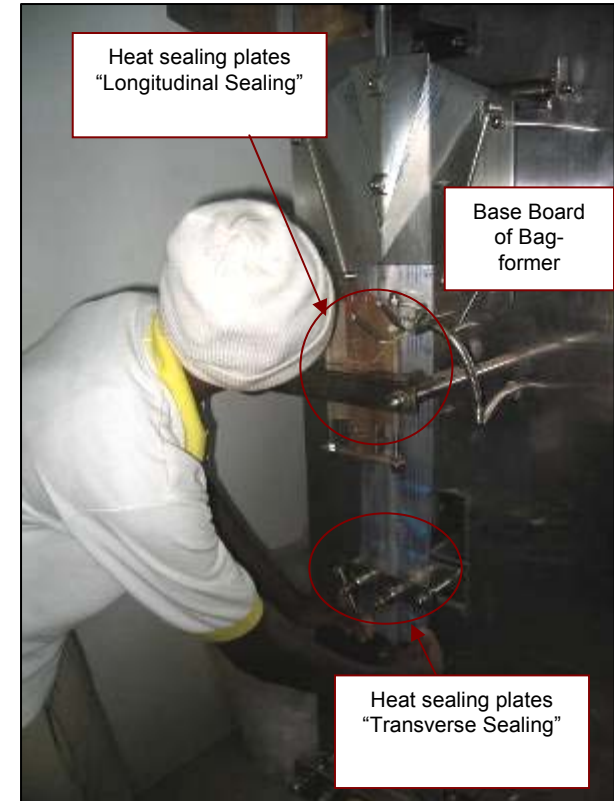
Hand-tied sachet
water

Source of Sachet Water

- ❑ Main source of water is tap water
- ❑ In Tamale, tap water treatment centrally at the Dalun Water Treatment Works, approx. 35 km North West of Tamale
- ❑ Centralized treatment processes include coagulation (rapid mixing), flocculation, sedimentation, filtration and disinfection
- ❑ Production from the treatment plant is approximately $19,560\text{m}^3/\text{day}$



Packaging of Factory-Produced Sachet Water



- Typical factory setting consists of a storage, conveyance, decentralized water treatment system (filters, UV disinfection units), and a packaging system (sachet machine).

Average production

- Average of 15,000 bags/day
- Cost of 1 sachet (0.5l) = \$0.02 in bulk, \$0.04 individual sachet (retail price)
- Bottled water costs about 5 times the retail price

Hand-tied Sachet-Water...



Cloth filter
used for raw
water



Filling sachets



Knotting the
sachets

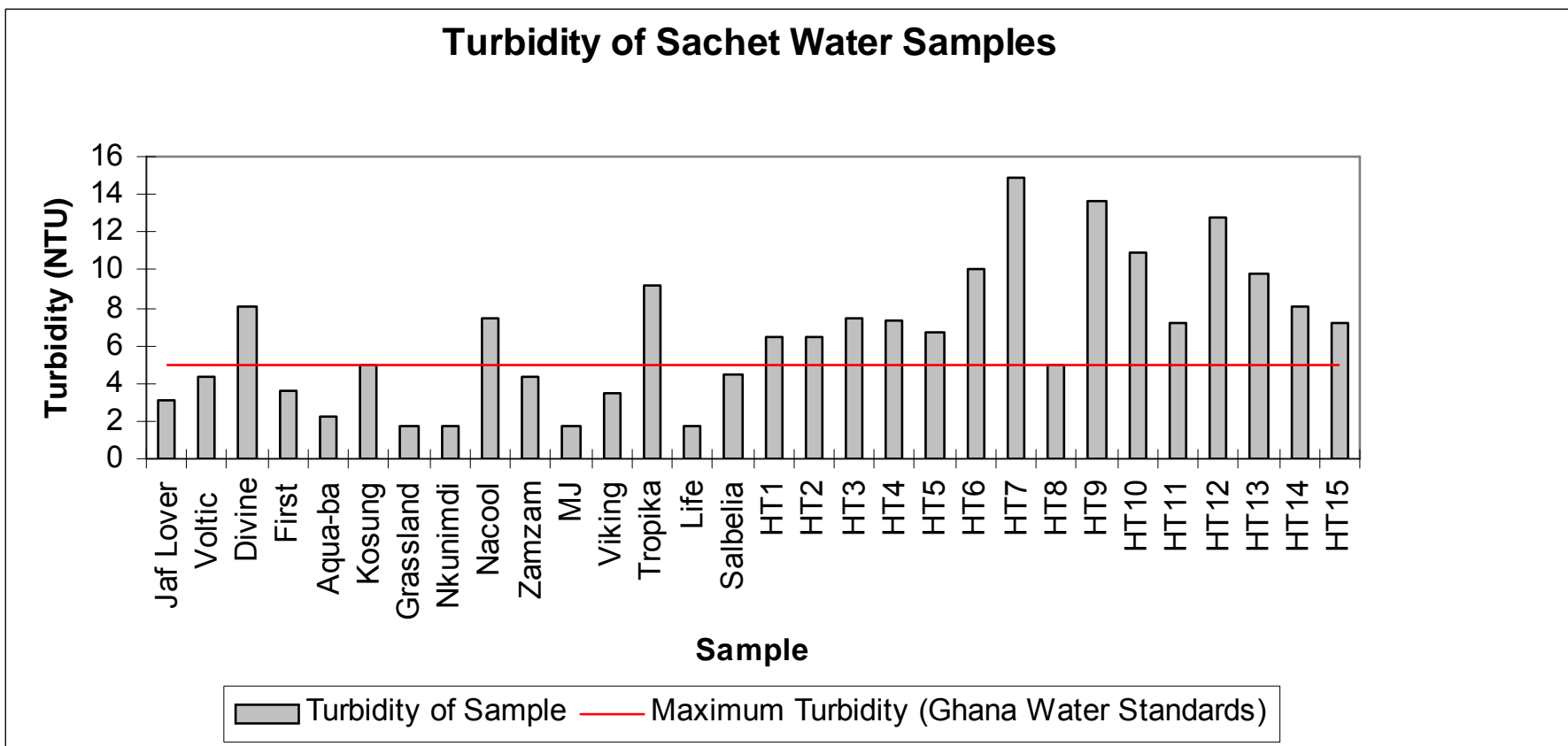
30 to 200 sachets bagged per day
Cost \$0.02 per sachet (0.7l)

Methodology

- ❑ Conducted microbial water quality tests and turbidity tests on 30 different samples of sachet water
- ❑ Conducted surveys/interviews
 - ❑ Sachet-water producers
 - ❑ Road-side vendors
 - ❑ Sachet-water customers

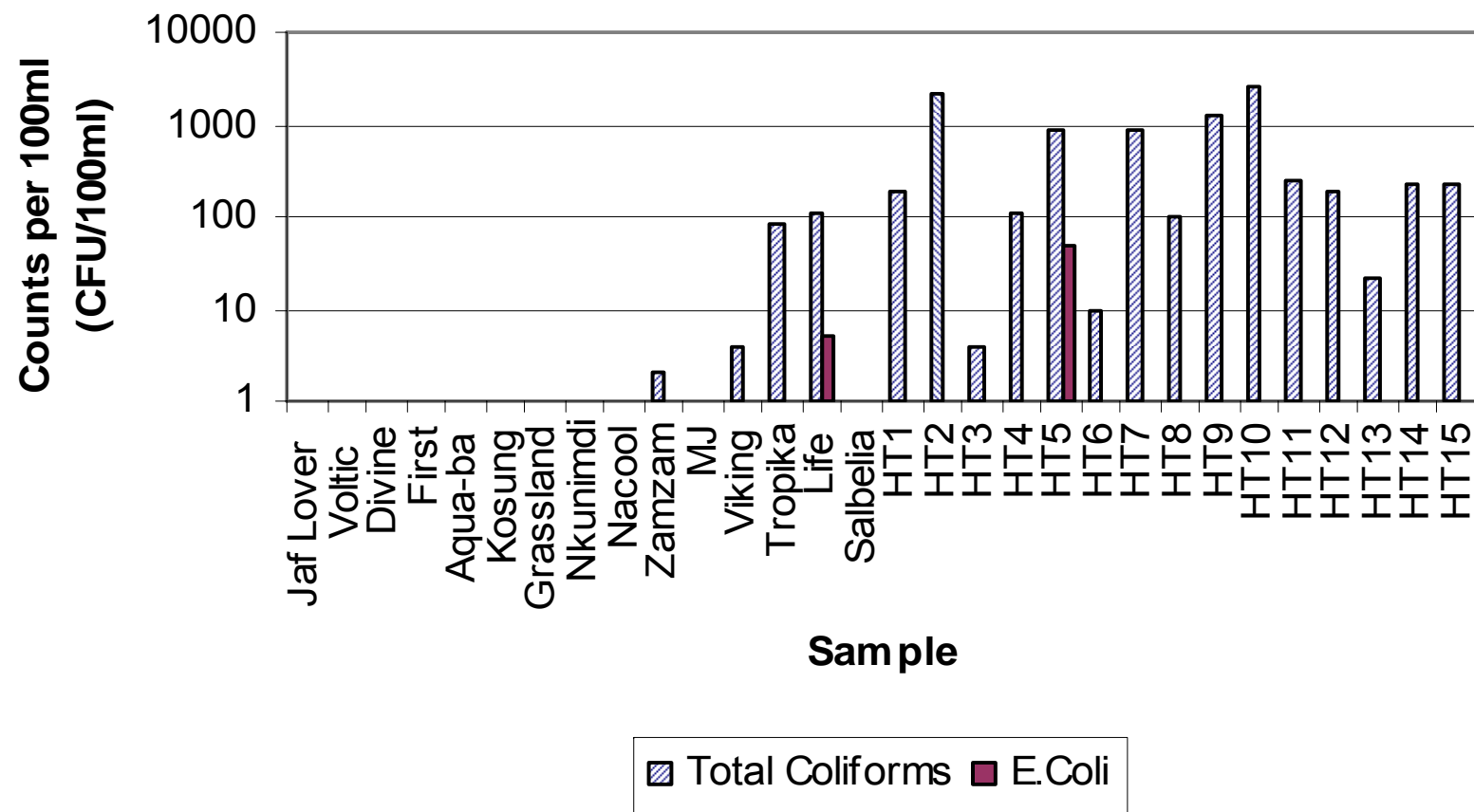


Turbidity Results



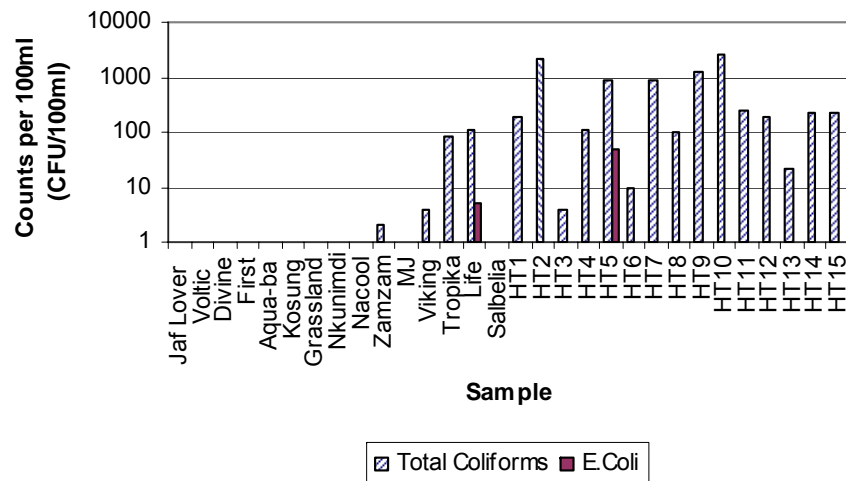
20% of the factory-produced sachet water that was tested and 93% of the hand-tied sachet water had turbidities greater than 5 NTU, the maximum turbidity level set by the 1998 Ghana Standards Board

Ecoli and Total Coliform Results (MF Test)- Log Sacle

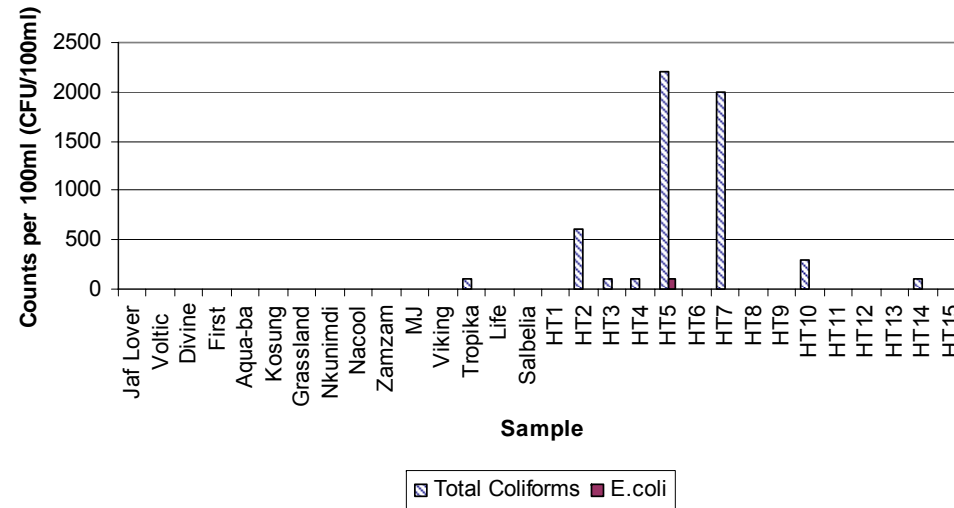


Hand-tied sachet water more problematic in terms of water quality and required more attention to improve through treatment, storage and handling

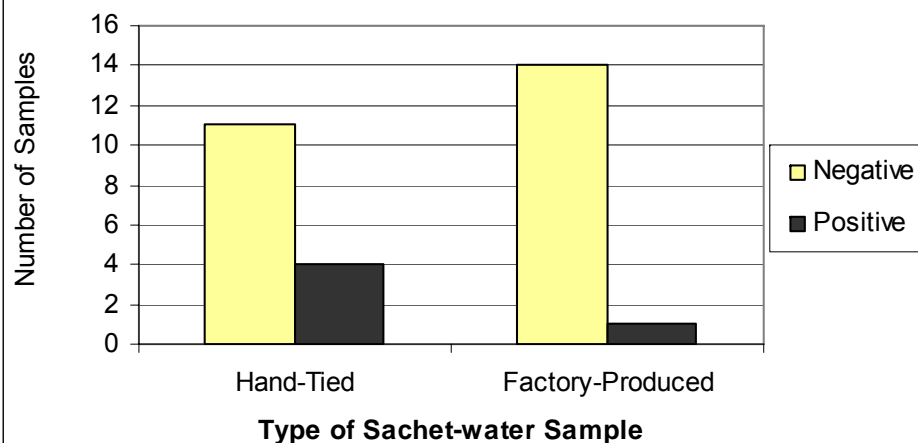
**Ecoli and Total Coliform Results
(MF Test)- Log Sacle**



**E.coli and Total Coliform Results
(3M Petrifilm Test)**



P/AH₂S Test Results on Sachet-Water Samples

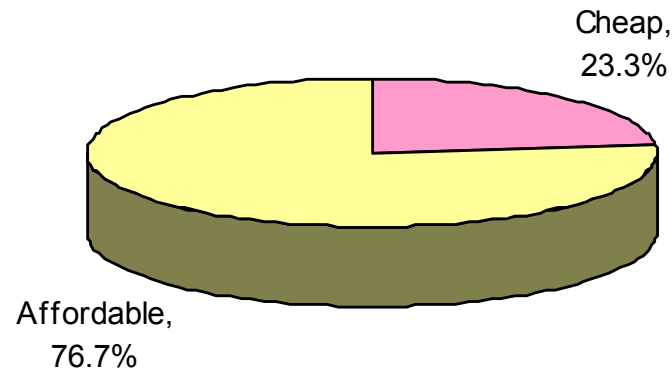


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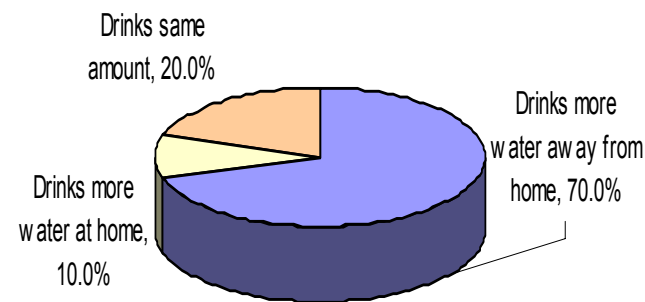
Interviews and Surveys – Customers (30 interviewed)



Price perception: Hand-tied sachet water



Comparison of water drank at home vs. away from home



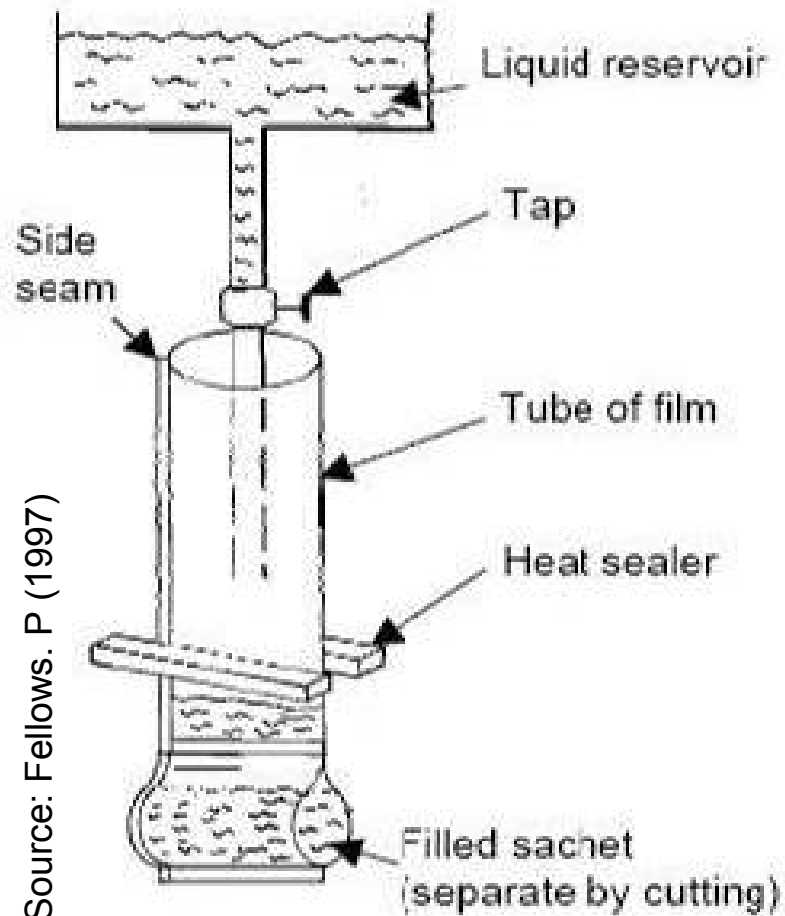
For 37%, sachet water formed the sole supply of drinking water, even at home!

Suggested Treatment and Storage

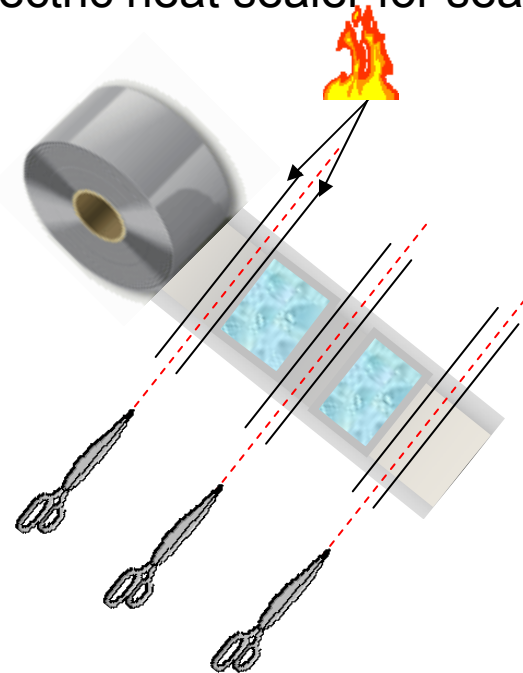
- ❑ Ceramic pot filter
- ❑ Advantage: Serves dual purpose of treatment and safe storage
- ❑ Disadvantage: Slow filtration rate (2 liters per hour). About 5 required per vendor
- ❑ Costs approx. \$6 - \$12 per filter (Tamale)



Suggested Low-cost Packaging Alternatives for Hand-tied Sachet Water



Electric heat sealer for sealing plastic films





Conclusions

- ❑ Sachet water industry profitable (100% -400% profits made)
- ❑ Hand-tied sachet water more contaminated compared to factory-produced sachet water (x4)
- ❑ PHW's ceramic filter might be a feasible option for treatment and storage of hand-tied sachet water but other options should also be explored



Recommendations

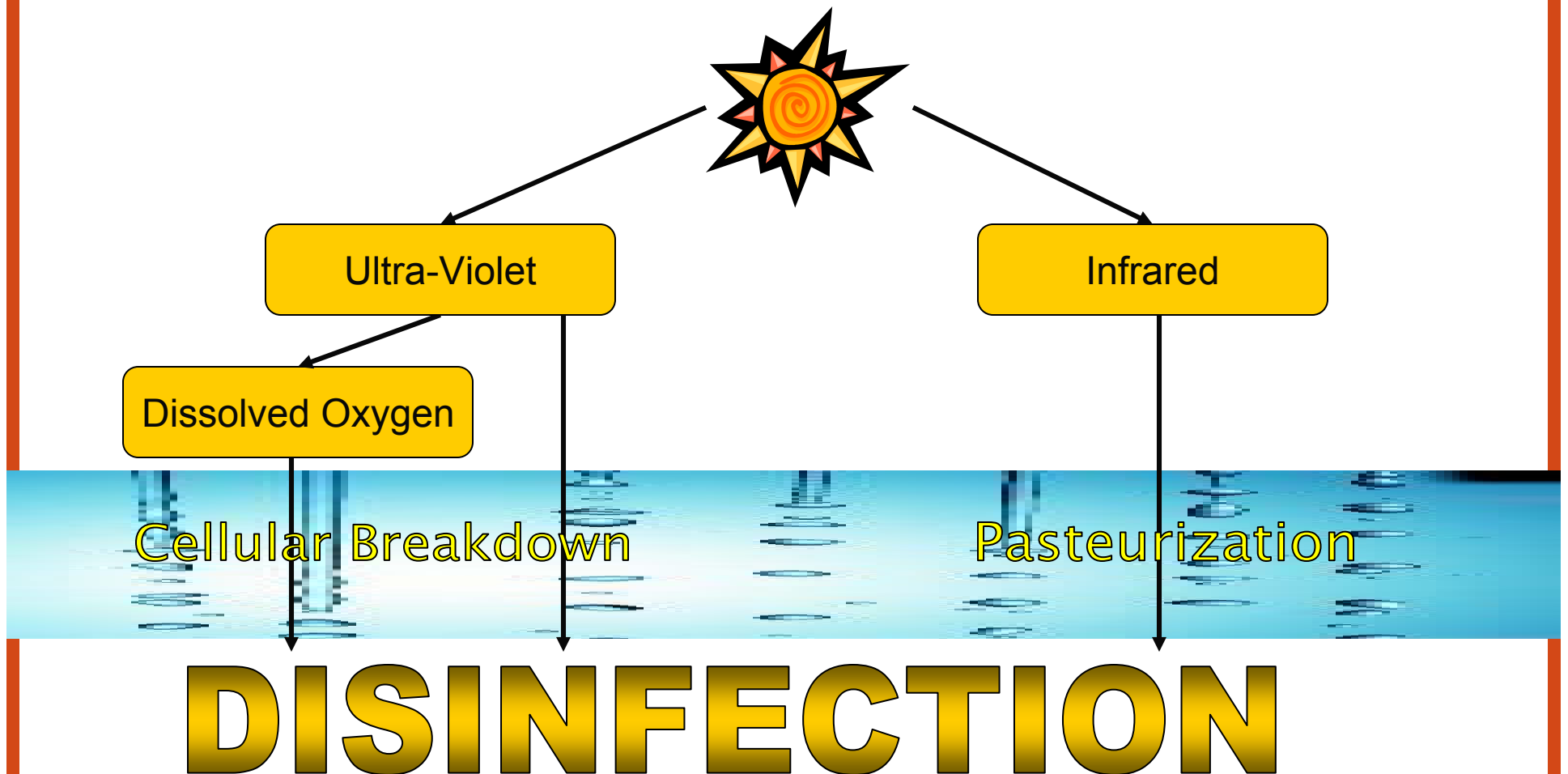
- ❑ Further develop and test low-cost packaging systems for sachet water vendors (hand-tied sachet water)
- ❑ Solid waste management of plastic bags, recycling/re-use of plastics (47% litter)
- ❑ Detailed study of the Dalun water treatment plant and water quality analysis of the distribution system - assessment of the fate of microbes that have gained access to the distribution system and remedial measures

SOLAR DISINFECTION OF DRINKING WATER IN THE NORTHERN REGION OF GHANA

Iman Yazdani

Solar Disinfection

- Use of the sun's energy to kill pathogens



Solar Disinfection: Some Constraints

- Low amounts of suspended material (turbidity)
 - ▣ <30NTU
- Strong solar radiation
 - ▣ 6hrs mid-latitude, midday sunshine ($\approx 500\text{W}/\text{m}^2$)

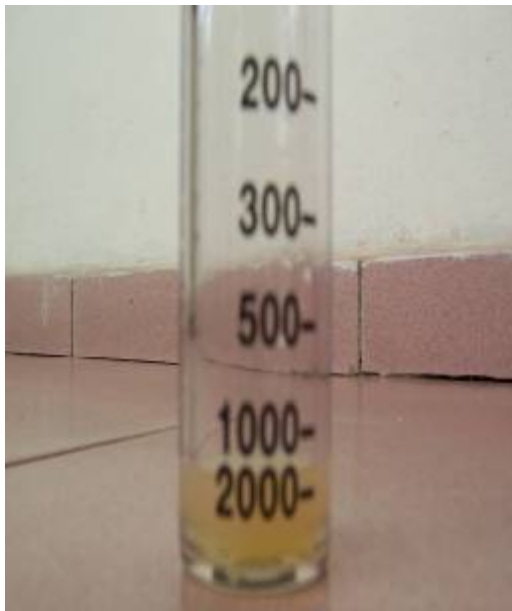


Photo by Melinda Foran

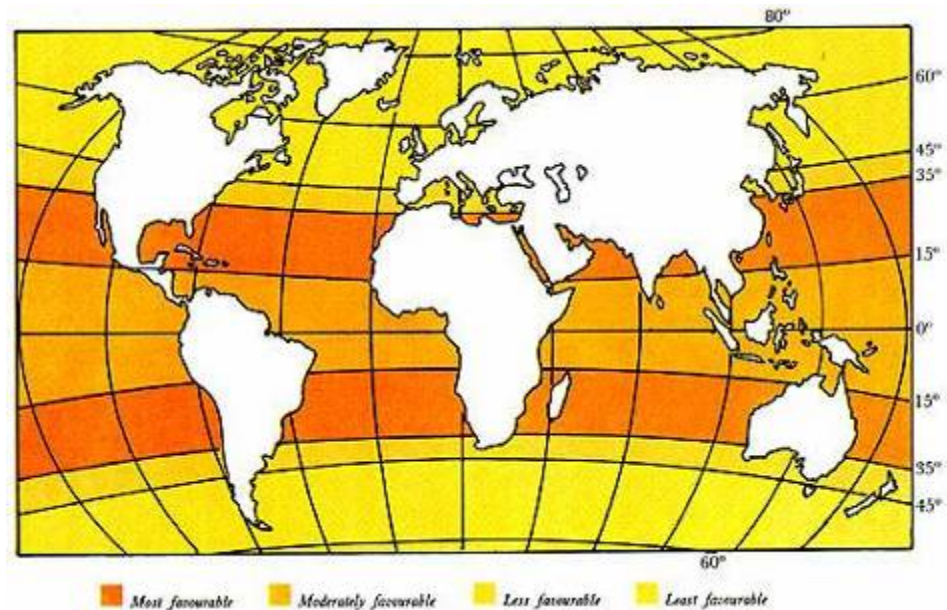


Figure: Aftim Acra 1984

Solar Disinfection: Method 1

□ SODIS

- Most common household scale technique
- Transparent plastic PET bottles (0.5-2L)
- Disinfection after 3-6hrs solar exposure in midday sun at mid-latitudes
- Extensive studies

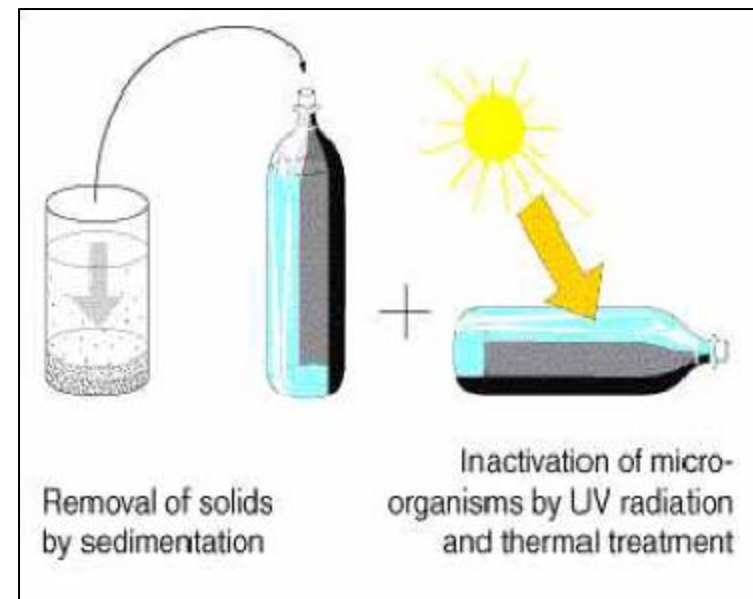


Figure: EAWAG/SANDEC

Solar Disinfection: Method 2

□ SOLAIR

- 2-25L translucent/opaque plastic HDPE containers
- Containers representative of those used in many rural communities
- Frequent shaking to **keep a high dissolved oxygen concentration**
- Disinfection after 4-7hrs solar exposure at the tropics
- Limited studies (Meyer et. al in South Africa)



Photo: Verana Meyer

Research Objectives

- To determine technical feasibility of SOLAIR
 - ▣ Disinfection efficiency
 - Total coliform & *E. coli*
- SOLAIR more practical than SODIS
 - ▣ Larger volumes can be treated
 - ▣ Containers more representative of local communities (translucent HDPE vs. clear PET)

Research Methodology

- ❑ 10L translucent HDPE containers filled with water
 - ❑ Exposed to sunlight
 - ❑ Frequent shaking maintains high dissolved oxygen concentration
- ❑ Hourly radiation measurements
- ❑ Hourly coliform (Total and *E. coli*) counts
 - ❑ Membrane filtration method

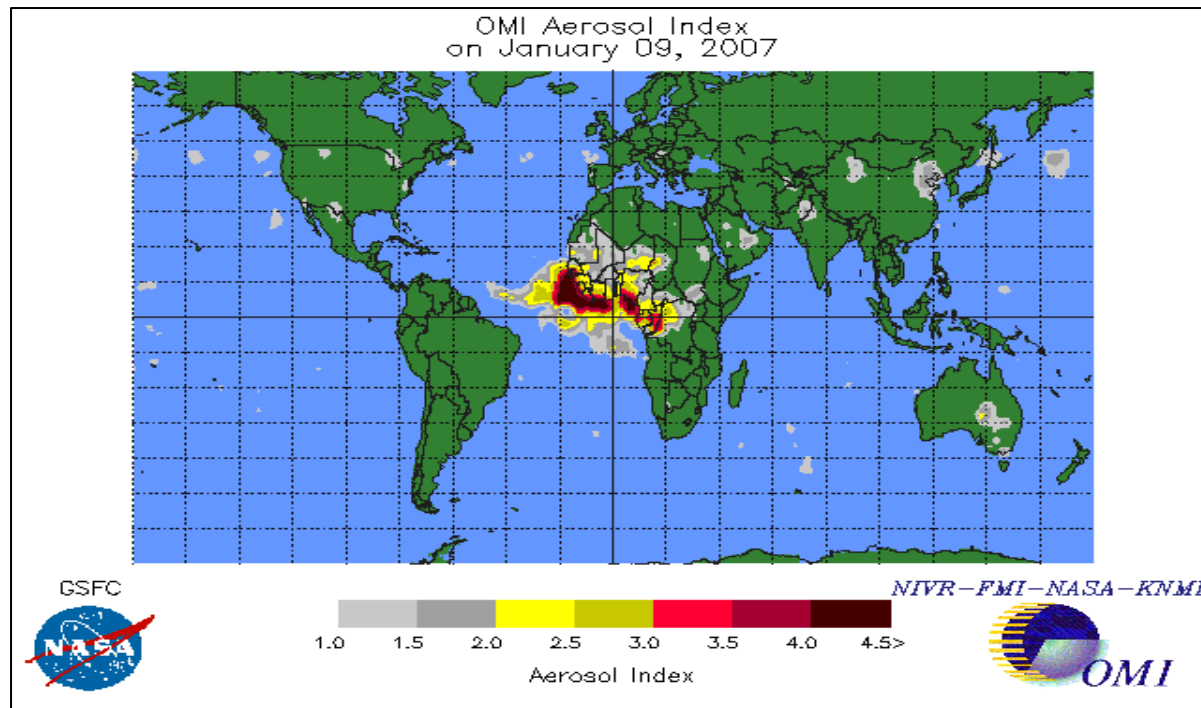


Radiation: Dust Haze



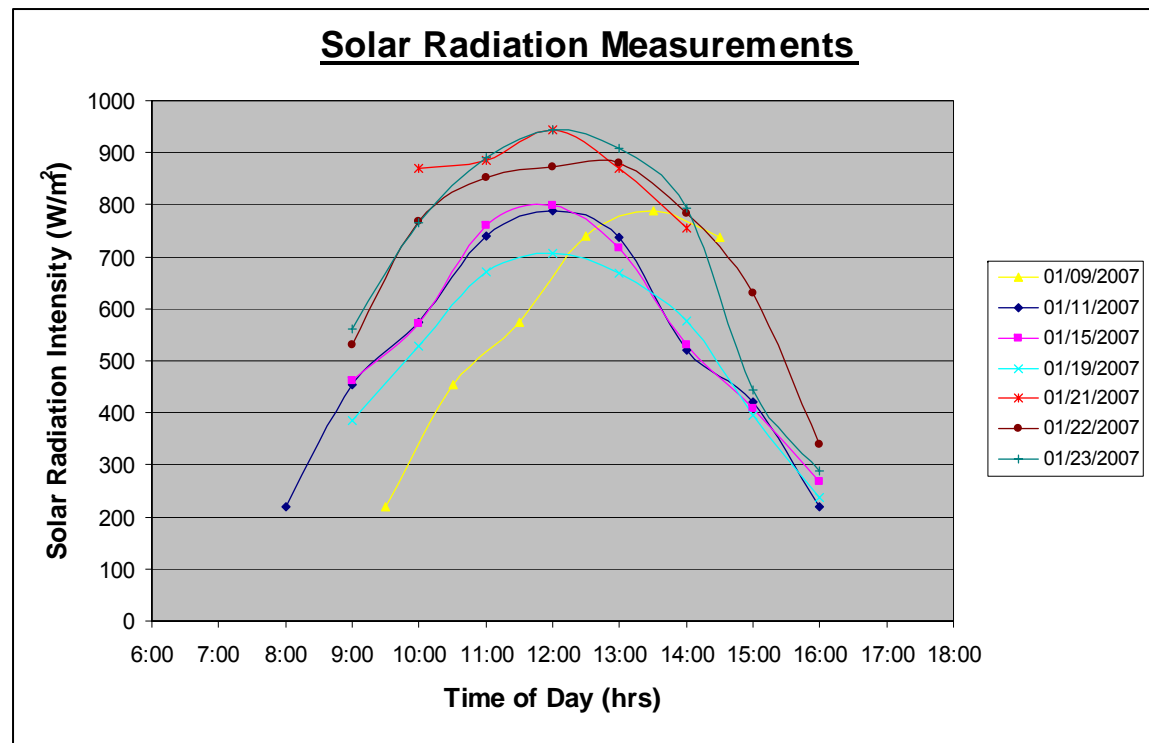
Results: Aerosol Index

- NASA's Aerosol Index (AI) is a scale depicting the amount of aerosol particulate in the atmosphere



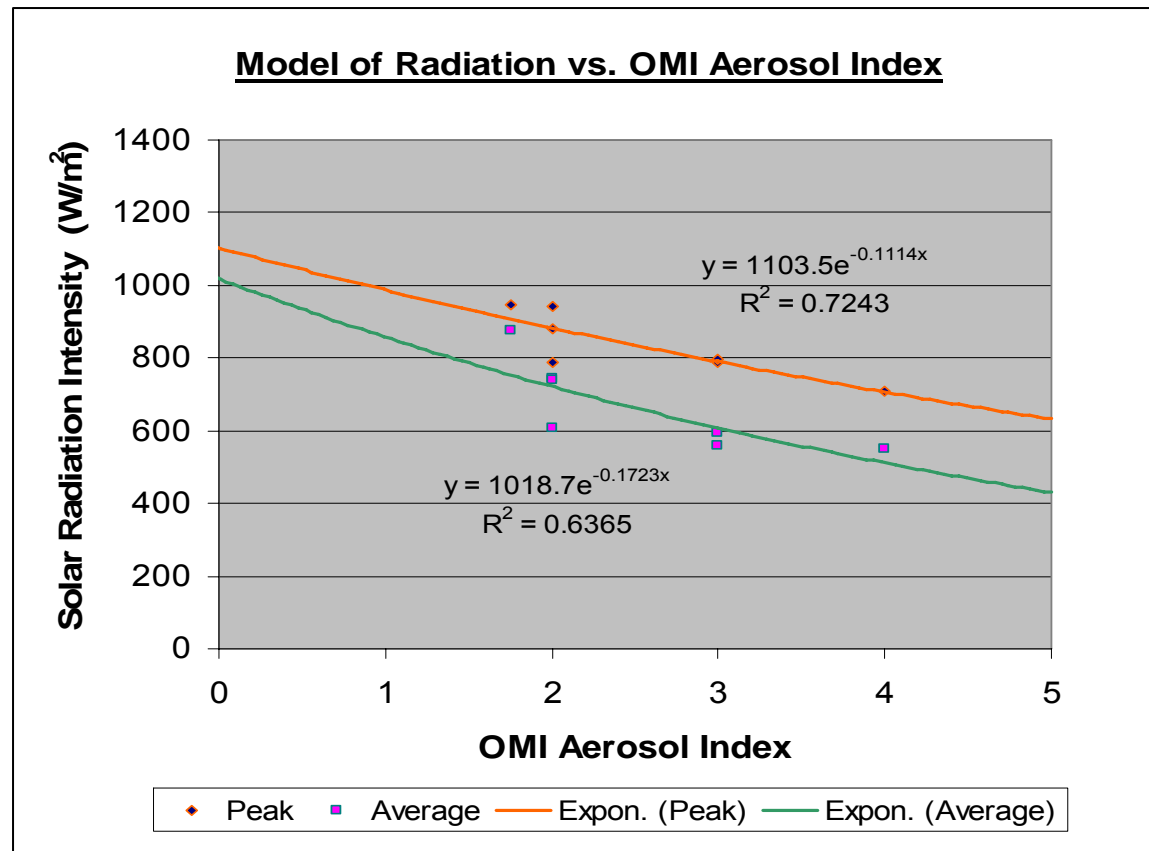
Results: Radiation Readings

- Large variations on a day-to-day basis
- ▣ Dependent on haze thickness



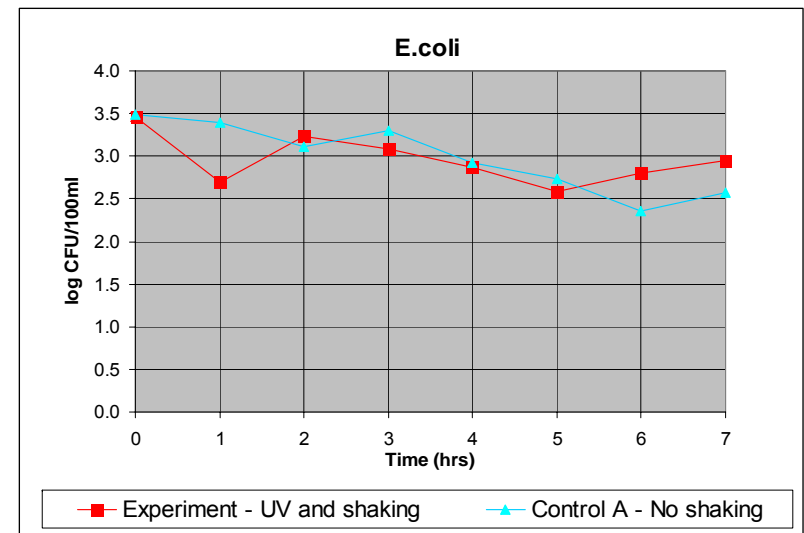
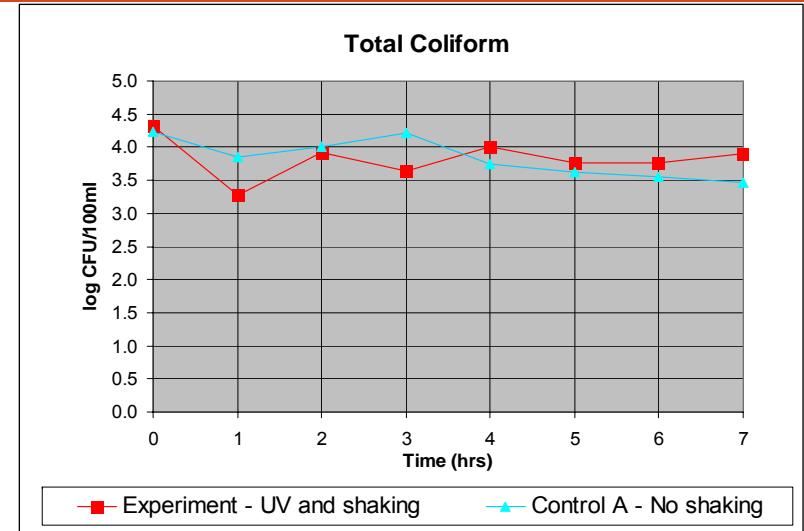
Results: Radiation vs. AI Model

- Comparable to an exponential model derived by Krotkov et al. (2002):



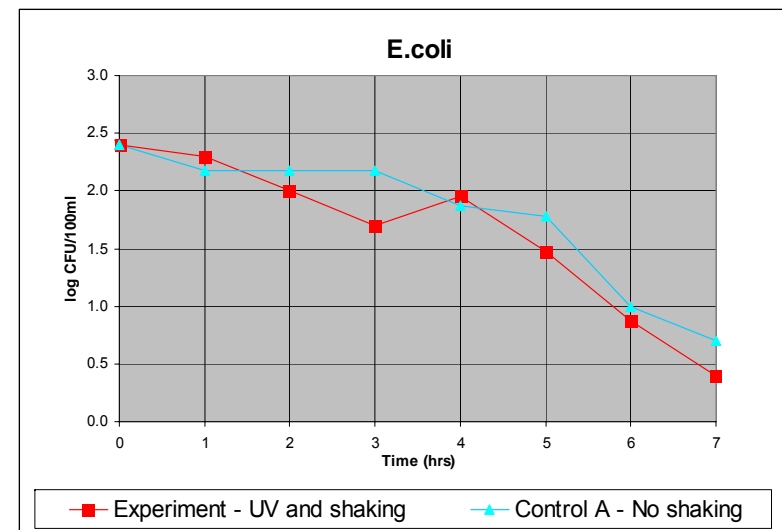
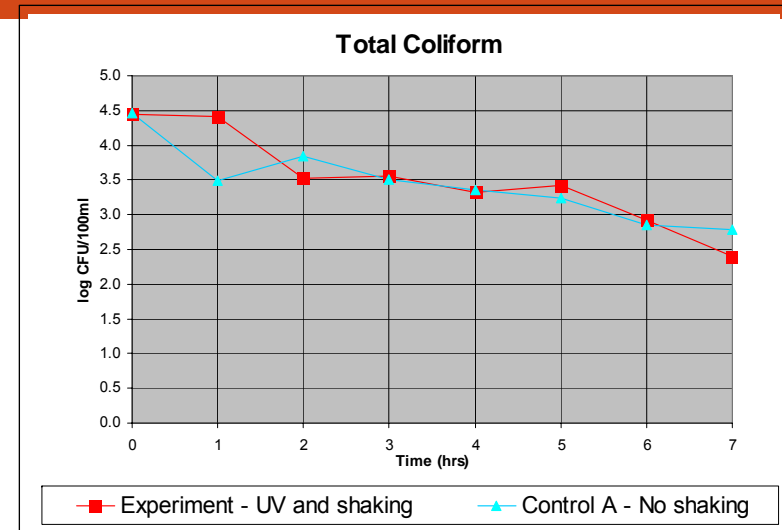
Results: Disinfection

- >100NTU Turbidity
- Low degree of disinfection
- The **control** (no shaking) yielded similar results to **SOLAIR**



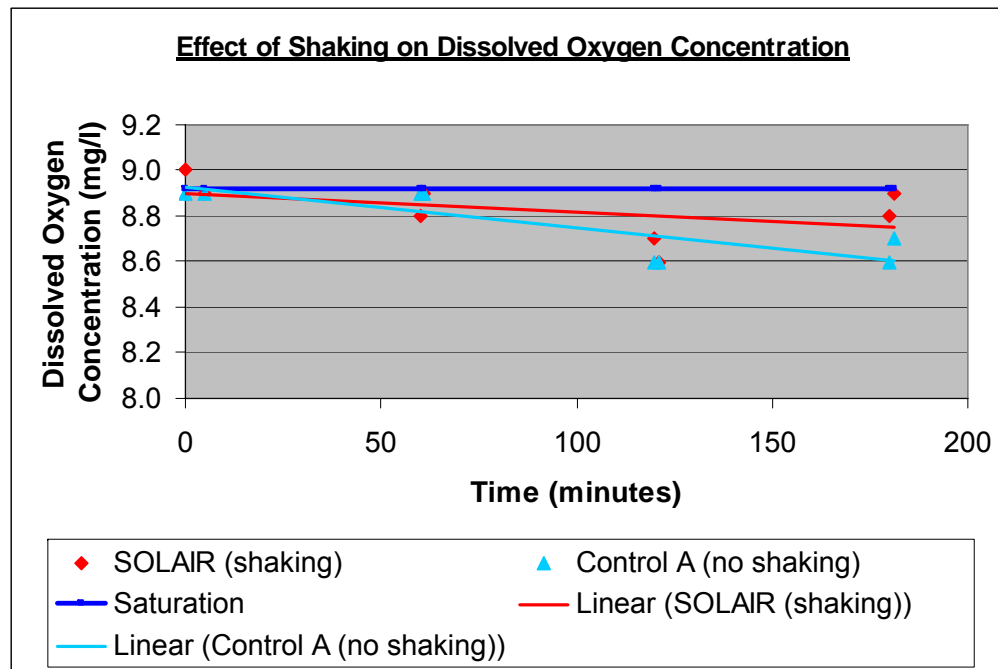
Results: Disinfection

- <20NTU Turbidity
 - ▣ Greater disinfection compared with high turbidity water, but still incomplete
 - ▣ Again, the **control** (no shaking) yielded similar results to **SOLAIR**



Results: Dissolved Oxygen Levels

- Tests show that shaking does **not** increase Dissolved Oxygen (DO) levels in the containers
 - ▣ Enough air above water-air interface in the container that the water is **almost saturated**, even without shaking



Conclusions

- Complete disinfection did **not** take place
 - ▣ Loss of UV due to scattering & absorption by dust haze
 - ▣ No increase in photo-oxidative disinfection with shaking
 - No increase in DO with shaking

Thank You!



Figure: unimaps.com

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