PURE HOME WATER- GHANA

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April 28th, 2006
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The Global Issue

- Globally, **1.1 billion people** lack access to an “improved” drinking water source
- **1.7 million deaths** annually are from unsafe water, sanitation, & hygiene
  - 90% of these deaths in children
  - Virtually all in developing countries

Millenium Development Goals

To halve by 2015 the proportion of people without sustainable access to safe drinking water

Household Drinking Water Treatment And Safe Storage (HWTS)

- Treats water at the point of use
- Made out of local materials
- Relatively cheap
- Hard to implement

Pure Home Water Team

- 2 Ghanaian social entrepreneurs
- MIT engineering and business teams
- Local Partners: World Vision

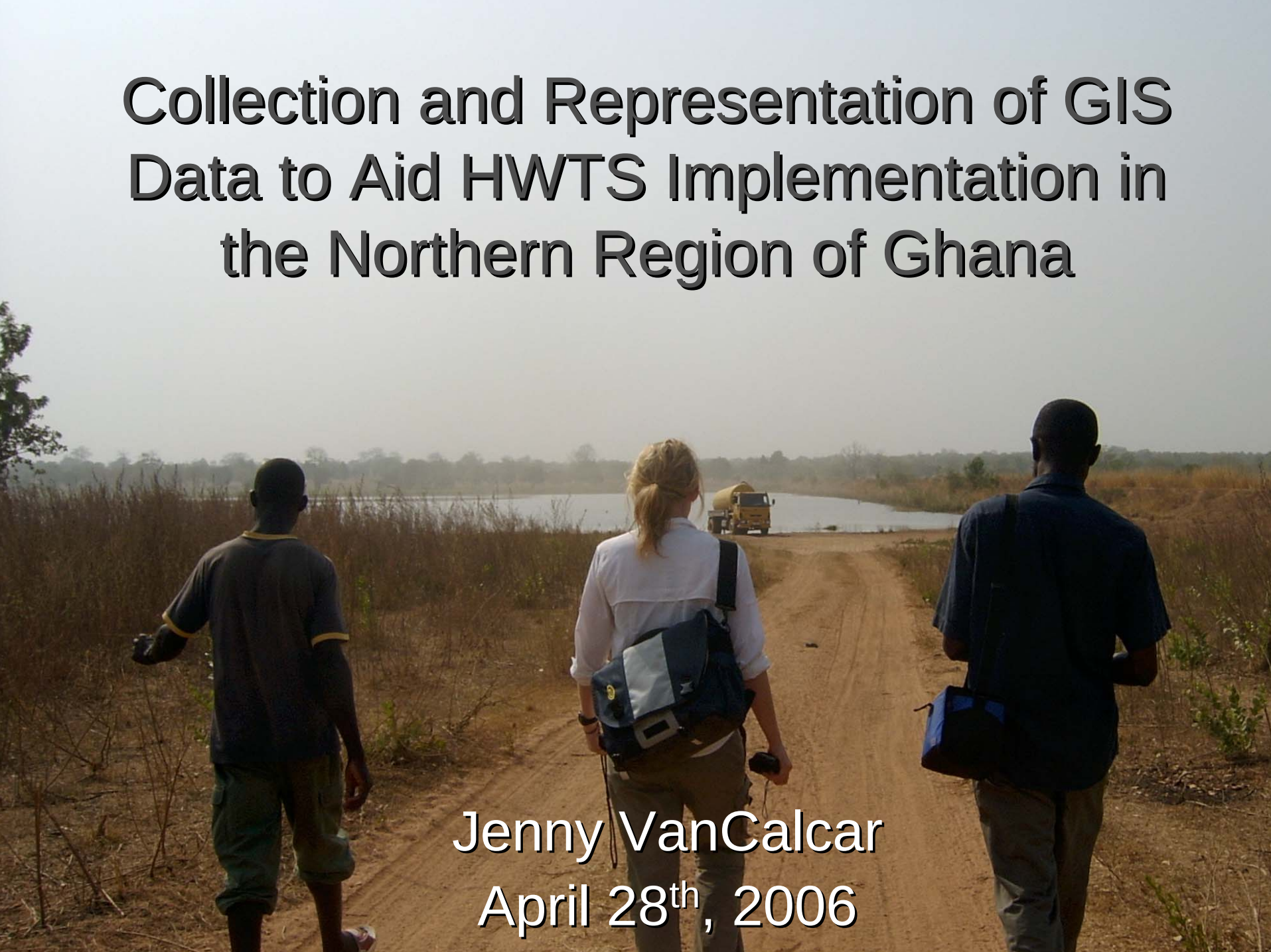
Pure Home Water

- Selling Household Treatment Products
  - Tamakloe
  - Nnsupa
  - Safe Storage

Ghana Background

- General
  - West Africa
  - Population: 21 million
  - Size: ~ Oregon
  - Language
    - English and over 60 Tribal
- Project
  - Fieldwork: January 2-27th
  - Northern Region
  - Accra, Kumasi -> Tamale

Collection and Representation of GIS Data to Aid HWTS Implementation in the Northern Region of Ghana



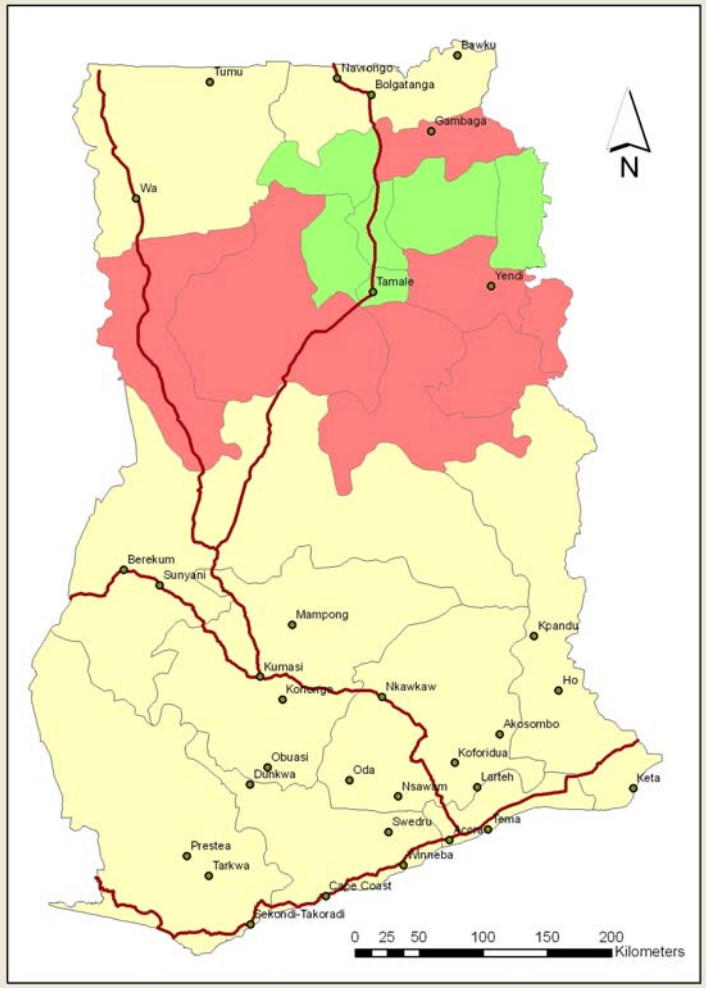
Jenny VanCalcar

April 28th, 2006

Thesis Objective

- Perform reconnaissance to see what kind of spatial and statistical information was available.
  - Demographics
  - Health
  - Water and Sanitation Infrastructure
- Display information in a way that is useful to Pure Home Water, future MIT teams and other interested parties.

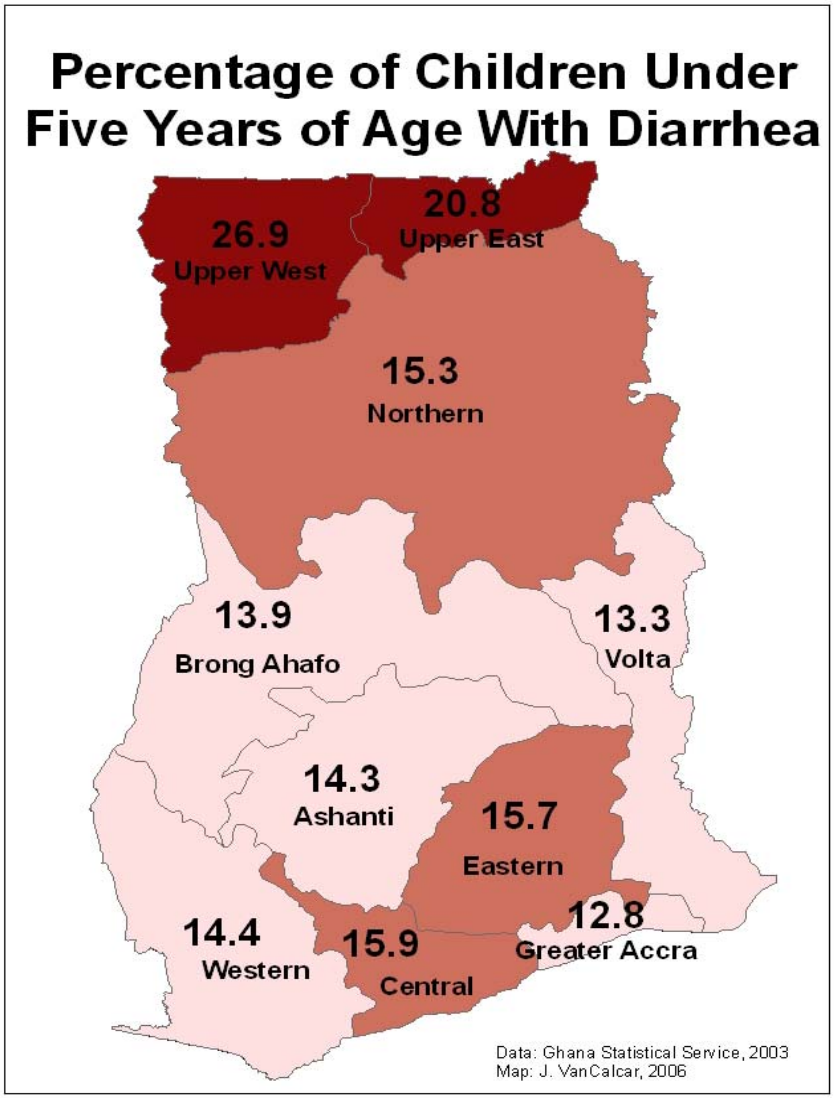
What Is GIS?

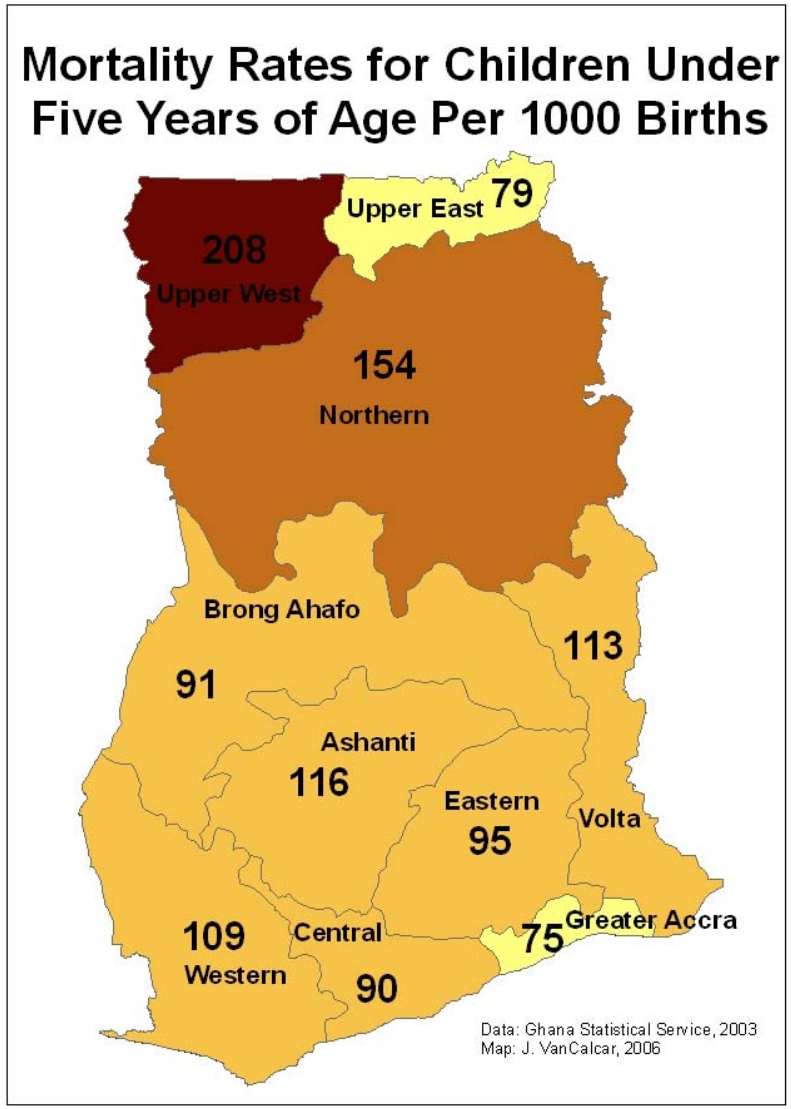


- A way to view and analyze data from a geographic perspective
- Spatial features can be connected to statistical information
- Overlaying of data layers to show interrelations

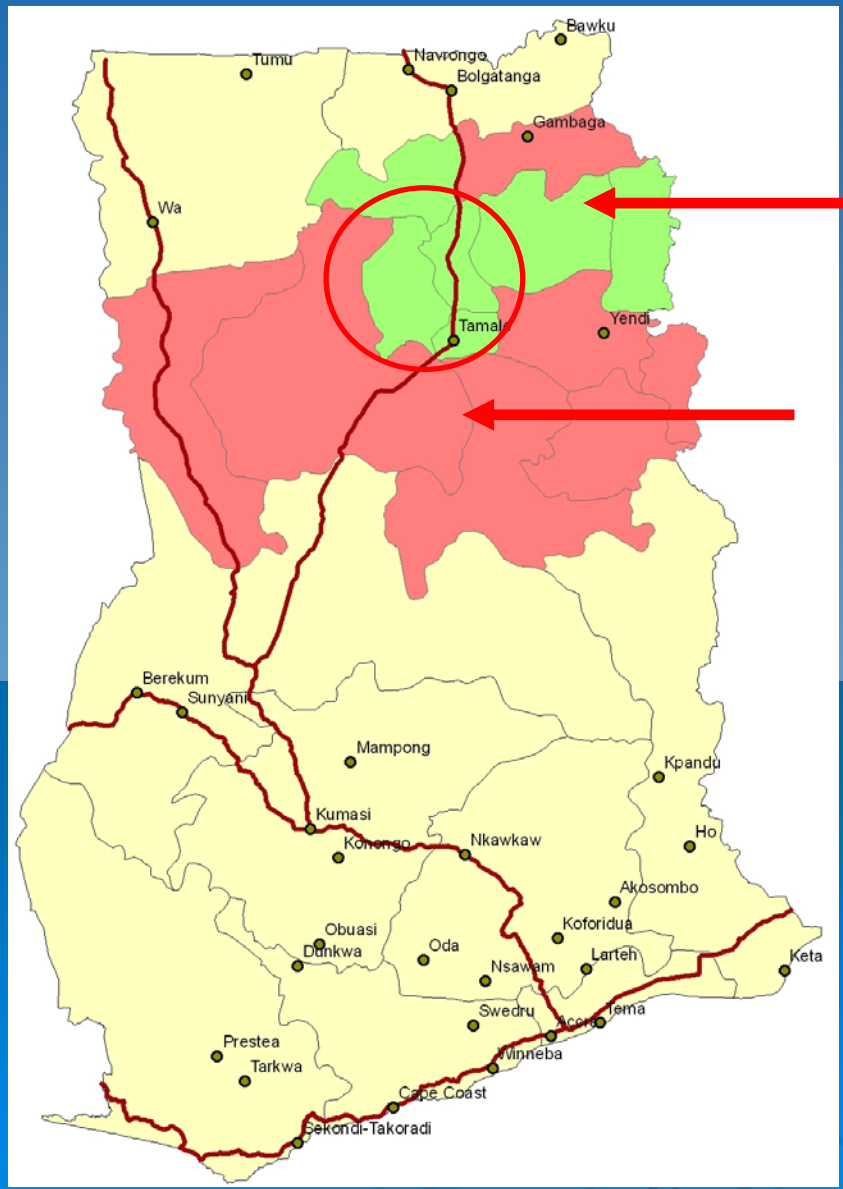
Current Situation

- Paper Maps within Ghana are from the 1960's and 1970's and contain little relevant information.
- Ghana Statistical Service provides a wealth of statistical information.
  - Year 2000 Census
  - 2003 Health and Living Standards Survey
- GIS work beginning but focused in the capital of Accra


Percentage of Children Under Five Years of Age With Diarrhea
26.9
Upper West
20.8
Upper East
15.3
Northern
13.9
Brong Ahafo
13.3
Volta
14.3
Ashanti
15.7
Eastern
14.4
Western
15.9
Central
12.8
Greater Accra
Data: Ghana Statistical Service, 2003
Map: J. VanCalcar, 2006


Mortality Rates for Children Under Five Years of Age Per 1000 Births
208
Upper West
79
Upper East
154
Northern
Brong Ahafo
113
91
Ashanti
116
Eastern
95
Volta
109
Western
Central
75
Greater Accra
90
Data: Ghana Statistical Service, 2003
Map: J. VanCalcar, 2006

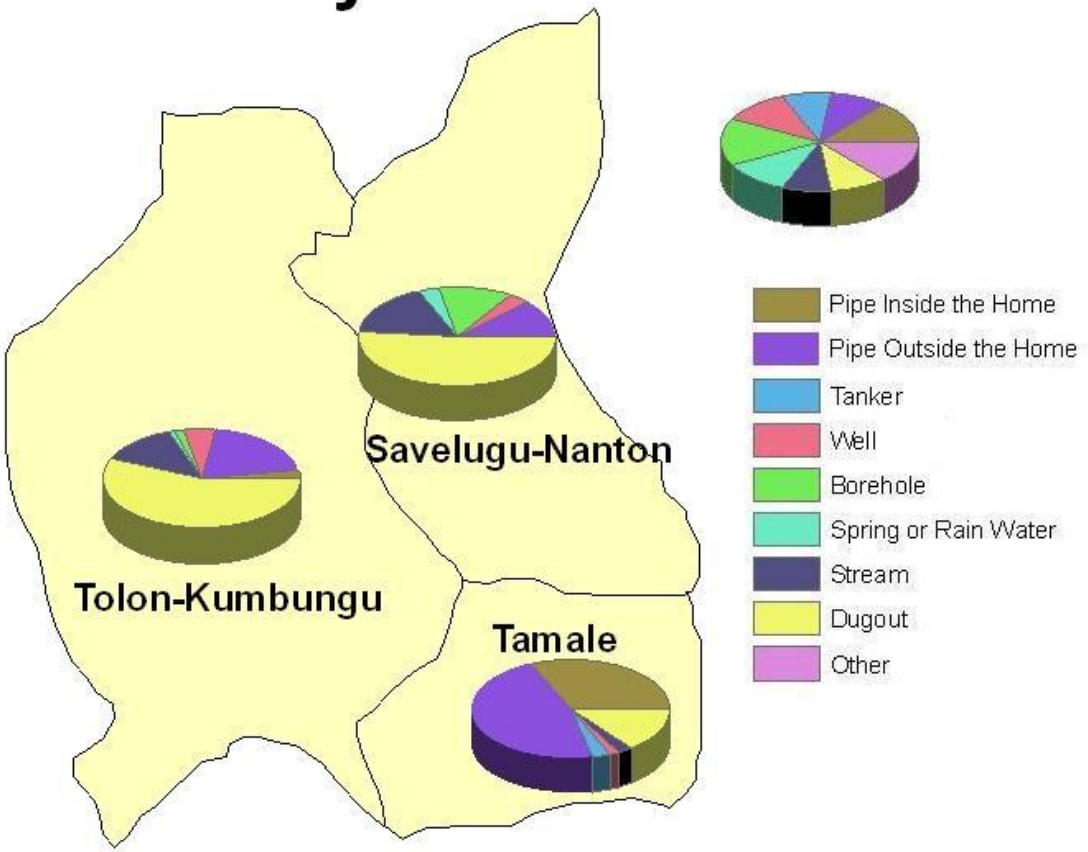
Project Location



Original Six Districts of Pure Home Focus

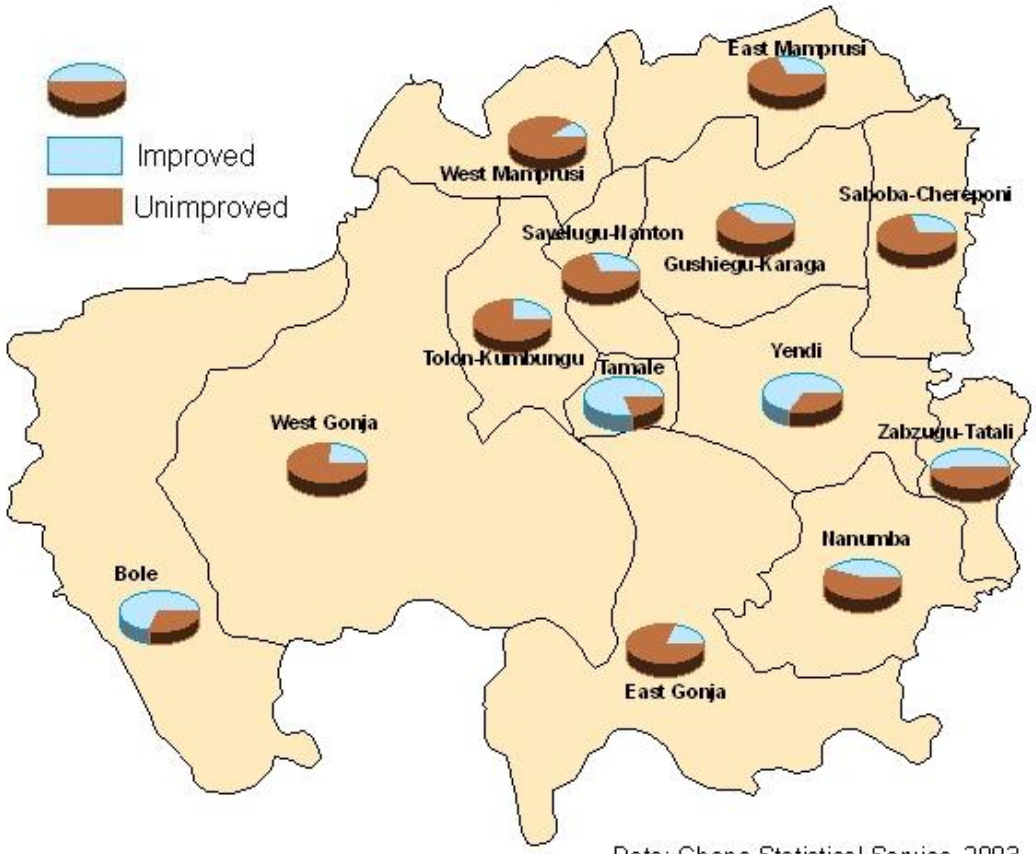
Northern Region

Types of Water Sources Used by Households



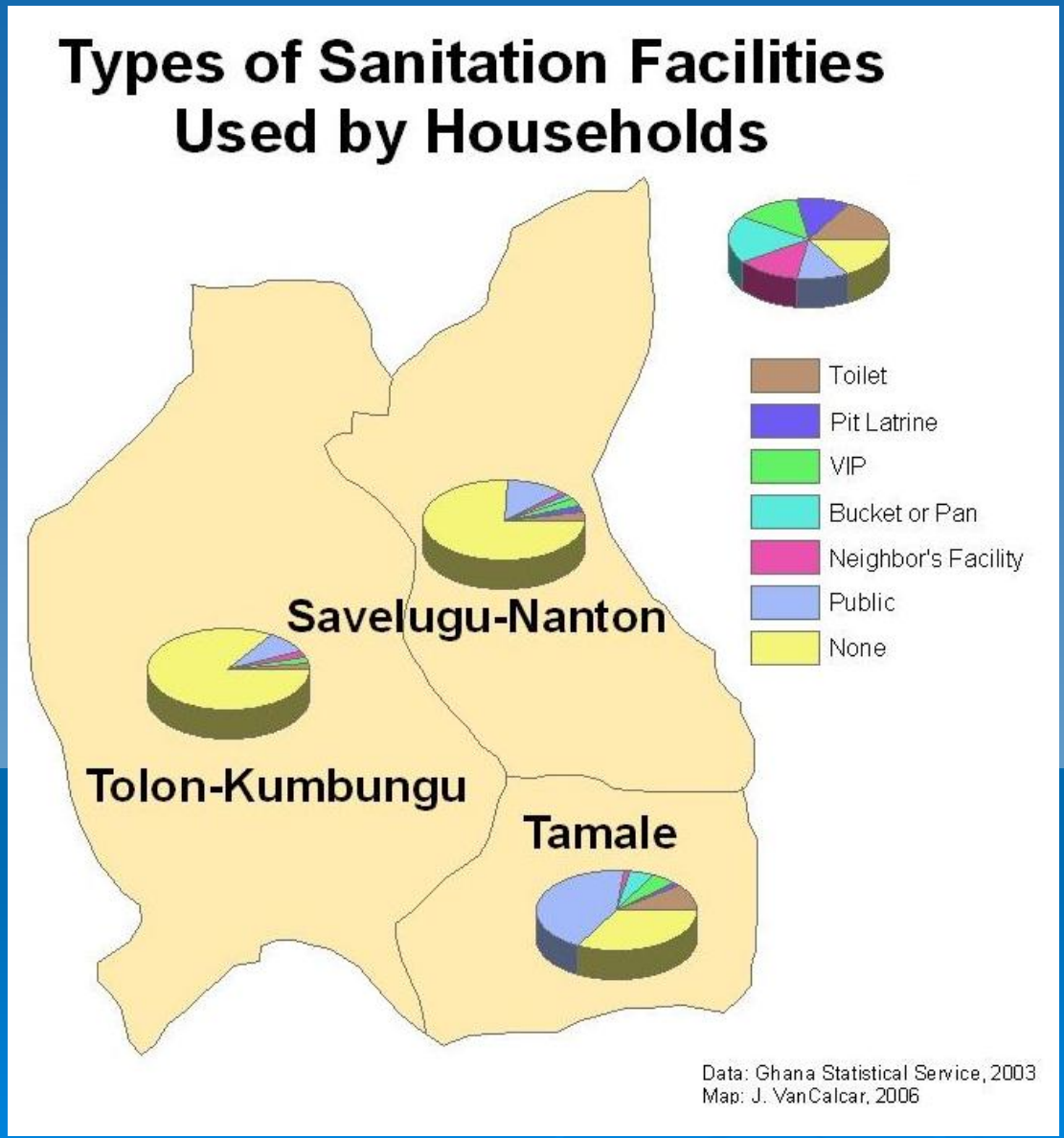
Data: Ghana Statistical Service, 2003
Map: J. VanCalcar, 2006

Percentage Use of Improved and Unimproved Drinking Water Sources



- Improved Sources
  - Boreholes
  - Household connection
  - Public standpipe
  - Rainwater harvesting
  - Protected springs and dug wells
- Unimproved Sources
  - All surface water sources
  - Unprotected springs and dug wells
  - Tanker trucks
  - Vendor water

1 million out of 1.8 million people in the Northern Region are currently using an unimproved source



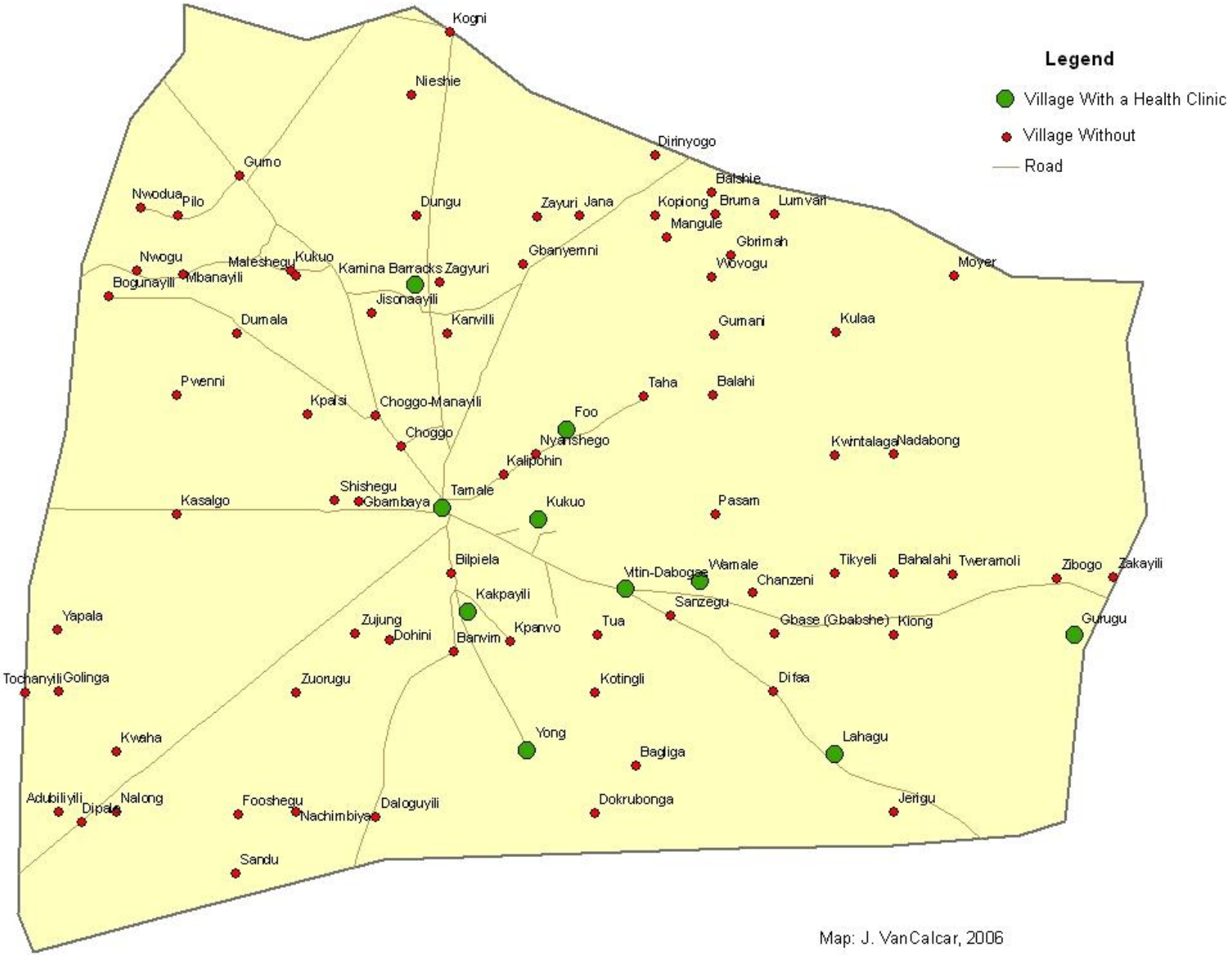
Latrine in the process of being built

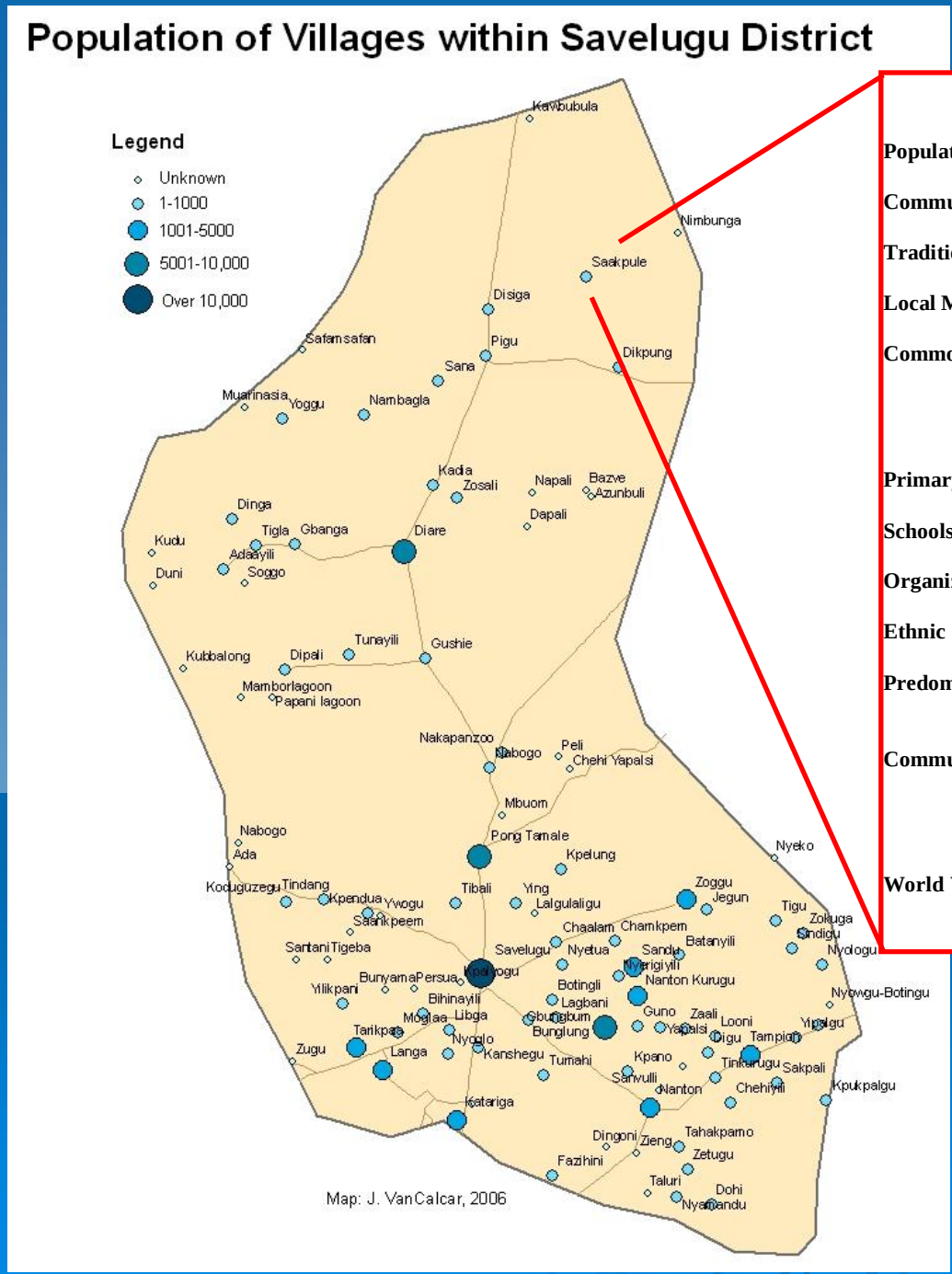
Village Database

- Take a closer look at the characteristics of individual villages.

	Number of Villages According to the Gazetteer	Number of Villages on the Map	Percentage of the Population Accounted For
Tamale	140	85	86%
Savelugu	148	109	82%
Tolon	251	137	58%

Villages With Health Clinics Within Tamale District





Saakpule

Population: 116

Community Leaders: Ibrahim Alhassan, Zenabu Ibrahima, Alhassan Yakubu

Traditional Water Source: One dug-out pond

Local Market Day: Every six days (in Diare)

Common Health Issues:
1. Malaria
2. Diarrhea
3. Dysentery
4. Guinea worm infection

Primary Occupations: Farming

Schools: None

Organized Groups Present: Unit Committees, WATSAN committee

Ethnic Groups: Dagomba

Predominant Religion:
1. Muslim
2. Traditional worship

Community's Needs Assessment:
1. Potable Water
2. School facilities
3. Clinic

World Vision Facilities:
1. Two boreholes
2. Two laundry pads
3. Thirty VIP latrines

Is GIS Appropriate?

- Technologies from the developed world do not necessarily transfer to the developing world.
  - Cost
  - Technical expertise
- Is the output worth the effort?
  - Planning
  - Data Management

Cross-Sectional Epidemiological Study

On Water and Sanitation Practices in the Northern Region of Ghana

Rachel Peletz
April 28, 2006

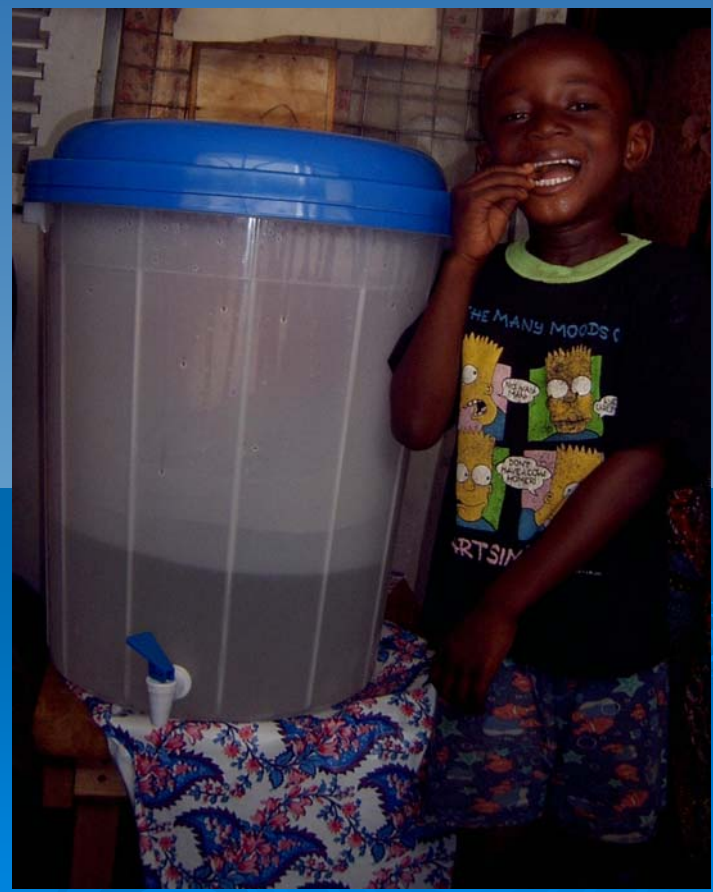
Thesis Objective

Surveys for baseline data on

- Water sources
- Sanitation practices
- Product feedback
- GIS and water testing

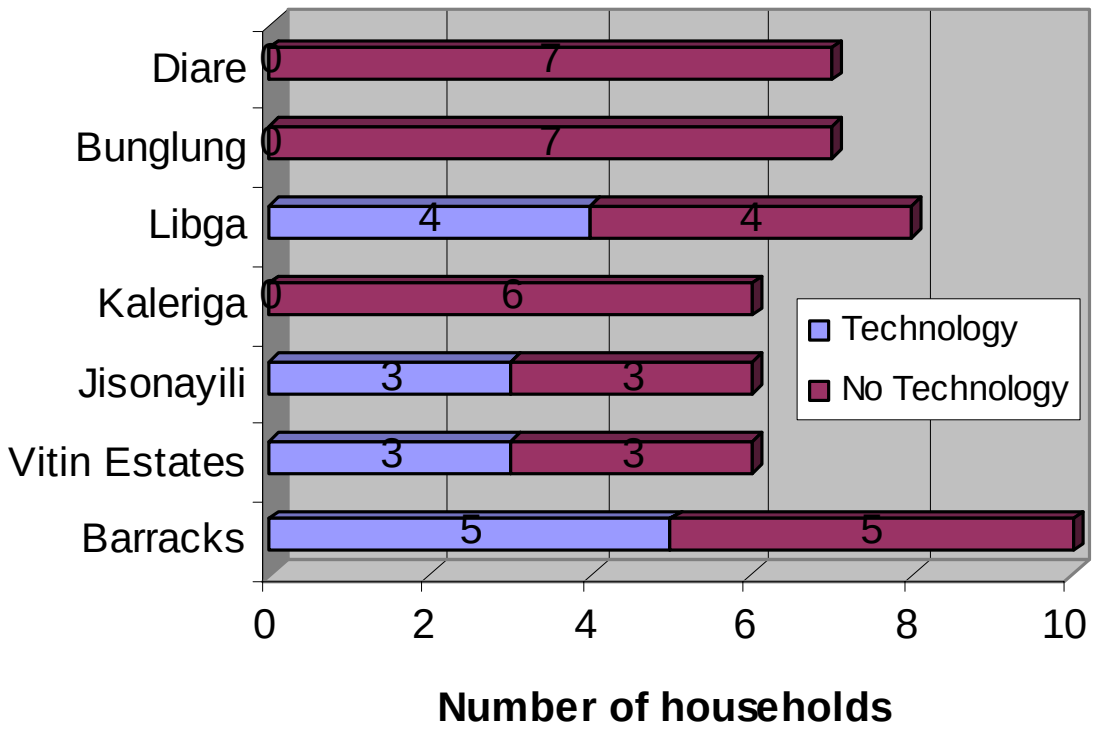
Information for

- Pure Home Water
- MIT student teams
- World Health Organization (WHO) International Network



COMMUNITIES SURVEYED

50 Households, 7 Communities, Mothers Interviewed



General Survey Results

WAWI (West Africa Water Initiative) Indicators

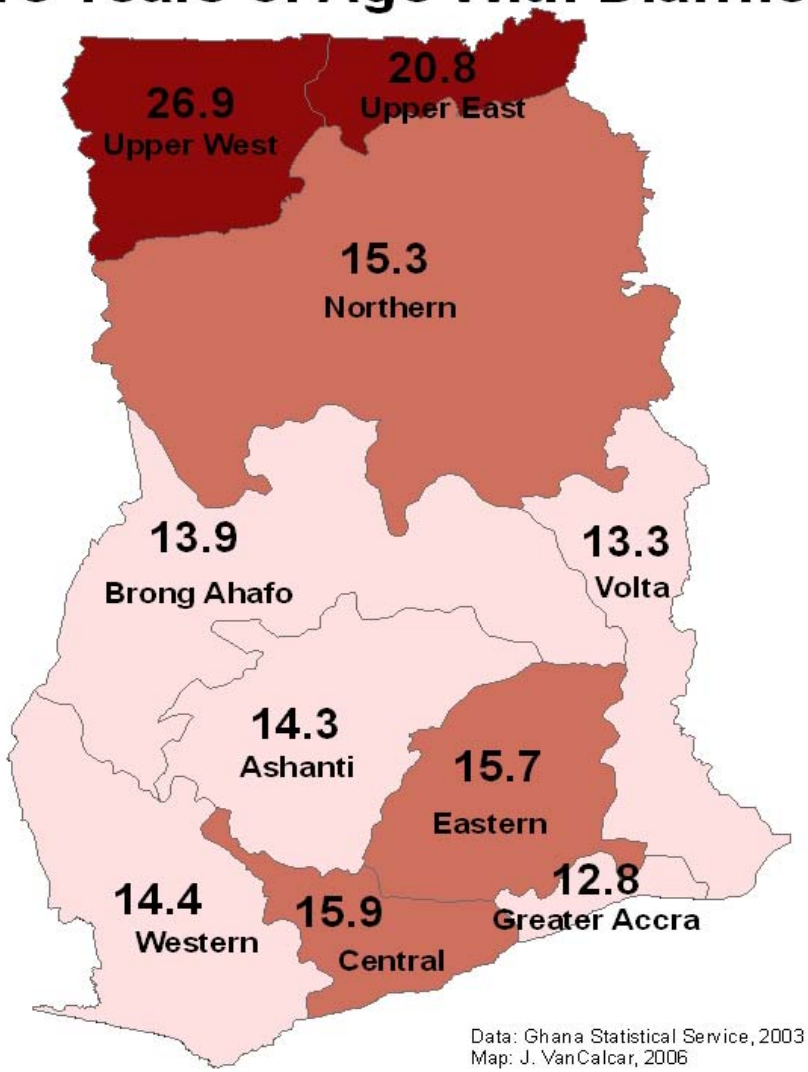
- *Access to Safe Water:* ***64%***
  - Improved water source always available
- *Access to Adequate Sanitation:* ***46%***
  - Latrine or flush toilet source always available
- *Appropriate Hand Washing:* ***86%***
  - Mothers always wash hands at appropriate times

Diarrheal Prevalence

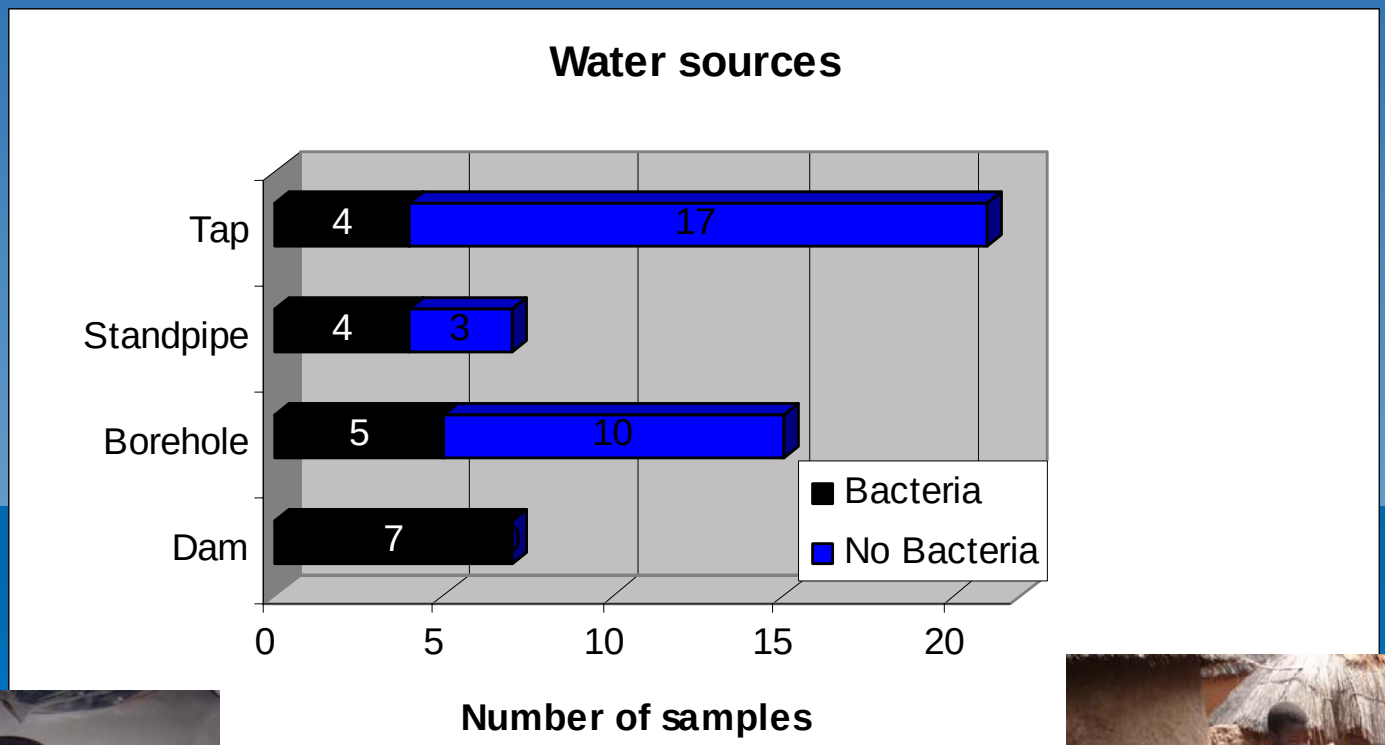
- *Overall Prevalence = **5%***
  - 5% (39/724) of all people suffered from diarrhea at time of study
- *Children under five years = **16%***
  - 16% (17/109) of children under five suffered from diarrhea at time of study

Children under 5 are at the greatest risk for diarrheal illnesses

Percentage of Children Under Five Years of Age With Diarrhea



H2S Bacteria Household Water Testing



Recontamination is probable!

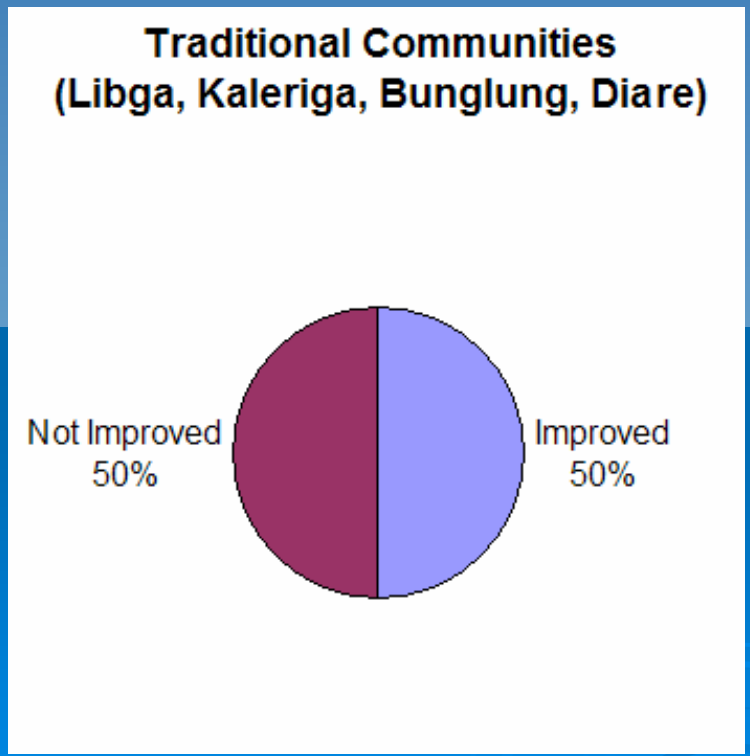
COMMUNITIES

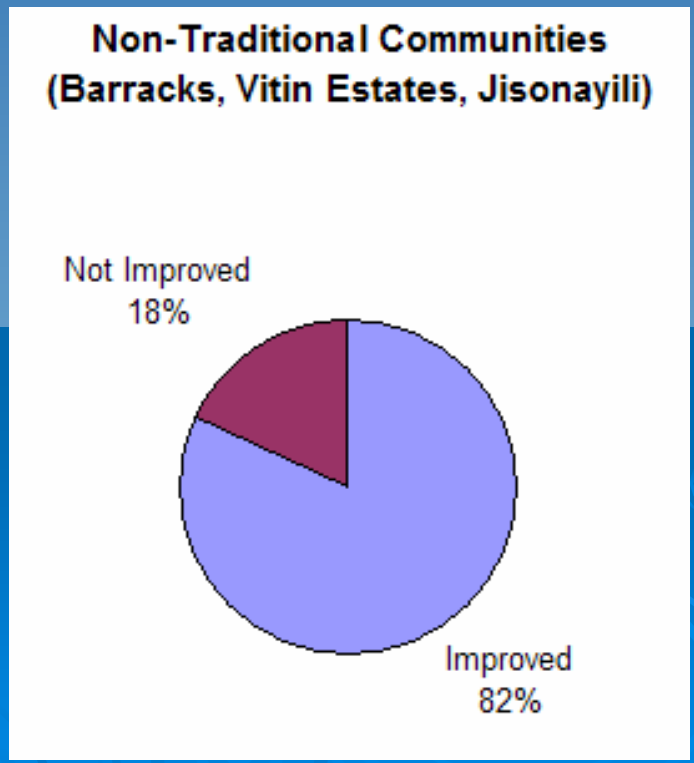
TRADITIONAL

NON-TRADITIONAL

Improved Water Source

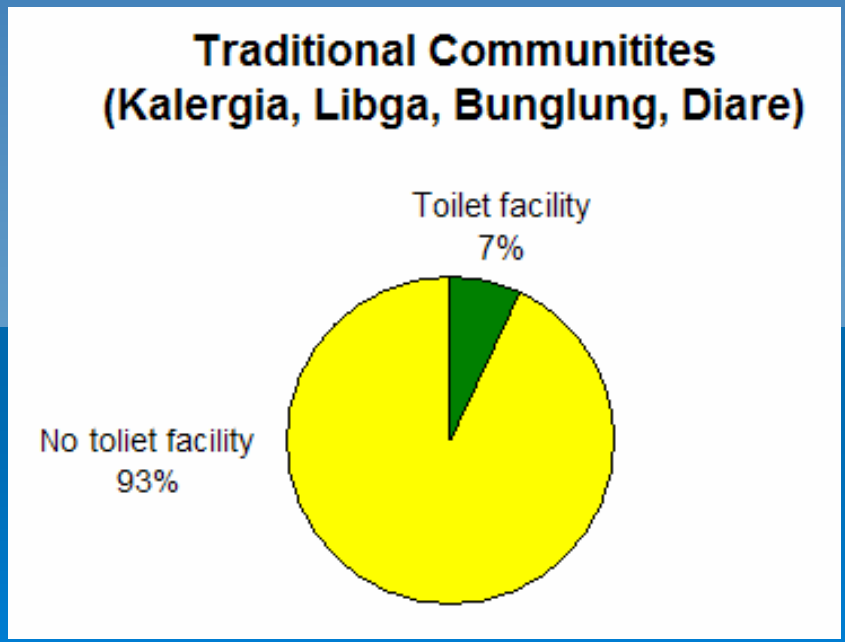
Improved=Borehole, Tap, Standpipe
Not improved=Dam, Dugout, Tanker Truck

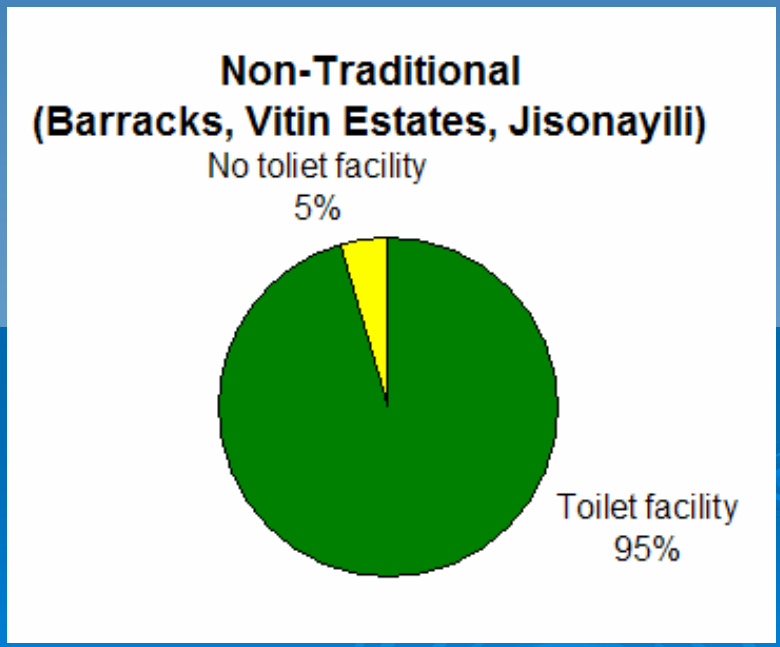




SANITATION

Toilet facilities = latrines and flush toilets
No toilet facility = ‘free range’ (fields)





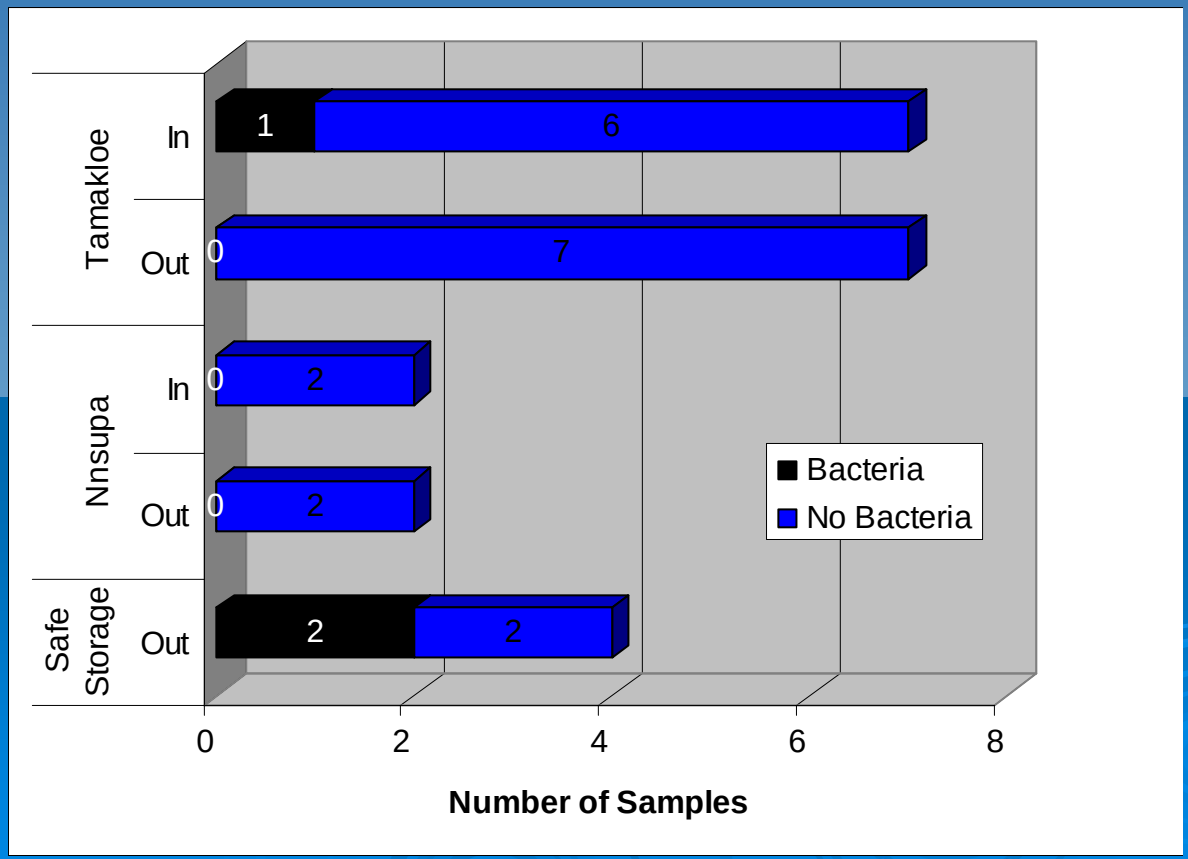
User Perceptions

Technology still in use	93%
Changes in water	80% = Better 20% = The Same
Recommend technology to others	100%
Noticeable health improvements	87%

94% of households without product are interested in treating their water

H2S Bacteria Household Water Testing

Product Performance



Relative Risk Analysis

	Diarrheal Illness	No Diarrheal Illness
Filters	1	10
No Filters	18	21

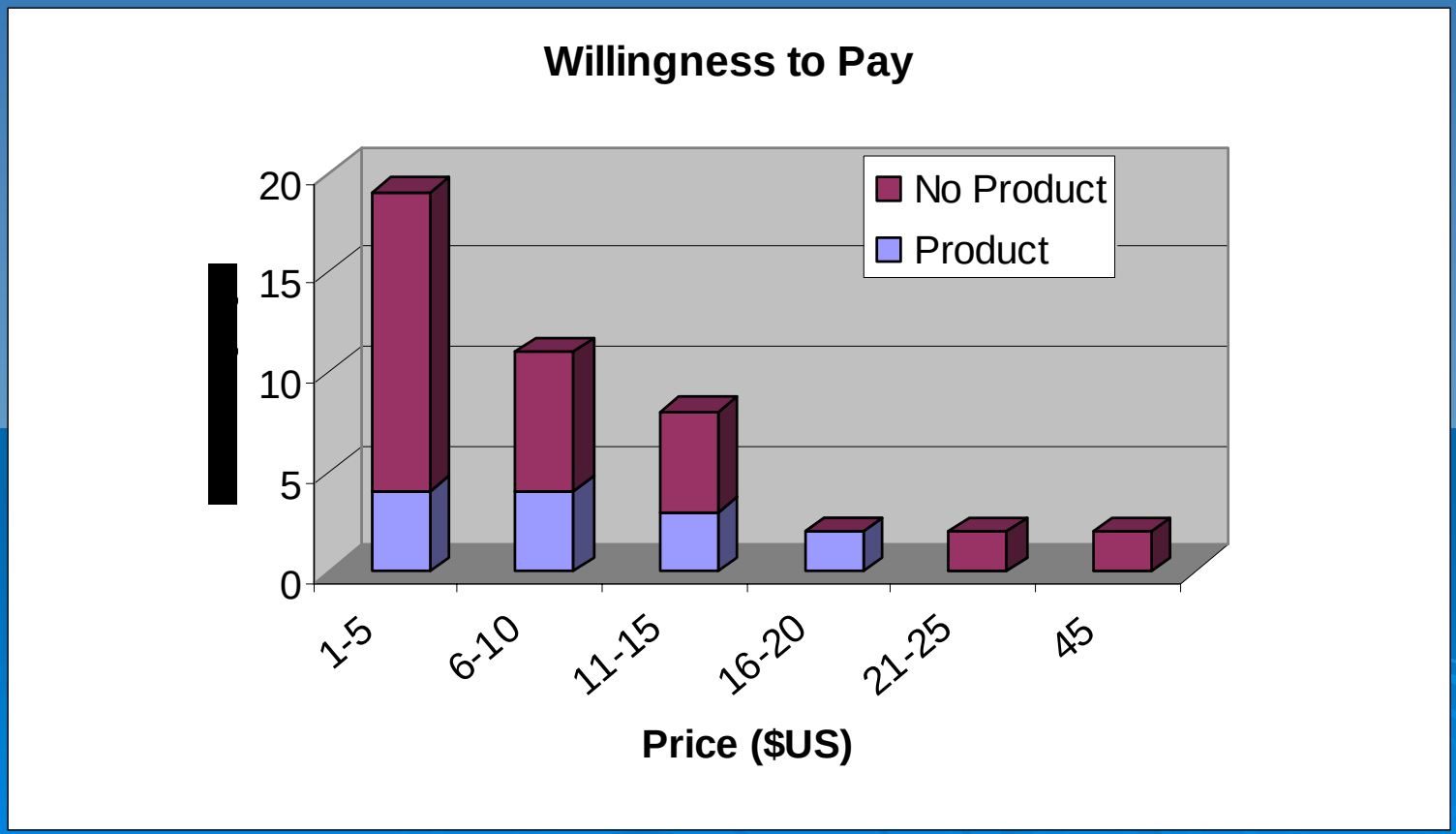
Odds Ratio= $\frac{(1x21)}{(18x10)}$ = 0.12

Statistically significant ($p<.001$)

*Households with filters have **12% of the risk** (78% less risk) of having diarrheal illness in the home compared to households without filters*

Product Pricing Feedback

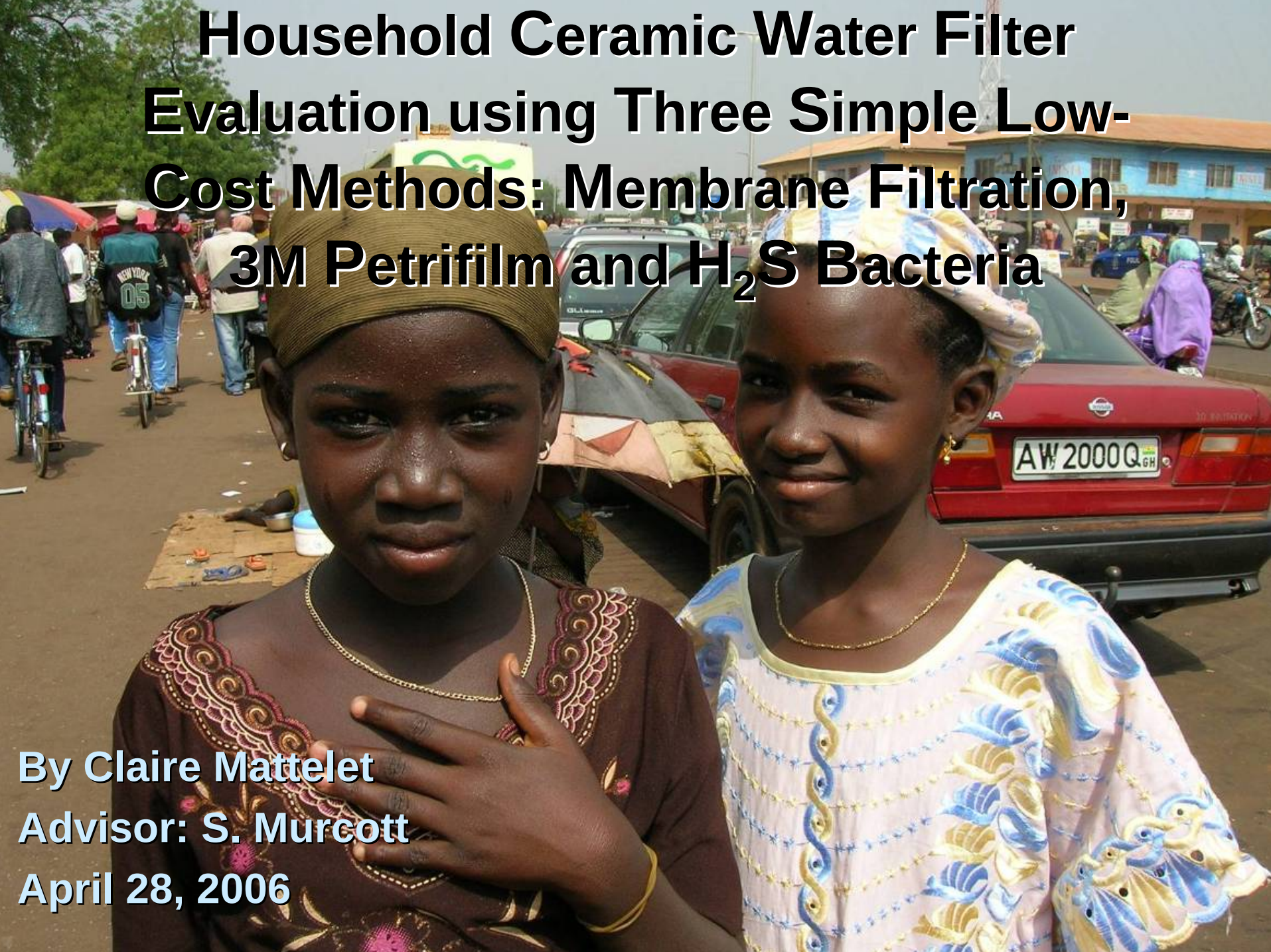
Average willingness to pay = $9
Product cost = $18



Conclusions

- Positive feedback from customers
  - Adoption rate: 93% (14/15) of households
- Greatest need in traditional communities
  - Lack of clean water and adequate sanitation
  - Higher prevalence of diarrheal illness for children under 5
    - 5% non-traditional
    - 18% traditional

Household Ceramic Water Filter Evaluation using Three Simple Low-Cost Methods: Membrane Filtration, 3M Petrifilm and H_2S Bacteria



By Claire Mattelet

Advisor: S. Murcott

April 28, 2006

INTRODUCTION

Motivations Simple and Low-Cost Methods for Drinking Water Testing:

- Fatal diseases in Ghana mainly linked to poor water & sanitation:

Malaria, Diarrhoea, Typhoid, Cholera, Gastroenteritis

- In Northern Ghana:

Communities are widely dispersed

→ **Limited ability to monitor HWTS, Need for simple methods**

- Poverty in Northern Ghana:

Need for cheap methods

Research Objectives

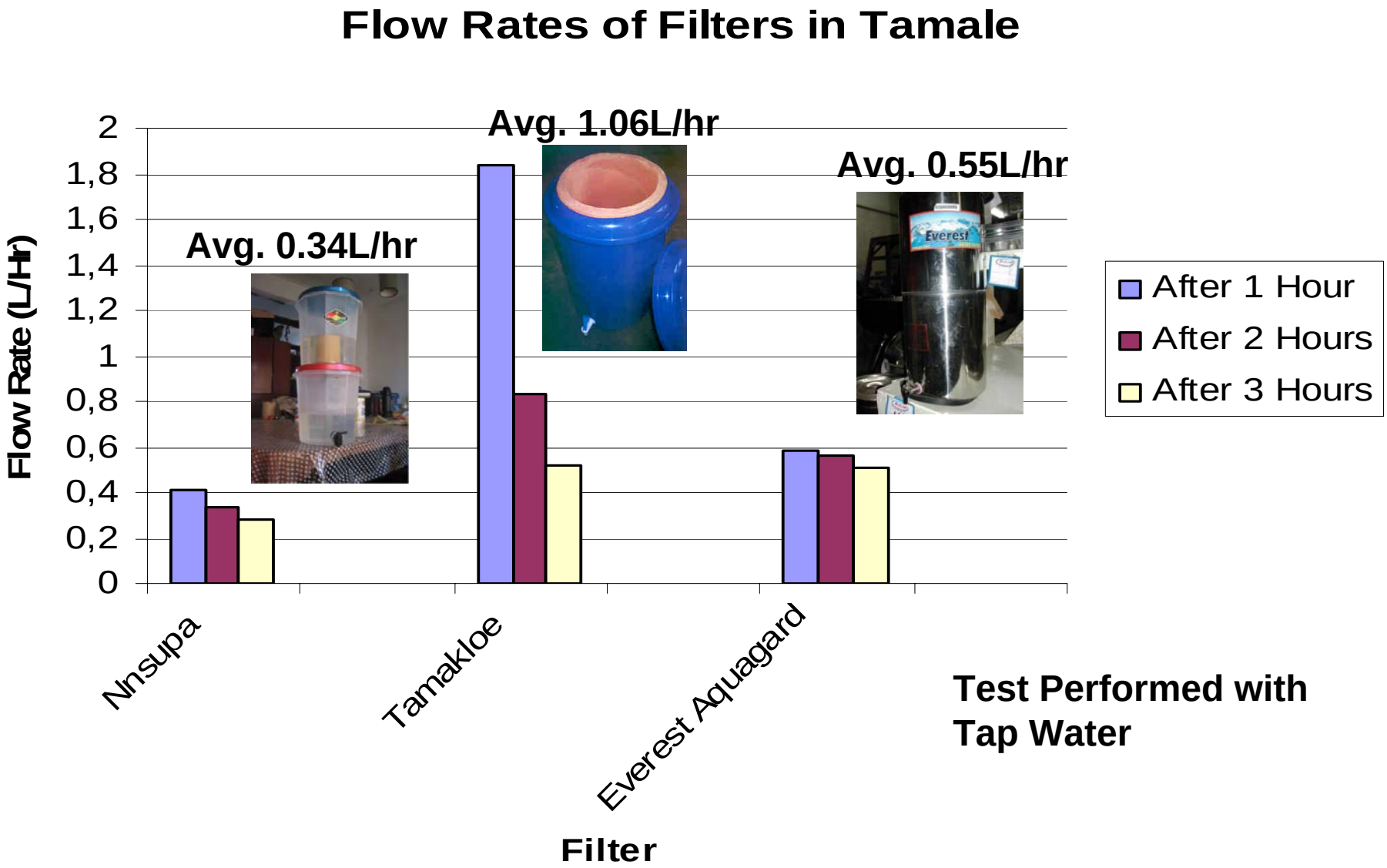
- ***Assessment and Comparison of Simple and Low-Cost Microbial Indicator Methods on the Basis of 6 Screening Criteria:***

- Cost
- Ease of use
- Ease of interpretation
- Labor requirements to complete test
- Level of skill required
- User acceptability

- ***Analysis of Water Samples from Dams and Rivers around Tamale***

- ***Microbial Assessment of the Filters sold by Pure Home Water Ghana***

Results: PHW Filters *vs.* Indian Filter



RESULTS: PHW FILTERS *vs.* INDIAN FILTER

- ***Tamakloe is the best performer***
  - Porosity is all over the bucket (great surface area)
  - Decrease in water head greatly affect the filter
- ***Indian filter is second***
  - Candle = Greater surface than Nnsupa until a certain height of water in top bucket
- ***Nnsupa is the worst performer***
- ***WHO (2004): «7.5L/D-person is necessary»***

Tamakloe	25.5L/D
Nnsupa	8.2L/D
Indian	13.1L/D

Materials & Methods

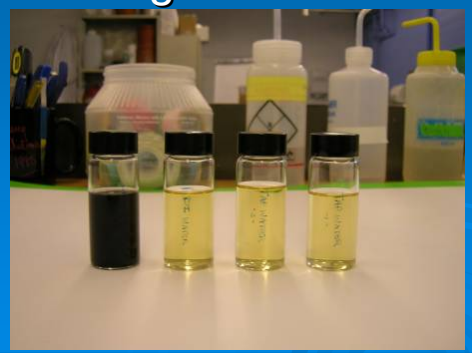
➢ 3M PetriFilm

Esherishia coli

+ Total coliform

➢ P/A H_2S test

H_2S-producing bacteria



➢ Membrane Filtration (m-ColiBlue)

Esherishia coli + Total coliform

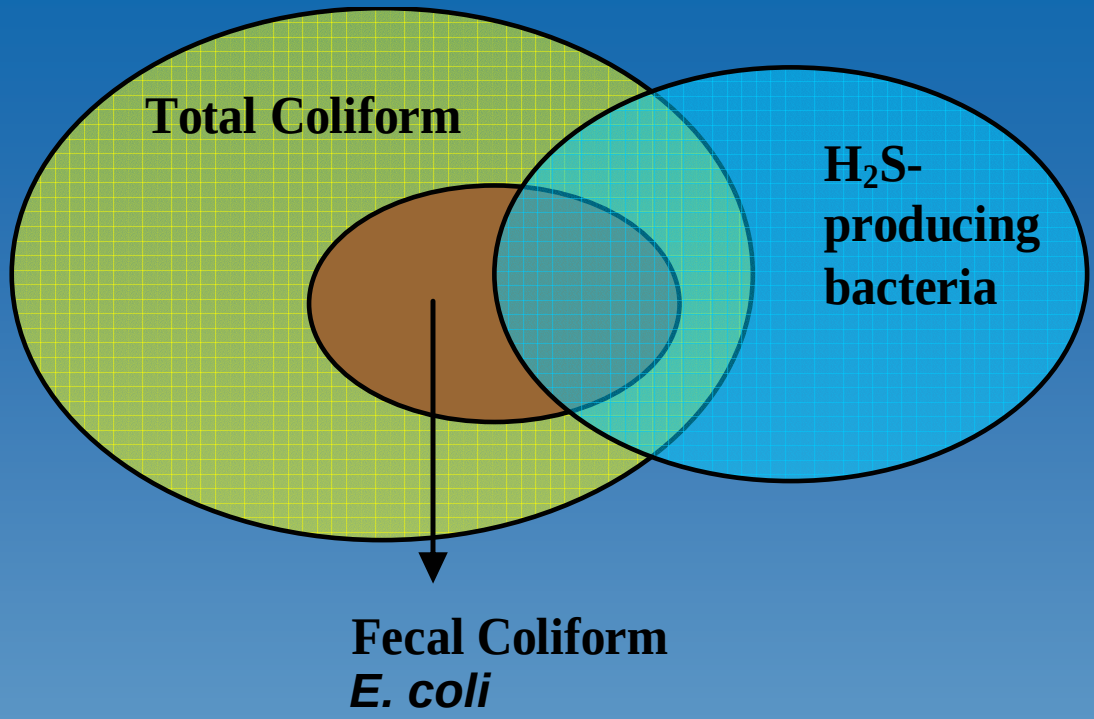


Illustration of the relationships between TC, FC and H_2S bacteria. **Low, 2002**

FC: Able to grow at 44.2°C

EC: Some *E. coli* able to grow at 37°C

TC: Multiply at 37°C

Results: Bacteria Removal

- ***Indian filter results got contaminated***

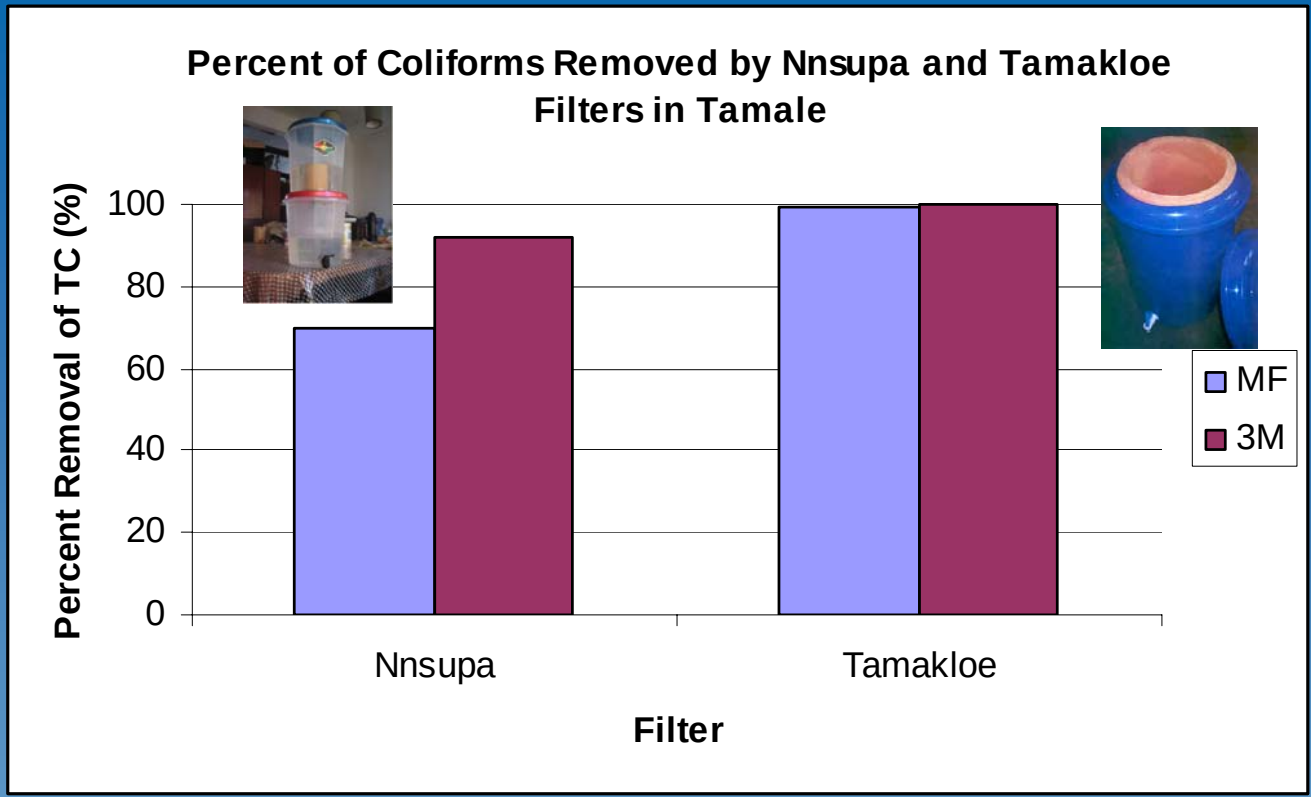
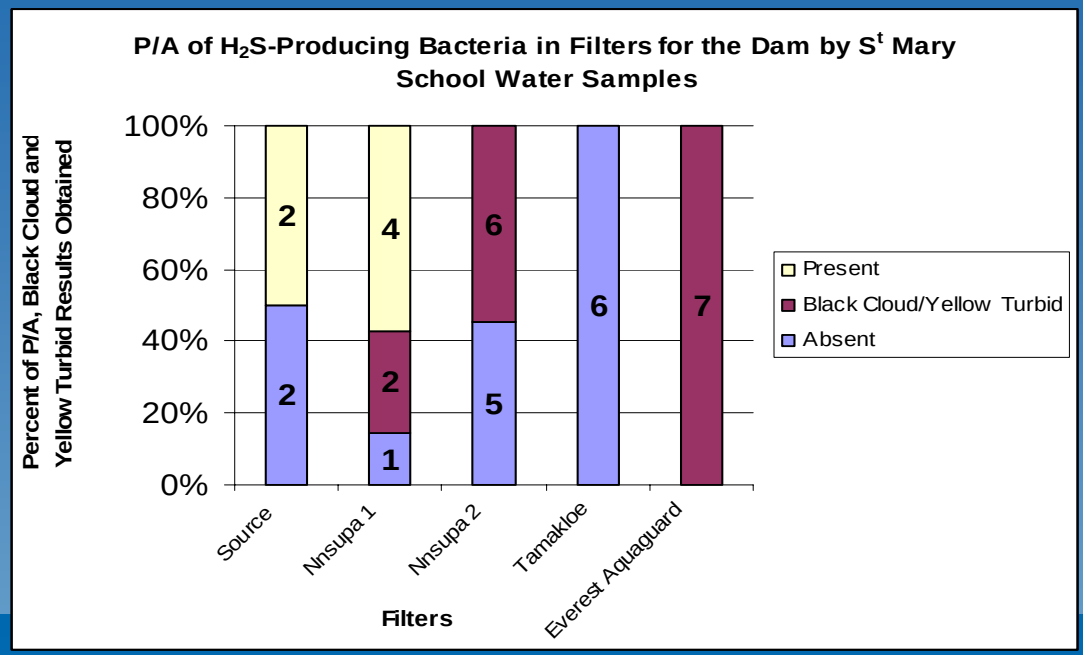


Table 5.2. Percent Removal of Total Coliforms (TC) and *E. coli* (EC) with the Nnsupa, Tamakloe, and Indian filters.

	Percent Coliforms Removed by Filters in Tamale			
Filter	**Avg. TC**		**Avg. EC**	
	MF[a]	**3M[b]**	**MF[a]**	**3M[b]**
Nnsupa First Candle	69.92	91.58	-	100
Nnsupa Second Candle	C[c] + CC[d]	74.06 + C[c]	-	100
Tamakloe	99.55	100	-	100
Everest Aquagard	CC[d]	CC[d]	-	100

[a] Membrane Filtration.
[b] 3M Petrifilm.
[c] Competition between total coliform bacteria growth and other red spot colonies.
[d] Suspected candle contamination enhancing the growth of total coliform bacteria (water flowing out of the filter is more contaminated than the water flowing in the filter).

RESULTS: BACTERIA REMOVAL



- ***P/A H_2S generally supported the results for all three filters***

- ***Intersted in the methods comparison***
  - **H2S *vs.* 3M and MF**
  - **3M *vs.* MF**

Table 5.5. Summary of the Data Obtained for Each Brand of Filter Tested.

		TC Removal (%)		EC Removal (%)			
Filter	**Flow Rate (L/Hr)**	**MF [a]**	**3M [b]**	**MF [a]**	**3M [b]**	**H_2S (Filtered Water)**	**Cost (US$)**
Nnsupa	0.34	69.92	91.58	-	100	P [d]	25
Tamakloe	1.06	99.55	100	-	100	A [e]	18
Indian	0.55	CC[c]	CC[c]	-	100	P [f]	14 (20L) 16 (24L) 18 (27L)

[a] Membrane Filtration.
[b] 3M Petrifilm.
[c] Supposed Candle Contamination enhancing the growth of total coliform bacteria (water flowing out of the filter is more contaminated than the water flowing in the filter).
[d] The colour of the media within the P/A tube tests was turbid or black for the filtered water for water dilutions until 100x.
[e] All P/A results were negative (remained yellow) for the filtered water.
[f] The colour of the media within the P/A tube tests was turbid and a black cloud formed at the bottom of the tube tests for water dilutions until 1000x.

- *Tamakloe is the most efficient (silver coating, small pore size)*
- *Remove Nnsupa from sells until improvement of the candle*
- *Indian filter & Nnuspa filter (second candle) got contaminated (candle, activated carbon?)*

RESULTS: 3M *vs.* MF

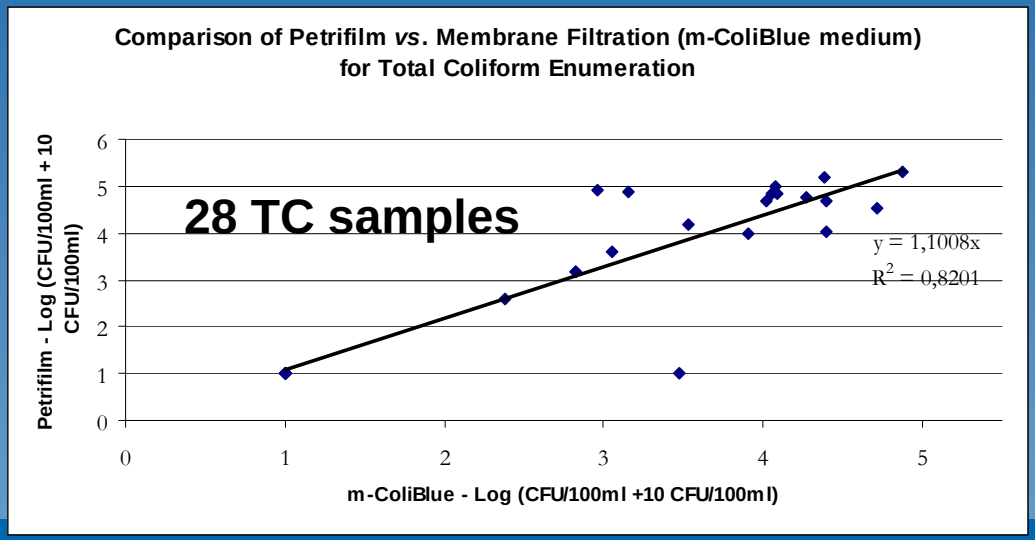


Figure 5.8. Comparison of Petrifilm vs. Membrane Filtration (m-ColiBlue medium) for Total Coliform Enumeration.

Are 3M and MF Significantly Different?

- ***T-test for paired samples***
- ***Interval of Confidence set at 95%***

Probability > 5%

No significant difference between the tests.

Test d'égalité des espérances: observations pairées

	Variable 1	*Variable 2*
Moyenne	2,871	3,159
Variance	2,065	3,062
Observations	28,000	28,000
Coefficient de corrélation de Pearson	0,906	
Différence hypothétique des moyennes	0	
Degré de liberté	27	
Statistique t	-2,014099746	
P(T<=t) unilatéral	0,027030783	
Valeur critique de t (unilatéral)	1,703288423	
P(T<=t) bilatéral	0,054061566	
Valeur critique de t (bilatéral)	2,051830493	

Results: Water Sources Contamination Assessment

Table 3.1. Faecal Contamination Assessment of Water Sources in Tamale.

Water Source	MF (CFU/100mL)		3M (CFU/100mL)	
	TC	EC	TC	EC
Dam by S[t] Mary	13,167	0	62,571	1,409
Bilpelar Dam	8,000	135	4,500	0
Ghanasco Muali	25,000	125	10,750	0
Kamina River	TNTC[b]	TNTC[b]	5,100,000	3,450,000
Dam near Gillbt	1,055	30	11,600	100
WV[a]	757	142	18,771	233

[a] World Vision Office, Savlegu.

[b] Too numerous to count.

CONCLUSION: The 6 Scree Criteria

	Cost	Ease of Use	Ease of Interpretation	Labor Requirement	
MF					
3M					
~~H_2S~~					

- ***H2S should not be recommended***
- ***3M should be recommended at high level of contamination (dams, dugouts, rivers)***
- ***MF should be recommended at low level of contamination (tap water, water coming out of the filter)***

Recommendations

- Concentrate on lowering prices or finding alternatives
  - Manufacturing within Tamale
  - Solar disinfection
- Plan how to best spread the technology
  - Through other organizations (Shell gas stations, midwives, schools, clinics)
  - Advertising

THANK YOU!