Water Quality Assessment of Stored Rainwater Samples in Northeastern Thailand and Evaluation of a Novel Compartmentalized Bag MPN Method for Quantifying *E. coli*

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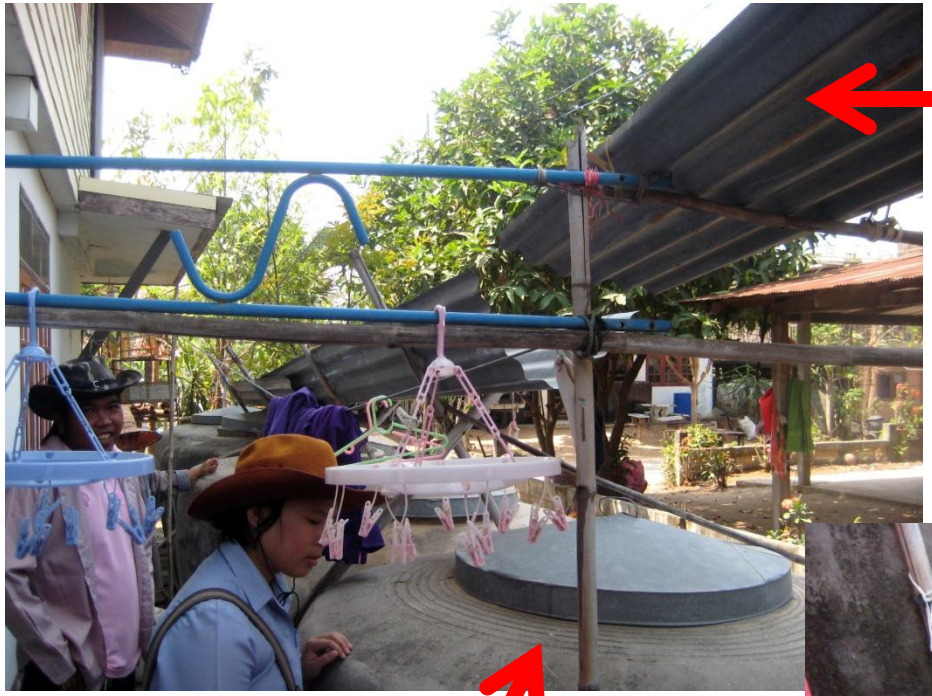
Introduction: Water and Health

- 4 billion cases of diarrhea per year
- 1.8 million cases result in death
  - Majority of deaths are children <5 years old
- Human exposures occur via drinking, recreational, irrigation and other water uses
  - Endemic and epidemic disease from these exposures is well-documented

Introduction: Rainwater Harvesting Systems (RWHS)

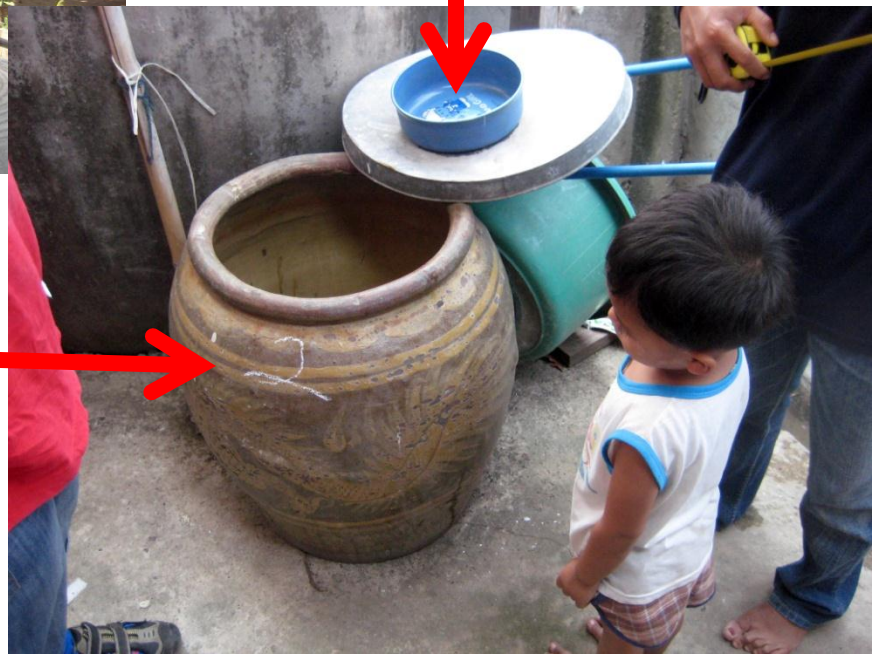
- Many people in NE Thailand depend on rainwater as their main source of drinking water.
- RWHS consist of a catchment area, conveyance system and storage container
- Main sources of microbial contamination in RWHS:
  - Collection and use of the first flush rainwater
  - Improper storage
  - Manual extraction of water from tank

Introduction: RWHS



Conveyance system

Scoop used for manual collection of water from tank



Earthen/cement rainwater storage containers

Introduction: Indicator organisms

- Indicator organisms are used to signal the presence of fecal pollution

- *Escherichia coli*
- H_2S –producing bacteria (e.g. *Clostridium perfringens)*
- Bacteriophages (F+ coliphages)

- WHO Drinking Water Quality Guidelines
  - No *E. coli* or thermotolerant coliforms should be present in 100-mL of water.

Experimental Aims

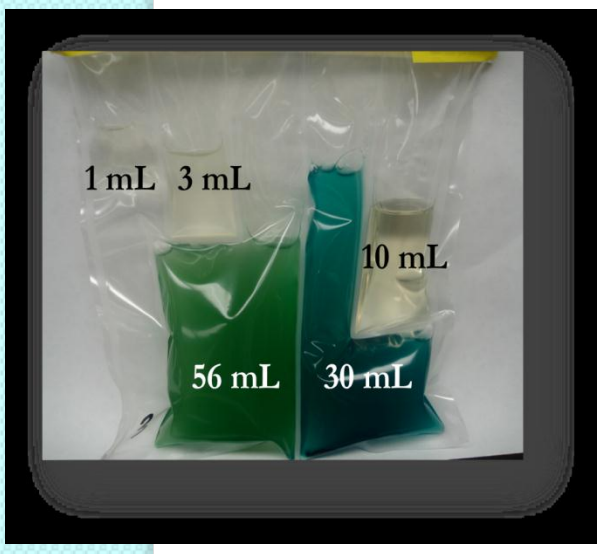
- Assess the physical and sanitary conditions of RWHS and local use practices
- Evaluate the microbial quality of stored rainwater during the wet and dry seasons in NE Thailand.
- Compare the compartmentalized bag-test (CBT) for the quantification of *E. coli* in water to the gold-standard IDEXX Colisure® Quantitray 2000 method (C-QT)

Methods

- Study site: Wailum, Khon Kaen, Thailand
- Observational survey of 60 randomized households
- Stored rainwater quality survey
  - Dry season (February – March, 2011)
    - *E. coli* (C-QT and CBT)
    - H_2S-producing bacteria [Pathoscreen/Quantitray (P-QT)]
    - F+ coliphages (EPA Method 1602: Single Agar Layer)*
  - Wet season (July, 2011)
    - *E. coli* (C-QT and CBT)

Methods continued

- Comparison of C-QT vs. CBT
  - The CBT is a new, simple to perform, low cost method to detect *E. coli* in 100-mL water samples. The chromogenic medium turns blue in the presence of *E. coli*. Different volume compartments within the bag allow for Most Probable Number (MPN) of organisms to be determined.



- Samples were tested by both C-QT and CBT methods in parallel.
- All samples were incubated overnight at 37°C (dry season) or at ambient temperature (~28-34°C) for up to 48 hours (wet season)
- MPN results were compared using Wilcoxon matched-pairs signed rank test.

Results: Occurrence of Fecal Indicators in Field Water Samples

Method (indicator organism)	Dry	Wet
Colisure-Quantitray (*E. coli*)	26/105 (24.8%)*	53/86 (61.6%)
Compartmentalized bag test (*E. coli*)	30/105 (28.6%)	45/84 (53.6%)
Pathoscreen-Quantitray (H_2S-producing bacteria)	30/59 (51%)	ND**
F+ Coliphage	11/24 (46%)	ND

*# samples positive/total samples (percentage of samples positive)
**No Data

Results: Comparison of C-QT vs. CBT *E. coli* MPN Concentrations

- 189 assayed samples demonstrated no significant difference in *E. coli* concentrations obtained from the CBT and the C-QT methods ($p=0.7074$)
- Additionally, no significant difference between methods was found when the dry and wet season results were analyzed separately ($p=0.263$ and $p=0.284$, respectively)

Conclusions

- Water Quality Assessment
  - 24.8% and 61.6% of stored rainwater samples from dry and wet seasons, respectively, exceeded WHO drinking water quality standards for *E. coli*
  - Untreated, stored rainwater may not be a safe source of drinking water

- C-QT vs. CBT
  - CBT provides comparable results to C-QT in stored rainwater
  - CBT may be a convenient alternative to standard water quality testing methods in resource poor settings

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