FLOATING TREATMENT PODS FOR LAKE COMMUNITIES

Irina Chakraborty, Wiley Jennings, Puthea Khon, and Taber Hand

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Wetlands Work! Ltd, Phnom Penh, Cambodia
Tonle Sap
Sanitation in Cambodia

- Less than 20% have a toilet
- Difficult terrain due to high groundwater and flooding
Floating villages

- >100,000 live in floating homes with no sanitation
- Villages move throughout the year
- Difficult to access
Water as playground

- Children spend hours each day in the water
Ambient water quality

E. coli/100 ml (log scale)


Inside Akol  Outside Akol  Kampong Luang
Ambient water quality

REC -1 limit: 200 cfu / 100 ml
REC -2 limit: 2,000 cfu / 100 ml
Objective

Improved ambient water quality, as measured by *E. coli* numbers and diarrheal disease incidence among 0-5 year old children.
The Basic Pod

- Widely used tarpauline
- Water bottles sewn into edge
- Volume of single pod: ~235 L
- ~1 x 1.5 x 0.4 m
The Pod

- Double pod (total vol: 470 L)
- Attached by ropes
Water hyacinth (*Eichhornia crassipes*)

- Well-documented remediation abilities
- Originally from South America, now widespread in tropics
- Fast growing
  - In Pod: mass increased 5-fold over 3 weeks
- Resilient
- Large root surface area for microbiological activity
Pod tests: Method

- Pods were filled with tap water and hyacinth (~3.5 kg)
- No exchange
- Sewage or raw feces added
- *E. coli* measured in water samples
Pod test 1: Sewer water

Pod treatment of 35 L sewage (daily)

E. coli cfu /100 ml (log)

Sewage: $\sim 10^{-5} - 10^6$
Pod test 2: Feces

Pod treatment of 500 g feces

E. coli cfu /100 ml (log)

0 2 4

Time (days)

Differences in smell and appearance of water
Pod tests on lake (Pod x2)

Input Pod: 65,000 cfu/ 100 ml (6.5 x 10^4)
Output Pod: 10,000 cfu/ 100 ml (10^4)

Total expected $E. \ coli$ in Pods from four-person household: $10^8$ cfu/ 100 ml
User experience

- Tested with a (floating) research station and a villager’s house
- Challenges:
  - Accurate user feedback
  - Smell
  - Mice
Evolution of design

Key features of design:

- Affordable (current model: $20, including platform)
- Local materials, production
- Low-maintenance
- User-friendly
Evolution of design

• Bucket as a “toilet”
• First pod section covered to address smell
• Indoor or external installation option
Evolution of design

- Strategies to replace tarp
  - Bamboo Pod lined with a waterproof material
  - Stability issues; new proposed design connects section with innertube tires to allow flexibility
- Biodegradable?
- Protect edges of tarp from light (e.g. paint)
Current work: Health impacts

• Adoption of Pods on the village scale
• Two villages: one with Pods, one as control
• Around forty households in one, fifty in the other; similar income levels
• Target: 0-5 year olds
• Simple questionnaire on gastrointestinal symptoms, contact with water
Lake Inle

• March - May 2012
• Connected with Buddhist Youth for Inle Watershed
• Water level changes and household sewage untreated, similar to Cambodia
• Houses are stilted; 70,000 inhabitants
• Different attitude to sanitation
Other future work

• Evaluate effectiveness beyond indicator organisms
• Analyze and respond to user feedback
• Tracer experiments
Other future work

- Adapt Pods for pig waste
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