CASE STUDY- HEALTH

Whittington, D., Jeuland, M., Barker, K., & Yuen, Y. (2012). Setting priorities, targeting subsidies among water, sanitation, and preventive health interventions in developing countries. *World Development*, *40*(8), 1546-1568.

EE465/EE463 Project Evaluation

Semester 2/2014

Introduction (1)

- This paper challenges the conventional understanding that water and sanitation improvements and other preventive health interventions are worth investing.
- 3 puzzles:

1. While the health benefits of preventive health interventions seem to be high, the demand for them is very low among households in developing countries.
2. Despite free or heavily subsidized provision of preventive health interventions, the usage remains low.
3. Governments in developing countries often support subsidization of sanitation infrastructure at the expense of other interventions that could be more beneficial to health improvement.

Introduction (2)

- Main argument:

  The fundamental reasons for the three puzzles are the *high uncertainty* (for given sites) and *inherit variability* (across sites) in the economic costs and benefits of water and sanitation and hygiene and preventive health intervention in developing countries.

- This paper presents cost-benefit calculations of six different interventions and performs a number of sensitivity analyses.
- Bottom-line: the global estimates of the costs and benefits of each intervention are subject to limitation, given the heterogeneity across different locations in developing countries.

Background

- Why uncertainty in parameters matter?

Consider the *mortality reduction benefits* of vaccinating against cholera. The followings need to be estimated:

1. $\Delta Cases = Pop * Effect * Incidence_{before}$

2. $\Delta Deaths = CFR * Pop * Effect * Incidence_{before}$

Where CFR = case fatality rate.

3. $Mortality\ benefits = VSL * (CFR * Pop * Eff * Inc_{before})$

Where VSL = value of statistical life.

- From above, the values of incidence, CFR, effect, or VSL are highly uncertain and are location specific.

Analytical Framework

- Focus on the impacts of initial "uptake" and sustained "usage" of new technologies on the net benefits
  - Uptake is a household's initial acquisition of a technology or participation in a program.
  - Usage is the rate (or frequency) of regular use among the "uptaking" households.
- Unit of analysis is the individual households
- Costs include both initial and continued costs.
- Benefits are measured from both health and non-health outcomes.
- Parameters are obtained from numerous previous related studies.

General typology of Costs and Benefits of Intervention (1)

Costs	Examples
Capital products	Infrastructures need for interventions (e.g. cost of latrine, water containers, bed nets, filters, etc.)
Program "software"	Implementation/delivery cost (NGO and govt staff time, promotion materials, rewards & incentives, etc.)
Operation & Maintenance	Replacement/cleaning of equipment (e.g. sanitization of latrines, purchase of chlorine product, etc.)
Household time expenses	Training and education programs, time required for use and maintenance of improved technologies
Community time expenses	Community maintenance or ongoing promotion of programs by community members
Discomfort/ inconvenience	Heat from bed nets, filters are bulky and take space, etc.

General typology of Costs and Benefits of Intervention (2)

Benefits	Examples
Morbidity and mortality reduction	POU water treatment, sanitation and hygiene intervention reduce fecal-oral transmission and incidence; bed nets decrease malaria incidence (e.g. reduction in mortality cost = COI per case x decrease in expected annual cases per household)
Time savings	In-house latrines reduce travel time to defecation sites
Esthetic gains	Hand-washing and increased water-use improves cleanliness
Improved social standing	Household status is associated with having in-house sanitation, or durable good (filters, bed nets)
Socialization benefits	Participants enjoy the social interactions of awareness-raising or education activities

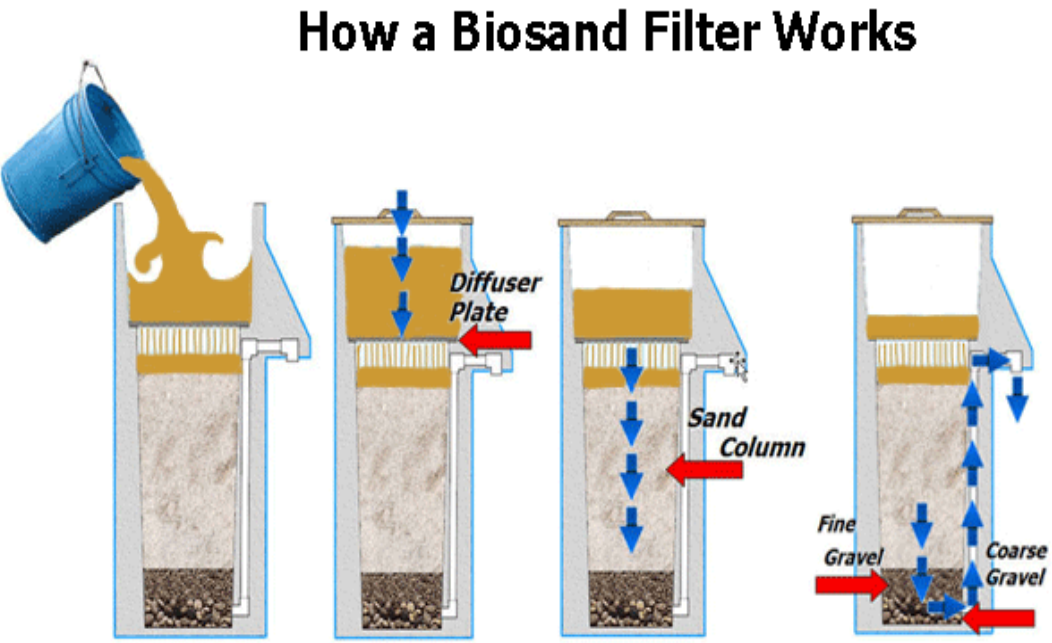
Six Interventions

- Promotion of hand-washing and improved hygiene
- Total sanitation campaigns
- Biosand filters
- Point-of use chlorination of drinking water
- Insecticide-treated bed nets
- Cholera vaccination

Long Lasting Insecticide Treated Bed Nets

Pixsource: www.diytrade.com

Biosand Filters



Pixsource:
www.waterforcambodia.org

Pixsource:
en.wikipedia.org

Bahavior-Response Parameters

Table 3. *Low and high coverage parameters affected by program design and the behavioral response of beneficiaries*

Parameter	Handwashing		Total sanitation campaign		Chlorination		Biosand filters		Long-lived Insecticide-treated bed nets		Cholera vaccination	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Initial uptake (%)	20	60	20	60	–	–	–	–	20	70	10	80
Regular usage (%)	20	80	50	90	10	80	60	100	15	80	–	–
Rate of disuse over time (% of users/yr)	–	–	6	0	12	4	15	1	20	5	–	–
Sources	Wilson and Chandler (1993); Borghi *et al.* (2002); Cairncross *et al.* (2005); and Waterkeyn and Cairncross (2005)		Hoque *et al.* (1996); Cairncross *et al.* (2005); WSP (2005); Pattanayak *et al.* (2009); and Trémolet *et al.* (2010)		Quick *et al.* (1996); Macy and Quick (1998); Semenza *et al.* (1998); Mong *et al.* (2001); Quick *et al.* (2002); Reller *et al.* (2003); Sobsey *et al.* (2003); Olembo *et al.* (2004); Waterkeyn and Cairncross (2005); and Arnold and Colford (2007)		Expert judgment and Duke *et al.* (2006); Sobsey *et al.* (2008); and Vanderzwaag (2008)		Hanson *et al.* (2003); Wiseman *et al.* (2007); Müller *et al.* (2008); Mueller *et al.* (2008); WHO (2009); Dupas (2010); and Tarozzi *et al.* (2010)		Ali *et al.* (2005); Thiem *et al.* (2003); Jeuland *et al.* (2010)	

Table 4: General Parameters

Parameter	Value	[Min–max range]
Household size	5	[4–6]
Number of adults per hh	2	[1–3]
Market wage (US$/day)	1.25	[0.5–2]
Value of time/market wage (%)	30	[10–50]
Diarrheal disease incidence (cases/person-yr)	0.9	[0.4–1.4]
Diarrheal disease case fatality rate (%)	0.08	[0.04–0.12]
Diarrheal disease cost of illness (US$/case)	6	[2–10]
Malaria incidence (cases/person-yr)	0.3	[0.02–0.6]
Malaria case fatality rate (%)	0.2	[0.05–0.35]
Malaria cost of illness (US$/case)	26	[12–40]
Cholera incidence (cases/1000 persons-yr)	2	[0.1–3.9]
Cholera case fatality rate (%)	1.75	[0.5–3.0]
Cholera cost of illness (US$/case)	50	[15–85]
Value of a statistical life (US$)	30,000	[10,000–50,000]
Discount rate (%)	4.5	[3–6]

Benefits – Intervention specific

Parameter	Handwashing	Total sanitation campaign	Chlorination
Benefit parameters			
Reduction in diarrhea cases (%)	45 [25–65] (Curtis & Cairncross, 2003; Ejemot, Ehiri, Meremikwu, & Critchley, 2009)	30 [10–50] (Fewtrell *et al.*, 2005)	37.5 [25–50] (Arnold and Colford, 2007; Clasen *et al.*, 2006; Hunter, 2009)
Reduction in malaria cases (%)	–	–	–
% of esthetic benefits that are health-related	25 [0–50]	–	–
Round trip travel time to defecation site (min)	–	15 [10–20]	–
Number of trips to defecation site per day	–	1 [0.75–1.25]	–

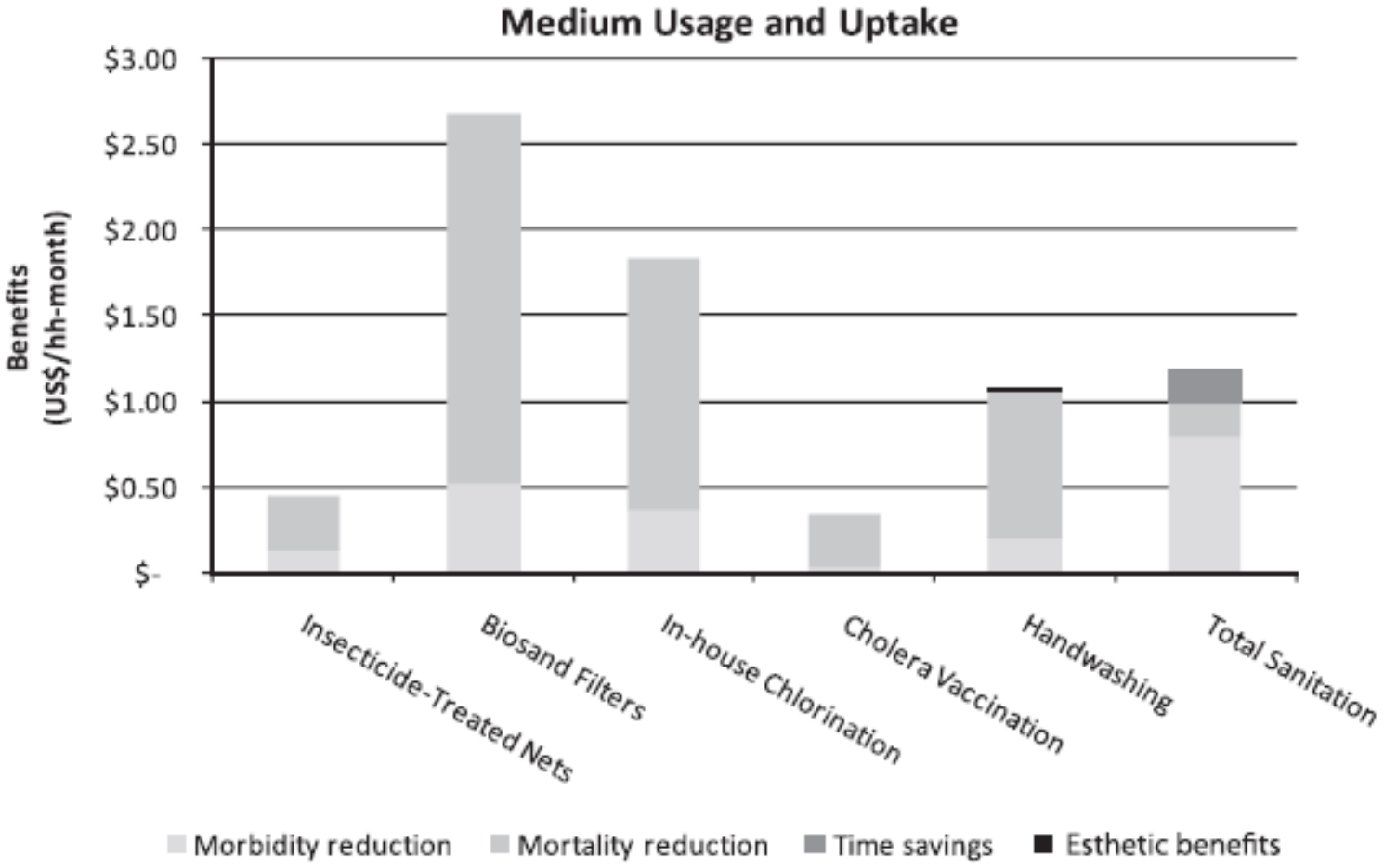
Benefits – Intervention specific

Parameter	Biosand filters	Long-lived Insecticide-treated bed nets	Cholera vaccination
Benefit parameters			
Reduction in diarrhea cases (%)	40 [20–60] (Fewtrell *et al.*, 2005)	–	Cholera reduction is a function of uptake (see technical Appendix available online)
Reduction in malaria cases (%)	–	30 [15–45] (Lengeler, 2004)	–
% of esthetic benefits that are health-related	–	–	–
Round trip travel time to defecation site (min)	–	–	–
Number of trips to defecation site per day	–	–	–

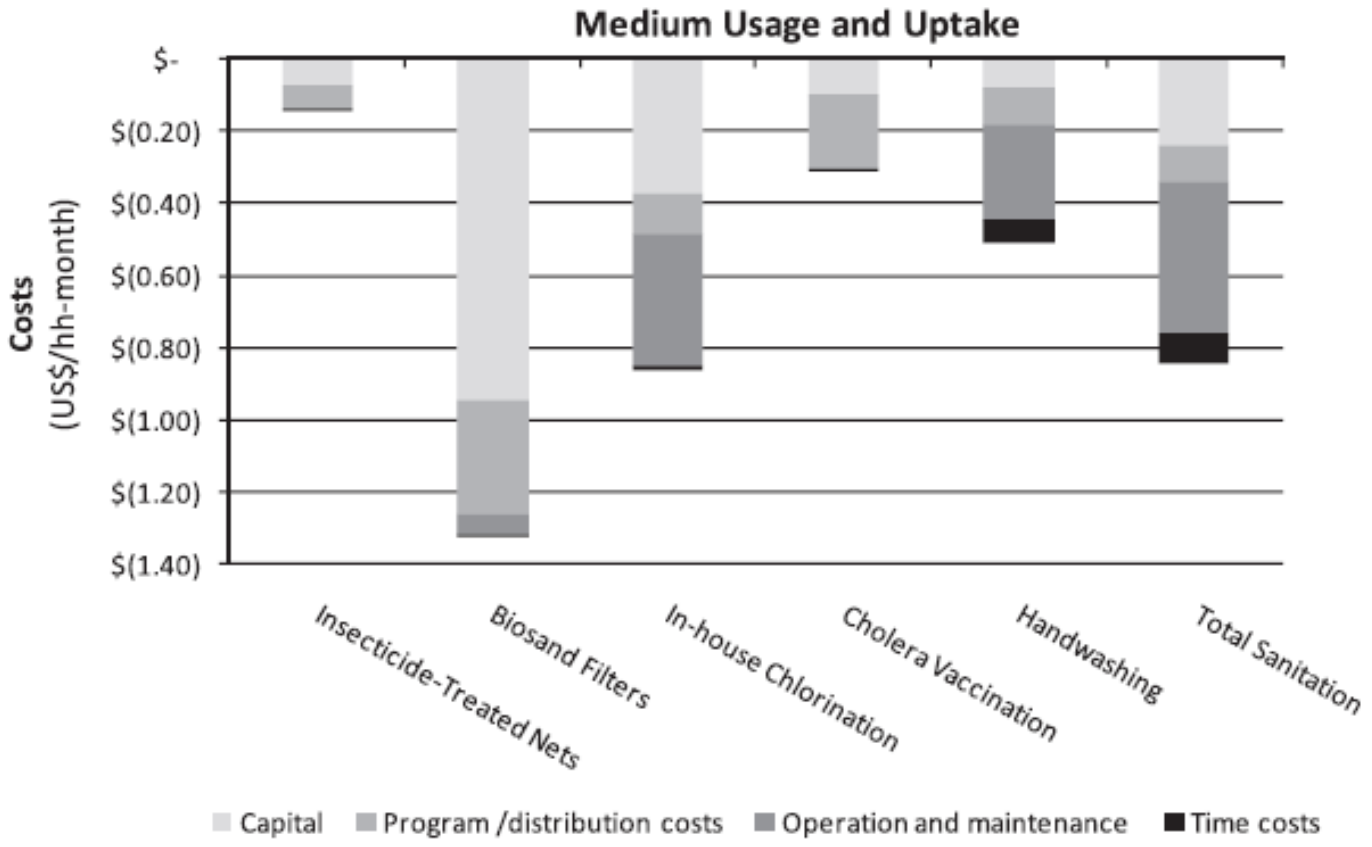
Costs – Intervention specific

Parameter	Handwashing	Total sanitation campaign	Chlorination
Cost parameters			
Capital cost ($)	3.5 [2–5] (online sources)	20 [10–30] (WSP, 2005)	8.5 [5–12] (expert judgment & Lantagne *et al.* (2007))
Transportation/ distribution cost ($)	–	–	–
Program software cost (% of upfront expenses)	Same as CLTS amounts	30 [20–40]	Same as total sanitation amounts
Initial time expense: uptakers (hours)	40 [20–60]	10 [5–15]	1 [0.5–1.5]
Initial time expense: nonuptakers (hours)	10 [5–15]	3 [2–4]	N/A
Operation and maintenance cost ($/yr)	Per person-yr: 3 [2–4] (Borghi *et al.*, 2002)	5 [2–8] (Trémolet *et al.*, 2010)	4.4 [3.2–5.6] (Clasen, Haller *et al.*, 2007; Clasen, Schmidt *et al.*, 2007; Lantagne *et al.*, 2007)
Water collection time (hr/20 L jerrican)	1 [0.1–2]	–	–
Water needed for washing (L/person-day)	0.8 [0.25–1.4]	–	–

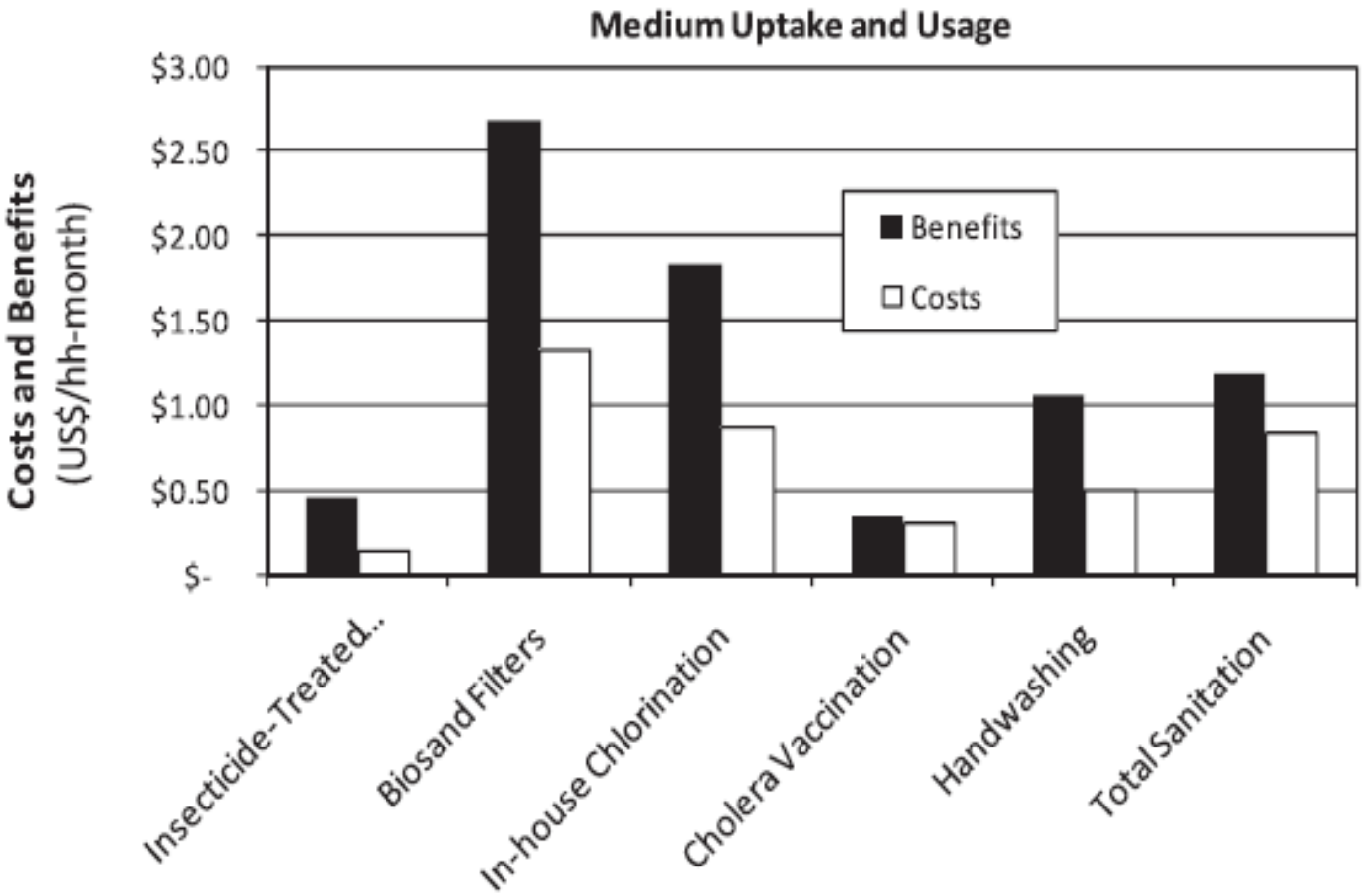
Results - Benefits



Results - Costs

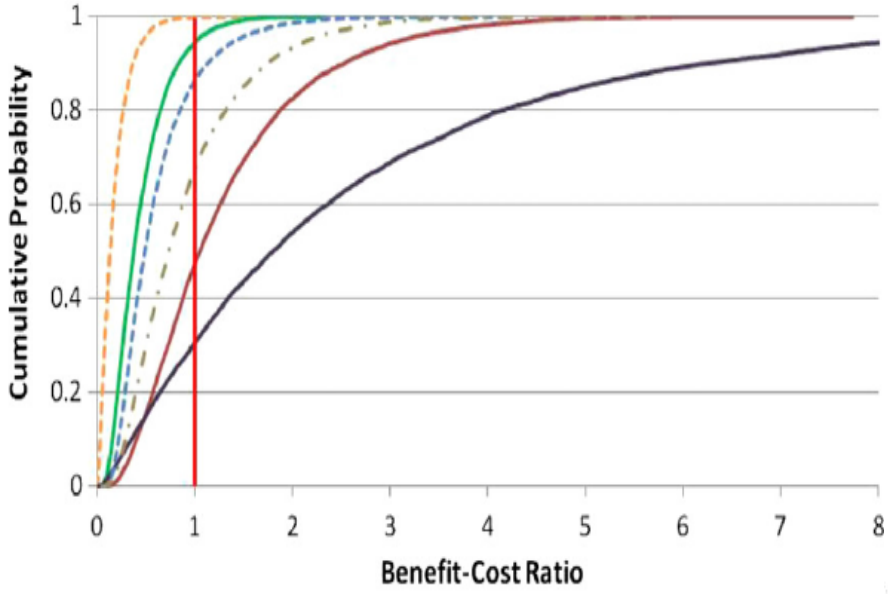


Results – Costs & Benefits

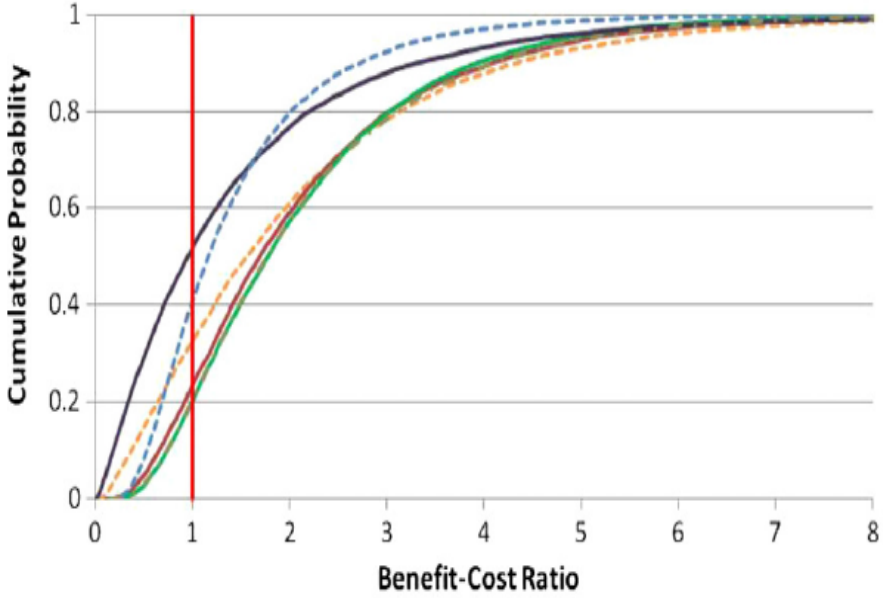


Benefit-Cost Ratios from Simulations

Low Uptake & Low Usage



Median Uptake & Median Usage



High Uptake & High Usage

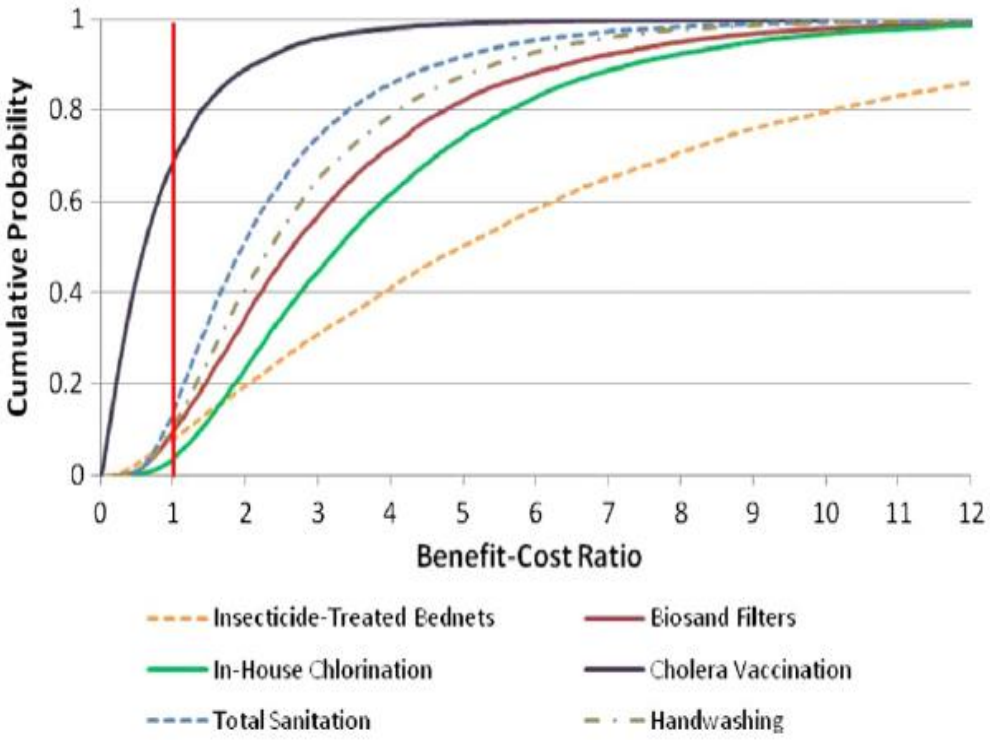
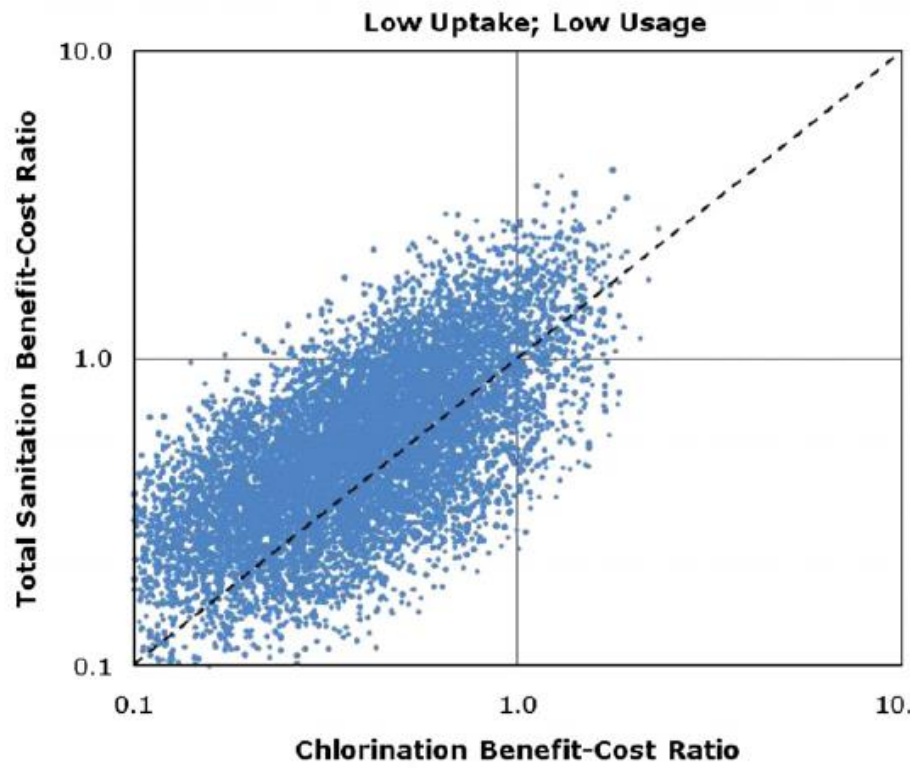
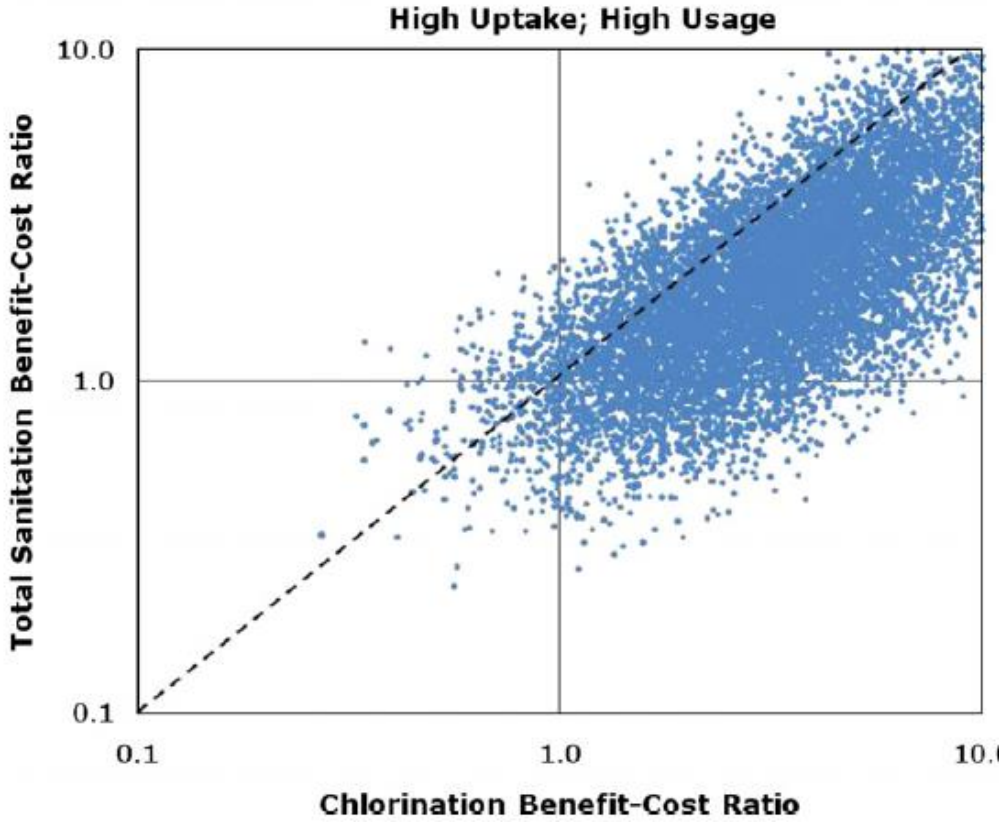


Table 6. *90% Confidence intervals for benefit–cost ratios for the six interventions with different behavioral responses*

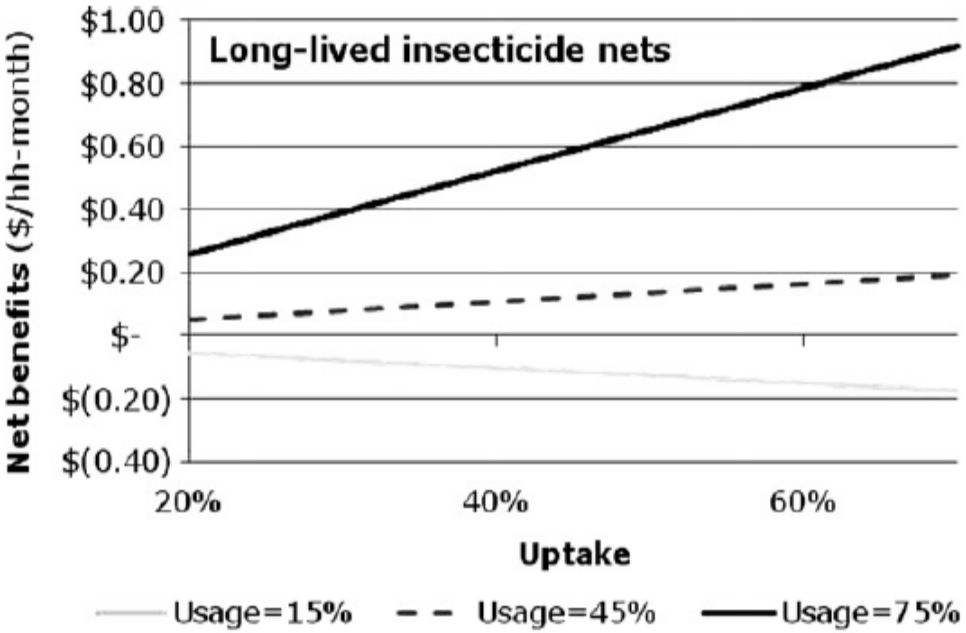
Usage	Uptake			
	Low	Median	High	No variation in uptake
	5–95%	5–95%	5–95%	5–95%
Low				
Handwashing	–0.2 to 0.9	–0.2 to 2.0	–0.3 to 3.0	
Total sanitation	–0.7 to 1.3	–0.6 to 3.0	–0.6 to 4.8	
Chlorination				–0.9 to 0.8
Biosand filters				–0.8 to 7.1
Long-lived insecticide nets	–0.1 to 0.0	–0.2 to 0.1	–0.3 to 0.1	
Median				
Handwashing	–0.1 to 2.5	–0.1 to 5.2	–0.1 to 7.8	
Total sanitation	–0.6 to 2.1	–0.4 to 4.7	–0.4 to 7.3	
Chlorination				–0.2 to 7.2
Biosand filters				–0.5 to 11.8
Long-lived insecticide nets	0.0 to 0.8	–0.1 to 1.8	–0.1 to 2.9	
High				
Handwashing	–0.1 to 4.1	–0.1 to 8.4	0.0 to 12.6	
Total sanitation	–0.5 to 3.0	–0.3 to 6.5	–0.1 to 10.0	
Chlorination				0.3 to 14.0
Biosand filters				0.0 to 18.7
Long-lived insecticide nets	0.0 to 2.7	0.0 to 6.0	0.0 to 9.3	
No usage				
Vaccination	0.0 to 0.9	–0.3 to 2.0	–0.6 to 2.1	

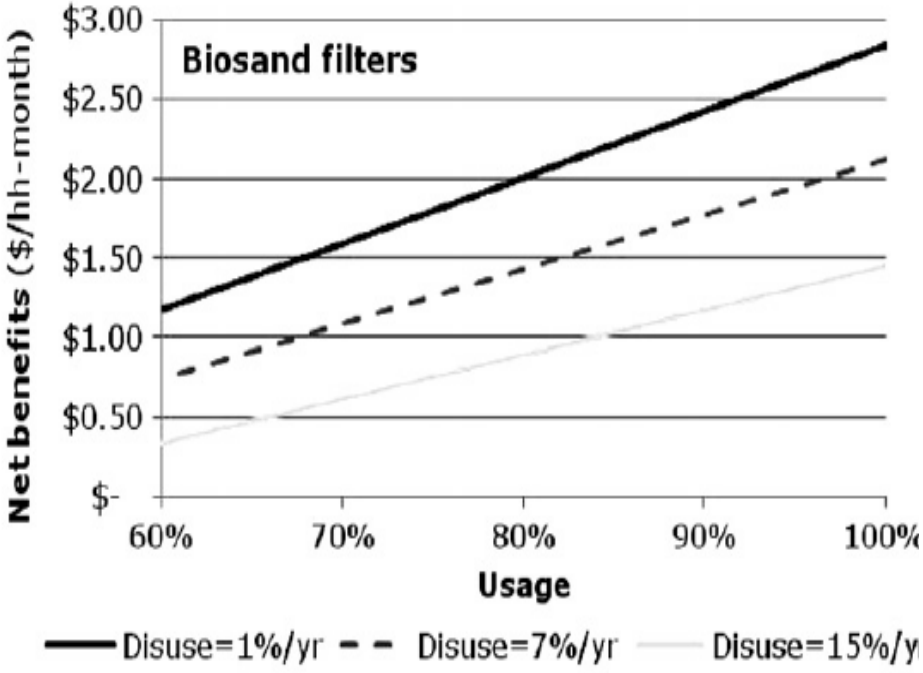
Scatter Plot of BCR Outcomes from Simulation of Chlorination and Total Sanitation Program

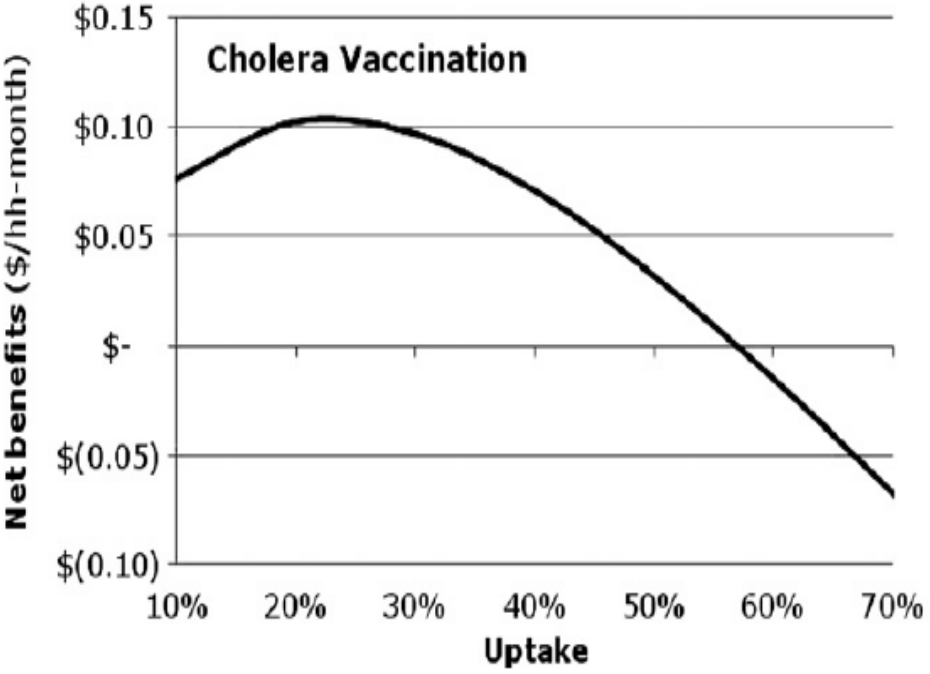




Selected Model Relationship between NB and Usage and Uptake Parameters







Discussions

- CB results are highly sensitive to both health and non-health outcomes. (ie. Household behaviroral responses are quite important).
- This is a strong case for decentralizing program design and investment decisions to the regional and local levels.
- Setting global targets in priority-setting in health intervention programs may not be ideal.