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SANITATION AND WATER

PERSPECTIVE PAPER

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Sanitation and Water

by

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1. Introduction

The principal messages found in Part I of the Challenge Paper by Whittington *et al.*—that water and sanitation services are expensive, and that conventional estimates of the value of economic benefits from household-level service provision in low-income countries are minimal—may strike some readers as provocative departures from the literature. Other recent papers dealing with the economic benefits of water and sanitation, many inspired by the Millennium Development process, have presented more sanguine conclusions regarding net benefits and cost-effectiveness of water and sanitation investments (1-2). Hutton and Haller (3), for example, concluded that the return on each US$1 investment in a range of water supply and sanitation improvements ranged between US$5 and US$28; these benefits were found "in all world regions" and none of the interventions considered yielded a benefit-cost ratio of less than 1. By contrast, the Challenge Paper authors conclude that in many cases "the incremental benefit of improved access to water and sanitation network infrastructure may simply not be large enough to cover the cost" of providing that access.

The apparent divergence of these conclusions is explained in large part by the fact that any number of interventions can be carried out under the guise of water and/or sanitation improvements. The first part of the Challenge Paper focuses on the costs and benefits of "top shelf" water and sanitation services, *i.e.*, in-home piped water connections, toilets with sewer connections, and wastewater treatment. By contrast, international development organizations

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tend to focus on the more modest goals of ensuring access to "improved" water supply and "basic" sanitation *as per* the Joint Monitoring Programme definitions.[2] Disparities in both costs and benefits should be expected when latrines are compared with sewerage and wastewater treatment, and shared wells with in-home water network connections.

It is also the case, however, that the authors have understated the benefits of networked water and sanitation services. Discussion of investments in piped water and sewer networks is presented in the next section of the paper. The authors' analyses of three non-network water and sanitation interventions—deep borewells with handpumps, community sanitation programs, and household water treatment filters—are reviewed in Section 3. A brief discussion of non-infrastructure investments designed to reduce water- and sanitation-related disease is provided in Section 4, followed by a brief set of concluding remarks.

2. Water and sewer networks

The Challenge Paper authors rightly point out that rigorous economic evaluation is rarely undertaken of water and sanitation interventions; one must rely on a literature that is replete with associative data and anecdotes. The authors use four types of data in order to estimate the economic benefits that accrue to households whose water supply and sanitation services are improved. Three of these—prices charged for vended water, household expenditures related to coping with poor services, and avoided costs of illness—are based on revealed preference (or, roughly, "market") data, while the fourth is grounded in stated preference information.

The authors do not consider the value of reduced risk of mortality from water- and sanitation-related illness. This omission is particularly egregious given that this parameter accounts for the majority (up to 80%) of the total economic benefits estimated for the non-network interventions evaluated in Part II of the Challenge Paper. Recent work suggests that mortality reductions resulting from the extension of piped water networks in urban areas can be substantial. Cutler and Miller (1), for example, find that the provision of treated, piped water supply was responsible for nearly half the total mortality reduction in major US cities between 1900 and 1940. The authors estimate a benefit-cost ratio of more than 23 (95% confidence interval of 7 to 40) for these investments.

With respect to the data that are presented in the Challenge Paper analysis, the limitations of stated preference ("willingness to pay" or contingent valuation) data for planning and policy decisions have been well documented (4-5). Contingent valuation approaches suffer from hypothetical bias for several reasons. A structured, one-hour survey with an individual head of household bears little resemblance to households' decision-making process about major expenditure decisions such as infrastructure investment. Moreover, respondents do not face

[2] http://www.wssinfo.org/en/122_definitions.html

actual budget constraints when discussing "what if" scenarios, making the contingent valuation approach prone to "yea saying" and inflated valuation estimates (6-8).

The revealed preference (market) data used by the authors might thus be expected to be more reliable, assuming that prices of alternative services and avoided health care are reasonable proxies for the value of improved water and sanitation services. There are several reasons why this might not be the case, however. First, as noted by the Challenge Paper authors the provision of these services generates external economic effects that are not fully reflected in market prices. In such circumstances the relevant question for economic analysis is not whether households themselves can or would pay the cost of improved services—which is how the authors have framed their analysis—but whether the expenditures required for such upgrades are greater than the value of the benefits they would generate, regardless of their distribution.

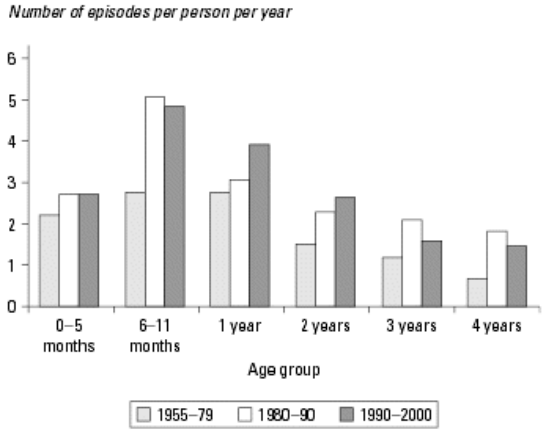
When analysis is limited to a microeconomic perspective that excludes consideration of both reduced risk of mortality and external effects (as found in Part I of the Challenge Paper), the conclusion that the net benefits of providing piped water, sewerage, and wastewater treatment to unserved households are non-positive should not be surprising. In general the people who currently lack access to water supply and sanitation services are poor. About one third of the unserved live on less than US$1 per day, and another third on US$1 to $2 per day (9). Moreover, the individuals who would benefit most from the increased availability of time stemming from water and sanitation improvements are women and children. Using traditional cost-benefit approaches, it becomes quickly apparent that the economic value of the poorest segment of the world's poorest families will be meager. Their budget constraint precludes large (and meaningful) willingness-to-pay values, and their low earning potential translates into small foregone wage values.

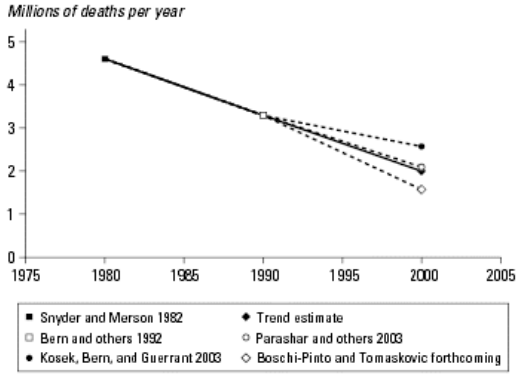
The types of external effects that can arise from water and sanitation service improvements have been repeatedly enumerated but poorly quantified. Acknowledging the paucity of data on external benefits, the Challenge Paper authors do not attempt to incorporate them in the analysis. International development organizations have often made the same observations regarding the difficulty of measuring external benefits from investment in water and sanitation, but conclude instead that the magnitude of these benefits must far exceed the costs of service improvements. Both of these approaches are unsatisfying: One ignores external effects (and concludes that costs often exceed benefits), while the other imputes unfounded value to such effects (and concludes that benefits exceed costs).

Improving our understanding of the health benefits (both direct and spill-over) of water and sanitation interventions is particularly important given the continued decline in mortality and rise in morbidity from water- and sanitation-related disease (Figures 1A and 1B). That is, the percentage of person-days spent suffering from diarrhea is rising, but the case fatality rate continues to fall. The Challenge Paper authors argue that the benefits of reducing non-fatal

episodes of diarrhea comprise a very small proportion of the total benefits derived from water and sanitation interventions. If true, and if trends in mortality and morbidity from water- and sanitation-related illness persist, we would expect the net benefits of water and sanitation investments to be decreasing over time, *ceteris paribus*.

It could be argued instead that the full costs of morbidity from water- and sanitation-related illness are poorly understood. Few studies have attempted to quantify the contribution of water and sanitation services, mediated through health, to educational performance or productivity. Lack of access to safe water and sanitation has been associated with reductions in chronic diarrhea which, in turn, is associated with malnutrition (11). Children suffering from malnutrition have been shown to exhibit symptoms of diminished cognitive ability and even lower educational attainment than healthy children (12-13), yet links with water and sanitation services are rarely made. Similarly, little is known about the impacts on savings, expenditures, and longer-term productivity of households whose health care expenditures are reduced because of water and sanitation improvements (14).





Figures 1A & 1B: Incidence of, mortality from diarrheal disease

Source: Keusch et al. (10)

A second set of reasons why market data may not accurately reflect the value of water supply and sanitation to households concerns the balance of power between men and women, both within the home and in the public arena. In most households of low-income countries, males have principal say over the family budget and expenditures. A considerable body of evidence in the practitioner or "grey" literature has suggested that women give relatively greater priority to water and sanitation services as compared to men (15). More rigorous academic work has also demonstrated that women prioritize child welfare and the provision of public goods relative to men (16). When women are given the opportunity to influence spending decisions, either directly or through democratic institutions, evidence suggests that allocations to water

supply and sanitation increase (17). In short, men—from whom the sort of market data that the Challenge Paper authors draw upon for their analysis is typically generated—appear to be highly imperfect agents for members of the household who tend to benefit the most from water and sanitation improvements.

Third, the authors point to evidence that access to other public services such as electricity is higher than to improved water supply and sanitation services as indicative of the relatively lower demand for the latter. This reasoning assumes that the absence of evidence for demand for water and sanitation services equates to evidence of absence of that demand. In some settings, however, plausible rival explanations exist on the supply side. For example, a substantial proportion of the hundreds of millions of people lacking access to water and sanitation services in urban areas are located in neighborhoods that are considered "unplanned" or "unregularized." These communities are often located beyond the reach of trunk infrastructure and/or are legally prohibited from receiving service improvements because of their tenure status.

An example from South Asia can help to illustrate this point. One well-known infrastructure upgrading project, the Slum Networking Project (SNP), was initiated in the Indian city of Ahmedabad in 1997. Municipal Corporation engineers worked together with NGOs to offer a bundle of infrastructure, environmental, and social services to slum households at affordable prices. The Ahmedabad Municipal Corporation was willing to allow unregularized slums located on city-owned land to participate; however, more than half of the unserved were located on state- or privately owned land. These communities were considered ineligible for participation in the project, regardless of residents' interest in service improvements (18).

In sum, the authors have done a service by raising awareness of the full economic costs of piped water, sewerage, and wastewater treatment services. Their reliance on market and revealed preference data from households to estimate benefits, however, clearly results in lower-bound values; it also brings into sharp focus the need for reliable evidence regarding spillover and longer-term effects of water and sanitation improvements on health and productivity.

3. Non-network water and sanitation interventions

The approach employed in Part II of the Challenge Paper is certainly innovative; it also responds to a chronic lack of nuance in the literature regarding the conditions under which particular water and sanitation investments are expected to yield positive net benefits. Any reasonable "solution" will be effective in some settings and a failure in others. The authors' focus on generating distributions of benefit-cost ratios as opposed to point estimates, as well as their attention to characterizing the settings in which their chosen interventions appear most promising, are thus well appreciated.

That the authors' analytical approach is unique also gives rise to questions that cannot be answered with information provided in the Challenge Paper. The selection of a uniform distribution for all parameters in the model, for example, should be elaborated (*e.g.*, whether alternative distributions affect results). In addition, the ranges of parameter values included in the models, as well as the standard deviation values, suggest less variation than some working in the water and sanitation field might postulate. Finally, while acknowledging the authors' time and resource constraints, the analysis would be strengthened by some comparison of the model results with empirical data. For example, one could categorize available data for a particular intervention based on the authors' "site attractiveness" criteria, and evaluate the extent to which outcomes on the ground exhibit roughly the pattern implied by the simulation results.

In the remainder of this section, a few other issues regarding individual parameters, as well as the relationship among parameters, used in the authors' analysis are raised for consideration.

The value of life

As noted above, the Challenge Paper authors find that the majority (between 67-80%) of the benefits for the community sanitation and point-of-use treatment interventions are derived from reduced mortality, and that the economic value of mortality reductions is very sensitive to their assumed value of a statistical life (VSL). The authors' choice of US$30,000 for the base case is not well substantiated, and is considerably lower than the values reported in other recent work on this topic. For example, Viscusi and Aldy (19) estimate the value of statistical life (VSL) for an individual in the US as US$7 million, with income elasticity of the VSL estimated to fall between 0.5-0.6. These findings have been used to argue that lives in developing countries should be valued at roughly 100 times *per capita* GDP (37). Setting aside possible moral objections regarding the calibration of the VSL for lower-income populations and using regional median values for *per capita* income, the implied values of a statistical life for sub-Saharan Africa and South Asia range between 4and 16 times higher than those used in the Challenge Paper's analyses. Modest adjustments of the VSL would improve the (already attractive) interventions considered by the authors. More importantly, as noted above inclusion of reduced mortality risk into the authors' piped network analysis might well lead to different substantive conclusions with respect to that level of service.

Incidence and reduction of diarrhea

The Challenge Paper authors' assumption of 0.9 cases of diarrhea per person per year is based on data from various developing regions and may understate regional incidence, particularly in Africa. Most incidence studies have restricted their focus to children less than five years old, whereas the Challenge Paper authors are apparently including all household members. Even considering the extrapolation required for comparison, the burden of diarrheal disease among

the target population for the borehole intervention appears to be larger than that considered by the authors. World Health Organisation data as well as literature reviews (20) have found under-five diarrheal incidence in Sub-Saharan Africa to be on the order of five episodes per child per year. Adjusting this parameter value would thus improve the benefit-cost ratio of the borewell scenario in particular.

However, the authors' "base case" assumption of a 30% reduction in diarrheal incidence as a result of a shared point source of water supply is probably optimistic (21). Even if the supply of water at the well is relatively safe, water quality often deteriorates during transport and storage (22). At the same time, the increased quantity of water to which a typical household will have access provides an opportunity for improved hygiene (handwashing), which could reduce transmission of diarrhea-causing illness if concomitant investments are made in handwashing promotion (23). The net effect of the implied adjustments to the benefit-cost analysis of the borewell intervention is unclear.

Decentralized water treatment

Water treatment at the point of use provides households with the opportunity to ensure that at least a minimal quantity of water needed for drinking and cooking is of good quality. As the Challenge Paper authors note, point-of-use (POU) treatment does not preclude the need to bring water to the dwelling. At the same time, POU approaches may have the effect of increasing the quantity of water available to a household for a given amount of time/effort, if adoption of POU allows the household to access lower quality source water that is more convenient to the home. In such cases it would be appropriate to incorporate the consumer surplus on increased water use.

Correct, consistent use of POU technologies is critical to maintain the flow of health benefits they can generate. Whereas the literature on POU technologies such as the Biosand filter suggests very high levels of efficacy in laboratory settings, field tests reveal a more mixed picture, as well as challenges in ensuring proper use (26). The Challenge Paper authors' assumption of a 2% decline annually in use of the household filter thus seems optimistic. For example, researchers from Cranfield University (27) found that 21% of a sample of Ethiopian households had ceased use of their Biosand filters after five years. Brown and Sobsey (28) found regular use of a ceramic filter—which admittedly requires more effort and recurrent investment on the part of users—fell by 2% per *month* among a sample of Cambodian households. Sensitivity analysis for this critical parameter is important for evaluating this intervention option, but is missing from the Challenge Paper.

Threshold effects in sanitation

The community sanitation analysis requires an assumption regarding the relationship between rates of household uptake and health outcomes for both participating and non-participating families. The authors assume that, in a typical case, 28% of households will fully participate in a

Total Sanitation program that is implemented in their community. "Full participation" is assumed to mean completion of educational and motivational training and the construction of an improved sanitation facility such as a latrine. Partial participation, which is estimated at an additional 12% of households, entails completion of training and installation of improved sanitation infrastructure, but limited or no use of the sanitation facilities installed. The typical resulting health outcome for this level of full and partial participation is given as a 30% reduction in diarrheal incidence for the entire community.[3]

Two concerns arise regarding about the conclusions of the Total Sanitation analysis. First, there is evidence to suggest the existence of threshold effects of sanitation coverage on health outcomes (24). There are very limited data on the relationship between changes in coverage with improved latrine facilities and health outcomes (and even fewer regarding proper use of such facilities). Impacts are mediated by users' behavior to a greater extent than the other interventions considered, and will also vary with population density, topography, and source of water supply. Such uncertainties should be better reflected in the authors' model, *e.g.*, by expanding the range of the diarrheal incidence reduction parameter and/or increasing its standard deviation.

Second, given that Community Led Total Sanitation is really a suite of activities and investments, it is difficult to discern the relative contribution of motivation and education *versus* improved sanitation infrastructure to health outcomes. Given that the ratio of "software" to "hardware" costs is on the order of 3 to 1, it would be very helpful to know whether smaller investments in education and motivation could be made without diminishing the resulting benefits, or conversely if promotion of improved hygiene practices without concomitant hardware investments would reduce benefits substantially. This final point is discussed further in the following section.

4. Non-infrastructure interventions

As the Challenge Paper authors note, it has been demonstrated in many settings that improvements in water supply and sanitation services may be necessary but insufficient to realize substantial improvements in health. Where reductions in diarrhea are not observed, a common explanation has been the lack of concomitant changes in behavior (29-30). For water supply improvements that entail water transport and storage by household members—which characterize the majority of interventions occurring in developing countries today—safe water management and hygiene practices are required to prevent re-contamination of supply (21).

[3] Research on Total Sanitation approaches is very limited; however, evidence from the processed literature suggests that participation rates higher than those assumed by the Challenge Paper authors are observed at least in some locations. One evaluation of 13 communities in Nigeria, for example, found a median 80% participation rate in training and latrine construction, although data on consistency of latrine use were not provided (25).

Investments in improved sanitation are maximized when users have the knowledge, ability, and motivation to wash their hands after defecation.

Historically hygiene promotion has received limited attention in water and sanitation projects. For example, less than 1% of the US$5.5 billion in support for water and sanitation projects provided by the World Bank during the period 1978-2003 was spent on health education or behavior change activities (31). In recent years, however, there is growing interest in the potential for hygiene promotion programs to make substantial contributions to health, whether in parallel with infrastructure improvements or as stand-alone interventions.

Evidence regarding the efficacy of handwashing in reducing diarrheal incidence is compelling, with typical impacts surpassing the median 30% reduction that the Challenge Paper authors employ for analysis of the non-network interventions. A meta-analysis by Curtis and Cairncross (32), for example, found that handwashing with soap reduces the risk of diarrhea by 42-47%. A randomized controlled trial in Pakistan found outcomes of this magnitude for both diarrhea and pneumonia incidence among children (33).

Less information is available regarding the economic costs and benefits of hygiene promotion programs. Hygiene promotion has been identified as a relatively cost-effective option for reducing child and infant mortality (34-36); however, evidence regarding full economic costs and benefits is too limited to enable direct comparison with the other interventions considered in the Challenge Paper.

Just as the sustaining of benefits from improved water supply and sanitation services are dependent on adequate maintenance of installed infrastructure, the benefits of hygiene are realized only so long as households continue to practice handwashing at critical times. The period over which behavior change is sustained will have a major effect on the net benefits of a given program. Long-term compliance with hygiene regimens appears to be a challenge in at least some settings, and thus the recurrent costs of effective hygiene programs may be substantial. With those caveats, it seems that hygiene promotion is deserving of greater consideration as a "water and sanitation" intervention in its own right.

5. Conclusions

Clearly there remains much to be learned about the impacts of water and sanitation improvements on health and welfare, both at the household and the national level. As demonstrated in the Challenge Paper, however, several types of investment have been shown to be economically attractive (within appropriate settings), even with an analytical approach that is restricted to localized and estimable benefits. Among the 1.2 and 2.6 billion persons lacking access to water supply and sanitation services, respectively, roughly 80% live in low-density ("rural") areas. The non-network interventions evaluated by the Challenge Paper authors appear particularly well suited for these types of communities.

The dangers of imputing unsubstantiated values to water and sanitation improvements were discussed above. Nevertheless, it is important to consider what is at stake in a world where two out of every five persons do not have even a basic pit for defecation, and two in ten cannot obtain safe drinking water. Certainly it is greater than health care costs and lost earnings. Certainly the impacts of poor water and sanitation are felt by others than the potential "beneficiaries" who have been considered in this exercise. Many groups and individuals have committed substantial resources to extending services to poor households, often in other parts of the world. They are motivated in part by belief in the economic returns to such investments, but also by moral and religious imperatives that value human dignity, compassion, and solidarity. As Simon (37) has noted, economic analysis which incorporates, rather than assumes away, the existence of such altruism and external effects would "have the merit of describing the world in which we actually live."

References

1. Stockholm International Water Institute. Securing sanitation: The compelling case to address the crisis. A report commissioned by the Government of Norway as input to the Commission on Sustainable Development (CSD) and its 2004–2005 focus on water, sanitation and related issues. Stockholm: Stockholm International Water Institute.

2. Sachs, J., ed. 2005. Investing in development: A practical plan to achieve the Millennium Development Goals. New York: The Millennium Development Project.

3. Hutton, G. & Haller, L. 2004, Evaluation of the non-health costs and benefits of water and sanitation improvements at global level, Report undertaken for the Evidence and Information for Policy Department, in collaboration with the Department for Protection of the Human Environment, World Health Organisation. WHO/SDE/WSH/0404.

4. Diamond, P.A and J. A. Hausman, (1994), "Contingent valuation: Is some number better than no number?" Journal of Economic Perspectives, 8(4),45-64.

5. Davis, J. Assessing community preferences for development initiatives: Are willingness-to-pay studies robust to mode effects? World Development **32**(4): 655-672.

6. Boyle, K., M. Walsh, and R. Bishop. 1993. The role of question order and respondent experience in contingent valuation studies. Journal of Environmental Economics and Management 25(1): 80-99.

7. Boyle, K., W. Desvousges, F. Johnson, R. Dunford, and S. Hudson. 1994. An investigation of part-whole biases in contingent-valuation studies. Journal of Environmental Economics and Management 27(1): 64-83.

8. Kanninen, B. 1995. Bias in discrete response contingent valuation. Journal of Environmental Economics and Management 28(1): 114-125.

9. United Nations Development Programme. Human Development Report 2006. New York: The United Nations.

10. Keusch, G., O. Fontaine, A. Bhargava, C. Boschi-Pinto, Z.A. Bhutta, E. Gotuzzo, J. Rivera, J. Chow, S.A. Shahid-Salles, and R. Laxminarayan. 2006. Chapter 19: Diarrheal Diseases. In Disease Control Priorities in Developing Countries, 2nd edition, D. Jamison et al., eds. Washington, DC: The World Bank.

11. Stephensen, C. 1999. Burden of Infection on Growth Failure. Journal of Nutrition 129: 534-538.

12. Berkman, D., A. Lescano MHS, R. Gilman, S. Lopez, and M. Black. 2002. Effects of stunting, diarrhoeal disease, and parasitic infection during infancy on cognition in late childhood: a follow-up study. Lancet 359 (9306): 564-571.

13. Alderman, H., J. Hoddinott, and B. Kinsey. 2006. Long term consequences of early childhood malnutrition. Oxford Economic Papers 58: 450-474.

14. Kochar, A. 2004. Ill-health, savings and portfolio choices in developing economies. Journal of Development Economics 73(1): 257-285.

15. Van Wijk, C. 1998. Gender in Water Resources Management, Water Supply and Sanitation: Roles and Realities Revisited. The Hague: IRC.

16. Miller, G. 2007. Women's suffrage, political responsiveness, and child survival in American history. Unpublished manuscript available at http://www.ssc.wisc.edu/cde/demsem/suffrage.pdf.

17. Chattopadhyay, R. and E. Duflo. 2004. Women as policy makers: Evidence from a randomized policy experiment in India. Econometrica 72(5): 1409-1443.

18. Davis, J. Scaling up slum upgrading: Where are the bottlenecks? International Development Planning Review 26(3): 301-319.

19. Viscusi, K., and J. Aldy. 2003. The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World. The Journal of Risk and Uncertainty, 27:1; 5–76.

20. Kirkwood B. 1991. Diarrhea. In: Feachem R. and D. Jamison, eds. Disease and Mortality in Sub-Saharan Africa. New York: Oxford University Press.

21. Zwane, A., and M. Kremer. 2007. What works in fighting diarrheal diseases in developing countries? A critical review. The World Bank Research Observer 22: 1-24.

22. Wright, J., S. Gundry and R. Conroy. 2004. Household drinking water in developing countries: a systematic review of microbiological contamination between source and point-of-use. Tropical Medicine & International Health 9(1): 106-117.

23. Curtis V, Cairncross S. 2003. Effect of washing hands with soap on diarrhoea risk in the community: a systematic review. The Lancet Infectious Disease 3(5):275-281.

24. Shuval, H.L., R. Tilden, B. Perry, and R. Grosse. 1981. Effect of investments in water supply and sanitation on health status: a threshold-saturation theory. Bulletin of the World Health Organization **59:** 243–248.

25. WaterAid. 2007. Community Led Total Sanitation (CLTS): An Evaluation of the WaterAid's CLTS Programme in Nigeria. London, UK: WaterAid.

26. Baumgartner, J., S. Murcott, and M. Ezzati. 2007. Reconsidering 'appropriate technology': The effects of operating conditions on the bacterial removal performance of two household drinking-water filter systems. Environ. Res. Lett. 2.

27. Earwarker, P. 2006. Evaluation of Household BioSand Filters in Ethiopia. MSc Water Management (Community Water Supply) thesis, Cranfield University, UK.

28. Brown, J. and M. Sobsey. 2007. Use of Ceramic Water Filters in Cambodia. Water and Sanitation Program Field Note. Jakarta: Water & Sanitation Program, Southeast Asia.

29. Esrey, S., J. Potash, L. Roberts and C. Shiff. 1991. Effects of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma. Bulletin of the World Health Organization 69 (5): 609–621.

30. Jalan, J. and M. Ravallion. 2003. Does Piped Water Reduce Diarrhea for Children in Rural India? Journal of Econometrics 112: 153-173.

31. Iyer, P., J. Davis, E. Yavuz, and B. Evans 2006. Rural Water Supply, Sanitation, and Hygiene: A review of 25 years of World Bank lending (1978–2003). Washington, DC: The World Bank.

32. Curtis, V. and S. Cairncross. 2003. Effect of washing hands with soap on diarrhoea risk in the community: a systematic review. The Lancet Infectious Diseases 3(5): 275-281.

33. Luby, S., M. Agboatwalla, et al. 2004. Effect of Intensive Handwashing Promotion on Childhood Diarrhea in High-Risk Communities in Pakistan: A Randomized Controlled Trial. JAMA 291(21): 2547-2554.

34. Larsen, B. 2003. Hygiene and health in developing countries: Defining priorities through cost-benefit assessments. International Journal of Environmental Health Research 13 (1): S37-S46.

35. Varley RC, Tarvid J, Chao DN. 1998. A reassessment of the cost-effectiveness of water and sanitation interventions in programmes for controlling childhood diarrhoea. Bull World Health Organ. 76(6): 617-31.

36. J. Borghi, L. Guinness, J. Ouedraogo and V. Curtis. 2002. Is hygiene promotion cost-effective? A case study in Burkina Faso. Tropical Medicine and International Health 7(11): 960–969.

37. Simon, H. 1993. Altruism and economics. American Economic Review 83(2): 156-161.