

Water and Sanitation Perspective Paper

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1. Introduction

Access to some form of drinking water is a necessary condition for survival for all people, hence “water is life.” Whittington et al. (2008) argue in the Water and Sanitation Challenge Paper that the *incremental* benefits of so-called “*improved water and sanitation*” may not be large enough to make investments in the sector attractive. The thorough and carefully constructed Challenge Paper argues that full, networked water and sanitation investments may likely be uneconomical, and that although low-cost technologies may be a better investment, the benefit cost-ratios of even these investments are low. Though Whittington et al. propose a somewhat cautious conclusion to their work saying that “...not all investments will pass [a rigorous economic test],” it is likely that, if the conclusions of Whittington et al. are accepted, the Copenhagen Consensus will be that water and sanitation is not a good investment for scarce donor or government funds. The Challenge Paper is important for its willingness to challenge received wisdom on this question and we welcome the chance to comment on it.

This Perspective Paper reviews the evidence and analysis provided by Whittington et al. (2008) and provides a complementary, and in some areas alternative, perspective on some key elements of the Challenge Paper. We argue that the balance of the rigorous economic evidence available suggests that Whittington et al. underestimate the benefits associated with water and sanitation investments and, as a result of the type of investments that they choose to study, also overstate the costs of these investments. Existing evidence based on actual behavior, as opposed to engineering estimates or stated preference reporting, does suggest that benefits of appropriate technologies can significantly exceed their costs. The challenge of making these beneficial investments sustainable should be researchers’ and practitioners’ central focus.

Whittington et al. focus in Part I of their paper on a discussion of the nature of “improved” water and sanitation services and the (economic and other) factors that make the rigorous economic analysis of water and sanitation services so complex. What constitutes “improved service” is indeed the subject of considerable debate in the literature and in the sector generally. Clearly, every human being does already have access to some form of water for drinking, or they would not be alive. The poor quality and limited quantity of water that is available to a large share of the world population, however, combined with a lack of access to sanitation and poor personal hygiene is indisputably linked to poor health, however. The global health burden of diarrheal disease is enormous and falls disproportionately on young children. Diarrheal illnesses account for

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perhaps 20% of deaths among children under age five (Bryce *et al.* 2005). These diseases are transmitted via the fecal-oral route, meaning that they are passed by drinking or handling microbiologically unsafe water that has been in contact with human or animal waste, or because of insufficient water for washing and bathing.

The central question is perhaps not the link between water and health, but rather, *what level of improvement is required* to capture the lion's share of the improved health benefits, at minimal costs, for the underserved population, a large share of whom live on incomes of less than US\$1/day, and virtually all on incomes of less than US\$2/day. In the second half of Part I Whittington *et al.* choose to focus on only one form of improved services, described as “networked” water and sanitation services, to serve as the cornerstone for their benefit-cost analysis. This consists of a conventional system, as used around the world, which combines a centralized storage, centralized water treatment plant, a piped network to provide water supply connections to individual households, a piped sewer system to collect wastewater and a centralized (minimal) sewage treatment plant. This system of taps and flush toilets in homes has indeed been the conventional gold standard that has been employed by water and sanitation utilities around the world for well over a century. Whittington *et al.* acknowledge the possibility to provide intermediate water and sanitation services at lower costs, but they appear to dismiss the possibility of significantly cheaper systems that still would provide a large share of the public health benefits. They select benefits estimates from the literature and compare these to illustrative cost estimates for the “networked” service and conclude that benefits do not exceed costs in likely scenarios. In short, in our view, the “gold-standard” opportunities chosen by Whittington *et al.* are not the most appropriate for the target group of beneficiaries; we believe that less costly (non-networked) options are available that would demonstrate significantly improved cost-benefit ratios.

In Part II of the Challenge Paper, Whittington *et al.* do examine a limited set of alternative “non-networked” interventions, including source water quality improvements (wells), a sanitation encouragement intervention, and point-of-use water treatment. In this case, they conclude that the benefits of each of these programs exceed their costs, but the benefit-cost ratios are fairly modest, in the range of two to four. Little discussion is given to the question of sustainability. In the case of wells, for example, Whittington *et al.* assert that community-based or demand-driven management models have solved many of the problems associated with maintaining rural water infrastructure. Sustained adoption of the other technologies in question, latrines and biosand filters, is not discussed.

In this paper we first discuss (in section 2) the health benefits estimated by Whittington *et al.* for the full-on networked services model – as we believe there is compelling evidence that these are underestimated because of a failure to include an estimate of the benefits of avoided mortality and by failing to quantify the externalities associated with these investments, though they acknowledge that they may exist. We do not disagree with Whittington *et al.*'s cost estimates for the model they chose, but are of the opinion that the focus ought to be on different, innovative, decentralized, low-cost forms of services, with special emphasis on management and governance that reduces corruption, makes the service effective and sustainable, and capitalizes on linkages with other water sub-sectors, notably water used for livelihoods. A broader discussion of

feasible and appropriate service levels beyond the “networked” approach would increase the relevance and value of the Challenge Paper. In section 3, we explore the potential for such systems in some detail. We summarize evidence that suggests that the net benefits of point-of-use water treatment products may be far above those estimated by Whittington et al. and discuss the pressing challenge of ensuring sustainability in the rural sector.

Section 4 summarizes and concludes. Our perspective is that appropriately designed and managed low-cost water and sanitation systems, perhaps including point of water treatment, and innovative information-based tools, can have significantly lower costs than the \$US10 per household per month cost that is used by Whittington et al. as a low boundary, and that their estimates of benefits are a lower bound that underestimate the total value of the opportunity. Rigorous economic analysis of behavior change in randomized trials suggests, for example, that non-networked solutions can be extremely cost-effective investments. The challenge remains one of identifying ways to bring accountability and financial sustainability to the sector-- to make water services work for the poor.

2. Networked water and sanitation services

Part I of the Challenge Paper devotes a significant effort to comparing the costs and benefits of networked municipal water and sanitation infrastructure, providing the conventional “gold standard” of taps in homes and flush toilets. Whittington et al. review four possible sources of data on the benefits associated with improved water and sanitation. These are: prices charged for vended water, averted expenditures, avoided cost of illness, and stated preference studies. They add representative figures for WTP from these sources to conclude that the benefits of networked water and sanitation services cannot automatically be assumed to exceed the costs. We believe that there are significant gaps in this analysis that, while they may not be sufficient to reverse the authors’ conclusions, certainly merit review.

The Challenge Paper concludes that it can easily be the case that piped water and sanitation investments will not be economical, despite the conventional wisdom that the benefits of improved water and sanitation service significantly exceed the costs. The authors also compare private willingness to pay to their estimate of the full economic costs of services to further emphasize that these investments may be inappropriate as cost-recovery may be difficult.

In this section, we discuss existing econometric evidence on the health benefits of water and sanitation service, and argue that there is substantial evidence that the benefits of this sort of investment are larger than estimated in the Challenge Paper. We also discuss the magnitude of the health externalities that have been identified for water-related illnesses as a further means of illustrating the point that using benefits estimates that capture only private willingness to pay (like stated preference valuations, and averted expenditures) may be inappropriately low. We choose to focus on the benefits side of the calculation made, as we believe that their cost calculations are reasonable, given their decision to focus on fully networked service provision. In the next section, we

discuss alternatives to fully networked service that we believe are more appropriate for those currently underserved: the poor.

Econometric evidence on the avoided mortality benefits of piped water and sanitation²

Contrary to Whittington et al.'s assertion, recent economic analysis has found that there are large health gains from networked water and sanitation, particularly in terms of child mortality. A failure to include an estimate of the benefits of avoided mortality, in addition to avoided illness, leads to an underestimation of the benefits associated with water related intervention. The cost of illness literature review presented by Whittington et al. is limited and appears to imply that a 30-40% reduction in diarrhea, "the best one could hope for," is disappointingly small.³ In fact, randomized control trials have demonstrated that reductions in diarrheal incidence of this order of magnitude can be sufficient to reduce child mortality (Crump et al. 2004) and there is a growing body of work. Whittington et al. do not reference that uses rigorous econometric techniques to estimate large impacts of networked water and sanitation service on health outcomes.

Recent econometric evidence on the large benefits from piped water and sanitation service includes a study that exploit historical variation in the timing and location of water filtration and chlorination technology adoption across U.S. cities to identify the contribution of improved water quality to the epidemiological transition in American cities (Cutler and Miller 2005). This study finds that clean water was responsible for about half the observed decline in mortality and nearly two-thirds of the reduction in child mortality in cities.

In a less dense setting, Watson (2006) demonstrates similar mortality benefits. She exploits the fact that a series of water and sanitation interventions (including taps and flush toilets) introduced on Native American reservations in the United States during 1960–1998 were likely uncorrelated with other factors affecting infant health and plausibly exogenous to local community characteristics after accounting for county and year fixed effects. This research suggests that a 10 percent increase in the fraction of homes with improved water and sanitation services reduced infant mortality by four percent.

In a modern middle-income country setting, child mortality benefits have also been demonstrated. Galiani and others (2005) study a privatization reform that took place for about 30 percent of municipal water companies in Argentina in the 1990s to identify the impact of ownership on child health. They estimate that child mortality overall fell five to seven percent in that privatized their water services because in this context

² This section draws on Zwane and Kremer (2007).

³ The citation for this effect size chosen by Whittington et al. is Esrey (1996); while this is an oft-cited paper in the economics and policy literature on the impacts of water, sanitation, and hygiene investments, it is a cross-sectional analysis of country-level data and the results are subject to omitted variable bias (confounding) of unknown magnitude. However, recent randomized control trials of point of use water treatment technologies, as summarized by Fewtrell and others (2005) find similar impacts of water quality improvements on diarrhea incidence.

privatization improved service and expanded coverage, and that the effect was largest in the poorest areas, at around 24 percent.

External benefits of water and sanitation interventions

Whittington et al. also underestimate the health benefits associated with networked water and sanitation by failing to quantify the externalities associated with these investments, though they acknowledge that they may exist. In practice, there is evidence that externalities associated with sanitation-related programs are large, which has important implications for any discussion of how to pay for an investment. Watson (2006) quantifies the externalities associated with networked water and sanitation service by demonstrating that infant mortality rates fell among local residents not living on the reservation, just as they did among households that received new service. Miguel and Kremer (2004) quantify the externalities associated with providing deworming treatment to Kenyan school children as part of a randomized impact evaluation of the impacts of deworming on school attendance. They find that the program led to large reductions in worm infections that arise from poor sanitation conditions and increased school participation among both treated and untreated children in the treatment schools and among children in neighboring schools. The external benefits of the program were qualitatively large; three quarters of the social benefit of treatment was in the form of externalities.

To the extent that private use of service affects the disease environment, private willingness to pay, the focus of Whittington et al.'s analysis, is only a partial indicator of the social value of an investment and should not determine whether a program or investment should go forward. Inefficiently low levels of demand can be expected even at subsidized service prices. In a companion study to the initial deworming evaluation, Kremer and Miguel (forthcoming) find that drug take-up was extremely sensitive to cost and that even modest efforts at achieving project cost-sharing with parents resulted in large reductions (80 percent) in drug use relative to free treatment.

Additional work is needed to further understand the externalities associated with sanitation programs. The examples given here cannot describe fully the externalities associated with the sorts of programs that might be provided in many settings in developing countries today. The Bill and Melinda Gates Foundation's recent decision to fund a large randomized impact evaluation of the Total Sanitation Campaign (a program that encourages communities to make their own investments to become open-defecation free) in several countries is a promising step in this direction. Nonetheless, existing evidence suggests that it is reasonable to begin from the assumption that externalities will be sufficiently large that on-going public support for sanitation programs is appropriate.

In contrast to the conclusions reached by Whittington et al., Cutler and Miller (2005) estimate that funds invested in U.S. urban water systems between 1900 and 1940 produced a social rate of return of roughly \$23 for every \$1 spent. Whittington et al.'s failure to account for external benefits and mortality impacts leaves an incomplete picture of the cost-effectiveness of water and sanitation investments and focuses too great of an extent on the possibility of full cost-recovery in this sector.

3. Water and sanitation services that work for the poor

The analysis in Part I of the Challenge Paper, and our comments in section 2 above, are based on a system that provides water through taps in homes and flush toilets with sewer systems. At estimated reasonable full costs of US\$2.50 per cubic meter, per capita consumption in the range of 110-220 liter per capita per day results in monthly costs per household of US\$50-100. This is a cost evidently unaffordable for the section of the population that needs service. Whittington et al. consider a lower cost of US\$1 per cubic meter, and 55 liter per capita per day consumption, yielding a cost per household of about US\$10 per month as a lower boundary on what service provision may require. They conclude that, particularly as there is a strong positive correlation between household income, the demand for water services, and the provision of water and sanitation services, networked water and sanitation services will be cost-beneficial (and will be built) only in cities in rapidly growing economies.

This conclusion, even if it were to hold with the larger health benefits that the economics literature has identified, has relatively few practical implications. Networked “gold standard” service is largely irrelevant for the rural poor in low income countries (where low population densities make networked services uneconomical) and the urban poor in the informal settlements or slums that characterize the places where the underserved live. Whittington et al. rightly turn their attention to “non-networked” solutions in the second half of the Challenge Paper.

Part II of Whittington et al.’s paper uses Monte Carlo simulations to estimate the cost-benefit ratios associated with a limited set of “non-networked” solutions including wells, sanitation campaigns that result in partial coverage in a representative village, and one point of use (in home) water treatment produce, a biosand filter, but the paper does not consider in detail either how improved service may realistically be provided to the urban or peri-urban poor or key management and information barriers to implementation of either networked or non-networked solutions.

In the remainder of this section we discuss the potentially transformative role of information in the water and sanitation sector to make investments more useful and sustainable. We discuss institutional barriers to investment that we believe are underplayed by Whittington et al. and that must be solved for the benefits of source water quality interventions to be realized. We also discuss alternative investments, not considered by Whittington et al. that have a much higher rate of return than the alternative investments that they consider. We argue that a greater focus on a wider range of non-networked solutions and barriers to their implementation suggests that the net benefits of non-networked solution may be 4-12 times greater than the estimates presented by Whittington et al. A pressing policy and research need is direction on how to make these non-networked solutions sustainable.

Information for accountability

A key reason that public investments in water services for the poor have not been successful enough to meet the MDG targets in the least developed countries⁴, particularly in Sub-Saharan Africa, is the same reason why other public services are failing the poor: a lack of accountability between providers, policymakers, and consumers has resulted in bad management and governance particularly (World Bank 2004). The Challenge Paper would be richer for a discussion of innovative ways to deliver service and increase accountability in the system, in addition to the analysis undertaken for networked service.

Efforts to increase accountability in the system will likely directly affect the net benefits of networked and non-networked water and sanitation service. The water and sanitation sector, with its large and complex investments and its inherent need for service and maintenance, is particularly prone to corruption (Transparency International 2008), directly affecting the attractiveness of investments in the sector. Curbing wastage and targeting investments will require improved information flows about how decisions are made and simply to make better decisions.

Accountability is linked to information quality and information flows. Citizens and civil society can hold governments accountable for investment levels and locations if informed accurately of what is being done. Governments can do a better job of improving coverage levels if they know better where need is greatest. Current data on need and coverage is largely based on information collected in health surveys administered for other purposes (e.g., the Demographic and Health Surveys). These data, as summarized and collated by the WHO/UNICEF Joint Monitoring Program⁵, are inappropriate for planning. It is insufficient because it is not locally representative and because it is based on engineering information about access rather than behavioral feedback on adequacy.

One example of a promising effort to generate the sort of data that can support data-driven planning is the recent work by UN-Habitat to measure water and sanitation service coverage, health, and socio-economic status in 15 towns around Lake Vitoria. Data collection efforts like this, which are locally representative, hold the potential to inform investment decisions in a way that the JMP data cannot. Combining data of this sort with efforts to improve information flows to consumers and policymakers holds promise as a means of using information to make the system more accountable and efficient. The utility benchmarking efforts supported by the Water and Sanitation Program (a multi-donor partnership of the World Bank) and consumer report cards to solicit bottom-up feedback that are being implemented by NGOs like WaterAid (Government of Kenya 2007) are other examples of the sort of programs that could allow informed investment to be responsive and appropriately targeted, even if it does not reach “gold standard” levels. We need more information about the magnitude of the gains associated with new information-based approaches to increasing accountability, transparency and efficiency, particularly in settings in which service provision is

⁴ Noting, at the same time that in rapidly growing economies the Millennium Development Goals on water and sanitation are being met – underscoring the conclusion, also drawn by Whittington et al., that in rapidly growing economies governments do invest successfully in water and sanitation services.

⁵ A discussion of the data sources can be found at: http://www.wssinfo.org/en/123_dataProcess.html

decentralized (such as Kenya and Ghana, for example).⁶ Kariuki and Schwartz (2005) show that a new class of small-scale indigenous private sector water service providers is emerging in developing countries that may also offer new opportunities for affordable water for low income groups at market prices⁷.

Sustainability

The challenge of maintaining non-networked water infrastructure, and how this challenge may impact relative net benefit calculations, gets relatively little attention in the Challenge Paper. While acknowledging that wells and other improved sources were difficult to maintain in the past, Whittington et al. claim that “demand-driven” community management approaches that give local communities the responsibility for funding maintenance and a larger role for women constitute “a set of planning and implementation procedures that promise much better results than were previously thought possible.”

We do not feel that the literature on community management warrants this conclusion. Instead, sustainability issues deserve more detailed treatment. In a recent comprehensive review of community-based development projects, Mansuri and Rao (2004) note that existing research examining “successful” community-based projects does not compare these projects with centralized mechanisms for service delivery or infrastructure maintenance (for example, city or state financed). This makes it difficult to determine whether alternative project designs would have had different results. The limited empirical evidence suggests the impact of the community-based development approach on infrastructure maintenance is mixed at best.

Perhaps most importantly, neither retrospective analyses nor case studies like those cited in the Challenge Paper can establish a causal relationship between community participation and observed outcomes because this evidence is hampered by concerns about reverse causality. To take one example, it is difficult to determine whether the inclusion of women causes a particular outcome to occur, whether the fact that an outcome occurs encourages the participation and inclusion of women, or whether some other factors are driving these results.

Rather than dismissing sustainability as a largely settled issue, we believe that this remains a central challenge of non-networked water and sanitation interventions. We need to understand better how to sustain private behavior change, like the use of point-of-use water treatment technologies, and maintain community-level infrastructure, perhaps via the creation of opportunities for income generation. Innovative solutions that allow for private service provision and/or income generation (e.g., multiple-use systems) should be rigorously evaluated, as well as other community based interventions.

⁶ Private sector water companies are emerging in these settings that are willing and able to serve towns as small as five to ten thousand inhabitants (e.g. WaterHealth International; www.waterhealth.org). This is new in the sector where until recently private sector service was equated with large multinational companies providing – highly controversial – services in major metropolitan areas.

⁷ Kariuki and Schwartz conclude there are at least 10,000 such small private sector water providers in 49 countries; while others conclude this is likely an underestimate in a rapidly growing industry.

Alternative technologies

Point of Use treatment Using the simulation approach and avoided morbidity benefits estimates drawn from Fewtrell et al. (2005) and discussed in detail above, Whittington et al. conclude that source water quality improvements are about twice as cost-beneficial as point-of-use (POU) water treatment products at preferred parameter values. This is in spite of an assumption that the health benefits associated with point-of-use water treatment are slightly higher than those associated with source water quality interventions. The conclusion about the relative cost-effectiveness of the alternative interventions is driven in large part by the decision to model a biosand filter as the POU technology, which is much more expensive than in-home chlorination, but has not been established to be of greater cost-effectiveness. Contrary to the claim made in the Challenge Paper, there is evidence from randomized evaluations that, in fact, the cost-effectiveness of point-of-use water treatment can dramatically exceed that of source water quality interventions and, as such, that understanding how to get people to use these products and adopt them permanently is a central challenge for the sector.

. As part of the Kenya Rural Water Project, Kremer et al. (2007) evaluate the impact of source water quality improvements achieved via *spring protection*, and estimate the valuation that people place on these improvements using a randomized evaluation approach, in which protection is phased-in to springs over time in an order chosen at random. The source water quality investment, in which natural springs are improved so that water flows through a pipe, give access to uncontaminated ground water, just as wells do. The intervention improved child health: diarrhea among young children in treatment households falls by 4.7 percentage points, or one quarter on a base diarrhea prevalence of approximately 20 percent. Because of the methodology used, this benefit can confidently be ascribed to the program.

These revealed preference estimates have the advantage of being based on actual behavior changes observed in response to an exogenous change in the environment, and are not subject to the weakness that any particular parameter value chosen could be questioned. As with any empirical analysis, concerns about external validity, or the extent to which the results are generalizable, apply. However, we believe that more guidance from this sort of impact assessment is what should be used to inform investment decisions in the rural water sector, and the use of scarce resources for water and health more generally.

Relatively rigorous cost-effectiveness estimations that are derived from observing behavior may be higher or lower than those derived from simulation models. Kremer et al. (2007) conclude that, at baseline levels of population density, the social returns to the source water quality investment they study are in fact negative. However, if the springs had 60 users each, like the wells that Whittington et al. model, social returns would be modestly positive. WTP estimates are similar in magnitude to the central benefits estimates that Whittington et al. use, as well.

While the randomized impact evaluation evidence from Kenya presented by Kremer et al. (2007) broadly supports the net benefit estimates from Whittington et al. for source water quality interventions, they do not support the conclusion that point-of-use water treatment is less cost-beneficial than source water interventions. Kremer et al. (2007) compare the diarrhea reduction cost-effectiveness of spring protection versus a point-of-use

(POU) water treatment, at-home chlorination, also introduced in their study sample. The reduction in diarrhea incidence among children under age three from introducing POU treatment was about 45%, double the effect from spring protection. These estimates allow them to compare the child health benefits associated with spring protection versus the reductions in diarrheal morbidity that could have been realized had the approximately US\$148,000 spent to protect the 100 treatment springs in their sample and maintain them for ten years, instead been spent providing POU products to households with young children. In their Kenyan study area, a one month's supply of the in-home chlorination product (called WaterGuard locally) can be purchased for roughly \$0.29 (20 Kenyan Shillings). If the chlorine POU product were given to every household with children under age three in their sample (about 80% of homes) for ten years, this would cost \$65,657 in current dollars using a time discount rate of 5%. The cost per case of diarrhea averted with WaterGuard is thus about \$0.17, and so four times as many cases could be averted by focusing on point-of-use treatment products instead of spring protection. If the cost of WaterGuard were lower, as a result of bulk distribution perhaps, spending the same amount of resources on point of use water treatment instead of spring protection could avert some 12 times as many diarrhea cases. After calculating the number of Disability Adjusted Life Years (DALYs) averted by WaterGuard, using the standard WHO approach,⁸ Kremer et al. conclude that WaterGuard may be highly cost effective, costing about \$12-\$46 per DALY averted, provided that short-run take-up levels can be sustained.

These numbers differ from the Whittington et al. results for two reasons; the cost of the point-of-use product considered and the benefits of source water quality interventions. Whittington et al. assume that there are significant non-health benefits associated with source water quality interventions (e.g., time savings) that are absent with point of use products. Kremer et al. find little empirical evidence of non-health benefits of spring protection-- in terms of water appearance, taste or ease of water collection – could theoretically contribute to willingness to pay, we find no evidence that these have a significant effect on WTP in practice. The inclusion of terms for measured *E. Coli* contamination available at a subset of alternative water sources, as well as the household's perception of water quality at each source, reduces the coefficient estimate on the spring protection treatment indicator near zero in discrete choice regression analysis. Because spring protection does not create a new water point, as well construction does, this finding may not hold for wells as it does for springs. However, even spring protection induces significant shifts in water source choice, which suggests that it is possible that water quality gains may account for a large portion of the gains associated with source water quality improvement interventions.

On the cost side, the decision by Whittington et al. to focus on relatively expensive biosand filters instead of a chlorine product like WaterGuard significantly increases the cost of point of use treatment in the Challenge Paper simulations relative to the figures used by Kremer et al.. A wider analysis of alternative point-of-use treatment products with different costs would enhance the Challenge Paper analysis.

In sum, we do not agree with the conclusion drawn by Whittington et al. that source water quality investments are more cost effective than point-of-use water treatment products is warranted. Rather, our reading of the literature is that additional work on the most effective and sustainable ways of increasing point-of-use technology adoption is needed as these may

⁸ For more information on the DALY concept, see: <http://www.who.int/healthinfo/boddaly/en/index.html>.

be very cost-effective technologies if adoption can be sustained. Dissemination approaches currently being studied as part of the Kenya Rural Water Project include alternative distribution models such as the distribution of point of use products at schools or clinics so that households with young children can be targeted, centralized treatment at water sources, and alternative marketing messages. In addition, we believe that the rapid emergence of a cottage industry of micro-utility providers that provide water services at market prices is a new phenomenon worth studying as a possible cost-effective alternative to the networked service provision analyzed by Whittington et al. in Part I of their paper.

Multiple use water services. Whittington et al. discuss water service systems that are designed, managed and financed for a single use: drinking water. This is in line with the sectoral or silo approach in the water sector – and indeed with the request of the Copenhagen Consensus organizers – but not in line with the reality on the ground. In practice, poor people in rural and peri-urban areas use water available to them beyond the minimum required for drinking to generate income. Livelihood activities supported by water range from (vegetable) farming, livestock and fishponds to micro-enterprises. In the previous round of the Copenhagen Consensus exercise Rijsberman (2004) raised this issue as a separate opportunity and estimated a ballpark cost benefit ratio for this opportunity of around 7 – admittedly without the benefit of the rigorous economic analysis that would be desirable. We offer no new evidence, but note that various publications document the dissemination and positive cost benefit ratios of small scale water technology for livelihoods – from treadle pumps to drip irrigation kits (e.g. Adetola, 2007).

It is of particular interest to this discussion, however, that Renwick et al. (2007) recently completed a study for the Gates Foundation that aimed to assess the investment potential (costs, benefits and poverty impacts) of multiple use approaches. Multiple use approaches involve integrated systems to provide water services for domestic or drinking as well as productive or livelihood uses. For new users this implies designing systems that can serve both needs, for existing users it means upgrading drinking water systems to larger volumes that can generate income; or upgrading irrigation systems to provide better quality water. Renwick et al. report that for new users, “intermediate multiple use systems” have a benefit cost ratio (BCR) range of 3.4-7.8 (at 10% discount rate); basic drinking water systems can be upgraded to intermediate multiple use systems at a BCR range of 4.7-8.6; and basic irrigation systems can be upgraded to intermediate multiple use systems at a BCR range of 2.9-6.8. The report estimates the potential users for this type of water services at about a billion people.

4. Conclusions

Whittington et al. provide a thorough and comprehensive overview of the complex issues associated with a rigorous economic analysis of the provision of water and sanitation services. Their analysis of the full costs of conventional, “gold standard” networked water and sanitation services, at a full economic cost of US\$2.50 per cubic meter and monthly household costs of US\$50-100, is complete and reasonable. However, it is not an appropriately designed opportunity for the target group, the un-served that have income levels at the \$1-2 per day range. These people are far more likely to be served by something less expensive if research can identify appropriate interventions.

The analysis of the benefits of this improved water and sanitation services is complete, but significantly underestimates the health benefits, in our view. This is because it fails to include an estimate of the benefits of avoided mortality or to quantify the positive externalities associated with the sector. We present recent evidence in the literature to support this argument.

We conclude that appropriate systems for the poor that currently lack water and sanitation services are unlikely to be of the full networked variety chosen by Whittington et al. Rather, a key question is how innovative low-cost systems can be designed and implemented to deliver services that work for the poor. In addition to innovative technology and engineering, a key focus of attention will need to be on effective management and governance systems. Transparent information on the services provided, and on the health impacts delivered, in a form that informs the managers in their pursuit of excellence and empowers the users to hold the service providers accountable, is likely to be a key element in the success of such systems. Point-of-use water treatment products are also likely to be an element of such systems; field evidence suggests that these technologies can be very cost-effective interventions if take-up rates can be sustained. Other innovative systems that deserve closer inspection – and from their rapid growth appear to offer attractive investment opportunities even at market rates – are the private micro-utilities springing up in (peri-)urban areas.

Early evidence from randomized field trials suggests that innovative water services such as point-of-use chlorination are likely to have health benefits that are significantly larger than those estimated by the Monte Carlo simulations presented by Whittington et al. Results from the Kenya Rural Water Project suggest that point of use water treatment may be 4-12 times as cost-effective as source water quality improvements, and extremely cost-effective relative to other health interventions, costing about \$12-\$46 per DALY averted. Scaling up the benefit cost ratios presented by Whittington et al. accordingly leads us to conclude that the benefit cost ratios for non-networked approaches may be on the order of magnitude of 10, an attractive investment, rather than in the more marginal range of 2-4. More research to test these findings, and ensure that benefits persist over time as a result of consistent product use, is needed.

Whittington et al. focus on drinking water and sanitation alone, as is indeed customary (but not helpful). A more realistic approach would be to address opportunities for water services to support income generating activities in addition to providing health services. Renwick et al. (2008) conclude that intermediate multiple use systems that provide water for drinking as well as support vegetable production, livestock rearing, fishponds or micro-enterprises have cost benefit ratios of 3.4-7.8 (at a discount rate of 10%).

Our review leads us to believe that there are indeed significant opportunities for investments in water services that provide health benefits **and** have poverty reducing impacts, potentially affecting a billion people, and with benefit cost ratios in the range of 5-10 (at a discount rate of 5%).

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