A Bibliography on Point-of-Use Water Disinfection

Compiled by Environmental Health at USAID and CDC/Safewater

December 2006

Contents

INTRODUCTION

- This bibliography consists of published articles as well as project and/or research reports. It was compiled with assistance from CDC/Safewater.

- The bibliography is a work in progress and contains studies published through 2006. It will be updated on a regular basis. Links are included to abstracts or full-text for most of the studies.

- Full-text documents are in pdf format and the Adobe Reader can be downloaded free of charge.

OVERVIEW STUDIES

- CDC (2005). Preventing Diarrheal Disease in Developing Countries: Proven Household Water Treatment Options 1-page Fact Sheet. Atlanta, GA: CDC. - This one page fact sheet provides a snapshot overview of the benefits and drawbacks of each of the household water treatment options that are proven to reduce diarrheal disease incidence.

- Clasen T, Roberts I, Rabie T, Schmidt W, Cairncross S. (2006). Interventions to improve water quality for preventing diarrhoea. (abstract) *Cochrane Database Syst Rev. Jul 19;3:CD004794.*

- Clasen T & Bastable A (2003). Faecal contamination of drinking water during collection and household storage: the need to extend protection to the point of use. *J Water & Health 1(3): 109-115*. - This study points to the need to extend drinking water quality beyond the point of distribution to the point of consumption. The options for such extended protection, including improved collection and storage methods and household-based water treatment, are discussed.

- Fewtrell L, Colford J (2004). Water, Sanitation and Hygiene: Interventions and Diarrhoea: A Systemic Review and Meta-analysis. Health, Nutrition, and Population Family of the World Bank Human Development Network. - This meta-analysis compares diarrheal disease reduction of various water and sanitation interventions. Handwashing (average 42% reduction) and household water treatment (39% reduction on average) were found to be the two most effective water and sanitation interventions.

- Hygiene Improvement Project. (2006). Summary of Household Water Treatment and Storage E-Conference Proceedings. Washington DC.

- IRC. (2005). Household water treatment FAQs. Delft: IRC. - The focus of this FAQ is on options, suitable for developing countries, for treatment of microbiological contamination and treatment of chemical contamination.

- Jensen PK, Ensink JH, Jayasinghe G, van der Hoek W, Cairncross S, Dalsgaard A (2002). Domestic transmission routes of pathogens: the problem of in-house transmission of drinking water during storage in developing countries. *Trop Med Int Health 7:604-609*. - Even if drinking water of poor rural communities is obtained from a 'safe' source, it can become contaminated during storage in the house. To investigate the relative importance of this domestic domain contamination, a 5-week intervention study was conducted.

- Lantagne, D., Quick, R., and Mintz, E. (2006). Household water treatment and safe storage options in developing countries: a review of current implementation practices (pdf, full-text). Washington DC: Woodrow Wilson International Center. This draft paper was commissioned the Navigating Peace Initiative, a project launched by the Woodrow Wilson International Center for Scholars' Environmental Change and Security Program and funded by the Carnegie Corporation of New York.

- Mintz E, Bartram J, Lochery P, Wegelin M. (2001). Not just a drop in the bucket: Expanding access to point- of-use water treatment systems. *American Journal of Public Health* 91:1565-1570. - This review paper summarizes the problem, and discusses chlorination, solar disinfection, and safe storage as household water treatment options.
- POUZN. (2006). Point-of-Use Water Treatment Products. Washington DC.

- Sobsey, M.D. (2002). Managing water in the home: accelerating health gains from improved water supply. Geneva: WHO. - This report describes and critically reviews the various methods and systems for household water collection, treatment and storage. It also presents and critically reviews data on the ability of these household water treatment and storage methods to provide water that has improved microbiological quality and lower risk of waterborne diarrheal and other infectious disease.

- WHO. (2005). 3rd annual network meeting and international symposium, Bangkok, 30 May-2 June 2005. Meeting report. and Presentations.

- Wright J, Gundry S, Conroy (2003). Household drinking water in developing countries: a systematic review of microbiological contamination between source and point-of-use. *Trop. Med. & Int'l Health 9(1):106-17*. - Policies that aim to improve water quality through source improvements may be compromised by post-collection contamination. Safer household water storage and treatment is recommended to prevent this, together with point-of-use water quality monitoring.

C. ECONOMIC ANALYSES

- Hutton G, Haller L (2004). Evaluation of the Costs and Benefits of Water and Sanitation Improvements at the Global Level. World Health Organization, Geneva. - This cost-effectiveness evaluation found that the Safe Water System was the most cost-effective water and sanitation intervention.

D. INTERVENTIONS/TECHNOLOGIES

1. Biosand filters

- Duke, WF; et al. (2006). The use and performance of Biosand filters in the Artibonite Valley of Haiti: a field study of 107 households (abstract). *Rural Remote Health. Jul-Sep;6(3):570.*

- Kaiser N, Liang K, Maertens M, Snider R (2002). Biosand Filter: Summary of all lab and field tests. - This summary details all of the microbiological laboratory data collected by various research organizations on BioSand Filtration.

- Ngai, T., Walewijk, S. (2003) *The Arsenic Biosand Filter (ABF) Project: Design of an Appropriate Household Drinking Water Filter for Rural Nepal*. Massachusetts Institute of Technology, Department of Civil and Environmental Engineering.

- Stauber, CE; et al. (2006). Characterisation of the biosand filter for E. coli reductions from household drinking water under controlled laboratory and field use conditions (abstract). *Water Science and Technology. 54(3): pp. 1-7.*

2. Ceramic filters

- Clasen, T. and S Boisson. (2006). Household-Based Ceramic Water Filters for the Treatment of Drinking Water in Disaster Response: An Assessment of a Pilot Programme in the Dominican Republic. (pdf, full-text) *Water Practice and Technology*.

- Clasen TF, Garcia Parra G, Boisson S, Collin S (2005). Household-based ceramic water filters for the prevention of diarrhea: a randomized, controlled trial of a pilot program in Colombia. *Am J Trop. Med. Hyg. 73(4):790-795.* - Oxfam undertook a pilot project to explore the use of household-based ceramic water filters in three remote communities in Colombia. In a randomized, controlled trial over a period of six months, the filters were associated with a 75.3% reduction in arithmetic mean thermotolerant coliforms.

- Clasen T, Brown J, Suntura O & Collin S (2004c). Safe household water treatment and storage using ceramic drip filters: a randomised controlled trial in Bolivia. *Water Sci. & Tech. 50(1):111-115. - A randomised controlled field trial was conducted to evaluate the effectiveness of ceramic drip filters to improve the microbiological quality of drinking water in a low-income community in rural Bolivia.*

- Clasen T, Brown J, Suntura O, Collin S, Cairncross (2004). Reducing diarrhoea through household-based ceramic filtration of drinking water: a randomized, controlled trial in Bolivia. *Am J Trop Med Hyg 70(6): 651-7.* In a six-month trial, water filters were distributed randomly to half of the 50 participating households in a rural community in Bolivia; the remaining households continued to use customary water handling practices and served as controls.

- Lantagne, Daniele, 2001. *Investigation of the Potters for Peace Colloidal Silver Impregnated Ceramic Filter. Report 2: Field Investigations.* - Report prepared for U.S. AID. Washington D.C. November 18, 2001. This investigation documents the effectiveness of the Potters for Peace colloidal silver ceramic filter as installed in users homes.

- Lantagne, Daniele, 2001. *Investigation of the Potters for Peace Colloidal Silver Impregnated Ceramic Filter. Report 1: Intrinsic Effectiveness*. - Report prepared for U.S. AID. Washington D.C. December, 2001. This investigation documents the effectiveness of the Potters for Peace colloidal silver ceramic filter in the laboratory.

- Mattelet, CE. (2006). Household Ceramic Water Filter Evaluation Using Three Simple Low-Cost Methods: Membrane Filtration, 3M Petrifilm and Hydrogen Sulfide Bacteria in Northern Region, Ghana (pdf, full-text). MIT, 2006.

3. Flocculant-Disinfectant

- Chiller T, Mendoz C, Lopez M, Alvarez M, Hoekstra R, Keswick B, Luby S. Reducing diarrhoea in Guatemalan children: randomized controlled trial of flocculant-disinfectant for drinking-water. *Bulletin of the World Health Organization. January 2006 94(1)*. - This paper documents 40% diarrheal disease reduction in users of the PuR household water treatment product in Guatemala.

- Crump JA, Otieno PO, Slutsker L, Keswick BH, Rosen DH, Hoekstra RM, Vulule JM, Luby SP (2004). Household based treatment of drinking water with flocculant-disinfectant for preventing diarrhea in areas with turbid source water in rural western Kenya: cluster randomized controlled trial. *BMJ 331(7515):478-84*. This paper documented a 25% reduction in diarrheal disease incidence in under-2's and a 19% reduction in all age groups of users of PuR as compared to controls in turbid water in Western Kenya. In addition, this study documented a 17% reduction in diarrheal disease incidence in under-2's and a 25% reduction in all age groups of users of the SWS as compared to controls in turbid water in Western Kenya. When the two arms were joined, there was a statistically significant reduction in all-cause mortality.

- Crump JA, Okoth GO, Slutsker L, Ogaja DO, Keswick BH, Luby S. (2004). Effect of point-of-use disinfection, flocculation and combined flocculation –disinfection on drinking water quality in western Kenya. *Journal of Applied Microbiology* 2004, 97, 225–231. This paper measured the effectiveness of PuR on microbiological contaminants in drinking water. In water from 30 sources, combined flocculant-disinfectant reduced Escherichia coli concentrations to <1 CFU100 ml)1 for 29 (97%) and reduced turbidity to <5 nephelometric turbidity units (NTU) for 26 (87%).

- Rangel, J. M., B. Lopez, et al. (2003). A novel technology to improve drinking water quality: A microbiological evaluation of in-home flocculation and chlorination in rural Guatemala. *Journal of Water and Health 01.1: 15-22*. This study documented that the use of PuR with a traditional vessel (83% potable water), PuR with a CDC vessel (92% potable water), PuR with a covered bucket with spigot (93% potable water) led to an increase in potable water provision as compared to controls (5% potable water).

- Reller ME, Mendoza CE, Lopez MB, Alvarez M, Hoekstra RM, Olson CA, Baier KG, Keswick BH, Luby SP (2002). A randomized controlled trial of household-based flocculant-disinfectant drinking water treatment for diarrhoea prevention in rural Guatemala. *Am J. Trop. Med. Hyg. 69:411-419.* This study documents a 24% reduction in diarrheal disease incidence in users of PuR in rural Guatemala.

4. SWS and Chlorine

- CDC (2005). Preventing Diarrheal Disease in Developing Countries: The CDC/PSI/Rotary Safe Water System Project in Western Kenya. Atlanta, GA. This fact sheet describes the SWS project, which includes social marketing with PSI linked to community groups, in Kenya.

- CDC (2005). Preventing Diarrheal Disease in Developing Countries: The CDC/PSI Safe Water System Program in Zambia. Atlanta, GA. This fact sheet describes the PSI social marketing SWS project in Zambia.

- CDC (2005). Preventing Diarrheal Disease in Developing Countries: The Safe Water System Program. Atlanta, GA.

- CDC (2005). Preventing Diarrheal Disease in Developing Countries: The CDC/Jolivert Safe Water for Families Project in Rural Haiti. Atlanta, GA. - This fact sheet describes a community-based, rural Safe Water System project, where the chlorine solution is made and distributed through a faith-based clinic to the surrounding community.

- CDC (2006). Safe Water System: A Low-cost Technology for Clean Drinking Water. Atlanta, GA. This fact sheet describes the SWS program worldwide as of March 2006.

- CDC (2001). Safe Water Systems for the Developing World: A Handbook for Implementing Household-Based Water Treatment and Safe Storage Projects. - This handbook, available in English, Spanish, French, and Arabic, guides organizations through implementing a SWS program.

- Crump JA, Otieno PO, Slutsker L, Keswick BH, Rosen DH, Hoekstra RM, Vulule JM, Luby SP (2004). Household based treatment of drinking water with flocculant-disinfectant for preventing diarrhea in areas with turbid source water in rural western Kenya: cluster randomized controlled trial. *BMJ 331(7515):478-84*. - This paper documented a 25% reduction in diarrheal disease incidence in under-2's and a 19% reduction in all age groups of users of PuR as compared to controls in turbid water in Western Kenya. In addition, this study documented a 17% reduction in diarrheal disease incidence in under-2's and a 25% reduction in all age groups of users of the SWS as compared to controls in turbid water in Western Kenya. When the two arms were joined, there was a statistically significant reduction in all-cause mortality.

- Dunston, C., D. McAfee, et al. (2001). Collaboration, cholera, and cyclones: A project to improve point-of-use water quality in Madagascar. *American Journal of Public Health 91(10): 1574-1576*. - This paper describes the initial launch of the PSI/CARE socially marketed Safe Water System in Madagascar.

- Hutton G, Haller L (2004). Evaluation of the Costs and Benefits of Water and Sanitation Improvements at the Global Level. World Health Organization, Geneva. - This cost-effectiveness evaluation found that the Safe Water System was the most cost-effective water and sanitation intervention.

- Jensen PK, Ensink JH, Jayasinghe G, van der Hoek W, Cairncross S, Dalsgaard A (2003). Effect of chlorination of drinking-water on water quality and childhood diarrhoea in a village in Pakistan. *J Health Popul Nutr 21:26-31*. - This study found that there was no statistically significant difference between diarrhea in children using non-chlorinated water supply systems and children using chlorinated groundwater water supply systems, and concludes that "reduction of faecal bacteria in the public drinking-water supply by chlorination does not seem to be a priority intervention to reduce childhood diarrhoea.

- Luby, S., M. Agboatwalla, et al. (2004). Delayed effectiveness of home-based interventions in reducing childhood diarrhea, Karachi, Pakistan. *American Journal of Tropical Medicine and Hygiene 71(4): 420-427*. This study documented a 71% reduction of diarrheal disease incidence in SWS users without a refridgerator not immediately, but after 1 year, indicating that houses of lower socio-economic status (as defined by ownership of a refridgerator) needed extra time to adopt the intervention. It also documented a 53% lower incidence of diarrhea in those who received soap initially, with a 35% reduction one year later.

- Luby, S., M. Agboatwalla, et al. (2001). A low-cost intervention for cleaner drinking water in Karachi, Pakistan. *International Journal of Infectious Diseases 5: 144-150.* This study documented a 99.8% reduction in the mean concentration of thermotolerant coliforms in users of hypochlorite solution and safe storage container as compared to controls. Two years after vessel distribution, 68% of the families were still using the safe storage container.

- Mahfouz AA, Abdel-Moneim M, al-Erain RA, al-Amari OM (1995). Impact of chlorination of water in domestic storage tanks on childhood diarrhoea: a community trial in the rural areas of Saudi Arabia. *J. Trop. Med. Hyg. 98(2): 126-30.* This study shows that children drinking water chlorinated with calcium hypochlorite had a 48% reduction of diarrhea as compared to controls, and that all water samples taken from participating families tanks were bacteriologically fit for drinking.

- Makutsa, P., K. Nzaku, et al. (2001). Challenges in implementing a point-of-use water quality intervention in rural Kenya. *American Journal of Public Health 91(10): 1571-1573*. This paper discusses and evaluates a SWS project implemented in communities CARE/Kenya was already working within. It was found 33.5% of families had residual chlorine in their drinking water, and 18.5% of families had and improved clay pot. This article discusses the way forward for the project.

- Mintz ED, Reiff FM, Tauxe RV (1995). Safe water treatment and storage in the home: A practical new strategy to prevent waterborne disease. *Journal of the American Medical Association 273(12):948-953*.

- Mong, Y., R. Kaiser, et al. (2001). Impact of the safe water system on water quality in cyclone-affected communities in Madagascar. American Journal of Public Health 91(10): 1577-1579. After a hurricane, 11,700 kits containing chlorine solution and foldable jerry cans were distributed in rural Madagascar. Five months after distribution, 25% of those surveyed had chlorine residual in their jerry can at the time of an unannounced visit.

- Ogutu, P., V. Garrett, et al. (2001). Seeking safe storage: A comparison of drinking water quality in clay and plastic vessels. *American Journal of Public Health 91(10): 1610-1611*. This study found that chlorine residual can be maintained in both plastic jerry cans and ceramic containers for 24 hours above 0.2 mg/L.

- Olembo L, Kaona F, Tuba M, Burnham G (2004). Safe Water Systems: An Evaluation of the Zambia CLORIN Program. U.S. Agency for International Development (USAID) through the Environmental Health Project (EHP). - This extensive, population-based evaluation found that 42% of people in a random population-based survey reported current use of Clorin (the PSI SWS product) and 13% of the population had chlorine residual in their drinking water at the time of the unannounced visit.

- Parker AA, Stephenson R, Riley PL, Ombeki S, Komolleh C, Sibley L, Quick R. (2006). Sustained high levels of stored drinking water treatment and retention of hand-washing knowledge in rural Kenyan households following a clinic-based intervention. *Epidemiol Infect. Jan 26: 1-8*. - This study showed that two weeks after being recommended to use the PSI socially marketed WaterGuard solution by nurses when going to a clinic for diarrhea, 67% of patients had purchased WaterGuard and had chlorine residual in their drinking water at an unannounced visit, and 1 year later 71% of patients had chlorine residual. This study also found that patients trained in handwashing retained the knowledge 2 weeks and year out.

- Quick, R. E., A. Kimura, et al. (2002). Diarrhea prevention through household-level water disinfection and safe storage in Zambia. *American Jnl Trop Med Hyg 66(5): 584-589*. - This study documented a diarrheal disease reduction of 48% in users of the Safe Water System.

- Quick, R. E., L. V. Venczel, et al. (1999). Diarrhoea prevention in Bolivia through point-of-use water treatment and safe storage: A promising new strategy. *Epidemiology and Infection 122: 83-90*. - This study documented a diarrheal disease reduction of 44% and a significant reduction of E. coli in stored water of users of the Safe Water System.

- Rangel, J. M., B. Lopez, et al. (2003). A novel technology to improve drinking water quality: A microbiological evaluation of in-home flocculation and chlorination in rural Guatemala. *Journal of Water and Health 01.1: 15-22*. - This study documented that the use of the SWS led to an increase in potable water provision as compared to controls (92% in intervention users, 5% in controls).

- Reiff, F. M., M. Roses, et al. (1996). Low-cost safe water for the world: A practical interim solution. *Journal of Public Health Policy 17(4): 389-408*. - This advocacy piece advocates for the use of household water treatment to reduce diarrheal disease incidence until infrastructure can be established.

- Reller, M., Y. Mong, et al. (2001). Cholera prevention with traditional and novel water treatment methods: An outbreak investigation in Fort-Dauphin, Madagascar. *American Journal of Public Health 91(10): 1608-1610.* This case-control study in a Madagascar cholera outbreak found that patients were more likely than controls to have drunk untreated water, and that drinking heated water, water from a tap, or water treated with SWS was protective.

- Semenza JC, Roberts L, Henderson A, Bogan J, Rubin CH (1998). Water distribution system and diarrhoeal disease transmission: a case study in Uzbekistan. *Am J. Trop. Med. Hyg. 59(6): 941-6*. This study documented a 84% reduction of diarrheal disease incidence in users of the SWS who used piped, infrastructure water.

- Sobel, J., B. Mahon, et al. (1998). Reduction of Fecal Contamination of Street-Vended Beverages in Guatemala by a Simple System for Water Purification and Storage, Handwashing, and Beverage Storage. *American Journal of Tropical Medicine and Hygiene 59: 380-387*. This study documented a significant decrease total and fecal coliform in stored water and beverages sold by vendors using the SWS.

- Sobsey MD, Handzel T, Venczel L (2003). Chlorination and safe storage of household drinking water in developing countries to reduce waterborne disease. *Water Sci Technol. 47(3): 221-8.* This study evaluated point-of-use chlorination and safe storage in Bangladesh (reduction of diarrhea by 43%) and Bolivia (reduction of childhood diarrhea of 24%). E. coli, Clostridium perfringens, and heterotrophic plate count bacteria were lower in intervention households than in control households.

- Thevos, A., S. Olsen, et al. (2003). Social marketing and motivational interviwing as community interventions for safe water behaviors: follow-up surveys in Zambia. *Int'l Quarterly of Community Health Education 21(1): 51-65*.

- Thevos, A., R. Quick, et al. (2000). Motivational interviewing enhances the adoption of water disinfection practices in Zambia. *Health Promotion International 15(3): 207-214*.

- Thevos, A. K., F. A. D. Kaona, et al. (2000). Adoption of Safe Water Behaviors in Zambia: Comparing Educational and Motivational Approaches. *Education for Health 13(3): 366-376*. Motivational intervewing appears promising for public health initiatives in the developing world. Further research to improve and refine the method is needed.

5. Solar Disinfection

- Acra A., M. Jurdi, H. Mu'allem, Y. Karahagopian, Z. Raffoul (1990). Water Disinfection by Solar Radiation, Assessment and Application, Technical Study 66e, IDRC. Sunlight with wavelengths of 315-400 nanometers (nm) on the ultraviolet (UV) range of the electromagnetic spectrum is most effective at destroying bacteria.

- Berney, M., Weilenmann, H.-U., Ihssen, J., Bassin, C., Egli, T. (2006). Specific growth rate determines the sensitivity of enteric bacteria to thermal, UVA and solar disinfection. *Applied and Env Microbio Vol. 72, No. 4*. Knowledge about the sensitivity of the test organism is essential for the evaluation of any disinfection method. In this work we show that sensitivity of *Escherichia coli* MG1655 to three physical stresses (mild heat, UVA light, and sunlight) that are relevant in the disinfection of drinking water with solar radiation is determined by the specific growth rate of the culture.

- Berney M, Weilenmann HU, et al. (2006). Efficacy of solar disinfection of Escherichia coli, Shigella flexneri, Salmonella Typhimurium and Vibrio cholerae. *J. Appl Microbiol. Oct;101(4):828-36*

- Caslake LF, Connolly DJ, Menon V, Duncanson CM, Rojas R, Tavakoli J (2004). Disinfection of contaminated water by using solar irradiation. *Applied & Environ Microbiol. 70:1145-50.*

- Conroy R. Meegan M, Joyce T, McGuigan K, Barnes J (2001). Solar disinfection of drinking water protects against cholera in children under 6 years of age. *Archives of Disease in Childhood, 85(4):293-5*. Point of consumption solar disinfection can be done with minimal resources, which are readily available, and may be an important first line response to cholera outbreaks. Its potential in chorine resistant cholera merits further investigation.

- Conroy R, Meegan M, Joyce T, McGuigan K, Barnes J (1999). Solar disinfection of water reduces diarrhoeal disease: An update. Archives of Disease in Childhood. *Arch Dis Childhood 81(4): 337-338*. 349 Maasai children younger than 6 years old were randomised by alternate household to drink water either left in plastic bottles exposed to sunlight on the roof of the house or kept indoors (control).

- Conroy R, Elmore-Meegan M, Joyce T, McGuigan K, Barnes J (1996). Solar disinfection of drinking water and diarrhoea in Maasai children: A controlled field trial. *Lancet 348(9043):1695-1697*. Our findings suggest that solar disinfection of water may significantly reduce morbidity in communities with no other means of disinfection of drinking water, because of lack of resources or in the event of a disaster.

- Fujioka R.S., Yoneyama B.S. (2002): Sunlight inactivation of human enteric viruses and fecal bacteria. *Water Science and Technology, Vol 46, No 11-12, pp 291-295*. Three human enteric viruses (poliovirus, echovirus, coxsackievirus) suspended in seawater or buffer were stable for 6 hr in the absence of sunlight but were inactivated at the same rate in the presence of sunlight.

- Gelover, S., et al. (2006) A practical demonstration of water disinfection using TiO2 films and sunlight (abstract) *Water Research Volume 40, Issue 17, October, 3274-3280*.

- Joyce T.M., McGuigan K.G., Elmore-Meegan M., Conroy R.M. (1996). Inactivation of fecal bacteria in drinking water by solar heating. *Applied and Environmental Microbiology, Feb. 1996, p. 399-402*. We report simulations of the thermal effect of strong equatorial sunshine on water samples contaminated with high populations of fecal coliforms.

- Kang, G., et al. (2006). Appropriate technology for rural India - solar decontamination of water foremergency settings and small communities (abstract). *Transactions of the Royal Society of Tropical Medicine and Hygiene Volume 100, Issue 9, September, 863-866.*

- Kehoe S..C, Barer M.R., Devlin L.O., McGuigan K.G. (2004). Batch process solar disinfection is an efficient means of disinfecting drinking water contaminated with Shigella dysenteriae Type I. *Letters in Applied Microbiology, 38, 410-414*. Posphate-buffered saline contaminated with Sh. dysenteriae type I was exposed to simulated solar conditions and the inactivation kinetics of this organism was compared with that of Sh. flexneri, Vibrio cholerae and Salmonella typhimurium.

- Kehoe S.C., Joyce T.M., Ibrahim P., Gillespie J.B., Shahar R.A. and McGuigan K.G. (2001). Effect of agitation, turbidity, aluminium foil reflectors and volume on inactivation efficiency of batch-process solar disinfectors. *Water Research 2001; 35: 4,1061-1065*. The effects of periodic agitation, covering the rear surface of the container with aluminium foil, container volume and turbidity on the solar inactivation kinetics of Escherichia coli (starting population = 10(6) CFU ml(-1)) were investigated.

- Khaengraeng R., Reed R.H. (2005): Oxygen and photoinactivation of Escherichia coli in UVA and sunlight. *Journal of Applied Microbiology 2005, 99, 39–50*. Overall, the results indicate that future studies of bacteria exposed to UVA or sunlight should consider the effects of oxygen at every stage in the procedure, and especially during enumeration, where the inhibitory effects of ROS must be neutralized in order to obtain a valid count.

- Kohler M. (2003): Migration of organic components from polyethylene terephthalate (PET) bottles into water. Report 429670. Swiss Federal Laboratories for Materials Testing and Research (EMPA).

- Lonnen J., Kilvington S., Kehoe S.C., Al-Touati F., McGuigan K.G. (2005): Solar and photocatalytic disinfection of protozoan, fungal and bacterial microbes in drinking water. *Water Research, 39, 877-883*. A reduction of only 1.7 log units was recorded for spores of Bacillus subtilis. Both SODIS and SPC-DIS were ineffective against the cyst stage of A. polyphaga.

- Mani S.K., Kanjura R., Singha I.S.B. and Reed R.H. (2006). Comparative effectiveness of solar disinfection using small-scale batch reactors with reflective, absorptive and transmissive rear surfaces. *Water Research, Volume 40, Issue 4, Pages 721-727*. This study investigated the enhancement of solar disinfection using custom-made batch reactors with

reflective (foil-backed) or absorptive (black-backed) rear surfaces, under a range of weather conditions in India.

- McGuigan K.G., Joyce T.M., Conroy R.M., Gillespie J.B., Elmore-Meegan M. (1998). Solar disinfection of drinking water contained in transparent plastic bottles: characterizing the bacterial inactivation process. *Journal of Applied Microbiology, 84, 1138-1148*. The results confirm that, where strong sunshine is available, solar disinfection of drinking water is an effective, low cost method for improving water quality and may be of particular use to refugee camps in disaster areas. Strategies for improving bacterial inactivation are discussed.

- Méndez-Hermida F., Castro-Hermida J.A., Ares-Mazás E., Kehoe S.C., McGuigan K.G.(2005): Effect of batch-process solar disinfection on survival of Cryptosporidium parvum oocysts in drinking water. *Appl. Env. Microbiology, Vol. 71, No. 3, 1653-1654*. The results of batch-process solar disinfection (SODIS) of *Cryptosporidium parvum* oocysts in water are reported. Oocyst suspensions were exposed to simulated sunlight (830 W m–2) at 40°C.

- Moser S., Heri S., Mosler H.J. (2005): Determinants of the diffusion of SODIS. A quantitative field study in Bolivia: Summary Report. EAWAG, Dübendorf.

- Meierhofer, R. and M. Wegelin. (2002). Solar Water Disinfection: A Guide for the Application of SODIS. (Full-text in various languages)

- Oates, P., Shanahan, P., and Polz, Martin. 2003. Solar Disinfection (SODIS) Simulation of Solar Radiation for Global Assessment and Application of Point-of-use Treatment in Haiti. *Water Research 37 (2003) 47-54*. We have developed a mathematical model based on satellite-derived daily total energies to simulate monthly mean, minimum, and maximum 5-h averaged peak solar radiation intensities. This model can be used to assess if SODIS technology would be applicable anywhere in the world.

- Rainey, R and Harding, A. (2005). Acceptability of solar disinfection of drinking water treatment in Kathmandu Valley, Nepal. *International Journal of Environmental Health Research. October 2005; 15(5): 361-372.* This research examines the acceptability of solar disinfection of drinking water (SODIS) in a village in Kathmandu Valley, Nepal, using constructs from the Health Belief Model as a framework to identify local understandings of water, sanitation and health issues.

- Rainey, R and Harding, A. (2005). Drinking water quality and solar disinfection: Effectiveness in peri-urban households in Nepal. *Journal of Water and Health. 03: 239-248*. The study examined pH, turbidity and fecal contamination of drinking water from household water storage containers, wells and taps, and the Godawari River, and tested the effectiveness of solar disinfection (SODIS) in reducing levels of fecal contamination from household containers.

- Reed R.H., Mani S.K., Meyer V. (2000), Solar photo-oxidative disinfection of drinking water: preliminary field observations. *Letters in Applied Microbiology 2000, 30, 432 – 436*. These results demonstrate that solar photo-oxidation may provide a practical, low-cost approach to the improvement of drinking water quality in developing countries with consistently sunny climates.

- Reed R.H. (1997). Solar inactivation of faecal bacteria in water: the critical role of oxygen, *Letters in Applied Microbiology 1997, 24.* The demonstration of an oxygen requirement for the inactivation of faecal bacteria in sunlight indicates that solar-based water disinfection systems are likely to require fully aerobic conditions in order to function effectively.

- Rose A, Roy S, Abraham V, et al. (2006). Solar disinfection of water for diarrhoeal prevention in southern India.. *Arch Dis Child. 2006 Feb;91(2):139-41.* Solar disinfection of water is an inexpensive, effective, and acceptable method of increasing water safety in a resource

limited environment, and can significantly decrease diarrhoeal morbidity in children.

- Smith R.J., Kehoe S.C., McGuigan K.G., Barer M.R. (2000). Effects of simulated solar disinfection on infectivity of Salmonella typhimurium. *Lett Appl Microbiol 31: 4, 284-288*. We report the results of experiments designed to improve the efficacy of the solar disinfection of drinking water, inactivation process.

- Sommer B., Mariño A., Solarte Y., Salas M.L., Dierolf C., Valiente C., Mora D., Rechsteiner R., Setter P., Wirojanagud W., Ajarmeh H., Al-Hassan A., Wegelin M. (1997). SODIS - an emerging water treatment process, *J Water SRT, Aqua Vol. 46, No. 3.*

- Wegelin M., Canonica S., Mechsner K., Fleischmann T., Pesaro F., Metzler A. (1994).Solar Water Disinfection: Scope of the Process and Analysis of Radiation Experiments, *J Water SRT, Aqua Vol. 43, No. 4, pp 154-169.*

- Wegelin M., Canonica S., Alder A.C., Marazuela D., Suter M.J.-F., Bucheli Th.D., Haefliger O.P., Zenobi R., McGuigan K.G., Kelly M.T., Ibrahim P., Larroque M.(2001), Does sunlight change the material and content of polyethylene terephthalate (PET) bottles?, *IWA Publishing, Journal of Water Supply: Research and Technology - Aqua, Vol. 50, No. 3.*

7. Others

- Clasen T, Edmondson P (2006). Sodium dichloroisocyanurate (NaDCC) tablets as an alternative to sodium hypochlorite for the routine treatment of drinking water at the household level. *Int'l J. Hyg. & Environ. Health*. Household water treatment using sodium hypochlorite (NaOCl) has been recognized as a cost-effective means of reducing the heavy burden of diarrhea and other waterborne diseases, especially among populations without access to improved water supplies.

- Colwell RR, Huq A, Islam MS, Aziz KMA, Yunus M, Khan NH, Mahmud A, Sack RB, Nair GB, Chakraborty J, Sack DA, Russek-Cohen E (2003). Reduction of cholera in Bangladeshi villages by simple filtration. *Proc. Nat. Acad. Sci. 100(3): 1051-5.* Effective deployment of this filtration procedure, from September 1999 through July 2002 in 65 villages of rural Bangladesh, of which the total population for the entire study comprised ≈133,000 individuals, yielded a 48% reduction in cholera ($P < 0.005$) compared with the control.

- Payment P, Franco E, Richardson L, Siemiatycki J (1991a). Gastrointestinal health effects associated with the consumption of drinking water produced by point-of-use domestic reverse-osmosis filtration units. *Appl. Environ. Microbiol. 57(4): 945-948*. During a prospective epidemiological study of gastrointestinal health effects associated with the consumption of drinking water produced by reverse-osmosis domestic units, a correlation was demonstrated between the bacterial counts on R2A medium incubated at 35 degrees C and the reported gastrointestinal symptoms in families who used these units.

- Rowe, A. K., F. Angulo, et al. (1998).Chlorinating well water with liquid bleach was not an effective water disinfection strategy in Guinea-Bissau. *International Journal of Environmental Health Research 8: 339-340*. This paper documents the fact that chlorinating well water with bleach, a common emergency response procedure, is not effective for water disinfection.

- Rowe, A. K., F. J. Angulo, et al. (1998). A Lime in a Litre Rapidly Kills Toxigenic Vibrio cholerae O1. *Tropical Doctor October: 247-248*.

- Venczel LA, Arrowood M, Hurd M, Sobsey MD (1997). Inactivation of Cryptosporidium parvum oocysts and Clostridium perfringes spores by a mixed-oxidant disinfectant and by free chlorine. *Appl. Environ. Microbiol. 63:1598-1601*. In this study, an alternative disinfection system consisting of an electrochemically produced mixed-oxidant solution (MIOX; LATA Inc.) was evaluated for inactivation of both *Cryptosporidium parvum* oocysts and *Clostridium perfringens* spores. The disinfection efficacy of the mixed-oxidant solution was compared to that of free chlorine on the basis of equal weight per volume concentrations of total oxidants.

E. IMPLEMENTATION APPROACHES

1. Emergency/Disaster Situations

- Doocy S., et al. (2006). Point-of-use water treatment and diarrhoea reduction in the emergency context: an effectiveness trial in Liberia (abstract). *Trop Med Int Health. Oct;11(10):1542-52.*

- WHO.(2005). Household water treatment and safe storage following emergencies and disasters. Geneva: WHO.

2. Handwashing

- Hutin, Y., Luby, S, et al. (2003). A large outbreak of cholera in Kano City, Nigeria : the importance of hand washing with soap and the danger of street-vended water. *Journal of Water and Health 01.1: 45-52*. This investigation of cholera transmission risk factors in an outbreaks found that cases were more likely than controls to have drunk street-vended water and less likely to have washed hands with soap before eating.

- Luby S, Agboatwalla M, Geikin DR, Painter J, Billhimer W, Altaf A, Hoekstra RM (2005). Effect of handwashing on child health: a randomized controlled trial. *Lancet 366(9481):225-33*. This study found that children younger than 5 that received plain soap had 50% lower incidence of pneumonia, 53% lower incidence of diarrhoea, and 34% lower incidence of impetigo. Results were not improved when children were given antibacterial soap.

- Luby, S., M. Agboatwall, et al. (2004). Effect of intensive handwashing promotion on childhood diarrhea in high-risk communities in Pakistan; A randomised controlled trial. *JAMA 291(21): 2547-2554*. This randomized, controlled trial found a 53% lower incidence of diarrhea in children washing their hands with soap as compared to control children.

- Luby, S., M. Agboatwalla, et al. (2004). Delayed effectiveness of home-based interventions in reducing childhood diarrhea, Karachi, Pakistan. *American Journal of Tropical Medicine and Hygiene 71(4): 420-427*. This study documented a 71% reduction of diarrheal disease incidence in SWS users without a refridgerator not immediately, but after 1 year, indicating that houses of lower socio-economic status (as defined by ownership of a refridgerator) needed extra time to adopt the intervention. It also documented a 53% lower incidence of diarrhea in those who received soap initially, with a 35% reduction one year later.

- Luby, S., M. Agboatwalla, et al. (2003). The effect of antibacterial soap on impetigo incidence Karachi, Pakistan. *American Journal of Tropical Medicine and Hygiene 67(4): 430-435*. This study found a 23% reduction (as compared to controls who received placebo soap) and a 43% reduction (as compared to controls) of impetigo in children who used triclocarban-containing soap.

- Luby, S. P., M. Agboatwalla, et al. (2001). Microbiologic effectiveness of handwashing with soap in an urban squatter settlement, Karachi, Pakistan. *Epidemiology and Infection 127: 237-244*. This study found that providing soap and promoting hand washing measurably

improved mothers' hand cleanliness in terms of bacterial reduction, even when the water used for washing was contaminated.

- Parker AA, Stephenson R, Riley PL, Ombeki S, Komolleh C, Sibley L, Quick R. (2006). Sustained high levels of stored drinking water treatment and retention of hand-washing knowledge in rural Kenyan households following a clinic-based intervention. *Epidemiol Infect. Jan 26: 1-8*. This study showed that two weeks after being recommended to use the PSI socially marketed WaterGuard solution by nurses when going to a clinic for diarrhea, 67% of patients had purchased WaterGuard and had chlorine residual in their drinking water at an unannounced visit, and 1 year later 71% of patients had chlorine residual. This study also found that patients trained in handwashing retained the knowledge 2 weeks and year out.

F. DISEASES

1. Arsenic related studies

- Meng X, Korfiatis GP, Christodoulatos C, Bang S (2001). Treatment of arsenic in Bangladesh well water using a household co-precipitation and filtration system. *Water Res 35:2805-10.* Laboratory and field tests were conducted to evaluate the effectiveness of a household filtration process and investigate the effects of phosphate and silicate on the removal of arsenic from Bangladesh groundwater by ferric hydroxides.

- Murcott, S. 2002. **"**Web Site Arsenic Remediation Database of > 50 Options**."** In: Arsenic Exposure and Health Effects V. Proceedings of the 5th International Conference on Arsenic Exposure and Health Effects, July 14-18, 2002. San Diego, CA. W.R. Chappell, C.O. Abernathy and R.L. Calberon, Eds. London: Elsevier Science Ltd.

- Murcott, S. 2001. **"**A Comprehensive Review of Low-Cost, Well Water Treatment Technologies for Arsenic Removal." In: Arsenic Exposure and Health Effects IV. Proceedings of the 4th International Conference on Arsenic Exposure and Health Effects, June 18 – 22, 2000. Society for Environmental Geochemistry and Health. San Diego, CA. W.R. Chappell, C.O. Abernathy and R.L. Calberon, Eds. London: Elsevier Science Ltd.

- Murcott, S. 1999. "Appropriate Remediation Technologies for Arsenic-Contaminated Wells in Bangladesh." In: Proceedings of the International Conference on Arsenic in Ground Water in Bangladesh: Sources and Remedies" Wagner College, Staten Island, New York, Feb. 27 - 28, 1999.

- Sutherland D, Swash PM, Macqueen AC, McWilliam LE, Ross DJ, Wood SC (2002). A field based evaluation of household arsenic removal technologies for the treatment of drinking water. *Environ Technol. 23:1385-403.* Seven household treatment technologies for the removal of arsenic (Alcan, BUET, DPHE/DANIDA, Garnet, Sono, Stevens, Tetrahedron) were each evaluated using water from 63 different tube wells taken from 3 different regions of Bangladesh.

- Yuan T, Hu JY, Ong SL, Luo QF, Ng WJ (2002). Arsenic removal from household drinking water by adsorption. *J Environ Sci Health 37:1721-36.* Geogenic inorganic arsenic contamination in drinking water has been raising public health concern especially in developing countries. Cost-effective and stopgap arsenic removal method for household use (cooking and drinking) is very urgent.

2. Cholera

- Besser RE, B. Moscoso Rojas, et al. (1995). Prevencion del la transmission del colera: Evaluacion rapida de la calidad del agua municipal en Trujillo, Peru. *Boletin de la Oficina Sanitaria Panamerica 119(3): 189-193*. This study documented variable chlorine levels (0-1.5 mg/L), with 17% of samples with no free chlorine in water associated with the 1991 cholera epidemic. This data supports the promotion of point-of-use water treatment.

- CDC (2004). Cholera epidemic associated with raw vegetables- -Lusaka, Zambia, 2003-2004. *Morbidity and Mortality Weekly Report 53(34): 783-786*. This report found that foodborne transmission via raw vegetables was indicated in cholera transmission in Zambia in 2003, and that handwashing with soap was protective against cholera.

- Colwell RR, Huq A, Islam MS, Aziz KMA, Yunus M, Khan NH, Mahmud A, Sack RB, Nair GB, Chakraborty J, Sack DA, Russek-Cohen E (2003). Reduction of cholera in Bangladeshi villages by simple filtration. *Proc. Nat. Acad. Sci. 100(3): 1051-5.* Based on results of ecological studies demonstrating that *Vibrio cholerae*, the etiological agent of epidemic cholera, is commensal to zooplankton, notably copepods, a simple filtration procedure was developed whereby zooplankton, most phytoplankton, and particulates >20 μm were removed from water before use. Effective deployment of this filtration procedure, from September 1999 through July 2002 in 65 villages of rural Bangladesh, of which the total population for the entire study comprised ≈133,000 individuals, yielded a 48% reduction in cholera ($P < 0.005$) compared with the control.

- Conroy RM, Meegan ME, Joyce T, McGuigan K, Barnes J (2001). Solar disinfection of drinking water protects against cholera in children under 6 years of age. *Arch. Dis. Child. 85(4): 293-5.* Results confirm the usefulness of solar disinfection in reducing risk of water borne disease in children. Point of consumption solar disinfection can be done with minimal resources, which are readily available, and may be an important first line response to cholera outbreaks.

- Daniels, N., S. Simons, et al. (1999). First do no harm: Making oral rehydration solution safer in a cholera epidemic. *American Journal of Tropical Medicine and Hygiene 60: 1051-1055*. This study found high levels of fecal contamination in ORS solution prepared with tap water in a clinic. The use of Safe Water System treated water to prepare the solution significantly reduced the microbiological contamination of the ORS solution (to 0 col/100 mL of E. coli).

- Dubois AE, Sinkala M, Kalluri P, Makasa-Chikoya M, Quick RE. (2006). Epidemic cholera in urban Zambia: hand soap and dried fish as protective factors (abstract). Epidemiol Infect. Apr 20:1-5.

- Shapiro, R. L., M. R. Otieno, et al. (1999). Transmission of epidemic Vibrio Cholerae 01 in rural Western Kenya associated with drinking water from Lake Victoria. *The American Society of Tropical Medicine and Hygiene 60: 271-276*. - This case-control study of a cholera outbreak in Western Kenya in 1997-1998 found that risk factors for cholera included drinking water for lake Victoria or from a stream, sharing food with a person with watery diarrhea, and attending funeral feasts.

- Swerdlow, D., G. Malenga, et al. (1997). Epidemic cholera among refugees in Malawi, Africa: Treatment and transmission. *Epidemiology and Infection 118: 207-214*. This case-control study of a cholera outbreak in Mozambique found that risk factors for illness included drinking river water and placing hands into stored household drinking water.

- Swerdlow, D. L., E. D. Mintz, et al. (1992). Waterborne transmission of epidemic cholera in Trujillo, Peru: lessons for a continent at risk. *Lancet 340(4): 28-33*. This case-control study of the 1991 cholera outbreak in Trujillo, Peru for that risk factors for illness included drinking

unboiled water, drinking water for a household water storage container in which hands had been introduced in the water, and going to a fiesta.

- Tauxe, R. V., E. D. Mintz, et al. (1995). Epidemic cholera in the new world: Translating field epidemiology into new prevention strategies. *Emerging Infectious Diseases 1(4): 141-146*. This summary discusses the cholera epidemic in the early 1990's and recommends the use of the SWS.

- Weber, J. T., E. D. Mintz, et al. (1994). Epidemic cholera in Ecuador: multidrug-resistance and transmission by water and seafood. *Epidemiology and Infection 112: 1-11*. This case-control study of a 1991 cholera outbreak in Ecuador found that drinking unboiled water, drinking a beverage from a street vendor, eating raw seafood, and eating cooked crab were associated with illness. The presence of soap in the home and drinking boiled water were protective against cholera.

3. Diarrhea

- Brooks, J., R. Shapiro, et al. (2003). Epidemiology of sporadic bloody diarrhea in rural Western Kenya. *American Journal of Tropical Medicine and Hygiene 68(6): 671-677*. - This study investigated bloody diarrhea in Western Kenya, and found that drinking Lake Victoria water and sharing latrines increased the risk of bloody diarrhea, while washing hands after defecating was protective.

- Iijima Y, Karama M, Oundo JO, Honda T (2001). Prevention of bacterial diarrhea by pasteurization of drinking water in Kenya. *Microbiol. Immunol. 45(6): 413-6.* The number of households in which drinking water was coliform bacteria-free increased from 10.7% to 43.1% after adoption of a pasteurization practice.

- Semenza JC, Roberts L, Henderson A, Bogan J, Rubin CH (1998). Water distribution system and diarrhoeal disease transmission: a case study in Uzbekistan. *Am J. Trop. Med. Hyg. 59(6): 941-6.* A randomized intervention study was conducted to provide epidemiologic data for water policy decisions in Nukus, Uzbekistan, where drinking water quality is suboptimal.

4. HIV/AIDS

- Dunne, E. F., H. Angoran-Benie, et al. (2001). Is Drinking Water in Abidjan, Cote d' Ivoire, Safe for Infant Formula. *Journal of Acquired Immune Deficiency syndromes 28(4): 393-398*. This study documented the presence of E. coli in 41% of stored water samples and 1% of source water samples in water that was given to infants to drink in households where the mother is HIV positive. It also documented widespread practice of giving infants stored water to drink (90% of households).

- Lule, J.R., J. Mermin, et al. (2005). Effect of home-based water chlorination and safe storage on diarrhea among persons with Human Immunodeficiency Virus in Uganda. *Am J Trop Med Hyg 73(5): 926-933*. This study documented that persons with HIV who use the SWS had 25% fewer diarrhea episodes, 33% fewer days with diarrhea, and less visible blood or mucus in stools than controls. Use of cotrimoxazole prophylaxis in addition to SWS reduced diarrhea episodes by 67%, and days with diarrhea by 54%.

- Laurent, P. (2005). Household drinking water systems and their impact on people with weakened immunity. MSF-Holland.

- Shrestha RK, et al. (2006). Cost-effectiveness of home-based chlorination and safe water storage in reducing diarrhea among HIV-affected households in rural Uganda (abstract).

Am J Trop Med Hyg. May;74(5):884-90.

5. Others

- Colford JM, Rees JR, Wade TJ, Khalakdina A, Hilton JF, Ergas IJ, Burns S, Benker A, Ma C, Bowen C, Mills DC, Vugia DJ, Juranek DD, Levy DA (2002). Participant blinding and gastrointestinal illness in a randomized, controlled trial of an in-home drinking water intervention. *Emerging Infectious Diseases 8:29-36.*

G. COUNTRY STUDIES

Bangladesh

- Colwell RR, Huq A, Islam MS, Aziz KMA, Yunus M, Khan NH, Mahmud A, Sack RB, Nair GB, Chakraborty J, Sack DA, Russek-Cohen E (2003). Reduction of cholera in Bangladeshi villages by simple filtration. *Proc. Nat. Acad. Sci. 100(3): 1051-5.* Based on results of ecological studies demonstrating that *Vibrio cholerae*, the etiological agent of epidemic cholera, is commensal to zooplankton, notably copepods, a simple filtration procedure was developed whereby zooplankton, most phytoplankton, and particulates >20 μm were removed from water before use. Effective deployment of this filtration procedure, from September 1999 through July 2002 in 65 villages of rural Bangladesh, of which the total population for the entire study comprised ≈133,000 individuals, yielded a 48% reduction in cholera ($P < 0.005$) compared with the control.

- Meng X, Korfiatis GP, Christodoulatos C, Bang S (2001). Treatment of arsenic in Bangladesh well water using a household co-precipitation and filtration system. *Water Res 35:2805-10.* Laboratory and field tests were conducted to evaluate the effectiveness of a household filtration process and investigate the effects of phosphate and silicate on the removal of arsenic from Bangladesh groundwater by ferric hydroxides.

- Murcott, S. 1999. "Appropriate Remediation Technologies for Arsenic-Contaminated Wells in Bangladesh." In: *Proceedings of the International Conference on Arsenic in Ground Water in Bangladesh: Sources and Remedies" Wagner College, Staten Island, New York, Feb. 27 - 28, 1999.*

- Sutherland D, Swash PM, Macqueen AC, McWilliam LE, Ross DJ, Wood SC (2002). A field based evaluation of household arsenic removal technologies for the treatment of drinking water. *Environ Technol. 23:1385-403.* Seven household treatment technologies for the removal of arsenic (Alcan, BUET, DPHE/DANIDA, Garnet, Sono, Stevens, Tetrahedron) were each evaluated using water from 63 different tube wells taken from 3 different regions of Bangladesh.

Bolivia

- Clasen T, Brown J, Suntura O & Collin S (2004c). Safe household water treatment and storage using ceramic drip filters: a randomised controlled trial in Bolivia. *Water Sci. & Tech. 50(1):111-115.*

- Clasen T, Brown J, Suntura O, Collin S, Cairncross (2004). Reducing diarrhoea through household-based ceramic filtration of drinking water: a randomized, controlled trial in Bolivia. *Am J Trop Med Hyg 70(6): 651-7.*

- Quick, R. E., L. V. Venczel, et al. (1999). Diarrhoea prevention in Bolivia through point-of-use water treatment and safe storage: A promising new strategy. *Epidemiology and*

Infection 122: 83-90. This study documented a diarrheal disease reduction of 44% and a significant reduction of E. coli in stored water of users of the Safe Water System.

Colombia

- Clasen TF, Garcia Parra G, Boisson S, Collin S (2005). Household-based ceramic water filters for the prevention of diarrhea: a randomized, controlled trial of a pilot program in Colombia. *Am J Trop. Med. Hyg. 73(4):790-795.*

Cote d'Ivoire

- Dunne, E. F., H. Angoran-Benie, et al. (2001). Is Drinking Water in Abidjan, Cote d' Ivoire, Safe for Infant Formula. *Journal of Acquired Immune Deficiency syndromes 28(4): 393-398*. This study documented the presence of E. coli in 41% of stored water samples and 1% of source water samples in water that was given to infants to drink in households where the mother is HIV positive. It also documented widespread practice of giving infants stored water to drink (90% of households).

Dominican Republic

- Clasen, T. and S Boisson. (2006). Household-Based Ceramic Water Filters for the Treatment of Drinking Water in Disaster Response: An Assessment of a Pilot Programme in the Dominican Republic. (pdf, full-text) Water Practice and Technology.

Ecuador

- Weber, J. T., E. D. Mintz, et al. (1994). Epidemic cholera in Ecuador: multidrug-resistance and transmission by water and seafood. *Epidemiology and Infection 112: 1-11*. This case-control study of a 1991 cholera outbreak in Ecaudor found that drinking unboiled water, drinking a beverage from a street vendor, eating raw seafood, and eating cooked crab were associated with illness. The presence of soap in the home and drinking boiled water were protective against cholera.

Ghana

- VanCalcar, JE. (2006). Collection and Representation of GIS Data to Aid Household Water Treatment and Safe Storage Technology Implementation in the Northern Region of Ghana (pdf, full-text). MIT.

Guatemala

- Chiller T, Mendoz C, Lopez M, Alvarez M, Hoekstra R, Keswick B, Luby S. (2006). Reducing diarrhoea in Guatemalan children: randomized controlled trial of flocculant-disinfectant for drinking-water. *Bulletin of the World Health Organization. 94(1)*. This paper documents 40% diarrheal disease reduction in users of the PuR household water treatment product in Guatemala.

- Rangel, J. M., B. Lopez, et al. (2003). A novel technology to improve drinking water quality: A microbiological evaluation of in-home flocculation and chlorination in rural Guatemala. *Journal of Water and Health 01.1: 15-22*. This study documented that the use of PuR with a traditional vessel (83% potable water), PuR with a CDC vessel (92% potable water), PuR with a covered bucket with spigot (93% potable water) led to an increase in potable water provision as compared to controls (5% potable water).

- Reller ME, Mendoza CE, Lopez MB, Alvarez M, Hoekstra RM, Olson CA, Baier KG, Keswick BH, Luby SP (2002). A randomized controlled trial of household-based flocculant-disinfectant drinking water treatment for diarrhoea prevention in rural Guatemala. *Am J. Trop. Med. Hyg. 69:411-419*.

- Sobel, J., B. Mahon, et al. (1998). Reduction of Fecal Contamination of Street-Vended Beverages in Guatemala by a Simple System for Water Purification and Storage, Handwashing, and Beverage Storage. *American Journal of Tropical Medicine and Hygiene 59: 380-387*. This study documented a significant decrease total and fecal coliform in stored water and beverages sold by vendors using the SWS.

Guinea-Bissau

- Daniels, N., S. Simons, et al. (1999). First do no harm: Making oral rehydration solution safer in a cholera epidemic. *American Journal of Tropical Medicine and Hygiene 60: 1051-1055.* This study found high levels of fecal contamination in ORS solution prepared with tap water in a clinic. The use of Safe Water System treated water to prepare the solution significantly reduced the microbiological contamination of the ORS solution (to 0 col/100 mL of E. coli).

- Rowe, A. K., F. Angulo, et al. (1998). Chlorinating well water with liquid bleach was not an effective water disinfection strategy in Guinea-Bissau. *International Journal of Environmental Health Research 8: 339-340*. This paper documents the fact that chlorinating well water with bleach, a common emergency response procedure, is not effective for water disinfection.

Haiti

- CDC (2005). Preventing Diarrheal Disease in Developing Countries: The CDC/Jolivert Safe Water for Families Project in Rural Haiti. Atlanta, GA. This fact sheet describes a community-based, rural Safe Water System project, where the chlorine solution is made and distributed through a faith-based clinic to the surrounding community.

- Duke, WF; et al. (2006). The use and performance of Biosand filters in the Artibonite Valley of Haiti: a field study of 107 households (abstract). *Rural Remote Health. Jul-Sep;6(3):570*.

- Oates, P., Shanahan, P., and Polz, Martin. 2003. Solar Disinfection (SODIS) Simulation of Solar Radiation for Global Assessment and Application of Point-of-use Treatment in Haiti. *Water Research 37 (2003) 47-54*. We have developed a mathematical model based on satellite-derived daily total energies to simulate monthly mean, minimum, and maximum 5-h averaged peak solar radiation intensities. This model can be used to assess if SODIS technology would be applicable anywhere in the world.

India

- Kang, G., et al. (2006). Appropriate technology for rural India - solar decontamination of water foremergency settings and small communities (abstract). *Transactions of the Royal Society of Tropical Medicine and Hygiene Volume 100, Issue 9, September, Pages 863-866.*

- Mani S.K., Kanjura R., Singha I.S.B. and Reed R.H. (2006). Comparative effectiveness of solar disinfection using small-scale batch reactors with reflective, absorptive and transmissive rear surfaces. *Water Research, Volume 40, Issue 4, Pages 721-727*. This study investigated the enhancement of solar disinfection using custom-made batch reactors with reflective (foil-backed) or absorptive (black-backed) rear surfaces, under a range of weather

conditions in India.

- Rose A, Roy S, Abraham V, et al. (2006). Solar disinfection of water for diarrhoeal prevention in southern India. Arch Dis Child. 2006 Feb;91(2):139-4. Solar disinfection of water is an inexpensive, effective, and acceptable method of increasing water safety in a resource limited environment, and can significantly decrease diarrhoeal morbidity in children.

Kenya

- Brooks, J., R. Shapiro, et al. (2003). Epidemiology of sporadic bloody diarrhea in rural Western Kenya. *American Journal of Tropical Medicine and Hygiene 68(6): 671-677*. This study investigated bloody diarrhea in Western Kenya, and found that drinking Lake Victoria water and sharing latrines increased the risk of bloody diarrhea, while washing hands after defecating was protective.

- CDC (2005). Preventing Diarrheal Disease in Developing Countries: The CDC/PSI/Rotary Safe Water System Project in Western Kenya. Atlanta, GA. This fact sheet describes the SWS project, which includes social marketing with PSI linked to community groups, in Kenya.

- Conroy RM, Meegan ME, Joyce T, McGuigan K, Barnes J (2001). Solar disinfection of drinking water protects against cholera in children under 6 years of age. *Arch. Dis. Child. 85(4): 293-5.* Results confirm the usefulness of solar disinfection in reducing risk of water borne disease in children. Point of consumption solar disinfection can be done with minimal resources, which are readily available, and may be an important first line response to cholera outbreaks.

- Conroy R, Meegan M, Joyce T, McGuigan K, Barnes J (1999). Solar disinfection of water reduces diarrhoeal disease: An update. *Archives of Disease in Childhood. 81(4): 337-338.*

- Conroy R, Elmore-Meegan M, Joyce T, McGuigan K, Barnes J (1996). Solar disinfection of drinking water and diarrhoea in Maasai children: A controlled field trial. *Lancet (N. American edition), 348(9043):1695-1697.*

- Crump JA, Okoth GO, Slutsker L, Ogaja DO, Keswick BH, Luby S. (2004). Effect of point-of-use disinfection, flocculation and combined flocculation–disinfection on drinking water quality in western Kenya. *Journal of Applied Microbiology 2004, 97, 225-231.* This paper measured the effectiveness of PuR on microbiological contaminants in drinking water. In water from 30 sources, combined flocculant-disinfectant reduced Escherichia coli concentrations to <1 CFU100 ml)1 for 29 (97%) and reduced turbidity to <5 nephelometric turbidity units (NTU) for 26 (87%).

- Crump JA, Otieno PO, Slutsker L, Keswick BH, Rosen DH, Hoekstra RM, Vulule JM, Luby SP (2004). Household based treatment of drinking water with flocculant-disinfectant for preventing diarrhea in areas with turbid source water in rural western Kenya: cluster randomized controlled trial. *BMJ 331(7515):478-84.* This paper documented a 25% reduction in diarrheal disease incidence in under-2's and a 19% reduction in all age groups of users of PuR as compared to controls in turbid water in Western Kenya. In addition, this study documented a 17% reduction in diarrheal disease incidence in under-2's and a 25% reduction in all age groups of users of the SWS as compared to controls in turbid water in Western Kenya. When the two arms were joined, there was a statistically significant reduction in all-cause mortality.

- Iijima Y, Karama M, Oundo JO, Honda T (2001). Prevention of bacterial diarrhea by pasteurization of drinking water in Kenya. *Microbiol. Immunol. 45(6): 413-6.* The number of households in which drinking water was coliform bacteria-free increased from 10.7% to 43.1% after adoption of a pasteurization practice.

- Makutsa, P., K. Nzaku, et al. (2001). Challenges in implementing a point-of-use water quality intervention in rural Kenya. *American Journal of Public Health 91(10): 1571-1573*. This paper discusses and evaluates a SWS project implemented in communities CARE/Kenya was already working within. It was found 33.5% of families had residual chlorine in their drinking water, and 18.5% of families had and improved clay pot. This article discusses the way forward for the project.

- Ogutu, P., V. Garrett, et al. (2001). "Seeking safe storage: A comparison of drinking water quality in clay and plastic vessels." *American Journal of Public Health 91(10): 1610-1611*. This study found that chlorine residual can be maintained in both plastic jerry cans and ceramic containers for 24 hours above 0.2 mg/L.

- Parker AA, Stephenson R, Riley PL, Ombeki S, Komolleh C, Sibley L, Quick R. (2006). Sustained high levels of stored drinking water treatment and retention of hand-washing knowledge in rural Kenyan households following a clinic-based intervention. *Epidemiol Infect. Jan 26: 1-8*. This study showed that two weeks after being recommended to use the PSI socially marketed WaterGuard solution by nurses when going to a clinic for diarrhea, 67% of patients had purchased WaterGuard and had chlorine residual in their drinking water at an unannounced visit, and 1 year later 71% of patients had chlorine residual. This study also found that patients trained in handwashing retained the knowledge 2 weeks and year out.

- Shapiro, R. L., M. R. Otieno, et al. (1999). Transmission of epidemic Vibrio Cholerae 01 in rural Western Kenya associated with drinking water from Lake Victoria. *American Journal of Tropical Medicine and Hygiene 60: 271-276*. This case-control study of a cholera outbreak in Western Kenya in 1997-1998 found that risk factors for cholera included drinking water for lake Victoria or from a stream, sharing food with a person with watery diarrhea, and attending funeral feasts.

Liberia

- Doocy S., et al. (2006). Point-of-use water treatment and diarrhoea reduction in the emergency context: an effectiveness trial in Liberia (abstract). *Trop Med Int Health. Oct;11(10):1542-52.*

Madagascar

- Dunston, C., D. McAfee, et al. (2001). Collaboration, cholera, and cyclones: A project to improve point-of-use water quality in Madagascar. *American Journal of Public Health 91(10): 1574-1576*. This paper describes the initial launch of the PSI/CARE socially marketed Safe Water System in Madagascar.

- Mong, Y., R. Kaiser, et al. (2001). Impact of the safe water system on water quality in cyclone-affected communities in Madagascar. *American Journal of Public Health 91(10): 1577-1579*. After a hurricane, 11,700 kits containing chlorine solution and foldable jerry cans were distributed in rural Madagascar. Five months after distribution, 25% of those surveyed had chlorine residual in their jerry can at the time of an unannounced visit.

- Reller, M., Y. Mong, et al. (2001). Cholera prevention with traditional and novel water treatment methods: An outbreak investigation in Fort-Dauphin, Madagascar. *American Journal of Public Health 91(10): 1608-1610.* This case-control study in a Madagascar cholera outbreak found that patients were more likely than controls to have drunk untreated water, and that drinking heated water, water from a tap, or water treated with SWS was protective.

Malawi

- Swerdlow, D., G. Malenga, et al. (1997). Epidemic cholera among refugees in Malawi, Africa: Treatment and transmission. *Epidemiology and Infection 118: 207-214*. This case-control study of a cholera outbreak in Mozambique found that risk factors for illness included drinking river water and placing hands into stored household drinking water.

Nepal

- Ngai, T., Walewijk, S. (2003) The Arsenic Biosand Filter (ABF) Project: Design of an Appropriate Household Drinking Water Filter for Rural Nepal. Massachusetts Institute of Technology, Department of Civil and Environmental Engineering.

- Rainey, R and Harding, A. (2005). Acceptability of solar disinfection of drinking water treatment in Kathmandu Valley, Nepal. *International Journal of Environmental Health Research. October 2005; 15(5): 361-372.* This research examines the acceptability of solar disinfection of drinking water (SODIS) in a village in Kathmandu Valley, Nepal, using constructs from the Health Belief Model as a framework to identify local understandings of water, sanitation and health issues.

- Rainey, R and Harding, A. (2005). Drinking water quality and solar disinfection: Effectiveness in peri-urban households in Nepal. *Journal of Water and Health. 03: 239-248*. The study examined pH, turbidity and fecal contamination of drinking water from household water storage containers, wells and taps, and the Godawari River, and tested the effectiveness of solar disinfection (SODIS) in reducing levels of fecal contamination from household containers.

Nicaragua

- Lantagne, Daniele, 2001. Investigation of the Potters for Peace Colloidal Silver Impregnated Ceramic Filter. Report 2: Field Investigations. Report prepared for U.S. AID. Washington D.C. November 18, 2001. This investigation documents the effectiveness of the Potters for Peace colloidal silver ceramic filter as installed in users homes.

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Nigeria

- Hutin, Y., Luby, S, et al. (2003). A large outbreak of cholera in Kano City, Nigeria : the importance of hand washing with soap and the danger of street-vended water. *Journal of Water and Health 01.1: 45-52*. This investigation of cholera transmission risk factors in an outbreaks found that cases were more likely than controls to have drunk street-vended water and less likely to have washed hands with soap before eating.

Pakistan

- Jensen PK, Ensink JH, Jayasinghe G, van der Hoek W, Cairncross S, Dalsgaard A (2003). Effect of chlorination of drinking-water on water quality and childhood diarrhoea in a village in Pakistan. *J Health Popul Nutr 21:26-31*. This study found that there was no statistically significant difference between diarrhea in children using non-chlorinated water supply systems and children using chlorinated groundwater water supply systems, and concludes that "reduction of faecal bacteria in the public drinking-water supply by chlorination does not seem to be a priority intervention to reduce childhood diarrhoea.

- Luby, S., M. Agboatwalla, et al. (2004). Delayed effectiveness of home-based interventions in reducing childhood diarrhea, Karachi, Pakistan. *American Journal of Tropical Medicine and Hygiene 71(4): 420-427*. This study documented a 71% reduction of diarrheal disease incidence in SWS users without a refridgerator not immediately, but after 1 year, indicating that houses of lower socio-economic status (as defined by ownership of a refridgerator) needed extra time to adopt the intervention. It also documented a 53% lower incidence of diarrhea in those who received soap initially, with a 35% reduction one year later.

- Luby, S., M. Agboatwall, et al. (2004). Effect of intensive handwashing promotion on childhood diarrhea in high-risk communities in Pakistan; A randomised controlled trial. *JAMA 291(21): 2547-2554*. This randomized, controlled trial found a 53% lower incidence of diarrhea in children washing their hands with soap as compared to control children.

- Luby, S., M. Agboatwalla, et al. (2003). The effect of antibacterial soap on impetigo incidence Karachi, Pakistan. *American Journal of Tropical Medicine and Hygiene 67(4): 430-435*. This study found a 23% reduction (as compared to controls who received placebo soap) and a 43% reduction (as compared to controls) of impetigo in children who used triclocarban-containing soap.

- Luby, S. P., M. Agboatwalla, et al. (2001). Microbiologic effectiveness of handwashing with soap in an urban squatter settlement, Karachi, Pakistan. *Epidemiology and Infection 127: 237-244*. This study found that providing soap and promoting hand washing measurably imporeved mothers' hand cleanliness in terms of bacterial reduction, even when the water used for washing was contaminated.

- Luby, S., M. Agboatwalla, et al. (2001). A low-cost intervention for cleaner drinking water in Karachi, Pakistan." *International Journal of Infectious Diseases 5: 144-150*. This study documented a 99.8% reduction in the mean concentration of thermotolerant coliforms in users of hypochlorite solution and safe storage container as compared to controls. Two years after vessel distribution, 68% of the families were still using the safe storage container.

Peru

- Besser RE, B. Moscoso Rojas, et al. (1995). Prevencion del la transmission del colera: Evaluacion rapida de la calidad del agua municipal en Trujillo, Peru. *Boletin de la Oficina Sanitaria Panamerica 119(3): 189-193*. This study documented variable chlorine levels (0-1.5 mg/L), with 17% of samples with no free chlorine in water associated with the 1991 cholera epidemic. This data supports the promotion of point-of-use water treatment.

- Swerdlow, D. L., E. D. Mintz, et al. (1992). Waterborne transmission of epidemic cholera in Trujillo, Peru: lessons for a continent at risk. *Lancet 340(4): 28-33*. This case-control study of the 1991 cholera outbreak in Trujillo, Peru for that risk factors for illness included drinking unboiled water, drinking water for a household water storage container in which hands had been introduced in the water, and going to a fiesta.

Saudi Arabia

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South Africa

- Gundry, S. et al. (2006). Contamination of drinking water between source and point-of-use in rural households of South Africa and Zimbabwe: implications for monitoring the

Millennium Development Goal for water. (pdf, full-text). *Water Practice and Technology, Sept.*

- Jagals, P. (2006). Does improved access to water supply by rural households enhance the concept of safe water at the point of use? A case study from deep rural South Africa (abstract). *Water Science and Technology. 2006. 54(3): pp 9-16.*

Uganda

- Lule, J.R., J. Mermin, et al. (2005). Effect of home-based water chlorination and safe storage on diarrhea among persons with Human Immunodeficiency Virus in Uganda. *Am J Trop Med Hyg 73(5): 926-933*. This study documented that persons with HIV who use the SWS had 25% fewer diarrhea episodes, 33% fewer days with diarrhea, and less visible blood or mucus in stools than controls. Use of cotrimoxazole prophylaxis in addition to SWS reduced diarrhea episodes by 67%, and days with diarrhea by 54%.

- Shrestha RK, et al. (2006). Cost-effectiveness of home-based chlorination and safe water storage in reducing diarrhea among HIV-affected households in rural Uganda (abstract). *Am J Trop Med Hyg. May;74(5):884-90.*

Uzbekistan

- Semenza JC, Roberts L, Henderson A, Bogan J, Rubin CH (1998). Water distribution system and diarrhoeal disease transmission: a case study in Uzbekistan. *Am J. Trop. Med. Hyg. 59(6): 941-6.* A randomized intervention study was conducted to provide epidemiologic data for water policy decisions in Nukus, Uzbekistan, where drinking water quality is suboptimal.

Zambia

- CDC (2005). Preventing Diarrheal Disease in Developing Countries: The CDC/PSI Safe Water System Program in Zambia. Atlanta, GA.

- CDC (2004). Cholera epidemic associated with raw vegetables- -Lusaka, Zambia, 2003-2004. *Morbidity and Mortality Weekly Report 53(34): 783-786*. This report found that foodborne transmission via raw vegetables was indicated in cholera transmission in Zambia in 2003, and that handwashing with soap was protective against cholera.

- Dubois AE, Sinkala M, Kalluri P, Makasa-Chikoya M, Quick RE. (2006). Epidemic cholera in urban Zambia: hand soap and dried fish as protective factors (abstract). *Epidemiol Infect. Apr 20:1-5.*

- Olembo L, Kaona F, Tuba M, Burnham G (2004). Safe Water Systems: An Evaluation of the Zambia CLORIN Program. U.S. Agency for International Development (USAID) through the Environmental Health Project. This extensive, population-based evaluation found that 42% of people in a random population-based survey reported current use of Clorin (the PSI SWS product) and 13% of the population had chlorine residual in their drinking water at the time of the unannounced visit.

- Quick, R. E., A. Kimura, et al. (2002). Diarrhea prevention through household-level water disinfection and safe storage in Zambia. *American Journal Trop Med 66(5): 584-589*. This study documented a diarrheal disease reduction of 48% in users of the Safe Water System.

- Thevos, A., S. Olsen, et al. (2003). Social marketing and motivational interviewing as community interventions for safe water behaviors: follow-up surveys in Zambia. *Int'l Quarterly of Community Health Education 21(1): 51-65.*

- Thevos, A., R. Quick, et al. (2000). Motivational interviewing enhances the adoption of water disinfection practices in Zambia. *Health Promotion International 15(3): 207-214*.

- Thevos, A. K., F. A. D. Kaona, et al. (2000). Adoption of Safe Water Behaviors in Zambia: Comparing Educational and Motivational Approaches. *Education for Health 13(3): 366-376*. Motivational intervewing appears promising for public health initiatives in the developing world. Further research to improve and refine the method is needed.

Zimbabwe

- Gundry, S. et al. (2006). Contamination of drinking water between source and point-of-use in rural households of South Africa and Zimbabwe: implications for monitoring the Millennium Development Goal for water. (pdf, full-text). *Water Practice and Technology, Sept.*