Woodrow Wilson International Center for Scholars

WATER STORIES: EXPANDING OPPORTUNITIES IN SMALL-SCALE WATER AND SANITATION PROJECTS

Report from the **Navigating Peace Initiative** of the **Environmental Change and Security Program**

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The water in these rusting tanks must last for a week's worth of cooking, washing, and bathing in Iztapalapa, Mexico City.

PREFACE

Ambassador John W. McDonald, Chairman
The Institute for Multi-Track Diplomacy

Understanding the relevance of this book, produced by the Navigating Peace Initiative, requires relating a bit of personal history. At the first inter-governmental world conference on water at Mar del Plata, Argentina in 1977, the represented governments adopted a Plan of Action recommending a large number of national and international actions on water. In 1978, after returning to the State Department after a four-year tour with the International Labor Organization, I read the plan for the first time. Water had fascinated me since my service in the Middle East and I was familiar with water-related problems facing developing countries, especially those suffered by the rural poor.

One recommendation stood out: a call for the United Nations to designate a decade focused solely on the problems of drinking water and sanitation. I decided to make that recommendation a reality. I drafted a UN resolution designed to launch the Water Decade, and over the next 18 months, pushed it until it was adopted by four different UN bodies and, on November 10, 1980, by the entire General Assembly. By 1990, the end of the Decade, the World Health Organization reported that 1.1 billion people received safe drinking water for the first time in their lives and 769 million people gained access to sanitary facilities.

Unfortunately, these impressive figures did not prevent water from falling off government radar screens at the end of the Decade. Little happened for the next 10 years. But finally, in 2000, the UN established the Millennium Development Goals (MDGs). Goal 7 called for reducing by half the number of people in the world without safe water by 2015. At the third world conference on the environment in Johannesburg in 2002, "sanitation" was added to Goal 7.

But how would we reach these lofty goals? I began promoting a second water decade at a meeting at the Wilson Center in early 2002, and drafted a UN Resolution calling for a second UN Water Decade designed to achieve the water MDG by 2015. Finally, with the government of Tajikistan taking the lead, the resolution was adopted by the UN General Assembly in 2003, and scheduled to launch on World Water Day, March 22, 2005.

The United States has now stepped up to the plate. Thanks to the combined efforts of Congressman Earl Blumenauer and Senator Bill Frist, on December 1, 2005, President George W. Bush signed into law the Senator Paul Simon Water for the Poor Act, which directs the secretary of State to develop a detailed strategy for integrating water and sanitation programs into U.S. foreign policy. The law also calls upon the United States to fulfill its commitment to Goal 7—the first time that a MDG has been adopted as part of U.S. law. This landmark bipartisan legislation puts the United States on the front lines of the fight to bring clean water and sanitation to those without it.

But high-level political attention alone will not be enough to meet this goal. The Navigating Peace Initiative, in the series of papers gathered here, calls not only for global action at the highest levels, but also at the lowest: By reporting and evaluating small-scale opportunities to expand water and sanitation, the authors show that we will not win this fight without unglamorous but effective solutions like ceramic filters and pit latrines. All of these efforts demonstrate that the United States is taking a global—as well as a local—leadership role in addressing one of the most critical issues the world is currently facing.

INTRODUCTION: WATER STORIES

By Alicia Hope Herron and Geoffrey Dabelko

Not surprisingly, the word "water" is found in every language in the world (UNESCO, 2006).[1] But water often denotes more than the substance we drink to survive. For example, the Setswana word for rain—pula—is also the name of Botswanan currency; and significantly, it is invoked after every tribal or political address (Turton, 2003; Hitchcock, 2000).

It would take millions of *pulas* to measure the cost to human health from lack of access to clean water and sanitation, for water—while necessary for life—can also be a vector for disease and death. Water sources contaminated by sewage can transmit preventable waterborne diseases such as cholera, typhoid, diarrhea, and gastroenteritis. Ninety percent of the wastewater in the developing world is released untreated into local watersheds, and more than 3 million people per year—mostly children—are killed by such diseases (OECD, 2003a). In severely affected countries, water-related diseases kill 1 in 5 children before the age of five (WEHAB Working Group, 2002).

The link between clean water and proper sanitation has been widely acknowledged at both the national and international level. The provision of fresh water is vital to meeting basic human needs and should be at the heart of any sustainable development initiative. Unfortunately, efforts to provide these basic services in the developing world are blocked by large funding gaps and often mired in debates over governance, privatization, and large infrastructure projects. However, small-scale and community-based solutions—the focus of this publication—can help bridge these gaps and move beyond the debates.

The Woodrow Wilson Center's Navigating Peace Initiative, funded by the Carnegie Corporation of New York, brings together experts and practitioners to reframe stale debates and generate fresh thinking on critical water problems. The papers collected here seek to shed light on the challenges of improving access to safe water and sanitation, as well as the possibilities afforded by innovation and cooperation. The initiative thus hopes to contribute to the ongoing discussion by examining alternatives to large-scale infrastructure projects in the water and sanitation sectors, including NGO and community-based water and sanitation efforts, and exploring how lessons learned from small-scale projects can be effectively communicated worldwide.

GROWING DIVIDE

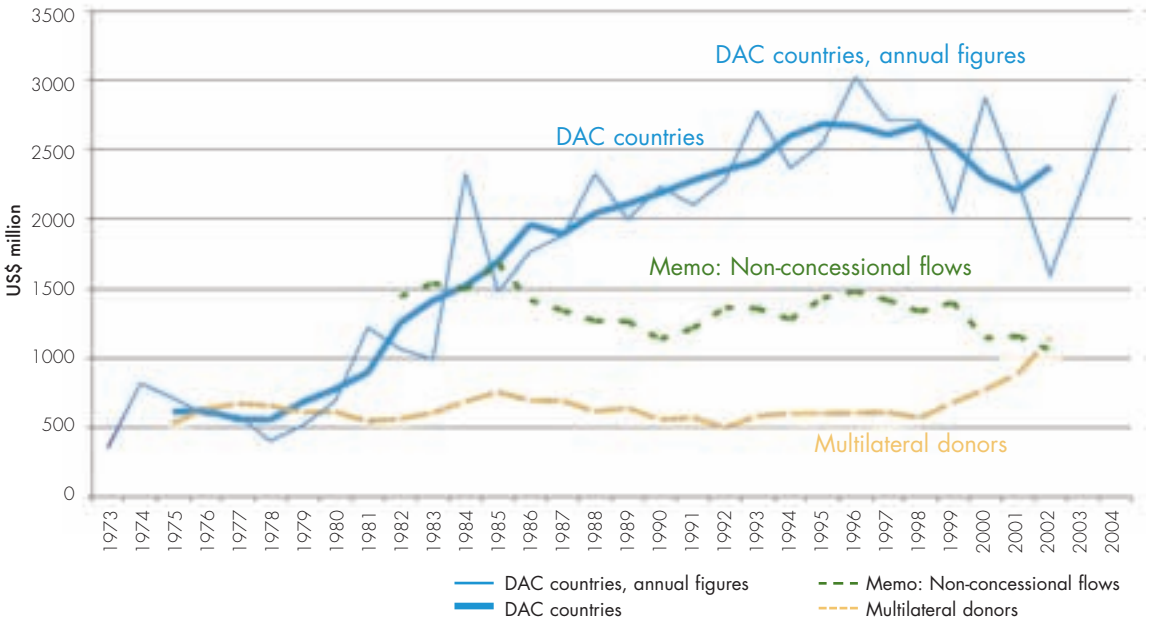
The gravity of the threats posed by lack of access to water and sanitation is revealed by the latest figures of the Joint Monitoring Program of the World Health Organization (WHO) and UNICEF: More than one billion people lack access to fresh water, equal to 17 percent of the

1. For examples, see http://www.unesco.org/water/wwd2006/world_views/water_language.shtml

global population (WHO/UNICEF, 2005).[2] Even more people lack access to sanitation: 2.6 billion people, or 42 percent of the population. In sub-Saharan Africa alone, 42 percent of the population lacks improved water sources and only 36 percent have sanitation services.

This divide is set to drastically increase as the world's water demand doubles every 20 years as the population burgeons (Revenga, 2000). By 2025, 48 percent of the world's projected population will live in water-stressed river basins. Water scarcity and lack of sanitation loom not only as imminent challenges for the countries that lack fresh water or the infrastructure necessary to treat water and sewage, but also as potential sources of conflict. Recognizing these threats, the world community

FIGURE 1: TRENDS IN OFFICIAL DEVELOPMENT ASSISTANCE FOR WATER SUPPLY AND SANITATION FIVE-YEAR MOVING AVERAGE FROM 1973–2004 (Measured in constant 2003 prices)



Note: The Development Assistance Committee (DAC) is the principal body through which the OECD studies issues related to cooperation with developing countries.

Source: OECD (2006) [3]

2. Coverage rate figures were obtained by the Joint Monitoring Programme using an assessment questionnaire, which defined access to water supply and sanitation in terms of the types of technology and levels of service provided. Summary statistics can be found online at http://www.unesco.org/water/wwap/facts_figures/basic_needs. shtml

3. Figure available online at http://www.oecdobserver.org/images//1806.photo.jpg; statistics available at http://www.oecd.org/dataoecd/50/17/5037721.htm

has agreed on three different occasions to set and meet goals to improve water and sanitation: during the first International Drinking Water Supply and Sanitation Decade (1980–1990); the Monterrey Consensus (2002); and the "Water for Life" Decade (2005–2015). This consensus offers an unprecedented opportunity to hold governments accountable to meeting these goals.

The effort to recognize access to fresh water as a basic human right has also gained significant traction. The NGO IUCN notes that there "have been both expressed and implied references to a right to water in public international law," despite the fact that there is no formal recognition of such a right (Scanlon et al., 2000). The International Covenant on Economic, Social and Cultural Rights declared water not only an economic good but also a social and cultural one (ECOSOC, 2002).

Water plays an important role in poverty alleviation and gender equality. According to a report released by Stockholm International Water Institute and the WHO (2005), access to improved water and sanitation increased developing countries' average annual GDP growth rates to 3.7 percent, compared to 0.1 percent for countries without such access. Gender equality has also been directly linked to the availability of adequate supply of fresh water. In many communities, women are the central users or gatherers of water, and also care for children sickened by water-related illness.

CURRENT FUNDING FLOWS = MISSED TARGETS

There are several disturbing trends in aid flows, despite the high level of attention that water and sanitation have received at the international level and an apparent increase in Official Development Assistance (ODA) to the sector (see Figure 1).

After declining in the 1990s, ODA rose to record levels in 2004. However, the increase since 2002 is largely due to debt reduction and rescheduling, and the large jump from 2003–2004 is principally U.S. aid to water projects in Iraq (Clermont, 2006). On the other hand, the 2002 Monterrey commitment by the international community to contribute 0.7 percent of GNP to ODA, and the 2005 Gleneagles Summit commitment to double ODA, offer hope that giving will continue to rise.

Two other disturbing trends in aid flows must be considered: First, most of the aid is going to a handful of middle-income countries; and second, the bulk of the funding is allocated to major infrastructure projects.

Of the total aid in 2000–2001, only 12 percent was given to countries where less than 60 percent of the population had access to an improved water source (OECD, 2003b). Figure 2 illustrates a further concentration in aid: 53 percent of the total is received by 10 countries. According to the World Water Council, allocation is dependent on "the demographic weight of the country…the economic and political stability of the country [and]…its geostrategic visibility" (Clermont, 2006, page 7). Areas with some of the greatest need, such as sub-Saharan Africa, remain on the losing end.

Figure 3 demonstrates the second trend. The vast majority of aid for water and sanitation funds large infrastructure projects, which exacerbates the rural-urban divide: 80 percent of people without access to sanitation live in rural areas, and roughly one-third of rural residents lack access to improved drinking water sources (UNESCO-WWAP, 2003).

Estimates of the investment necessary to achieve the Millennium Development Goal (MDG) to reduce by half the proportion of

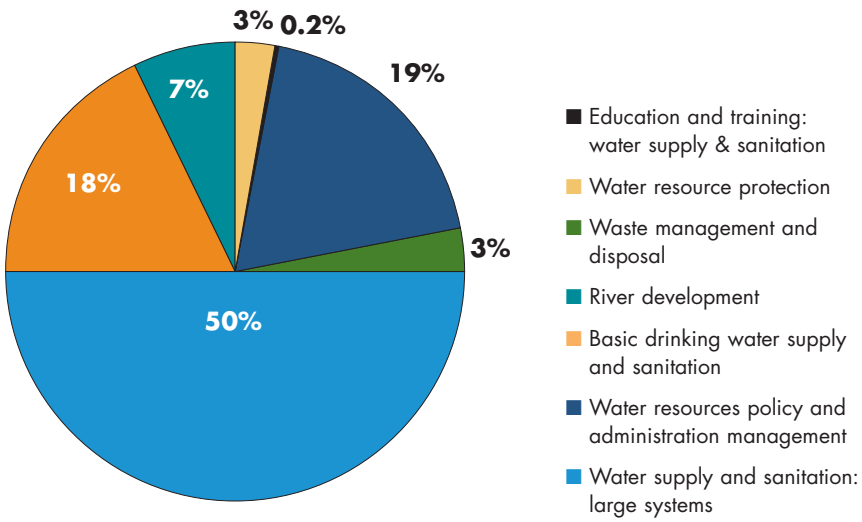
FIGURE 2: MAIN DONORS AND RECIPIENTS OF BILATERAL OFFICIAL DEVELOPMENT ASSISTANCE (ODA) TO WATER SUPPLY AND SANITATION, 2000–2004

(Annual Average Commitments in US$ Million, Constant 2003 Prices)

	Japan	Germany	United States	France	Netherlands	Other DAC Donors	Total DAC Countries
China	222	5	1	6	4	37	275
Iraq	0	1	170	-	0	10	181
Vietnam	52	10	0	17	7	30	117
Palestinian Adm. Areas	2	23	72	5	1	9	113
India	39	8	2	3	18	32	102
Jordan	6	24	45	-	0	12	87
Malaysia	90	-	-	-	-	1	81
Morocco	24	26	2	16	0	7	75
Peru	55	11	0		1	6	74
Tunisia	28	12	-	26	-	1	68
Other recipients	326	254	52	100	93	420	1245
Total	**835**	**376**	**344**	**173**	**124**	**567**	**2417**

Source: OECD (2006) [5]

FIGURE 3: BREAKDOWN OF ODA FOR WATER BY PROJECT TYPE, 1990–2004



Source: OECD (2006) [6]

5. Figure available online at http://www.oecdobserver.org/images//1806.photo.jpg
6. Data available online at http://www.oecd.org/dataoecd/3/29/36253954.xls

people without sustainable access to safe water and sanitation vary from US$9 billion to US$30 billion (Toubkiss, 2006). A comparative analysis prepared by the World Water Council in preparation for the 4th World Water Forum found that the estimates are actually quite similar if analyzed on comparable bases,[4] and that current investment must be roughly doubled to reach the MDG target (Toubkiss, 2006). Reaching the sanitation target will require 2–5 times the expenditure necessary to meet the water targets (Toubkiss, 2006). In addition, 48 percent of the world's projected population growth is expected to occur in areas already experiencing, or expected to experience, water stress, raising the stakes even higher (Revenga, 2000). Within the last few years, donors and NGOs have begun to explore options that will stretch their funding further, and many argue that low-cost, community-based approaches should play a larger role in efforts to meet the MDG.

EXPANDING OPPORTUNITIES FOR SMALL-SCALE WATER AND SANITATION

Given the magnitude of the problem and the disturbing aid trends, we must re-evaluate traditional approaches. "Financing Water and Environmental Infrastructure for All," a background paper prepared for the Commission on Sustainable Development, states that "the most successful programs are those that respond to local demand, with heavy local participation, using low-cost local technology, and without any public subsidy" (OECD Global Forum on Sustainable Development, 2004, page 16).

Water Stories: Expanding Opportunities in Small-Scale Water and Sanitation Projects seeks to move past technical "hardware" evaluations by incorporating "software" issues. To ensure the effectiveness and sustainability of water and sanitation projects, the users must support them. Project designers thus must understand how culture and gender issues affect demand and acceptance by the community. As John Oldfield notes in his chapter, "breakthrough practices in [the water and sanitation sector] are rarely new technological solutions," but are instead those that innovatively and cooperatively apply current technology to meet local needs. Beginning with J. Carl Ganter's photo essay, this publication focuses on this nexus of hardware choices and software understanding, along with a look at the media channels that frame the larger debate.

In "Household Water Treatment and Safe Storage Options in Developing Countries: A Review of Current Implementation Practices," Daniele S. Lantagne, Robert Quick, and Eric D. Mintz summarize five of the most common household water treatment and safe storage (HWTS) options—chlorination, filtration (biosand and ceramic), solar disinfection, combined filtration/chlorination, and combined flocculation/chlorination—and describe implementation strategies for each. They identify implementing organizations and the successes, challenges, and obstacles projects have encountered. They also consider sources of funding and the potential for large-scale distribution and sustainability of each option, and propose future research and implementation goals. They find that "HWTS systems are proven, low-cost interventions that have the potential to

4. Reasons include different assessment scopes, understandings of infrastructure and level of service, and calculation methods (Toubkis, 2006).

provide safe water to those who will not have access to safe water sources in the near term, and thus significantly reduce morbidity due to waterborne diseases and improve the quality of life."

John Oldfield provides a ground-level review of small-scale and rural projects in his chapter, "Community-Based Approaches to Water and Sanitation: A Survey of Best, Worst, and Emerging Practices." Through a combination of research and interviews with leaders from selected NGOs in the water sector—including WaterPartners International, Water For People, WaterAid, Living Water International, CARE, and the Hilton Foundation—Oldfield finds that while community-based small-scale solutions can work well, the most successful projects focus not just on supplying water, but also on sanitation and hygiene, which often are more immediate causes of death or illness. He concludes that "water projects are rarely simple. They are, however, eminently *doable*."

Alicia Hope Herron also stresses the need for a holistic approach to water and sanitation in "Low-Cost Sanitation: An Overview of Available Methods," which presents several options—pit latrines, dehydration systems, pour flush latrines, aquaprivies, and septic tanks—and examines whether these methods are cost-effective, sustainable, and likely to be accepted by users. With sanitation—even more so than water supply—determining which option will be most effective requires weighing a complex set of variables ranging from culture and cost to geology and climate. Not only are these considerations important for efficacy and sustainability, but the lack of consideration of one variable in sanitation planning has the potential to cause serious damage to community health, exacerbating rather than ameliorating an already dangerous situation.

Given the centrality of water to the human condition, why does water fail to rally a forceful, sustained response by the collective global consciousness? It is not the absence of solutions, or even the lack of opportunities—it is a lack of political will. J. Carl Ganter argues that the political will to recognize and address the expanding global freshwater crisis cannot come from random efforts to increase awareness, but from "transcending moments" that create movements. "Navigating the Mainstream: The Challenge of Making Water Issues Matter" argues for a new paradigm for social change—one that recognizes the needs and unites the strengths of citizens, leaders, NGOs, and especially the news media. This approach requires emphasizing relevance, creating or identifying major events, involving varied talents and disciplines, developing new uses of proven techniques, and pioneering communications and information tools.

One old-fashioned but proven way to make water issues meaningful to people is by telling good stories, ones that make the issues personal and relevant, and connect humanity through the simple dramas of life, faith, and culture. The "Water Stories" multimedia website (http://www.wilsoncenter.org/waterstories), also developed by the Navigating Peace Initiative, tells those stories through audio and video presentations of the people living and working in water-stressed communities in Mexico.

Providing clean water and sanitation is a truly monumental challenge and must be addressed from a multitude of angles. *Water Stories* focuses on innovative ways to incorporate a community's needs and demands—the "software" issues—and argues that these opportunities have the best chance of success. However, as Barbara Schreiner (2001), chief director of the Department of Water

Affairs and Forestry of South Africa, observes, "it is an unfortunate aspect of the nature of water that it flows toward power," and therefore the power to make decisions about water and sanitation rarely trickles down to those most in need. This publication hopes to redirect this flow by demonstrating that decisions made by the least powerful can be the most effective. The spectrum of water and sanitation projects is broad enough to allow innovative techniques and collaboration to flourish. By expanding the opportunities for small-scale projects to reach communities in need, we could potentially save some of the 3 million people lost each year to waterborne disease, and help restore water to its rightful place as the giver—not taker—of life.

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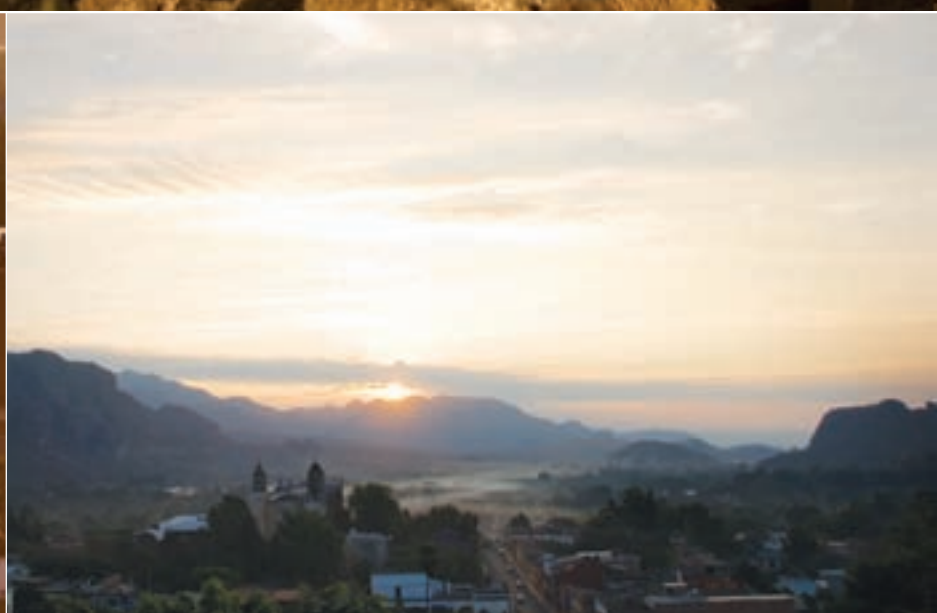
Water Stories Photo Essay

Real people exist behind every statistic and chart. What does the global freshwater crisis look like? There are families like the Silvas, who live without access to an adequate supply of freshwater in a Mexico City barrio, and are just one family among the one-third of the world's population for whom safe water is scarce. And there are people like Ron Sawyer, faces of change and hope—people who provide basic, sustainable technology home by home, person by person, school by school.

Presented here are photo essays by journalist J. Carl Ganter, a member of the Navigating Peace working group, that chronicle water and sanitation endeavors in three resource-strapped regions of Mexico: Tepoztlán, Valle de Bravo, and Mexico City. The images provide a vivid glimpse of the lives behind the columns of numbing statistics. They remind us of the real families worldwide who can benefit so profoundly from the simple, available, and effective solutions discussed in *Water Stories*.

photo credits:©2006 J. Carl Ganter/Circleofblue.org



Dry Sanitation

Tepoztlán, Mexico—Stunning sunrises, picturesque mountains, and bustling markets belie the underlying water and sanitation challenges in this popular tourist destination south of Mexico City. In the small villages like San Juan Tlacotenco that tuck into the surrounding mountains, disposal of human waste is a serious problem: outhouses and leaking sewer pipes contaminate the region's groundwater through the porous rock.

Ron Sawyer, the matter-of-fact director of the Mexican nonprofit Sarar Transformación, is working to clean up the sanitation problem in Tepoztlán, by promoting nontraditional options that do not require significant flows of water to operate. Dry, water-less ecological toilets separate waste streams into useable byproducts, capturing urine for fertilizer while directing solid waste into a separate container for compost treatment.

"The dream," Sawyer says, "is that we can have a town where there are mixed systems that will include the water-based sewage system for the downtown area, but will have a set of concentric circles with different levels of services for different parts of the population, depending on the physical areas, and depending on their social and cultural preferences, and their economic possibilities."

PHOTOS (clockwise from top):
A dry sanitation building near the village of San Juan Tlacotenco with separate urine and solid waste collection systems.

Ron Sawyer, director of Sarar Transformación, a nonprofit organization in Tepoztlán, Mexico, that focuses on affordable dry sanitation options.

Morning on the streets of Tepoztlán, a popular tourist destination outside Mexico City.

photo credits:©2006 J. Carl Ganter/Circleofblue.org

Valle de Bravo

Valle de Bravo, Mexico—Like giant sentries, white pumping towers dot the horizon between Valle de Bravo and Mexico City. The Cutzamala water system, a complex web of massive concrete and steel pipes, stretches for miles to connect dams and spring water to the world's second largest metropolis, Mexico City. Indigenous communities in the Valle de Bravo region are concerned about the large amounts of water being diverted to meet the city's demands.

Valle de Bravo is a popular weekend retreat for Mexico City's upper class and home to the world-renowned winter nesting grounds for monarch butterflies.

PHOTOS (clockwise from top):
Feeding hand-tended irrigation trenches, water flows plentifully from the ground, often from clear springs that are eventually captured by the Cutzamala system to sate Mexico City's thirst.

The giant pumping towers of the Cutzamala system force water from Valle de Bravo's manmade Lake Avándaro up and over the mountains toward Mexico City.

Hundreds of years old, a small fish farm provides protein for villagers using the cold headwaters above Valle de Bravo.

photo credits:©2006 J. Carl Ganter/Circleofblue.org

Batallones Rojos

Mexico City—As the sky brightens over the Batallones Rojos apartments in the Iztapalapa district of Mexico City, Rogelio Gonzalez turns a giant blue valve, releasing a rush of water to the apartment buildings across the street, home to 1,500 working-class people.

The residents have to hurry their morning washing and cooking tasks, though. Gonzalez will turn off the water two hours later, just before the giant reservoir tank above him runs dry. Engineers say there isn't enough water in the Iztapalapa system to supply this and many other Mexico City neighborhoods with enough water.

PHOTOS (near right, top to bottom):
Water tankers proliferate throughout Mexico City, especially in Iztapalapa, where water demand exceeds the supply provided by the municipal underground infrastructure.

Rogelio Gonzalez manages this pumping and reservoir station that supplies water—for only two hours each day—to the 1,500 residents of the Batallones Rojos apartment complex.

Children play in the parking lot of the Batallones Rojos apartment buildings.

photo credits:©2006 J. Carl Ganter/Circleofblue.org

San Miguel

Iztapalapa, Mexico City—In Colonia San Miguel, water trickles from the small plastic pipe for only an hour each week in the Silva family's austere home. This is enough water to fill three rusting tanks with about 200 gallons for bathing, washing clothes, and flushing the toilet. But the water is not safe to drink and the family, like many here, buys water from vendors who travel daily throughout the neighborhoods yelling, "Water for sale!"

PHOTOS (near left, top to bottom):
The family's makeshift kitchen overlooks the sprawling metropolis of Mexico City.

The Silva family stands outside their makeshift home in the Iztapalapa district of Mexico City.

A young boy plays soccer in the streets outside the Silva family's house in Colonia San Miguel.

Jemima Odo of Nyanza, Kenya, demonstrates PūR sachet
(courtesy of Greg Allgood)

HOUSEHOLD WATER TREATMENT AND SAFE STORAGE OPTIONS IN DEVELOPING COUNTRIES: A REVIEW OF CURRENT IMPLEMENTATION PRACTICES

By Daniele S. Lantagne, Robert Quick, and Eric D. Mintz

The United Nations' International Drinking Water Supply and Sanitation Decade (1981–1990) failed to achieve its goal of universal access to safe drinking water and sanitation by 1990 (World Health Organization [WHO], 2003). Even though service levels rose by more than 10 percent during the decade, 1.1 billion people still lacked access to improved water supplies, and 2.4 billion people were without adequate sanitation, in 1990 (WHO/UNICEF, 2000). Reasons cited for the decade's failure include population growth, funding limitations, inadequate operation and maintenance, and continuation of a traditional "business as usual" approach (WHO/UNICEF, 1992).

The world is on schedule to meet the Millennium Development Goal (MDG), adopted by the UN General Assembly in 2000 and revised after the World Summit on Sustainable Development in Johannesburg, to "halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation" (World Bank Group, 2004; WHO/ UNICEF, 2004). However, success still leaves more than 600 million people without access to safe water in 2015 (WHO/ UNICEF, 2000). In addition, although the MDG target specifically states the provision of "safe" drinking water, the metric used to assess the MDG target is the provision of water from "improved" sources, such as boreholes or household connections, as it is difficult to assess whether water is safe at the household level (WHO/UNICEF, 2004). Thus, many more people than estimated may drink unsafe water from improved sources.

HOUSEHOLD WATER TREATMENT AND SAFE STORAGE

To overcome the difficulties in providing safe water and sanitation to those who lack it, we need to move away from "business as usual" and research novel interventions and effective implementation strategies that can increase the adoption of technologies and improve prospects for sustainability. Despite general support for water supply and sanitation, the most appropriate and effective interventions in developing countries are subject to significant debate. The weak links among the water, health, and financial sectors could be improved by communication programs emphasizing health[1]—as well as micro- and macroeconomic—benefits that could be gained.

1. The health consequences of inadequate water and sanitation services include an estimated 4 billion cases of diarrhea and 2.2 million deaths each year, mostly among young children in developing countries (WHO/UNICEF, 2000). In addition, waterborne diarrheal diseases lead to decreased food intake and nutrient absorption, malnutrition, reduced resistance to infection (Baqui et al., 1993), and impaired physical growth and cognitive development (Guerrant et al., 1999).

The new focus on novel interventions has led researchers to re-evaluate the dominant paradigm that has guided water and sanitation activities since the 1980s. A literature review of 144 studies by Esrey et al. (1991) represents the old paradigm, concluding that sanitation and hygiene education yield greater reductions in diarrheal disease (36 percent and 33 percent, respectively) than water supply or water quality interventions.[2] However, a more recent meta-analysis commissioned by the World Bank contradicted these findings, showing that hygiene education and water quality improvements are more effective at reducing the incidence of diarrheal disease (42 percent and 39 percent, respectively) than sanitation provision and water supply (24 percent and 23 percent, respectively) (Fewtrell & Colford, 2004).

The discrepancy between these findings can be attributed in part to a difference in intervention methodology. Esrey et al. (1991) reviewed studies that largely measured the impact of water quality improvements at the source (i.e., the wellhead or community tap). Since 1996, a large body of published work has examined the health impact of interventions that improve water quality at the point of use through household water treatment and safe storage (HWTS; Fewtrell & Colford, 2004). These recent studies—many of them randomized controlled intervention trials—have highlighted the role of drinking water contamination during collection, transport, and storage (Clasen & Bastable, 2003), and the health value of effective HWTS (Clasen et al., 2004; Quick et al., 1999, 2002; Conroy et al., 1999, 2001; Reller et al., 2003).

In 2003, as the evidence for the health benefits of HWTS methods grew, institutions from academia, government, NGOs, and the private sector formed the International Network to Promote Household Water Treatment and Safe Storage, housed at the World Health Organization in Geneva, Switzerland. Its stated goal is "to contribute to a significant reduction in waterborne disease, especially among vulnerable populations, by promoting household water treatment and safe storage as a key component of water, sanitation, and hygiene programmes" (WHO, 2005).

HWTS OPTIONS

This article summarizes five of the most common HWTS options—chlorination, filtration (biosand and ceramic), solar disinfection, combined filtration/chlorination, and combined flocculation/chlorination—and describes implementation strategies for each option.[3] We identify implementing organizations and the successes, challenges, and obstacles they have encountered in their projects. We consider sources of funding and the potential to distribute and sustain each option on a large scale, and propose goals for future research and implementation.

This article focuses on point-of-use drinking water treatment and safe storage options, which can accelerate the health gains associated with improved water until the longer-term goal of universal access to piped, treated water is achieved. By preventing disease, HWTS practices can contribute to poverty

2. This study reinforced previous work (Esrey, 1985) that led the water and sanitation sector to de-emphasize improving water quality as a way to reduce diarrheal disease incidence.

3. Space precludes exhaustive consideration of all HWTS options, and thus we have chosen those that are most widely used. For a thorough technical review of all HWTS options, see *Managing Water in the Home: Accelerated Health Gains From Improved Water Supply* (Sobsey, 2002). For reviews of safe storage options, see Mintz et al. (1995, 2001).

alleviation and development. Their widespread use, in conjunction with hygiene education and sanitation, could save millions of lives until the infrastructure to reliably deliver safe water to the entire world population has been created.

We use a consistent evaluation scheme for each of the HWTS options discussed (see Table 1):

1. Does the HWTS option remove or inactivate viral, bacterial, and parasitic pathogens in water in a laboratory setting?;
2. In the field, is the HWTS option acceptable, can it be used correctly, and does it reduce disease among users?; and
3. Is the HWTS option feasible at a large scale?

OPTION 1: CHLORINATION

Chlorination was first used to disinfect public water supplies in the early 1900s, and helped drastically reduce waterborne disease in cities in Europe and the United States (Gordon et al., 1987). Although there had been small trials of point-of-use chlorination (Mintz et al., 1995), larger-scale trials began in the 1990s as part of the Pan American Health Organization (PAHO) and the U.S. Centers for Disease Control and Prevention (CDC) response to epidemic cholera in Latin America (Tauxe, 1995). The Safe Water System (SWS) strategy devised by CDC and PAHO includes three elements:

TABLE 1: SUMMARY OF HWTS OPTION PERFORMANCE CRITERIA

Criterion	Lab Studies				Field Studies		Can intervention be brought to scale?
HWTS Option	Virus	Bacteria	Protozoa	Residual Protection?	Acceptable to users?	Health impact?	
Chlorination	Medium	High	Low	Chlorine	Yes	Yes (4 studies)	Yes (operates at village and national scale)
BioSand Filtration	Unknown	Medium-High	High	No	Yes	Unknown	Unknown (operates at village and regional scale)
Ceramic Filtration	Unknown	Medium-High	High	No	Yes	Yes (1 study with imported filters)	Unknown (operates at village and regional scale)
Solar Disinfection	High	High	High	Safe Storage	Yes	Yes (4 studies)	Unknown (operates at village and regional scale)
Filtration and Chlorination	Medium	High	Unknown	Chlorine	Yes	Yes (1 unpublished cross-sectional study)	Unknown (operates at village and regional scale)
Flocculation and Chlorination	High	High	High	Chlorine	Yes	Yes (5 studies)	Yes (operates at village and national scale)

- Treating water with dilute sodium hypochlorite[4] at the point of use;
- Storing water in a safe container; and
- Educating users to improve hygiene, as well as water- and food-handling practices.

The sodium hypochlorite solution is packaged in a bottle with directions instructing users to add one full bottle cap of the solution to clear water (or two caps to turbid water) in a standard-sized storage container, agitate, and wait 30 minutes before drinking. In four randomized controlled trials, the SWS reduced the risk of diarrheal disease by 44–84 percent (Luby et al., 2004; Quick et al., 1999, 2002; Semenza et al., 1998). At concentrations used in HWTS programs, chlorine effectively inactivates bacteria and some viruses (American Water Works Association, 1999); however, it is not effective at inactivating some protozoa, such as cryptosporidium.[5] Initial research shows water treated with the SWS does not exceed WHO guidelines for disinfection by-products, which are potentially cancer-causing agents (CDC, unpublished data). Because the concentration of the chlorine solution used in SWS programs is low, the environmental impacts of the solution are minimal.

Chlorination: Implementation Strategies

SWS implementation has varied according to local partnerships and underlying social and economic conditions. The disinfectant solution has been distributed at national and subnational levels in 13 countries through social marketing campaigns, in partnership with the NGO **Population Services International** (PSI). In Indonesia, the solution is distributed primarily by private sector efforts, led by a local manufacturing company. In several countries—including Ecuador, Laos, Haiti, and Nepal—the ministries of health or local NGOs run the SWS programs at the community level. In Kabul, Afghanistan, the SWS is provided at no charge to pregnant women receiving antenatal care. The SWS has also been distributed free of charge in a number of disaster areas, including Indonesia, India, and Myanmar following the 2004 tsunami, and also in Kenya, Bolivia, Haiti, Indonesia, and Madagascar after other natural disasters. When SWS programs are in place, the product's ready availability greatly facilitates emergency response. The CDC has developed an implementation manual and provides technical assistance to organizations implementing SWS projects (CDC, 2001).

PSI's Social Marketing of the SWS in Zambia

PSI is the largest social marketing NGO in the world, with offices in more than 70 countries. PSI designs a brand name and logo for health products; sells them at low prices; distributes them through wholesale and retail commercial networks; and generates demand for the products through behavior change communications such as radio and TV spots, mobile video units, point-of-sale materials, theater performances, and person-to-person communications.

4. Sodium hypochlorite (NaOCI) is a slightly yellow, transparent liquid. As a chlorine donor, it serves as a strong oxidizer, bleaching agent, and sterilizer.
5. Microscopic parasites of the genus Cryptosporidium cause a diarrheal disease called cryptosporidiosis. Once an animal or person is infected, the parasite lives in the intestine and passes in the stool. The parasite is protected by an outer shell that allows it to survive outside the body for long periods of time and makes it very resistant to chlorine-based disinfectants.

Safe Water System reseller in Jolivert, Haiti
(courtesy of Daniele Lantagne)

In October 1998, PSI launched its Zambian SWS product, a bottle of sodium hypochlorite solution branded as "Clorin." This program is one of the oldest PSI/CDC collaborations. Sales steadily increased from 732 bottles per month in October 1998 to 132,000 bottles per month in November 2003. A cholera epidemic in 1999 increased demand for Clorin; sustained social marketing and promotion in health centers and door-to-door visits stimulated further sales (Olembo et al., 2004). A population-based, cross-sectional study conducted by an independent agency reported that 42 percent of households said they were currently using Clorin, and 22 percent reported using it in the past (Olembo et al., 2004). However, only 13 percent of households had residual chlorine in their water at the time of the unannounced visit, indicating a discrepancy between reported and actual use. The study did not find a lower rate of reported diarrhea among users of Clorin as compared to non-users. However, using large cross-sectional studies to assess the efficacy of household water treatment options requires further refinement. The limitations of this study, which was the first large cross-sectional population study (as opposed to a randomized study with a controlled population), impacted the results.

The Clorin product is subsidized by USAID; the full cost of the 250-milliliter bottle—including production, marketing, distribution, and overhead—is US$0.34, and the retail price is set at US$0.12. The total program cost per person-month of protection from diarrhea is US$0.045 (CDC, unpublished data). Increasing the price to recover full costs could have a negative impact on demand, particularly in a country like Zambia, which ranks 164th out of 177 on the Human Development Index (UN Development Programme, 2004). The program needs studies of the price elasticity of demand for this product, and is currently implementing options to significantly lower costs.

PSI's Zambia project is an example of a successful social marketing intervention that creates demand for a product and makes it widely available through the commercial sector. Interested NGOs can readily incorporate Clorin into their own programming. The two major challenges this program faces are achieving financial self-sufficiency while maintaining access to the product, and increasing demand among the highest-risk populations. With its wide Clorin use and distribution, Zambia is an ideal location for future research on program effectiveness in disease prevention, cost-effectiveness, and interventions to reduce economic and behavioral barriers to utilization.

Community-Based NGO Program in Northern Haiti

In contrast to PSI's national-scale approach, the **Jolivert Safe Water for Families Project** (JSWF) produces its own disinfectant, "Dlo Pwòp," at the Missions of Love Clinic in Jolivert, Haiti, for distribution in nearby communities. The JSWF Project installed a hypochlorite generator—a simple device that passes electric current through water and salt to generate hypochlorite—and trained two Haitian technicians to produce the disinfectant, sell it to families, provide educational support, and test for residual chlorine in users' household water. Small-scale local production and distribution has ensured a continuous supply of disinfectant to families in spite of natural disasters and political upheavals.

JSWF spends about US$7 to provide a bucket with a lid and spigot for safe storage, as well as

educational materials, for a family in the program. After that initial investment, disinfectant sales almost meet operating expenses. One month's supply of the disinfectant sells for US$0.09, which is within the budget of most Haitian families. The project uses refillable bottles to reduce the cost of the disinfectant. JSWF began in September 2002 with 200 families; an independent evaluation four months later documented a reduction in diarrheal disease incidence of 55 percent (Brin, 2003). However, the data were from a cross-sectional survey, which is not as reliable for determining diarrheal disease outcomes as randomized, controlled, cohort studies. JSWF has expanded to more remote areas by transporting bulk disinfectant and distributing it through satellite refilling stations. Currently, the program distributes about 1,000 bottles of solution per month to approximately 1,200 participating families (7,200 people).

This type of program reaches rural populations in ways that are culturally appropriate and more cost-effective than many other programs. In addition, this program has created demand in surrounding communities via word-of-mouth advertising. The main drawbacks are the dependence on the hypochlorite generator and on outside programmatic support to enroll new families.

Chlorination: Benefits and Drawbacks of the SWS

The benefits of point-of-use chlorination include:

- Proven reduction of bacteria and most viruses;
- Residual protection against contamination;
- Ease of use and thus acceptability to users;
- Proven health impact in multiple randomized, controlled studies;
- Scalability; and
- Low cost.

The drawbacks include:

- Relatively low protection against some viruses and parasites;
- Lower effectiveness in water contaminated with organic and certain inorganic compounds;
- Potential objections to taste and odor; and
- Concerns about the potential long-term carcinogenic effects of chlorination by-products.

OPTION 2: FILTRATION

Porous stones and a variety of other natural materials have been used to filter visible contaminants from water for hundreds of years. These mechanical filters are an attractive option for household treatment because:

- There are many locally available and inexpensive options for filtering water;
- They are simple and easy to use; and
- Such filter media are potentially long-lived.

However, filtration is the least-studied HWTS intervention; and pathogen removal, filter maintenance, and the lack of residual protection pose challenges to implementation.

A recent health impact study in Bolivia documented a 64 percent reduction in diarrhea in users of 0.2 micron ceramic candle-shaped filters manufactured in Switzerland (Clasen et al., 2004).[6] Users prevented recontamination by using a tight-fitting lid over the receptacle, a tight seal

6. Most currently used filtration options are locally manufactured.

to prevent leaking around the filters into the receptacle, and a spigot to access the water. In addition, users can clean the filters without removing them and potentially exposing the water in the receptacle to contaminants.

OPTION 2A: BIOSAND FILTRATION

The BioSand Filter (BSF) is a slow-sand filter adapted for use in the home. The most widely used version of the BSF is a concrete container approximately 0.9 meters tall and 0.3 meters square, filled with sand. The water level is maintained at 5–6 centimeters above the sand layer by setting the height of the outlet pipe. This shallow water layer allows a bioactive layer to grow on top of the sand, which helps reduce disease-causing organisms. A plate with holes in it is placed on the top of the sand to prevent disruption of the bioactive layer when water is added to the system. To use the system, users simply pour water into the BSF, and collect finished water from the outlet pipe in a bucket. In laboratory and field testing, the BSF consistently reduces bacteria, on average, by 81–100 percent (Kaiser et al., 2002) and protozoa by 99.98–100 percent (Palmateer et al., 1999). Initial research has shown that the BSF removes less than 90 percent of indicator viruses (Mark Sobsey, personal communication, March 20, 2005).

BioSand Filtration: Implementation Strategies

The BSF has been implemented through two main strategies. In the NGO model, employed in Cambodia and other countries, the cost of the filters is subsidized, and a NGO promotes the use of the BSF in the community and provides the filters. In the micro-entrepreneur model, used in Kenya and the Dominican Republic, local entrepreneurs construct the BSF, receive training and start-up materials, and then develop micro-enterprises to sell filters within their communities.

Regional-Scale NGO Project in Cambodia

Samaritan's Purse, an international faith-based NGO, is one of the principal implementers of the BSF, responsible for the installation of approximately 30,000 of the 100,000 BSF filters in use worldwide. Samaritan's Purse has developed an implementation manual and employs a staff water expert to provide technical support to BSF projects across the world.

Samaritan's Purse has installed 15,000 filters in Cambodia, where it works with local partners to hold informational meetings for potential BSF users. Attendees interested in receiving a BSF are invited to a second training meeting to sign up for the program. This self-selected group is then asked to contribute a small amount of the cost of the BSF (about US$3), attend focus group trainings on hygiene and use of the BSF, and send one family member to assist with the construction and transportation of the BSF. The full cost of installing a BSF in a home in Cambodia is US$67; funding for this project primarily comes from the Canadian International Development Agency.

The success of this project is directly related to the strength of the cooperating staff in Cambodia (Kaida Liang, personal communication, December 24, 2004). Implementation challenges include human errors and the weight of the BSF (350 pounds), which makes transportation difficult and complicates installation in homes on stilts. Currently, 75,000 families are waiting to receive a filter, and lack of funding has limited expansion. As the project has grown, economies of scale and lessons learned have made installation more efficient and less costly.

BioSand Filtration: Benefits and Drawbacks

The benefits of the BSF include:

- Proven removal of protozoa and approximately 90 percent of bacteria;
- High user acceptability due to ease of use, and improved look and taste of water;
- Produced from locally available materials;
- One-time installation with few maintenance requirements; and
- Long life.

The drawbacks of the BSF include:

- Low rate of virus inactivation;
- Lack of residual protection and removal of less than 100 percent of the bacteria, which leads to recontamination;
- The current lack of studies proving health impact; and
- Difficulty in transport and high initial cost, which make scalability more challenging.

OPTION 2B: CERAMIC FILTRATION

Ceramic filters have traditionally been used for water treatment throughout the world. Currently, the most widely distributed ceramic filter is the **Potters for Peace** (PFP) filter, which is shaped like a flowerpot and impregnated with colloidal silver.[7] Holding 8.2 liters of water, it sits inside a 20- to 30-liter plastic or ceramic receptacle with a spigot. Laboratory testing has shown that although the majority of the bacteria are removed mechanically through the filter's small (0.6–3.0 microns) pores, colloidal silver is necessary to inactivate 100 percent of the bacteria (Lantagne, 2001a). The filter removes 99.99 percent of protozoa by mechanical processes (Lantagne, 2001a); however, the effectiveness of the filter in inactivating or removing viruses is unknown.

Ceramic Filtration: Implementation Strategies

PFP is a U.S.-based NGO whose mission is to build an international network of potters concerned with peace and justice issues. PFP helps potters learn appropriate technologies and marketing skills that improve their livelihoods and sustain their environment and cultural traditions. After staff members were introduced to the ceramic filter design, PFP established a filter-making factory in Managua, Nicaragua. Funding for the project initially came from private donations. The filter factory is now a self-financed microenterprise in Nicaragua. NGOs pay US$10 per filter, and transport the filters themselves to project locations. From 1999–2004, PFP made and sold a total of 23,000 filters in Nicaragua. PFP has also established filter-making factories in 12 other countries, contracted by organizations that provide funding for technical assistance and factory construction.

In the current model, the factory sells filters to NGOs, who then implement a water program. This model is attractive to NGOs because they do not have to produce the filters, but it suffers from a lack of consistent training and education for both the NGO implementers and the users. Poor cleaning and maintenance of the filter often leads to recontamination of finished water (Lantagne, 2001b). To address this issue, PFP is working with cooperating NGOs to develop, implement,

7. Colloidal silver—tiny silver particles suspended in liquid—is a disinfectant, preventing bacterial growth in the ceramic filter and assisting in inactivating the bacteria in the filter. The use of colloidal silver in the PFP filter does not leave a residual in the drinking water.

and evaluate an educational program that includes safe storage, proper procedures for cleaning the filter, and follow-up visits to ensure proper use continues and broken filters are replaced. This educational component is critical for the real-world performance of the filter to match its effectiveness in the laboratory, and to test whether filters made with locally produced materials will prevent diarrhea.

Ceramic Filtration: Benefits and Drawbacks

The benefits of the PFP ceramic filter include:

- Proven reduction of bacteria and protozoa in the laboratory;
- Ease of use;
- Long life, if the filter remains unbroken; and
- Relatively low cost due to local production of the filter.

The drawbacks include:

- Unknown effectiveness against viruses;
- Lack of residual protection, leading to recontamination;
- Lack of health impact studies of this particular filter design;
- The need to educate the user to keep the filter and receptacle clean; and
- A low flow rate of 1–2 liters per hour.

OPTION 3: SOLAR DISINFECTION

Solar disinfection (SODIS) was initially developed to inexpensively disinfect water used for oral rehydration solutions (Acra et al., 1984). In 1991, the Swiss Federal Institute for Environmental Science and Technology began to investigate and implement solar disinfection as a HWTS option. Users of SODIS fill 0.3–2.0 liter plastic soda bottles with low-turbidity water, shake them to oxygenate the water, and place the bottles on a roof or rack for six hours (if sunny) or two days (if cloudy). SODIS has been proven to inactivate bacteria and viruses (Wegelin et al., 1994; Sommer et al., 1997); the protozoa cryptosporidium and giardia are also sensitive to solar irradiation (Méndez-Hermida et al., 2005; Martin Wegelin & Regula Meierhofe, personal communication, March 8, 2005). Randomized controlled studies have shown SODIS to reduce diarrheal disease incidence by 9–86 percent (Conroy et al., 1996, 1999, 2001; Hobbins, 2003).

Solar Disinfection: Implementation Strategies

As a virtually zero-cost technology, SODIS faces marketing constraints. Since 2001, local NGOs in seven countries in Latin America—as well as in Uzbekistan, Pakistan, India, Nepal, Sri Lanka, Indonesia, and Kenya—are disseminating SODIS by training and educating users at the grassroots level, providing technical assistance to partner organizations, lobbying key players, and establishing information networks. The program has been funded by the AVINA and Solaqua Foundations, private and corporate sponsors, and official development assistance. The program has shown that SODIS is best promoted and disseminated by local institutions with experience in community health education. Creating awareness of the importance of treating drinking water and establishing corresponding changes in behavior requires a long-term training approach and repeated contact with the community. The Swiss Federal Institute for Environmental Science and Technology has developed an implementation manual, and provides technical assistance to NGOs implementing SODIS. The method, which has been disseminated in more than 20 developing countries, is regularly applied by more than one million users.

A NGO Project in East Lombok, Indonesia

After a successful pilot project, two local NGOs worked closely with the district health department in East Lombok, Indonesia, to promote SODIS (Meierhofer, 2005). This large-scale dissemination project worked through community health centers to train health officials, sanitarians, teachers, and community representatives in improved hygiene practices and use of SODIS. These trainers, in turn, trained 144 villages and 70 elementary schools in the use of SODIS, reaching 130,000 people in 14 months.

The project ensured sustainability by working closely with government partners. Integrating hygiene education and SODIS into the community health center structure provided long-term continuity for the project, which reduced bacterial contamination of household drinking water by 97 percent. Acquiring enough plastic bottles for each family was a challenge, so the project established a mechanism to transport and sell bottles. Georg Fischer AG, a German corporation, provided funding at a cost of US$0.80 per capita.

Solar Disinfection: Benefits and Drawbacks

The benefits of SODIS include:

- Proven reduction of bacteria, viruses, and protozoa;
- Proven health impact;
- Acceptability to users because of the minimal cost to treat water, ease of use, and minimal change in water taste; and
- Unlikely recontamination because water is consumed directly from the small, narrow-necked bottles (with caps) in which it is treated.

Using solar disinfection (SODIS) in Nepal
(courtesy of EAWAG/Water and Sanitation in Developing Countries [SANDEC])

The drawbacks include:

- Need to pretreat water that appears slightly dirty;[8]
- Low user acceptability because of the limited volume of water that can be treated at one time and the length of time required to treat it; and
- Requires a large supply of intact, clean, and properly sized plastic bottles.

OPTION 4: FILTRATION AND CHLORINATION

Several systems incorporate both a physical filtration step for particle removal and a chlorination step (or steps) for disinfection. This dual approach produces high-quality finished water. The **Gift of Water, Inc.,** (GWI) purifier is a two-bucket system with a polypropylene string-wound filter in the top bucket and a granulated activated-carbon filter in the bottom bucket. Users collect water in the top bucket, add chlorine (purchased locally each month), wait 30 minutes, and then place the

8. Turbidities higher than 30 Nephelometric Turbidity Units.

top bucket on the bottom bucket, which activates a check-valve allowing water to flow through the two filters into the bottom bucket. Water is removed from the system via a tap in the bottom bucket, and a small amount of chlorine is added manually to the bottom bucket as residual protection. This system has been proven to reduce bacteria sufficiently to meet WHO guidelines (Varghese, 2002). Studies of protozoal removal have been inconclusive (Borucke, 2002); viral removal has not yet been studied.

Filtration and Chlorination: Implementation Strategies

GWI is a faith-based organization headquartered in Florida that assembles, distributes, and implements village-based programs with the GWI purifier. Church groups in the United States sponsor communities in Haiti, many through the Catholic Parish Twinning Program of the Americas.

Once a village is sponsored, Haitian GWI staff work with the community to establish a water committee and install purifiers in 200–400 homes. In addition, two local community health technicians are trained by master technicians to visit the users' homes weekly and perform maintenance and residual chlorine spot-checks. The purifier has garnered high levels of community acceptance, and an independent cross-sectional study found a 56 percent reduction in diarrheal disease incidence in users, with a 35 percent reduction when controlling for socio-economic status and hygiene practice (Varghese, 2002). As noted earlier, however, cross-sectional studies are not a reliable method for evaluating diarrheal disease. There are currently 70 sponsorships, covering 120 villages, and more than 16,000 purifiers, with 200 paid Haitian staff in the GWI program. The program is expanding at a rate of 8,000–10,000 new families per year.

The program offers a successful product (water treatment for a village) to consumers (churches) who have resources and good intentions, but lack the technical capacity to implement a water intervention in a needy community. In July 2004, a church in Atlanta, Georgia, provided GWI with US$5,600 to install 400 purifiers, train the community members and health technicians, and pay annual salaries for two of the technicians (Molly Brady, personal communication, December 29, 2004). By September 2004, the program had conducted the training and installed 200 filters; the church was very pleased with the program's progress, but was concerned about its ability to provide the technicians' salaries indefinitely. The drawbacks thus include the uncertainty of consistent support from community health technicians.

Filtration and Chlorination: Benefits and Drawbacks

The benefits of the GWI purifier are:

- High removal rates of bacteria, even in turbid waters;
- Residual protection;
- High acceptability among users due to the ease of use and visual improvement of the water; and
- Health impact, as measured by a cross-sectional study. (Internal GWI studies attribute their success to the program's community health technicians [Phil Warwick, personal communication, March 8, 2005].)

The drawbacks of the GWI purifier are:

- Unknown viral and protozoa removal; and

- The need for regular filter replacement, ongoing technical support, and continuing education, in addition to concurrent ongoing costs.

OPTION 5: FLOCCULATION AND CHLORINATION

Several systems incorporate both a chemical coagulation step for particle removal (flocculation[9]) and a chlorination step (or steps) for disinfection. This dual approach produces high-quality finished water. The **Procter & Gamble Company** (P&G) has developed a HWTS option for sale at no profit to users and NGOs, called PūR Purifier of Water. This small sachet contains powdered ferrous sulfate (a flocculant) and calcium hypochlorite (a disinfectant). To use PūR, users open the sachet, add the contents to an open bucket containing 10 liters of water, stir for five minutes, let the solids settle to the bottom of the bucket, strain the water through a cotton cloth into a second container, and wait 20 minutes for the hypochlorite to inactivate the microorganisms.

PūR incorporates both the removal of particles and disinfection. Because of this dual process treatment, PūR has high removal rates of bacteria, viruses, and protozoa, even in highly turbid waters (Souter et al., 2003; Le et al., 2003). Use of PūR reduced diarrheal disease incidence by 16 percent to more than 90 percent in five randomized controlled health intervention studies (Reller et al., 2003; Chiller et al., 2003; Crump et al., 2004; Agboatwalla 2004; Doocey, 2005). It also can remove heavy metals, such as arsenic. PūR is provided to global emergency relief groups for US$0.035 per sachet, plus shipping.

Using solar disinfection (SODIS) in Nepal
(courtesy of EAWAG/Water and Sanitation in Developing Countries [SANDEC])

Flocculation and Chlorination: Implementation Strategies

P&G has recently moved from research and development of the PūR product to research into effective implementation strategies. P&G is investigating social marketing—in partnership with PSI—in Haiti, Pakistan, and Uganda, and distribution during emergency responses.

Emergency Response Using PūR

Three hundred thousand PūR sachets were distributed in response to the flooding after Hurricane Jeanne struck Gonaives, Haiti, in September 2004. PSI and CARE staff were trained in the use of the product and, within weeks of the flooding, distributed PūR and educational materials to affected communities.

9. In flocculation, fine particles in water are gathered together (aggregated) into larger particles by mixing water with coagulant chemicals.

As correct use of PūR requires several steps, the program's success in Haiti was due to well-trained staff who understood the product, "trained the trainers" (local community members), and provided them with the skills, knowledge, and materials to teach others through community demonstrations (Bowen et al., 2005). Adequate supplies of instructional and promotional materials in the local language were also very useful.

The lessons learned in Haiti helped inform emergency response procedures elsewhere. In refugee camps in Liberia, Johns Hopkins University researchers provided trainings, demonstrations, and the two buckets necessary to use the product. They documented a 93.6 percent reduction in diarrheal disease incidence among PūR users compared to a control group of safe storage users (Doocey, 2005). Before the South Asia tsunami in December 2004, 5 million sachets of PūR had been procured for emergency response (Greg Allgood, personal communication, February 3, 2005). Since then more than 16 million sachets have been purchased and transported to tsunami-affected areas in Indonesia, Sri Lanka, and the Maldives by Samaritan's Purse, AmeriCares, and PSI. Samaritan's Purse, UNICEF, World Vision, the International Rescue Committee, and the International Federation of the Red Cross have all mobilized and trained communities to use PūR, following an initial model established by Samaritan's Purse, which provides affected people a cloth, a spoon, soap, an instruction card, and 72 sachets of PūR packaged in two buckets.

Flocculation and Chlorination: Benefits and Drawbacks

The benefits of PūR are:

- Removal or inactivation of viruses, bacteria, parasites, heavy metals, and pesticides, even in highly turbid waters;
- Residual protection;
- Proven health impact;
- User acceptability due to water's visual improvement;
- Ease of scalability or use in an emergency because the sachets are centrally produced, and easily transported (due to their small size, long shelf life, and classification as a non-hazardous material for air shipment); and
- Reduced concern about carcinogenic effects of chlorination because organic material is removed in the treatment process.

The drawbacks of PūR are:

- Mulit-step process requiring demonstrations for new users and a time commitment for water treatment from the users;
- Requires two buckets, a cloth, and a stirring device; and
- High relative cost per liter of water treated.

DISCUSSION

Many researchers, private companies, faith-based organizations, international and local NGOs, donors, ministries of health, and end users are interested in HWTS options and in mechanisms for their implementation. The evidence base for these interventions is well-established and growing, and an active program of further technical and operations research is being pursued on multiple fronts.

HWTS implementation has enjoyed numerous successes. First and foremost, field-based programs have documented reductions of diarrheal diseases in end users. Factors that contributed to successful programs include:

- The ability to obtain quality HWTS option components (and any replacement parts) locally;
- Behavior change communications including person-to-person communications and/or social marketing; and
- Availability of implementation materials and technical assistance to support on-the-ground implementers.

HWTS implementation projects have also encountered significant challenges, including:

- Questions regarding the health impact of these interventions in large-scale "real-world" situations;
- Long-term sustainability of the projects, especially long-term access to supplies; and
- Scaling up to efficiently reach people without access to improved water sources.

Larger studies will demonstrate the health impact of HWTS in real-world settings, and more time will tell us whether these programs are sustainable. Expanding efficiently to global scale will require a creative combination of market, microenterprise, and community-based approaches. The long-term goal of water infrastructure for all, however, should not be delayed by efforts to meet the short-term goal of health benefits from household water treatment. Research could help ensure that these two strategies can be implemented together to achieve both goals.

An additional challenge for implementers is choosing the best HWTS option in a given area. Important criteria to consider when selecting an HWTS option include:

- *Community specific needs and preferences:* For example, if the turbidity of the source water is high, users should pretreat water with filtration or coagulation before disinfection and safe storage—or, if users prefer a current practice, such as storing water in ceramic pots, incorporate that practice into the project;
- *The mechanism to prevent recontamination of the treated water.* A number of HWTS options incorporate some form of residual protection (SWS, SODIS, GWI, PūR); safe storage or other mechanisms to prevent post-treatment contamination should be a part of every HWTS project; and
- *The mechanisms (financial and otherwise) to provide sustained availability:* Long-term access to the HWTS option requires not only activating some type of supply chain, but also ensuring that once activated, access is uninterrupted.

Unfortunately, these criteria may not be systematically considered when HWTS interventions are implemented. We studied a BioSand Filter installation in a peri-urban slum with access to piped, processed, municipal water—likely not the most cost-appropriate or effective intervention for this setting. An investigation of source water quality before implementation would have discovered this, and potentially a more appropriate intervention—such as improving the local water supply, educating users about safe water storage to prevent recontamination, or using chlorination alone—could have been implemented.

In some situations, there may not be an appropriate HWTS option. While accompanying a U.S. school group on a trip to Mexico to plan a joint Mexico-U.S. student-run SWS project, an investigation showed the project communities' existing piped, treated water was of good quality, though with sub-optimal residual chlorine (Lantagne,

TABLE 2: COST OF HWTS OPTIONS

HWTS Option	Project Location and Implementer	Cost of Product to User	Full Cost of Product*	
			Initial equipment	Ongoing Cost
Chlorination	Zambia, PSI	1 bottle of chlorine solution at US$0.12 per family per month	Accounted for in cost of bottle	US$0.37 per bottle of chlorine solution (US$0.25 per bottle subsidized by donor)
Chlorination	Haiti, JSWF	1 bottle of chlorine solution at US$0.09 per family per month	US$7 start-up fee per family paid by NGO	US$0.09 per family per month for chlorine solution (no subsidy)
BioSand Filtration	Cambodia, Samaritan's Purse	One-time cost of US$3 to family for BSF	US$67 per BSF paid by NGO covers all expenses	None
Ceramic Filtration	Nicaragua, Potters for Peace	Zero	US$10 for filter paid by NGO covers all factory expenses	Unknown
Solar Disinfection	Indonesia, local NGOs	Zero	Zero	US$0.80 paid by NGO per person reached in 14-month project
Filtration and Chlorination	Haiti, GWI	US$1.71 per family for filter US$0.12–0.34 per family per month for chlorine	US$12-15 paid by NGO per family for filter	US$4 paid by NGO per family per year for education and replacement filters
Flocculation and Chlorination	South Asia tsunami emergency response	Zero	Unknown	US$0.07 per day per family for sachets

*Including delivery, installation, distribution, education, marketing, overhead, and other costs.
Source: Costs reported in this table are self-reported by program coordinators.

2004). Although the SWS project was well-intentioned, it was not an appropriate intervention for these communities. Instead, investigators recommended improving the existing water treatment and distribution infrastructure.

A critical piece of every development program is cost (see Table 2). Costs are highly program-specific; they vary with location, implementation strategy, and desired endpoint, and cannot be generalized. For example, in comparing the GWI and JSWF projects, both of which operate in rural Haiti, we find that the JSWF project requires a smaller subsidy and thus appears the better option. However, the GWI project incorporates a filtra-

tion step that the JSWF project does not, and thus treats turbid water more effectively. Program planners must evaluate both the costs and the treatment needs in a community to determine the most cost-effective and appropriate intervention.

When reviewing cost data, it is important to compare them to the costs of other water and sanitation improvements. A recent cost-benefit evaluation found that all water and sanitation improvements analyzed were cost-beneficial in all regions of the world, with returns of US$1.92–$15.02 on each US$1 invested, depending on region and type of improvement (Hutton & Haller, 2004). However, disinfection at the point of use (the only HWTS option considered in the analysis) had the lowest cost per person when compared with all non-HWTS interventions to provide improved water supply or sanitation. This initial work indicates that HWTS options are cost-effective mechanisms for providing improved water to households.

FUTURE WORK

Although much research has been completed on HWTS options, more is needed, including:

- Health impact studies:
  - Of the HWTS options that are widely distributed but have not yet been proven effective at reducing disease;
  - Of a large-scale real-world project, such as one of the national or sub-national PSI SWS projects; and
  - With longer-term endpoints in children, including growth, cognitive development, and mortality.
- Development of real-term, practical parameters and performance measures to predict safety of drinking water in developing countries;
- Investigations of the economics of moving to large-scale projects, including cost analysis, economic demand assessment, and sustainability; and
- Determination of the relative and absolute impact of HWTS options and other water, sanitation, and hygiene (WASH) interventions, and research investigating optimal combinations of HWTS and WASH interventions.

In addition, important operational research questions remain, including:

- What motivates users to purchase and use a HWTS option?;
- What are current purchase (use) and repurchase (sustained use) rates in different demographic, socio-economic, and cultural groups; and how do these correlate with waterborne disease prevalence rates?;
- What is the health impact of routine versus sporadic use of HWTS options in the home?;
- What are optimal behavior-change strategies for hygiene and sanitation practices; and how do we best incorporate these into different HWTS implementation strategies?; and
- What are the most sustainable and cost-effective ways to reach rural and remote areas?

To address these research questions, the HWTS community should continue to work with academic institutions that provide technical knowledge and student labor. The University of North Carolina, Emory University, MIT, Johns Hopkins University, and the London School of Hygiene and Tropical Medicine, among others, have existing programs in public health or engineering departments that research HWTS options. This path has resulted in numerous successes, such as

the development of a computer model to ascertain SODIS appropriateness for any area of the world using NASA data (Oates et al., 2002).

One question to ponder: are students being trained for job opportunities that do not yet exist? The interest in HWTS options is very high at the student level. The HWTS community should seek to identify and coordinate future human resources with the growing number of graduates with relevant field experience.

Lastly, HWTS options need to be implemented at scale, and in conjunction with other water and sanitation programming to help reduce disease burden and alleviate poverty. A diverse array of creative partners, with adequate capital and technical support, will be needed to complete this work.

CONCLUSION

HWTS systems are proven, low-cost interventions that have the potential to provide safe water to those who will not have access to safe water sources in the near term, and thus significantly reduce morbidity due to waterborne diseases and improve the quality of life. HWTS implementations have developed from small pilot projects into national-scale programs, and now face the challenge of reaching the more than 1.1 billion in need of safe drinking water, and effectively working with other water, sanitation, and hygiene programs to achieve the greatest health impact. The active, diverse, and expanding community of researchers, private companies, faith-based organizations, international and local NGOs, and donors interested in answering these questions can play a major role in helping the world achieve the Millennium Development Goal to halve, by 2015, the proportion of people without access to safe water (World Bank Group, 2004). Achieving this goal, and surpassing it, will require continued collaboration, investment, and research and development, but it is our best hope for rapidly reducing waterborne disease and death in developing countries.

BIOGRAPHIES

Daniele S. Lantagne, **Dr. Robert Quick**, and **Dr. Eric D. Mintz** work for the Foodborne and Diarrheal Diseases Branch of the U.S. Centers for Disease Control and Prevention (CDC). Lantagne is an environmental engineer with more than 10 years of experience in water treatment. She has evaluated and implemented household water treatment options in more than 30 developing countries, first as a lecturer with the MIT Department of Civil and Environmental Engineering and with her own consulting firm, and for the last three years with the CDC. Medical epidemiologists Dr. Quick and Dr. Mintz, who also work at the Center for Global Safe Water at Emory University, have been with the CDC for more than 15 years. Both were involved in the initial cholera epidemic investigations that led to the development of the Safe Water System, and have been evaluating and implementing the Safe Water System since 1995.

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COMMUNITY-BASED APPROACHES TO WATER AND SANITATION: A SURVEY OF BEST, WORST, AND EMERGING PRACTICES

By John Oldfield

Unsafe water and inadequate sanitation and hygiene in small rural communities throughout the developing world are some of the world's most important, timely challenges. This review of small-scale and rural water, sanitation, and hygiene projects incorporates case studies that highlight best, worst, and emerging practices in the sector. Based on research and interviews with senior leaders at leading NGOs, this report recounts lessons learned primarily over the past two decades; illustrates these lessons by using case studies from the surveyed organizations; and concludes with a brief discussion of breakthrough practices identified by the surveyed NGOs. Although the environments, villages, and projects examined differ widely, initial findings reveal:

- Community-based small-scale solutions work well if designed, built, and maintained effectively;
- The most successful projects (measured primarily by time saved and health benefits to communities) focus not just on supplying water, but also on sanitation and hygiene, which often are more immediate causes of death or illness;
- Social marketing—deploying commercial marketing tools to promote habit change and health benefits—often reduces the time necessary to change poor health habits;
- The projects and their results often do not meet the initial expectations of the communities, donors, or NGOs (but this does not necessarily reflect project success or failure);
- Project management and ownership—including financial management—should be decentralized as much as possible;
- Government involvement, although frequently not necessary in small rural projects, becomes essential—and potentially beneficial—when NGOs scale their work up or move into peri-urban or urban areas;
- Substantial women's involvement is important to project success, particularly for sanitation and hygiene programs;
- Lack of financial support, caused by a lack of political will (in both the developed and developing world), is slowing progress; and
- It is not easy: Sustainable development for water, sanitation, and hygiene requires thoughtful design, well-managed project implementation, and extensive local capacity building.

METHODOLOGY

This report's findings are built on two primary sources of information:

1. *Literature Review*: I reviewed relevant literature, primarily online. While a great deal of literature addresses the challenges of small-scale, rural projects on water, sanitation, and hygiene, there is a dearth of accessible research bringing together the work of multiple organizations, highlighting the strengths and weaknesses of differing approaches to the task; and
2. *Phone Interviews*: I surveyed leaders from six nonprofit NGOs (five in the United States, one in the United Kingdom) over a period of three months from late 2004 to early 2005. The interviews began with a standard set of questions, and I gave each respondent the opportunity to comment on related issues.

I selected WaterPartners International, Water For People, WaterAid, Living Water International, CARE (see Box A), and the Hilton Foundation due to their current leadership positions in the field and because they have operated for at least 15 years, thus facilitating a longer-term look at operational practices.[1]

Much of this research is anecdotal, as I did not have the resources to investigate these claims on the ground. Also, it is difficult to gather accurate data in this sector, as definitions vary, and countries use different sets of indicators. As WaterAid (n.d.) notes on one of its factsheets, "statistics tend to understate the extent of water and sanitation problems, sometimes by a large factor. There are not sufficient resources available for accurate monitoring of either population or coverage" (page 1).

DEFINITIONS

How much water and for what period of time: This report does not address industrial or agricultural water usage. Although the linkages among agricultural, industrial, and household water usage are manifold, I am chiefly concerned with the amount of water each person needs for daily survival: the amount of clean water necessary for drinking, cooking, and bathing without dying or becoming ill from unsafe water.

Although the Millennium Development Goals (MDGs) do not explicitly define what constitutes access to safe drinking water, the World Health Organization (WHO)/UNICEF Joint Monitoring Programme describes reasonable access as "the availability of at least 20 liters (c. five gallons) per person per day from a source within one kilometer of the user's dwelling."[2] All of the organizations surveyed design projects to meet or exceed these basic requirements, taking into account growing populations through and beyond the life cycle of the system, ranging normally from 5 to 15 years.

Size and scope of projects: This report tackles challenges relevant to small-scale—predominantly rural—water, sanitation, and hygiene development projects. Projects range in size and scope from a $500 repair to a broken handpump in Africa, to several hundred thousand dollars for multifaceted peri-urban activities in Latin

1. This report does not include, for the most part, the experiences of multilateral and bilateral organizations.
2. For further guidance on what constitutes "improved" water supply and sanitation, please refer to "Water Supply and Sanitation Technologies Considered to be 'Improved' and Those Considered To Be 'Not Improved'" as presented by the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (2000); see http://www.who.int/docstore/water_sanitation_health/Globassessment/Global1.2.htm#BOX%201.5

America, and from one day to 1–2 years in length.

NGOs vs. nonprofits: Although these words are often used interchangeably, I prefer to use NGOs. Although predominantly nonprofit, NGOs can—and do—include for-profit enterprises doing development work.

Community-based: A community-based solution involves decentralized (village-level) decision-making, village-level ownership, locally appropriate technology, and locally sustainable business and financial models as much as possible. A truly successful community-based project will require no external inputs once the project is completed. For the purposes of this report, community-based projects range in size from a few hundred to several thousand individuals.

IMPACT OF SAFE WATER (RETURN ON INVESTMENT)

Current research shows that the economic returns on successful water projects are very high, both on a macroeconomic level and a project/household level. Of the NGOs surveyed, WaterAid (UK) has most extensively evaluated the economic return on water projects. Based on an assessment of WaterAid projects in Ethiopia, Ghana, India, and Tanzania, the economic returns range from US$2 to US$52 for each US$1 invested (Redhouse, Roberts, & Tukai, 2005).

Another recent evaluation by the WHO concluded that the returns range from US$5 to US$28, strongly stating: "The results show that all water and sanitation improvements were found to be cost-beneficial, and this applied to all world regions" (Hutton & Haller, 2004, page 3*)*. These results hold steady on global, national, regional, village, and individual levels, and vary based on the design and cost of the project and the type of benefits that accrue (e.g., time savings, calorie-energy savings, water purchase savings, improved health, and more). In some cases these benefits put cash directly in people's pockets—for example, by enhancing agricultural productivity. In other cases, the connection is less direct. The biggest impact from these projects often comes from the time savings for villagers who no longer have to walk miles to get unsafe water, then boil it to make it potable. Although there are uncertainties associated with the initial data from which these findings are derived, the Hutton and Haller report stated that "even under pessimistic scenarios the potential economic benefits generally outweighed the costs" (page 3).

WaterAid draws the following conclusions from its research (Redhouse, Roberts, & Tukai, 2005):

- The clearest impacts were improved livelihoods and education attendance;
- Women and children received more benefits;
- There were positive and significant environmental impacts;
- Technical quality and effective management were equally important in operating water systems; and
- Ongoing support for communities increased their ability to sustain both supply systems and hygiene behavior changes.

THE FACETS OF SUSTAINABILITY

Although the global drinking water, sanitation, and hygiene field continues to advance rapidly, it is not too early to draw some preliminary conclusions about best, worst, and breakthrough practices. This report intends to shorten the learning curve for new and growing water-related organizations (and their supporters) in both the developed and developing worlds.

Handwashing in Guatemala
(courtesy Nancy Haws, Water For People)

BOX A: NGOS SURVEYED

WaterPartners International
- Founded 1990, based in Kansas City, Missouri (USA)
- Active in Central America, Africa, Middle East, Asia
- In 2005, WaterPartners expected to spend US$2.5 million on water, sanitation, and hygiene projects
- WaterPartners has helped more than 60,000 people in 70 communities develop safe water supplies and improved sanitation systems
- Slogan: "We envision the day when everyone in the world can take a safe drink of water."
- http://www.water.org
- Respondent: Gary White

Water For People
- Founded 1991, based in Denver, Colorado (USA)
- Active in Latin/Central America, Africa, Asia
- In 2003, Water For People spent US$1.3 million, and completed 58 projects in 12 countries
- Slogan: "Water For People helps people help themselves."
- http://www.waterforpeople.org
- Respondent: Steve Werner

WaterAid
- Founded 1981, based in London (UK)
- Active in Africa, Asia
- WaterAid spends £12 million per year (approx. US$22.6 million), providing water to about 700,000 people and sanitation to 500,000, averaging £15 (US$28.25) per person
- http://www.wateraid.org
- Respondent: Stephen Turner

Living Water International
- Founded 1990, based in Houston, Texas (USA)
- Global operations, US$4.6 million in 2003
- Close to 3,000,000 people currently being served, pumping 15 million gallons a day.
- Per capita costs (water supply only) from US$1 to US$50
- Slogan: "A cup of water in Jesus' name."
- http://www.water.cc
- Respondent: Gary Evans

CARE's Water Program
- Founded 1945, based in Atlanta, Georgia (USA)
- Operations in more than 70 countries
- In FY 2003, CARE spent US$16.3 million on water and sanitation. Nearly 3 million people in 29 countries gained access to clean water, sanitation, and hygiene education.
- Slogan: "Where the end of poverty begins."
- www.care.org
- Respondent: Susan Davis

Water projects in the developing world fail as often as they succeed. Despite best intentions, projects often are not sustainable for the long run, especially after the donor leaves the country. Historically, sustainability has often been an afterthought. Traditionally, more effort has been put into constructing new systems than into making sure the old ones continue to work.[3] Well-thought-out, sustainable design has the best chance of enabling stakeholders to achieve the scale needed to significantly reduce the number of people without water and sanitation. More fundamentally, sustain-

3. For more on this topic, see the WHO's "Sustainability and Optimization of Water Supply and Sanitation Services," available online at http://www.who.int/docstore/water_ sanitation_health/wss/sustoptim.html

able design will lower the rates of mortality and morbidity due to unsafe water, and create opportunities for related social development.

Although normally the technology involved is—or should be—quite straightforward, additional systems need to be instituted to ensure that each project is sustainable on technical, social, and financial levels. All of the leading water-related nonprofit organizations now focus on the following facets of sustainability throughout the life cycle of their projects:

1. Technology;
2. Social sustainability or "soft skills";
3. Finance/business models;
4. Management/ownership; and
5. Gender.

Technology

The oft-debated 1981–1990 International Drinking Water and Sanitation Decade[4] was criticized for focusing too much on large-scale technical infrastructure and capital expenditures, and too little on designing and institutionalizing systems that would build local capacity and ensure permanence. Although most conversations with NGOs in this sector include discussions of the technology of water and sanitation, the nature of those discussions has changed. The best planners and project developers address not only which technology is most *appropriate*, but also consider technology as a subset of the overall requirements for a successful water system, and include an in-depth appreciation of "soft skills." In short, it is increasingly rare for the sector to *solely* focus on technology.

With that said, the phrase "appropriate technology" encapsulates what is widely perceived as best practice today among leading nonprofits: technology that is locally derived and managed, and that meets needs in the most simple, efficient manner possible. Examples of appropriate technology include technical solutions designed so that local communities can obtain replacement parts for a pump and repair it themselves, and, at best, ensure that communities have the capacity to craft or manufacture the part locally.

The water supply hardware used by the respondents to this survey includes but is not limited to:

- Gravity-fed water supply systems;
- Boreholes with manual or electric pumps;
- Rainwater harvesting systems with storage tanks;
- Village-level sand filtration systems for surface or groundwater;
- Microdams and catchment basins; and
- Point-of-use (household) filtration systems (e.g., buckets with cloth/charcoal filters or chlorine disinfection systems).[5]

Additionally, to ensure adequate sanitation, pit latrines may be constructed locally.

Living Water International (LWI) asserts that there are five major components to a successful water project:

1. Access to safe water;
2. Access to safe water;

4. For more information about the 1981–1990 International Drinking Water and Sanitation Decade and other United Nations water resources, see http://www.unesco.org/water

5. For example, see the CDC's Safe Water System at http://www.cdc.gov/safewater/index.htm; for a discussion of this and other point-of-use systems, see the accompanying chapter in this volume, "Household Water Treatment and Safe Storage Options in Developing Countries: A Review of Current Implementation Practices," by Daniele S. Lantagne, Robert Quick, and Eric D. Mintz.

3. Access to safe water;
4. Health and hygiene training; and
5. Sanitation.

LWI has thus historically focused the majority of its efforts on water supply solutions, arguing that without the foundation of safe water there is little hope of making effective or sustainable gains in hygiene, sanitation, or health (Gary Evans, personal communication, January 14, 2005).

The lower end of LWI's technical projects may be a simple 100-foot borehole and handpump serving 500–1,000 rural villagers in India for five years. On the high end, the system may entail a 1000-foot borehole drilled through granite, with a generator, storage tank(s), and distribution system of kiosks and taps in a peri-urban area outside Nairobi, Kenya, designed to last 15–20 years.

LWI only infrequently incorporates soft skills training (health, hygiene, and sanitation) into its projects.[6] They do, however, train and equip local people to drill and maintain boreholes and pumps. To achieve permanent capacity and scale, and create full-time jobs, LWI has also instituted a "circuit rider" approach, whereby a small number of workers service a series of water systems.[7] The benefits of this approach are:

- Creating full-time jobs for engineers (instead of relying on village-level volunteers who may be called into service only once in five years);
- Keeping these engineers' skills current due to more frequent installation and maintenance projects; and
- Cost-effectiveness.

The overall capital cost of a LWI water-only project ranges from US$2,500 to more than US$50,000, with per capita costs ranging from under US$2 to more than US$50. These costs depend on many variables, including but not limited to:

- Country/region;
- Terrain and depth of the well(s);
- Number of people served;
- Pump model and other hardware;
- Whether storage and distribution systems are built; and
- Who performs the work (local or overseas contractor).

LWI seeks to train and contract with local organizations as much as possible to achieve cost reductions and economies of scale. Local contractors, using in-country equipment, are particularly important for larger-scale projects. LWI also repairs existing handpumps and boreholes instead of drilling and installing new ones, which may cut capital costs by up to 80 percent, but does little to improve local capacity to maintain the equipment without outside intervention and support.

Even if a particular technology is appropriate in one place, it may be ineffective—even if quite simple—in another. For example, the Northern Region of Ghana remains one of the last few regions of the world where Guinea worm disease is endemic. Safe drinking water is the best long-term solution to the disease.[8] While drilling boreholes has been the tradi-

6. Since my initial conversations with Living Water International, the organization has made a concerted effort to increase the sanitation and hygiene components of its projects (Jerry Wiles, personal communication, June 9, 2006).
7. For other examples of the "circuit rider" approach, see http://www.newforestsproject.com/ English/cwigeneral.html and http://www.ruralwater.org/irwa/
8. For more on Guinea worm disease, see the Carter Center Guinea Worm Eradication Program, http://www.cartercenter.com/health programs/program1.htm

tional solution, boreholes are not, in fact, the best solution in the Northern Region of Ghana, as the wells are frequently dry due to hydrogeological conditions. In this instance, the Carter Center has found that the appropriate technology may be a more complex—yet still straightforward and locally sustainable—water filtration system for surface water held in catchment basins (Don Hopkins, personal communication, December 21, 2004).

NGO leaders I surveyed consistently asserted that the technical solution that is often most visible, tangible, and therefore appealing to donors is not necessarily the right solution, even if it meets the appropriate technology criterion. Like other consultants, global NGOs should work with a particular village's leadership to consider the solutions to its water problems. The consultant NGO then steps back and lets local people make the final decision, enabling (rather than insisting) that they do the majority of the work themselves, and pay for it. A well-designed water project can be implemented locally in a sustainable, self-sufficient fashion—and not simply satisfy the technical or financial requirements of an overseas partner. The best practice thus combines local knowledge with innovative technology and sound sustainable design. These critical elements can be found, for example, in arsenic-removal projects in Bangladesh and water-quality testing throughout the world (see, e.g., United Nations, n.d.)

Social Sustainability

Most respondents strongly asserted that the best technological solution in the world will achieve very little unless it is grounded in *social* sustainability. In water projects, this typically means adding culture-specific sanitation and hygiene components to the water supply work. Donors, implementing organizations, and recipients of assistance are increasingly attentive to this concept. It is vital that donors, in particular, incorporate social concerns into each project for two reasons:

1. Donors are often more aware than their local partners of the long-term benefits that accrue to communities that properly implement the sanitation and hygiene aspects of a water project; and
2. Local partners are historically accustomed to—and have come to expect—purely technological solutions; today's donors and NGOs must in some cases lead them to a more sustainable solution.

Most respondents also consistently pointed out that the most immediate, tangible life-saving impacts of a water project may not come from the technical water supply solution alone. Often, in fact, these impacts come from simply teaching community members, especially women, to more effectively and frequently wash their hands. For example, the *Lancet Infectious Diseases Journal* reported that 42–47 percent of all diarrheal transmission could be stopped by handwashing with soap (Curtis & Cairncross, 2003). Respondents also pointed out that the Water Supply and Sanitation Collaborative Council is devoting more resources to sanitation and hygiene issues through a wide array of literature and marketing campaigns, such as the "Water, Sanitation and Hygiene for All" (WASH) campaign.[9]

Each NGO interviewed for this report brought up the issues of sanitation (primarily pit latrines) and handwashing, and the difficulty of changing

9. For more information on the WASH campaign, see http://www.wsscc.org/dataweb. cfm?code=26

habits deeply ingrained in local cultures. Donors and implementing organizations know that without attention to sanitation and hygiene, projects will not achieve health benefits. How do project planners ensure that the recipient communities agree to use latrines and appropriate handwashing? Respondents pointed to social marketing tools such as theater performances, board games, house-to-house education programs, formal hygiene committees, and training schoolchildren to teach their parents to adopt these new habits.

In the overall nonprofit/health space, respondents singled out the thought-provoking social marketing work of Population Services International (PSI), which "deploys commercial marketing strategies to promote health products, services, and other types of healthy behavior that enable low-income and other vulnerable people to lead healthier lives."[10] In many cases, respondents are integrating similar efforts into their own water projects; for example, a joint CARE-PSI-Centers for Disease Control and Prevention (CDC) project in Madagascar used social marketing and community mobilization to combat the spread of cholera (Dunston et al., 2001). CARE projects combine social marketing with capitalism by training vendors of water filtration systems and products to educate their customers about health and hygiene (Susan Davis, personal communication, December 13, 2004).

Respondents unanimously agreed that no matter how well-designed a pit latrine might be, its use and the concomitant health benefits require significant changes in habits. Individuals may not readily accept the "improvement"—even if they do, their culture may not allow them to use latrines—in the absence of targeted and culture-specific education and social marketing programs (often led by women). Or, as Water For People (WFP) warns, villagers may find a better use for the latrines once built, like storing crops (Steve Werner, personal communication, January 8, 2005). Yet once the benefits of the program become clear over time (e.g., fewer cases of diarrhea), the intended habit change will stick.

Successful handwashing does not come naturally in many rural communities, especially in the absence of ample supplies of clean water. In Guatemala, WFP partners with the U.S. Peace Corps to not only bring safe water supply to the schools, but also to teach students about washing their hands. WFP gives the schoolchildren tools (primarily posters) to teach their family members, and uses Peace Corps volunteers to reinforce the lessons over the long term. (Before WFP helped provide safe water to the schools, Peace Corps volunteers had been *miming* handwashing techniques.)

On the other hand, LWI asserted that habit change takes a generation to become ingrained, meaning that it also takes a generation before such projects achieve sustainable health benefits. LWI therefore suggested that the sector focus predominantly on water supply in order to meet the Millennium Development Goals. However, every other NGO I surveyed stressed that they will no longer consider any project without a primary focus on education before, during, and after implementation.

Project Management/Ownership

Top-down, centralized decision-making for water projects of all sizes is no longer seen as an acceptable approach. Instead, many NGOs support decentraliz-

10. For PSI's mission, see http://www.psi.org

ing ownership and management of development projects to the lowest possible level. NGOs consider this a good idea objectively, but occasionally get themselves in trouble by responding too willingly to solutions that, although chosen by the local communities, may in fact be unsustainable over the long run. NGO leaders aim to work themselves out of a job by building the local capacity to operate and maintain projects for the long term. They must remain cognizant that even if local people want a particular solution, it may not be the right answer for that particular situation.

Small-scale rural water systems supported by NGO leaders interviewed for this report are typically led by village water committees or water user associations that report to village leaders or local government. Operations are often handled by unpaid members of the water committee trained in the technical and financial skills necessary to maintain the system and collect user fees. Multi-village systems often benefit from a circuit rider, a full-time paid employee who maintains several systems. The size of communities and projects covered by this report rarely attracts large private-sector operators, thus creating few full-time jobs.

Decision-making should be decentralized, engaging all community stakeholders, as decentralization increases a project's speed and transparency. However, as demonstrated by the controversy surrounding (real or perceived) unfunded federal mandates in the United States, decentralization does not automatically result in increased technical or financial capacity, nor does it guarantee project success. Respondents suggested that decentralization for the sake of decentralization can doom a project to failure.

Respondents also insisted that the key to management of each project is keeping track of both process and outcome measures: Does the project save lives? Does it reduce morbidity risks? Will it function effectively 10 years down the line? Will local people have the technical and financial capacity to maintain, repair, replace, and/or upgrade the system?

Village Water Committees: The NGOs surveyed reported that during the early stages of each project, communities, local NGOs, and the donor typically form and support a village water committee—often accompanied by a hygiene promotion committee—of 5–9 villagers, including a:

- Project manager;
- Technical manager;
- Financial manager;
- Sanitation leader(s);
- Hygiene promoter(s); and
- Volunteer leader(s).

This committee consolidates local support for the project; identifies and trains responsible laborers, trainers, and managers; and makes sure the entire project meets the community's self-identified needs. On an ongoing basis, the water committee:

- Identifies water supply infrastructure, sanitation, and hygiene needs and solutions;
- Collects fees from communities to at least partially support the capital costs of the initial water project, and also to support ongoing maintenance costs;
- Identifies local leaders for advanced technical and social training;
- Organizes training programs in community organization, maintenance, watershed management, sanitation, and related matters; and
- Follows up on water, health, sanitation, education, and other social development opportunities.

For each project, the water committee assembles drillers, hydrogeologists, mechanical engineers, environmentalists, businesspeople, volunteers, and local workers (as necessary) to design, implement, and assess projects. Depending on the size and scope of the project, the committee and donors may also choose to work with local women's groups, other NGOs, local government agencies, or additional international partners.

Note, however, that communities may also choose not to manage the project themselves, and instead hire an experienced operator. Villages are advised to approach this relationship carefully, with clear information about pricing, service-level agreements and contract management expertise.

Hygiene Promotion Committee: This committee comprises 1–3 women leaders responsible for training their peers in hygiene techniques. NGOs work with these leaders to design hygiene training materials and techniques appropriate to the local culture.

Government and Project Management: NGO leaders interviewed about government involvement in small-scale, rural water projects consistently replied with a knowing groan, adding an admonition to avoid it as much as possible. According to those surveyed, government involvement above the village water committee level politicizes both the planning and implementation process, tending to detract rather than contribute.

On small-scale rural water projects, it is possible—and arguably beneficial—to avoid extensive government interaction. The key is to depoliticize the situation by making the project's communications as public and transparent as possible. Transparency leads to a distribution of water points (boreholes with handpumps, for example) based more on the needs of the population than on local political exigencies (Stephen Turner, personal communication, December 13, 2004). If or when projects scale up, however, it becomes advisable and even necessary to cultivate productive relationships with governments.

WaterAid's Hitosa Water Supply Scheme in Ethiopia incorporated local government structures when scaling up a large gravity-driven water supply project (Silkin, 1998). The project effectively created a cooperative—a mini-utility—which is owned by an elected Water Management Board comprised of an equal number of men and women from village water committees. The board employs tap attendants and enjoys a surplus on its operations and maintenance budget. The next challenge for the cooperative is to move to a viable business model that serves the poorest households, which are unable to pay anything for their water (Shivanathan-Beasty, Gelpke, & Jarman, 1998).

A WaterAid project of similar size and scope, completed in Bale, Ethiopia, in 2001, incorporated regional government structures before work even started. The rural Water Management Board (comprised of representatives from rural village water committees) was initially supposed to manage the entire rural/urban project, including water, sanitation, and hygiene promotion activities for small villages and for citizens of Robe, a town of 35,000 people. However, the government's Water Bureau lacked confidence in the Water Management Board's ability to manage such a large project, and was hesitant to hand over control of its water supply work in Robe. They agreed to a compromise in which the Water Bureau manages the town's water supply, while the rural Water Management Board manages all other aspects and retains overall responsibility for the entire project. Although this project is

arguably successful, many questions remain about its long-term sustainability.

Project Financial Models

Water may fall from the sky for free, or be available in the form of a stream or other surface water reservoir, but it is often not potable, much less delivered to a village standpipe or a house at no cost. WaterPartners' Gary White (personal communication, December 10, 2004) describes the evolution of the water sector as evolving through the "4 C's":

- Compassion (post-World War II foreign assistance, starting with the Marshall Plan); to
- Competency (engineers, advanced technology, long-term capacity-building projects focused on water supply); to
- Common sense (community participation and collaboration, including sanitation and hygiene systems); to
- Capital (tools that enable local communities to afford their own water projects, and therefore ensure sustainability).

In the near and medium term, capital questions will remain at the forefront. There are far more questions than answers about financing small-scale rural water projects, especially when considering the sheer number of people needing water and sanitation.

It is relatively simple to address the costs associated with maintaining a borehole and handpump, and perhaps a small filtration system. But consider:

- How should the project address the capital costs of installing the system in the first place?
- How can it ensure that the poorest of the poor have access to water regardless of their ability to pay?
- How should it incorporate the costs of sanitation and hygiene, which experience suggests have more impact on mortality and morbidity than does water supply per se?

Local communities are already paying for their water supplies, directly or indirectly. In many cases, the poorest communities are in fact paying above-market rates for unsafe water that is killing and sickening them through the spread of waterborne diseases. It should be the goal of those communities, governments, and the development sector to rationalize the costs paid for drinking water, to ensure that the water is safe, and to finance adequate sanitation and hygiene training in order to decrease waterborne mortality and morbidity.

Even though each water project surveyed in this article differs, the NGOs surveyed assert that initial capital costs for a rural, small-scale project encompassing water supply, sanitation, and hygiene training should normally be US$25–50 per person. These projects should be self-financed after the donor leaves, and self-sufficient both technically and socially. It is important to highlight that the above figures include only the initial capital costs.

WaterAid (2006) states that US$25 will "provide a person with a lasting supply of safe water, adequate sanitation and knowledge of good hygiene practices" in Africa and Asia (Stephen Turner, personal communication, December 13, 2004). WaterPartners agrees with the US$25 figure in Africa, but cautions that costs double to $50 in Latin America. Almost singularly focusing on technical water supply projects, LWI has refurbished handpumps for villages for as little as US$1–$2 per capita (Gary Evans, personal communication, January 14, 2005).

All of these figures should be used with caution. One of the field's biggest private donors, the Conrad N. Hilton Foundation (see Box B),

has explored cutting costs by hiring fewer contractors from the United States and more from the developing world. This may save money in airfare and salaries, and augment local capacity in some cases. Yet it may render monitoring and evaluation more difficult, and may actually reduce the overall efficacy of a project. Choosing to fund a local nonprofit directly can work well, but by doing so, a donor loses the technical expertise and capacity in monitoring and evaluation provided by an international NGO. Relatively small donors like the Hilton Foundation (with 17 full-time staff) would be hard-pressed to provide the implementation and monitoring and evaluation skills typically offered by an international NGO.

On the other hand, even if donors choose to finance projects through a large international organization or use U.S.-based consultants, they will always have to work at the local level with the village water committees, government agencies, village elders, etc. Regardless of the donor's business and financial models, unless ownership of the project lies squarely in the community's hands, no project will be sustainable (Steve Hilton, personal communication, January 10, 2005 and June 29, 2006).

Community Contributions: Leading water NGOs now insist that local communities pay at least the maintenance costs of their water projects, and in many cases, part or all of the capital costs as well. The NGOs' argument is two-fold:

1. Communities are already paying for their water, and for the most part can afford to do so; and
2. Communities will not respect or maintain water systems unless their pocketbooks are directly affected.

In a World Bank project in Ghana, for example, the World Bank finances 90 percent (through a grant), the community pays 5 percent, and the district government pays 5 percent (World Bank, 1999). The community and district government percentages vary from community to community according to the cost of the project and the community's ability to pay.

Anecdotal evidence points to a divide between the philosophy of donor organizations and the local partners implementing the projects. In some cases the community's financial contribution may not come directly from each household but from the village leadership or local government. This removes project ownership from the individual household level, thus arguably reducing its sustainability. Sector leaders advise donors to pay close attention to this potential divide to ensure the permanence of their projects (Gary White, personal communication, December 10, 2004).

As the water sector has advanced, pressure to include sanitation and hygiene components in projects has increased. Traditional financial accounting systems are hard-pressed to quantify the return on an investment in sanitation and hygiene, thus making it difficult to set a price that will reflect both cost and benefit. Until the costs and

Handwashing in Nepal
(courtesy WaterAid)

BOX B: A BRIEF CONVERSATION WITH THE HILTON FOUNDATION
(Steve Hilton, personal communication, January 10, 2005)

- The Hilton Foundation (http://www.hiltonfoundation.org) supports small-scale, rural water projects for two reasons: 1) unsafe water is one of the world's biggest killers of children, and therefore arguably the most vital development issue; and 2) safe water opens doors to numerous other social development opportunities, including education, health care, and job creation.

- The most important contributors to the success of the Hilton Foundation's projects, as evidenced by its West Africa Water Initiative, are competent local managers and a holistic approach accomplished by partnering with complementary international and local NGOs. For its work, Hilton focuses not necessarily on the least expensive implementing organization, but on those organizations that (alone or in a consortium) can achieve the greatest financial and operational leverage—and therefore the most positive outcomes.

- Quantifiable process measures are important to Hilton (e.g., number of latrines, boreholes), but they also know that technical water solutions are inseparable from the "soft skills" of sanitation and hygiene.

- The Hilton Foundation's biggest frustrations are also held by the other nonprofits surveyed:
  - A lack of awareness of the problem of unsafe water and inadequate sanitation; and
  - Potential donors' hesitation to get involved because the situation seems intractable, especially considering the ambitious targets set by the Millennium Development Goals.

the benefits of sanitation and hygiene are clear to governments and communities, subsidizing capital costs—for sanitation in particular—will continue to be necessary in many cases.

Regardless of the model, respondents argued that the project must be self-contained financially. The project managers may approach an outside lending agency to pay for capital expenditures, but they themselves must reach that decision based on their ability to manage debt repayment and a more complex project.

Gender

Water, sanitation, and hygiene are unquestionably gender issues. In many cultures, women and children bear primary responsibility for collecting water and making it safe to drink. In addition, women and children suffer severe opportunity costs since they spend so much of their lives dealing with water issues or caring for family members sickened by unsafe water. The NGOs surveyed widely acknowledged that women should assume prominent roles on village water committees—especially when the issue at hand is sanitation or hygiene. The impact of their participation may extend beyond health benefits: women could see greater economic opportunities and girls could achieve higher levels of education.

Water For People's small-scale, rural projects are each managed by a village water committee. Normally, 2 of the 5 members are women. This is logical because women often bear the primary

responsibility for the health of their families, and adolescent girls arguably have a greater need for sanitation and hygiene than boys. Water For People's experience also suggests that women manage money better and are more attentive to the required reporting. They may also make better decisions when it comes to dealing with villagers who can not or will not pay. Water For People's projects rely on women to constantly reinforce hygiene messages throughout the community, such as forbidding children to drink directly from the tap and keeping animals away from it. (Steve Werner, personal communication, January 8, 2005).

Several organizations caution against pushing the role of women too far. Many societies in the developing world remain highly patriarchal and do not look kindly on women in leadership positions. If the male leaders of the community do not at least "believe" they are in charge, projects may face serious obstacles. As CARE puts it, the goal is to "pull women in, but not push men out" (Susan Davis, personal communication, December 13, 2004).

EMERGING PRACTICES

Despite all of the water sector's progress, the problem is still massive. What is holding back the solution, and what are the surveyed NGOs planning next?

Respondents universally acknowledged that the two major obstacles to continued progress are lack of finances and a lack of scale. Breakthrough practices that address these constraints are rarely new technological solutions; they will likely continue to be new ways of applying old technologies, creative business or financial models, or new ways of designing and implementing water projects that are more holistic and more easily scaled up. It is too early to tell if the practices discussed below will prove effective in the long run, but I believe that they are important to consider and, in many cases, already worth replicating.

Improved financing for water projects

WaterPartners' WaterCredit initiative combines microcredit with best practices in water supply projects.[11] Through this facility, communities will have access to credit to pay for the capital costs of a water supply project. WaterCredit decisions are made by local water supply and grassroots organizations, and repayment rates are expected to be high. If managed properly, WaterCredit will become a small revolving loan fund, increasing the financial reach of limited donor support.

Improved management

The franchising model for managing small-scale water supply systems, and sometimes sanitation initiatives, is very similar to traditional for-profit franchised businesses. Some respondents argued that this system provides incentives for good management and operations, and helps to solve the lack of institutional capacity (too few engineers and middle managers) throughout the developing world.

Collaboration with governments

It is impossible to achieve the scale necessary to succeed in this effort without effectively tackling the peri-urban and urban challenge. Operating in an urban environment requires the active support of government. Urbanization is not going away; more and more individuals are moving to larger

11. For more information on WaterPartners' WaterCredit initiative, see http://www.watercredit.org

cities for economic reasons, and many of these newcomers are legally "off the grid" and lack infrastructure. Thus, many suffer from a lack of water and from waterborne maladies. As water NGOs scale up their projects, and as cities continue to expand into formerly rural areas, they need to know how to address this issue.

Under a U.S. Environmental Protection Agency grant, Water For People is actively working to research this problem, stating that the world has no chance of meeting the MDGs unless the urban water situation is addressed. WaterAid's community-management project in Dacca, Bangladesh, recently experienced a breakthrough. The city of Dacca had said that it could not supply water to illegal squatters. WaterAid negotiated with the city so that community organizations registered as NGOs could purchase drinking water in bulk for the new communities. The city's water corporation realized it could get new customers through the use of trusted local NGOs. Until these new communities benefit from permanent water infrastructure, there will continue to be reliability and pricing challenges, but this is a good start toward addressing a seemingly intractable problem (Steve Werner, personal communication, January 8, 2005).

Reviving an under-appreciated "technology"

Rainwater harvesting is a millennia-old method of meeting water supply needs. Many of the NGOs surveyed suggested that rural villages should take a new look at this proven practice. It lessens the stress on groundwater tables, almost entirely removes the need to treat water, and solves the problem of rural communities whose traditional water supplies disappear during the dry season.[12]

Advocacy

Nonprofit leaders unanimously expressed their concern that the global drinking water sector suffers from a lack of awareness—and therefore funding—compared to other development sectors. Naturally, none is interested in shifting money away from other high-priority concerns, but all expressed interest and support for third-party organizations pushing the safe drinking water and sanitation agenda from a public relations or awareness-raising standpoint.

A new organization addressing this issue is Water Advocates, a Washington, D.C.-based lobbying and advocacy NGO targeting five constituencies: the U.S. federal government, civic organizations, faith-based organizations, corporations, and traditional philanthropies.[13] Water Advocates aims to triple financial and other support for the sector over the next several years through a combination of lobbying, advocacy work, and matchmaking.

CONCLUSION: POLITICAL WILL, FINANCING, AND SCALE

The question remains: Why are there still billions of people without safe drinking water and sanitation when there are so many talented individuals and organizations working on the problem throughout the world? At the Commission on Sustainable Development's 12th meeting in New

12. For more information about rainwater harvesting, visit the Centre for Science and Environment's website at http://www.rainwaterharvesting.org

13. Note: The author joined Water Advocates' staff in March 2006. For more information on Water Advocates, see http://www.wateradvocates.org

York in 2004, the Chairman's Summary concluded that, regardless of progress being made on all fronts, "the [Millennium Development] Goal can only be met if efforts are scaled up" (United Nations, 2004, page 35). This article seeks to increase the level of activity by providing easily accessible, neutral, reliable, and actionable guidance for all stakeholders, thus shortening the learning curve for international NGOs, donors, and local people who are designing, funding, and/or implementing water projects.

As the United Nations Under-Secretary-General for Economic and Social Affairs noted, "a lack of political will at both international and national levels had hampered progress, notably in resource mobilization" (United Nations, 2004, page 23). By highlighting the feasibility immediacy, and notable economic multiplier of water-related development work, this article hopes to contribute to generating the political will necessary to increase funding levels. As evidenced by my interviews with nonprofit leaders of water-related organizations, water projects are rarely simple. They are, however, eminently doable. If designed properly, they contribute almost immediately to saving lives and reducing, if not eliminating, the myriad opportunity costs attributed to unsafe water, inadequate sanitation, and poor hygiene.

The next decade is vital. Gro Harlem Brundtland, former director of the WHO, said: "Simple, inexpensive measures, both individual and collective, are available that will provide clean water for millions and millions of people in developing countries—now, not in 10 or 20 years" (WHO, 2001). Ambassador John McDonald, one of the driving forces behind both of the World Water Decades, stresses that 2005-2015 is the time to make those commitments real, and use water as the foundation for progress in other fields of social development (personal communication, January 12, 2005).

All of the leaders surveyed for this article support Ambassador McDonald's assertion that water ranks high—if not first—in the hierarchy of needs in the developing world. As discussed earlier, clean water, sanitation, and hygiene have an impressive multiplier effect at both macroeconomic and household/village levels. Above and beyond the health benefits, proponents avow that safe water contributes positively to the challenges of population, urbanization, and economic development, and is a powerful starting point for environmental protection and/or remediation.

This article concludes that small-scale, rural, community-based water projects can and should be simple, sustainable, and scalable. They can be started quickly with limited resources. Bottom-line responsibility should rest with the local end-users. Yet I remain cognizant of the dangers: projects cannot be oversimplified, as many individuals and organizations have seen water projects fail because of unsustainable technical, social, or financial design.

Most importantly, NGOs cannot afford to lose focus on the goals: saving lives and reducing water-related illness through sustainable development. I hope this article will motivate individuals, organizations, and governments to act quickly, decisively, and in a sustainable manner.

BIOGRAPHY

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A dry sanitation building near the village of San Juan Tlacotenco with separate urine and solid waste collection systems.

LOW-COST SANITATION: AN OVERVIEW OF AVAILABLE METHODS

By Alicia Hope Herron

Unsanitary conditions and contaminated drinking water exact a crippling toll on both the health of the human population and the environment. Approximately 40 percent of the world's population does not have access to improved sanitation.[1] In addition to the indignity suffered by those lacking sanitation facilities, millions of people in the developing world die each year from diseases contracted through direct and indirect contact with pathogenic bacteria found in human excreta. Infectious diseases such as cholera, hepatitis, typhoid, and diarrhea are waterborne, and can be contracted from untreated wastewater discharged into water bodies. More than half of the world's rivers, lakes, and coastal waters are seriously polluted from wastewater discharge (UN Environment Programme, 2002). The cost of inadequate sanitation translates into significant economic, social, and environmental burdens.

Sanitation coverage has lagged behind water provision since the first International Decade of Water and Sanitation (1980–1990). We are far from meeting the Millennium Development Goal of halving by 2015 the proportion of people without sustainable access, as agreed upon in the Monterrey Consensus and reinvigorated as part of the "Water for Life" Decade (2005–2015). A midterm assessment by the World Health Organization (WHO) and UNICEF (2004) suggests that 370,000 people will need to gain access each day until 2015 to fulfill this goal—an increase in performance of 90 percent—which will still only provide coverage to half of those lacking it.

As the world attempts to realize these goals, we must reassess the lessons learned, evaluate new technologies, identify research gaps, and critically discuss ways forward. Most of the World Bank's portfolio of $2.6 billion—the largest in the field—funds "traditional" sewage and wastewater treatment operations for urban populations. Since 2 billion of the 2.6 billion people lacking sanitation live in rural areas, we must complement large-scale urban investments with low-cost, on-site technologies that target rural communities (UN Economic and Social Council, 2005). Low-cost sanitation options have significantly improved, especially for the reuse of sewage for agriculture or aquaculture.

This article is not a technical review or a design manual; several already exist.[2] Rather, I attempt to consolidate the information available on several

1. According to the United Nations Millennium Development Goals, improved sanitation is defined as access to facilities that hygienically separate human excreta from human, animal, and insect contact.
2. See Franceys, Pickford, and Reed (1992) and Kalbermatten et al. (1981).

low-cost options. I also attempt to frame these low-cost options within the context of necessary considerations, primarily the need to ensure community acceptability, cost-effectiveness, and sustainability. With sanitation—even more so than with water supply—determining which option will be most effective requires weighing a complex set of variables ranging from culture and cost to geology and climate. Not only are these considerations important for efficacy and sustainability, but the lack of consideration of one variable in sanitation planning has the potential to cause serious damage to community health, exacerbating—rather than ameliorating—an already dangerous situation.

UNDERSTANDING SANITATION: COMPOSITION AND REUSE

Understanding sanitation projects requires understanding human excreta's composition, hazards to human health, and potential for reuse. Human excreta are feces and urine, which consist of proteins, carbohydrates, and fats. Excreta contain moisture, organic matter, nitrogen, phosphorous, potassium, carbon, and calcium.[3] Excreta also contain pathogens that cause infectious diseases—such as cholera, hepatitis, typhoid, schistosomiasis, and diarrhea—through fecal-oral contamination. Helminthes (worm-like parasites, including human hookworms, roundworms, and whipworms) cause gastrointestinal infections that make up part of the excreta-related global health burden (Mara, 2004). It is estimated that approximately one-third of the world population has intestinal worms (Chan, 1997). The loss of blood from a human hookworm leads to iron-deficiency anemia and protein malnutrition, particularly in women of reproductive age and children.

The discharge of untreated sewage into water resources provides a vector for pathogens capable of sickening humans and animals. Pathogenic bacteria are able to survive in bodies of water for days or weeks, and eating contaminated seafood can cause typhoid fever, infectious hepatitis A and B, polio, and cholera (GESAMP, 2001).

TABLE 1: ANNUAL EXCRETION OF ONE HUMAN, COMPARED WITH THE AMOUNT OF FERTILIZER NEEDED TO PRODUCE CEREAL

Fertilizer	500 liters urine	50 liters feces	Total Excreta	Fertilizer needed for 230 kg of cereal
Nitrogen	5.6 kg	0.009 kg	5.7 kg	5.6 kg
Phosphorous	0.4 kg	0.19 kg	0.6 kg	0.7 kg
Potassium	1.0 kg	0.17 kg	1.2 kg	1.2 kg
Total (N+P+K)	7.0 kg (94%)	0.45 kg (6%)	7.5 kg (100%)	7.5 kg (100%)

Source: Wolgast (1993), quoted in Austin & Van Vuuren (2001)

3. For a complete percentage breakdown, see Gotaas (1956) and Mara (1976).

These pathogens are particularly deadly in developing countries; diarrhea alone kills some 1.3 million children under the age of five each year. The WHO estimates that poor sanitary conditions and practices cause 85–90 percent of diarrheal cases in developing countries (Prüss-Üstün et al., 2004).

Many low-cost methods are able to treat excreta and sewage so that it can be reused. Reducing pathogens, particularly human intestinal nematodes and fecal bacteria, is the most important step in treating human waste. The WHO's guideline limit for fecal coliform bacteria is 1000 per 100 milliliters (Havelaar et al., 2001). The Endgelberg guidelines limit nematodes to no more than one egg per liter. Once these standards are met, human excreta can be reused as fertilizer or for aquaculture. Table 1 illustrates the potential value of excreta as a productive resource: One person's annual average excreta—500 liters of urine and 50 liters of feces—equals the amount of fertilizer needed to produce a year's worth of cereal for one person (230 kilograms).

DRY SANITATION METHODS

Dry sanitation methods do not use water as a carrier; instead, excreta are broken down by anaerobic methods (i.e., decomposition or dehydration). In decomposition systems, bacteria, worms, and other organisms break down urine and feces. Dehydration methods separate urine and feces, and then scatter feces with ash, shredded leaves, or sawdust to absorb excess moisture and deodorize. The added material also improves the nitrogen content in the event that the feces are reused as fertilizer.[4]

Decomposition Systems: Pit Latrines and Ventilated Improved Pit (VIP) Latrines

Pit latrines are the most rudimentary form of sanitation. Structures made out of locally available materials cover a defecation hole—a pit dug in the ground to collect waste. Once full, the pit is covered with sediment. The water table should be no less than 0.5 meters below the surface of the pit or it could contaminate the ground water. Geological conditions are a primary concern when considering a pit latrine; rocky substrates and shallow water tables negate this option for many communities, and areas with non-cohesive soils require a lined pit.

The health problems posed by pit latrines have been widely documented.[5] The open defecation hole attracts mosquitoes and flies and produces a ghastly odor. Pit latrines often serve as breeding grounds for mosquitoes, thus increasing the incidence of malaria in some areas. These adverse conditions lead many communities to abandon latrines.

Ventilated Improved Pit (VIP) latrines are an improvement over traditional latrines in two important respects: they mitigate the noxious odor and reduce the number of flies and other insects that plague users of traditional latrines. In a VIP latrine, a vent pipe allows fresh air to flow through the latrine, reducing odor. The vent also allows light into the latrine, attracting insects into the pipe, where they are trapped by the fly screen at the top of the pipe. The screen also keeps out insects looking to enter the pipe from the outside. The VIP latrine has been successfully used in Zimbabwe since the mid-1970s, where it is known as the Blair Latrine (Robinson, 2002).

4. For reviews of dry sanitation technology, see Del Porto and Steinfeld (1999), Esrey et al. (1998), and Drangert et al. (1997).
5. See, for example, Grimason et al. (2000), WHO (2004), Intermediate Technology Development Group (2003), and Bakir (2001).

Other dry decomposition options utilizing anaerobic breakdown have been developed to allow excreta to be reused for agricultural purposes. If VIP latrines are constructed with two pits, instead of moving the latrine when the pit is full, users switch to the other pit. After the waste in the full pit composts, it can be reused as fertilizer. The amount of time before the compost can be used as fertilizer depends on climate and ranges from 3–12 months.[6]

Other decomposition toilets include Reed's odorless earth closet (ROEC), the Clivus Multrum, the Pacific Island Carousel toilet, and the Mexican SIRDO. Variations in design include the use of aboveground vaults (constructed of concrete, brick, or other materials), solar energy to heat the compost, different seat designs, electric fans, mechanical vault rotation, and alternate vault locations. The vaults themselves can be emptied by hand or by mechanical means (e.g., with a vacuum). One of the lessons learned from the first Water and Sanitation Decade is the importance of keeping the latrine affordable (Cairncross, 1992). However, the product must also be desirable and able to serve the community's needs—a delicate balance.

Dehydration Systems

Dehydration systems separate urine and feces using a special pedestal or urine diversion pan. Urine is diverted into a holding pot or into a soak field, while a watertight vault collects the feces. After defecation, ash or another absorbent (e.g., lime, dry soil, husks, organic matter) is sprinkled into the vault. Material used for anal cleansing is put into another container rather than dropped into the vault. Once the vault is three-quarters full, the feces is covered with dry earth. Both the urine and the dehydrated feces can be reused as fertilizer. Urine is often used immediately, but it should ideally sit for six months to ensure that nematode eggs are destroyed. Dehydrated feces should not be used for at least a year, although case studies identify different amounts of storage time.

One advantage of dehydration systems is better groundwater protection due to the use of watertight and aboveground vaults, which can be used in areas that have geotechnical limitations. The absorbent material also helps to deodorize the chamber and reduce flies. Dehydration can be employed in a wide range of climates. Due to the specific nature of the technology, however, the most common problem is moisture entering the dehydration chamber, either from leaks, urine splashing into the chamber, or other accidental spills. Children might find the latrines more difficult to use, and blocked urine separators also pose problems.

The Vietnamese double-vault latrine has been in use since the mid-1950s, and dehydration systems can be found in South Africa, China, Mexico, El Salvador, Ecuador, Yemen, Guatemala, Ethiopia, Zimbabwe, and Sweden. Specific models include the Mexican Dry Ecological toilet, the Ethiopian EcoSan toilet, and the EcoSanRes. Depending on the materials available, the urine diversion pedestals can be constructed or prefabricated from concrete, plastic, and fiberglass. Models such as the Mexican Dry Ecological toilet can be designed for use inside a home, complete

6. Although pH level and time are the most important factors, the rate of pathogen destruction is also influenced by temperature, competition for nutrients, antibiotic action, and toxic byproducts of decomposing organisms (Winblad, 1985).

with a conventional toilet seat (Esrey et al., 2000). In Yemen, a one-chamber dehydrating toilet has been adapted for use in a building that has several floors (Winblad, 1985). Solar panels, ventilation pipes, and other building materials can be used to tailor this technology to a community's specific needs.

Health Aspects of Dry Sanitation

Unfortunately, no systematic analysis documents the rate of pathogen and nematode egg die-off in dry sanitation systems. Anne Peasey (2000) reviewed the existing literature on the subject and found that the two most influential factors are pH level and the amount of storage time needed before the material can be reused, which varied from 3–12 months. A study cited by Strauss and Blumenthal (1990) asserts that 10–12 months are needed in tropical regions, while 18 months is suggested for highland areas. Studies of the prevalence of nematode eggs also did not take into account the health of the users, which is crucial to determining whether nematode eggs were already present. This lack of information could be significant, depending on the product's end use. In areas where a proportion of the population hosts intestinal worms, secondary treatment may be necessary.

Reuse: Dry Sanitation

Both dehydrated and composted human excreta can be used for many different purposes at the community and individual levels. By selling excreta for agricultural or aquacultural use, a community can recoup the costs of its initial investment in sanitation. Excreta can serve not only as a fertilizer, but also as a soil conditioner, due to its high organic content. Many countries—including India and China—use human excreta and wastewater to help grow fish and vegetables (Edwards, 1985). Ponds using wastewater have been found to be productive, possessing high pH and oxygen levels; in addition, the fish are not susceptible to enteric bacteria (Hepher & Schroeder, in Rybcynski et al., 1982). Using excreta to grow duckweed, algae, and water hyacinth are other options; duckweed can be used in animal feed or fish food (Leng et al., 1995). Reused excreta and wastewater are increasingly recognized in Europe as valuable resources (Langergraber & Muellegger, 2001; Johansson et al., 2001).

Biogas is another way to reuse human excreta—and provide a much-needed resource. The anaerobic decomposition of human excreta produces methane gas, which can be harnessed by biogas plants to produce energy (Singh et al., 1987; Gustavsson, 2000). These plants can be designed to operate at the individual household level and produce tanks of biogas for domestic cooking and lighting. One person produces one cubic foot of biogas per day—enough to meet the daily energy needs of a person in the developing world (Food and Agriculture Organization, 1996).

WET SANITATION METHODS

Wet sanitation methods utilize water to treat waste. These methods are only recommended for communities that have liberal supplies of water. The most widely used models are the pour flush latrine, the aquaprivy, and the septic tank. These systems are usually more expensive than the VIP latrine, although some argue that the cost of the pour flush latrine is comparable. Primary treatment produces effluent and sludge; ability to reuse the effluent depends on household land-use patterns. However, a second treatment using natural processes can be easily achieved.

POUR FLUSH LATRINES

A pour flush latrine consists of a cover slab and a special pan that provides a water seal. A U-shaped pipe is used to maintain the water seal. Approximately 1–3 liters of water are needed for each flush. The latrines can be constructed with pits directly underneath or offset, or with two pits. They can also be built inside a dwelling, with the pit located outside. If properly built and maintained, pour flush latrines reduce odors and flies. They should be considered in communities where anal cleansing habits require the use of water. Disadvantages of pour flush latrines include the high water requirements, higher cost, and problems caused by clogged pipes.

The pour flush latrine is used in parts of Asia and the Caribbean, and most widely in India, where it is called the Sulabh toilet (Jha, 2005). The Sulabh toilet replaced the bucket system, saving more than 60,000 people (mostly women) from manually handling waste. In addition, public pour flush latrines connected to biogas plants generate electricity.

Aquaprivy

An aquaprivy is an underground watertight tank, filled with water, which is connected to a flush toilet or defecation hole. The tank is located directly underneath the toilet and separates solid matter from liquids. The tank can also be used to dispose of greywater. Over time, the solid matter in the tank degrades anaerobically. A soak field absorbs the effluent; however, sludge must be removed from the tank every 1–5 years. Usually a vacuum tanker or service crew performs this difficult and potentially dangerous task. A bucket of water must be poured down the drop pipe daily to clear any buildup and maintain the water seal.

Aquaprivies, found in more than 39 countries, can be set up inside a home and connected to a sewage system at a later date (Brikke et al., 1997). If operated properly, there are usually no problems with flies or odors. The tank must be maintained; if the tank is leaking, odor can become a problem. The aquaprivy, which requires the use of water, is more expensive than the sanitation methods discussed above. The soak fields used by aquaprivies and septic tanks can also cause problems, which are described below.

Septic Tank

A septic tank is similar to an aquaprivy, except that a septic tank can be located outside the house. The toilet used with a septic tank also has a U-trap water seal. As with the aquaprivies, septic tanks can be used to dispose of greywater and must be periodically emptied of sludge. They also require the use of a soak field for the secondary treatment of effluent. Septic tanks may have two chambers to separate and promote further settlement of liquid and solid excreta.

Septic tanks are more costly than aquaprivies; given the higher initial investment required, plus the recurring costs of emptying the tanks, this method is not generally recommended for poor rural communities. For peri-urban areas, the ability to connect the household to a sewage system at a later date is a major benefit. The disadvantages include faulty or leaking septic tanks, water requirements, higher costs, and the use of a soak field. If the septic tank is faulty, flooding can cause hydraulic overloading. Septic tanks are used widely across the United States; it is estimated that only 4–6 percent of these tanks are watertight. U.S. EPA (2002) estimates suggest that 10–20 percent of these systems are failing and that rates of groundwater contamination may be even higher.

Health Risks Related to Soak Fields

Soak fields, also known as soil absorption systems, treat the effluent from aquaprivies and septic tanks. A soak field is comprised of drainage ditches or gravel-lined trenches that allow effluent to percolate through the soil, achieving secondary treatment by absorption and biodegradation. A conventional soil absorption system allows the effluent from a septic tank to outflow into perforated pipe laid in the bottom of trenches two-feet deep; stoneware can also substitute for pipe.

The soak field presents health risks, as the effluent coming out of the tank could contain pathogens or nematode eggs (Wolverton & Wolverton, 2001). The effluent is potentially hazardous to humans and the area's groundwater. In addition, the effluent could overflow the trenches if it exceeds the absorptive capacity of the soil. The soak field also requires that the user possess an adequate amount of land with certain geological characteristics; septic tanks and soak fields cannot be located on a slope, in flood zones, or in areas with shallow water tables. In addition, areas with non-permeable soil do not allow the percolation necessary to achieve secondary treatment.

Other natural treatment processes have been shown to complement septic tanks and aquaprivies to achieve tertiary treatment of waste. Wolverton and Wolverton's (2001) work with phytoremediation provides one model: planting the trenches of a soak field with native semi-aquatic plants, flowers, or vegetables. This process ensures that the soak field maintains equilibrium and will not overflow; provides a safe conduit for effluent; and also produces end products that can be decorative, used for food, or sold.

LESSONS LEARNED

Given the traditionally poor performance of efforts to achieve widespread sanitation coverage, we must evaluate lessons learned. The literature I reviewed highlights several critical aspects of a sustainable sanitation program:

1. Sanitation must be addressed together with hygiene and water to fully stop disease transmission;
2. Success depends on responding to consumer demand;
3. Educating consumers on sanitation and hygiene practices is essential; and
4. Women should be involved at every level of the process.

It is not enough to provide a sanitation facility; a great deal of care must go into the "soft" aspects of a program, as successful low-cost sanitation systems must adapt to local cultural traditions and have clear project management (Evans, 2004; Manikutty, 1998). Projects should educate the broader community about sanitation and hygiene's role in stopping the transmission of disease, as well as promote consumer demand (Okin & German Agency for Technical Cooperation, 1988). Women should be incorporated into projects and involved in selecting the site and technology, as they wield major influence over children's hygienic practices (Evans, 2004). Training users to operate and maintain the technology is also critical, due to the risk of contaminating ground water with seepage from septic tanks and pit latrines, and other health risks associated with misuse of waste in closed systems.

It is important to provide a community with two or more options in the pilot phase to ascertain the acceptability of a particular technology

(Cairncross, 1992). To provide the technology at a low cost and ensure sustainability, the facilities must be constructed out of locally available materials, adhere to the land-use patterns of the community, and conform to the geotechnical demands of the area. Human excreta do not necessarily have to be waste products, but can be reused for agriculture or aquaculture. The desire of the community to reuse excreta will affect the choices and operation of a sanitation program. Sanitation programs cannot simply be transplanted, but must be molded to fit the needs of each community, and thus they rely on innovation (Cairncross, 1992).

FUTURE WORK

There are many research gaps that prevent a comprehensive understanding of sanitation technologies, including survey methods, implementation, cost-benefit analysis, and health risks within specific contexts. The health risks associated with the reuse of excreta need to be further evaluated. Researchers should study cost-incentive structures for community-based approaches and examine the roles of the stakeholders. Little research details the motivations of those who reuse human excreta and wastewater or the different modes of collaboration with stakeholders (Allison, 1998; Strauss & Blumenthal, 1990). The process of project integration and eventual scaling-up should also be considered. Many sources assert that water, sanitation, and hygiene should be approached holistically, but few case studies point the way forward. Much work has studied low-cost models for peri-urban and urban regions, particularly Mara (1996), Bakalian et al. (1994), Melo (1996), and Wolverton & Wolverton (2001); however, the process of scaling-up has not been examined. With the tremendous amount of population growth projected for these areas, research on this subject would be particularly timely.

CONCLUSION

Meeting the sanitation Millennium Development Goal will require an investment of at least $2 billion per year to mobilize the resources for 370,000 people to gain access to basic sanitation services a day until 2015 (UN Millennium Project Task Force on Water and Sanitation, 2005). This article has sought to provide an overview of current low-cost sanitation methods, covering both wet and dry technologies, in an effort to promote a broader understanding of available options. The tremendous challenge of providing services to rural areas with diverse climate, geology, water usage, and cultural practices requires innovative approaches that account for these differences. The reuse of human excreta should be considered in relation to cost-incentive structures, as well as cultural practices.

BIOGRAPHY

Alicia Hope Herron received dual master's degrees from American University and the University of Queensland in Brisbane, Australia. She is currently employed by TetraTech in Baton Rouge, LA. She previously worked for the Environmental Change and Security Program of the Woodrow Wilson International Center for Scholars. She has also been a high school English teacher, a research associate for the Mississippi Mineral Resources Institute, a graduate assistant at American University in International Relations and Cross-Cultural Communications, and an environmental education officer in the Lake Mead Recreation Area in Nevada.

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Plastic pipes twist their way through the alleys, providing a tenuous supply of freshwater to a neighborhood in the Iztapalapa district of Mexico City.

NAVIGATING THE MAINSTREAM: THE CHALLENGE OF MAKING WATER ISSUES MATTER

By J. Carl Ganter

High on the rim of the geologic bowl that is home to the 24 million residents of Mexico City, the dusk presses down over the smoggy brown haze. The nighttime yelps of street dogs ripple from rooftop to tarpaper rooftop. Like a sonic tidal wave, canine communications echo up the shores of this former lakebed and dissipate into the heavy air.

These are the sounds of the barrios in one of the world's largest metropolitan areas, where millions struggle daily for life's basic necessities. Many have come to the city in search of work, displaced from water-stressed regions such as Oaxaca, Chiapas, and Tehuacán. Here in Colonia San Miguel, a neighborhood in the Mexico City municipality of Iztapalapa, water systems struggle to keep up with burgeoning demand.

It's just after lunch on Valentine's Day. A clapboard door along the street swings open to reveal a muddy stoop of three adjacent shacks where Fidel and Emilia Silva are getting their grandchildren ready for school.

Carlos and Luis, seven and eight years old, grab their pencils and skip ahead of Fidel and Emilia. They wind through the churchyard and past cramped *panería* and tortilla shops before reaching the heavy steel gate that separates the playground from the busy city street. Emilia hugs the boys and Fidel watches proudly as teachers greet the children and disappear inside. The pride in his eyes soon turns to a grandfather's pain as he notices that other children clutch flowers in tiny hands, humble gifts for their teachers. He'd forgotten this Valentine's Day tradition. Quietly distraught, he finds a corner vendor selling red roses and buys two. He begs for the attention of the schoolmaster, who unlocks the chain on the gate and promises to deliver the roses to Carlos and Luis's teachers.

Back at the Silvas' austere home, Emilia hangs clothes out to dry. Many of her neighbors live side-by-side in cramped shacks made of corroded metal sheets, decaying tarpaper, and cement bricks. Most pieces of the homes are scavenged from junk piles, and electricity comes from a spiderweb of wires clipped dangerously to power lines above.

To Emilia's side, five rusting containers hold about 200 gallons of turbid water near her makeshift kitchen and laundry tubs. These tanks must supply enough water for the family's needs for the entire week.

The water flows for only one hour from a fragile plastic tube emerging from the dirt, and that single hour comes only once every seven days, says Fidel, sitting on the edge of a stone wall where similar shanties interlock like stair steps 20 feet below. Sunday morning, about one o'clock, the water trickles out, he says, precious for washing clothes, bathing, and flushing the toilet when they can no longer stand the reek. But this trickle is not safe to drink.

Vendors travel daily throughout the neighborhoods, passing on the street just below, yelling, "Water for sale!" They sell five-gallon containers of water for seven and a half pesos (about 71 cents). For Emilia, the expense can be a crippling portion of the family's income, which is derived from odd jobs and her daughter-in-law's work at the *lechería*, a nearby dairy.

The evening darkness brings warnings of street gangs, and even the dogs are on edge, nipping and snarling at strangers. While the family eats a handful of tortillas and boiled meat before bedtime, Emilio latches the street-side door with a thin strand of wire, a meager gesture of security against the threats of the night.

A PROLIFERATION OF NEED

For all the advances of the new millennium, 1 of every 6 people still labors to carry water to their home, and 1 in 3—like the Silva family—lives in an area of moderate to high water stress, generally in the same regions where population growth is the highest.[1]

"A communications and computer revolution is sweeping the globe," writes Peter H. Gleick (2000), co-founder of the Pacific Institute for Studies in Development, Environment, and Security, in his biennial report, *The World's Water*. "International financial markets and industries are increasingly integrated and connected. Efforts are being made to ensure regional and global security. In this context, our inability to meet the most basic water requirements of billions of people has resulted in enormous human suffering and tragedy and is one of the 20th century's greatest failures" (page 15).

Projections of freshwater supplies worldwide warn that resources will not meet the proliferation of need, which is spurred by the pressures of population, industry, agriculture, climate change, and the excesses of waste. Increasing incidents of shortage, from New Delhi to New England to Mexico, provide glimpses of a world water crisis that is advancing inexorably upon civilization, gathering menace with every step.

OF WILL AND LEADERSHIP

Why, then, does water fail to rally a forceful, sustained response from the collective global consciousness? It is not an absence of solutions, or even a lack of opportunities. In his book *Collapse: How Societies Choose to Fail or Succeed,* Pulitzer Prize-winning scientist Jared Diamond argues that civilization is poised at a unique, perilous moment in history. While we face threats of a scale unimagined by our ancestors, we also hold the keys to survival: the technology to solve our problems, and the ability to communicate the solutions and the sense of urgency.

"We are not beset by insoluble problems," says Diamond (2005). "While we do face big risks, the most serious ones are not ones beyond our control…The future is up for grabs, lying in our own hands. We don't need new technologies to solve our problems; while new technologies can make some contribution, for the most part we 'just'

1. In Iztapalapa, most of the infrastructure to bring water to families like the Silvas exists, but the deep supply wells, according to engineers who provided a tour of the region, cannot keep up with demand. Mexico City's wealthier neighborhoods rely on the constant flow of the Cutzamala water system, massive pipelines winding into the city from dams like the one in Valle de Bravo, 95 miles away.

need the political will to apply solutions already available" (pages 521–522).

Political will, that potent elusive force, flows in both directions. It can build from the ground up or arc from on high—from the pressure of public opinion or the impetus of leadership. It can be a flash storm or a slow sea change in the climate of self-governance.

As many pundits have shown, predicting (or influencing) political will is about as easy as divining the weather. Favorable conditions for action often meet with unforeseen events, or underestimated fronts. Authentic, focused, and productive political will requires the same sort of concatenation of circumstances needed for the perfect storm.

Average citizens, the fundamental units of public opinion, are often too preoccupied with the daily demands of life, whether that is finding food and water, working two jobs to support a family (or lifestyle), participating in local issues, or being distracted by other needs and wants. Unless water issues directly affect their lives—and as long as safe and affordable water comes through the tap—people tend to take water as a given.

WATER: NOT ON THE TABLE

"In the developed world, average people are not substantively engaged in the water issues that are defining the quality of their lives," says Karin Krchnak, co-chair of the Global Water Partnership and director of international freshwater programs for The Nature Conservancy. "While many coordinated efforts of NGOs and governments around the world strive to protect our fragile freshwater systems, their efforts fall short. Broad-platform public awareness and support remain woefully inadequate to mobilize the necessary political will on the largest scale" (personal communication, July 2004).

In their critical evaluation of the "post-environmental" world, 2004's "The Death of Environmentalism," strategists Michael Shellenberger and Ted Nordhaus observe that even though most Americans are concerned about their environment, it is not a priority. This personal perspective is reflected in the political realm, where environmentalism has, in essence, atrophied into a special interest. It no longer captures the popular attention. Without a public mandate, environmental concerns fail to command action in society, even when the dangers are great and the solutions are accessible.

Mark Van Putten, founder of Conservation Strategies in Washington, D.C., wrote in 2004:

> *The missing ingredient is leadership....We know most (but not all) of what the problems are and a good deal about where they are. We have knowledge and expertise to begin to tackle them. We have developed excellent concepts, such as equity and sustainability. Yet inertia at leadership level, and a world population not fully aware of the scale of the problem (and in many cases not sufficiently empowered to do much about it) means we fail to take the timely corrective actions and put the concepts to work. (page 29)*

This "leadership inertia" has similar roots to the inertia of the citizenry. A water crisis is subtle, not sexy. It's not a mainstream topic. It is slow to unfold, hard to comprehend, and, until the taps run dry, not very relevant to the very people who have the most power to avert it. Additionally, political and economic leaders have an incentive not to draw attention to the fact that freshwater is vanishing at an astonishing rate: fear of the politi-

cal fallout should the public seize upon the notion of a world water crisis.

Peter Goldmark (2001), former chairman and CEO of the *International Herald Tribune*, claims that powerful forces conspire to keep important issues such as water off the table. "In the case of the environment, a strange and uneasy alliance of business and government—often fierce antagonists in other arenas—simply does not want to face the scale, cost, and dislocation implied by the changed models of economic production and consumption that would be required to respond seriously to environmental deterioration" (page 8).

The inextricable corollary to safe drinking water—sanitation—is even more vexing to communicate. For example, the cost of cleaning up the United States' Great Lakes is estimated at $20 billion. But few members of advocacy groups see straightforward ways to raise the funds required to fix aging municipal sewer systems and other mostly invisible—but crucial—threats to the 20 percent of the world's freshwater stored in the lakes.

AGGREGATING AN ISSUE

Mayer Zald, an authority on social change and professor emeritus at the University of Michigan, is one of the founders of the "resource mobilization" approach to the study of social movements, which he says can be applied to issues like water: "As long as [the water issue] doesn't aggregate, it will be dispersed within local issues. It won't be transformed into a kind of call for broader policies and long-term issues, rather than just a problem of X state and X city. Getting that aggregation is in some ways the challenge" (personal communication, June 24, 2004).

Playing a part in that aggregation—reaching the public mandate—are two entities that work in the realm between the individual and the government: NGOs and the news media. In the boardrooms and in the trenches, NGOs have been hammering away at the policies, programs, and perceptions that frame humanity's response to water concerns.

LACKING A PUBLIC CONSTITUENCY

Shellenberger and Nordhaus struck a nerve in the NGO world when they asserted in "Death of Environmentalism" that environmental organizations were out of touch with mainstream values, acting symptomatically instead of holistically, unable to grapple with the symbiosis of policy and politics. The introduction to *U.S. in the World: Talking Global Issues with Americans* also made this point:

> *The sense of urgency we feel today has led us and others working on global issues to acknowledge that whatever we have been doing to reach out to the American public, and however successful we have been in engaging citizens in discrete policy debates, it is simply not enough. At a time when our country faces fundamental questions of national identity and purpose, we still lack a broad, bipartisan public constituency for pragmatic, principled, effective, and cooperative U.S. global engagement. (Heinz & Isaacson, 2004, page 3)*

It will be informative to follow the progress of the Water for the Poor Act, which President George W. Bush signed into law on December 1, 2005. The Act makes increasing affordable, equi-

table access to safe water and sanitation a major purpose of U.S. foreign assistance efforts. It calls for increased funding for water and sanitation, and supports innovative funding mechanisms, greater international coordination, and better integration of water and sanitation into other development efforts. Finally, it requires the secretary of State to develop a strategy to meet specific goals and benchmarks on the way to halving the percentage of people without access to safe water and sanitation.[2]

Passed in the House by a vote of 319–34, the Act is the first bill to write a United Nations Millennium Development Goal into law. The National Wildlife Federation (2005), which played an active role in the bill's process, declared it "a victory for people and wildlife worldwide," and with the current administration's reach of influence, the potential is great. But if there is no attempt to sustain political will, those close to the legislation fear that it will exist only as unfunded window-dressing—a curtain, perhaps, obscuring the greater need for action.

MIA IN THE MEDIA

A Google search conducted six weeks after the bill was signed, and using the terms "Water for the Poor Act" and "Bush," turned up 212 matches—none of them from news organizations, whose role in our self-governing society is to alert and inform its citizens. Many people directly and indirectly involved in the legislation's process privately lamented the lack of media interest in the bill, as well as the failure of organizers to use established channels to widely spread the news.

With neighbors' help, this resident of San Juan Tlacotenco and her family built a dry sanitation outhouse.

Water NGOs, by their nature, promote an agenda, with specific behaviors, policies, and goals in mind. The news media have a different role to play, and it includes creating a platform for public discussion. Known as the Fourth Estate, the free press has traditionally served as a balance to the three branches of government, a watchdog to ensure accountability. Its role in the democratic process is profound: to inform and enlighten citizens without fear or favor, to frame the issues of the day, and to explore the concerns of tomorrow. Traditionally, journalists have professed to adhere to a code of unbiased and balanced reportage. Today, the distinction between news and opinion, between information and entertainment, has been blurred, and the public is increasingly left to determine fact or fiction on its own.

2. For more information on the Water for the Poor Act, see U.S. Representative Earl Blumenauer's website, at http://blumenauer.house.gov/Issues/ Issue.aspx?SubIssueID=129

A number of factors come into play: the consolidation of the media—owned by fewer and increasingly powerful, homogenous entities; a push for higher revenues and lower costs (making coverage of complex, long-term global issues difficult); the resulting tendency to offer coverage that is an "easy sell," favoring sensationalism over substance.

"They're in a competitive business," observes Tom Brokaw, recently retired from his 21-year anchor position at "NBC Nightly News." The pressure is intense to generate an audience, he said, sitting on the sofa in his Rockefeller Center office:

> *You're not in the business to drive viewers away, you're in a business to get people to watch you. You can't get around that reality. News ought not to be just about 'eat your spinach.' I was looking at the* New York Times *today—the very dramatic picture on the front page, they've gone to color, they're finding very striking photographs. They're not doing that because they think this is in the interest of journalistic purity. They're doing it because they're in a heated battle to retain circulation, and to get people to keep coming back to the paper. So it is always that funny little Faustian bargain that you have to make. (personal communication, June 8, 2005)*

TROUBLE WITH "HEAVY" ISSUES

The media's balancing act discourages coverage of "heavy" issues such as the environment, social justice, and economics—all of which relate to water. According to Peter Goldmark (2001), good journalists "help frame the terms of public debate and they leave behind benchmarks against which future actions and utterances by public leaders are measured, and we are not doing that now. We are not covering the real movement of the tectonic plates in the landscape around us" (page 13).

Photojournalist Brent Stirton, a South African who has covered most recent wars, famines, and major international news events for Getty Images, agrees. "Our leaders are not focused enough on water resources. We're living in a false paradise and there will be consequences. In Mexico, for example, you can make the direct connection between a lack of water in rural areas, a consequent lack of opportunity, and increasing migration toward the U.S." (personal communication, February 23, 2006).

The proliferation of news sources, from network broadcasts to online podcasts, offers a multiplicity of information and perspectives that may further burden citizens who are already distancing themselves from an overload of data. Americans no longer have a Walter Cronkite to tell them "the way it is" by prioritizing and editing the concerns of life. In effect, the informational evening meal has been transformed into the all-you-can-eat buffet. The fries are always hot, and no one will force you to eat the spinach.

Carlos Silva plays near the tanks that hold his family's week-long supply of freshwater.

REACHING FOR THE MAINSTREAM

When do water issues reach into the mainstream, the fertile environment for political will? A good story—something with drama that rises above the background hum—will capture attention. An event, tragic or amazing, that tells us something about ourselves as a people—the flooding of New Orleans, the East Asia tsunami can offer a compelling, though regrettably fleeting, public frame for larger issues. In the case of the tsunami, the larger, long-term story was nearly missed and is already fading from the radar screen.

"One of the things the tsunami has shown us is how absolutely vital water is to every aspect to human survival, from the prevention of disease to simply providing drinking water so people can live," Peter Gleick (2005) told National Public Radio's "Morning Edition." "But it's also shown us that large numbers of people who live in the tsunami-affected areas not only don't have clean drinking water and sanitation, but they haven't had it for a long time. They've never had it. Ironically, in the countries hardest hit by the tsunami, there are and have been 200 million people without access to clean drinking water on a day-to-day basis anyway."

LINKING AND FRAMING VALUES

Water—often tagged simply an "environment," "health," or "social justice" concern—cannot be reduced to a subset of life, as it is inextricably linked to every aspect. From economy to gender equality to border security, water is not just an environmental issue.

The failure of current environmentalism, Shellenberger and Nordhaus (2004) hold, is a failure to find "deeper causes or connections with other root causes" (page 15). They believe we need to reunite what is pigeonholed as "environmental" with all the other aspects of everyday life, building upon the core values that influence behavior, politics, and policy. But this goes against the established practices of the day: "In their public campaigns, not one of America's environmental leaders is articulating a vision of the future commensurate with the magnitude of the crisis. Instead they are promoting…proposals that provide neither the popular inspiration nor the political alliances the community needs to deal with the problem" (page 6).

NEW PARADIGMS, SOCIAL CHANGES

Making water stewardship a mainstream concern of the global community requires nothing short of a new paradigm for social change. This paradigm must recognize the needs and unite the strengths of citizens, leaders, NGOs, and the news media.

This new approach emphasizes relevance, establishes an appropriate scope, creates or identifies major events, involves varied talents and disciplines, develops new uses of proven techniques, and pioneers communications and information tools. This paradigm should draw strength from societal values and involve new, coordinated "power constituencies" such as business and popular culture—and it should cultivate hope for a better future.

It seems inconceivable that nations and individuals would not be deeply concerned with the welfare of our water supplies. But in his bestselling book *The Tipping Point*, Malcolm Gladwell (2000) points out that an idea—for example, water stewardship—is only the germ of human communication. Every important issue needs a "tipping point" to effect change. "Ideas and products and messages and behaviors spread just like viruses do…In order to be capable of sparking epidemics,

ideas have to be memorable and move us to action"(page 7). They must be spread by the right people, in the right form, under the right conditions.

TELLING STORIES, MAKING IT PERSONAL

One sure way to make water issues meaningful to people is by telling good stories. "You can take on these subjects and do them in a way that will be appealing to people, that will get them involved in it," says Tom Brokaw (personal communication, June 8, 2005). "You've got to make it personal. The abstract is wonderful if you're sitting in a library in an academy somewhere, or you're on an airplane by yourself and you're reading it, but the attention span of the American news consumer, print or electronic, these days is in milliseconds, so you have to reach out and get 'em. Journalism's always about storytelling. It always is. Watergate was a whodunnit."

Beyond journalism's ability to engage citizens, of course, is its power to reach them in sufficient numbers. Successfully modifying collective behavior requires "collaborative action on a global scale," Goldmark maintains (2001, page 11). "And that cannot happen and will not happen without the indispensable fuel, the critical catalyst of independent journalism."

BEYOND THE "NEWS HOOK"

A successful approach to social change must recognize the power of events to frame issues and to initiate mass movements, and offer newsworthy "hooks" for public attention. The news media thrives on compelling content, and the number of stories that put a face on water issues is as great as the ways in which water touches our lives. Truly imaginative and extraordinary events that speak to the "adventure" of confronting water challenges are powerful opportunities for awareness.

Earth Day 1970 "galvanized environmentalism into the national consciousness," writes Andrew J. Hoffman (quoted in Zald, 2004, page 29). Such attention raises the public profile of NGOs, which are established resources for identifying problems and presenting solutions. Independent events such as Live AID and "We Are the World" garnered coverage as legitimate news stories, but also provided a neutral zone for groups to collaborate, creating a critical mass that increased impact.

Of course, in the interest of journalistic integrity, a strict separation must be maintained between the news media and any entity that has an agenda other than engaging and informing citizens. A forum for public discourse encourages all ideas; those that public values most will represent the common will.

A SPECTRUM OF TALENT AND PASSION

Raising the profile of water requires a new approach, one that will counter the special interest "environment" label by connecting water to all fields—from education to economics, from social security to national security. Unlike narrow "policy fix" orientations, this approach would seek to explore the areas where water intersects with all aspects of life, tapping the expertise of all sectors of society.

To create a social movement—within the disparate organizations, cultures, and issues related to water—activities should involve an unprecedented spectrum of talent and passion, including leading communicators, scholars, and professionals. They should embrace the widest channels of social dialogue, from the fine arts to popular culture.

Such coverage of water issues should naturally include emerging communication trends such as

blogging and other channels. In his article "Abandoning the News," Merrill Brown (2005), former editor-in-chief and senior vice president of MSNBC.com, relates the findings of a study of 18–29 year-olds: "What the survey data (gathered by Carnegie Corporation of New York)—as well as the message that's coming in loud and clear from bloggers and their readers—are telling us is that there are new forms of participatory or citizen journalism that can engage those who had been outside today's news environments" (page 5). Brown, who currently directs the NEWS21 initiative, warns, "Without a new openness to new approaches, the news industry is in peril.... A turnaround is certainly possible, but only for those news organizations willing to invest time, thought, and resources into engaging their audiences, especially younger consumers (page 5).

Photojournalist Brent Stirton, who believes that water, poverty, and religion conspire to create many of the world's most abhorrent tragedies, says there is hope for the news media, but it will take determination. "Right now our world seems very caught up in the 24-hour news cycle, and it's just like a distraction. It's astonishing. We [have] essentially become pawns in that game. But impotence is a choice. Covering an issue like water is saying, 'OK, there really are bigger issues at stake here'" (personal communication, February 23, 2006).

FRAMING WATER: IDENTIFYING VALUES, PERCEPTIONS

Efforts to frame water issues for public discourse would benefit from the type of research marketing firms do to identify values and perceptions. A vital component of this method is creating a platform for leaders to put forth meaningful, enforceable policy. David Sandalow—a Brookings Institution scholar and assistant secretary of State for oceans, environment, and science in the Clinton Administration—sees the challenge of recasting water as an issue, especially for the media. But, he adds, with the right approach, "Water is an opportunity for right and left coalitions, even in today's political realm" (personal communication, November 18, 2004).

Diplomatic opportunities for water-related issues are unprecedented, Ambassador Harriett C. Babbitt (2006), co-chair of the Aspen Institute forum "Silent Tsunami: The Urgent Need for Clean Water and Sanitation," told an audience at the Aspen Institute Ideas Festival: "We know that we in the U.S. have lost great deal of moral authority around the world. But if we galvanize around an issue such as water, that's a very strong platform."

The other "body of power," the corporate realm—which in today's world wields comparable influence to the political sphere—is awakening to water issues. Companies such as Coca-Cola and General Electric (GE) have visible campaigns and interests in the issue. Influential membership organizations such as the Business Roundtable, United Nations Foundation, and Rotary International have chosen to pursue special initiatives on water.

Just as politicians are motivated by their own convictions, interest groups, and public opinion, corporations have their own codes of conduct, as well as economic incentives to enact certain policies. The growing trend of "corporate social responsibility" (CSR) will play heavily in water's future. Such efforts invest companies in water stewardship—they make businesses less wasteful and more efficient, and they can make products and services more appealing to customers. And they encourage openness, trust, and transparency.

Feeding hand-tended irrigation trenches, water flows plentifully from the ground, often from clear springs that are eventually captured by the Cutzamala system to sate Mexico City's thirst.

SEEDS OF CHANGE?

In the years since Zald's report and Shellenberger and Nordhaus' sharp critique, there are some signs of change, indications that the "story"—told through the media, NGOs, and corporate outlets—may be generating solutions to significant global challenges such as water. For example, in a New York hotel ballroom on a sunny September afternoon in 2005, 800 of the world's most successful businessmen and women, NGO executives, and political leaders convened to test a new idea of former president Bill Clinton.

The Clinton Global Initiative attracted a "who's who" of attendees, including Fortune 100 company chairmen, Nobel laureates, and world leaders, who pledged more than $2.5 billion in combined funds and resources to address poverty, climate change, religious conflict, and governance issues. The construct was simple: spend three days learning from one another and do not leave without making a significant commitment to solve a specific quandary.

This remarkable success was exceeded by the second round in September 2006, which garnered more than $7.3 billion in pledges. First Lady Laura Bush opened the session with the first commitment, a $16.4 million joint effort by the U.S. Agency for International Development (USAID), the President's Emergency Plan for AIDS Relief (PEPFAR), and foundations to bring clean drinking water to communities in sub-Saharan Africa.

Predicted financial gains are also motivating new actors. *The New York Times* and others report growing investments in water technologies and infrastructure: "Most analysts expect the water market in the United States to be worth at least $150 billion by 2010" (Deutsch, 2006). And China alone expects to spend $125.5 billion on water and sanitation by 2010.

Bennett Freeman, former managing director for CSR at public relations giant Burson-Marsteller and a former deputy assistant secretary of State, sees the need to merge bottom-line opportunities with CSR and build coalitions of environmental NGOs, humanitarian groups, political leaders, corporations, and the public. Water, he says, is a particularly challenging and complex problem, and is difficult to label with a universal slogan. "But it's also an issue where companies can demonstrate they're 'walking the talk'" (personal communication, November 18, 2004).

GE is certainly walking the talk, reaping the rewards of its new "Ecomagination" campaign, which publicizes its efforts to benefit the environment through creative thinking and innovative products. The corporation's commitment, observes

Brokaw, former news anchor for GE-owned NBC, "is pretty substantial because it's good business" (personal communication, June 8, 2005). "Green is green," GE Chairman Jeffrey Immelt told the Clinton Global Initiative audience in 2005, referring to the economic benefits of "doing the right thing." GE understands, as Zald puts it, that "movements are made of conscience constituencies, which are all over the place. In today's world, you have to capture the imagination" (personal communication, June 24, 2005).

Ethos Water, a subsidiary of Starbucks, includes a call to action on each bottle of water it sells. "We saw an opportunity to create a brand with emotional appeal," recalls Jonathan Greenblatt, Ethos' co-founder. "If we could convert 5,000 Starbucks into classrooms…perhaps we could enable activism and build momentum. We have the chance to move the needle of awareness." Ethos Water bottles, he says, inform with a compelling story, leaving consumers with a positive feeling of participation (Greenblatt, 2006).

SUMMONING TRANSFORMATIVE IDEAS

Summoning the transformative power of ideas is a critical component of social change, and a compelling one. As Shellenberger and Nordhaus (2004) point out, "The world's most effective leaders are not issue-identified but rather vision and value-identified. These leaders distinguish themselves by inspiring hope against fear, love against injustice, and power against powerlessness. A positive, transformative vision doesn't just inspire, it also creates the cognitive space for assumptions to be challenged and new ideas to surface" (page 31). Such a vision accentuates the positive: "Imagine how history would have turned out had King given an 'I have a nightmare' speech instead."

Ambassador Babbitt (2006) also summons the transformative power of ideas to tackle water issues: "I hope that we have a perfect storm in the positive sense. The single most important element is political will."

EMPOWERING VISION WITH EFFORT

Even with the discussion of engineered movements, growing "green" markets for companies such as GE and Starbucks, and a more vigorous press, there exist no simple "bullet-point" answers that will solve the communications and public awareness dilemmas of the global freshwater crisis and other long-term, slow-onset problems. It will take unprecedented, dedicated efforts to make the issues personal and relevant, to connect humanity through the simple dramas of life, faith, and culture such as the simple gesture of a flower on Valentine's Day in a Mexico City barrio. And it will take committed journalists, such as Brent Stirton, who are using their visual and storytelling talents to bring the frontlines of the world's challenges to readers of the world's major magazines.

A movement for social change builds upon successful methods as it explores the potential for new ones. It embraces a diversity of views, pursues relevancy, excites interest, expands discussion, involves expertise, engages broad constituencies, and inspires possibilities. Is there an opportunity for such an approach in an atmosphere of divergent audiences and compressed communications? Or has the window of opportunity already closed, and the global freshwater crisis joined the other critical sustainability issues that are being diluted by their very ubiquity and the public's distraction?

"Just for once," Stirton says, "I'd really like to say to some mother or father who has just lost a child

to some ridiculous lack of resource, some ridiculous lack of medicine, a ridiculous lack of water, I'd just like to be able to say that there really is a plan out there, that things will change within their lifetime" (personal communication, February 23, 2006).

BIOGRAPHY

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A woman demonstrates a correct water filtering technique during a Guinea worm eradication outreach activity in Niessega, Burkina Faso.

CLOSING THE GAPS: IMPROVING THE PROVISION OF WATER AND SANITATION

By Charlotte Youngblood and Geoffrey Dabelko

Water Stories: Expanding Opportunities in Small-Scale Water and Sanitation Projects outlines a range of approaches that are helping close gaps in water and sanitation coverage. Rather than focus on traditional large-scale projects, Wilson Center working group members investigated small-scale and under-researched approaches and stakeholders, including communities, NGOs, and the media. *Water Stories* suggests that these approaches and stakeholders are more than marginally important in expanding coverage—they are critical.

The research, site visits, and dialogue commissioned and conducted by the Wilson Center's Navigating Peace Initiative revealed many insights, including the need to:

- **Invest in community-based and small-scale approaches** in water and sanitation. Such efforts have shown significant success to date and warrant renewed and more regular attention; to meet water needs in a sustainable way, development portfolios must be diversified to include community-based and small-scale approaches. Effective diversification and implementation will require systematic research and communication.
- **Increase funding for sanitation, especially small-scale projects.** Sanitation has been severely under-funded and is still a "taboo" topic in some development circles. The international development community should not only increase funding for sanitation programs, but should also consider systematically supporting and implementing small-scale sanitation programs that sustainably and safely dispose of waste, as well as take advantage of its potential for reuse.
- **Use the media and communication tools to catalyze political will to address water and sanitation problems.** Communication efforts could help translate research results and lessons learned into information that communities and donors can use to implement safer, more effective, and sustainable programs. The media could help increase public participation, which also plays an important role in garnering political will.

COMMUNITY-BASED AND SMALL-SCALE APPROACHES: GETTING BACK TO BASICS

In the global environmental field, a perceptible shift toward viewing the world as an interconnected whole has led to better-integrated approaches. In sanitation, for example, there is a growing interest in "closed loop" solutions such as ecological sanitation, which reuses waste. As we recognize the potential for reusing our resources, we also start to see the potential for reusing our knowledge base, informed by centuries of experience in communities worldwide.

Concepts such as "community management" and "participatory approaches" are not new. Community management has often been a central organizing factor in societal decision-making, and community management and participation have appeared in development discourse since at least the 1960s. Throughout the 1990s and up to the present, community management has been a key underlying principle of water and sanitation programs; it was even identified as a guiding principle of Agenda 21, the comprehensive sustainable development plan adopted at the 1992 Earth Summit in Rio de Janeiro.

Although community management and participation have long been identified as important factors, many community resources remain untapped. As John Oldfield points out in "Community-Based Approaches to Water and Sanitation," many age-old methods may still be extremely effective: "Rainwater harvesting is a millennia-old method of meeting water supply needs. Yet many of the NGOs surveyed suggested that rural villages should take a new look at this proven practice. Its benefits include lessening the stress on groundwater tables, drastically reducing the need to treat water, and solving the problem of many rural communities whose traditional water supplies disappear during the dry season" (Oldfield, page 54). In meetings with foundation representatives in Mexico City in February 2005, the Navigating Peace working group learned that foundations had been implementing water projects in Mexican communities for years before they discovered that community "water councils" could provide critical information about land and culture that could help make the projects far more successful (Deborah Barry, personal communication, February 2005).

It is also important to consider the scale of projects. While there is avid debate about "large" vs. "small" projects, we lack the information necessary to evaluate the potential of a range of small-scale programs. As Oldfield points out, "While a great deal of literature addresses the challenges of small-scale, rural projects on water, sanitation, and hygiene, there is a dearth of accessible research bringing together the work of multiple organizations, highlighting the strengths and weaknesses of differing approaches to the task" (page 40).

In "Household Water Treatment and Safe Storage Options in Developing Countries," Danielle Lantagne and her co-authors examine one category of small-scale interventions, looking at five household water treatment options—chlorination, filtration (biosand and ceramic), solar disinfection, combined filtration/chlorination, and combined flocculation/chlorination—and evaluate their respective strengths and weaknesses. They conclude that household water treatment and safe storage (HWTS) systems "are proven, low-cost interventions that have the potential to provide safe water to those who will not have access to safe water sources in the near term, and thus significantly reduce morbidity due to waterborne diseases and improve the quality of life" (Lantagne et al., page 34). Accurately assessing the appropriateness of HWTS systems, however, requires further research, including performing health impact studies; developing performance measures; investigating the economic considerations needed to scale up; and determining the optimal combination of HWTS options and other water, sanitation, and hygiene (WASH) interventions (page 33).

Donors will need to adapt their financing mechanisms to support small-scale, community-

based efforts. Funding generally favors water over sanitation, middle-income countries over the poorest, and large-scale infrastructure over small-scale solutions. As the introduction notes, "Of the total aid in 2000–2001 [to developing countries], only 12 percent was given to countries where less than 60 percent of the population had access to an improved water source" (Herron and Dabelko, page 3). Moreover, although the importance of behavior has been identified time and time again, especially for improving hygiene, only 0.2 percent of official development assistance in water and sanitation went to education and training. Such funding biases persist despite the evidence supporting the effectiveness of small-scale, participatory projects.

SANITATION: TIME TO CLEAN UP OUR ACT

The "taboo" on sanitation has led to unmitigated disaster. While the international development community tiptoes around it, the World Health Organization and UNICEF suggest that performance will have to increase 90 percent by 2015 to fulfill the Millennium Development Goal(s), which will still only reach half of those lacking sanitation (Herron, page 59). The international development community, in partnership with governments, the private sector, and civil society, can no longer afford to underplay the role that waste management plays in community health and dignity.

Although discussions of the importance of sanitation have noticeably increased in international fora, sanitation has yet to receive adequate attention or funding. Most funders show a significant bias toward large-scale projects; in "Low-Cost Sanitation: An Overview of Available Methods," Alicia Hope Herron points out that "most of the World Bank's portfolio of $2.6 billion—the largest in the field—funds 'traditional' sewage and wastewater treatment operations for urban populations" (page 59). Yet, traditional, large-scale sewage treatment options will not be viable for many of the underserved populations. "Since 2 billion of the 2.6 billion people lacking sanitation live in rural areas, we must complement large-scale urban investments with low-cost, on-site technologies that target rural communities (UN Economic and Social Council, 2005)" (page 59).

Luckily, a variety of viable, innovative, and effective small-scale sanitation options are available, including those that take advantage of nutrient-rich waste for agriculture and aquaculture, and those that utilize methane gas byproduct as fuel. However, Herron notes the danger of poorly designed or implemented systems. A complex set of variables—including climate, geology, and culture—must be assessed to prevent serious damage to community and environmental health, and to ensure efficacy and user acceptance: "It is not enough to provide a sanitation facility; a great deal of care must go into the 'soft' aspects of a program, as successful low-cost sanitation systems must adapt to local cultural traditions and have clear project management" (page 65).

MOMENTUM THROUGH MESSAGE: A NEW PARADIGM

Public understanding of water and sanitation challenges is critical for actions to be effective. As J. Carl Ganter observes in "Navigating the Mainstream," people tend to "take water as a given" (Ganter, page 73). Until those who have access to water and sanitation begin to take the problem seriously, it will be very difficult to garner the political will necessary to move forward.

Ganter outlines a key role for the media: by more effectively telling stories about water and sanitation, they could catalyze action. He also notes that the "water message" poses a problem for journalists: water and sanitation do not lend themselves to "sexy" storytelling. Yet, the stories must be told—and told well—to mobilize the public, and, in turn, leaders of all stripes. According to Ganter, we just need to find the right "hook": "The news media thrives on compelling content....Truly imaginative and extraordinary events that speak to the 'adventure' of confronting water challenges are powerful opportunities for awareness" (page 78).

Ganter quotes Jared Diamond: "We don't need new technologies to solve our problems; while new technologies can make some contribution, for the most part we 'just' need the political will to apply solutions already available" (page 72). As Ganter points out, the communication challenge is larger than media alone: "Making water stewardship a mainstream concern of the global community requires nothing short of a new paradigm for social change. This paradigm must both recognize the needs—and unite the strengths—of citizens, leaders, NGOs, and the news media" (page 77).

MORE WAYS FORWARD

- **Do not exclude "traditional" stakeholders:** *Expanding Opportunities* chose to focus on non-traditional projects and stakeholders. However, the importance of more traditional stakeholders, especially governmental actors, cannot be overstated. In policy design, funding, implementation, and long-term sustainability, local and national government involvement are critical to long-term success. In addition, the private sector, although also largely outside the purview of this publication, plays unique roles in funding and implementing projects. Further research on both governmental and private sector involvement is required to systematically address the vast gaps in provision.
- **Integrate environmental impacts:** Every water and sanitation decision has an environmental impact, which is often forgotten in program design. Sustainable, long-term projects must integrate environmental impact; good examples include Integrated Water Resources Management and Ecological Sanitation programs, which attempt to combine social as well as environmental perspectives. Further research into these and other methods will help programmers effectively design integrated approaches.
- **Approach water, sanitation, and hygiene holistically:** Integrating water, sanitation, and hygiene programs is also important. As Herron points out, "few case studies point the way forward" (page 66); further research in integrating water, sanitation, and hygiene programs in poverty alleviation and environmental protection is desperately needed.

CONCLUSION: TAKE ADVANTAGE OF THE UNPRECEDENTED OPPORTUNITIES TO EXPAND COVERAGE

"It is not easy: sustainable development for water, sanitation, and hygiene requires thoughtful design, well-managed project implementation, and extensive local capacity building," Oldfield observes (page 39). On the other hand, as the UN Development Programme stated in its 2006 report *Water Supply and Sanitation for All*, "expanding water and sanitation coverage is not

rocket science; it requires neither colossal sums of money nor breakthrough scientific discoveries and dramatic technological advances" (page 6). Closing research and communication gaps and investing in a variety of methods, financing mechanisms, and stakeholders will go a long way toward full coverage. Building on a strong foundation, a coalition of actors must revisit "old" ideas—and add more funding, modern communication channels, and innovative technologies—to expand access to safe water and sanitation.

While there is no "silver bullet" to magically expand access to safe water and sanitation, the challenge offers an unprecedented opportunity for a range of cost-effective, cooperative solutions. Expanding coverage will require considerably more funding than is currently available, yet we can see results from programs with extraordinarily low costs. It will take technological advances, yet sometimes technology will not be necessary at all. It will benefit from market-based incentives and private-sector investment in some areas, government funding in others, and in some cases, from community-based strategies that need no government or private sector participation. Widespread public mobilization will undoubtedly help build political will, yet much can be done now, even as we work to build broader social awareness. We have the necessary tools. Our challenge is to use them better.

BIOGRAPHIES

Geoffrey Dabelko is director of the Environmental Change and Security Program (ECSP), a nonpartisan policy forum on environment, population, and security issues at the Woodrow Wilson International Center for Scholars in Washington, DC. For the past 12 years, he has helped facilitate dialogue among policymakers, practitioners, and scholars grappling with the complex connections linking the environment, health, population, conflict, and security. His recent research focuses on environmental pathways to confidence building and peacemaking, with a special emphasis on managing fresh water resources. He is principal investigator for ECSP's Navigating Peace Initiative.

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The Environmental Change and Security Program's Navigating Peace Initiative, supported by the Carnegie Corporation of New York and led by ECSP Director Geoffrey Dabelko, seeks to generate fresh thinking on the world's water problems on three areas:

- Expanding opportunities for small-scale water and sanitation projects;
- Analyzing water's potential to spur both conflict and cooperation; and
- Building dialogue and cooperation between the United States and China using lessons from water conflict resolution.

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