COMBATING WATERBORNE DISEASE AT THE HOUSEHOLD LEVEL

The International Network to Promote
Household Water Treatment
and Safe Storage

The Network

World Health Organization

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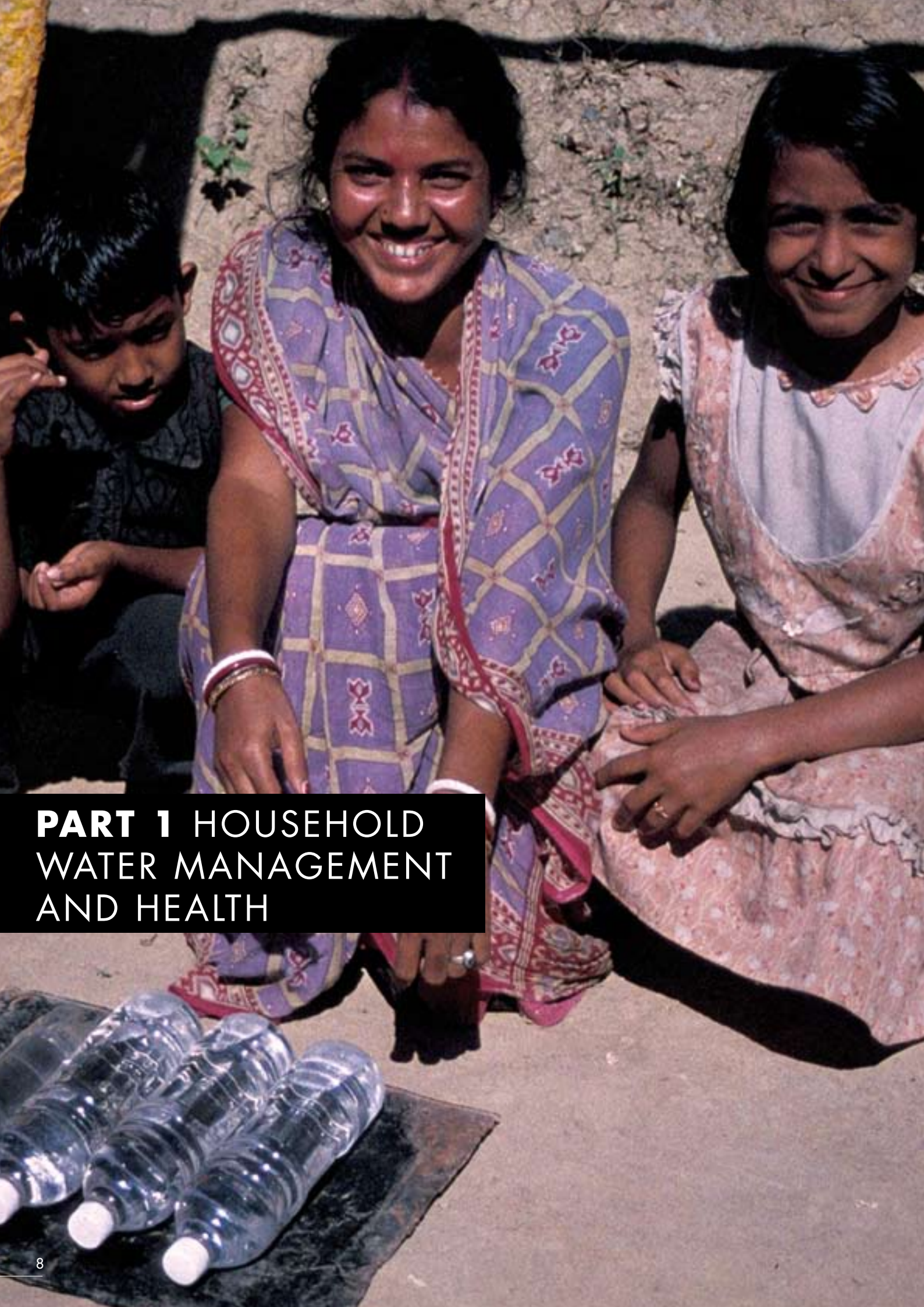
HOW MUCH OF THIS CAN BE **PREVENTED**?

WHO estimates that 94% of diarrhoeal cases are preventable through modifications to the environment, including through interventions to increase the availability of clean water, and to improve sanitation and hygiene.

World Health Organization



PART 1 HOUSEHOLD WATER MANAGEMENT AND HEALTH

The promise

"Simple techniques for treating water at home and storing it in safe containers could save a huge number of lives each year"

WHO and UNICEF 2005[1]

…There is now conclusive evidence that simple, acceptable, low-cost interventions at the household and community level are capable of dramatically improving the microbial quality of household stored water and reducing the attendant risks of diarrhoeal disease and death.[2]

…Recent evidence suggests that point-of-use water quality improvements alone result in a one-third or greater reduction in diarrhoeal disease morbidity.[3]

…Self-sustaining, decentralized approaches to making drinking water safe, including point-of-use [treatment]…target the most affected, enhance health, contribute to development and productivity, and merit far greater priority for rapid implementation.[4]

…Safer household water storage may be an appropriate additional intervention to prevent contamination of domestic water.[5]

…A policy shift towards household water management appears to be the most attractive short term water-related health intervention in many developing countries.[6]

The case for managing water in the home

Lack of access to safe drinking water, together with inadequate sanitation and hygiene, is the overwhelming contributor to the 1.8 million annual deaths caused by diarrhoeal disease.

Providing safe and reliable water services to the 1.1 billion people who currently lack access to improved water sources is an essential long-term goal that will yield great health and economic benefits. Less well known is the large potential contribution that household-level water quality interventions can make to immediately improve the health of the most vulnerable.

Health can be compromised when harmful bacteria, viruses, and parasites contaminate drinking water either at the source, through seepage of contaminated run-off water, or within the piped distribution system. Moreover, unhygienic handling of water during transport or within the home can contaminate previously safe water. For these reasons, many of those who have access to improved water supplies through piped connections, protected wells or other improved sources are, in fact, exposed to contaminated water.

Therefore, potentially billions of people can benefit from effective household water treatment and safe storage.

A growing body of research suggests household water treatment and safe storage (HWTS):

1. *dramatically improves microbial water quality*
2. *significantly reduces diarrhoea*
3. *is among the most effective of water, sanitation and health interventions*
4. *is highly cost-effective*
5. *can be rapidly deployed and taken up by vulnerable populations.*

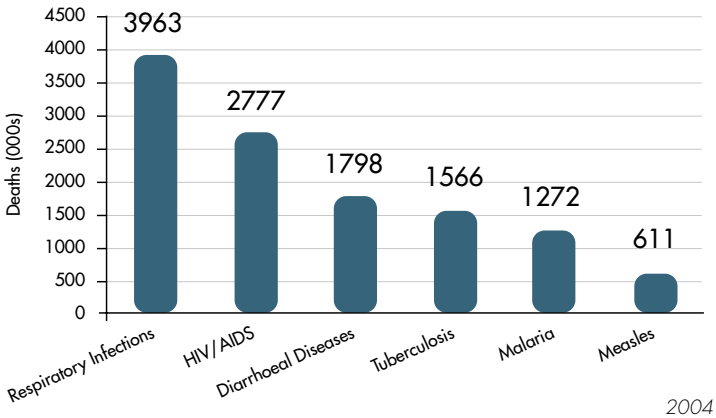
Terminology:
Household-level approaches to drinking water treatment and safe storage are also commonly referred to as managing the water at the "point-of-use". This term or its abbreviation "POU" typically describe the same procedures as other abbreviations derived from household water treatment, like "HHWT" or "HWT" or "HWTS". (The "S" in "HWTS" refers to safe storage.) "Household water management" is also commonly used, and can encompass both treatment and storage. All these terms can refer to a variety of treatment procedures, for example, with chlorine or other chemical disinfectants, sunlight or UV lamps, various filters, or flocculation-disinfection formulations.

There is increasing recognition that simple household-based approaches to ensuring drinking water safety should be incorporated into country strategies to reduce waterborne disease.

Preventing diarrhoea

Diarrhoea occupies a leading position among diseases as a cause of death and illness, killing 1.8 million and causing approximately 4 billion cases of illness annually. Children suffer the most from diarrhoea, with every episode reducing calorie and nutrient uptake, setting back growth and development. 90% of diarrhoeal deaths are borne by children under five, mostly in developing countries.

Leading Causes of Deaths from Infectious Diseases

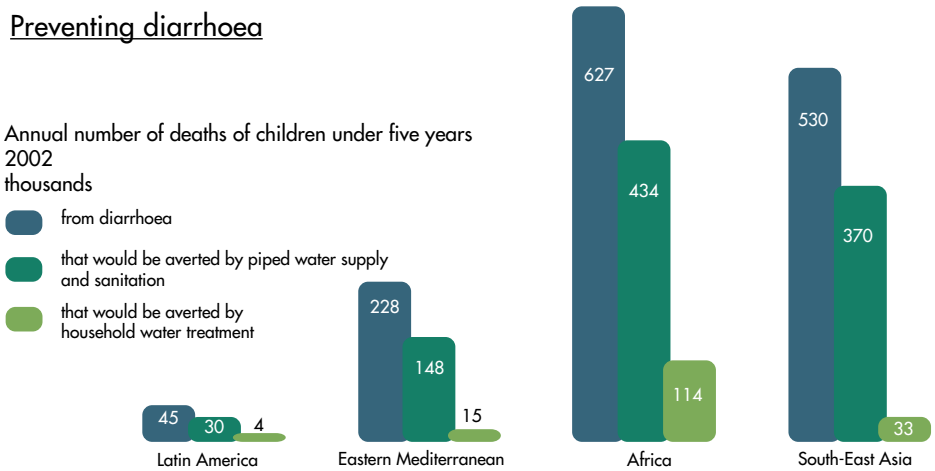


2004 World Health Report

WHO estimates that 94% of diarrhoeal cases are preventable through modifications to the environment, including interventions to increase the availability of clean water, and to improve sanitation and hygiene.[7] In addition, a 2005 systematic review concluded that diarrhoeal episodes are reduced by 25% through improving water supply, 32% by improving sanitation, 45% through hand washing, and by 39% via household water treatment and safe storage.[8]

A more recent (2006) Cochrane review of randomized controlled trials confirmed the key role that point-of-use water quality interventions could play in reducing diarrhea episodes, reporting a reduction in diarrhoeal disease morbidity by roughly half, on average, with some studies resulting in disease reductions of 70% or more.[9]

Preventing diarrhoea



Adapted from *Inheriting the World: The Atlas of Children's health and the environment* © WHO 2004

Reaching the vulnerable

Point-of-use disinfection can be a low-cost option. Solar disinfection is free, provided plastic bottles are available. Bleach solution costs very little to produce, and according to the US Centers for Disease Control and Prevention (CDC) 10-25 US cents worth can last a family an entire month. Simple ceramic pot filters moulded by local artisans can be used to filter water in the home for approximately US$ 3 per year, making them sustainable and economical.[10] Boiling is by far the most commonly used approach to disinfect water at household level. At the global level, a recent World Health Organization report suggests that household water interventions can lead to a benefit of up to US$60 for every US$1 invested.[11]

Water treatment also needs to be accompanied by safe storage. This can be accomplished by using containers with narrow openings and a dispensing device such as a tap or spigot to protect collected water against recontamination. These measures are particularly important because the microbial quality of drinking water frequently declines after collection.

Reaching the vulnerable, however, implies much more than developing affordable HWTS products. These interventions are most effective in preventing disease only if they are used correctly and consistently. Identifying and implementing successful approaches to increase uptake HWTS products on a sustainable basis is essential for this intervention to achieve widespread and long-term success.

Field studies show that important considerations in home treatment are taste and other aesthetic properties of the water, convenience of use, price and cultural attitudes. Furthermore, positive attitudes and ideas were better predictors of whether people were likely to consistently treat water than were negative attitudes. Experience suggests that educational and promotional messages should target positive ideas, such as clarity, taste, good health, affordability, and ease of use. Researchers are finding that many householders would be willing to pay for home treatment at an acceptable price (e.g. less than US$ 10 for water filters in Southern Africa). Payment by installments may be one method of enabling the poor to deal with the relatively high up-front costs of certain technologies.

Treating and safely storing water in the home would clearly accelerate progress towards meeting the MDGs (Target 10) in situations where families have access to sufficient quantities of water that is of poor or questionable quality.

Contributing to the Millennium Development Goals (MDGs)

MDG 7, Target 10, calls for reducing by half the proportion of people without sustainable access to safe drinking water by 2015. Reaching this target implies tackling both the quantity (access) and quality (safety) dimensions to drinking water provision.

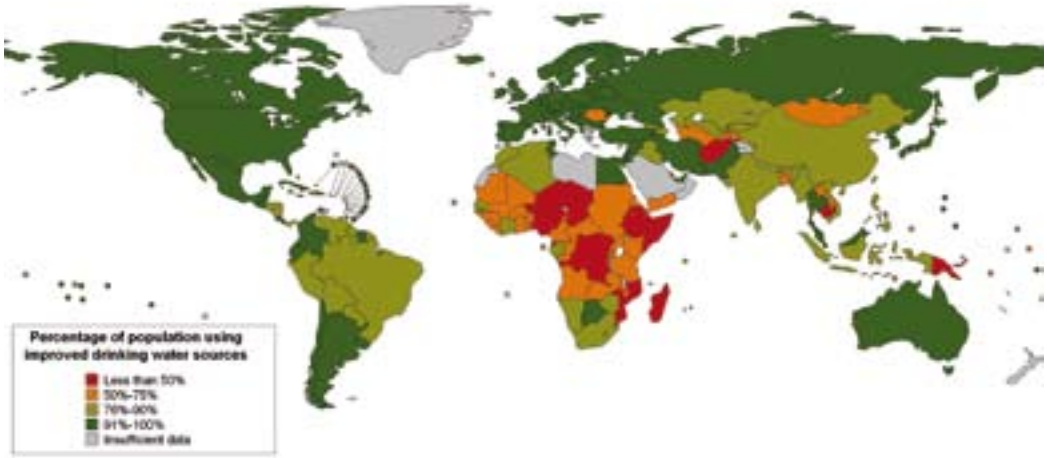
Progress towards this target is indicated by the proportion of households reporting the use of improved water supplies, such as piped household connections or protected wells. Individual studies and a recent six country survey carried out by the WHO/UNICEF Joint Monitoring Programme, however, suggest that depending on local conditions, a significant proportion of water from these sources may be contaminated.[12]

In light of these findings, great efforts are required, not only to extend services to the unserved, but to ensure these services are indeed supplying water that is safe.

Household-level interventions can make an immediate contribution to the safety component of this target, and would significantly contribute to meeting the MDGs in situations where access to water supplies is secure, but household water quality is not assured.

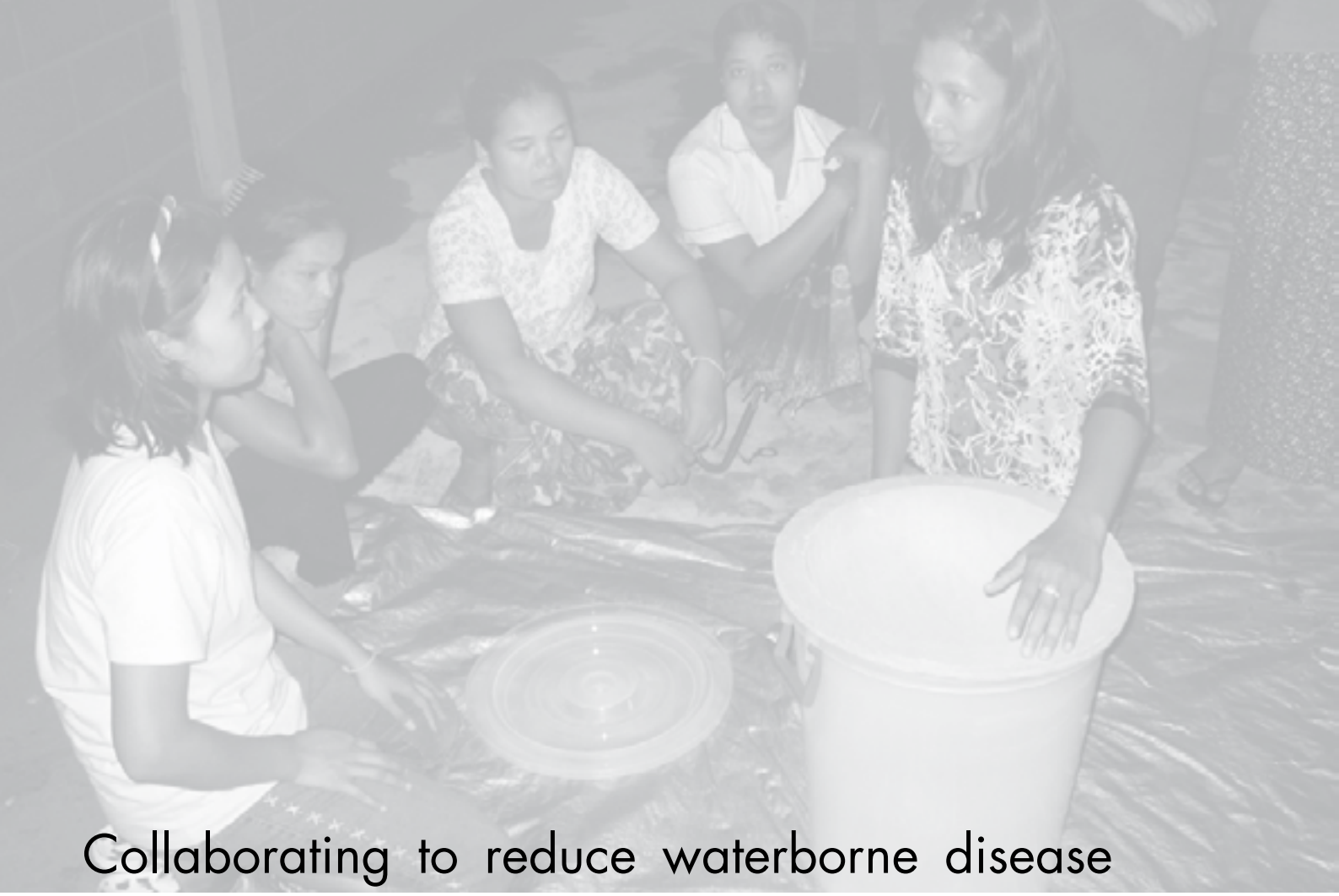
Questions have been included in surveys that will allow HWTS to be captured in future MDG monitoring activities.

Figure 1 – Percentage of population using improved drinking water sources in 2004.



Source: WHO/UNICEF Joint Monitoring Programme for Water and Sanitation. Meeting the MDG drinking water and sanitation target: the urban and rural challenge of the decade, Geneva 2006

PART 2 THE NETWORK



Collaborating to reduce waterborne disease

The promise of household water treatment and safe storage can only be unlocked with collaboration: **joint action** to ensure that families become empowered to take charge of their drinking water safety; **working together** to make certain that affordable and appropriate HWTS options become available; and **partnering** to ensure that solutions are delivered and used sustainably.

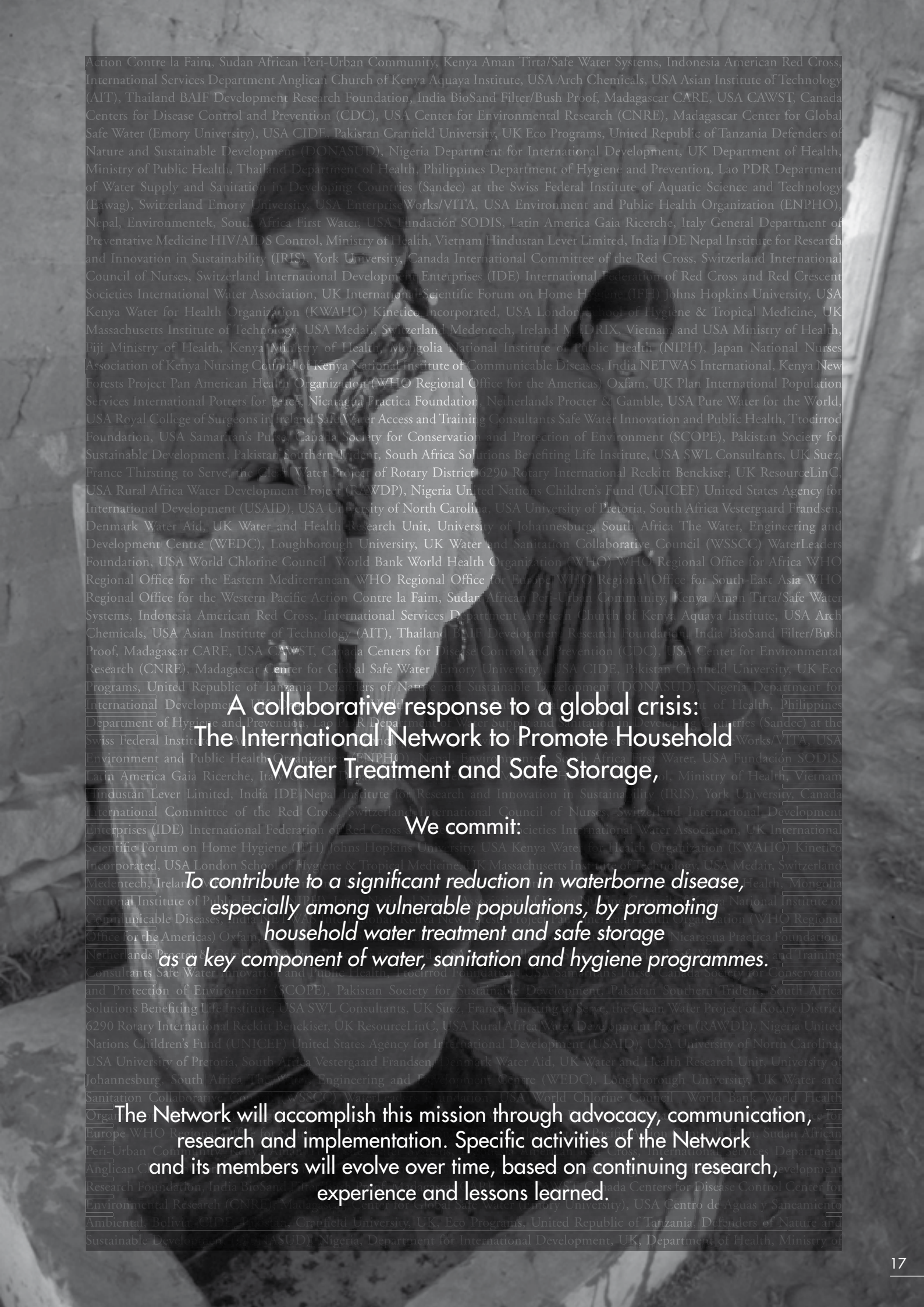
Collaboration is fostered via the Network's four core working groups on: advocacy, communication, research and implementation.

Establishment of the Network

In the early 2000's, a variety of stakeholders, ranging from concerned health agencies to product suppliers and implementing NGOs, welcomed new evidence demonstrating the potential value of HWTS technologies to reduce diarrhoeal disease. However, they realized that the availability of effective technologies alone was insufficient in itself to provide health gains. Indeed, they understood that a series of significant barriers posed a challenge to scaling-up implementation activities, including a lack of awareness of the recent rapid developments, research gaps, and inaccessible information.

In response, WHO convened a meeting in February 2003 to explore the formation of an international network to surmount these barriers. Participants included representatives of UN agencies, bilateral development agencies, international non-governmental organizations (NGOs), research institutions, international professional associations, the private sector and industry associations. It was agreed that a network model would optimize efforts to promote household-level water management, with the aim of contributing to a significant reduction in waterborne disease. To this end, the participants established the International Network to Promote Household Water Treatment and Safe Storage (the "Network").

The Network was organized to promote household water treatment and safe storage and to provide an effective means to address an important and overlooked mechanism to support substantive health gains, benefiting especially disadvantaged populations. In doing so, it seeks to contribute to the achievement of the MDG target of halving the proportion of people without access to safe drinking water and to the MDG of reducing child mortality.



A collaborative response to a global crisis: The International Network to Promote Household Water Treatment and Safe Storage,

We commit:

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.

The Network will accomplish this mission through advocacy, communication, research and implementation. Specific activities of the Network and its members will evolve over time, based on continuing research, experience and lessons learned.

Objectives

Objective 1 (Advocacy): The Network will directly advocate, promote and facilitate the inclusion of household water interventions in policies and practices at the national, regional and global level across all relevant sectors.

The principal outputs of the network advocacy working group will be resources targeted towards decision makers, engagement in policy forums, and support to network members that are promoting household interventions at the country level.

Objective 2 (Communication): The Network will be a forum and vehicle to actively share high quality information focused on an evidence-based approach in order to create awareness of point-of-use treatment.

Outputs of this working group include a website, newsletter, and other communications tools which will feature technologies and approaches, results of relevant laboratory and field research, suitable applications, implementation strategies, project sites, populations served, cost of technology, estimated implementation costs, cost-effectiveness data, project partners, and contact information for organizations implementing projects.

Objective 3 (Research): The network will promote research by academic and other institutions to evaluate interventions by collecting, analysing and disseminating independent and comparable data on efficacy, cost-effectiveness, continued work on health impact (e.g. of different technologies), acceptability, affordability, scalability, and sustainability.

Outputs include the identification of critical knowledge gaps and the development of a common research agenda. The network will also strengthen the evidence base by evaluating household water interventions according to WHO criteria.

Objective 4 (Implementation): The network will strive to empower those without access to improved water sources, and those with improved but unsafe sources to take charge of their own drinking water safety by working with communities to implement effective, affordable, and sustainable household interventions. Particular attention will be given to those most affected by waterborne diseases, such as children, pregnant and lactating women, immunocompromised persons, the poor, refugees, and internally displaced persons. Each collaborating organization in the Network is also requested to implement the network principles in its own activity through practical actions that will have an impact on households without access to safe water.

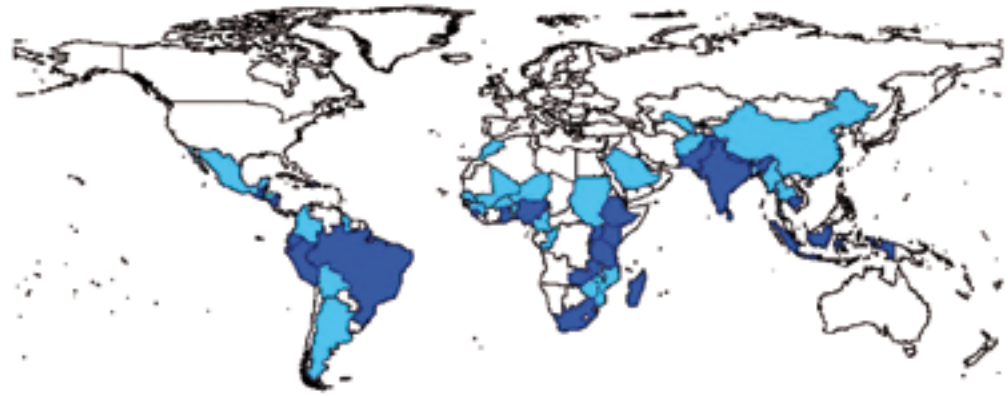
Outputs include programme implementation of household water treatment, documenting and disseminating the results of at-scale programmes, and development of strategies and practices for effective social marketing.

Supporting Implementing Alliances

At the 3rd Annual Network meeting in Bangkok, HWTS suppliers, trainers, implementers and other stakeholders agreed to cooperate more intensively around larger scale, project-focused alliances, aimed to provide households with a "menu" of technologies and resources. This agreement, carried forward with leadership from Fundación SODIS, resulted in the *Alianza para la Promoción del Agua Segura e Higiene en Latinoamérica*. The Alianza has initiated work in many Latin American and Andean Countries in South America. More information: www.aguasegura.org

The *Safe Drinking Water Alliance* is a public-private collaboration comprising Network participants USAID, Johns Hopkins Bloomberg School of Public Health, Center for Communications Programme, CARE, PSI, and Procter & Gamble. They have joined forces to leverage their respective expertise and resources to better understand the behaviors and motivations for choosing particular technologies for treating household water, share the knowledge gained, and identify opportunities for scaling up successful efforts. Implementation is occurring in multiple countries, including Pakistan, Haiti and Ethiopia.

Network survey of HWTS project implementation



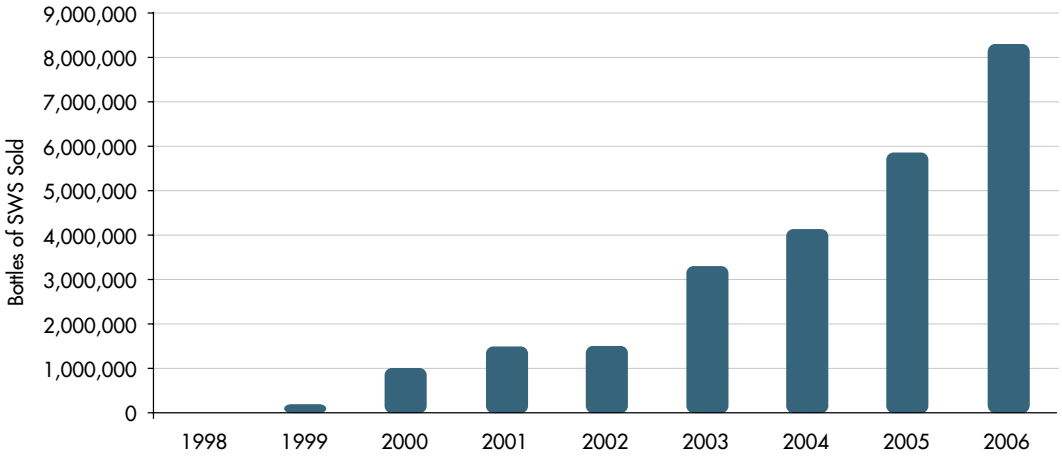
No Data
Some HWTS project implementation (1-2 projects)
Significant HWTS project implementation (3 or more projects)

Source: WHO Network Implementation Working Group Survey Data, 2005

Expanding consumer choices
Ensuring that households have a menu of technologies to choose from contrasts with the typical approach where householders are asked to accept a specific technology without alternatives. Household preferences are strongly influenced by costs and consumer values. Householders may be more likely to sustainably use a home drinking water treatment system that they have chosen for themselves.

Global sales of locally-produced dilute sodium hypochlorite. Each bottle offers one to two months protection for a household of six.

PSI Safe Water Solution Sales 1998 - 2006



Sales data courtesy of PSI and CDC

Achievements

The Network has contributed to driving HWTS from a fringe intervention to one that is increasingly recognized as mainstream. This recognition has in turn ramped up implementation activities, partly because many implementers are now operating in policy environments more accepting of household-level interventions.

The Network has grown from 20 organizations in 2003 to more than 100 in 2006. Developing country participation continues to grow, and stands at more than a third. Government agencies and ministries in a number of countries, notably in South Asia, have joined the Network, incorporated HWTS into water policies, and begun pilot projects. Implementation efforts have significantly expanded and are now occurring in at least 60 countries. The Network, through information exchange (web, listserv, face-to-face meetings, and informal mechanisms), dialogue with authorities, product suppliers, NGOs and community organizations, has catalysed action and helped create an enabling environment for real scaling-up of activities.

The Network has developed and reached consensus on a common agenda to direct research priorities and ensure that research groups coordinate activities, that comparable methods are used, that best practices are documented, and that data is pooled and disseminated.

The Network has promoted HWTS at regional, national, and international meetings addressing water and health (e.g. 4th World Water Forum, held in Mexico City, March 2006, and the World Water Congress, held in Beijing, September 2006). Finally, the Network is constantly improving its "pooled" information hub with data regarding available technology, advances in product development, case studies, and experience with implementation strategies, which can be accessed at the Network website www.who.int/household_water

"Of course [household water treatment] costs money, but that is nothing compared to the large amount of cash spent for doctor's treatment" Bishnumaya Adhikari, Nepal

Moving forward

At the time the Network was assembled, HWTS was not well recognized, there was limited cooperation, including fragmented advocacy, research and implementation efforts. Thus, the initial objectives of the Network centred on surmounting these barriers by focusing on global advocacy, bringing together stakeholders, sharing information, and identifying research priorities. A "light", flexible, and inclusive organization was the best way to make rapid initial progress.

With global acceptance of HWTS on the rise, the Network is now firmly set on tackling the significant barriers to scaling up at country level. To achieve this, the Network agreed to focus its activities on the following set of outputs:

1. ***Demonstrating sustained health impact at scale:*** The Network will progressively provide close support to countries where real potential for scale-up exists. Activities include securing commitment from decision-makers, connecting stakeholders, supporting governments to integrate HWTS with wider country water, sanitation and hygiene policies, and to more effectively coordinate the diverse implementation activities occuring within countries.
2. ***Mainstreaming advocacy and integration in seven areas:*** The Network will backstop efforts to move HWTS out of its "silo" at country level, via targeted outreach to organizations and people working within established structures and programmes that would facilitate HWTS scaling, such as those dealing with education and the school setting, maternal and child health, HIV/AIDS, health care facilities, faith-based organizations, child nutrition, and emergencies.
3. ***Tools and resources for scale-up:*** The Network will tap into expertise from within and outside the health and water sectors to provide critically needed generic tools to guide stakeholders to identify and overcome barriers. Network participants are working on a strategic framework for scaling up that will cover a range of topics where little guidance is currently available, such as on delivery systems, distribution models, marketing strategies, education and training, the role of government, and regulatory issues.
4. ***Improved monitoring of HWTS programmes:*** Accurately tracking HWTS implementation progress can help stakeholders understand what implementation approaches are working best, and provide the evidence needed to convince policy makers, donors and others to continue the drive towards scale up. The Network will aim to develop and use improved metrics, compile and disseminate HWTS programme impact, and document overall implementation HWTS progress.

Join us

Participation in the Network can aid any organization interested in HWTS. This includes government officials in the health or water sector interested in learning more about POU treatment as a policy option, local authorities engaged with HWTS pilot projects, NGOs carrying out projects in communities or training implementers, universities, companies developing or supplying products, and other stakeholders.

Benefits include the ability to:

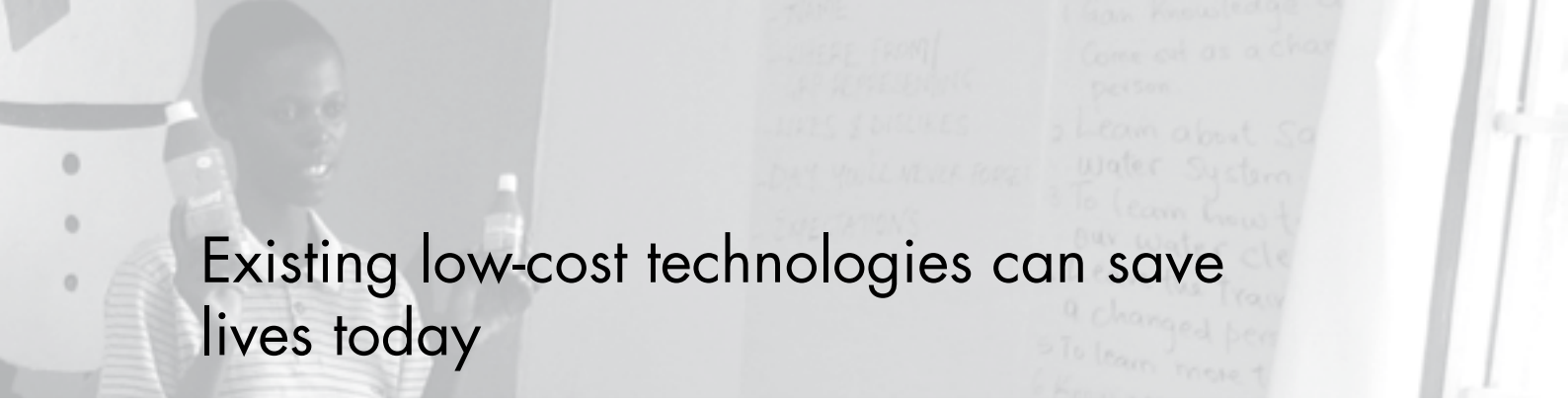
- Be connected to a global Network of HWTS experts, including senior officials, programme implementers, researchers, and on-the-ground practitioners
- Receive the latest news on HWTS projects, meetings, and events through the Network listserv and newsletter
- Receive guidance on implementation approaches
- Receive guidance on protocols to verify HWTS technology and systems
- Discuss emerging issues
- Facilitate formation of partnerships or collaborations
- Find out who is active where and engage those who have faced similar challenges
- Have your work disseminated and highlighted in Network communications material
- Have a voice in the annual network meeting and in turn, provide input to the annual work plan

How to join the Network:

To join the Network, interested organizations should write to the World Health Organization Network Secretariat, via email (hhwater@who.int) to confirm their agreement with the mission and guiding principles of the Network and their willingness to contribute to the achievement of the Network's objectives.

The Secretariat would also appreciate receiving a brief profile of the organization (website, if available) as well as any particular interests in the context of HWTS.

PART 3 FINDING OUT MORE



Existing low-cost technologies can save lives today

1) Chlorination – adding chlorine in liquid or tablet form to drinking water stored in a protected container

At doses of a few mg/litre and contact times of about 30 minutes, free chlorine generally inactivates >99.99% of enteric bacteria and viruses, provided water is clear. Chlorine can come a variety of sources, including solid calcium hypochlorite, liquid sodium hypochlorite or NaDCC tablets. Household-level chlorination has been implemented most commonly in combination with safe storage and behaviour change techniques, including social marketing, community mobilization, motivational interviewing, communication, and education.

2) Solar disinfection – exposing water in disposable clear plastic bottles to sunlight for a day, typically on the roof of a house

A combination of heat and ultra-violet radiation from the sun are used to inactivate pathogens present in water. One low-cost technique involves exposing water in clear plastic bottles to sunlight for six hours, for example on the roof of a house (or for 2 days if the sun is obscured by clouds). The water should be consumed directly from the bottle or transferred to a clean glass. To be effective, solar disinfection must be applied to relatively clear water.

3) Filtration

Water filtration is another option to purify water. Higher quality ceramic filters with small pores, often coated with silver to control bacterial growth, have been shown to be effective at removing many microbes and other suspended solids. Filters need to be cleaned regularly to maintain flow rates. If properly maintained, they have a long life. Ceramic filters can be mass-produced centrally or manufactured locally in smaller batches. Some commercial systems that combine filtration and disinfection have also been shown to be safe and effective, though their up-front cost may be an obstacle to low-income populations.

4) Combined flocculation/disinfection systems – adding powders or tablets to coagulate and flocculate sediments in water followed by a timed release of disinfectant

These are typically formulated to coagulate and flocculate sediments in water followed by a timed release of chlorine. These typically treat 10-15 litres of water, and are particularly useful for treating turbid water. The water is normally stirred for few minutes, strained to separate the flocculant, and then allowed to stand for another half hour for complete disinfection.

5) Boiling

If practical, households can disinfect their drinking water by bringing it to a rolling boil, which will kill pathogens effectively. In order to be effective, however, the treated water must be protected from re-contamination. Caution must also be exercised to avoid scalding accidents, especially among young children. While boiling is widely practiced, it may be more costly, inconvenient and environmentally unsustainable than other emerging POU water treatment options.

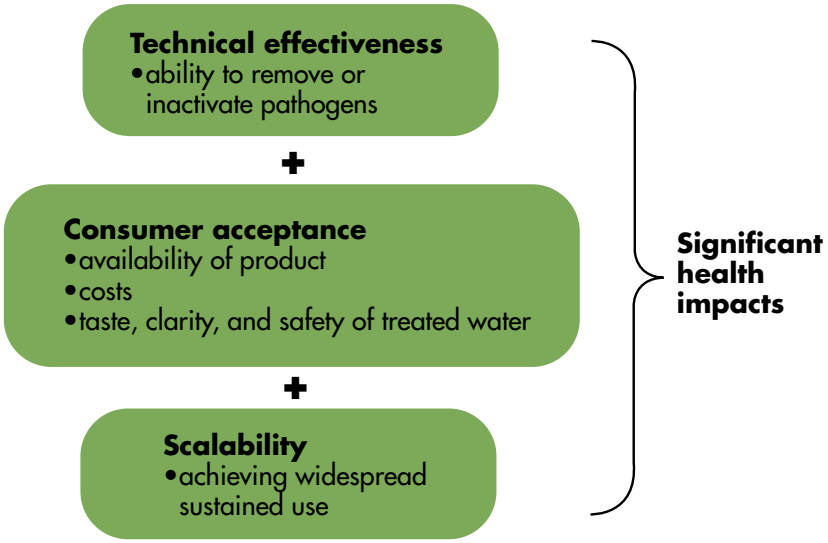
6) Safe Storage

Research has shown that water that is safe at the point of collection is often subject to faecal contamination during collection, transport and use in the home, mainly by unclean hands. Studies have also shown that vessels with narrow mouths and taps can significantly reduce such contamination and reduce the risk of diarrhoeal disease. Where possible, safe storage should also be incorporated included in interventions to treat water in the home.

Different technologies are better suited for different situations. Solar disinfection, for example, may be especially suited for very poor households in sunny regions that draw relatively clear water. Combined flocculation/ disinfection systems are a suitable option for treating turbid surface water. Filters have higher-up front costs, but are straightforward to use, and may not require the same degree of behaviour change efforts as other approaches. Household chlorination has achieved widespread use, is appropriate for the very poor, and after boiling is the most common treatment approach.

Achieving Health Gains

A technology must pass three tests for it to achieve significant health impacts:



Frequently asked questions and answers

What is Household Water Treatment and Safe Storage (HWTS)?

HWTS includes a wide array of treatment and storage techniques that are applied primarily at the point-of-use. Examples of household water treatment include boiling, filtration, chemical, solar and UV lamp disinfection, flocculation for the removal of turbidity, and other techniques. Safe storage refers to techniques that minimize the risk of recontamination, including the use of narrow-mouth, screened, and covered containers, as well as dispensing devices such as taps or spigots. Safe storage is a key component of household water management because improper storage can allow recontamination of stored water by microbial pathogens and other contaminants, nullifying the benefits of effective treatment.

Why implement HWTS measures instead of focusing exclusively on infrastructure improvements?

Promoting HWTS and improving water infrastructure are a complementary, not alternative, means to reduce waterborne disease. Infrastructure investment to ensure the safety of improved water supply is essential. The ultimate goal is to provide every family with a safe household connection. However, the high front-end capital costs and long time frame associated with implementing centralized treatment and distribution may exclude many communities, particularly in poor rural areas, from the health benefits of a piped water source in the immediate future. Meanwhile, "improved" water sources (e.g. piped connections, protected shallow wells etc.) do not necessarily deliver safe water, and where and when they do not, additional water management may be required to ensure safety. HWTS is an additional step that can be taken immediately.

When should a household consider using HWTS?

All households unsure of their water safety should consider using HWTS. The main geographic areas of exposure to disease-causing microbial agents in drinking water are developing countries with failing or absent water treatment infrastructure. However, HWTS is appropriate for vulnerable people in countries at all levels of socio-economic development, particularly in smaller communities. Indeed, a report issued by the US National Academy of Sciences concludes that POU systems may be appropriate in communities of under 500 inhabitants in the United States of America.

How do we know if an HWTS technology "works" – that is, that it is actually producing safe drinking water?

Many low-cost HWTS technologies do not come with clear labels and reliable accreditations attesting to their ability to provide "safe" water. This has led to uncertainty and confusion among consumers and other stakeholders.

One obstacle to determining whether a

technology works is the absence of consensus international guidelines on HWTS performance. To address this problem, WHO is developing guidelines that will establish microbial reduction benchmarks and propose minimum criteria for protocols to verify HWT system performance.

Until such technology verification answers whether a technology "works" with precision, existing studies demonstrate that a variety of HWT technologies improve water quality and result in significant health benefits. For example, a variety of studies examining the impact of porous ceramic filters, with *E. coli* removal rates of 99-99.9%, show significant reductions in diarrhoeal disease morbidity. Household chlorination and safe storage, solar disinfection, and commercially-produced flocculant/disinfection mixtures are examples of other HWTS approaches shown to reduce diarrhoea significantly. Researchers are currently testing other technologies for health impacts.

All HWT measures should be developed to achieve the highest removal rates across important pathogen groups. Significant reductions of diarrhoeal disease are dependent not only on an HWT measure's ability to kill or remove microbial agents from drinking water, but also on its likelihood of adoption by target beneficiaries over the long-term.

What HWST technology is best?

The "best" technology significantly improves water quality, is available, affordable, and accepted for sustainable use by poor households, and has proven health impact. Consumer preferences, willingness to pay, source water quality, and other factors will dictate which technologies are best suited to local circumstances. Since there is no easy formula that will answer this question, consumers should be given choices.

Implementers of treatment devices such as porous ceramic and intermittently-operated household sand filters (biosand filters) have reported relatively high rates of user acceptance. Filters are easy to operate – users simply pour water through the filters. Ceramic filtration in particular has been demonstrated to achieve significant health benefits. At the same time, low rates of virus removal, the absence of residual protection against recontamination, variable treatment capacity, and inconsistent

quality control (in the case of locally-produced units) have been cited as potential weaknesses of the technology. Both porous ceramic and mixed media filtration devices are extremely cost-effective measures over their lifetimes. Poor families can be assisted in paying the front-end capital investments through either subsidies or financing.

Solar disinfection is an example of another measure with proven health impact that requires little capital investment on the part of end-users, and is thus appropriate for the very poor. Additional advantages include water taste being largely unchanged following treatment and minimal risk of recontamination if water is consumed directly from the bottle in which it was treated. Its proper execution relies on significant community education and training whose costs must be borne by implementing organizations. Other limitations of solar disinfection include length of time required to treat water, the limited volume of water that can be treated at once, and the requirement to remove suspended solids before treatment.

Chemical treatment techniques, generally relying on chlorine as a disinfectant, have demonstrated health benefits, are extremely affordable, cost-effective, and significantly reduce microbial pathogen concentrations (with the notable exception of dilute bleach solutions and chlorine tablets against protozoa such as *Cryptosporidium*). Importantly, these techniques leave residual protection against contamination. However, they can leave an odor and taste that some households can find objectionable, and thus can face adoption obstacles among target beneficiaries. Chlorine solutions and tablets are also less effective at treating turbid source water.

Commercially-produced flocculation/disinfection mixtures are very effective at reducing pathogens of all classes (even in turbid waters), have demonstrated health benefits, leave residual protection, and remove muddy sediment as well. Drawbacks include the higher relative costs per litre of water treated.

Furthermore, usage of the treatment process is marginally more complicated than the other measures described above. In deployment of these measures, community education and marketing are essential to achieving sustained adoption.

Boiling is a simple way of killing all classes of microbial pathogens, however large amounts of fuel are required, which make it costly. Furthermore, some users object to a perceived unpleasant taste, which limits acceptability. Boiling can also cause accidents due to the very hot water temperatures and boiled water can become recontamined once it becomes cooled.

Safe storage vessels should be designed to reduce the risk of recontamination, limiting contact between potentially contaminated hands and water. This can be done by using a vessel that has a lid or narrow mouth, and is also fitted with a tap or spigot to withdraw water hygienically.

In short, many HWTS measures have the potential to seriously reduce diarrhoeal disease, and choosing the best measure or suite of measures ought to be driven by a number of factors, a central one being community-articulated preferences.

What constitutes a successful HWTS implementation?

First of all, a successful HWTS implementation should be *effective*, it should reduce incidence of waterborne disease.

Second, it should be *scalable*: initial small-scale pilots that reach a small number of beneficiaries are important, but they are not enough. Truly successful implementations should lead to widespread adoption of HWTS, eventually reaching millions.

Third, a successful HWTS implementation should be *sustainable*: a pilot implementation should necessarily lead to longer term adoption rates that reach increasing numbers of beneficiaries with decreasing requirements for outside funding and programmatic support.

At their most successful, HWTS implementations generate local economic benefits through, for example, the formation of small-scale industries, in addition to health benefits. Self-sustaining projects that, after some period, need no additional donor funding, are ideal. To achieve this, some implementations will require external support in the form of product subsidy or program support in the form of marketing and distribution in their initial stages.

What are keys to successful HWTS implementation?

Achieving sustained and widespread adoption is the major challenge to HWTS implementation. Realizing behaviour change at scale will require solutions tailor-made for specific HWTS measures.

For filtration devices, implemeters need to consider either free distribution or some amount of subsidy or financing to ensure that the capital outlay required does not exclude poor consumers. Ensuring that devices are durable and that maintenance is undemanding (i.e. spare parts are available) are also keys to successful uptake.

Chemical addition measures such as dilute hypochlorite solutions and tablets and flocculant/disinfectant powders require minimal capital investment by the consumer, and are generally distributed in amounts intended to treat much smaller quantities of water than treatment devices such as filters (with regular repeated distributions or sales required). A key challenge associated with these options is the possibility of chemical odor and taste that some beneficiaries may find objectionable. Some socialization is required in these circumstances, and evidence suggests target populations can become accustomed to minimal chlorine residual in their drinking water, just as consumers have in more industrialized economies.

All HWTS measures require some user education to ensure that techniques are properly applied. Solar disinfection, for example, requires that users be trained to array a series of bottles for sun exposure, making sure to wait the required time period before consumption. For flocculation/disinfection powders, a short (5 minute) period of stirring, followed by a filtration through a fabric and a 20-minute waiting period, is often required. The labor associated with these procedures is sometimes perceived as onerous; as such, it has been suggested that user adoption of HWTS measures would be more successful if the labor required for their execution were communicated in contrast to other household work tasks, including other means of obtaining drinking water (such as transporting water to and from distant water supply sources).

Finally, there is evidence that many households are unaware of the health risks associated with drinking contaminated water. Emphasizing the connection between safe water and good health is critical to any HWTS intervention, but other adoption factors (such as price, labor, treatment capacity, taste, odor, and water clarity) may be just as important, depending on context. Meanwhile, there is certainly geographic and cultural variation in community understanding of waterborne disease risks. Women in remote areas of Central Java, Indonesia, for example, demonstrated prior awareness that aluminum salts remove suspended sediment from drinking water. Many vulnerable populations do have awareness of the need for clean water, sanitation, and hygiene, but simply lack access. With that said, education remains a necessary and crucial component of HWTS interventions.

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Photo credits: cover: Karen Kasmauski (home chlorination and safe storage in modified clay pots, Kenya); page 5 WHO/J. Littlewood (Colombia); 7 top to bottom: World Bank/Eric Miller (hospital waiting room, Mozambique), Kasmauski (Kenya), WHO/H. Bower (woman with child on drip due to diarrhoea, health clinic, Afghanistan), Susan Murcott (diarrhoea ward in Homa Bay Hospital, Kenya), Greg Allgood (safe water intervention at village AIDS clinic, Kenya), 8 SANDEC (solar disinfection, India), 9 World Bank/Eric Miller (local hospital, Mozambique); 11 Murcott (Kenya); 12 Greg Allgood (Kenya); 14 Frans Lemmens/Still Pictures (Algeria); 15 clockwise from top: Kathy Bradner (education on care and maintenance of filters, Thailand); Curt Bradner (pressing filters, Thailand), Rob Quick (pottery group with water storage vessels, Kenya); 16 Donna Coveney (health care clinic, Nepal); 17 WHO (collecting water, Mozambique); 18 clockwise from top; UNICEF Nepal (promoting HWTS); Greg Allgood (refugee camp, Sri Lanka), SANDEC (students learning about solar disinfection, Indonesia); left to right, Christine Stauber (water quality analysis Dominican Republic), Greg Allgood (flocculation/disinfection process); 19 Christine Stauber; 21 CDC (Kenya); 23 Daniele Lantagne (water collection in Ethiopia); 24 Liz Wood (demonstrating correct use of ceramic filters, Ghana); 27 Greg Allgood (Morocco); 28 Daniele Lantagne (testing locally made chlorine solution, Haiti); 29 Adriaan Mol (comparing source water to water filtered with a biosand filter, Kenya); 30 PSI Myanmar (disinfecting water at home); 32 Andrew Buller (water filtration, Mozambique); back cover World Bank/Eric Miller (Mozambique).

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Annex

Network Guiding principles

1. The network will use evidence-based approaches with agreed upon standards of effectiveness (e.g. behaviour change, health impact, cost, sustainability) and promote dissemination of information about program approaches.
2. The network will actively involve local people in developing the most appropriate strategies for implementing interventions.
3. The network will recognize the role of women in household management of water and in acceptance and implementation of solutions.
4. The network will operate in a balanced manner in terms of regions, technologies, and types of member organizations involved.
5. The network will promote the use of local technology and resources and local capacity building.
6. The network will maintain an agile structure and administration.

Private-Sector Participation within the Network

NGOs, local governments, communities and other groups have been successful in seeding and supporting household water pilot projects. However, if widespread uptake and sustainability of the interventions are to be achieved, public health and water sectors need to recognize and act on the confluence of interest with the private sector. Using the agreed public health mission of the network, joint public and private-sector action could make greater health gains as it would be fueled by expanded resources, expertise and commitment.

This parallels WHO recognition of the need for open and constructive relations with the private sector and civil society in order to advance its mission.[13] Global public policy networks that link international organizations, governments, non-profit organizations and for-profit corporations to share information and combine resources have been shown to be effective in advocating for common causes, gathering and disseminating knowledge, and building coalitions to address important issues, including health[14].

Membership revocation

Membership may be revoked by WHO from actions including, but not limited to:

1) the improper use of the network name or WHO's name, or any name or reference confusingly similar thereto on any product packaging, sales materials or advertisements, or in any other manner that implies that the network endorses, authorizes or approves of any particular product or service
2) violations of network guiding principles
3) action contrary to the agreed mission of the network

The expulsion process may take place without notice or a hearing. WHO has the authority to interpret whether or not actions on the part of members constitute improper use of the network or WHO's name, violations of guiding principles, or action contrary to the mission of the network, and thus reserves the right to make the final decision on the issue of network membership revocation.

Following written notice of membership revocation, the network Secretariat will remove the member from the Network communications, a website list of collaborating organizations, and ensure the entity is not included on future promotional material or other documents.

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The International Network to Promote Household Water Treatment and Safe Storage

The Network

World Health Organization

The WHO-led Network brings together more than 100 organizations who share its mission of "contributing 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. Participants are currently engaging with decision-makers, actively carrying out research, and implementing projects in more than 60 countries around the globe.