

# ENVIRONMENT, HEALTH, & PEOPLE

An Update from USAID's Environmental Health Project

Spring 1997

## WS&S "Software" and "Hardware"—the Cost-Effectiveness Argument

*Viewed from the perspective of the health sector, water supply and sanitation interventions such as hygiene are highly cost-effective for control of diarrhea in children under five, comparing favorably with ORT.*

In 1979, epidemiologists Julia Walsh and Kenneth Warren argued in a widely discussed article that the most cost-effective way to bring about reductions in infant and child mortality was through "a program of selective primary health care," rather than through a broad public health agenda.<sup>1</sup> The selective approach consisted of the now-familiar intervention package: immunizations (measles and DPT), treatment for malaria, ORT for diarrhea in children and tetanus toxoid and encouragement of breastfeeding in mothers.

The article praised water supply and sanitation (WS&S) for the "substantial difference" it can make in the "amount of disease" but did not consider it cost-effective enough for inclusion in the selective approach.

According to the Walsh and Warren analysis, the cost-effectiveness of low-tech WS&S infrastructure was \$3,600 to \$4,300 per child death averted, compared with \$200 to \$250 for selective primary health care.

This conclusion has had the long-term effect of lessening interest in WS&S as a health intervention.

### Cost-Effective Child Health Programs

In recent months the Environmental Health Project (EHP) has revisited the Walsh and Warren thesis and has taken a new look at the cost-effectiveness of WS&S interventions, both infrastructure and WS&S hygiene activities. When cost-effectiveness is used as a means of prioritizing interventions for the health sector, it is found that WS&S hygiene promotion and education are highly cost-effective for controlling diarrhea in children under five, comparing favorably with ORT, an integral part of USAID's Child Survival program.

Figure 1 compares the cost-effectiveness of selected child-survival interventions. The values are given in dollars per DALYs, or disability-adjusted life years saved, a measure that combines mortality and morbidity

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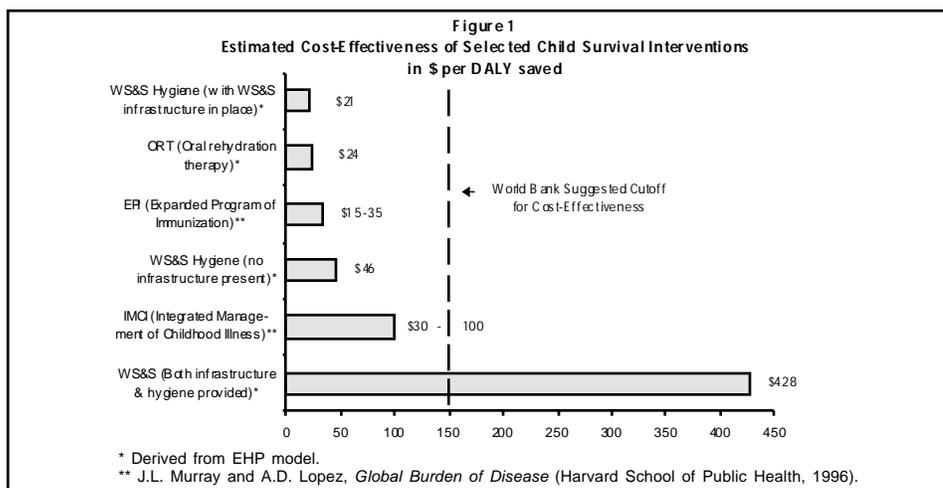
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reductions. Note that the cost-effectiveness of WS&S interventions is on a par with ORT, EPI, and IMCI.

### Health-Sector Financed WS&S

The cost-effectiveness model designed by EHP assumes that, for purposes of comparison with other health interventions, an analysis of the cost-effectiveness of WS&S interventions should take into consideration only those costs which have traditionally been the responsibility of the health sector. However, Walsh and Warren's analysis assumed that WS&S infrastructure would be paid for out of the health sector budget. This was an unwarranted assumption. The health sector normally would *not* fund installation of standpipes, laying of sewer lines, or wastewater treatment; whereas, it would fund a health extension program to change WS&S-related behaviors, such as handwashing. Usually, cost-effectiveness analysis is used to compare alternative programs or projects being funded from one sector, not among sectors.

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## UPDATE: Current Activities of Note

### Environmental Health Indicators Stress Behavior Change

EHP has developed a preliminary set of environmental health indicators for the three major diseases that affect children: diarrhea, malaria, and acute respiratory infections. It is easy to visualize the kinds of household- and community-level activities that would have to be carried out to register progress on these indicators.

The examples below for diarrheal disease and malaria focus on changing behaviors, increasing knowledge and understanding, and assuring that changes will be sustainable.

#### Knowledge/Attitudes

Percent of mothers who report the need to wash hands after handling fecal material and/or can demonstrate proper methods.

Percent of mothers aware of malaria prevention techniques.

#### Practices

Proportion of households with child-friendly latrines.

Proportion of mothers practicing safe food-handling of specific foods fed to children under 5 in the home.

Proportion of children under 5 who use insecticide-treated materials (ITMs) for vector control.

#### Sustainability

Percentage of bednets and insecticides for retreatment of ITMs supplied by the private sector.

Changes in policy, institutional supports, and capacity which improve the provision of environmental health services.

These and other similar environmental health indicators are being reviewed by USAID's Child Survival Indicator Working Group for inclusion in a list of suggested indicators for mission guidance.

### Urban Health Program in Zambia Seeks to Break Environmental Links to Disease

EHP is assisting the Kitwe District government in Zambia to launch an ambitious integrated urban health program. Kitwe is a medium-sized heavily urbanized district with a population of 500,000 in the northern "Copperbelt" area. Activities are getting underway in six health

"thrust" areas specified by the Zambian government: malaria, water supply and sanitation, tuberculosis, maternal health and family planning, child health, and HIV/AIDS. EHP will coordinate technical assistance to the Kitwe District in malaria and diarrheal disease prevention; other cooperating agencies (BASICS, CARE, and PCI) and the Tropical Disease Research Center will work in the other thrust areas.

Current local activities to reduce malaria and diarrhea are limited to non-systematic residual insecticide spraying and spraying of swampy areas, ORT treatment of diarrhea, and minimal hygiene education. The new Kitwe urban health program will reorient the approach toward preventive interventions that target environmental links to disease.

For malaria control, one such important link is the existence of numerous swampy areas ("dambos") in Kitwe District. Plans call for draining, filling, and planting trees in these dambos to reduce mosquito breeding. To reduce exposure to the vector, residents will be encouraged to use insecticide-impregnated bednets. Similarly, diarrhea control will stress the adoption of behaviors that block transmission of diarrheal disease, such as handwashing, proper latrine use, and proper water storage.

The program involves a host of public- and private-sector partners in Zambia, including the Ministry of Health, the Kitwe City Council, the Kitwe District Health Management Team, community NGOs, the ZCCM (Zambia Consolidated Copper Mine), and local service organizations (Rotary and Lions).

Interventions will be implemented through Neighborhood Health Committees, and the overall program will be guided by a working group of municipal and health-sector officials and



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## Update *(from page 2)*

community members. At present activities are limited to three areas in Kitwe, but plans call for rapid scale-up into other areas of the district.

EHP's work in Kitwe began last year with a rapid assessment of urban malaria that led to the development of control measures and a broadening of the scope of activities to address wider urban health problems. The Kitwe Urban Health Program is part of USAID's *Zambian Child Health* project.

### **CCH Project in Bolivia Sets Environmental Health Goals**

Plans are going forward to add an environmental health component to the ongoing USAID-supported CCH (Community and Child Health) project in the Santa Cruz region of Bolivia. The overall objective of the new component is to decrease the incidence of child and infant diarrhea, which is still very high in the project area despite the existence of water and sanitation systems in many communities.

Household- and community-level interventions to decrease high-risk behaviors and environmental risk factors will be identified and implemented using a community-driven process. These interventions, or microprojects, which are the new component's basis for action, will be partially funded by USAID.

The CPI (community-based participatory intervention) approach, on which the environmental health component of CCH will be modeled, was used by EHP in Ecuador to reduce cholera incidence in areas of high cholera endemicity. A post-project evaluation found measurable decreases in cholera and marked improvement in hygiene-related behaviors.

To evaluate the new component in Bolivia, data on diarrheal morbidity and mortality, KAP (knowledge, attitudes and practices), and environmental conditions will be collected on project and nonproject towns both before and after the interventions are put in place. By the fall of 1998, results on the success of this endeavor will be in.

To pave the way for possible scale-up of this project, Bolivian senior officials from key governmental and nongovernmental organizations will visit the site of the Ecuador cholera project for a first-hand look at how communities confronted serious health problems. Later, these NGO officials, joined by teams of health workers from three departments outside Santa Cruz, will attend the project start-up and skill-building workshops so that they can apply the

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Alternativa supports women micro-entrepreneurs who collect solid waste in Lima's slum areas. (Credit: Al Kettler)

## **Pedal Power Achieves Results in Solid Waste Collection**

Results of a solid waste management program in two Cono Norte peri-urban communities on the outskirts of Lima are obvious to the eye—and to the nose. Hundreds of tons of solid waste that had accumulated in the neighborhoods of Ancon and Ventanilla have been collected and transferred to an upgraded sanitary landfill. A solid waste collection system now being put in place will assure that in the future garbage will be sorted, recycled, collected, and disposed of safely. The Peruvian nongovernmental organization Alternativa is spearheading this effort with support from USAID and technical assistance from EHP.

The new solid waste collection system is a network of existing and newly created microenterprises brought together by Alternativa to work collaboratively with the municipality. The smallest of the enterprises are house-to-house trash collector tricycles that take the wastes to secondary collection and storage points. From there, the wastes are transported to the landfill by small trucking operations. Alternativa provides a loan program for acquisition of vehicles, safety equipment, and uniforms,

and training in management for the entrepreneurs—many of whom are women.

Other aspects of the program include reducing the trash stream through sorting and recycling at the household level, social marketing to promote changes in behavior that will lead to cleaner communities, hygiene education to increase awareness of the health hazards of solid waste, creation of an environmental health committee in the communities, and assisting the public sector to adopt new solid waste management methodologies.

In the two communities, where 85,000 persons reside, 31 tons of solid waste are generated per day—approximately 20% of which up to now has been tossed into open dumps, where it accumulates: a permanent source of contamination and a nesting ground for insects and rodents.

Unfortunately, comparable conditions prevail in other Cono Norte communities. Alternativa is exploring ways to replicate this pilot project with funds already committed from the European Commission. *Based on a report by Albina Ruiz Rios, Alternativa.*

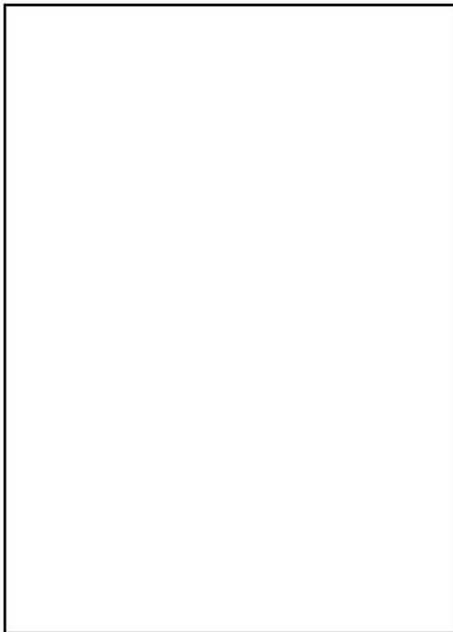
## Update (from page 3)

EHP approach in their home organizations or departments.

### GIS Methods Refined in Lusaka

EHP's rapid assessment of Kitwe, mentioned in a previous article, included preparation of a GIS map showing the health facilities, roads, rivers, and dambos, and superimposing information on malaria morbidity and mortality. EHP is now preparing a similar map of the malaria- and cholera-prone areas of Lusaka City, Zambia, for use by the city's Public Health Department.

Data similar to that included on the Kitwe map has been collected by a local consultant and a Peace Corps volunteer. The next steps include analysis and mapping of environmental risk factors and strengthening the capacity of public health officers in the Lusaka District to use GIS in decision-making and the monitoring of interventions.



The Bolivia CCH environmental health component is being modeled on the approach used in Ecuador. Microprojects, like the use of a water *bidon* as shown here, facilitated behavior change. (Photo: Linda Whiteford)

### New Methodology Assesses Feasibility of Private-Sector Investment in Water Supply

Water supplies in many developing-country communities are intermittent, unreliable, and unsafe. To compensate, residents develop coping strategies ranging from purchasing water to digging private wells to hoarding water. What do these coping strategies cost the average household, and can the level of coping costs be used to predict what customers would pay for a fully functioning system? With funding from the New Delhi RHUDO, EHP developed a methodology for estimating the real costs of coping with malfunctioning systems and applied it in Dehra Dun, a city of about 300,000 in the state of Uttar Pradesh, India, to find answers to these questions.

Although groundwater resources are adequate and the piped water network is extensive in Dehra Dun, water is supplied only four or five hours a day, often at very low pressure. These conditions compromise water quality and lead to increased rates of diarrheal disease.

The survey collected coping cost information from 1,100 households and concluded that consumer demand in Dehra Dun is sufficient to support a full-service water supply system without the need for extensive investment in a new system. In fact, current coping costs are at least as great as the amount paid to the Dehra Dun Water Works from billings, on average. Coping costs per cubic meter for those with household connections was 2.11 rupees compared with 2 rupees paid to the water company. For public tap users, who pay no water bill, coping costs can reach as high as 50 rupees in the dry season.

The "coping costs" methodology is presented as a lower-cost substitute for a willingness-to-pay study to

predict what customers would pay for a full-service metered supply by estimating what they are actually paying in direct out-of-pocket and indirect, or coping, terms. Alternative investment strategies for water supply cannot be developed without some gauge of customer willingness to pay and hence the ability of a water supply utility to recover costs.

Dehra Dun would be a good candidate for private investment. Customer willingness to pay, as revealed through the coping costs methodology, exceeds the revenues currently received by the Dehra Dun Water Works. Total revenue for 1994 was 30 million rupees but could have been 46 million rupees on the same volume.

The study demonstrates that affordability of water is not an issue in Dehra Dun; the important issues are increasing the reliability and improving the management of the system.

### Jagiellonian University in Krakow, Poland, Adopts Environmental Health Curriculum

The School of Public Health at Jagiellonian University in Krakow, Poland, has created an entirely new environmental health program, with assistance from EHP. In October 1996, the school offered its first-ever environmental health course: a 22-hour module attended by 31 health professionals. Based on the success of this course and the work of the faculty and EHP, the school has formally decided to institute a 200-hour post-graduate certificate course in environmental health beginning in September 1997.

EHP's work in curriculum development for the Jagiellonian University is part of a larger effort by the Bureau for Europe and the New Independent States to assist health care systems in Poland, Slovakia, and Romania to improve their capacity to

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*Child Survival and Environmental Health Interventions: A Cost-Effectiveness Analysis.* Robert C. G. Varley. 30 pages. (Applied Study 4) See the article on page 1 for a summary of this report.

*Beyond Participation: Locally Based Demand for Environmental Health in Peri-Urban Areas.* Robert C. G. Varley, May Yacoob, and Scott Smith. 34 pages. (Applied Study 6)

*Monitoring the Effect of Behavior Change Activities on Cholera: A Review in Chimborazo and Cotopaxi, Ecuador.* Linda Whiteford, Carmen Laspina, and Mercedes Torres. 120 pages. (Activity Report 25)

*Coping with Intermittent Water Supply: Problems and Prospects, Dehra Dun, Uttar Pradesh, India.* KyeongAe Choe, Robert C. G. Varley, and H. U. Bijlani. 98 pages. (Activity Report 26)

*Development of Indicators for the Water and Wastewater Sector in Egypt.* David Laredo, Tarek Selim, and James Carney. 82 pages. (Activity Report 27)

*Environmental Assessment for the Gaza Industrial Estate Project.* Bob Davis, Iyad Abumoghli, Frank Castaldi, Sana Hamady, and Jonathan Hodgkin. 168 pages. (Activity Report 28)

*Summary of Phase II: Restructuring and Environmental Improvement Assistance to RAS Kiviter, Kohtla-Järve, Estonia, 1994-1996.* Don Jackson et al. 52 pages. (Activity Report 29)

*Institutional Assessment for Lead Exposure Abatement and Reduction in Cairo.* Laurence J. O'Toole, Janet A. Phoenix, and M. Walid Gamaleldin. 62 pages. (Activity Report 31)

*Prevention Preserves Wellness.* An 18"x26" poster on interventions that break environmental links to disease. Available from EHP.

Contact EHP for copies of reports; many reports can also be accessed on the Internet. Visit the EHP home page to see what is available: <http://www.access.digex.net/~ehp>.

— Betsy Reddaway

## Update (from page 4)

cope with the health effects of environmental pollution.

### Leveraging Opportunities Realized

USAID's "Principles for Sustainable Development" cites the importance of leveraging funds from other donors or development organizations. In several cases, EHP technical assistance has helped bring about this "leveraging" effect.

■ The World Bank has agreed to provide \$4 million in assistance to the Tunisian government to scale up a successful 18-month program coordinated by EHP to improve the capacity of municipalities to involve peri-urban communities in the planning and implementation of environmental health activities. The EHP assistance, which was provided from buy-ins from RHUDO/Tunisia and the WID office, totalled \$595,000.

■ The city of Ahmedabad in India is putting in place an environmental action plan based on a risk assessment carried out with assistance from EHP staff. Implementation of the plan will be financed by local, state, and

private entities, with possible World Bank funding of major infrastructure improvements. Similar work is ongoing in Asansol-Durgapur. EHP's contribution to leveraging these considerable investments was \$50,000 from core funds. RHUDO/India also provided \$50,000; other contributions included support from the FIRE (Financial Institutions Reform and Expansion) project and from the Ahmedabad municipality.

In the Tunisia and India examples, the work begun by EHP is being continued by others; whereas, in the examples below, leveraging consists of influencing how other organizations invest their funds.

■ Approximately \$100,000 in EHP assistance to UNICEF in revising its sanitation strategy and producing a set of sanitation guidelines for field personnel will have a major effect on how the organization invests \$125 million annually in water and sanitation activities. Increased attention to sanitation and hygiene behavior change prescribed by the new strategy will lead to greater health impact from UNICEF efforts.

■ EHP also participated with PAHO in the production of guidelines for a water and sanitation sector assessment. EHP was responsible for the health, community, and institutional components of the guidelines. PAHO has used the assessment as a starting point in each country in its Health and the Environment Initiative, a plan to raise \$216 billion over the 1992-2000 period for water and sanitation in the region.

### Technical Assistance Provided to Mission S.O. Teams

In recent months, EHP consultants have been assisting two mission strategic objective teams to develop results packages. In Egypt, EHP is helping to develop a completely new results package aimed at improving water and wastewater infrastructure and strengthening the institutions responsible in three provincial cities and Alexandria. In the Dominican Republic, EHP assistance amplified the water supply and sanitation component of a new integrated health strategic objective. □

## Cost-Effectiveness *(from page 1)*

Investments in WS&S infrastructure are largely beyond the control of the health sector decision-maker. WS&S infrastructure is almost always financed by some combination of user fees and public investment subsidies. Health is only one of its many benefits. From a consumer's point of view, the benefits of WS&S infrastructure are the accessibility and convenience of safe water and waste disposal. People will pay for these benefits, and demand analysis is the basis for user fees or public subsidies.

### WS&S "HW" and "SW"

The experience of the International Drinking Water Supply and Sanitation Decade (1981-1990) confirmed that WS&S infrastructure alone has limited health impacts. Health impacts can be maximized only if WS&S infrastructure is accompanied by programs promoting health-enhancing behaviors: proper use of latrines, safe water storage, safe disposal of babies' feces, and so on. WS&S programs should always include a hygiene component and stress community involvement in and commitment to it.

To make this distinction between aspects of WS&S that are within or outside of the responsibility of the health sector, the model uses the short-hand designation "HW" (hard-

ware) for WS&S infrastructure and "SW" (software) for interventions that promote WS&S-related behavior change or influence how the HW is used. In the model, SW interventions are lumped together under the general heading "hygiene."

The model examines the cost-effectiveness of four possible combinations of WS&S SW and HW in reducing the impact of diarrheal disease on children under five: (1) add SW to existing HW, (2) provide both SW and HW where neither exists, or (3) and (4) supply HW alone or SW alone. Cost-effectiveness is estimated for each of the options in terms of reduction in incidence or number of cases, reduction in deaths, and reductions in DALYs lost.

The model was constructed as a set of spreadsheet equations and input parameters that vary depending upon the locale. The parameters must include reasonable estimates of (1) the local incidence, duration, and case fatality rate (CFR) of the target disease, (2) the cost of the intervention, and (3) the effect of the intervention under local conditions.

### Empirical Assumptions

The data used in the model is the most reliable available about conditions in peri-urban communities in sub-Saharan Africa, an area chosen to demonstrate the model because of the

### What is Cost-Effectiveness?

The **cost** (*in monetary terms*) of producing a **unit of effect** (*such as reduction in diarrhea cases*) through some **intervention** (*such as a hygiene program*).

prevailing high rates of diarrheal disease. The community is assumed to have a population of 1 million, 17% under five years of age. It is assumed that the children have an average of five episodes a year of diarrheal disease with a CFR of 0.50%.

Estimates of costs are based on both professional and "gray" literature. HW is assumed to be a low-tech system costing \$72 per five-person household per year. SW is assumed to be a health extension program for excreta, water, personal, domestic, and food hygiene at a cost of \$3 per household per year for labor, supervision, transport, administration, materials, and rent.

The model generates estimates of the cost-effectiveness of ORT in reducing diarrheal mortality and shows how a preventive program, such as hygiene promotion, can reduce the amount that the health sector has to spend on ORT (costed at \$2 per episode).

Through an examination of the literature, estimates were made of the effects of WS&S HW and SW interventions, both individually and combined, in reducing the incidence of child diarrheal disease. The greatest effects are achieved when HW and SW are introduced together (30%) or when SW is added to existing HW (20%). As mentioned, the effect of SW is much less in the absence of HW, and HW alone has the same reduced effect (10%). ORT's effectiveness was assumed to be a halving of the CFR, i.e., from 0.50% to 0.25%.

A few additional pieces of information had to be plugged into the model

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Figure 2  
Cost-Effectiveness of Four Scenarios & ORT

Scenario	Per Case Averted	Per Death Averted	Per DALY Saved
I. Provide SW to existing HW. HW+ SW- → HW+ SW+	\$3	\$689	\$21
II. Provide both HW and SW. HW- SW- → HW+ SW+	\$61	\$14,253	\$428
III. Provide HW only. HW- SW- → HW+ SW-	\$169	\$39,720	\$1,193
IV. Provide SW only. HW- SW- → HW- SW+	\$6	\$1,520	\$46
ORT	N.A.	\$800	\$24

## Mathematics of Prevention

The EHP cost-effectiveness model illustrates the positive impact that preventive interventions can have on the health care budget. For example, in a hypothetical urban area of 1 million, 17% of whom are children under five, the cost-effectiveness of a hygiene program, where water and sanitation infrastructure already exists or is being constructed, is calculated as follows.

- Assuming a diarrheal disease incidence of five episodes a year per child and program effectiveness of 20%, then **170,000 cases will be averted per year**.
- At \$3 per five-person household per year, the total **yearly cost of the hygiene program is \$600,000**.
- But this cost will be offset by savings in the ORT budget. If it costs \$2 per case to administer ORT, and if it is assumed that 30% of the cases are treated, then the hygiene program will make possible **savings of \$102,000 per year** because the 51,000 cases averted will not have to be treated with ORT.

- This \$102,000 is subtracted from the hygiene program costs of \$600,000, giving a **total cost to the health sector of \$498,000 per year**. It is this figure, the net cost to the health sector, that is used to estimate the cost-effectiveness of hygiene—in this example, **\$21 per DALY saved**.

The cost-effectiveness of hygiene improves if more “optimistic” assumptions are used, that is, if the cost is reduced to \$2 per household per year, the program effectiveness increased to 25%, and the incidence increased to 10 episodes per year. Then 425,000 cases would be averted and \$255,000 that would have been spent on ORT could be subtracted from the hygiene budget of \$400,000, yielding a net cost to the health sector of \$145,000. In this scenario, the cost-effectiveness of hygiene is the very low **\$2.41 per DALY saved**.

— Robert C.G. Varley and Diane B. Bendahmane

### Cost-Effectiveness (from page 6)

so that cost-effectiveness could be given in DALYs, as well as in cases and deaths averted. The DALY formula combines rates of reductions in deaths and cases with a number of subjective parameters, such as a “severity” index, which ranks diseases according to how disabling they are, an age-weighting factor based on the onset of the disease, projected life expectancy, and a discount rate. Detailed information on the DALY formula and other aspects of the workings of the model are given in EHP Applied Study No. 4 “Child Survival and Environmental Health Interventions: A Cost-Effectiveness Analysis,” available from EHP.

### Results and Policy Implications

Running the model using the estimates of cost and program effectiveness given above produces some interesting results. See Figure 2.

First, adding SW to existing HW is the most cost-effective option at \$2.93 per case averted, \$689 per death averted, and \$21 per DALY saved. The net cost to the health sector for this and for all options is the cost of the WS&S intervention, minus the

savings realized by reducing the number of cases of diarrhea treated with ORT. (See “The Mathematics of Prevention” above.)

A cost-effectiveness of \$21 per DALY saved is clearly below the cut-off point of \$150 for cost-effectiveness suggested by the World Bank’s 1993 *World Development Report: Investing in Health*.

Second, the model confirms the Walsh and Warren finding of 18 years ago that it is not cost-effective for the health sector to finance both HW and SW *from the health point of view*. The cost-effectiveness of this option is \$60.53 per case averted, \$14,253 per death averted, and \$428 per DALY saved.

Compared to investing in both HW and SW, it is even less cost-effective for the health sector to provide HW alone, because it does little to reduce costs while significantly reducing effectiveness. The cost per DALY saved for HW alone is \$1,193. By contrast, adding SW alone *is* cost-effective because, although the health benefit is reduced, the cost to the health sector is substantially less. The cost-effectiveness

of SW alone is \$46 per DALY saved.

WS&S infrastructure coverage has been greatly extended in many developing countries in the past 20 years. The presence of existing HW, or of HW now being built, offers a tremendous opportunity for these countries to invest relatively small amounts in SW to achieve significant health impacts.

WS&S SW interventions are cost-effective for improving child health. They also reduce the pressure on the health care system by preventing illness before it strikes. Given that potential, health policymakers and planners should seriously consider incorporating WS&S SW interventions in programs to improve child health. Doing so would create a better balance between case management and prevention—the essence of environmental health.

— R.C.G. Varley and  
Diane B. Bendahmane

<sup>1</sup> Selective primary health care. An interim strategy for disease control in developing countries, *New England Journal of Medicine*, 301(18), 1979.

## Information Center Resources on Solid Waste

The EHP library database contains 126 records on solid waste, the health impacts of scavenging or living near landfills, and the technical design and management of solid waste projects, like the *Alternativa* project described on page 3. Two recent acquisitions on this topic are described briefly below.

*Solid Waste Management for Economically Developing Countries*, by L. Diaz et al. Copenhagen: International Solid Waste Association, 1996. 415 pages. A comprehensive reference book covering all aspects of solid waste management from storage and collection to processing and treatment. An updated chapter on sanitary landfills provides valuable information on the higher levels of engineering now required for landfill sites.

*Plastic Waste: Options for Small-Scale Resource Recovery*, by I. Lardinois et al. Gouda: WASTE Consultants, 1995. 112 pages. Examines the economics of plastics recovery and the health and environmental aspects of plastic wastes.

In addition, the "Warmer Bulletin" acts as a worldwide information service and newsletter to encourage recycling. Contact: 83 Mount Ephraim, Tunbridge Wells, Kent TN4 8BS, UK.

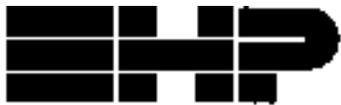
As might be expected, many useful resources on solid waste are available via the Internet.

The Solid Waste Management Recycling Network (an informal network to exchange information on recycling and composting in peri-urban areas) URL: <http://www.lboro.ac.uk/departments/cv/wedc/garnet>

Ground Water & Solid Waste (provides links to solid waste manuals and associations) URL: <http://chppm-www.apega.army.mil/gwswp>

Envirosense (a comprehensive listing of free U.S. Environmental Protection Agency reports on solid wastes) <http://es.inel.gov/index.html>

— Dan Campbell



### ENVIRONMENTAL HEALTH PROJECT

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