# CLEANER WATER AT THE SOURCE

Protecting naturally occurring springs with simple infrastructure significantly improved source water quality and reduced the incidence of diarrhea in young children by one-quarter.

Each year more than one million children under the age of five die from diarrheal diseases, which are often caused by unsafe drinking water. Even when diarrheal episodes are not fatal, they can lead to severe dehydration and have long-term impacts on children's cognitive and physical development. Diarrheal diseases are often transmitted when a water supply is contaminated with fecal matter and bacteria are passed into the mouth either through drinking, bathing, or touching one's face with dirty hands.

Though the technology exists to deliver uncontaminated water to households through pipes, in developing countries such methods are prohibitively expensive in most rural settings where households are far apart. In areas where decentralized water sources such as wells, boreholes, or springs are the norm, local governments and donors commonly fund the construction of new or improved water sources to combat diarrheal disease.

J-PAL affiliate Michael Kremer, Jessica Leino, J-PAL affiliate Edward Miguel, and Alix Zwane implemented the first randomized evaluation of spring protection, an intervention already widely used throughout Africa to improve source water quality. Spring protection entails sealing off a spring's water source and encasing it in concrete so that water flows out from a pipe—and directly into a water collector's bucket—rather than seeping from the ground where it is vulnerable to contamination. The evaluation addressed several questions: Can protecting springs reduce diarrhea in children? Are local populations willing to pay for access to improved water sources?

- **Spring protection dramatically improved source water quality.** Protecting naturally occurring springs with a simple concrete base and pipe reduced fecal matter contamination by two-thirds at the water source and by nearly one-quarter in users' home water supply.
- **Spring protection can be a cost-effective option to reduce diarrhea in young children.** Although some of the water quality improvement was lost when households transported or stored water in dirty containers, spring protection nonetheless reduced reported diarrhea in children by one-quarter. Spring protection is also highly cost-effective when a sufficient number of users collect water from a common spring (Figure 2).
- **Despite the benefits, households are not willing to pay very much for cleaner water.** Researchers estimate that households in the study area were only willing to pay US$2.96 for one year of spring protection, and US$769 to avert one child diarrheal death—far less than the estimated values typically used by public health planners. Low valuation by households may present a rationale for governments to subsidize water treatment.

# EVALUATION

The evaluation took place in a semi-arid region of rural Kenya, where over 90 percent of the population has access to naturally occurring springs, but very few have access to safe water. Diarrheal diseases are common in the study area. Working with a local NGO, International Child Support (ICS), researchers identified 200 springs that would be suitable for protecting.

## INTERVENTION

A randomly selected half of the 200 springs had their sources encased in concrete, so that water was forced to flow through a pipe rather than seeping from the ground, where it could be contaminated by runoff from surrounding fields or by contact with people's hands when they collected water.

The cost of the spring protection infrastructure was approximately US$956 per spring, and local communities contributed 10 percent of the project cost, usually in the form of labor. ICS conducted community meetings at which user maintenance committees, comprised of local residents, were formed. After spring construction, these committees were expected to undertake routine maintenance, including patching concrete, cleaning the catchment area, and clearing drainage ditches.

In four rounds of surveys between 2005 and 2007, water was sampled at all springs and in local households and tested for the presence of E. coli, a bacterium associated with the presence of fecal matter. Researchers also surveyed households to determine the prevalence of diarrheal disease.

## DESIGNING HEALTH INTERVENTIONS: CONVENIENCE MATTERS

Although the technology to combat diseases such as diarrhea is widely available in developing countries, take-up of preventive health products is often low, even when they are provided for free. This is because convenience matters. Evidence shows that even free products may not be adopted if they require additional time or effort from users. For example, in Kenya, the majority of households added chlorine to their water when it was delivered free to their doorstep, but far fewer used chlorine when they had to travel to redeem coupons for the same product (Kremer et al. 2011b). In India, the take-up of iron fortified flour (to combat anemia) dropped off sharply over time, particularly for individuals whose closest miller was not fortifying flour (Banerjee et al. 2010).

These and other results suggest that interventions which **maximize convenience for users** may be more successful at sustaining high take-up over time. Because take-up is so sensitive to convenience, interventions such as spring protection, which incorporate the preventive health intervention into everyday activities—in this case, fetching water from a spring—may be more successful than those which require additional effort from beneficiaries.

**Featured Evaluations:** Kremer, Michael, Jessica Leino, Edward Miguel, and Alix Zwane. 2011a. "Spring Cleaning: Rural Water Impacts, Valuation, and Institutions." *The Quarterly Journal of Economics* 126(1): 145–205.

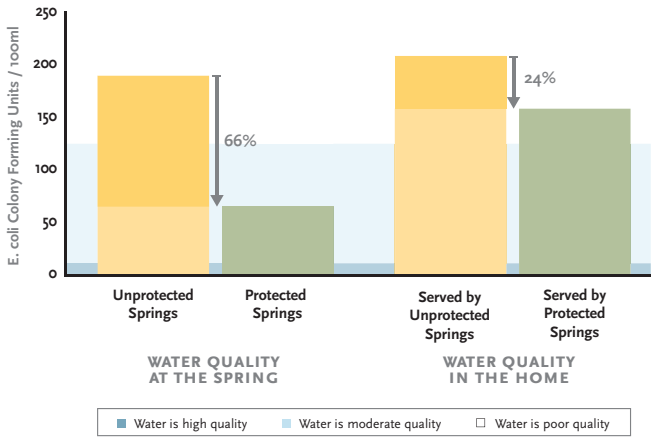
Kremer, Michael, Edward Miguel, Clair Null, and Alix Zwane. 2011b. "Social Engineering: Evidence from a Suite of Take-up Experiments in Kenya." Working Paper.

# RESULTS

**The simple spring protection infrastructure significantly improved the quality of source water.** Across four rounds of surveys, treated springs had 66 percent less E. coli contamination than untreated springs.

**Spring protection improved the quality of users' home water supply, but by less than the improvement in source water quality.** Households that collected water from treatment springs had 24 percent less E. coli contamination in their home water supply. The reduction in quality from source water to home water may be due to some households transporting and storing water in contaminated containers or collecting part of their water from unprotected springs (Figure 1).

**FIGURE 1:** WATER CONTAMINATION LEVELS, AT THE SOURCE & IN HOMES




**Spring protection significantly reduced the incidence of diarrhea for children.** Despite the incomplete transfer of benefits from protected springs to users' home water supply, diarrheal incidence for children under three years old fell by 4.7 percentage points, or one-quarter, relative to the comparison group. The effect was disproportionally concentrated among girls, who experienced a 9 percentage point reduction in diarrhea.

**Households were more likely to collect water from protected springs.** Possibly due to the perceived benefits of using protected springs, households in the treatment area increased their use of protected springs for drinking water, relative to other sources. However, they were only willing to walk on average an additional 3.5 minutes to reach a protected spring. Comparison households also increased their use of protected springs, in many cases making trips to use the springs in treatment areas.

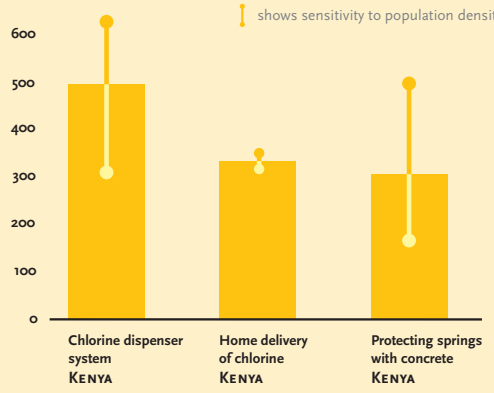
**Households have a low willingness to pay for spring protection.** Researchers used estimates of the amount of time households spent to get cleaner water to infer how much they were willing to pay for cleaner water. At US$2.96 for one year of spring protection, this "revealed preference" estimate is considerably less than the amount households stated they were willing to pay. Assuming people understand the effect of spring protection on health, this implies a valuation of only US$769 for averting one child diarrheal death, or US$23.68 per Disability Adjusted Life Year (DALY) saved, roughly one-fifth of the value that policymakers often use when assessing social programs.

## REDUCING CHILD DIARRHEA: COMPARING MULTIPLE INTERVENTIONS

Between 2003 and 2010, researchers evaluated a suite of water treatment interventions under the Kenya Rural Water Project. Beginning with the spring protection intervention discussed here, researchers also tested free home delivery of chlorine, coupons for discounted or free chlorine paired with community promotional campaigns, and a point-of-collection chlorine dispenser system that provided an unlimited supply of free chlorine at local water sources.

While all these interventions reduced the incidence of child diarrhea, their benefit per dollar spent varied. Chlorine dispensers avert the most diarrhea incidents per $1000 spent, but spring protection and home delivery of chlorine are also cost-effective approaches.

**FIGURE 2:** COST-EFFECTIVENESS, DIARRHEAL INCIDENTS AVOIDED PER $1000 SPENT



# POLICY LESSONS

PHOTOS BY AUDE GUERRUCCI

**Spring protection is an effective investment to improve water quality.** In rural areas, where piped water may be prohibitively expensive but households have ready access to naturally occurring springs, spring protection is an effective way to improve source water quality and reduce diarrhea in children.

**Spring protection dramatically improves water quality at the source, but much of this benefit is lost in households' home water supply.** Recontamination when water is transported or stored in unclean containers, or mixed with water from unprotected sources, presents a barrier to households receiving the full benefit of protecting springs. Therefore, water treatment interventions that disinfect water at the point of consumption or provide lasting protection from recontamination (for example, through chlorination) may be more effective options.

**Subsidies may be necessary to ensure lasting adoption of clean water technologies.** Across several different interventions that sought to improve water quality, households were found to have a low willingness to pay for the benefit of clean water. This suggests that households may have a lower valuation of child health than typically assumed or that they do not fully understand the consequences of chronic diarrhea in young children. In either case, these results suggest a rationale for governments to fund such water treatment interventions.

**Interventions that offer convenient access and require limited behavior change may address the challenge of people's low valuation of diarrhea prevention.** Households are not willing to expend much additional energy for cleaner water, either by walking farther to protected springs or by changing routine behaviors (see the box on page 2). Therefore, interventions that combine convenient access with a free supply of chlorine may be preferable to source improvements and point-of-use technologies. The point-of-collection chlorine dispenser system is one such technology, which was found to be highly effective at sustaining take-up and reducing child diarrhea in a related evaluation in Kenya (Kremer et al. 2011b).

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**Suggested Citation:** J-PAL Policy Briefcase. 2012. "Cleaner Water at the Source." Cambridge, MA: Abdul Latif Jameel Poverty Action Lab.

**About J-PAL** The Abdul Latif Jameel Poverty Action Lab (J-PAL) is a network of affiliated professors around the world who are united by their use of randomized evaluations to answer questions critical to poverty alleviation. J-PAL's mission is to reduce poverty by ensuring that policy is based on scientific evidence.

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