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Sustainability of water, sanitation and hygiene interventions in Central America

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Abstract

The American Red Cross and U.S. Centers for Disease Control and Prevention collaborated on a sustainability evaluation of post-hurricane water, sanitation and hygiene (WASH) interventions in Central America. In 2006 and 2009, we revisited six study areas in rural El Salvador, Guatemala, Honduras and Nicaragua to assess sustainability of WASH interventions finalized in 2002, after 1998's Hurricane Mitch. We used surveys to collect data, calculate indicators and identify factors that influence sustainability. Regional sustainability indicator results showed there was a statistically significant decline in access to water. The presence of sanitation facilities had not changed since the beginning of the project; however, maintenance and use of latrines declined but continued to meet the goal of 75% use after 7 years. The hygiene indicator, hand washing, initially declined and then increased. Declines in water access were due to operational problems related to storm events and population changes. Sanitation facilities were still present and sometimes used even though they reached or surpassed their original design life. Changes in hygiene practices appeared related to ongoing hygiene promotion from outside organizations. These results provide

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useful input for making WASH programs more sustainable and informing future, more in-depth research into factors influencing sustainability.

Keywords

Central America; evaluation; hygiene promotion; sanitation; sustainability; water

INTRODUCTION

One United Nations Millennium Development Goal (MDG) is to halve, by 2015, the proportion of the world's population that is without access to safe drinking water and basic sanitation. The world reached the MDG drinking water target in 2010, five years ahead of schedule. However, reaching the MDG sanitation target by 2015 is unlikely (UNICEF/WHO 2012). One major obstacle for both water and sanitation interventions is long-term sustainability.

Projects often focus on providing basic infrastructure, rather than on ongoing functionality. Moe & Rheingans (2006) reported on many examples of 'failed water and sanitation projects supported by well-intentioned but ill-informed agencies'. When assessing sustainability, projects often fail to consider community capacity and needs. Various estimates have documented somewhere between 30 and 60% of existing water supply systems do not provide adequate service (Brikke & Bredero 2003; Davis 2011; Lockwood & Smits 2011). 'Water-supply and sanitation projects should not be viewed as an end in themselves, but as the initiators of benefits that continue long after the projects have been handed over to the communities' (Brikke & Bredero 2003).

Organizations around the world have made significant progress in providing access to improved water and sanitation worldwide. However, limited evidence is available on sustainability of rural water and sanitation interventions (Montgomery *et al*. 2009). The focus of this evaluation is sustainability over the medium to long term. Our evaluation has reconfirmed that sustainable water, sanitation and hygiene (WASH) interventions should address several elements, including:

- Technical appropriateness.
- Continuing functionality through design life.
- Social acceptability to the community.
- Economic viability.
- Protection of the environment and natural resources (Brikke & Bredero 2003).

In this evaluation, we do not propose a universal definition for sustainability but, rather, we assess sustainability using WASH indicators. The indicators integrate the sustainability elements so that if water and sanitation systems continue to function and people continue to practice positive hygiene practices, then communities will meet at least some of the sustainability elements.

We documented the first 7 years of a 10-year WASH sustainability evaluation in rural communities in Central America. At the time of data collection in 2009, 19% of the rural population in the four Central American countries in our evaluation had no access to improved drinking water sources; 38% of this population had unimproved sanitation facilities, with 14% of that population not using any type of sanitation facility (WHO/UNICEF 2013).

BACKGROUND

In 1998, Hurricane Mitch struck Central America. It caused major damage to infrastructure especially throughout El Salvador, Guatemala, Honduras and Nicaragua and was recognized as the deadliest Atlantic hurricane since the Great Hurricane of 1780 (NOAA 2009). The devastation left many without water, sanitation and other services, affecting an estimated 3.6 million persons. Some 10,000 died and nearly 100,000 homes were destroyed (USAID 1999). The American Red Cross (ARC) responded to the disaster by providing community- and household-level WASH interventions to 110 communities.

The ARC's goal for the program was to 'decrease health risks associated with water and sanitation to Hurricane Mitch survivors'. The objectives were for communities to have sustainable water systems, to have access to potable water and to learn how to improve sanitation and hygiene practices. In providing interventions, the ARC took a participatory approach and integrated community participation in project development and implementation at the beginning of these projects. A minimum of 80% of the population in each community had to be willing and able to participate through labor and willingness to pay a water fee. Hurricane-affected communities also provided input on the level of services they were able to support and selected their interventions based on the costs, benefits and feasibility of each option (Moll *et al*. 2007). Water system designs included projected population growth rates and per capita water needs. Sanitation design considered local geologic factors such as depth to water table and soil type.

In collaboration with ARC, the U.S. Centers for Disease Control and Prevention (CDC) evaluated the effectiveness and the health impacts of the ARC WASH program. The evaluation occurred in eight study areas located in four Central American countries. ARC defined the study areas as either a single community or two adjacent communities that shared similar demographics, geographic region and intervention type. The ARC WASH program's health objective was a 25% reduction in childhood diarrhea from baseline (2000) to final (2002). The 2002 final evaluation showed that ARC's WASH reconstruction program met this goal on a regional basis (i.e. across all study areas). Results from the 3-year health impact study have been previously documented (Moll *et al*. 2007).

Because of the short 3-year period, however, the health impact study was limited in its ability to address longer-term intervention sustainability. The CDC recommended follow-up evaluations every 3 or 4 years over a decade to assess the long-term sustainability of the WASH interventions in these communities. After 2002, the study areas received no technical or financial assistance from ARC. This paper documents the first 7 years of that 10-year sustainability evaluation.

METHODS

For the sustainability evaluation, we revisited six study areas from the health impact study (Table 1). We excluded two of the original eight study areas for logistical reasons (e.g. inaccessibility), Waspam, Nicaragua and Huitzitzil, Guatemala. The sustainability evaluation consisted of:

- A community survey conducted with one or more members of each community's water committee and community leaders.
- A cross-sectional household survey, which included a questionnaire, visual inspection of household water and sanitation facilities, and visual assessment of hygiene behaviors.
- An infrastructure inspection/assessment by CDC and ARC of the community water system and sanitation facilities to assess functionality and maintenance.

The U.S. Agency for International Development (USAID) Food and Nutrition Technical Assistance (FANTA) Project 'Water and Sanitation Measurements Guide' (Guide) (Billig *et al*. 1999) provided the basis for the original health impact study and was used in the sustainability evaluations for consistency. ARC requested use of the eight performance indicators for the health impact study. We continued the sustainability evaluations using four of eight performance indicators as we could reliably collect data for those four. Performance indicators were a consistent way to evaluate WASH interventions over time (Table 2).

We used monitoring indicators to evaluate the progress of the intervention toward achieving its programmatic goal. Monitoring indicators assess both water access and access to sanitation facilities. We based the water access indicator on the FANTA Guide definition that includes connection to a piped system, distance to water and reported year-round water availability. Access to a sanitation facility means the presence of a private/shared facility in close proximity to the home. This indicator does not measure whether families use the facility, but rather the physical presence of the facility. An improved sanitation facility in rural areas is a dry pit latrine, ventilated improved pit (VIP) latrine, pour-flush latrine or composting latrine.

We used impact indicators to assess the effect the interventions have on behavior, such as handwashing and use/maintenance of sanitation facilities. Appropriate handwashing knowledge is based on both the interviewee's self-reported ability to recite – unprompted – critical times at which handwashing occurs and the interviewee's ability to demonstrate specific handwashing techniques. Sanitation facilities were assessed using a standard checklist in the household survey to determine use and if they were hygienic.

We determined sample size by region rather than by community. We calculated the number of households needed to conduct statistical analyses of handwashing behaviors. The handwashing behavior indicator required the largest sample size. The target sample size for the region was 94 households, a range of 14–16 households in each of six study areas, with a probability of alpha = 0.05 and 80% power. We collected data using a form developed in EPI INFO 2002 (CDC 2003) and did additional statistical analyses using SAS software

versions 9.1 and 9.2 (SAS Institute, Inc. 2002–2003). We compared survey results using Chi-square odds ratios to determine differences between the years.

We collected water quality samples from stored household drinking water, community water sources and tap water from the distribution system. Given that the focus of this paper is on sustainability in terms of the indicators described above, we report only generalizable water sampling results.

RESULTS

The 'Sustainability of WASH interventions' section contains results of the sustainability evaluation using the performance indicators. The household participation rate was 100% in six study areas (eight communities). The 'Factors influencing sustainability of WASH interventions' section describes the factors we identified through evaluation of community and household surveys.

Results: Sustainability of WASH interventions

Table 3 summarizes the results of the performance indicators from 2000 (baseline), 2002 (immediately post-intervention), 2006 and 2009. We used household survey data to estimate indicators by percentages. Although the sample sizes were different (526 in 2000, 569 in 2002 vs. 94 in 2006 and 104 in 2009), these results represent the region.

Water infrastructure—When ARC completed WASH interventions in all study areas in 2002, 89% of households had access to improved water sources. This level of coverage was below the ARC goal of 100% access. Results in Table 3 show a statistically significant decline in year-round access to an improved water source from 2002 to 2006, dropping from 89 to 71%. This decline remained approximately the same in 2009, at 74% coverage.

Sanitation infrastructure—In 2002, 97% of households had improved sanitation present at or near the home. No statistically significant changes in coverage occurred after 2002. Coverage in 2006 and 2009 was 98 and 95%, respectively. However, a statistically significant decrease in use and maintenance of latrines did occur from the 2002 baseline level of 87 to 77% in 2006 and then remained at that lower level in 2009. These lower levels of use still met ARC's original goal for percentage of population using hygienic sanitation facilities of 75%.

Hygiene promotion—By 2002, appropriate handwashing behavior met the ARC goal of a 50% increase over the 2000 baseline. From 2002 to 2006, households with appropriate handwashing behavior declined from 67 to 57%, although not with statistical significance. Yet the period 2006–2009 saw a statistically significant *increase* from 57 to 73% in households with appropriate handwashing behavior.

Results: Factors influencing sustainability of WASH interventions

We found five factors from community and household survey data that had potential effects on WASH intervention sustainability:

1. Occurrence of natural disasters or events.
2. Population growth or decline.
3. Presence of active water committees.
4. Lifespan of WASH infrastructure.
5. Follow-up from outside organizations.

Occurrence of natural disasters/natural events—Interviews with community leaders and water committees in 2006 and 2009 revealed that these study areas struggle with frequent severe weather events and natural disasters. Flooding occurs annually during the rainy season. Heavy rains cause landslides and earthquakes occur at times. Not only do these events affect community water systems, they can also damage household sanitation facilities. Table 4 shows that all study areas reported issues with natural disasters or events affecting their water and sanitation infrastructure. All study areas reported issues in 2006, and five of the six study areas reported storm-related damage in 2009.

Population growth/decline—Interviewers obtained population estimates as part of the community survey. Although populations both grew and declined after the ARC WASH interventions, in four of the six study areas community populations increased. From 2002 to 2009, significant population growth occurred in two communities – Las Lomas, Honduras and Plan Shalagua, Guatemala – with 131 and 233% growth, respectively. In contrast, Las Pozas, El Salvador had a −88% population decrease.

Active water committees—At the time of the 2009 data collection, all six study areas continued to have designated water committees and most were active, except for Plan Shalagua in Chiquimula, Guatemala. The committee, however, had just reconvened after a long period of inactivity to address their water source problem. As of 2009, most of the six study areas had set up bank accounts for water fee deposits. Chiquimula, Guatemala and Nueva Segovia, Nicaragua (only Dipilto Nuevo) did not have any savings in their accounts.

Lifespan of WASH infrastructure—The percentage of households with access to an improved sanitation facility remained relatively constant (Table 3) from 2002 to 2009. However, the percentage of those using a hygienic sanitation facility decreased significantly in 2006 and remained at that lower level in 2009. Community survey results in 2006 and 2009 found problems with pit latrines (dry pit/VIP) and pour-flush latrines. The latrines would fill and overflow, especially during the rainy season. The interviewers observed and confirmed these conditions in the household surveys.

Follow-up from outside organizations—After completion of the WASH programs, communities received no ARC support. Water and sanitation infrastructure, hygiene promotion and the health impact study were finished in 2002. We found that five of the six study areas reported that they received some type of follow-up education from outside organizations after 2002. Our survey results identified the local Red Cross National Societies, non-governmental organizations (NGOs) and local ministries of health providing follow-up.

Water quality results—General water quality results showed that microbial water quality was better in chlorinated water systems. In addition, water quality degraded through household water management. We will report complete water quality results in a future paper.

DISCUSSION

Occurrence of severe natural events/natural disasters

We found that natural disasters and events in every study area were responsible for substantial damage to community water systems and sanitation facilities and reduced their sustainability (Table 4). The climate in this region in Central America has a dry and rainy season. Daily rains during the regular rainy season contributed to rivers overflowing their banks and causing local flooding in addition to other natural disasters or events.

Damage to water systems in these instances limits access to an improved water source. For example, in 2005, rains from Hurricane Stan caused a landslide in Plan Shalagua, Guatemala that greatly reduced the quantity of water produced by the spring source. In El Guayabo, Guatemala, the conduction pipeline from the source to the storage tank is constantly prone to damage from falling trees during annual rainstorms and strong winds. El Guayabo constructed this conduction pipeline above ground owing to rocky terrain. Water system design in such a region may have to be more robust to avoid damage and annual washouts of pipelines during the rainy season.

The percentage of households with the presence of an improved sanitation facility near the home did not decrease. However, the percentage of the population using hygienic latrines did show a statistically significant decline. Our observations and comments reported during the community and household surveys found structurally damaged latrines. Households at times were not able to repair their latrines, rendering them either unusable, lacking privacy or unhygienic owing to waste seepage from cracked slabs or absorption tanks. Because of these issues, the better indicator of sanitation sustainability was not access (which did not change), but use and maintenance, which showed declines. Sanitation system design in this region should also consider severe natural events and disasters to enhance sustainability.

Population growth/decline—Owing to population growth, water systems in some study areas were unable to keep up with consumer demand while population decline put water system sustainability into question in other areas. In Las Lomas, Honduras, ARC planned for projected growth at the initiation of the project, expecting that families would be attracted to this community owing to the water service. From 2002 to 2009, there was 131% population increase. Water system expansion, however, was limited owing to seasonal washouts of water pipelines that required the community to spend available funds annually on water system repairs. New homes still received access to the water system, which put a greater demand on the system causing water service issues for the entire community. The water system expansion did not keep up with community growth. Community growth surpassed the system’s capacity to provide 24 hours per day water service. The lesson is that there must be a balance between planned projection for growth needs and a community’s circumstances.

In contrast, Las Pozas, El Salvador, had a decrease in population after 2002. Hurricane Mitch destroyed the original coastal community of Las Pozas residents, and they relocated inland during ARC's post-disaster community reconstruction in 2000–2002. Yet despite the improved water supply and the improved sanitation, the 2006 household survey found that lack of economic opportunity forced many residents to leave this community. Residents returned to the original location closer to the coast to seek jobs in the fishing and shrimping industries. Previous work has shown that resettlement in a new location after a natural disaster can pose a socio-economic challenge to relocated families, particularly with regard to employment and income (Badri *et al*. 2006). This significant population decrease in Las Pozas left many homes empty, latrines unused, and because of fewer paying households, an increased financial strain on the water system. Post-disaster resettlement or transition can continue for several years until the community has regained its social and economic production systems (Partridge 1989; Oliver-Smith 1991). This situation led to issues regarding sustainability of both the water and sanitation interventions.

Active water committees—Well-maintained and functioning water systems invariably had active water committees that met regularly to resolve problems and to make repairs. These water committees were responsible for collecting and depositing water fees into a bank account, and operating and maintaining the water system. A well-run water system leads to more paying customers and to more revenue for maintenance and repair. Water committees that were not diligent in collecting water fees had no water bank account and had more difficulty making needed repairs. Chiquimula, Guatemala (Plan Shalagua) and Nueva Segovia, Nicaragua (Dipilto Nuevo) both had active water committees but had no water system bank account. When communities do not repair water systems in a timely manner, disruptions in service, inadequate water quantity and poor water quality result, and dissatisfied consumers refuse to pay their water fees.

Lifespan of WASH infrastructure—According to the ARC, depending on the design and type of latrine (dry pit/VIP, pour-flush, composting), design life is subject to considerable variation. ARC based design life on local criteria (e.g. soil type, depth to groundwater and number of family members using the latrine) (WHO 1992; USAID 1993). ARC-constructed pit latrines had a design life of 5 to 10 years, while ARC expected composting latrines to last up to 20 years. A composting latrine requires constant maintenance to function properly and last through its designated design life span. Household survey results showed that after 4 years, communities that received pit latrines (dry pit/VIP) and pour-flush latrines were experiencing problems. When their latrines were filled or overflowing during the rainy season, household members used a relative's or neighbor's sanitation facility or simply defecated outdoors. The lesson here is that when investing in long-term, sustainable sanitation – and particularly when there is a need to construct new latrines in the future – organizations should consider appropriate latrine design factors as well as community education that teaches how to use readily available local materials for repairs or construction.

Follow-up education and assistance

A lack of follow-up hygiene promotion may help explain the decrease in appropriate handwashing behavior and decreased use of hygienic latrines from 2002 to 2006. However, the provision of follow-up from 2006 to 2009 may explain the regional improvement in handwashing behavior and lack of change in use of hygienic sanitation facilities over that time. Several study areas (Las Pozas, El Salvador; Las Lomas and Marcovia, Honduras; and Nueva Segovia, Nicaragua) received hygiene promotion from organizations other than ARC after 2002. Chiquimula, Guatemala (Plan Shalagua) was the only study area that did not receive any follow-up after 2002 and showed a decline in the hygiene promotion indicators.

During both the community and household surveys, interviewees emphasized the importance of follow-up assistance and education. Water committees reported a need for ongoing assistance and technical development of members on water system management to improve service to the community or to repair their water systems after stormor earthquake-related damage. Many household interviewees also reported a need for ongoing technical assistance and materials on how to maintain and continue using their specific type of latrine (e.g. composting latrines) or how to build a new one after their latrines reach the end of their design life.

Changes in hygiene practices, both positive and negative, appeared related to the presence or absence of ongoing hygiene promotion from other organizations. Although that follow-up education is not likely at the same level of programming as the ARC pre-2002, it can be a positive influence. Previous work has shown that behavior change requires consistent messaging to communities (Arnold *et al*. 2009; Luby *et al*. 2009) to be effective.

LIMITATIONS

Several limitations in this sustainability evaluation could influence our results. Owing to limited resources, the CDC designed overall sample sizes for the 2006 and 2009 sustainability evaluations to detect expected differences in the USAID WASH indicators (Table 2) over the entire region rather than at the study area level. Sample size calculations did not account for clustering and the design effect could be large. Thus, sample sizes only allowed for statistical analyses at a regional level, across all study areas combined, whereas only trends in the USAID WASH indicators are observable at the study area level.

Additionally, limitations due to the random selection of households within the study areas might have changed some of the evaluation results. New households might never have received certain ARC WASH interventions (e.g. water system access, sanitation facilities, hygiene promotion) before or after 2002. When conducting the surveys for the 2006 and 2009 sustainability evaluations, these households were included in the random selection. These households may not have known who provided WASH interventions to their communities. If these households did not receive certain interventions and were unaware of who provided them, it would be difficult to assess accurately the sustainability of these interventions.

Self-reporting of data is also a limitation in this evaluation. CDC included self-reported knowledge and observed practice of appropriate handwashing behavior in each household according to the FANTA Guide. Ram (2010) recognized that self-reporting of handwashing knowledge is not a valid measure of actual behavior; however, we collected data in this manner to be consistent from survey to survey. This indicator introduces bias since observed and evaluated respondents may have modified their normal handwashing techniques. To lessen the impact of this limitation, interviewers received thorough training in the proper way to conduct this survey.

Finally, we did not initially use these indicators to measure sustainability. CDC used the same indicators from the health impact study and added questions to the survey to identify the factors associated with long-term sustainability. Two indicators, for example, measure sanitation access and use. Our results show that although access to sanitation appears sustainable (monitoring indicator), use of sanitation facilities did decline (impact indicator) as we have noted in our results. We must consider indicator results collectively to get a better picture of the sustainability of each intervention. Despite such limitations, our evaluation was a unique opportunity to follow the same study areas over a number of years.

CONCLUSIONS

The goal of this evaluation was to observe and measure the sustainability of infrastructure and hygiene interventions once communities began the operation and maintenance of these interventions, with no additional ARC follow-up. We wanted to identify possible factors that influenced WASH intervention sustainability. Community participation and input did not vary widely across the region and would not have a differential impact on sustainability in this study.

The primary factors that influenced the sustainability of water systems were severe storm events, population changes and active water committees. Our results suggest that improving water system design by accounting for such weather events could promote sustainability. If available, using localized population growth estimates rather than standard rules of thumb or national growth estimates, could also help promote sustainability. Active water committees also enhanced water system sustainability, indicating that developing or identifying appropriate community-level capacity to manage water systems is an important consideration (Gelting & Ortolano 1998).

We can best evaluate sanitation interventions by looking at indicators for both access and use. ARC initially provided latrines to households, which require proper maintenance and use. Simply looking at access did not provide an adequate measure of sustainability. In some areas, latrines were still accessible and in use but were damaged or past their usable life, and could not therefore be considered sustainable. Thus, organizations beginning a sanitation intervention should consider what would happen at the end of the sanitation facilities' design life. Planning for eventual replacement or pit emptying could be included at project initiation. Replacement could result from new interventions in the future or by training community members in techniques for constructing new latrines when needed, or making

repairs to existing latrines. Most helpful to these communities will be developing training materials that emphasize the use of locally obtained materials for repairs or construction.

Rural communities, with limited resources and expertise, can benefit most from follow-up by local organizations once the initial WASH program is complete. The follow-up hygiene promotion that occurred in some of these communities, appeared in every instance to improve WASH intervention sustainability (appropriate handwashing behavior). Hygiene promotion programs involve teaching materials and/or technical assistance as opposed to capital investment in infrastructure. Organizations can accomplish ongoing follow-up hygiene promotion programs with relatively little expense using local resources available from municipalities, local health clinics or NGOs.

Our sustainability evaluation results can potentially guide future program start-up toward ensuring and enhancing the long-term sustainability of these types of projects and lead to programmatic change in international development organizations. The ARC has incorporated our results to make changes in their current WASH programming to reflect this. In addition, our results provide the background research for future studies to explore sustainability further, such as investigating which WASH interventions are most sustainable and identifying additional factors contributing to sustainability. If interventions are not sustainable, health and other benefits derived from them are lost. Thus for all water and sanitation interventions, future investigators need to address sustainability issues.

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DISCLAIMER

The findings and conclusions in this journal article are those of the author(s) and do not necessarily represent the views of the Centers for Disease Control and Prevention.

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Table 1

Study area, population size and interventions in the sustainability evaluation

Country/study area	Size of community (2009)	Type of community	Water intervention (year completed)	Sanitation intervention (year completed)
El Salvador				
1. La Ceiba	100–105 households	Rural; existing community in hilly region	New water system: spring source, pumped to tank, gravity flow to household taps (2001)	Household composting latrines (2002)
2. Las Pozas	1,004 households	Peri-urban; resettlement community	New water system: deep drilled well, pumped to tank, gravity flow to household taps (2001)	Household composting latrines (2002)
Guatemala				
3. Chiquimula (2 communities)				
Plan Shalagua[a]	300 households	Rural; existing mountain communities	Upgrade existing water system: spring-fed, gravity flow to shared communal household taps (2002)	Household VIP latrines (2002)
El Guayabo[a]	180 households	Rural; existing mountain communities	New water system: spring-fed, gravity flow to household taps (2002)	Household VIP latrines (2002)
Honduras				
4. Las Lomas	500 households	Peri-urban; existing community in hilly region	Upgrade water system: new tank and source, additional household connections, spring- fed, gravity flow system to household taps (2002)	Household pour-flush latrines (2002)
5. Marcovia	245 households	Peri-urban; resettlement community in flat area	New water system: deep drilled well, pumped to tank, gravity flow to household taps (2002)	Household pour-flush latrines (2002)
Nicaragua				
6. Nueva Segovia (2 communities)				
Dipilto Nuevo[a]	50 households	Peri-urban; existing community	New water system installed by municipality (not by ARC): spring fed gravity flow system to household taps (2000)	Household dry pit latrines (2002)
Dipilto Viejo[a]	90 households	Peri-urban; existing community	New water system installed by municipality (not by ARC): spring fed gravity flow system to household taps (2001)	Household dry pit latrines (2002)

[a]Two communities grouped together as a study area for a sufficient number of households to sample.

VIP, ventilated improved pit latrine.

Table 2

USAID water and sanitation performance indicators

Intervention	Performance indicator	Description of indicator	Goal
Water infrastructure	Monitoring indicator	Percentage of households with year-round access to improved water source	100%[a]
Sanitation infrastructure	Monitoring indicator	Percentage of households with access to (presence of) sanitation facility	100%[a]
Hygiene promotion	Impact indicator	Percentage of households with appropriate handwashing behavior	50% increase
	Impact indicator	Percentage of population using hygienic sanitation facilities	75% in use

[a]Goal defined by the American Red Cross; the Guide specified no goal for this indicator. See FANTA Guide (Billig *et al*. 1999) for how each indicator was calculated.

Table 3

Regional results for the sustainability evaluation

Intervention	Performance indicator description	Goal	Baseline (pre-intervention) %	2002 %	2006 %	2009 %	p-value (2002 vs. 2006)	p-value (2006 vs. 2009)	p-value (2002 vs. 2009)
Water infrastructure	Households with year-round access to improved water source	100%	47	89	71	74	< 0.0001	0.60	< 0.0001
Sanitation infrastructure	Households with access to (presence of) sanitation facility[a]	100%	54	97	98	95	0.97	0.53	0.28
Hygiene promotion	Appropriate handwashing behavior	50% increase above baseline Goal ≥53%[b]	35	67	57	73	0.06	0.02	0.22
	Population using hygienic sanitation facilities[a]	75% in use	36	87	77	77	0.01	0.90	0.01

Bold indicates that the indicator met the goal. Underline means statistically significant difference.

[a] Both indicators represent sanitation infrastructure.

[b] The calculated goal is 50% increase above baseline of 35%.

Table 4

Community survey reporting of events and natural disasters damaging water and sanitation infrastructure (2006 and 2009)

Event	Occurrence after event	Impacted communities
Hurricanes/Storms	Flooding damaged water system	La Ceiba, Chiquimula, Las Lomas, Nueva Segovia
	Strong winds damaged latrines	La Ceiba, Las Pozas, Chiquimula, Marcovia, Nueva Segovia
	Landslide damaged water system	Chiquimula (Plan Shalagua only)
Earthquakes	Damaged water system and latrines	Las Pozas
Deforestation	Landslides affected water quality	Nueva Segovia (Dipilto Nuevo only)