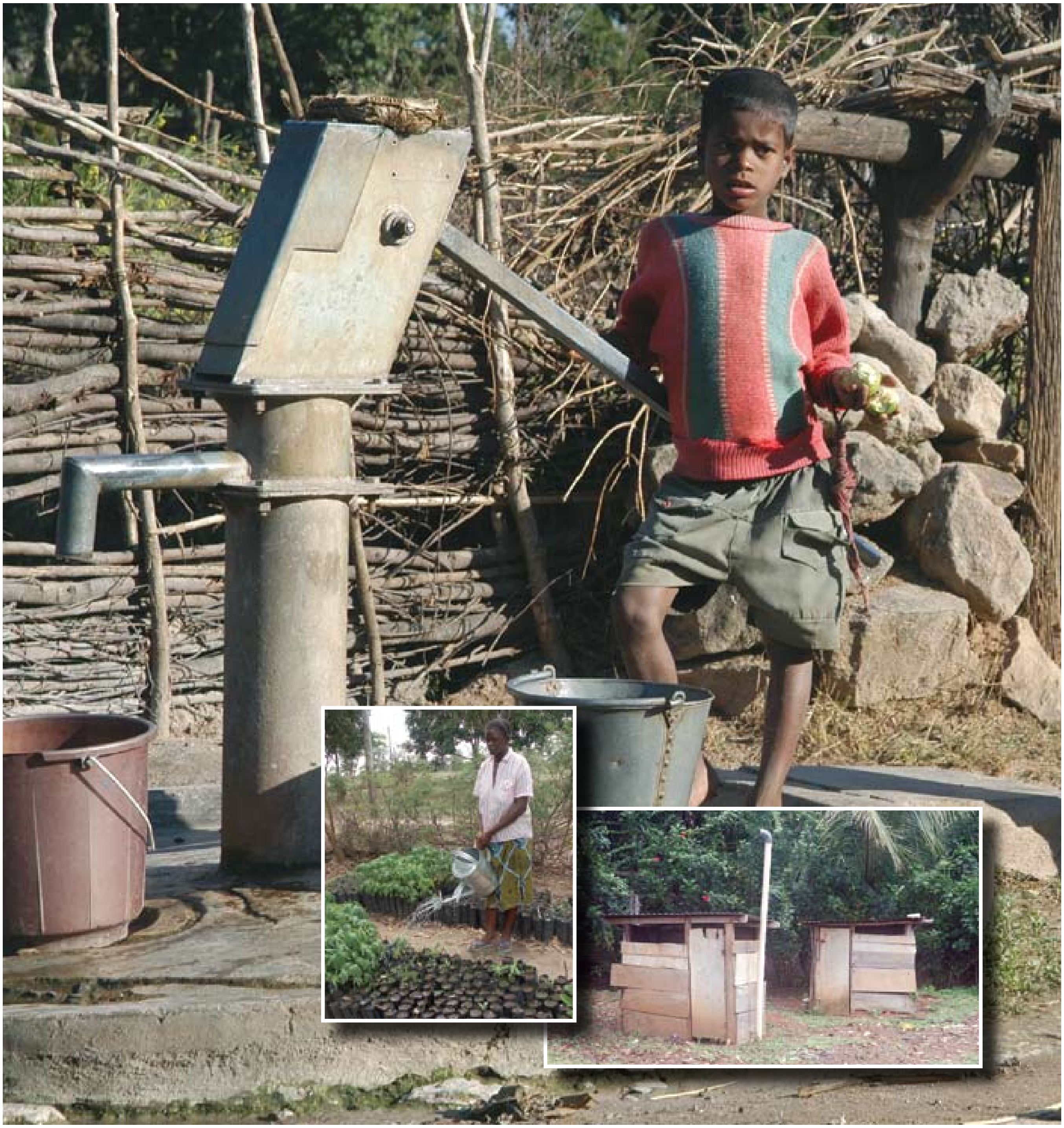
Best Practices in Water and Sanitation



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CRS Best Practices in Water and Sanitation

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Since 1943, Catholic Relief Services has had the privilege of serving the poor and disadvantaged overseas. Without regard to race, creed, or nationality, CRS provides emergency relief in the wake of natural and manmade disasters. Through development projects in fields such as education, peace and justice, agriculture, microfinance, health, and HIV and AIDS, CRS works to uphold human dignity and promote better standards of living. CRS also works throughout the United States to expand the knowledge and action of Catholics and others interested in issues of international peace and justice. Our programs and resources respond to the U.S. bishops' call to live in solidarity—as one human family—across borders, over oceans, and through differences in language, culture and economic condition.

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CRS Best Practices in Water and Sanitation

Title: Aboveground Sand Dams

Category: Water Supply Technologies / Innovative But Available

No. WAT – 1

Type of Practice

Provision of seasonal river water using an aboveground concrete dam to collect and store this sediment-laden water in an aboveground reservoir. The dam structure traps the sediment and water, which creates an artificial groundwater condition upstream of the dam. The impounded water then recharges the natural groundwater through infiltration and is extracted by using a pumping and piping system to deliver water to tap stands where it can be collected

Purpose

The purpose of sand dams is to provide water for domestic uses, small home gardens, larger community gardens in agroenterprise schemes, and livestock watering.

Background

Sand dams have been used for many years in Kenya. In addition, traditional water harvesting at certain points along dry rivers has been widely practiced on a smaller scale in arid/semi-arid lands (ASALS) with good results.

Due to limited and unreliable rainfall, most rivers are ephemeral with seasonal flows and only experience heavy water run-off for short periods of time after a rain. During such periods of high flow, large quantities of sand are transported downstream while other deposits get trapped on the upstream sides of rock ledges along the stream. Such sand traps form natural aquifers that are capable of providing clean adequate water if well harnessed. The sand dam is an appropriate technology that exploits this water storage phenomenon.

During the dry periods, pastoralists and agropastoralists get water for themselves and livestock by scooping into the sand beds of the dry streams at upstream sides of ledges that cut across the channel. Water at such sites is usually clean for drinking but quite finite and is quickly depleted. Sand dams are an artificial enhancement of this traditional practice and puts extra water into these sand beds to recharge and store water.

Description

In Kenya, the Ndunguni sand dam is located in the Ndunguni Parish in the Embu District, Kenya. The project was implemented by the Diocese of Embu with funding support provided by CRS at a cost of 2.5 million Kenya Shilling (KSh) (Note: In 2007, 1 USD = 65 KSh). The project commenced in 2002 and construction ended in 2004. An outside contractor was hired to construct the sand dam, which consists of reinforced concrete. The structure was built onto firm rock and is 3.4 meters tall and about 50 meters long.

The Ndunguni sand dam was constructed across the stream channel at this specific site due to the gently sloping land and its sandy and gravelly conditions that is seasonally dry but experiences high sand and soil particle sediment during periods of high flow. Excess water flows over the top of the dam to replenish aquifers downstream. A 3-inch galvanized iron pipe was placed through the concrete structure to convey the stored water to a tap stand located approximately 20 meters downstream of the dam and away from the high water level of the stream. Water enters the pipe through a slotted pipe filter. A concrete splash pad apron was constructed around the tap stand to convey wastewater away from the tap stand and to provide for a dry area for people to take water.

A Water Committee was formed at the start of the project. They are responsible for collecting water-user fees, maintaining the tap stand, and reporting any problems that may arise to the Diocese Engineer.

Current Status

The Water Committee greeted us during the July 2007 site visit. At the time, vegetation was growing on the upstream side of the sand dam. Water was overtopping the sand dam. On both sides of the sand dam and downstream of its location, groundwater was seeping out of the ground. The tap-stand area was covered in standing water, rendering the filling of water containers difficult. Animals were not allowed to drink water directly from the sand dam reservoir but were led to a site downstream of the structure. Conversations with the CRS/Kenya Water Program Manager and the Diocesan Engineer revealed their surprise at the amount of groundwater present at the site. Although they understood the potential for groundwater storage as a result of the sand dam, neither expected to see the results witnessed during this visit. Their previous visit to the site occurred in October 2006 when water was neither overtopping the dam nor seeping out of the ground. At that time a meeting was held with the Water Committee where the participants were actually sitting on the sand dam structure, which is not possible now. Three photos from the July 2007 site visit are below.

Community Benefits and Environmental Impacts
The following benefits to the Ndunguni community were achieved, or have the potential to be achieved, through the use of the sand dam technology:

- Potable water supply for human and livestock consumption due to the filtering effect of sand (regular testing of the water should be performed and other treatment provided if necessary)
- Water supply for other domestic uses such as cooking, bathing, and clothes washing
- Environmentally friendly erosion control through tree and shrub planting and silt-deposition management within the stream watershed
- Increase in the groundwater level through infiltration providing both soil and water conservation benefits. Indigenous trees are able to quickly regenerate along the streambanks, thereby attracting other biological resources such as grass materials used for house construction promoting ecosystems susceptible to threats from recurring droughts, and increasing wildlife populations
- Small-scale crop production through irrigation that was otherwise not possible

Disadvantages
The sand dam technology is labor and capital intensive, and most local communities cannot implement it without external technical support and funding.

Operation and Maintenance
Once construction is complete further operation costs are negligible. The presence of seeping groundwater requires the tap stand to be located either at a higher elevation or to raise the tap-riser pipe and improve the concrete apron and drainage. Streambanks also need to be protected against erosion from seeping groundwater as well as floodwater that can cut around the dam. Protection can take the form of planting local groundcover vines and grasses to prevent erosion as well as thorny trees and shrubs to prohibit animals from entering the reservoir area.

Future Considerations
At present, people in the surrounding communities must travel to the sand dam to fill their water containers and travel back to their homes with the filled containers. People transport these containers on their heads, on their backs, or packed on bicycles and donkeys. The nearest villages are approximately two kilometers away. With the increased groundwater availability, a shallow well or borehole with a pumping system could be installed to pump water to storage tanks located in closer proximity to the surrounding communities. From these tanks, a piped distribution system with tap stands located closer to houses would require less time and effort for villagers to obtain the potable water.

Also, the construction of small-scale community gardens should be investigated. Crops grown in the gardens could be sold at local or regional markets or, if this is not feasible, crops could be grown for local consumption. Three areas need to be investigated to determine the feasibility of creating community gardens:

1. Hydrological Capacity
    a. How much water is available for the various domestic, livestock, and agricultural/agroenterprise uses?
    b. How much water is required by the types of crops that could be grown in this area?

2. Markets
    a. What types of crops are bought and sold in the local and regional markets?
    b. What are the prices people are paying for the same crops?
3. Technology
    a. Are the irrigation system components sustainable, especially regarding spare parts?

Further considerations include the need to stabilize the surrounding soil, especially in areas where there is seeping groundwater. A 30-meter "no activity" buffer zone should be enforced around the sand dam reservoir area to limit the amount of run-off sediment, such as fine soil particles, that could enter the reservoir and reduce the capacity of reservoir volume and slow the rate of water through the reservoir.

Conclusions

Sand dams are a viable option where geologic and hydrologic conditions are appropriate for capturing water for multiple purposes. Sand dams intercept the seasonal flow of water and sediment in streams, thereby raising groundwater levels behind the structure. A clean and reliable water source can be provided to surrounding communities by the construction of a permanent system for water collection, transmission, and distribution. Groundwater can be further exploited for watering livestock as well as agricultural or possible agroenterprise initiatives. Other benefits include improving the health of the immediate ecosystem. Sand dam technology is labor and capital intensive and most local communities cannot implement it without external technical support and funding.

Resources Needed

- Contractors to construct sand dams and boreholes
- Cement
- Sand and gravel (preferably locally supplied)
- Hydrological information on availability of streamflow and rainwater

Outcomes Expected

Community water supply system that utilizes more abundant groundwater to positively impact livelihoods.

Adaptations Required

- Water committee responsible for routine maintenance of the dam, surrounding area and tap stands

Additional References

Smith, M., & Shaw, R.J. (1991). Technical Brief No. 24: Groundwater Dams. *The Worth of Water: Technical Briefs on Health, Water and Sanitation*, IT Publications, pp. 97–100.

Technical Brief: Sand Dams—Feasible Rain Water Harvesting Technology For Arid and Semi Arid Lands, Practical Action Eastern Africa, www.practicalaction.org.

Date Prepared: 9/19/07

CRS Best Practices in Water and Sanitation

Title: Borehole Drilling Equipment

Category: Water Supply Technologies—Conventional

No. WAT – 2

Type of Practice

Equipment used to drill boreholes for the extraction of groundwater. The borehole is lined with casing/piping to create a well and then installed with a pumping system to extract the groundwater.

Purpose

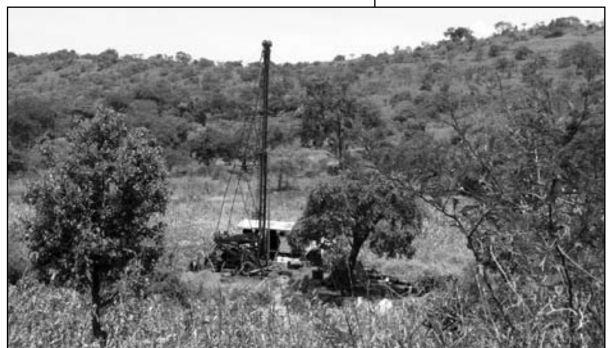
The purpose of borehole drilling is to gain access to groundwater for domestic and other uses when surface water or rainwater sources are unavailable, insufficient, or of poor quality.

Background

In many areas of the world where CRS operates, such as the arid/semi-arid regions of East Africa, water is a scarce resource. Surface water is usually found only during the rainy season and it tends to be short-lived. Women and children often have to travel many kilometers to access water and then return their filled containers to their households. The most feasible technology that can provide water to people for domestic purposes and to sustain livestock and agricultural activities is groundwater exploitation. Boreholes are used to access groundwater and can be installed closer to people's homes, which may reduce the time and energy spent in collecting water and increase the volume used.

Currently, there are CRS drilling programs in EARO, LACRO, SARO, and WARO. Only the program in Sudan is operated by the CRS country program; the others are operated by partners or contractors within the country.

Because groundwater is often of better quality than surface waters, it needs little or no treatment. Most groundwater contains no suspended matter and practically no bacteria. Microbial contamination, originating from human and animal activity (i.e., sanitation, agricultural practices), is greatly reduced with the installation of a cased borehole and a sealed wellhead and pump system in the borehole. This system is now less susceptible to ground surface contamination. However, the natural presence of chemical contaminates in the ground can be of concern. The three chemical contaminants of particular concern due to their immediate health impact as specified by WHO are arsenic, fluoride (that can occur naturally), and nitrate/nitrite (from excessive use of fertilizers or from the leaching of wastewater or other organic wastes into groundwater). Excess exposure to arsenic in drinking water may result in a significant risk of cancer and skin lesions. High levels of fluoride in drinking water can lead to mottling of teeth and, in severe cases, crippling skeletal fluorosis. Nitrate and nitrite in drinking water has been associated with methaemoglobinaemia ("blue-baby syndrome"), especially in bottle-fed babies, which prohibits the transport of oxygen in the bloodstream around the body.



Description

There are numerous borehole drilling and well-installation methods available. Some example methods include various types of percussion ("down the hole," DTH) , rotary drilling, reverse circulation rotary drilling, jetting, and earth auger boring.

This document focuses on the direct rotary drilling method because it is the most widely used drilling method of CRS and its partners. In direct rotary drilling, the borehole is drilled by applying force to a rotating bit against the ground formation to break up the formation and these cuttings are then removed by the continuous circulation of a drilling fluid as the bit penetrates the formation. The bit is attached to the lower end of a string of drill pipe, which transmits the rotating action from the rig to the bit. In the direct rotary system, drilling fluid is pumped down through the drill pipe and out through the ports or jets in the bit; the fluid then flows upward in the annular space between the hole and drill pipe, carrying the cuttings in suspension to the surface. (Johnson, 1986)

Depending on the physical and chemical conditions found in the borehole, drilling fluids serve the primary functions of:

- Removing cuttings during drilling
- Stabilizing the borehole walls and preventing expansion of swelling clays
- Cleaning and cooling the drill bit and lubricating the drill string
- Sealing the borehole wall to control fluid loss
- Allowing cuttings to drop out into the settling pit after they have exited the borehole to prevent recirculation
- Collecting additional geophysical information about the borehole
- Suspending cuttings in the borehole when the drilling fluid is not being circulated

There are two main types of drilling fluids used to construct water wells: air based, which can be dry air only or have a small amount of water and/or surfactant added to make mist or foam to help control dust; and water based, which can consist of clean, fresh water or be mixed with clay or polymeric additives to make "mud." Air and foam are normally used for a single pass through the borehole while muds are recirculated. A disadvantage of using any of the air-based or water-based fluids is that when drilling is stopped these fluids cannot keep the cuttings in suspension, which allows the cuttings to settle to the bottom of the borehole. The use of a drilling mud keeps the cuttings in suspension. However, the drilling mud must have enough consistency so the cuttings will settle out of suspension in a settling pit outside of the borehole before the mud is reintroduced into the borehole.

Rotary drill rigs are comprised of various equipment and tools mounted on a carrier truck. The following is a list of the major components of a rotary drill rig:

- Carrier truck
- Drill rig, consisting of an engine (to power the drill rig), rotary head (to turn/rotate the drill string), drawworks (used for lifting drilling components at the drilling site), tower (to position/align the drill string), hydraulic break-out wrench (for turning one drill pipe section relative to another drill pipe section to disengage the drill pipe sections), outriggers (used to stabilize and level a drill rig that is operating on uneven terrain), fuel tank, electric system, control console, and night lights
- Drill string, consisting of drill pipes/rods (imparts the turning motion to the bit, provides a conduit for the drilling fluid), drill collars (adds weight to the bit, keeps the hole straight), and the drill bit
- Drill bits of various sizes, shapes, and composition to be used depending on the ground formation
- Air compressor—provides air for air-rotary drilling; it can also be used to supply air for drilling large diameter holes using the foam method
- Mud pump—provides circulation of drilling fluid ("mud") during drilling operations
- Water injection system—injects water and foam into the drilling system discharge line during certain drilling operations
- Electric injection lubricator—provides lubrication into the air discharge line to lubricate down-the-hole drilling tools
- Auxiliary hoist
- Accessories, tools, spare parts

Depending on the size of the drilling equipment and carrier truck, other support vehicles may be needed to transport the drill pipes and collars and the drilling team.

Resources Needed

- Truck-mounted rotary drilling rig, including accessories and spare parts, as noted above
- Truck for carrying drill pipes and casings
- Water tanker
- Clay or polymeric additives for making drilling mud
- Pick-up truck for transporting drilling manager and crew
- Sand and gravel (preferably locally supplied)
- Geophysical investigations to obtain hydrogeological information on best drilling location and availability of groundwater

Outcomes Expected

Deep tube wells that penetrate the groundwater table into productive aquifers.

Adaptations Required

- Water committee responsible for operation and maintenance of the completed borehole

Additional References

Elson, R.J., & Shaw, R.J., Technical Brief No. 43: Simple Drilling Methods. *Running Water: More Technical Briefs on Health, Water and Sanitation*, pp. 41–44, 1999.

Atlas Copco, *Waterwell Technical Training Manual*, 4th Edition, 2005.

www.atlascopco.com

Driscoll, Fletcher G., *Groundwater and Wells*, Johnson Filtration Systems Inc., 1986.

WHO, *Guidelines for Drinking-water Quality*, Volume 1, 3rd Edition, 2004.

WHO/Robens Institute, University of Surrey, UK, Fact Sheet 2.3: Boreholes and Tubewells. *Cholera and other Epidemic Diarrhoeal Diseases Control: Fact Sheets on Environmental Sanitation.*

Date Prepared: 11/2/07

Title: Irrigation of Home Gardens Using Shallow Wells with Foot-Pumps
Category: Water Supply Technologies / Irrigation
No. WAT – 3

Type of Practice
Provision of irrigation water to home gardens. The water is drawn from adjacent shallow hand-dug wells with the aid of foot-powered treadle pumps.

Purpose
The purpose is to provide irrigation water to small home gardens during the dry season when normal cultivation of fields is not possible.

Background
In Niger, the dry season effectively brings land cultivation to a halt because of the lack of water. To assist villagers to cultivate vegetables during the dry season, CRS/Niger used its DAP for FY2001–FY2005 to construct or rehabilitate 400 hand-dug water wells as a source of irrigation water for small gardens. The wells are fitted with a locally made foot-powered (treadle) pump that allows relatively easy lifting of water into buckets, which are then carried to the adjacent gardens. In 2005, CRS/Niger submitted a proposal to OFDA to construct 100 wells with foot-powered pumps for the irrigation of off-season vegetables in drought-stricken regions of Niger.

Description
The wells average 6 meters in depth, 1.5 meters in diameter, and are reinforced with cast in-place concrete well rings. The foot-powered treadle pumps are locally made. The basic design of the pump originated in Bangladesh and had World Bank support in its early years. The introduction of the pumps to the project area has led to the development of a self-sustaining, private sector, pump-manufacturing activity. In Tchibiri Village in the Doutchi Region of Niger, a local mechanic, with CRS assistance, has begun a village-level industry of pump fabrication. He provides both pumps and services

to communities on a self-sustaining basis. The cost of the pump is FCFA 40,000 to 80,000 ($90–$180), depending on size, which includes installation. Over the past seven years, the mechanic has sold 443 locally manufactured pumps to communities. Simple repairs to the pumps are provided free by the mechanic and his staff, but major repairs must be paid for by the villagers.

In the CRS/Niger program, one shallow well and pump serves four (or more) garden plots. The maintenance of these wells and pumps is the responsibility of villagers working the adjacent gardens. In implementing the project, CRS provided the pump and the construction tools and materials for the wells.

CRS/Niger also provided seeds and tools for the gardens and trained a volunteer Animateur to assist the villagers with the agricultural issues. The project was administered through a village development committee that, in principle, had 50% women members. These gardens allow the local people to cultivate vegetables (generally poivrons) during the dry season when otherwise no crops can be grown.

Resources Needed

- Foot-powered treadle pump (preferably locally manufactured)
- Laborers to construct the shallow well (preferably from the households that will use the well)
- Cement
- Sand and gravel (preferably locally supplied)
- Hydrogeological information on availability of groundwater

Outcomes Expected

Shallow well with foot-powered pump capable of supplying irrigation water in the dry season to a small cluster of home garden plots.

Adaptations Required

- Establishment of local fabrication of the pump.
- Pump manufacturer must provide maintenance services for major repairs.
- Households must set out garden plots around well sites.
- Households must agree to sharing water and costs of repairs.

Additional References

Elson, R.J., & Shaw, R.J. (1993). Technical Brief No. 35: Low-Lift Irrigation Pumps. *Waterlines: Journal of Appropriate Technologies for Water Supply and Sanitation*, 11 (3), 15–18. (Available in CRS Watsan Technical Reference CD.)

Date Prepared: 8/25/05

Title: PlayPumps

Category: Water Supply Technologies—Innovative but Available

No. WAT – 4

Type of Practice

Provision of water to villages, schools, and clinics from a merry-go-round-driven pump that draws water from a borehole well located under its spinning axis.

Purpose

The purpose of PlayPumps is to provide water to villages, schools, and clinics.

Background

The idea for the PlayPump arose in 1989 when a child's roundabout, or merry-go-round, attached to a water pump was seen at an agricultural fair outside of Johannesburg, South Africa. As it turned, water was pumped from beneath the ground onto a field. This simple pump was being displayed by an engineer and professional borehole-driller, who dreamed of designing a tool that would both delight and help the rural children who often gathered to watch his drilling machinery at work, children who had boundless energy and few outlets for play.

From this simple pump came the idea to develop a more complex water system. A large-capacity water storage tank and four billboard spaces (one on each side of the square tank) for both advertising and public education messages was added to the pumping system. Thus, the merry-go-round system that pumps water now includes advertising billboards that can be used to raise revenue to support the system. This simple pump provided an innovative, sustainable, child-friendly answer to one of the region's most pressing problems: the need for more clean drinking water.

The concept was licensed from its inventor and Roundabout Outdoor, a company with a social mission dedicated to the new PlayPump® water system, was launched. Its innovative business model uses donations to underwrite the merry-go-round pump head, with its sealed water storage tank, water tap stand, concrete water spillage runoff, and borehole, as well as advertising revenue to fund maintenance, thereby guaranteeing sustainability.

The first two pump installations occurred in 1994 in South Africa's Masinga District, the most remote area of KwaZulu-Natal Province. Umgeni Water Company sponsored the manufacture and installation of the pump and Colgate-Palmolive advertised toothpaste on the storage tank's boards. By 1997, almost nine years after the pump was discovered and the system created, 20 PlayPump systems had been installed in South Africa, with 50 more systems planned.

Roundabout Outdoor and the PlayPump system gained recognition when, in 1999, President Nelson Mandela attended the ceremonial opening of a new school with a new PlayPump system. More recognition came in early 2000 when Roundabout Outdoor won the prestigious World Bank Development Marketplace Award for its ability to deliver both water and powerful HIV/AIDS prevention messages. The funds and the visibility of the award enabled the PlayPump system to upscale at a much faster rate. Roundabout Outdoor created a South African NGO to facilitate partnerships with corporations, foundations, governments, and individuals. That organization is now called PlayPumps International and is incorporated as a U.S. nonprofit organization.

To date (2007), more than 900 PlayPump systems have been installed in South Africa, Mozambique, Swaziland, and Zambia.

Description

PlayPumps refers to a water-pumping system whereby children play on a merry-go-round set over a borehole. When the merry-go-round spins on its vertical axis, water is pumped from the borehole into a 2,500 liter elevated steel water storage tank, from which it flows by gravity to one or more water taps in the courtyard and household of nearby homes or schools, community areas, and clinics.

The water storage tank provides an opportunity to advertise in outlying communities. All four sides of the tank can be leased as billboards, with two sides for consumer advertising and the other two sides for health and educational messages. The revenue generated by this unique model is used for pump maintenance.

Despite the wide publicity received by PlayPumps and the widespread installation of these units throughout southern Africa, there appear to be limitations as to the effectiveness of the PlayPump as a means of lifting water from the ground and making it available at low cost to the surrounding community. Several of the concerns are:

1. *Capacity of the system.* According to the PlayPump website, one PlayPump is capable of producing 1,400 liters of water per hour from a borehole depth of 40 meters while rotating at 16 revolutions per minute. Over a 12-hour day of pumping, this delivery rate equates to 16,800 liters of water, enough water for 840 people at 20 liters per person per day. To achieve this level of supply over a 12-hour period, the PlayPump will need to revolve 11,520 times.

2. *Cost of the system.* System cost is approximately $9,000 and does not include the drilling and finishing of a borehole (if needed). Unless an existing borehole is available, a newly drilled borehole may cost an additional $10,000.

3. *Functioning of the system.* The capacity figures in item 1 are based on the assumption that children will play continuously on the merry-go-round for 12 hours. If it is assumed that students will operate the merry-go-round for only 2 hours per day (an hour during recess and an hour after school), then the system will provide 2,800 liters of water, enough to serve 140 people at 20 liters per person per day. At this rate, the 2,500-liter storage tank would fill if there are no withdrawals of water during the day. It will contain less water depending on the rate of water usage by the community.

   The website also indicates that the system can function using a borehole with a depth of 40 to 100 meters. Performance data for deeper boreholes is unavailable, but the pumping rate can be assumed to be much less than that of a 40-meter-deep borehole. These limitations are affected by the type of pump used and the ability of the students to rotate the merry-go-round at a rate sufficient to raise the water in the borehole.

4. *Maintenance of the system.* Further information is needed on the operations and maintenance history of currently installed PlayPumps.

Resources Needed
- Borehole, either pre-existing (and in operable condition) or newly drilled.
- Merry-go-round-driven pumping system
- Elevated storage tank, piping, and tap stands
- Technical manpower for installation and maintenance
- Advertisers

Outcomes Expected
Merry-go-round-driven pump capable of supplying water to villages, schools, and clinics. In addition to providing access to drinking water, other benefits to the community are:
- Exposure to positive social messages such as HIV/AIDS prevention and hygiene education
- Improved hygiene and sanitation in schools
- Valued play equipment

Adaptations Required
- Establishment of local fabrication of the pump.
- Pump manufacturer must provide maintenance services for major repairs.
- Households can set out garden plots around well sites.
- Households must agree to sharing water and cost of repairs.

Additional References
www.playpumps.org

Date Prepared: 12/04/07

CRS Best Practices in Water and Sanitation

Title: Rooftop Rainwater Collection

Category: Water Supply

No. WAT – 5

Type of Practice

Provision of rainwater for primary or supplementary domestic water uses. Rainwater is collected from an impermeable rooftop area and conveyed to a storage tank.

Purpose

The purpose of rooftop rainwater collection is to provide water to homes and villages as the primary source of domestic water use or to supplement an existing water source.

Background

Rainwater collection is appropriate in those parts of the world that experience heavy, intense storms followed by prolonged periods of little or no rainfall. This scenario is true for many of the countries where CRS operates. At a minimum, rainwater collection should be investigated for those villages in mountainous areas that are located high above their existing spring or river sources. In such cases, rainwater collection systems could be sized to accommodate consumptive water uses while the existing sources could be continued to be used for other water-use purposes (i.e., clothes washing, bathing, gardens, livestock).

The three main pieces of information required to design a rainwater collection system are the availability of rainwater, the area of the collection surfaces, and the anticipated water demand. The design of a rainwater collection system involves comparing the cumulative monthly supply (i.e., rainfall) to the cumulative monthly water demand. The supply is determined by the amount of rainfall expected, the size of the collection area, and a factor of the efficiency of the catchment area to collect the rainfall. It is advisable to use average monthly rainfall data from at least the previous 20 years for two reasons: (1) the amount of monthly data, as opposed to daily data, is much more manageable for analysis, and (2) a minimum of the previous 20 years worth of data will reflect the current climatic and seasonal variations that can be anticipated during the design life of the system.

If the rainwater is to be used for domestic purposes, the factors required to determine the water demand are the size of the population to be served by this supply and the amount of water required by the population each day, which is usually reported as liters per person per day. If the supply is to be used for domestic crop production, then the demand can be calculated by the number of containers used to water the garden per day and the volume of each container used.

Once the supply and demand data have been collected, the required volume of the storage tank can be determined. The storage volume is the maximum difference between the cumulative monthly supply and cumulative demand over an annual period. (An example calculation sheet is attached to this document. To ensure that the water needs of the community are met, at no point during the year should the cumulative total rainwater supplied be less than the cumulative total water demand. If the cumulative water demand of the community to be served is determined to be greater than the cumulative total rainwater available then the size of the catchment area needs to be increased. Although this adjustment may be required, one needs to consider the amount of rainfall available as well. If too little rainfall is available, the size of the required catchment area will be too large, and thus costly and impractical, to construct.

Some key points about designing a rainwater collection system, as referenced on the example calculation sheet located at the end of this chapter, are:

- Columns 1, 2, 3, 4, and 6—When designing a rainwater collection system, the calculations should start on the first month following the dry season when the historical average monthly supply is larger than the monthly water demand. In the example table, May is the first month when the historical monthly rainfall average (67 mm) equates to a monthly supply of 32,696 L, which is greater than the monthly water demand of 27,000 L. A review of the rainfall data indicates that the dry season is from November to April.
- Columns 5 and 7—The cumulative monthly supply is always larger than the cumulative monthly demand. If this is not true, then the community will run out of water.
- Column 8—The required storage is equal to the largest difference between the cumulative monthly supply and the cumulative monthly demand. In the example, the required storage volume is 133,544 L, or 134 cubic meters.
- Column 9—In addition to the rainfall amounts, the values in the System Parameters table determine to what degree a rainwater collection system is appropriate for a community. The initial unknown value driving the design is the *available collection area*.
    - The per person water demand value of 5 L/day is to account for drinking and cooking purposes only.
    - The population size is the number of people who will directly benefit from using this system.
    - The efficiency factor of 0.8 is an acceptable value for the assumed corrugated iron roofing used in the example. (Pacey and Cullis, 1986)
    - The collection area size is the horizontal rooftop area measured by multiplying the length times the width of the roof area, not the building wall area. Also, the pitch of the roof is not of concern because it is assumed that the rain falls straight down.

In the attached example, it is assumed that the rainfall data, population size, and water demand are known values. In order for the system to be successful as per above, a minimum collection area of 610 square meters (sqm) is required. Ideally, this collection area would be located on one preexisting building. However, if the total collection area required is scattered over several buildings, then individual storage tanks need to be placed at each location, each sized proportionately to the size of the individual roof area to the total roof area. If a larger rooftop collection area is available on one building then either (1) more rainwater will be available for the population (i.e., a larger per person usage rate can be used or more land area can be watered, depending on the system's design), or (2) a smaller storage volume is required at the same water-usage rate.

Description

Rainwater collection systems consist of three main components:

- Building roof area—This area is constructed of an impermeable material, typically corrugated iron or fiberglass sheeting. Appropriate roof areas are usually found on churches, school buildings, community centers, health clinics, and businesses. If the existing roof area is of poor quality then a new roof will need to be installed, or if there is no impermeable roof available then a structure will need to be constructed.
- Storage container—A storage container is required when rainfall amounts during certain times of the year, such as the dry season, do not meet the water demands of the community. Storage containers are typically constructed of ferrocement, plastic (HDPE), or galvanized iron.
- Conveyance system—This system is used for transporting the collected water from the rooftop to the storage container and consists of gutters, a "first flush" device, and a downspout. These components are typically made of PVC but galvanized iron is also used. The "first flush" device allows the first rainfall amount collected on the roof (20–25 liters) to be discharged from the system. This water is usually polluted by the accumulation of dust, leaves, and droppings from birds and other animals on the roof surface and in the gutters since the previous rainfall.

Disinfection of the collected water is required if it is to be used for consumption.

Resources Needed

- Building roof area constructed of an impermeable material, such as corrugated iron sheeting
- Conveyance system that includes gutters and downspouts, typically PVC or galvanized iron, and a first-flush mechanism
- Storage tank, typically constructed of ferrocement, plastic (HDPE), or galvanized iron
- Historical monthly rainfall data, preferably from the previous 20 years
- If water is to be used for consumption purposes, some type of water treatment is required

Outcomes Expected

New water source for domestic or home garden needs or to supplement an existing domestic water supply.

Adaptations Required

- Ground collection areas can be used to collect rainwater in a system of concrete or asphalt open areas that are curbed and gently sloped to a point of exit leading to a storage container. Such a storage is typically constructed below ground, and water is extracted by means of a pump.

Additional References

Ball, S., Technical Brief No. 11: Rainwater Harvesting. *The Worth of Water: Technical Briefs on Health, Water and Sanitation*, IT Publications, 1991, pp. 45–48.

Fact Sheet 2.6 *Rainwater Harvesting, Cholera and other Epidemic Diarrhoeal Diseases Control: Fact Sheets on Environmental Sanitation*, Robens Institute, University of Surrey and WHO.

Guidelines for Drinking-water Quality, 3rd ed., Vol. 1, WHO, 2004.
(Available in CRS Watsan Technical Reference CD.)

Date Prepared: 10/24/07

Rainwater Catchment Calculations

Month	Days in Month	20-year Avg Monthly Rainfall (mm)	Avg Monthly Supply (mm)	Cumulative Monthly Supply (L)	Monthly Water Demand (L)	Cumulative Monthly Demand (L)	Required Water Storage (L)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
May	31	67	32,696	32,696	27,900	27,900	4,796
Jun	30	112	54,656	87,352	27,000	54,900	32,452
Jul	31	82	40,016	127,368	27,900	82,800	44,568
Aug	31	102	49,776	177,144	27,900	110,700	66,444
Sep	30	164	80,032	257,176	27,000	137,700	119,476
Oct	31	86	41,968	299,144	27,900	165,600	133,544
Nov	30	31	15,128	314,272	27,000	192,600	121,672
Dec	31	2	976	315,248	27,900	220,500	94,748
Jan	31	0	0	315,248	27,900	248,400	66,848
Feb	28	1	488	315,736	25,200	273,600	42,136
Mar	31	6	2,928	318,664	27,900	301,500	17,164 ◄ Should be close to zero
Apr	30	20	9,760	328,424	27,000	328,500	-76
TOTAL		673					

Required Storage= 133,544 L / 134 m^3

	(9)
Demand =	5 L/cap/day
Population =	180
Efficiency =	0.8
Catchment area =	610sqm

INPUT:

- ◄ Start with first month of rain season, using the three-letter abbreviation
- ◄ Corresponding 20-year average monthly rainfall amount in millimeters
- ◄ As appropriate
- ◄ Input the Total Available Catchment Area and adjust Population to determine the population the catchment area can support, or Input Population total and adjust Catchment Area to determine what is required

CRS Best Practices in Water and Sanitation

Title: ArborLoo

Category: Sanitation

No. SAN – 1

Type of Practice

Management of human excreta through ecological sanitation.

Purpose

The purpose of ecological sanitation is twofold: first and foremost to provide better sanitation infrastructure to more people at less cost, and secondly to improve food security through recycling human excreta for agricultural fertilizer.

Background

A 2004 evaluation of CRS Ethiopia's emergency water and sanitation program revealed serious deficiencies in the implementation of sanitation. Sanitation coverage in projects was nominal, no more than demonstration level. The cost of latrines being promoted exceeded what rural Ethiopian households could afford, even though that cost had been reduced in recent years from $150 to $60 per toilet by shifting the design standard from ventilated improved pit (VIP) latrines to conventional simple pit latrines. In many areas soil conditions were unsuitable for these latrines, which usually call for a pit of 3 meters depth to last on average about 10 years. Soils were often rocky and difficult to dig or too sandy, so that a pit would collapse after only a few months of use. And there was a high percentage of female-headed households without a male labor source to assist in construction. These conditions called for a drastic change in approach to sanitation.

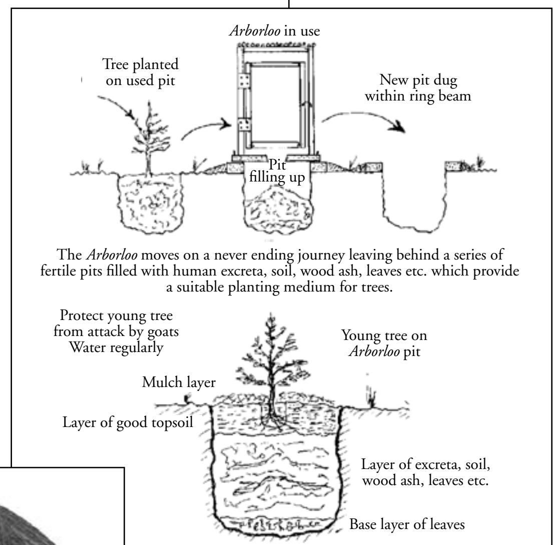
From 2004 to mid-2008, CRS Ethiopia partners assisted over 32,000 households in rural Ethiopia to build ArborLoos, one of several "eco-san"-type toilets. The cost of the ArborLoo is mainly in the slab, currently about $5 to $8. The design uses a shallow pit and simple privacy structure, which households can dig and construct on their own, and there are no other costs. The pit is intended to eventually become the site for a fruit tree, and in Ethiopia many households have now as many as 4 or 5 tree seedlings growing in the ArborLoo sites in their compounds.

CRS partners also promote urine harvesting (collecting household members' urine in a jerry can or jar) as a source of fertilizer for small gardens. Trials to date indicate that fertilizing garden plots increased crop production 200% to 400% over unfertilized control plots.

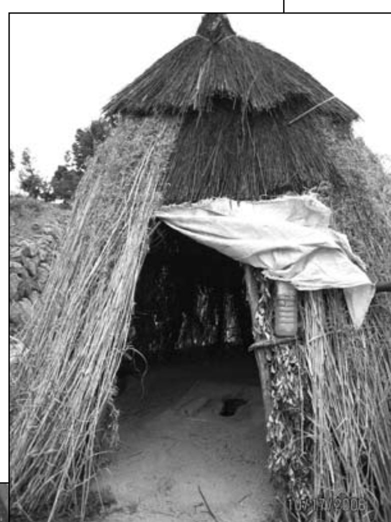
The success of ecological sanitation has opened the eyes of all stakeholders, including communities and government staff, and provides hope for meeting the sanitation challenge in Ethiopia. Communities are promoting ecological sanitation with enthusiasm, which has not happened with other sanitation alternatives. Decision makers now consider ecological sanitation an option to meet the Millenium Development Goals. At the European Union Water Initiative Multi-Stakeholder Forum in October 2006 in Addis Ababa, ecological sanitation was recommended as a main sanitation option for Ethiopia, and this was clearly stated in the MOU signed by the Ministries of Water Resources, Health and Education at the conclusion of the forum.

Description

The ArborLoo is a very shallow pit that is designed to be, eventually, a site for a fruit tree. Designed by Peter Morgan of Zimbabwe especially for African conditions, the toilet is the simplest of all ecotoilets. A pit about 80 centimeters deep and 60 centimeters in circumference is dug, and dry leaves are added to the bottom. A simple concrete slab is placed over the opening. After each use, a cup of a soil/wood ash mixture is added to encourage soil composting, reduce smell, and discourage insect breeding. A very simple superstructure can be added for privacy.



Drawing by Peter Morgan



Photos by Mayling Simpson-Hebert, CRS EARO

Photo by Bekele Abaire, CRS Ethiopia

This toilet is used by a household for one year and then the slab is removed, the pit is topped up with good topsoil, and a fruit tree seedling or other crop is planted in the topsoil. As the roots grow downward into the pit, the seedling takes up rich nutrients, which result in a very healthy tree that produces in abundance. In Ethiopia local farmers have elected to make the pits smaller and use a toilet site for only about 4 months, so that they can speed up the planting of seedlings.

Resources Needed

- Shallow pit latrine
- Trained staff and a budget for producing slabs and educating farmers. In Ethiopia, the slabs are produced at a cost of only US$5 each. It is essential to connect the sanitation project with agricultural practices and local agronomists. Ecological sanitation is a system and needs a systems approach—that is, having teams of sanitarians, agronomists, health workers, and water supply engineers all involved and understanding the approach as a package. Ideally these toilets should be part of larger water and sanitation programs that include facilities for handwashing and hygiene education.

Outcomes Expected

Food security through planting food crop in post-pit latrine location.

Adaptations Required

- Households construct their own ArborLoo toilets
- Local fabrication or access to simple concrete squatting slabs

Additional References

www.ecosanres.org

www.aquamor.tripod.com

"Ecological Sanitation," Winblad and Simpson-Hebert, 2004

"Toilets that make compost," Morgan, Stockholm Environment Institute, 2007. Reprinted by TALC, 2008.

Date Prepared: 10/15/08

CRS Best Practices in Water and Sanitation

Title: Basic Participatory Hygiene and Sanitation Transformation (PHAST) Methodology Guide

Category: Hygiene Promotion and Education

No. HPE – 1

Type of Practice
A participatory approach for the control of diarrheal disease.

Purpose
Participatory Hygiene and Sanitation Transformation (PHAST) is both an educational and a community planning tool. It is designed to promote hygiene behaviors, sanitation improvements, and community management of water and sanitation facilities using specifically developed participatory techniques. PHAST helps people feel more confident about themselves and their ability to take action and make improvements in their communities. Feelings of empowerment and personal growth are as important as the physical changes, such as cleaning up the environment or building latrines.

PHAST is unique because the underlying basis for the approach is that no lasting change in people's behavior will occur without understanding and believing. To summarize the approach, specific participatory activities were developed for community groups to discover for themselves the fecal-oral contamination routes of disease. They then analyze their own hygiene behaviors in the light of this information and plan how to block the contamination routes.

Background
The PHAST methodology is a joint program of the World Health Organization (WHO) and the United Nations Development Program (UNDP)/World Bank Water and Sanitation Program. It began with a pilot study in four African countries in 1993 to test the use of participatory methods for promoting hygiene behaviors, sanitation improvements, and community management of water and sanitation facilities. The participatory process leads to programs that are much more likely to be successful than those that impose solutions on communities.

Description
The methodology has seven steps. The first five help take the community group through the process of developing a plan to prevent diarrheal diseases by improving water supply,

hygiene behaviors, and sanitation. The sixth and seventh steps involve monitoring and evaluation. The seven steps are:

Step 1: Problem identification
Step 2: Problem analysis
Step 3: Planning for solutions
Step 4: Selecting options
Step 5: Planning for new facilities and behavior change
Step 6: Planning for monitoring and evaluation
Step 7: Participatory evaluation

Each step contains between one and four activities. The information gained from these activities is used to work out whether the plan has been successful. Most of the activities require the use of drawings or a chart, called "tools," to help facilitate the discussion.

PHAST has proven that people, regardless of age, gender, social and economic status, or educational background are capable of analyzing their situation and solving their own problems. PHAST does not teach per se but rather creates the conditions, through good facilitation, sound questions, and visual aids/materials, for effective community-based learning and planning. PHAST does not only stimulate local decision-making around health, but also increases community participation in the implementation of sector initiatives and the sustainability of a project (e.g. Operation and Maintenance issues).

Resources Needed

- Previous PHAST training for the community facilitators
- PHAST Toolkit

Outcomes Expected

A community enabled to work out what they want to do (especially related to water supply, sanitation and hygiene), how it should be implemented, how it should be paid for and how they can sustain it in the future.

Adaptations Required

- Participation by community, especially women, in PHAST process

Additional References

www.who.int/water_sanitation_health/hygiene/envsan/phastep/en/

Self-esteem, Associative strengths, Resourcefulness, Action-planning, and Responsibility (SARAR).

Tools for community participation: a manual for training trainers in participatory techniques, by Lyra Srinivasan.

The PHAST initiative: Participatory Hygiene and Sanitation Transformation. A new approach to working with communities.

(Available in CRS Water Supply and Sanitation Technical Reference Library CD.)

Date Prepared: 6/6/08

Title: PUR Water Disinfection Packets

Category: Water Quality and Treatment

No. WQT – 1

Type of Practice

Provision of potable water through use of PUR packet where non-potable water exists. Nonpotable water is made potable by mixing the PUR packet contents with nonpotable water, mixing for a prescribed amount of time, and then decanting the clean potable water from the mixing container.

Purpose

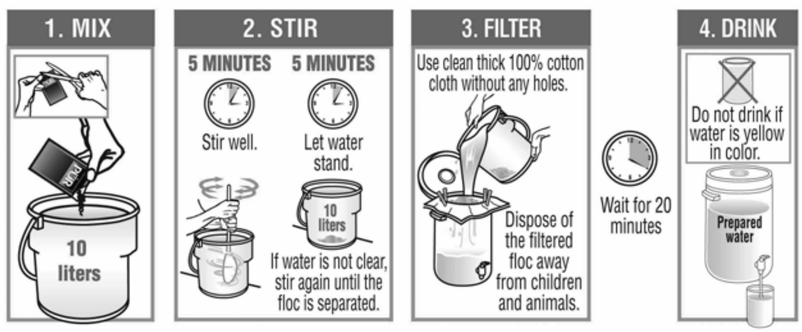
The purpose of PUR is to disinfect nonpotable water in emergency situations.

Background

Chlorine bleach is one of the more widely available disinfectants in the developing world. However, people have difficulty gauging how much is needed to treat a given amount of water without creating an unpleasant taste or harmful concentrations. Although the chlorine bleach approach continues to be used in many parts of the world, it does not remove suspended material from the water, leaving users with water that is microbe-free but that can still look dirty. Procter & Gamble (P&G) researchers tackled the challenge with flocculants: agents that promote molecular aggregation and can cause colloids or loose particles in a liquid to amass in clumps that sink to the bottom. In the mid-1990s, P&G, the leading manufacturer of bleach in many of the affected countries, entered into a formal Cooperative Research and Development Agreement with the Centers for Disease Control (CDC) that focused on how drinking water could be better treated at the point of use.

By combining the flocculants with large-particle calcium hypochlorite—essentially, powdered bleach—the result was PUR, a proprietary formulation that can be described as reverse engineering the municipal water-treatment process. PUR now occupies a place at the forefront of P&G's Children's Safe Drinking Water Program, a nonprofit venture for the consumer-products company that manufactures the packets.

P&G's leaders strongly back the charitable project. Like other major U.S. companies with international interests, P&G sees long-range business benefits in charitable projects in developing countries, what some call "strategic philanthropy." Companies that work to improve health and education overseas can also improve their images in foreign countries and among consumers at home. They can reap benefits to employee morale and recruiting. Plus, they can lay the groundwork in future markets.



Description

PUR is a water purifier in powder form that combines a flocculant, which separates particles and organisms from water, and a disinfectant that kills microbes after 30 minutes. The small packet of powder is added to a large container holding 10 liters of polluted water and stirred constantly. Within a matter of seconds, any floating material will start to flocculate into clumps that sink to the bottom. In no more than five minutes, the water is clear. The water is then filtered through a cloth to remove the debris, if necessary, and allowed to sit for 20 minutes to become completely disinfected. The water is now clear and safe for drinking.

The main active ingredients of PUR are calcium hypochlorite (bleach) and ferric sulfate. The first kills a wide range of deadly pathogens, while ferric sulfate is a particle binder: it binds to particles of soil and disease-causing pathogens that aren't killed by the bleach. The packets can kill the water-borne pathogens that cause cholera, typhoid, and dysentery, for example, and remove some toxic metals like lead, arsenic, and mercury, as well as dangerous pesticides like DDT and PCB. PUR does not reduce the salinity of water.

The PUR packets are very efficient: a single packet can decontaminate 10 liters, or 2½ gallons, of drinking water. In randomized controlled trials conducted by the U.S. Center for Disease Control, the chemical packets reduced the incidence of diarrhea by 50%.

PUR is intended to be a cost-effective way of treating contaminated water. Unlike large stationary purification systems, PUR packets are small and portable, enabling them to be easily used in remote locations and emergency situations. This portability makes them promising for boosting water safety after natural disasters, like earthquakes, floods, and hurricanes, which can compromise water quality quite suddenly. In addition to its humanitarian value in disaster relief, the product is also being marketed as a household commodity in many other parts of the world where large portions of the population lack reliable water treatment.

PUR is not approved for use in the United States yet. PUR has been used throughout Africa, Asia, and Central America. On the open market, packets sell for around US$0.10 apiece. Population Services International (PSI) oversees the advertising and selling of PUR in different regions.

Resources Needed

- 10 liters of non-potable water
- 1 PUR packet
- Mixing container with stirrer
- Straining cloth
- Clean receiving container

Outcomes Expected

Potable water where only nonpotable water exists.

From the PSI website: PUR-treated water meets World Health Organization standards for potable water. PUR is very effective in removing bacteria (99.99999% removal), viruses (99.99%), and parasitic cysts like giardia and cryptosporidium (99.9%). PUR has limited effects on chemical contaminants, but it does remove arsenic and DDT. Because of its efficacy in removing sediments and parasites from water, PUR is often targeted to people living with HIV/AIDS and to those drinking muddy water.

Adaptations Required

- Initial demonstrations to show people how to use PUR

Additional References

www.psi.org/our_programs/products/pur.html

www.csdw.org/index.shtml

Date Prepared: 10/16/07

Title: Solar Water Disinfection (SODIS)

Category: Water Quality & Treatment

No. WQT – 2

Type of Practice

Purification of drinking water through solar disinfection of water in clear plastic (PET) bottles with a volume of up to three liters. By exposing these water bottles in the full sun for a minimum of six hours, the ultraviolet solar radiation of the sunlight will kill the diarrhoea-causing bacteria and viruses in the water. A synergy of radiation and heat occurs to disinfect the water if the water temperature increases above 50°C (120°F) and remains at this temperature for at least one hour.

Purpose

The purpose of solar disinfection is to provide household-level water made potable and safe to drink by a simple and inexpensive process.

Background

The solar disinfection process has been extensively tested and shown to be effective for microbiological disinfection of drinking water. However, it neither purifies water contaminated with chemicals (arsenic, fluoride, nitrates) nor makes saline water potable.

For emergency purposes solar disinfection can be used to produce small quantities of potable drinking water for camps and rural villages where boiling, chlorination, or other forms of water treatment are not possible. Solar disinfection is particularly applicable to household treatment of drinking water. It requires only a supply of empty plastic water bottles and some initial instruction on how to prepare and re-use the bottles.

Description

The following points outline the solar disinfection process at the household level:

1. Obtain clear plastic water bottles with caps of a volume of up to 3 liters.

2. Fill plastic bottles with clear water. If the water is murky or contains suspended sediments reduce the turbidity first through sedimentation (let the water stand for some time and decant it), filtration or flocculation/sedimentation using crushed seed of Moringa oleifera or Alum.

3. Set bottles on their sides in direct sunlight for a full day. Water will be safe to drink after one day of exposure to sunlight.

4. Maintain a sufficient supply of bottles so that a minimum of 1.0 liter of disinfected drinking water per person (including children) is available per day in the household. For example, a five-person household requires 10 one-liter bottles, or 5 bottles in the process of being disinfected and another 5 bottles inside the house with water from the previous day.

Resources Needed
- Clean water that is low in turbidity
- A supply of clear plastic (PET) bottles
- Full sunshine for 6 hours

Outcomes Expected
Microbiologically safe drinking water at the household level.

Adaptations Required
- If cloudy, a minimum of 12 hours of exposure time is required.

Additional References
www.sodis.ch

Date Prepared: 9/19/07

Title: Community Water, Sanitation, and Hygiene Needs Assessment Questionnaire

Category: Strategies

No. STR – 1

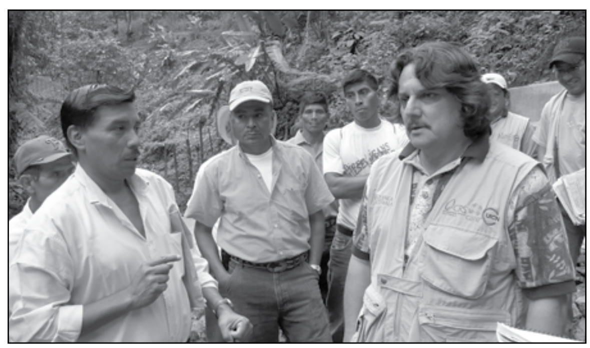
Type of Practice

Participatory approach to understand the water, sanitation, and hygiene systems and practices of a rural community.

Purpose

The purpose of the questionnaire works on two levels: (1) to collect qualitative and quantitative information regarding the water and sanitation facilities and conditions, and (2) to assess the knowledge and practices of the community required to develop improvement activities of these systems and practices.

Background



The questionnaire was developed in response to the CRS/DRC request for water and sanitation intervention assistance during their FY09-FY13 MYAP proposal development. Originally developed in English, the questionnaire was translated into French for the MYAP effort, but applied to the communities in the local language of South Kivu Province. The questions were asked by a team of Rural Development Technicians to targeted community groups.

Description

The questionnaire collects various qualitative and quantitative data about water, sanitation, and hygiene that can be used to formulate intervention strategies. Its questions about water, sanitation, and hygiene are categorized as follows:

- Water sources
- Water transport
- Water storage
- Water uses
- Water treatment
- Sanitation—Latrines

- Sanitation—Community hygiene
- Sanitation—Community health
- Hygiene promotion
- Community involvement

The questionnaire is located on the next page.

Resources Needed

- The attached questionnaire to this document
- Community health workers fluent in the language used by the targeted community and educated in the general practices and issues of water, sanitation, and hygiene activities

Outcomes Expected

Collected information used to develop approaches to improve water, sanitation, and hygiene services in the targeted communities.

Adaptations Required

- It may be necessary to modify the questionnaire based on cultural practices of the targeted community.
- It may be necessary to translate the questionnaire into the language of the targeted community.

Date Prepared: 9/19/07

Water, Sanitation, and Hygiene Questionnaire
CRS WATSAN Assessment

Location: ______________________________
Date: ______________________________
Name of Facilitator: ______________________________
Organization of Facilitator: ______________________________

No.	Question/Topic	Description
Water Sources		
1	What are the main sources of water for the community? • Open well • Well with hand pump • Well with motorized pump • Traditional water hole • Spring • Stream or lake • Water reservoir • Rainwater collection • Other • Don't know	Describe the three main sources. Which are used for drinking?
2	What is the distance between the main water sources and the community?	Describe the distance in meters or kilometers or one-way walking time for each of the main water sources.
3	How reliable are these main water sources? • Water is available all year • Water is available except in the dry season • Water is available only when it rains • Other • Don't know	Describe the causes of unreliable sources
4	What potential new sources are possible for a community water supply? • No new sources possible • Well/borehole • Traditional water hole • Spring • Stream or lake • Water reservoir • Rainwater collection • Other • Don't know	Describe the main potential new sources
5	How many people take their drinking water from each of the sources listed above? • The entire community • Most of the community • Only a few households • Don't know	Use either number of people or percent of the community

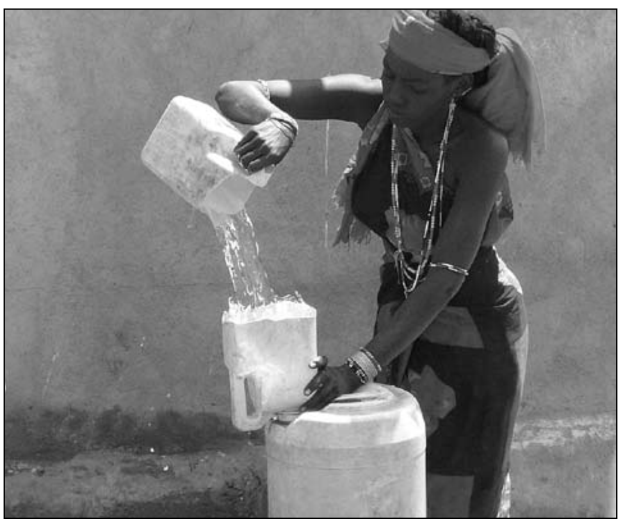
6	What is the condition of the land around the main water sources? • Forested • Grassland with some trees • Cultivated land • Barren land • Mountainous • Rolling hills • Flat • Other • Don't know	
7	What is the quality of water in the main sources? • Safe for drinking • Not safe but is being used for drinking and other purposes • Not used except in emergencies • Other • Don't know	Describe any problems with the quality of the water.
8	What is the cause of pollution in the water sources? • Water is not polluted • Human excreta and trash • Animal excreta • Agricultural activities • Erosion/deforestation • Drainage from mines and factories • Minerals in the underground water • Other villages • Other • Don't know	Describe the causes of water pollution in the three main sources
9	Who is responsible for maintaining the operation of the water sources? • No one • Community water operator • Community volunteers • Other • Don't know	Describe the duties and frequency of maintenance.
Water Transport		
10	How is water transported from the source to the household? • Carry water on head or back • Bicycle • Animal • Pipeline, gravity • Pipeline, pumping • Open channel • Other • Don't know	Describe the three main methods of transporting water to the households.
11	Who is responsible for transporting water to the households? • Women • Young girls • Boys • Men • Other • Don't know	Describe the roles of the main transporters of water.

12	How many return trips per day does each household make to the water sources? • None • 1 to 2 • 3 to 5 • 6 to 10 • More than 10 • Other • Don't know	Describe the water containers used.
13	Are there any problems with transporting water to the household? • No problems • Seasonal (rainy/dry season) • Seasonal (planting/harvesting season) • Land or water source ownership • Conflict and lack of security • Other • Don't know	Describe the three main problems with transporting water to the household.
Water Storage		
14	How does the community store its water? • No water storage occurs • Community water storage tank • Household water storage tanks • Small containers inside the households • Open pond or reservoir • Open well • Other • Don't know	Describe the three main methods of storing water in the household, giving capacity (cubic meters or liters) of each storage system.
15	Who is responsible for maintaining the water storage facilities? • No one • Women of household • Community water operator • Community volunteers • Other • Don't know	Describe the duties, methods and frequency of water storage maintenance.
Water Uses		
16	What are the main uses of water at the household? • Drinking • Cooking • House cleaning • Bathing • Clothes washing • Animals • Home gardens • Food/beer processing • Brick making • Handicrafts • Other • Don't know	For an average household, describe the total average number of liters per day used at the household.

17	How many liters per day does the average household use in each of the above uses?	Provide an estimate of average household population and average daily water use for each of the above uses.
18	Which of the main water uses does the community want to increase?	Describe the most important water needs in the community.
19	Are there any special water and sanitation needs in the community? • No special needs • Health centre • School • Market • Home based care of PLWHA • Orphans and vulnerable children • Elderly • Other • Don't know	How can the water and sanitation systems meet these special needs?
Water Treatment		
20	Does the community do anything to improve the quality of safety of the water at the source, during transport or during storage? • No treatment activities given • Improve the watershed • Fence the water source • Filter the water • Add chemicals to the water • Other • Don't know	Describe the type and frequency of water treatment activities.
21	Do individual households do anything to improve the quality or safety of the water in the household? • No treatment • Cooling • Boiling • Filtering • Add chemicals • Solar disinfection • Other • Don't know	Describe the type and frequency of water treatment activities in the household.
Sanitation—Latrines		
22	What are the main methods of excreta disposal in the community? • Improved (sanitary) pit latrine • Unimproved (unsanitary) pit latrine • Disposal in sacs or containers • Defecation area in the brush • Temporary shallow pits • No special method • Other • Don't know	Describe the three main methods of excreta disposal

23	What are the main problems in having a household latrine? • No problems • Cost of materials • Lack of knowledge • Difficult to keep clean • Soil or groundwater problems • Other • Don't know	Describe the three main problems.
Sanitation—Community Hygiene		
24	Are there any hygiene or environmental sanitation problems in the community? • No problems • Household wastes/garbage • Drainage • Vector control • General community cleanliness • Other • Don't know	Describe the main problems in the community.
Sanitation—Community Health		
25	Are there any illnesses caused by water and sanitation in the community? • Diarrhea • Malaria • Skin diseases • Eye diseases • Worms • Bilharzia • Other • Don't know	
Hygiene Promotion		
26	How often are water, sanitation or hygiene presentations given in the community? • Never • Only once • Yearly • Every six months • Monthly • Weekly • Other • Don't know	Describe the types of presentations given in the community.

Community Involvement		
27	What can the community contribute to a water and sanitation project? • Nothing • Unskilled labor • Skilled labor • Local materials • Cash • Support to outside technical advisors • Other • Don't know	Describe the types and amount of support to be contributed.
28	What are the responsibilities of the community water and sanitation committee? • No committee exists • Responsibilities not defined • Control operation of water system • Collect user fees • Purchase spare parts • Employ system operator • Other • Don't know	Describe the effectiveness of the committee



CRS Best Practices in Water and Sanitation

Title: Formulation of Water and Sanitation Strategies for the Development of a Multi-Year Assistance Program (MYAP)

Category: Strategies

No. STR – 2

Type of Practice

Water and sanitation strategy guidance during the Multi-Year Assistance Program (MYAP) development. This discussion includes examples of the water and sanitation development issues observed during the FY08 CRS/DRC MYAP proposal preparation.

Purpose

The purpose of this document is to provide water and sanitation component strategy guidance to CRS non-technical staff during the development of a MYAP.

Background

A Multi-Year Assistance Program (MYAP) is a Title II program. Title II programs focus on global food insecurity, specifically adopting a single Strategic Objective (SO)—*Food insecurity in vulnerable populations reduced.* Title II programs are administered by the Office of Food For Peace (FFP) at the United States Agency for International Development (USAID). A MYAP is approved to operate for more than one year (usually three to five years in duration). It can be funded with a combination of Title II emergency and non-emergency resources, or only non-emergency resources over the life of the activity. MYAP resources focus on a select number of priority countries, proposals for which are submitted to FFP on an annual basis.

CRS' definition of food security is similar to that of USAID's:

- *When all people at all times, have the necessary physical and economic access to sufficient food and water to meet their dietary needs necessary for a productive and healthy life today, and the good health to use that food properly, without undermining future food security.*

Furthermore, the food security problem can be defined in one or more of the following ways:

- **Chronic food insecurity:** Inadequate access to sufficient food and/or water, or poor health, on a continuous basis.
- **Seasonal food insecurity:** Inadequate access to sufficient food and/or water, or poor health, during a certain time of year.
- **Temporary food insecurity:** Inadequate access to sufficient food and/or water, or poor health, immediately following a manmade or natural disaster.

There are three priority water and sanitation development issues that should be addressed in the MYAP: (1) levels of water and sanitation technology, (2) community participation and hygiene education, and (3) environmental degradation and climate change. These issues are discussed in the following sections.

Levels of Technology

The typical communities considered for inclusion in an MYAP have many common characteristics, including widespread poverty, difficult access to and availability of adequate quantities of safe household water supplies, low levels of household water use, unsanitary latrines, absence of domestic water-use facilities (handwashing points, showers/bathing enclosures, clothes washing slabs), non-existent water sanitation committees, lack of awareness of technological options for water and sanitation services, and weak local government support. The clearest indicator of inadequate water supply services is an extremely low level of per capita water consumption at the household. In the South Kivu Province, DRC, all of the assessment communities reported average water use rates of 8 to 12 liters/person/day. This is far below the minimum level of 20 liters/person/day considered essential for basic public health. Moreover, the current low levels of water use of the household provide no additional water for agricultural production or other livelihood activities that can mitigate shocks to food security.

All of these common negative characteristics are constraints on the provision of sustainable water and sanitation services intended to strengthen food security. At the same time, these constraints define the range, applicability, and acceptability of technologies for water-sanitation facilities that are most appropriate for the CRS/DRC MYAP Project in South Kivu Province.

For the CRS/DRC MYAP Project, several types of technologies, both physical (hardware) and behavioral (software), were suggested as most appropriate in all areas where the assessment was conducted. Water and sanitation technologies in the MYAP should be drawn from the following list:

1. Technologies should be simple, low cost, and easy to maintain, including the following:
    - Simple protected springs (people must come to the spring for water)
    - Protected springs with gravity piped water systems terminating in tap stands/borne fontaines (people can take their water from the tap stands/borne fontaines)
    - Dug wells (generally to a maximum depth of 20 meters) with a well cover and a hand pump (necessary to protect the well from external contamination)
    - Rainwater collection from roofs (preferably new corrugated metal roofs) using simple gutters that channel water to adjacent water storage tanks
    - Water storage tanks (can be 1,000 to 100,000 liters capacity and constructed of plastic, concrete, burnt brick and/or stone masonry)
    - Household water storage (can be in plastic 20-liter jerry cans/bidons, clay vessels, natural gourds, or other materials that can be kept clean and sanitary)
    - Village water treatment (can be chlorine-based chemical dosing)

- Household water treatment (can be solar disinfection, simple filters, or chlorine solution additions)
- Home garden irrigation (use foot pump/treadle pump to lift water from a nearby source)
- School latrines (made of materials that can be easily cleaned, with concrete or plastic slab, and separate latrines for boys and girls)
- Household latrines (use locally-made concrete slab or SanPlat slab that can be re-used when latrine is full)
- Household water devices (bathing enclosures, clothes washing slabs, handwashing points)
- Participatory methodologies (especially PHAST—Participatory Hygiene and Sanitation Transformation)
- Ecological sanitation (especially the ArborLoo latrine and urine-separating latrine slabs)

2. Priority for community-level activities should be given to the rehabilitation of former (but nonfunctioning) water systems when it can be shown that rehabilitation is less costly and equally effective in comparison to the construction of new facilities.

3. All technologies should be the expressed choice of the target population. This may require considerable (six months or more) prior community sensitization, awareness raising, hygiene promotion, and technical demonstrations.

4. The choice of technology should have a clear relationship to the improvement of food security, such as time savings, improved health, livelihoods, and environmental protection.

5. The choice of technology must be based on the capacity of the community and individual households to take responsibility for the maintenance and continued operation of the resulting facilities.

Community Participation and Hygiene Education

The establishment of sustainable water and sanitation facilities and services requires full involvement of the community from the beginning of project planning through implementation and finally long-term operation. In South Kivu, the communities appear to be poorly organized to carry out sustainable development activities, which may be the result of the disruption caused by years of war and civil conflict that led to massive population movements and the widespread destruction of civil infrastructure, especially water supply systems. It appears that communities visited by the assessment team have not yet returned to a normal, settled pattern whereby all households are fully integrated into a range of communal activities. The process of returning to normalcy undoubtedly is occurring, but it probably will require an indeterminate period to reach completion.

Because of the special challenge of sensitizing the population to the development opportunities before them and of the need to mobilize community acceptance and support for MYAP activities, CRS and its partners will have to give special attention to the promotion of community involvement. In the water-sanitation domain, the most effective approach is the PHAST method for community participation. It is widely used throughout CRS and by many other international and national development agencies.

The developer of this method, Dr. Mayling Simpson-Hebert, CRS/EARO RTA for water and sanitation, has prepared useful guides and other documentary materials for use at the community level. The great advantage of PHAST is that it combines both the participatory involvement of the target population with an effective promotion of sanitation, hygiene, and proper water use. Further information is available from CRS/HQ or CRS/EARO.

It has been found from experience that the process of strengthening participatory community efforts on water-sanitation activities usually requires a considerable amount of time and effort prior to the construction of water and sanitation facilities. In EARO, guidelines have been developed that suggest a period of six months to a year may be necessary to fully sensitize and mobilize a new community for water-sanitation improvements. In South Kivu, the preparatory period may be less than 6 to 12 months, but should be a part of the development process. There is general agreement among the field personnel of CRS and its partners that community water and sanitation committees should be established and trained before actual construction of facilities is initiated. This conclusion requires the CRS/DRC MYAP Project to give special attention to the *animateurs* and other technical personnel responsible for the initial promotional and educational activities in the project communities.

Environmental Degradation and Climate Change

It is readily apparent that many changes are occurring in the natural environment of South Kivu. Most of these changes are manmade and the majority are having not only

negative consequences for the future of the province but are occurring at an accelerating rate. As time passes, these changes will further interact with each other, causing even greater problems. A quick review of some of the more obvious environmental issues is revealed in the following discussions.

Despite the fact that the climate and rainfall regime is conducive to lush forest cover, there are no major forested areas in the province. Discussions with local personnel reveal that most of the highlands in South Kivu were heavily forested as recently as the 1950s. Today, most hills and mountainous areas are bare of trees save for scattered clumps of woodlands. The process of deforestation has probably been the result of:

- Population growth
- Expansion of cultivated areas
- New house construction
- Forest cutting for:
  - Commercial timber
  - House building materials
  - Fuel for domestic purposes
  - Charcoal production
  - Production of burnt bricks (briques cuits)
- Population movements caused by war (IDPs)
- Activities by militia groups during the wars

The absence of effective government regulation and control over forests and land use is especially noticeable (cultivation on steep slopes, expansion of fields into marginal areas) as is the uncontrolled cutting of trees for the numerous purposes noted above. As the forests progressively disappear, people will find it increasingly difficult to find fuel for their cooking fires and fodder for their animals.

Another aspect of deforestation is the affect on stream flows and groundwater levels. Without trees to intercept and capture rainfall for infiltration into the soil, rainwater quickly runs off denuded hills into the lower watercourses, causing progressively severe removal of topsoil from hillsides and erosion of gullies in the streambeds. The soil picked up on the hillsides flows into the streams, choking them with sediments and degrading the quality of water for human consumption. There appear to be no organized attempts to mitigate these problems by reducing soil erosion through contour planting, leaving buffer vegetation strips, or land terracing.

The process of soil erosion and degradation of streamflows is particularly evident in areas where mining is occurring, and especially where crude methods of streambed excavation and water washing of gravels and sand is carried out. In these areas, most notably in the highland areas of the Haut Plateau, severe bank erosion is endangering adjacent roads and valley slopes.

The overall trend of deforestation, soil erosion, gully formation, and sediment transport is resulting (or eventually will) in a decline of groundwater levels in the hills and mountains and a consequent reduction of flows from streams and springs. Local people have already noticed decreased flows from some formerly good springs. The continued diminution of stream and spring flows will place increasing hardships on communities and on the water facilities built to serve them.

In addition to the above, some evidence is beginning to appear in the scientific domain that extensive deforestation, as has occurred in South Kivu, results in climate change as a result of changes in the previous levels of evaporation, transpiration, and solar insolation (radiation). These changes can affect annual rainfall patterns, which cause them to shift to more severe and short-term rains that result in even more erosion and land degradation on the bare hillsides. All of these changes can pose enormous challenges to local populations already living on the edge of survival.

Although the CRS/DRC MYAP is not a project focused on the natural environment, it does have the opportunity to raise awareness of the above issues and their consequences. It should be possible to introduce activities that support sustainable land-use management. In EARO and LACRO, CRS is giving increasing attention to the watershed as the basic framework for organizing water resources development. It is suggested that CRS/DRC consider ways such ideas and related actions can be incorporated into the MYAP.

Description

In terms of water and sanitation activities, the *overall objective* of the MYAP is to improve food security of vulnerable populations in the project areas through the expansion of water supply, sanitation, and hygiene-promotion services that support greater access to food and health care, greater availability of food stocks and productive livelihood activities, and greater utilization of food nutrients as a result of improved health care.

The overall objective will be achieved through meeting each of these four objective areas:

- Access
- Availability
- Utilization
- Resilience

Each of the four objective areas is described in the following sections.

Objective 1 (access): To provide greater opportunities for households—especially women and young girls—to participate in educational, food production, and other livelihood activities by reducing constraints to essential water and sanitation services.

Objective 2 (availability): To support increased food production through the provision of adequate, reliable, and accessible quantities of water.

Objective 3 (utilization): To encourage improved public health and nutrition through the provision of water and sanitation services that result in a reduction of water-related diseases arising from polluted drinking water, inadequate household and community sanitation, poor personal hygiene, and unsanitary behavioral practices.

Objective 4 (resilience): To strengthen the capacity of communities to resist water-related shocks to their food supply by establishing sustainable and resilient water and sanitation facilities and services.

Resources Needed

Background information is usually collected by conducting various needs assessments in the targeted communities prior to the development of the MYAP. The assessments are used to determine the level of food insecurity and the causes of this insecurity, develop cause-effect problem trees to help identify the key strategic sectors that would best bolster the food security of the targeted communities and to collect qualitative and quantitative data in each strategic sector.

Anticipated project inputs from CRS, its partners, and participating communities that result once MYAP has been approved and projects have been defined include:

Typical Material Inputs

- Construction materials (cement, sand, gravel, steel reinforcement, lumber, pipes, fittings)
- Tools (hand tools, electrical generators, winches, pulleys)
- Vehicles (pickup trucks, motorcycles, bicycles)
- Supplies (fuel, spare parts, office supplies)
- Equipment (computers, telephones, cameras)

Typical Technical Assistance

- CRS/Bukavu supervision and support
- CRS Partners staff involvement

- Participation by other stakeholders (local government, zonal health bureaus, local church parishes, other NGOs, and international organizations)

Outcomes Expected
Expected outcomes of the CRS/MYAP include:

Sensitization and Training
- Formation of water sanitation committees
- Acceptance of participatory methods for community action (PHAST—Participatory Hygiene and Sanitation Transformation)
- Hygiene education targeting women in households (water disinfection and storage, household waste management, personal hygiene)
- Training of water sanitation committees in management, system repairs, cost recovery, monitoring, and record keeping
- Awareness of the importance of community involvement, participatory actions, hygienic behaviors, water sanitation committee management, routine maintenance and repair, system monitoring, and community financial support.

Physical Outputs
- Protected springs with or without gravity flow pipelines
- Water storage tanks (1,000 to 100,000 liter capacity)
- Tap stands/borne fontaines (water taps distributing water from pipelines)
- Shallow dug wells with covers and hand pumps
- Sanitary latrines with durable and easy-to-clean slabs (sanplats)
- Additional sanitation facilities (handwashing points, bathing enclosures, clothes washing slabs, trash disposal pits)
- Household-level water disinfection (solar disinfection, filtration, chlorine dosing)
- Improved land and water management (forests, springs, rivers, cultivated fields, household compounds)

Examples of expected beneficial consequences of the CRS/MYAP related to each of the project objectives include:

Objective 1 (access): To provide greater opportunities for households—especially women and young girls—to participate in educational, food production, and other livelihood activities by reducing constraints to essential water and sanitation services.

Greater access to adequate quantities of safe (and potable) water and to sanitary latrines will result in:

Time savings (for women and young girls who carry water to the household)
- Greater agricultural production/home gardening
- Improved child care
- Strengthened economic activities (food preparation, beer brewing, handicrafts, brick making)
- Girls attend school more regularly

Improved health (through better quality and quantity of water at the household and use of sanitary latrines)

- Availability of safe drinking water
- More frequent bathing
- More frequent laundering of clothes
- Improved domestic cleanliness and household sanitation
- Prevention of fecal contamination of household environment

Greater economic production (through use of water on livelihood activities)

- Irrigation water for home gardens
- Animal husbandry (cows, goats, sheep, chickens) at the household
- Manufacture of handicrafts, bricks, household utensils

Improved social status (through improved personal hygiene)

- Children bathe before attending school
- Young girls have proper (and private) latrines during menses
- Women with a household latrine do not have to defecate in the fields
- Women with a household latrine can avoid walking to insecure and violence-prone defecation fields

Objective 2 (availability): To support increased food production through the provision of adequate, reliable, and accessible quantities of water.

Greater availability of water for food production will result in:

- Increased irrigation of food crops, especially in home gardens
- Increased size of home gardens
- Greater variety of food crops in home gardens
- More animal husbandry (cow, goats, sheep, chickens) at the household
- Establishment of seed nurseries
- Creation of fish ponds

Objective 3 (utilization): To encourage improved public health and nutrition through the provision of water and sanitation services that result in a reduction of water-related diseases arising from polluted drinking water, inadequate household and community sanitation, poor personal hygiene, and unsanitary behavioral practices.

Greater utilization of water-sanitation facilities and services for improving public health and nutrition will result in:

Improved health

- Interruption of numerous fecal-oral transmission routes of pathogenic organisms, especially
  - – Reduction of water-borne diseases (cholera, typhoid, dysentery)
  - – Reduction of water-washed diseases (skin infections related to lack of cleanliness)
  - – Reduction of water-related diseases (helminths, schistosomiasis, dracunculiasis)
  - – Reduction of water-based disease vectors (malaria, dengue, onchocerciasis)
- Improved sanitary environments around water taps, latrines, showers/bathing enclosures, clothes washing slabs
- Reduced transmission of illnesses among children at schools

Improved nutrition

- Increased absorption of nutrients when eating food
- Greater variety of food types (fruits, vegetables, meat)

Objective 4 (resilience): To strengthen the capacity of communities to resist water-related shocks to their food supply by establishing sustainable and resilient water and sanitation facilities and services.

Greater resilience of water-sanitation facilities to resist (and buffer) shocks to the community food supply will result in:

- Greater sustainability of water and sanitation services over the long term
- Strengthened community sense of ownership and responsibility toward their water sanitation facilities
- Continued availability of water during droughts
- Greater community solidarity during periods of political or ethnic conflict
- Enhanced awareness of growing environmental problems (deforestation, soil erosion, river pollution, groundwater decline, climate change)

A possible brief outline of the strategic water and sanitation framework for the implementation of water and sanitation activities in the MYAP is as follows:

Year 1

Planning Phase (months 0 to 6)

- Carry out a water and sanitation needs assessment in each project health zone.
- Formulate priorities of water and sanitation development for all health centers in the project health zones.
- Prepare initial implementation plan (with zonal and health center budgets).
- Recruit, train, and equip the project technical support team.
- Carry out initial planning, design, and implementation of two or three relatively straightforward infrastructure activities as a means of developing effective coordination in the CRS technical team.

Initial Implementation Phase (months 7 to 12)

- Prepare technical designs for initial implementation activities.
- Carry out field implementation activities (including community sensitization, hygiene promotion, and participatory community involvement).
- Develop and incorporate project approaches for community participation, hygiene promotion, technical and material support, monitoring, and sustainability.

Year 2

Full Implementation Phase (months 13 to 24)

Operate as a fully integrated component within the CRS MYAP Program, with emphasis upon the contributions of improved water, sanitation, and hygiene services to the access, availability, and utilization aspects of food security as defined in USAID/FFP guidelines.

Within the food security guidelines, the water and sanitation component of the CRS MYAP program will emphasize:

- Community involvement
- Expansion of water sanitation services
- Technical soundness
- Sustainability of water sanitation systems
- Intersectoral linkages (health, agriculture, governance, and peacebuilding)
- Environmental protection

Year 3

Continuation of Full Implementation Phase (months 25 to 36)

Evaluation Phase (months 31 to 36)

Adaptations Required:

- Not applicable

Additional References

- P.L. 480 Title II Program Policies And Proposal Guidelines—Fiscal Year 2008—Draft, Office of Food For Peace, USAID, August 8, 2007
- Strategic Plan 2006—2010, Office of Food For Peace, USAID, May 2005.

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