Achieving Sustainable Water Supply and Sanitation Improvements for Rural Ecuadorian Communities

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Introduction

Sustaining community water systems protect health in rural areas of developing countries. This paper addresses the importance and strategies of self-sustaining rural water systems based on 28 years experience in Ecuador.

Water transmitted disease is one of the most frequent causes of death worldwide. Diarrheal disease kills almost two million children annually. More than one billion people lack an improved water source; many more endure low quality and poor availability of water. Yet, rarely does water-transmitted disease receive due attention.

Quichua boy in Lirio San Gonzalo enjoys clean spring water.

Sustaining water and sanitation interventions offer a more significant health impact than merely improved medical care. In the US, for instance, the average life expectancy doubled over the last three centuries. The increase is primarily due to preventative factors and less than four percent can be attributed to twentieth century advances in medicine. In developing countries where preventative health measures lag the rest of the world, patients with diarrhea and other water-transmitted diseases occupy more than half of all hospital beds.[1]

The UN Millennium Development Goals for this decade (2005-15), aspire to save 30 million children, who would normally die before age five by reducing the child mortality rate two thirds. A key objective augments the water and sanitation infrastructure available to rural populations. The Millennium goals include investments needed in water, sanitation, living conditions, education, health, environmental management, and other basic infrastructure to reduce poverty and inequalities.[2]

Rural Ecuadorian Water and Sanitation Needs

Ecuador made strong progress building rural water systems and providing sanitation in recent years, as shown by the World Health Organization statistics. It is

important to realize that these statistics do not take into account drinking water quality, reliability of water service, or treatment of wastewater.

WHO Water and Sanitation Statistics [3]

Ecuador water and sanitation coverage	Urban	Rural
Sanitation coverage 1990	60%	45%
Sanitation coverage 2004	81%	82%
Homes with water service 1990	74%	32%
Homes with water service 2004	82%	45%

Urban Ecuadorian water supply services are interrupted with some degree of frequency in 50% of the areas served and water pressure is often below standard in low-income outlying neighborhoods. Untreated surface water is used for public water supply in 30% of urban areas. Only 8% of all wastewater receives treatment prior to discharge.

In general, water supplies for rural populations of Ecuador are of low quality. According to a 2004 study, 38% of the rural water systems have collapsed, 20% are seriously damaged, 29% are somewhat damaged and only 13% are considered sustainable. The limited rural water system sustainability and near absence of wastewater treatment reduces the effective coverage.[4]

Sustainability – A Global Need

The World Health Organization points out that, "the lack of safe water, sanitation and hygiene remains one of the world's most urgent health issues." Ensuring sustainability is the greatest challenge in rural water supply and sanitation. Many Latin American countries invest in rural water supply and sanitation, only to find a few years later that the infrastructure does not perform as designed. It is vitally important that progress be made in providing infrastructure with higher levels of sustainability.

Chachi boy demonstrates importance of hand washing.

The World Bank and organizations involved in building rural water systems during the decade of the 1980's were sobered by subsequent evaluations. The failure rate of rural water systems prompted a study revealing that sustaining water and sanitation projects directly correlated to the proportion of resources invested by the beneficiaries and their participation in decision making. As a result, the World Bank adopted the *Demand Response Approach* (DRA) as its guiding principle for rural projects. Communities define the level of service they are willing to build and to maintain.

Vozandes Community Development Objectives

In response to the accentuated need for sustaining community water systems, Vozandes Community Development (VCD) works with Ecuadorian communities, government entities, and other non-government organizations (NGO's) to develop models providing long-term benefits. The program intentionally emphasizes principles of community development, provides follow-up, and does health measurement studies to better understand the factors leading to strong levels of sustainability.

VCD began in 1980, and forms part of the HCJB health care ministry in Ecuador. HCJB Global, a Christian organization, also operates two hospitals and a number of family practice clinics. VCD aspires to improve health in areas with limited medical attention. VCD's clean water projects staff is a multi-national and multi-disciplinary team, which helps communities improve their water supply and sanitation. All of the water systems built by VCD over the past 18 years, in more than 50 communities continue to operate successfully.

Community Development Principles

The following principles are integral to the VCD program.

1. Community commitment

The benefiting community commitment is a key factor for sustainability. Communities are selected on the basis of their commitment to positive change, rather than solely because of need. These communities provide an important model of success to the neighboring area. The community development process normally succeeds when people own their problems; participate in the solution; and provide labor and resources to build the infrastructure.

Community digging pipe trench.

Unified communities should be respected. The temptation to aggregate communities unnecessarily into regional projects or to split communities must be avoided. Community loyalty valuably motivates, promoting sustainable infrastructure. Regional projects do not normally capitalize on this dynamic and therefore, often fail.

Corruption rarely penetrates at the community level to the degree found in other levels of government. Communities effectively use time, skills, and resources. Ecuadorian communities are agile decision makers and relatively unhampered by politics. Communities that are ready for positive change, understand their need for improved health rather than solely a convenient water supply.

Vozandes Community Development responds to communities that recognize their need for water and sanitation and are willing to provide a significant amount of the resources. VCD limits the assistance provided to the level of help needed by the community. It is important to not displace what a community can do for itself. The

dignity and pride of successful completion, without exorbitant outside help, invigorates the community spirit.

2. Commitment of the facilitating organization

The facilitating organization must make a commitment to the successful project outcome on par with the community's commitment. All too often, government programs change, the funding ends, or NGO's alter their original commitment, leaving communities to finish projects with their own resources, or to look for help elsewhere. An adequate follow-up period provides helpful learning for both the community and the project facilitator. Corrective work is often required during the follow-up period to insure long-term sustainability.

The contribution of VCD in each community project normally includes;

- Health emphasis and teaching/learning
- Topographic studies, project design and drawings
- Project supervision
- Assistance in securing funding
- Training and follow-up.

The community normally;

- Provides leadership and coordination of volunteer labor
- Provides all manual labor
- Provides meals and room in the community for VCD personnel
- Provides local materials such as sand, gravel, and wood
- Secures permission, easements and land required
- Obtains water rights for water source(s)
- Builds a latrine or toilet for each home.

3. Leadership by the benefiting community

Longevity of water and sanitation infrastructure requires sustaining leadership. In Ecuador the body responsible to build and maintain community infrastructure is the *Junta Administradora de Agua Potable (JAAP).* The community elects a JAAP at two year intervals. Each community member becomes a stakeholder in the long-term success of the water system.

Ecuadorian law empowers each JAAP to protect and maintain the benefits enjoyed by the community and to appropriately sanction abusers. The nature of the JAAP duties, authority, and obligations are clearly defined. The benefiting community executes the project and is the owner from the onset of construction. VCD only provides technical supervision and other help needed to complement the community skills and resources. This approach minimizes responsibility transitions at the time of construction completion.

In each of the three sectors of Ecuador (mountains, coast, and eastern jungle), where VCD works, trained local indigenous people from that area teach the health/hygiene component and provide the plumbing/building skills needed. These team members are bilingual, speaking both Spanish and the local indigenous language. Indigenous staff understand the unique aspects of local culture required to successfully implement projects. Some field staff have long-term experience

facilitating successful water and sanitation projects which gives them a unique level of confidence and respect.

4. Appropriate technology

Selection of the proper level of technology is critical to long-term sustainability. Traditional community development focuses on rustic solutions. Experience of VCD projects shows that the technology applied must be adequate to provide for important felt needs, but simple enough to insure sustainability. A water system that is difficult to operate, expensive to maintain, or difficult to understand, is not likely to provide long-term sustainability.

Protected ground water sources, such as an encapsulated spring or sealed well, are simple solutions to provide a secure source of uncontaminated water. Adequately protected spring and well water sources can provide water free from coliform bacteria. A water source of this nature capitalizes on rural ingenuity rather than employing expensive water treatment or disinfection. Frequently, a spring or well is already being used and only requires improved protection from contamination.

The picture on left shows the La Pacifica spring filled with algae and debris prior to the water system renovations. The picture on the right shows the protected spring.

The La Pacifica spring provides an example of the transforming difference in a protected water source. During the renovations, the spring was cleaned of all mud and debris; and then a filter pack of clean gravel was placed on the floor of the excavation. Slotted pipe in the filter pack collects the clean spring water which is received by a concrete tank on the far side of the fence. The gravel pack was disinfected with a shock dose of chlorine, covered with plastic sheeting and a 10 cm layer of concrete before being covered with earth backfill. A concrete wall on the downstream side of the spring forms a barrier to insure that the spring water enters the collection pipe. The spring supplies clean water to metered spigots at 96 homes. The water distribution system includes two reservoirs and approximately 8 kilometers of pipe placed in a trench excavated to 1.2 meter deep. The community built all aspects of the water system by hand.

Solar disinfection (SODIS method) for water directly ingested provides opportunity for an additional level of confidence to the users. Water placed in ordinary clean clear plastic (PET - Polyethylene terephthalate) soda bottles are left in the sun for six hours. The UV rays in ordinary sunlight and the increased temperature

inactivate any micro-organisms and pathogens rendering them harmless. Solar disinfected water is free of chemical taste and the cost is minimal.

Rural Ecuadorian communities rarely operate the chlorine disinfection capability included in all government-built rural water systems. The Ecuadorian government design for rural chlorine dosing uses a manually regulated gravity-fed drip or drizzle flow from a plastic chlorine solution tank. Since water demand is quite variable, this design provides an erratic level of chlorine concentration creating questionable confidence in disinfection effectiveness and periodically allowing objectionable peak concentrations.

Rural Ecuadorian communities do not perceive a need to chlorinate and are extremely discriminating of chemical tastes in water. Communities are likely to chlorinate only during an epidemic or when a government engineer might visit them. For this reason, VCD encourages communities to use a protected ground water source combined with solar disinfection for water directly ingested. In addition, communities should disinfect their reservoirs after cleaning or maintenance.

Normally, PVC bell and spigot pipe with solvent welded joints is used for the buried water distribution. PVC pipe is manufactured in Ecuador and available at reasonable cost. PVC pipe is normally buried at a depth of 1.2 meters to avoid damage by erosion, plowing, and vehicles.

Quichua woman in La Pacifica uses a metered spigot providing water to each home.

Older rural community water systems in Ecuador use polyethylene pipe, which leaks excessively. Pipe unions between 100-meter lengths of pipe were formed by using stainless steel clamps to secure an internal plastic sleeve. Joints of this type leak when significant internal water pressure is applied. Exterior compression unions for polyethylene pipe are now available in Ecuador in a limited number of pipe diameters for repairing older water systems.

Reservoirs and all other hydraulic structures in the water system should be sanitary structures protected from contamination. Commonly in rural Ecuador, light-duty steel covers are used for tank access, allowing possible contamination. The VCD reservoir design uses an adequate strength cover on a raised curb. Sanitary structures should also have an entry ladder, an overflow, a drain, and a valved outlet. Rural water systems in the mountains often include multiple pressure zones and reservoirs because of extreme elevation variations.

Inexpensive VCD standard designs for reservoirs include reinforced concrete base and top slabs; and reinforced masonry walls of concrete-filled structural building block. Walls are cement plastered on the interior and exterior surfaces. The structures are normally $5m^3$, $10m^3$, $20m^3$, $30m^3$ and $40m^3$ in storage capacity. Larger reservoirs are custom designed. All reservoirs $30m^3$ and larger are round, due to the structural advantages. Concrete/masonry reservoirs are more durable and less problematic than the ferro-cement tanks commonly used by others in rural Ecuador.

Water system pressure must be maintained during peak-use periods to avoid contamination. When water systems become intermittent, users store water in open containers which are easily contaminated. Providing a water meter for each user allows families to be charged for the volume of water used. Metered services substantially eliminate excessive water use, help the community maintain pressure, and help cover costs by appropriately charging users. Normally, a concrete pedestal formed with a 160 mm PVC drain pipe is used to protect the pipe riser and support the meter with a spigot.

Proper pump selection and design of pumping facilities is critical to the sustainability of a water system when pumping is necessary. Common problems for pumped systems include: oversized pumps, poor efficiency at the pressure head required, inadequate cooling, inadequate electrical protection, lack of backup pump, and lack of training in pump operation/maintenance. Carefully selected submersible well pumps can provide an effective efficient solution to the high pressures needed for the elevation differences required in mountainous areas. These pumps require adequate provision for cooling and electrical protection. Automated pump operation can help the community keep reservoirs full.

5. Appropriate economy

Sustainable rural water systems should be built at the economic level of the community served. Normally, the community finances continuing maintenance, distribution extensions, new home services, and other improvements. The design and nature of the initial water system should start the community on the proper footing to be sustaining long term.

Communities often need help in defining operational costs on a cubic meter basis. Tools, supplies, pipe, valves, and fittings must be on hand to keep the water system operating and to respond to emergencies. The remote nature of many rural communities, combined with erratic availability of materials in the third world, underline the importance of this issue. Establishing a volumetric value for delivered water enables the community to better control water demand and to finance these routine needs.

Outside funding for the expensive manufactured materials is normally required to build rural water systems. Third world communities do not commonly have access to bonds and loan capital for building their water system. The materials for VCD projects are financed by Ecuadorian government, International Migration Organization, churches, Rotary clubs, Water for People, Safe Water in Ecuador, and a variety of other NGO's.

6. Positive value changes

Improved sustainability can only be achieved when the beneficiaries modify their values and priorities regarding health. Improved hygiene and adequate attention to a quality water supply occur when fatalistic world views are set aside and positive change embraced. Personal health as well as the health of family and community are a sacred trust; a responsibility that must be taken seriously.

The facilitators must model a humble learning attitude if they expect the community to be receptive to learn. Facilitators must realize that they themselves do

not have the skills to survive or to keep children alive at the economic level of most rural third world communities. Facilitators, government, and communities must all learn the lessons necessary to improve sustainability. Community development methodology and sustaining technologies appropriate for the rural sector are needed rather than impractical academic solutions.

Unrealistic water quality standards are not helpful in the rural sector. The development process should follow logical steps of progress which are sustaining rather than taking leaps to unrealistic goals. Non-sustaining steps can leave the community in a worse condition than prior to the intervention. Successful water and sanitation interventions are best measured by long-term sustainable benefits and improved health, rather than by the percentage of homes served.

Health measurement studies

Studies done by VCD and Calvin College in 2005, were inconclusive in demonstrating health improvement by VCD interventions. Intestinal parasites infect 80 to 85% of the people in the rural mountain communities studied. The high levels are caused by inadequate hygiene, poor sanitation and misunderstanding of disease transmission.[5] A systematic de-parasiting of the intervention communities had not been done prior to the 2005 study. The study shows that improvements to the water supply alone will not reduce intestinal parasite levels.

In response to the findings of the 2005 study, further monitoring of intestinal parasite levels is being done in intervention communities to provide feedback on health improvement progress. De-parasiting efforts and data collection have been more difficult than anticipated. No further data is available for presentation at this time.

Improved sustainability levels of rural water and sanitation can be achieved by using community development methodology when there is an adequate commitment to long-term success by all parties involved. Further study is still needed in Ecuador to demonstrate measurable improvements to health.

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[2] http://www.un.org/waterforlifedecade/factsheet.html
[3] World Health Organization, *Safe Water, Better Health*, 2008.
[4] OAS, *Criterios y Acciones para el Cumplimiento de las Metas del Milenio en Agua y Saneamiento*, 2005.
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[6] Holy Bible, Isaiah 41:17-20.