Water and Development in Siuna, Nicaragua

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A 26,000 liter water tower stands at one end of a barbed-wire fenced compound that serves as the hospital in Siuna, Nicaragua. Emblazoned with several European flags and marked at its foot with plaques commemorating the generosity of the donor organizations that built it, the water tower serves as a reminder that assisting a developing country is not always straight forward. The water tower is empty and there is, in fact, no running water at the hospital.

During afternoon rainstorms, hospital personnel can be seen running outside with pails to collect water running off roofs. Water is essential to the functioning of any hospital, and a dry sink in the operating room highlights the extent to which basic infrastructure is lacking in Siuna. Family members of patients used to take soiled bed cloths for washing in the Siuna River, a small muddy stream that serves dual uses as a sewer and laundry facility, until there was a community outcry that hospital laundry was contaminating the river with disease. Presently, river water is brought to the hospital by truck, so laundry can be washed on site. In showing the interrelated facets of water, health and development, the hospital in Siuna captures several of the key themes faced by poor countries around the world, such as lack of most basic infrastructure, poor sanitary conditions, well meaning and ineffective international intervention, and local public perception regarding health issues. Here, several of these issues will be examined in the context of Siuna’s water supply situation and its future plans.

Introduction

Siuna, Nicaragua, is a municipal region in Northeastern Nicaragua, known sometimes as the “Mining Triangle” because of a history of gold mining in the region. There are about 18,000 people living in a 2 km² urban section, divided into 17 neighborhoods, and an additional 56,000 people living in 133 rural communities in the 5,162 km² that makes up the municipality of Siuna. It is a very poor region of Nicaragua, separated politically and geographically from the more developed Pacific coast and the seat of the national government in Managua. It takes about 12 hours to drive from Managua to Siuna, and since much of the road between the two cities is unpaved, the route is often impassible during the rainy season. Only 10% of the population of Siuna is employed in the formal economy; average monthly per capita income is US$ 24, and over 83% of the population lives in extreme poverty. Historically, natural resources such as timber and gold have been the region’s major products, but these have been extracted by foreign companies and have resulted in little benefit to the local population [Martin, 2003]. Presently, Siuna is primarily a ranching community, where forests are cleared for livestock [Larson, 2002].

Gleick [1993] reports that about 11% of Nicaragua’s rural population had access to safe drinking water, and only about 16% had access to improved sanitation in the early 1990s. Lack of economic development, the impact of a major hurricane in the late 1990s, and population increases in the region indicate that the situation has probably not improved significantly in the last decade.

Had it not been for the discovery of gold in the 1890’s, Siuna might not exist today, and had some of the profits stayed in local hands, rather than being extracted by foreign interests and a corrupt dictatorship, current conditions in Siuna might be different.

In order to better understand the present situation and to explore possibilities for improving conditions, let us first turn to the historical development of the region.

History and Political Background

In 1934, the head of the US-trained military in Nicaragua, General Anastasio Somoza organized the assassination of a leading political figure, and became the country’s president in 1937 via a rigged election. The United States was supportive of the Somoza dictatorship due a pretense of democracy [Plunkett, 1999] where by Somoza was re-elected in every vote, and because the Somoza dictatorship was profitable for trade through extraction of raw materials such as gold and timber by foreign companies. Although General Somoza was assassinated in 1956, his sons continued the dictatorship until 1979. The family’s rule of Nicaragua was characterized by vast personal wealth accumulation, support from powerful allies in Washington [Kinzer, 1991] and the development of extremely small elite by capture of internal assets and by stealing international aid intended to improve the conditions of the general population.
The Frente Sandinista de Liberación Nacional (FLSN), or Sandinistas, lead a successful popular revolt against the Somoza dictatorship in 1979, and created a socialist state in Nicaragua. In the first years of Sandinista power, health and education systems were vastly increased, assets such as land and natural resources were nationalized, and by measures such as literacy rates and infant mortality, conditions in Nicaragua improved. The Regan administration was deeply opposed to the development of another socialist state in Latin America and suspended aid to Nicaragua in 1981. Over the next several years the United States funneled in millions of dollars (both legally and illegally) to support counter revolutionary rebels known as the Contras.

Daniel Ortega and his Sandinista Party won the elections in 1984, but the Contra War continued, the US imposed a trade embargo in 1985, and by 1987, the Sandinistas were allocating 18% of Nicaragua’s Gross Domestic Product (GDP) to fight the rebellion [Curtis, 1998]. The tactics of the Contras included targeting social infrastructure, such as health clinics, schools and their staff. The destruction of assets and the murder and molestation of social workers, combined with an already strained national social spending budget caused conditions in Nicaragua to deteriorate drastically. Much of the violence occurred in the mountainous Northeastern region of Nicaragua, where Siuna is located, and this area remains a haven for anti-governmental and rebel military activity. [Travax, 2004]. The history of violence and lack of security in the area still impact social welfare in general, and the provision of water supply in particular, as will be discussed later.

Largely due to United States support of the Contras, and the Sandinistas’ inability to effectively govern Nicaragua during the war, they lost the 1990 elections to a liberal party that favored introduction of capitalistic markets, the return of nationalized land and assets to private (elite) ownership, and greater connection with the international community. This trend has continued to the present through recent elections.

The Eastern Atlantic region holds of 51% of Nicaragua’s national territory, 80% of its natural resources, and only 6% of the country’s population [Wickre, 2002], making it predominantly rural and lacking in political clout, since most of Nicaragua’s population faces differing climatic, topographic, social and economic situation on the more developed Pacific Coast.

The Eastern portion of Nicaragua is divided into two regions, the North Atlantic Autonomous Region (RAAN) and the South Atlantic Autonomous Region (RAAS). These regions were granted autonomy in 1987, meaning they are governed by regional parliaments, but, apparently, autonomy was granted without the power to collect taxes. With little financial assistance coming from Managua, and without the ability to raise money independently, the regional governments have little capacity to provide services, including water supply [Wickre, 2002]. Additionally, the national government retains exclusive authority to grant concessions to foreign companies seeking to extract minerals or timber from the region, and only recently has the law entitled regional governments to a portion of the tax income from these concessions [Larson, 2002].

Siuna has seen a dramatic increase in population, from about 11,000 in 1970 to 74,000 in early 2000. The combined effects of a high birth rate, and large influx of opportunity seeking migrants from the west has lead to a heavy burden on the local environment and water infrastructure that was never intended to serve such a large population.

In 1998, Hurricane Mitch caused large scale loss of life and assets. About 10,000 people were killed and in terms of water and wastewater infrastructure about 800,000 people lost municipal systems. Another 10,000 latrines in rural areas were destroyed. [Lockwood, 2001].

**Macroeconomics**

Nicaragua is a heavily indebted developing country, with a large trade deficit, low GDP, and high dependence on foreign aid. In 2000, national exports were valued at US$ 631 million, and imports were $1600 million [Wickre and Martin, 2002]. Nicaragua imports a significant portion of its food. Bad weather
and falling world coffee prices have further increased the trade deficit by reducing an already small agricultural sector capacity. Per capita GDP was US$ 442 in 1998 [Curtis, 1998].

The policies of the liberal governments following the Sandinistas have attempted to comply with stabilization measures promoted by international organizations such as the World Bank and the International Monetary Fund, including tendencies toward reduction in credit, deregulation of markets and reduction of price controls, privatization of health care and water resources, and foreign debt repayment. In can be argued that these policies have not been helpful in the short term, as evidenced by annual per capita health expenditures which dropped from $58 (by the cash strapped, rebellion-fighting Sandinistas) in 1988 to $17 in 1991 after the new (peacetime, U.S. supported) government took power [Curtis, 1998].

Declining government assistance is coupled with a regressive aid allocation structure to further impact the poor. Although 90% of staple crop production in Nicaragua comes from small farmers, only 10% of national farm aid is provided to them. It is elite large scale growers who receive the vast majority of governmental aid [Martin, 2003]. Often it is easier for governments to disburse larger grants to fewer politically connected beneficiaries, but this does little to increase capacity for the vast majority of producers and erodes their ability to compete as production costs for subsidized growers fall.

Foreign debt is on the order of 6 times Nicaragua’s GDP [Gibson, 1996]. In 1997, they were spending approximately 40% of their GDP on debt repayment, 11.2% of that simply on servicing foreign debt. [Curtis, 1998] With total foreign aid amounting to 8% of Nicaragua’s GDP, it is still suffering a net loss of capital. Hurricane Mitch caused several nations, including Russia, Mexico, and members of the Paris Club to cancel some of Nicaragua’s debt [Plunkett, 1999], however Nicaragua is still seeking relief from foreign debt. Income to the country comes from remittances of expatriates to family members [Gibson, 1996], but the tax base is very small. In the mid 1990’s about 30% of all tax revenue was collected from only 11 companies [Gibson, 1996].

The informal economy is growing. In 1999 the formal sector employed only 44% of the urban work force, meaning the majority of workers are either unemployed, or working in the informal sector [Wickre, 2002]. The existence of a large informal economy, makes the implementation of government aid programs such as a minimum wage less effective in reaching many of the people who are most in need of help. Unfortunately, governmental programs which increase benefits to formal sector labor and drive up cost often cause employers to reduce staffing and dump more labor into the informal sector where they receive no regulatory coverage of any kind.

The decay of a formal economy also hinders tax collection which could be used for much needed infrastructure and social services. Small-scale private enterprise, often a successful approach to poverty reduction, is very minor in rural regions of Nicaragua because of inability to compete with cheap manufactured goods imported from urban areas or abroad [Corral and Reardon, 2001]. The policies supporting free trade do decrease the cost of consumer goods, however they also reduce the returns on labor and employment prospects in localities such as Siuna. It remains a question as to whether the drain of capital away from a region through the importation of consumer goods is ultimately more harmful for a region with already staggering unemployment and a lack of comparative advantage in some exportable good that could offset the regional trade deficit.

Political and economic conditions combine with the natural environment to set the stage on which efforts to improve the water supply and health situation must play. We turn now to Siuna’s hydrology and then to the more specific issues of water supply and the institutions involved.

**Hydrology**

Siuna receives an average of 82 inches (2100 mm) of rain per year, an enormous amount of precipitation by most standards, reduced in practical usability somewhat by its distribution in two distinct seasons. The wet season lasts from May to December, and the dry season from January through April. Precipitation has been reported by Proconsult [2000] to vary from about 1400 mm to 2500 mm annually. Average annual temperature is 25.4 oC, and annual evaporation is estimated at 2100 mm [Proconsult, 2000]. If
evaporation is truly equal to precipitation, it indicates very little water is available for runoff or infiltration. This means the region has a large potential to desiccate during the dry season.

Groundwater has not been adequately explored, primarily due to the lack of drilling equipment, however shallow dug wells, often placed in ditches that become flooded during the rainy season, provide water for much of the region’s population. Many of these wells are unlined and improperly covered [Wickre and Martin, 2002] and since they are shallow, they provide little protection against biological contamination.

There are several small streams and rivers running directly through the urban center of Siuna and in the outlying region. The streams in Siuna are heavily polluted with raw sewage and debris. Three rivers within several kilometers of Siuna have been considered for possible future water supply to the urban region. Their average discharges are moderate: Wani, 1373 L/s; Rio, 103 L/s; and Ul *, 1825 L/s.

The region is mountainous, with elevation ranging from 200 to 500 meters above sea level in the urban district, and up to 2000 meters above sea level in the rural regions of Siuna [Proconsult, 2000]. Bedrock is primarily igneous and metamorphic in the area, and crops out at many locations, indicating a relatively shallow soil layer, which tends to be predominantly silt. Vegetation cover appears very important for maintaining soil moisture and related dry season river flows, and areas lacking vegetation appear extremely dry in April. Anecdotal evidence indicates that two of four streams supplying the current water supply reservoir system have dried up due to deforestation [Proconsult, 2000].

Water Supply System

The municipal system that supplies about a third of the urban population (1000 homes) with water once every eight days was built in 1945 by an American mining company to supply the mining operation. Originally water was filtered and chlorinated, and Siuna residents who remember those days, indicate that water was plentiful and clean [Wickre and Martin, 2002].

A system of three reservoirs collects water for supply. Average inflow to the system is only 1.54 L/s, and dry season collection can be as low as 0.5 L/s [Proconsult, 2000]. The first reservoir is remote and accessible only by trails, and water flows from this reservoir via a small stream to the second reservoir, called El Mango. The second reservoir is several acres in size and heavily forested on the banks, although deforestation is encroaching. From there, water flow through as system of 8- to 14-inch iron pipe into a third reservoir, located in a fairly deforested area used for livestock grazing near Siuna. A chain-link fence has recently been erected around the reservoir to keep animals out, however we observed cow feces inside the fence, on the shore of the reservoir.

We spoke with three technicians responsible for keeping people and animals away from the second reservoir, and for operating the valve at its outlet. They said they can not open the valve more than a little, because pressurizing the pipe system between the second reservoir and the reservoir closest to Siuna causes pipe breaks. One operator said the system is so decayed that he can crush the pipe walls with his hand. They said there is no money to buy materials for repairing the system and we asked the operators about the possibility of collecting small fees from the users in Siuna. They said people were accustomed to receiving water for free and thus would be unwilling to pay. They mentioned the additional problem of corruption, and general distrust of public officials collecting funds.

Basic health is intrinsically tied with sanitation and a safe drinking water supply. The lack of water for basic hygiene is a major barrier to improvement of health. Urinary tract infections, parasitic infection, and dysentery are common in Siuna. [Engelhardt, 2004]. At the hospital, water is desperately needed to maintain hygienic conditions. At the town jail, they receive water only once every 8 days, and a prisoner told us they wash only on the day when water comes. Lack of hygiene, and generally deplorable conditions, in the jail lead to rapid spread of diseases including lice and skin infections.

Institutions
There are institutions on the international, national, and local level which, to varying extents, are involved in water supply and sanitation in Siuna. Unfortunately, most of the organizations involved, are non-profit or aid groups, rather than governmental agencies with a legal mandate to provide service and who could sustain operations in the region. The presence of the Nicaraguan Enterprise for Aqueducts and Drains (Enacal) would be most helpful to the region.

Enacal is a government run organization that develops and operates water supply systems, primarily in Managua and other parts of Pacific Nicaragua. Water supply problems are evident even in the more affluent regions of Nicaragua, and a consumer group claims the water crisis is more pressing than electric energy problems. Presently, there is debate about privatization of Enacal [Gomez, 2004] and while they are locked in debate, struggling with rising costs, and facing a disgruntled service area in Managua, Enacal provides no service to Siuna.

Residents in Siuna have said that Enacal’s lack of presence stems from the fact that there is little cost-recovery potential there. Since there is also little development potential for industry or tourism, expenditures for water supply do not promise adequate returns [Martin, 2003]. Privatization of Enacal would make extension of national service to Siuna less likely since a profit seeking enterprise would avoid the risk of financial loss in the region. Enacal has said civil instability, rebel military action, and lack of necessary supporting infrastructure such as all-weather local and regional roads, are reasons for not working in the Siuna.

The Municipalities Laws of 1997 delegate more authority from the national level to the local level, in part to align Nicaraguan policy with the policies of international funding agencies such as the World Bank and IMF. This policy of responsibility delegation has followed the same pattern as other services in Nicaragua, such as health care [Larson, 2002]. In Siuna, responsibility would fall to the local government in any event, simply due to the lack of involvement by the national government.

Local authorities complain that they have been given more responsibility for providing services, without the technical knowledge or authority to raise funds in support of those additional responsibilities.

The Non-Governmental Organizations (NGOs) active in Siuna include: Medicos del Mundo, Salud sin Limites, Save the Children Canada, Horizonte 3000, Bridges to Community, Oxfam Great Britain, and the Austrian Development Cooperation. One neighborhood representative told us that NGOs are the only organizations that produce any results in Siuna.

Aid from the European Union founded a college in Siuna called the University of the Autonomous Region of the Caribbean Coast of Nicaragua (URACCAN), and this institution holds great promise for the long-term development of social capital in the region. The university offers degrees in business administration, forestry engineering, and economic development and has 70 faculty, 220 resident and 700 part-time students. Infrastructure is lacking at the college also, with no running water, and most “sanitation” being of the self-service variety in the surrounding forest.

International aid and NGO activity in Siuna appear to be the most hopeful option for short-term relief of poor conditions in the region, however one such effort that is unlikely to improve conditions much is the plan to construct a new central water supply system. One million US dollars is being given by the Inter America Development Bank, through the Nicaraguan Emergency Social Fund (FISE) for the construction of the new water supply system. The details follow.

The Planned Water Supply System

The proposed water supply system will draw water from the Ul River located about 5 km to the west of Siuna. High-grade water treatment is planned, including chemical coagulation and settling, rapid sand filtration, and chlorination. The treated water will be delivered via pressurized PVC main pipes and initially connected to the existing distribution network. Future plans include replacement of the failing distribution system [Proconsult, 2000].
An estimated US$ 2 million would be required to build a system that would serve the entire urban district of Siuna, however FISE grants are capped at $1 million each. The cap is in-part designed to promote local contribution of the remaining funds to increase local ownership, commitment, and stake in the project, but additional funds have not been raised in Siuna, and the decision to build a $1 million system serving only half the population was made. Reflecting the frustration locals feel with national implementation of programs, Siuna’s mayor Gaitón complains, “Under FISE, half the money goes to pay consultants, to pay engineers to fly from Managua to Siuna. This takes mountains of money. We consider it an enormous waste of the State.” [Martin, 2003].

A complex bureaucracy involving numerous individuals is planned for the management of the new water system, and annual cost for operation and maintenance are estimated at about 230,000 Cordoba, or US$ 15,000 [Proconsult, 2000]. Some community members are skeptical that this system will be any more sustainable than the currently decaying one. Professors at URACCAN laughed when we spoke with them about the treatment system plans, and others say ultimately the responsibility will fall on Siuna for maintaining the new system, a task for which local capacity probably does not exist. [Martin, 2002]

The plans for the new water system seem to incorporate features that have proven ineffective in Siuna. The need for officials to collect funds, a centralized system requiring local engineering expertise, and need for organization on the municipality level to maintain a centralized system do not appear to be realizable by Siuna at present. Still, the need for safe water is urgent, and perhaps alternative technologies for water supply should be considered.

Rainwater Collection

A colleague and I were standing in front of a small wooden house with a corrugated galvanized steel roof, talking about water supply issues with a neighborhood representative, when a small child ran passed us and into the house with two jugs of water he had collected from a shallow dug well down the road. The water from these wells is heavily biologically contaminated and some evidence suggests it may also be contaminated with metals from historic mining operations [Wickre, 2003]. A few minutes later, on the hot afternoon about a month prior to the end of the dry season, it began to rain, hard. There was a 3 meter gutter under the eave of the roof, apparently to keep water away from the doorless entry to the earthen-floored hut, and during the 20 minute storm, the flow rate from this gutter was about 5 gallons per minute. The gutter collected from about a third of the house’s roof area, thus about 300 gallons of rainwater fell on the roof and then dropped onto the ground that afternoon, while the family drank polluted groundwater from the well down the street. According to the neighborhood representative, it rains every week or two in similar quantities during the dry season, and much, much harder in the wet season.

IETC [1998] recommends the first 15 liter/m² of roof runoff be used only as flush water to remove contaminants from the roof surface and should not be collected as water supply. After flush losses, there would remain about 220 gallons from this storm. Two hundred gallons for each family, every two weeks, during the dry season, and much more during the wet season could go far in meeting drinking water and basic hygiene requirements.

Kumar [2004] discusses some of the issues regarding collection of rainwater for supply in India, and concludes the economic viability of rooftop collection is low compared to augmenting a public supply system. His conclusions are likely not applicable to Siuna, since, in one example, he discusses the viability of collecting rainwater for “a typical 10-story apartment building.” No such structures exist in Siuna. He rightly points out that benefits from a rooftop collection program would be unequally distributed since those with smaller dwellings could collect less water. In Siuna, where the poorest residents have thatched roofs, rainwater collection for them would not be desirable (although some believe it is possible [Gould and Nissen-Petersen, 1999]), thus there would be inequality in benefit distribution of a rainwater collection program. However, where the public supply system has failed, and the region has a history of official corruption and lack of the social capacity needed to support large-scale physical infrastructure, domestic collection of rainwater still appears a viable option.
Rainwater collection is a very old technique for water supply and was in common use in developing countries at the beginning of the 20th century. Interest in cisterns declined in the mid 1900’s as hope increased for large scale dam projects and new technology for mechanized groundwater pumping, and as international loans and “wisdom” poured into developing countries to support large-scale, capital intensive public works projects. In the last two decades, fueled by expanding populations, failure of many piped supply systems due to problems with operation and maintenance, and the development of low cost storage tank designs, such as ferrocement, rainwater collection has increased in popularity [Gould and Nissen-Petersen, 1999]. Extensive rainwater collection is being practiced in many rural areas of Central American countries such as Honduras, Costa Rica, Guatemala and El Salvador [ITEC, 1998].

Distributed collection of rainwater on the household scale stands as a counter idea to centralized projects, such as the existing system that currently under-serves Siuna with polluted surface water, and to the planned system which appears unsustainable at the outset.

Social Conditions and Capacity Building

In Siuna there seems to be a passive acceptance of poor conditions regarding water supply. People have a phrase, “no hay,” simply meaning, “there isn’t any.” [Martin, 2003]. A neighborhood representative told us that people simply wait for a non-governmental organization to come and give them things, and that people are not motivated to help themselves. Breaking this welfare mentality will be an important step in improving the water supply situation.

Elimination of corruption is also critical. In Siuna, there is mistrust of public officials, and given the long history of corruption in Nicaragua and neglect of the region by the national government, this feeling appears justified. Collecting money for investment in public projects is difficult since the population has little cash and because people fear that the collector would simply disappear with their money.

Julie Schaffner, from Tufts University’s Fletcher School, teaches that infrastructure consists of both physical assets and the social system necessary to operate and maintain them effectively. Infrastructure requires continual support by people with appropriate expertise and a public commitment to operation and maintenance. The lack of a social system can be as limiting as a lack of physical assets.

There are cases of one community and one neighborhood in the region with functioning leadership and public participation. These communities have organized to supply themselves with apparently high quality water from nearby springs, and the fact that pockets of functioning infrastructure exists, lends support to the argument that a functioning social system is a critical element in public projects. In other parts of Latin America, communities are realizing it is ineffective to remain “expectant users” of government provided services and they are organizing to find ways to improve their own lives through micro-irrigation projects and small scale industry. [de Freitas and de Faria Salviano, 2000]

At the university, URACCAN students say they chlorinate their drinking water, “when they remember.” The public lack of concern for water supply was further evidenced when we passed a yard where cars and buses were being repaired. The employees were washing cars with large quantities of water and forming puddles in the road. We asked our guide whether people were concerned about this large consumption of water when supplies are so scarce. He replied that no one cares.

Development of a caring public for water quantity and quality is necessary. A representative from ENEL, Nicaragua’s national electric utility, estimates that 70% of the people could pay for water, based on ability to pay for electricity, but this may not be a valid interpretation, since the motivations for investment in clean water is risk reduction rather than productivity increase, as with electricity purchase [Martin, 2003]. Only about half of Siuna’s population chlorinates their water, and boiling is not a practical option for most due to the lack of fuel. If people perceive little risk, or if they believe illness caused by bad water is normal, they will not be willing to invest to reduce that risk.

I asked the URACCAN professors what their actions would be if they could do anything to improve the water supply situation. They said that education about water conservation is most important, because
with current prevailing attitudes, people will waste water if it is given to them. It is interesting to note that even in the midst of a severe lack of physical infrastructure, the professors point to a social issue as a top priority.

Peter Rogers [2004] stated in a recent lecture at Tufts University, that unless people pay the full price of water, they will not protect the resource. Dr. Rogers may be right in an economic sense, if our assumptions of the purely self-serving economic agent are correct, however there are other factors involved in resource protection and management, such as membership in a functioning community that allows individual participation and a sense of commitment to a location or group [Ravnborg, 2003].

Simpson-Hebert [1993] says:

The degree of community and individual involvement and commitment is dependent upon at least two primary factors: the degree of understanding of the problem or concept, and the perceived advantages to the primary economic unit (normally the individual or the family).

This idea goes beyond Rogers’ theory of self-serving cost minimization (balancing the negatives of paying for water versus paying for the loss of the resource through a tragedy of the commons) to one of self-serving income or opportunity maximization. Ownership and resource conservation can be achieved through increasing the perceived value of the asset. Even when one does not pay the full cost of obtaining a resource, if she has the ability to put the resource to a beneficial use, the value of that resource will be based on its return potential, rather than on its cost. With a functional social system to broker sharing among multiple users, organized communities could effectively manage their resource.

Women may provide a key to effective capacity building, with the added benefits of increasing their voice in the community and power within families. Extension agents working on a micro-irrigation program in Brazil have reported that although whole families receive training on treatment and appropriate use of water in the agro industry, it is women who give more value to the information received and who try to put it into practice [de Freitas and de Faria Salviano, 2000]. Since daily collection of water and management at the household level are typically the job of women in Latin America, women are likely better equipped to understand the value and to effectively manage the resource at broader levels [Donoso, et al., 2000].

A multi-layered effort including non-didactic community workshops for adults, colorful magazines with games and puzzles for children at school, and media attention on the radio, could increase public awareness, understanding, and discussion about water resources and health [Simpson-Hebert, 1993]. A demonstration of rainwater collection at a local school combined with educational programs for collecting data on rainfall, usage, and cistern operation could capture children’s attention and give them a sense of empowerment regarding the management of water resources. If this program were combined with calculating chlorine dosages and with using collected water for hand washing, education of water resources could be combined with basic health lessons. As children grow to adulthood, these early lessons could translate in better decisions, community action, and improvements in basic health.

Conclusions

The failure of the international community to bring water to Siuna’s hospital highlights the fact that water supply relies both on physical infrastructure and the social system needed to support it. Donor organizations completed neither the physical system necessary to fill the water tower’s tank nor the development of a social system necessary to sustain operations.

Siuna’s decaying reservoir and pipe system stands as testament that there is presently a lack of ability to sustain a centralized project on this scale, and even so, there are plans for a new centralized system that, at best, will serve only half of Siuna’s population, and at worst, will suffer the same fate as its predecessor. Given the political and economic history of the region, it appears likely that a successful new large-scale public supply system will require increasing the level of education and awareness within
the community, increasing technical ability of a maintenance and operations staff, increasing the
governing capacity to effectively collect and spend funds for their intended use, and perhaps increasing
general economic capacity of the region such that tax funds are available in the first place. Lacking these
other social developments, it may be better to invest in distributed projects that can provide immediate
improvements in water supply at low cost, and that can be used as teaching tools.

Small scale projects like rainwater collection that require active management at the household or school
level could be instrumental in developing as sense of ownership, stewardship, and empowerment.
Projects of this type circumvent difficulties with corrupt and ineffective officials and could reduce the
“welfare mentality” of hopelessness that pervades the region. If combined with advanced training at
institutions like URACCAN, early lessons for children in small-scale water collection and basic hygiene
could contribute to the development of people who could someday staff effective public institutions to
support larger-scale physical infrastructure.

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