Developing Rural Water Systems in Haiti: An Evaluation of the First Chlorinated Municipal Water System in the Central Plateau

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ABSTRACT: *Haiti has the worst drinking water indicators in the Western Hemisphere and access to improved water sources has not dramatically improved for over two decades. This limited success despite hefty investments can be attributed to a variety of reasons including lack of community involvement and lack of long-term support of operation and maintenance for rural water systems. This paper presents a case study of Haiti's first municipal chlorinated water system in the rural Central Plateau and critically examines its effectiveness. While the technology behind the Cange water system is highly innovative and effective, its lack of community involvement and feasible operation/maintenance jeopardises its long-term viability. Methods to sustain the system without major external intervention are currently being developed and attempted through a partnership with Haiti's public water sector. NGOs and organisations should ensure that an appropriate community development framework is established prior to system installation so that these problems can be avoided.*

KEYWORDS: Water, Haiti, community, rural water systems, Central Plateau, chlorinated water, internship

1 BACKGROUND

1.1 Rural water systems

Since 1990, 2.6 billion people have gained access to improved drinking water sources (UNICEF, 2015). Of the 663 million people still lacking clean water, the majority live in developing countries and 80% live in rural areas (UNICEF, 2015). This stark disparity between urban and rural areas has only grown in the past two decades even though the World Bank has invested $1.5 billion (USD) in rural water projects (UNICEF, 2015; World Bank, 2016).

The limited success of external agencies in improving rural communities' access to improved water sources is not a new phenomenon. In fact, the majority of global increases in access to water, sanitation, and hygiene (WASH) can be attributed to recent urbanisation and worldwide economic development trends rather than explicit development endeavours (Moriarty, 2013). This limited success despite hefty investments can be attributed to a variety of reasons including:

- Technological/equipment failure
- Poor organisational structures in the community or sponsoring agency
- Neglecting operation and maintenance (WHO, 2003).

The implementation of WASH projects in developing countries became especially popular during the first

"International Drinking Water Supply and Sanitation Decade" from 1981 to 1990 sponsored by the United Nations (Najlis, 1991). The results of this effort were extremely mixed, especially in rural areas, where access to WASH decreased (Churchill, 1987). These failures were attributed to several factors, but the main issue identified was the top-down approach implemented by most non-governmental organisations (NGOs), government agencies, and multilateral organisations (Briscoe, 1988).

Recent efforts have focused on community development and continued operations and maintenance of systems typically through a water committee comprised of community members. A 2009 study in Peru, Bolivia, and Ghana revealed that the majority of water systems were still operational and the established water committees had been able to repair broken systems. However, many households in these areas were still using unimproved sources despite the existence of the water supply system, and the finances of these committees were disorderly or non-existent (Bakalian, 2009; Whittington, 2008). According to the Rural Water Supply Network (RWSN), a village water committee usually requires support or long-term assistance from external agents such as a local government office or NGO in order to be successful (RWSN, 2010).

1.2 Water in Haiti

Haiti has the lowest access to improved water sources in the Western Hemisphere. In rural areas, only 51% of people have access to improved water sources, and in the Central Plateau, the rate is 67.7% (JMP 2015, Patrick 2013).

Haiti's legal framework for WASH is dated and jumbled among various pieces of legislation. The public water and sanitation department, Direction Nationale d'Eau Potable et d'Assainissement (DINEPA), was founded in March 2009 following the shortcomings of the Service National d'Eau Potable (SNEP), the agency that existed during Haiti's tumultuous 20th Century (DINEPA, 2014). DINEPA struggles with similar problems as SNEP including a lack of qualified professionals for projects outside of Port-au-Prince, a lack of program monitoring, poor local construction practices, and issues with collecting water tariffs (DINEPA, 2016).

Most WASH infrastructure in Haiti is donated or subsidised by the state, multilateral institutions and/or NGOs (DINEPA 2016). In most rural areas of Haiti, WASH is left to NGOs who are free to operate without control or accountability (DINEPA 2014). As of 2013, there are hundreds of NGOs working to bolster Haiti's access to clean water but only 23 have registered with DINEPA (Gelting, 2013). This registration, known as a 'Framework Agreement,' enables DINEPA and the NGO to take advantage of potential synergies, allows better sectorial coordination, and grants DINEPA regulation over the system to ensure it is effective and functional. This regulation by the state can create a more sustainable system by certifying the technical feasibility and treatment efficacy (DINEPA 2014).

DINEPA notes that Haiti's culture and many of its political leaders and policy makers consider clean water to be a universal and free resource (DINEPA 2016). Consequently, many Haitians disagree with the concept of paying for water (DINEPA 2016). As a result of this cultural perception, policy problems, and poor infrastructure, Haiti has made limited progress in improving access to clean water since 1990 (UNICEF, 2015).

This paper presents a case study of Haiti's first municipal chlorinated water system in the rural Central Plateau and examines its effectiveness. The system represents an example where a technical and complex project has been implemented in a remote village in Haiti where a lack of community engagement has jeopardised long-term viability. Recent efforts to engender more community responsibility for the system are also highlighted. Professionals, non-profits, and other stakeholders in rural water development should consider this case study when developing major water projects in the future.

2 PROJECT BACKGROUND

2.1 Cange and the Episcopal Diocese of Upper South Carolina

The village of Cange lies on the shores of Lake Peligre in Haiti's mountainous Central Plateau. It was formed originally as a collection of squatter settlements after the Lake Peligre dam was constructed in the 1950s by the U.S. Army Corps of Engineers (Kidder, 2003). The rising water forced hundreds of people to higher ground as the fertile soil and arable farmland flooded (Kidder, 2003).

For over 30 years, the Episcopal Diocese of Upper South Carolina (EDUSC) and Zanmi Lasante, a local NGO, have served Cange by promoting and funding medical, education, and infrastructure projects. Pere Fritz Lanfontant, the Haitian priest who initially solicited the support of the Episcopal Diocese of Upper South Carolina, advocated to provide clean water to students at the Episcopal school in Cange. At that time, Cange had no easily accessible source of clean water. A local Baptist mission had attempted to drill wells in the area in 1982, but no reliable water source was found at a well depth of up to 182.9 m (600 feet).

2.2 Water system development

The first report concerning the original Cange water system was written in 1983 when a team of professional engineers from Greenville, South Carolina travelled to

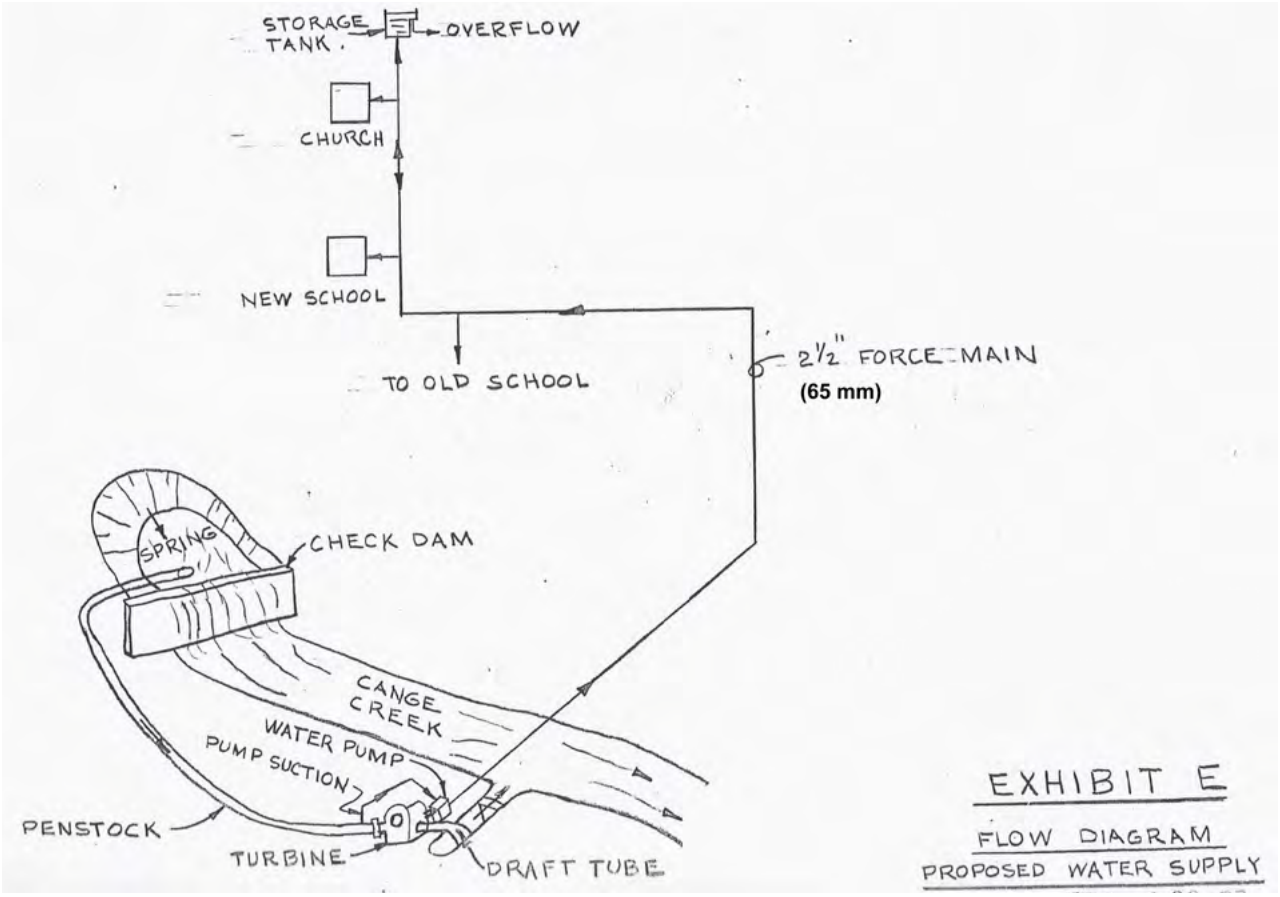

Figure 1: Original concept figure found in the 1983 feasibility study

Haiti to perform a feasibility study on behalf of EDUSC. The purpose of the feasibility study in 1983 was to ascertain whether it was possible for the water from a large spring near Lake Peligre to be directed to Cange using a pumping system. The report concluded that it was feasible to provide the school with water using the large flow rate and vertical fall from the spring to drive a hydraulic turbine to power a pump (Figure 1).

The engineers also added that Lafontant desired the system to be gradually upgraded in a step-wise fashion to serve as many others as possible outside the Episcopal school. Consequently, the engineers proposed a water supply system for the school that could be expanded for the village as necessary. They also suggested budgeting an operation and maintenance cost for the system for five years. However, the report cites no plans or efforts about maintaining the system after these first five years of operation. There is no mention of involving the government to bolster long term success of the system.

2.3 Water system construction

Construction on the Cange water system began in 1984 and was completed in 1985. The original idea was expanded from providing water to the local school only to providing water to the whole community via two large cisterns feeding eight public water fountains throughout the village. It is not clear how this change in scope was addressed, or to what extent the village was involved in this decision.

Professional engineers in the United States complete the design for the whole project and travelled to the Haiti for important milestones, such as the installation of the pump. Construction work, namely dam and pump house construction, laying water lines, building cisterns, and assembling fountains was contracted out to local Haitian engineers and masons. The general community of Cange was not involved in the original construction of the system outside basic labour. No water treatment was included at this time as faecal coliform testing yielded no contamination.

When the system was completed in 1985, EDUSC celebrated with the people of Cange. The hydro-powered pumping system required no electricity and water became widely available to all residents at no cost. Consequently, Cange was no longer a squatter settlement with temporary residents; water provided the villagers with a reason to stay.

2.4 Evaluation of the original water system

The original designers of the system were more concerned with the feasibility of the construction and logistics rather than the long term sustainability of this project. At the time, Lafontant was heavily involved on a community-level and

perhaps the engineers trusted his ability to rally the school and population to fully support this endeavour.

The scope of the project was initially only for the school and the American designers did not expect the system to be municipal when it was proposed. The designers mention its capability to become a public system for thousands of people as part of a step-wise process but this gradual scaling did not occur. Furthermore, it appears that little effort was made to engage with the village. The community was not responsible for maintaining the water supply did it make financial or logistical contributions.

The impact of the water system on the village cannot be understated. Cange's lack of arable land and industry, have been outweighed by free and accessible drinking water. Without the water system, it is possible that the residents would have relocated to surrounding villages with more job prospects and larger economies.

Overall, the mindset reflects that of many other development organisations during the 1980s. Rather than interacting with the community, Lafontant was the primary voice of Cange when a highly complex, albeit effective, pumping technology was implemented. This project represents a top-down solution to WASH in Haiti and a microcosm of the failure of the WASH sector to effectually penetrate developing countries during the 1980s.

3 WATER SYSTEM RENOVATION

3.1 Project background

After the water system's construction, the operations and maintenance of the system was performed and funded by EDUSC entirely. Day-to-day operations were handled by a handful of trained Haitians but any major tasks were handled by members of EDUSC in the United States.

A thorough reassessment of the Cange water system was not performed until 2008 when an engineering team from EDUSC travelled to Haiti to examine issues with the pumping system. These engineers concluded that the water system was at risk of total failure. The pump was past its life expectancy and water was undermining the dam.

Faced with these issues, EDUSC sought American engineers to volunteer their time and efforts to oversee repair of the Cange water system. To meet this need, a team of industry engineers and university students from Clemson University in South Carolina created Clemson Engineers for Developing Countries in late 2009 with the goal of providing oversight of this project (Plumblee, 2010).

3.2 Project construction

The devastating Haiti earthquake in January 2010 disrupted CEDC's efforts with the country in turmoil. When the project was revisited in late 2010, cholera had struck the area which heightened the need for improved water in Cange. Members of EDUSC, the Haitian technicians who had worked on the system for decades, Zanmi Lasante employees in Cange, and engineers from South Carolina established the scope. It included the following:

- Constructing a new dam to direct water into two penstocks
- Constructing two additional pump houses and installing two additional turbine/piston pumps to meet the rising population
- Constructing two additional cisterns
- Designing and laying a new water line from the pump houses to the cistern
- Designing and construction a treatment system to purify the water and eliminate cholera

Construction officially started in early 2011 as CEDC sent student interns to Haiti to serve as an intermediary between the engineers in the United States and the construction crews in Haiti (Bargar, 2016). CEDC student interns spent 6 to 12 months working on the system, learning the local language, and engaging in the local community in the process (Ogle, 2016; Bargar, 2016). Work proceeded for the next 24 months as CEDC remained heavily involved with the project's executions by overseeing Haitian work crews and managing project expenses. Few community members were included in major decisions involving the construction.

The system was officially commissioned in June 2012 but the final touches were not complete until December 2012. A local Haitian news organisation heralded the system as the Central Plateau's first chlorinated municipal water system (Haiti Libre, 2012). The treatment eliminated all traces of faecal coliform as of its installation. See Figure 2 for a satellite view of the full system.

3.3 Community development initiatives

Since its completion in 2012, EDUSC has fully funded the system's operation and maintenance. This not only involves purchasing the necessary consumable items for operation and maintenance of the system (such as chlorine tablets and oil for the pump) but also paying six Haitians a monthly sum to test, clean, and monitor the system. Since its completion, the system has only undergone minor repairs to the fountain piping and treatment system.

Local labour and Haitian technicians are leveraged to provide the water system with steady operation and maintenance, however, the system is still entirely funded and managed by external entities. Some local Haitians have embraced the system and maintained their fountains by keeping them clean and beautifying them. Figure 3 depicts one such fountain that has been painted by the locals. Outside of these small beautification measures and general upkeep of the fountains, the greater

Figure 2 (top): A Google Earth satellite image of Cange with water system overlayed (Google Earth, 2013)

Figure 3 (middle): A public fountain in the Cange water system that the Haitians have decorated

Figure 4 (bottom): CEDC student interns lead a community meeting to talk about the future of the Cange water system

community has little to no participation in the day-to-day operations of the water system.

However, EDUSC is still heavily involved and the community has not taken over funding or responsibility of the system since its establishment in 1983. The annual cost of the system precludes EDUSC from pursuing other opportunities, and if EDUSC were to halt their donations to the system, the system would be at risk of failure. CEDC has made many efforts to grant the community more responsibility for the system including facilitating the hiring of six Haitians by Zanmi Lasante to maintain the water system as detailed above. CEDC interns have continued to have a major presence in Cange and have organised multiple community meetings to discuss the future of this water system and engender more community involvement, such as the formation of a water committee. See Figure 4 for a photo of CEDC interns leading one of these meetings.

These community meetings have stalled for a variety of reasons. A sizeable portion of the residents in Cange were born after 1985; they have never known life without a water system that delivers water for free. As previously mentioned, Haitian culture does not appreciate the need to pay for water as Cange has been receiving complimentary water for decades. (DINEPA, 2016). In addition, with Cange's status as the oldest chlorinated water system in the Central Plateau, there is very little precedence for a grassroots funding mechanism in the region.

CEDC has met with DINEPA representatives on several occasions to discuss the process of a framework agreement and getting DINEPA involved in the Cange water system. Whilst DINEPA is interested in creating a more sustainable water model for Cange, the citizens of Cange have been reluctant to work with this government agency. Many

residents claim that DINEPA is bureaucratic and unresponsive when it comes to constructing and maintaining rural water systems. The overwhelming consensus from village meetings is that the people would rather continue to work with CEDC and EDUSC, who, in their opinion, offer better and more reliable service than DINEPA. However, DINEPA has much more experience in increasing community participation and their efforts would reduce external involvement.

4 DISCUSSION AND CONCLUSIONS

This case study highlights the importance of establishing the long-term viability of a rural water system project in a developing country prior to construction. Unfortunately, whilst the technology behind the Cange water system is innovative and effective, lack of community involvement in operation and maintenance is a common risk to system failure. Many governments and NGOs advertise and publicise the number of new water supply system installations rather than focusing on the number of water supply systems that have been maintained (WHO, 2003). As of 2011, 69% of government funds in developing countries was apportioned to new water systems, with only 31% of funds going to operation and maintenance (WHO, 2012).

Many of the problems with the Cange water system can be traced back to the development philosophy of the original sponsors in the 1980s and the original "International Decade for Water and Sanitation," when providing water to developing countries was a project rather than a service that required long-term planning and development. Engineering students and professionals must consider water projects as a critical piece of infrastructure that is to be adopted by a community, rather than a simple semester or year-long project by a team of volunteers.

Once established, a relationship with a developing community is difficult to alter, as evidenced by the struggles of CEDC to mount effective change after three decades of precedence. Recent initiatives to transition the water system have been laborious and less than effective. The Cange water system represents a triumph of engineering design but a failure of social design. Future efforts to deliver drinking water to rural communities must learn from the lessons here concerning community development by applying community engagement strategies prior to construction.

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