Establishing the Rwanda Potable Water Project

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Abstract*– Roughly one quarter of the world lives without regular access to potable water [1]. In 2018, the students of the Engineers Without Borders Vaughn College Chapter began a partnership with the community of Kigarama in Western Rwanda to resolve the lack of safe drinking water in the village. The project is community-driven, and sustainability is a core requirement throughout the project process. The chapter sent a team of four students, one faculty advisor, and one professional mentor on a fact-finding mission to Rwanda in February 2019. The purpose of the trip was to establish relationships, survey the land, collect baseline data, and evaluate the capacity of the community to sustain the project. During the Assessment Trip, the travel team completed all planned activities. Baseline water testing revealed that one hundred percent of the community uses unsafe water proving that potable water is the community's priority. The team concluded that the community has the financial, organizational, and technical capacity to continue the project. Next, the team will analyze all possible alternatives for project design in preparation for the Implementation Phase of this project. Once the project has been completely constructed, the team will complete a year-long Monitoring Phase to ensure the longevity of the project.

***Keywords*— water, potable, rainwater catchment, rainwater harvesting, global development**

I. Introduction

2.1 billion people, roughly one quarter of the world, do not have access to safe drinking water in their home [1]. In Fall 2015, the Engineers Without Borders Vaughn College chapter (EWB-Vaughn) was formed so students had the opportunity to be the change they wished to see in the world. Engineers Without Borders (EWB) is a U.S.-based organization comprised of over two hundred student and professional chapters addressing some of the most pressing challenges in developing countries across the world. Global development is only effective when it is sustainable. Aid organizations often implement elaborate solutions that are damaged or neglected after the project is completed. For these reasons, sustainability is at the core focus of every EWB project. Every EWB project is initiated by the beneficiaries themselves. In 2017, representatives from Gihombo Forward (GIFO), a local non-governmental organization in Rwanda, as well as the local priest and school headmaster collaboratively identified potable water as their community's first and most important need. In June 2018, the EWB-Vaughn and Kigarama, Rwanda, partnership was established. The Kigarama Potable Water Project was approved by EWB in September 2018, and the first Assessment Trip was completed in February 2019.

A. Project Background

Rwanda is a small landlocked country in East Africa. The project is mainly focused in Kigarama in the country's Western Province. Kigarama is a community of approximately 900 people. Kibingo Center can be considered a "downtown" area where everything is accessible. Kibingo Center is located in the center of Kigarama and consists of residences, a church, a school, and a health center. There is an existing pipeline nearby the school in need of repair. The pipeline was built by the local government and is not protected against the elements. For example, automobiles passing on the road have broken the pipe many times causing disruptions in the water service and pressure. Further, the water is sourced from a stream in a nearby town, but the water is not filtered or disinfected.

The community is located less than three kilometers from Lake Kivu, a lake separating Rwanda from the Democratic Republic of the Congo. Community residents currently obtain water from unsafe sources such as this. Lake Kivu is 1,674 square kilometers and 485 meters deep. Due to the meromictic nature of the lake, carbon dioxide and methane stay trapped in its depths, thus earning the moniker "killer lake [2]." Additionally, locals obtain their water from the unreliable pipeline near the school and multiple improved springs (Fig. 1) in and around Kigarama.

Fig. 1: Improved Spring

Lastly, there are three existing rainwater catchment (RWC) systems in the area: the church system, the broken school system, and the GIFO system. The country experiences a rainy season from March to May and from June to mid-September [3]. The rest of the year, Rwanda is plagued by a dry season, so RWC systems are increasingly being implemented in small communities in Rwanda. Water from the church RWC system is available for the community to use at no cost. Since it is located nearby the boarding school, the students typically use all the water within a day. The school's RWC system was damaged and has not been repaired. Meanwhile, GIFO is located too far away from Kigarama for anyone in the village to utilize its RWC system. Despite the source of the water, it was found through baseline water testing that every source was contaminated to some degree, meaning that one hundred percent of the village is using unsafe drinking water.

B. Project Objective

The goal of this project is to resolve the issue of unsafe and insufficient drinking water for the residents of Kigarama. The community's proposed solution is building a rainwater catchment system or implementing a different solution. Other solutions under consideration include rehabilitation of the existing pipeline, improvement of existing RWC systems by integrating chlorination, and implementation of a pump from a spring to a tap stand at a centralized location.

II. EWB PROJECT PROCESS

The EWB project process is organized into three strategic phases to ensure the success and sustainability of the project.

A. Assessment Phase

When an EWB partnership begins, the EWB chapter has only very limited information about the project. The purpose of the Assessment Phase is to establish relationships, obtain a comprehensive understanding of the community's needs, and evaluate its capacity to sustain a project. During this phase, the chapter travelled to Kigarama to survey and identify the area that will benefit from the water project. The team identified additional challenges, requirements, and needs that could be addressed. Travel team members met with key leaders in the area to learn about the community. Within Kigarama, the team evaluated resources available for the project and determined external resources that may be needed outside Kigarma. Baseline data was recorded for future impact analysis.

B. Implementation Phase

EWB-Vaughn will return to Kigarama, Rwanda, to lead and assist in construction and implementation of the project. The team will keep detailed logs of progress, challenges and troubles that occur during the construction phase. The chapter plans on using said documentation for future reference by the chapter and others.

C. Monitoring Phase

After the project is implemented, the chapter will address the maintenance of the water project for one year. EWB-Vaughn will continue to educate the Kibingo community on how to utilize, troubleshoot, repair and maintain the equipment for maximum productivity and life span of the implemented project. The monitoring phase will equip the community with sufficient knowledge to ensure that the project will reach the maximum life span of the implemented system. The team will have fail-safes in place so that upon reaching the limit lifespan, the community is empowered to make decisions on their own. This may vary from choices such as whether or not to replace, overhaul, or continue usage of the system.

III. ASSESSMENT TRIP: FEBRUARY 2019

A. Partnership Formation

The team spent a significant portion of the trip meeting with local community members and leaders. The team conducted 29 door to door surveys during which the community answered questions regarding monetary support they are willing to contribute and other topics (Fig. 2). The survey data provided the team with valuable information such as the size of the household. There is an average of 5.7 people per household. Also, the surveys showed that people are willing to pay an average of 37,120 RWF per month per household for operation and maintenance (O&M). This is roughly equivalent to $41 per month. The surveys also revealed the most common source of income is farming and other useful information. It should be noted that out of a total population of 900, the surveys only reflect approximately 3.2% of the Kigarama Village population. Consequently, the results of the survey could be skewed due to the small sample size. Community surveys are very time consuming as they are very thorough and locals are not able to answer surveys most of the day because they are working. On future trips, the team will add more people to the community survey team to be able to sample a larger size of the population.

Fig. 2: Conducting Community Surveys

The team also met with several key leaders in the community including the Executive Secretary of Gihombo Sector, the Chief of Kigarama Village, the headmaster of the local school, and the priest of the local Catholic parish. These connections are key for the success of the partnership especially when the EWB-Vaughn chapter cannot travel to Rwanda. The leaders signed a memorandum of understanding with the EWB-Vaughn chapter outlining each partners' roles and responsibilities in the partnership.

B. Availability of Local Materials and Labor

The team met with the local suppliers at their storefronts in Mugonero and Kibuye. These local suppliers have coarse aggregates, sand and concrete. They also have available an array of small hardware and the mesh needed for rainwater catchment systems. However, their stock of high density (HD) pipe is lacking. For HD piping 2” and over, the HD water tanks, and all the structural steel will have to be ordered and delivered to the project site from Kigali, the capital of Rwanda. Recent Chinese development in Rwanda has resulted in a quality system of highways. Due to this construction, Kigarama is accessible for large trucks to ship materials to the community.

C. Baseline Water Testing

There are three methods the team used to determine the physical and chemical properties of each water source (Fig. 3). A colorimeter test was used to determine the turbidity of the water. Turbidity in simple terms is the cloudiness of the water caused by a large number of particles contained in the water. Additionally, the colorimeter was used to measure the amount of iron present in the water sample. Next, a Hach Sension5 was used to measure salinity, acids, bases, and other parameters to determine the conductivity of the water.

Fig. 3: Conducting Physical and Chemical Water Tests

The Sension5 was also used to measure the temperature of the sample. Lastly, by dipping test strips into collected samples from varying water sources, the team tested for iron, ammonia, total hardness, and nitrates/nitrites. After water sources were identified and samples collected, the team deposited one milliliter of each sample on petrifilms. Once the samples were plated, they were sealed in an insulated container with heating pads, to keep the temperature constant. The samples were then left to incubate for twenty-four hours, at which time they were removed from the insulated container and analyzed for E. coli and other total coliform (Fig. 4).

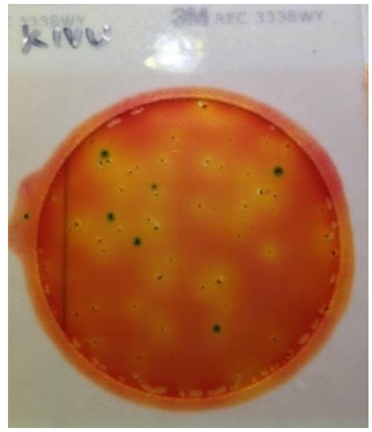

Fig. 4: Lake Kivu Petrifilm after 24 hours

As previously stated, all water sources tested were found to be unsafe for drinking when compared to the National Primary Drinking Standards [4].

D. Geospatial Data

Before the Assessment Trip, the chapter could not locate Kigarama on a map. To understand the extents and layout of the community, the travel team travelled around Kigarama village collecting Global Positioning System (GPS) points that were deemed important such as landmarks, water sources, water collection points and other buildings. Post-trip, several maps of the area were created using computer aided design and the recorded GPS points. The team was able to view the area plans, details of Kibingo Center, and land use.

E. Building Measurements

At each potential location for a rainwater catchment system, the following measurements were taken: the length and height of the buildings, as well as the pitch of the roof (Fig. 5). These measurements will be used to determine the maximum size of the system and how much water could be harvested. Additionally, measurements from the tip of the roof wing to the opposite side of the roof wing were taken, and the height from the roof wing tip with respect to the ground directly below. All of the roofs had a 20-25º angle.

Fig. 5: Building Measurements

V. Conclusion

In conclusion, the Assessment Trip revealed pertinent information that will be used to design and implement a solution for the Kigarama Potable Water Project. The team successfully completed all of the planned assessment activities and collected sufficient information to move forward with the project. Baseline data was collected concerning water quality and availability. It was determined that the community has no access to potable drinking water throughout the year. The capacity of the community to organize, implement, and maintain a project reinforced through community surveys and meetings with local leaders. Meetings with local leaders also proved the community's support and willingness for this project. Throughout the trip, it became very clear that the main goal for all partners involved is sustainability of the project after it is completed. The team has decided the project is a "go," and will complete the next steps necessary to move forward with the project including partner communication, obtaining outstanding information, alternative analysis, and fundraising.

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