This is StellaWriting's copy edit of a water survey report, submitted to the nongovernmental organization (NGO) that commissioned the report.

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Study on Water Management in Four Villages of Babessi Municipality

Introduction

Babessi municipality is located near Bamenda, in the North West region. It comprises four main villages: Babessi, Babungo, Baba, and Bangolan. This area is flat, with rice cultures. There are some hills with spring catchments, and developed boreholes.

In each village, an organization called the Water Management Committee (WMC) is responsible for providing high-quality water to the population. The WMC is often autonomous. This insures transparency, and builds public trust in the organization.

WMCs should include many members of the surrounding community. The community should be trained and educated to manage water in a sustainable way. The community should understand that paying water levies is necessary to support the water management infrastructure. Just like electrical power, potable water needs to be paid for.

All four villages surveyed for this report need water infrastructure rehabilitations, including pipe extensions. Until these technical refurbishments can be made, communities (led by the WMC) must know how to treat water at home. This will ensure that the population has access to highquality water, even if distribution networks or catchments are not currently renovated. (Instructions for treating water at home are provided at the end of this report.)

This report presents the results of a baseline water study in Babessi municipality. More exhaustive feasibility studies regarding water well location, sizing, and design are needed to plan facilities improvements. Comprehensive studies will provide information on how to properly select and correctly implement water management equipment. Such studies will help avoid issues created by the use of inappropriate equipment. Alexandra Clarà Saracho and Clàudia Ylla Arbós describe the data needed for these extensive feasibility studies in their report, "Baseline Survey - Santa Subdivision" (July 2015). The Saracho-Arbós report is summarized at the end of the current document.

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19 October 2015 – BABUNGO

Interlocutors

Mr Ghande Edwin Nwigende - Chairman of the Water Management Committee - 670515420

Mr Bebe Tumenta Joseph - Chairman of the Traditional Council - 677258572

Water catchments

About sixteen thousand people live in Babungo. Three water catchments supply the village. There are approximately fifty-five public stand taps, and seventy-five private taps.

The catchment is composed of a dam, where water is collected, and the drainage basin, which sends the water to the village. When we visited it, there was a leak in the pipe between the dam and the basin. The leak was causing overflow, and a significant amount of wasted water. The roots from trees in the surrounding area often damage the catchments. In addition to necessary repairs, the catchments need to be cleaned periodically.

Due to the leakage, the overflow was tremendous, and much water was wasted.

Catchments are not fenced off; they are often surrounded by many trees. Although the catchment areas are not well-delineated, they are far from the village and thus free from human or bovine interference. However, some catchments exist on private land. A publicly-owned catchment area would ensure free access to regularly-monitored water for the whole population.

Existing catchments are not enough to supply the whole village. However, building a single new catchment would require forty-five million CFA francs.

The Water Management Committee faces some difficulties with water distribution. First of all, the water pipes are not sized appropriately. The pipes near the catchment, at a higher altitude, are smaller. The pipes near the houses, at lower elevations, are larger. This disparity creates a lack of water pressure. The whole system needs to be revamped.

Secondly, there are some leakages and blockages due to broken pipes. Moreover, damaged head taps prevent water flow shutoff; this leads to more wasted water. Unfortunately, the WMC does not have enough money to replace all the damaged head taps.

One main water distribution problem is the fact that there is no storage tank: The catchment is directly linked with the stand taps. The WMC reasons that the topography is not conducive to the functioning of a storage tank between the catchment and houses, as the water pressure would be too low. Further, it is believed that a storage tank would cause stagnation, and poor water quality. However, the construction of a tank can help to regulate the flow of water to the village. The storage tank would allow the water flow to be rationed, avoiding shortages.

In addition to the three catchments, the village counts four boreholes.

Borehole

Water Management Committee

The Water Management Committee was created in the beginning of the 1980s. It consists of a chairman, a secretary, a financial secretary, a treasurer, and two members. These are all volunteers, publicly elected for five year terms. They decide on water management rules, such as, "If people do not pay a water levy for a private connection, they will be blocked from the water supply," or, "If the area around the tap is not cleaned, the tap will be blocked." The WMC directly supervises two caretakers; one is a professional, and the other is an apprentice. The WMC itself is supervised by the village development committee.

Because there is no water levy for private or public taps, the WMC faces a chronic lack of funds. People are used to paying when water is connected to their house; the price of a private connection is thirty thousand CFA francs. However, no one is charged for the ongoing use of private or public taps. At present, the Chairman of the WMC believes that people would not agree to pay separate levies for water. The public needs to be educated on the necessity of paying for water, just as they pay for electricity.

Although communities pay three hundred CFA francs per resident to the General Assembly of Development, these fees also pay for other services. Therefore, they are not sufficient to support building and maintaining the needed water infrastructure.

Insufficient revenue causes the WMC many difficulties. For example, the WMC does not have the wherewithal for building. It has inadequate means of transportation. It also lacks maintenance equipment. Finally, it cannot pay proper salaries to committee members. In particular, the unsatisfactory salary of the caretakers means that they are often unmotivated in their work.

The WMC's relationship with the traditional authority is good. The WMC has complete autonomy to buy some of the needed equipment to build and maintain water infrastructure. That said, the traditional authority must approve the WMC's decisions.

The traditional authority assists the WMC with any problems. The village development union performs annual audits of the WMC's work. During the General Assembly, a report on the WMC's work is presented publicly.

The transparency of the WMC has earned it the trust of the public; this is its greatest strength. However, the organization's ongoing financial difficulties sap its motivation and practical ability to perform its duties.

Consumers

Some quarters do not have water, so people need to walk for two kilometres to the nearest stand tap. Some pay other people to bring them water. Water is transported in closed containers. Those handling it are well-educated about good hygiene, such as handwashing.

Despite accessibility issues, consumers are globally satisfied with the quality of water. They say that they would pay for water treatments. They would also contribute more to help make water accessible to everyone. Today, they do not pay for regular water usage; they only give a periodic contribution at development meetings held by the council.

Recommendations

Regarding water catchments:

- A complete rehabilitation of catchments is needed. This will help avoid leakages, and will decrease wasted overflow. Regular maintenance of rehabilitated catchments will be necessary to avoid damage from tree roots.

- With sufficient funds, a new catchment could be constructed. Feasibility studies must be undertaken so that the new catchment is built correctly. These studies will help the WMC ascertain water flow during rainy and dry seasons, as well as other critical information.

- The entire distribution network must be revamped in order to generate adequate water pressure. If topography is taken into account, an adapted network could give water access to some quarters that are currently without water.

- The construction of a storage tank could help to ration water and to decrease shortages. Stopping the flow of unused water will allow communities to store sufficient water for times of drought. Regular cleaning of the storage tank can eliminate the issue of degraded water quality.

- The WMC can work with the Traditional Council to insure that catchment areas are situated on publicly-owned lands. Community ownership of catchments safeguards water quality and accessibility for all residents.

Concerning the WMC:

- The WMC must either educate the populace about the importance of paying water levies, or find alternative sources of funding. The WMC can collaborate with the Village Development Association, the Babessi Council, or the Traditional Council in its search for funding.

- The WMC must be educated about sustainable management.

- It must involve young people in its work, and represent the needs of women.

- The WMC must acquire effective means of transportation to support its infrastructure maintenance duties.

- It must budget sufficient funds to offer its caretakers satisfactory salaries, thus keeping them motivated to conscientiously carry out their maintenance duties.

20 October 2015 – BABA I

Interlocutor

Mr Tamfu Enusa Konnigongoh - Former interim mayor of Babessi Council - 675848719

Water catchments

There are more than forty thousand inhabitants in Baba I. The village has both lowlands and an upper, mountainous area. Five gravity-powered catchments supply the village. These spring catchments were built at different periods by various organizations (such as the World Bank and the Council). In 2011, when the last two catchments were built, complete feasibility studies were performed. Distribution maps were also issued at that time, but they were not updated when network extensions were done.

These spring catchments were initially treated with chlorine. Currently, the water is untreated. Moreover, irregular maintenance has allowed tree roots to grow and damage equipment. During dry seasons, water shortages are regular. The catchments need to be rehabilitated and modernized.

Current population growth has rendered these catchments inadequate. Extensions of catchments and tanks are needed. There are five storage tanks, but they are undersized. Also, new spring catchments could be created in three or four additional locations. This will vastly extend the network of pipes, making water more accessible to the community.

Most of the catchments in Baba I are not protected. However, the catchment areas are community-owned, which is a step forward in water management. To convince the previous owners to relinquish their lands, the traditional authority and the Water Management Committee offered them the first stand tap near their compound.

Water distribution in the village is uneven: In the mountainous region, water flows at taps; conversely, the flow is irregular in the village lowlands. Consequently, people in the lowlands do not have access to clean water. Instead, they collect rainwater or standing water, or use boreholes. Most of the time, the water is untreated.

Poor flow has created significant water pressure issues; some smaller-diameter pipes even burst upon installation. The irregular flow is mainly due to pipe damage from carelessness, route maintenance, animals, etc.

In light of all these degradations, pipe maintenance is not enough.

There are more than forty public stand taps in the whole village. In addition, there are a number of private connections, for which we do not have statistics.

As well as the aforementioned catchments, there are four main boreholes located near centers of village life, such as the market, council, and school. There are also smaller boreholes.

The contamination of wheels is sometimes an issue with the quality of water sourced from boreholes. Nonetheless, boreholes can bring water to places where pipes cannot reach, such as hilly areas. Therefore, it may still be important to encourage their construction.

Marshlands pose a special challenge to water access. These areas must be completely drained before boreholes can be installed. Due to their distance from the catchment areas, it is impossible to link them directly to catchments. Again, adequate water pressure is very important to insure the flow of water to these areas.

New projects are being discussed: Firstly, streams could be used as additional water sources. Naturally, the water from streams will require treatment to make it potable. Secondly, a comprehensive water project for the whole municipality of Babessi would pool the resources of the region to provide optimal water access and management for all villages. An essential part of this strategy would be to create a large catchment on Meneh Stream in Babungo, where the water quality is good. For this project, both the technical aspects of catchment implementation and the management system for the resultant infrastructure must be thoroughly studied. This project would require the involvement of the WMC, and the instauration of commune rules.

Carrying water between villages within the plateau may prove especially challenging. However, this challenge is not insurmountable; further research may yield solutions which have not yet been considered.

Water Management Committee

The Water Management Committee in Baba I is composed of approximately twenty people, each representing one of the twenty different quarters. The committee members are elected by the public. The WMC supervises water supply, monitors the network, and remediates damage to the infrastructure. It also considers new projects and improvements, such as pipe extensions, or the establishment of purification systems. The WMC is also in charge of collecting the water levy.

In 2011, when the WMC was established, it was able to effectively do its work. Initially, the committee members were well-trained, and well-equipped to perform their duties. Over time, however, various factors have caused the WMC to become less efficacious.

The WMC meets periodically. They give instruction to the caretaker. Since the caretaker is an unpaid volunteer, he may not have adequate time to devote to his water-management duties. Also, without compensation, he may be unmotivated to perform regular maintenance on the water management infrastructure and equipment.

In addition to the performance of the caretaker, the WMC faces another obstacle: The majority of the community does not pay their share of the water levy. The very few contributions received are too meager to support all the needed maintenance. Lack of adequate transportation and maintenance materials also stymies the WMC's efforts.

One of the main issues facing the WMC is the public's unwillingness to pay for the work required for the distribution of water. The populace refuses to provide compensation to the caretaker or the members of the WMC. This leaves the caretaker and the WMC with little motivation to conscientiously perform their duties. Again, if these agents are not paid, they may not be able to spare the time from their primary livelihoods to attend to the community's water management needs.

The WMC does not report directly to the public. Rather, the WMC reports directly to the Water and Energy delegate when he comes to Baba. Without a tangible connection to the WMC, the public perceives the WMC as irrelevant to their lives.
Along with the former mayor, the Council of Babessi advises the WMC. The Council briefs and supervises the WMC. Despite this association, political issues often prevent the WMC from carrying out its plans and duties effectively.

Logistically, water distribution presents very real technical problems. Politics compound them.

Recommendations

Regarding water catchments:

- The network and current catchments must be rehabilitated.
- To reduce disease, the public must learn how to treat water at home.
- Marshlands must be drained so that boreholes can be effectively implemented.
- New spring catchments should be developed.

Concerning the WMC:

- The WMC must find funding for the following critical needs: to pay the caretaker, to retain adequate means of transportation to cover their service area, and to undertake regular maintenance of the equipment and infrastructure within catchment areas.

- To ensure continuity in their actions, the WMC must become autonomous, free from political complications to their work.

- A new WMC should be elected. This new committee could be smaller, but it should still represent the entire population.

- Extensive studies must be done before the proposed comprehensive Babessi water project is undertaken. This project would merge the resources and responsibilities of the local WMCs.

21 October 2015 – BABESSI

Interlocutors

Mr Taboa Vincent Tumenta - Council officer sanitation - 675934822
Mr Che Anselm Suh - Council Development officer - 676412570 - 65511433

Water catchments

The village counts two spring sources for a population of nineteen thousand inhabitants. A stream joins these two springs, and the stream is served by two different catchments. However, only one catchment is currently functional. The Council of Babessi is seeking funding for rehabilitation.

Springs of water joined in a stream, with significant flow

First catchment: rehabilitation needed

The first catchment is not used because it needs rehabilitation. The first component of the catchment is a dam, with two different collection chambers. The collection chambers are full of mud, and it is impossible for water to flow into them.


The two different collection chambers of the first catchment

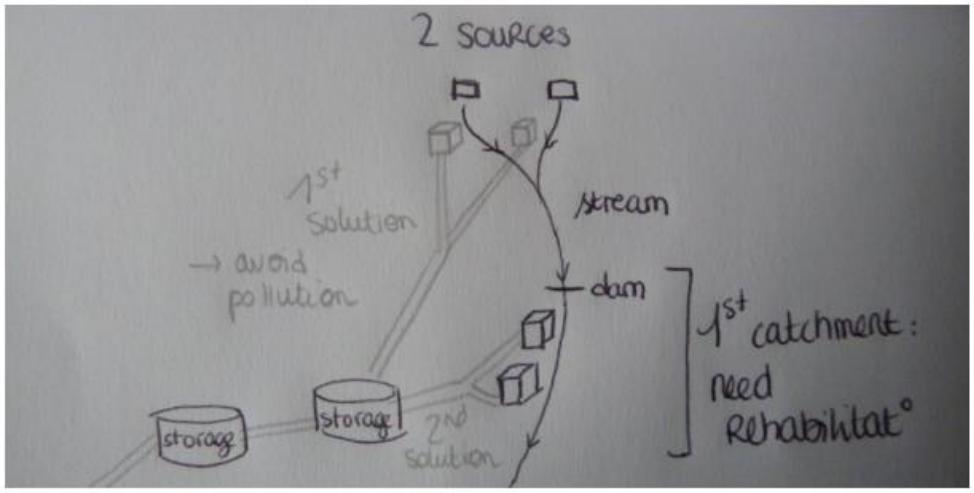
Moreover, pipes are broken, and also filled with mud. This catchment used to be linked with two storage tanks: one held 1400 litres, and the other held 6000 litres. They have not been used for about the past fifteen years: Stagnant water is present inside, roots have broken through the storage tanks, and the tanks themselves are quite dirty.


Unused storage tank and roots growing in the tank

Rapid rehabilitation of this catchment is necessary to reduce continued damage. Mud and heterogeneous particulate must somehow be removed from the collection chamber entrances.

This will be a low-cost rehabilitation. It requires mud removal from the collection chambers, pipe changes in the tanks, tank cleaning, and removal of tree roots to protect the tank structure. Finally, the catchment needs to be connected to the distribution chamber. Many of the facilities for doing so are already established. Pipes are the main materials needed for this project.

Another approach would be to bypass the dam entirely, relying only on tanks and completely rebuilt collection chambers near the spring source. At present, there is a significant distance between the springs and the collection chambers. This situation increases the likelihood of water pollution. If the collection chambers were nearer, pollution would decrease, and contamination with mud would be reduced. The storage tanks themselves can be reused without any modifications. Prior to undertaking the rehabilitation of this first catchment, a study must be done to compare the two solutions. The decisive factors will be differences of costs and of water quality.



Schema of the two rehabilitation solutions for the catchment (cubes are collection chambers)

Second catchment: in rehabilitation

The second catchment is in rehabilitation. It had been abandoned for two years. The collection chamber traps water from the stream.

Catchment and collection chamber

Water is sent to the treatment tank, which is composed of different chambers. The first one is used to accumulate water. The second one is a gravel filter, which removes large particles. Water is then sent to the third chamber (sand filter) to remove smaller particles. After filtering, the water is sent to the collection chamber, and then piped to the distribution tank. From the distribution tank, pipes carry the water to the village.

The treatment tank, shown during the rehabilitation work. In the upper right-hand corner, a photo of one of the individual chambers. Beneath that, an image of the removed mud from sedimentation chamber.

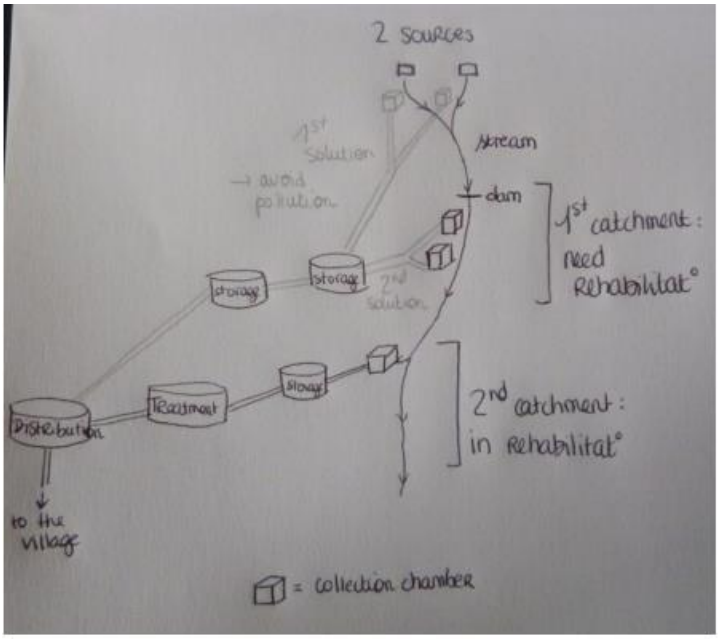
The main issue is that the piping system of the rehabilitated catchment is designed incorrectly, severely reducing water flow: 40mm pipe supplies the intake of the treatment tank, while the outtake pipe is 63mm in diametre. The intake pipe must be changed. The current configuration prevents the population from accessing water.

Even if these design flaws did not exist, the use of one unique catchment would not be enough to supply the whole community.

The distribution tank, which is supposed to supply the entire village with water, and its intake pipe

Proper pipe connection

There are few other problems: Due to the lack of a galvanisation tool, the connections between pipes were made incorrectly. (The picture to the left shows a proper pipe connection.) Another problem is that this catchment it is situated beside the highway. The vibrations from highway traffic, especially the transportation of heavy goods on the highway, directly affect the cover of the storage tank. The traffic vibrations can cause cracks in the storage tank cover. Over time, these vibrations can indirectly cause the tank to collapse.



General scheme of the two catchments and the two different solutions for rehabilitation

An iron sieve would allow water to pass through the water collection system, but would protect the catchment area from interlopers. Currently, people cross the catchment area to go to work in the field, and the catchment is accessible to cattle. This unsanitary exposure pollutes the water in the catchment.

The water itself is of poor quality, even after it has been filtered. A road built near the spring sources adulterates the water. Many cases of typhoid in the village are due to the unsanitary water. Chemical water treatment is needed to eliminate these impurities, to make the water safe for drinking.

Water Management Committee

One year ago, Babessi council decided to take over the existing WMC. Mostly due to a lack of motivation and training, the community was not able to manage the water infrastructure. Also, funding was lacking, making maintenance impossible. The caretaker had not been paid for sixteen months. His payment was five thousand CFA francs per month, which is a pittance. Now the caretaker has been employed by the council for one month.

When the Council took over for the WMC, the committee's duties had been completely abandoned. Currently, the Council is working on rehabilitation. The safety of the caretaker is a particular concern: He works in flip-flop sandals, and has not been not been outfitted with any needed safety accoutrements.

Involving the community in the creation of a new, well-trained WMC is crucial. However, the new WMC will need the financial means to continue the work of the Council.

Currently, no-one pays regular levies for water. As a result, the new WMC's revenues would be as severely restricted as those of its predecessor.

Recommendations

Regarding water catchments and distribution:

- The pipe between the collection chamber and the treatment tank of the second catchment must be changed without delay to a higher-diameter pipe. A modest length of pipe is needed to cover the distance between the collection chamber and the treatment tank; this will keep costs manageable. The higher-diameter pipe will greatly increase the flow of water. The remaining rehabilitation of the second catchment will then need to be finished.

- The studies pertaining to the rehabilitation of the first catchment must be undertaken as soon as possible. In the interim, roots should be removed from the unused storage tanks to help prevent their collapse.

- A strategy to avoid mud accumulation in both catchments must be determined and deployed. This strategy might use traps to filter out the mud. Regardless of which preventative measures are chosen, regular maintenance needs to be performed. Ideally, this maintenance will occur about every other day.

- The catchment area must be protected with trees and fences. Human beings or animals should not be able to get close to the catchment. Also, farming activities should be prohibited near the stream.

- Water-treatment feasibility studies must be undertaken. Currently, people are drinking rainwater or standing water. To avoid the spread of disease, is imperative that they learn home water treatment protocols.

Concerning the WMC:

- An election must be held to appoint all-new members to the WMC. The committee also needs to be completely restructured to address all the different concerns described under "General Recommendations" (near the end of this document). It is imperative that the community be involved in water management. The Council should only have temporary control over water management, until such time as the noted issues with the WMC can be remediated.

- The caretaker should outfitted properly for the performance of his duties. This will ensure his safety as he carries out the work of the WMC. At the very least, the caretaker must be supplied with appropriate footwear, such as boots.

- The WMC must acquire the means of transportation to perform regular maintenance.

- Additional funding should be procured to increase the compensation of the WMC. The caretaker in particular needs to receive additional recompense.

22 October 2015 – BANGOLAN

Interlocutors

Mr Ndimundoh John Chafan – Chairman of the Water Management Committee – 694673142 – 662313307 – 664171052 – ndimundoh@yahoo.com

Caretaker, members of WMC, and mayor of Bangolan – 655598443

Water Catchments

There are approximately fifteen thousand inhabitants in Bangolan. The community is supplied by two spring catchments. Thirty-six public stand taps and fifteen private connections are currently in use.

Water from the catchment initially passes through a scan water filter. The scan water kit purifies water by filtering it through a membrane that removes cysts and bacteria.

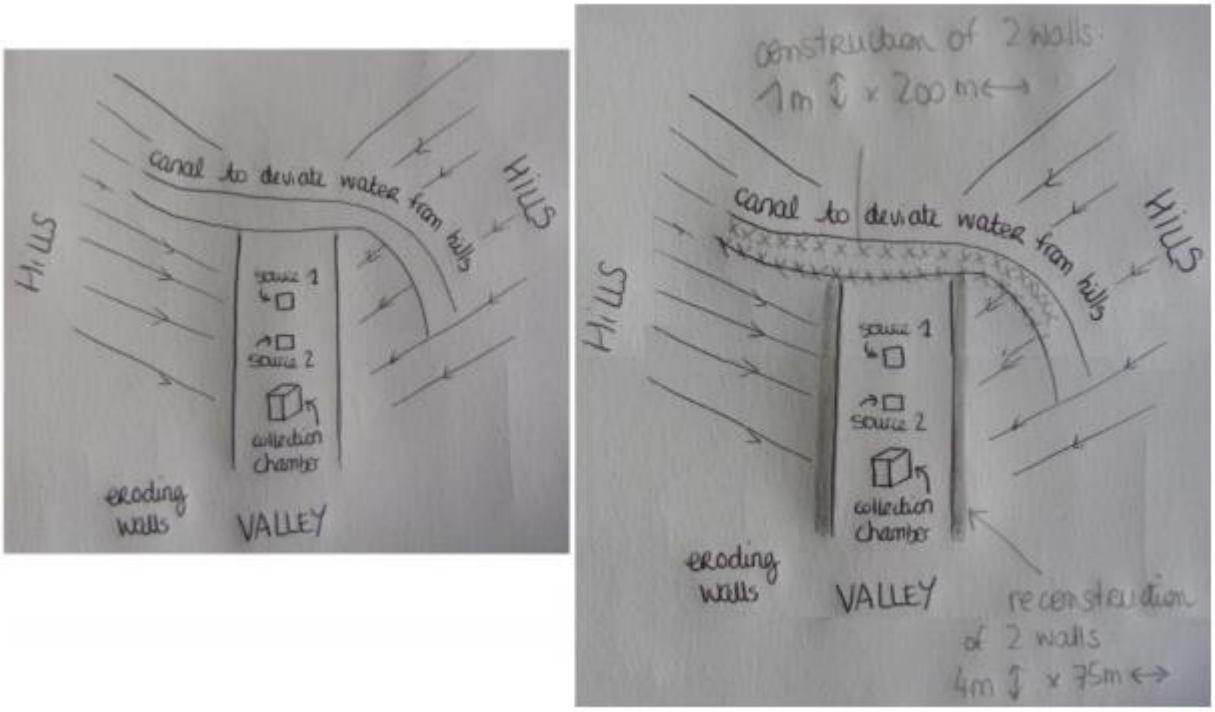
Originally, a generator was used to carry water from the catchments to consumers. The generator had enabled the community to have water, even during the dry season. However, this generator required an inordinate amount of fuel. It would have been too expensive to refurbish the generator. Therefore, it was replaced with a gravitational system.

The main catchment is composed of two different spring sources. These two sources gather in one collection chamber. From the collection chamber, water goes to the storage tank. Finally, it reaches the distribution chamber.

The sources of this catchment are situated in a valley. During the rainy season, mud, leaves, and other foreign objects are introduced into the catchment. Thus, particulate accumulates in the tanks. Technicians must perform regular cleanings of the tanks; but this is only a temporary solution. It does not eliminate the source of the pollution.

A canal was created to divert this polluted water from entering the catchment. However, erosion has rendered the canal walls ineffective. The tops of the walls are deteriorating. The lower part of the canal is laden with eroded soil.

The catchment itself is four metres below the surrounding land. Walls protecting the catchment in the valley are approximately seventy-five metres long on either side; but they are quickly collapsing, due to erosion.



Scheme of the current situation (left) and the proposed solution (right)

A feasibility study suggested building a concrete wall in order to divert the polluted rain water. Packing stones, aggregate, and concrete would be cemented together to form the wall.

In order to compensate for the low elevation of the catchment, relative to the surrounding land, the two protective walls will need to be rebuilt. These walls must be four metres high and seventy-five metres long.

To address the rapid erosion, two parallel walls could be built. These would be one metre high, and two hundred metres long. They would be separated by a gap of 1,2 metres.

There is another, smaller catchment. Stopcocks are needed to regulate the flow of water from this smaller catchment.

The catchments are protected by barbed-wire fences. However, termites are eating the wooden poles that stake the fences into the ground. This is destroying the structural integrity of the fences, and leaving the catchments vulnerable to contamination.

The tanks themselves are not protected. In fact, they are often opened by unauthorized personnel. This is very dangerous for two reasons: 1) The water can be deliberately polluted by a malicious person, and 2) someone could accidentally fall inside the tank.

Wayward students sometimes vandalize the tanks. People who need large quantities of water for industrial purposes (such as manufacturing bricks) have been known to take the water directly from the unprotected tanks. Locks are often installed to keep the tanks closed; however, these locks are subject to tampering. An authority must take immediate charge of this situation to resolve these issues.

Concerning water distribution, broken or blocked pipes are causing a lot of leakage. Although the quantity of water of the two catchments is sufficient for Bangolan, these leakages cause water shortages during the dry season. Pipes are damaged by people and by fire. They may also explode due to excessive water pressure. Pipe sealant cannot adequately repair this damage.

The excessive water pressure can be decreased in one of two ways: Either the village can use a single tank at any given time, while the others remain closed, or the existing pipes can be replaced with better-quality, higher-diameter pipes. Currently, the main network uses 110mm diameter PVC pipe. However, this pipe is difficult to acquire. For the distribution tank, 63mm PVC pipes are used.

The heads of stand taps become damaged by cumulative public use, creating wasted flow and causing water distribution problems. Cracks in the tanks cause both water leakage and infiltration. The damaged tank can be reinforced with a preparation of sand, Sikalite (a waterproofing admixture), and cement.

Private water connections are sometimes made without the permission of the WMC. Those who misappropriate the water in this way do not pay connection fees. Their machinations change the water flow for the whole village. Moreover, these unauthorized connections sometimes cause water waste. The chairman of the WMC often discovers these illicit connections, but the only sanction is blocking them. Those so sanctioned sometimes reopen their connection anyway.

One way to respond to water shortages is rationing water. Under this plan, one quarter in the village would have water on a given day; others would not have access for that day. The accessibility of water would rotate between quarters. Rationing in this manner would lessen the amount of wasted water. However, this plan is currently not feasible for these reasons:

- The current infrastructure only has two stopcocks, so it is not possible to give only one quarter at a time water access. To resolve this issue, the WMC needs to purchase and install additional stopcocks, as well as **T**-connectors.
- Closed water connections might be re-opened by those who disagree with the WMC's decision to ration the water.

The water quality in Bangolan is poor. Typhoid has spread significantly in this community, due both to contamination of water sources, and people drinking untreated rainwater and standing water.

Water Management Committee

Eight trained members make up the Bangolan WMC. The WMC supervises one caretaker. All members of the WMC are publicly-elected volunteers. Regular meetings of WMC are not scheduled; they only assemble for meetings in response to incidents and crises.

The current WMC was elected one year ago. Its members now need to be trained by the Council Development Officer.

The Bangolan WMC does not have enough funds for maintenance. Aside from the initial fee of twenty-five thousand CFA francs for a private connection, the public does not pay for water. Due to the chronic lack of funds, WMC members often subsidise needed supplies out of their own personal incomes. These supplies might include such items as new heads for stand taps, or pipe sealant.

The WMC's relationship with the Traditional Council is very positive. In fact, the Traditional Council chairman is also a member of the WMC.

The municipality Council has a good rapport with the WMC. The committee chairman often contacts the Council Mayor and Council Development Officer for assistance with various problems that arise. For example, the WMC worked with the Council to resolve the issue of pipe destruction incurred during road construction. The WMC keeps the Chairman of the Development Committee abreast of its activities by including him in all its correspondence.

Currently, the main threat to the Bangolan water infrastructure is the damage it sustains through public use. Sanctions are not in place to discourage carelessness or vandalism, nor to make reparations. We would advise the WMC to work with the Traditional Council and the Babessi council to impose financial sanctions, deterring public misuse of the water infrastructure.

The Bangolan WMC is strongly determined to carry out its mission, despite inadequate funding. Members agree to work without any compensation. As noted earlier, they use their own money to subsidise needed equipment and supplies. The Chairman has acknowledged these contributions in encouraging letters sent to each member of the WMC.

Recommendations

Regarding water management:

- A reliable method to purify rainwater and standing water must be implemented. Although there are more complicated plans for rehabilitating the existing water catchments, including the construction of walls to protect the water sources from pollution and contamination, these plans require more funding than is currently available. Rainwater purification would quickly produce potable water, albeit in smaller quantities than water sourced from the catchment. Further, rainwater purification could be performed at a reasonable cost to the WMC.

- The public must be educated on how to treat water at home. Home water treatment is a quick and effective tool to reduce disease.

- Storage tanks must be protected by the installation of valves from any threats to their integrity.

- Catchments must be protected with fences and locks from the polluting incursions of people and cattle.

- The procurement of stopcocks will allow the WMC to ration water in the event of shortages, especially during the dry season.

- Educating the public to pay the water levy is imperative to insuring adequate revenue for the maintenance, repair, and expansion of the water infrastructure.

Concerning the WMC:

- The WMC needs to work in cooperation with Babessi and Traditional Councils to enforce water use rules.

- The water rules must first be established through work sessions between the WMC and the Councils. Examples of such rules for the public might be, “Do not open any storage tanks,” “Do not open water access if it has been closed by the WMC,” and “Do not create private connections without the WMC’s permission.” The Councils and the WMC must cooperatively establish sanctions to be enforced in response to rule violations.

- These rules and sanctions would then be presented to the entire community during a General Assembly.

- Finally, the WMC, the CDO, and other involved bodies must continually remain vigilant for any violations of the established water rules, and impose sanctions whenever needed.

- It is imperative that the WMC procures funding for maintenance. If water levies are not collected, other sources of revenue must be found. The WMC might consider negotiating with the Babessi Council or Village Development Association for access to the needed funding.

How to make potable water at home

Even water that is potable at the catchment source can become contaminated before home use. There are many sources of impurities, microbiological as well as physical. Contamination can occur for several reasons:

- Storage in unclean tanks, or damaged pipes that allow contamination.
- Collection at the stand tap in unclosed containers.
- Transportation of water under unsanitary conditions.
- Improper storage at home.

Clean, safe, high-quality water is a major public health issue. Contaminated water can be a vector of many diseases. There are three main approaches to water treatment:

- Sedimentation screenings to remove particulate contamination (suspended solids larger than two microns).
- Filtration to remove dissolved solids (smaller than two microns).
- Disinfection to kill microorganisms, to improve the microbiological quality of water.

The choice of water treatment should be based upon the type(s) of contamination present.

Sometimes, more than one type of treatment will be needed. For example: Fresh stream water may require sedimentation screenings, followed by boiling to destroy the majority of pathogens.

All of these treatment methods are detailed in "Conservation et traitement de l'eau domicile" by Denis Désille, Programme Solidarité Eau (pS-Eau), December 2012. In addition, these water treatment methods are discussed in the "Baseline Survey - Santa Subdivision" report by Alexandra Clarà Saracho and Clàudia Ylla Arbós (July 2015).

Needed data for feasibility studies

Before new facilities are built, complete feasibility studies should be performed. Their size, location, and design must all be appropriate to their function. Current water infrastructure has been hindered by the incorrect implementation of structures and equipment.

Alexandra Clarà Saracho and Clàudia Ylla Arbós describe the needed data for the feasibility studies in their aforementioned report, "Baseline Survey - Santa Subdivision" (July 2015):

- Annual flow rate, to distinguish dry and rainy seasons.
- Topographical maps, to determine the correct plumbing design.
- Soil composition information.
- Projected population statistics for the coming years.

All of these pieces of information are crucial to the successful design of new catchments. These are the essential factors which minimize mistakes in catchment design. Based on these elements, proper catchment design will address minimal-to-nonexistent flow rates during the dry season, as well as the potential waste created by undersized pipes during the rainy season. Accurate topographical maps will inform plumbing specifications and distribution chamber design, thereby optimizing water distribution. Further, the critical information from the feasibility studies can be used to determine how to build the storage tanks correctly, to avoid leakages.

Advice on the organization of the WMCs

It is important to take the following into account:

- Women and youth should be represented in the WMC. They are both important segments of the population. Youth need to be involved in WMC activities early in their lives, to reinforce the importance of water stewardship throughout their lives.
- The WMC's mission to improve and sustainably maintain the water system must be undertaken in relationship with the following governing bodies:
    - Village Development Association.
    - Traditional Council.
    - Municipality Council.

  These governing bodies should work interdependently, providing each other financial support, as well mutually enforcing established rules.
- The WMC should be a transparent structure, engendering public trust.
- WMC members need to be trained in the following areas:

- Technical aspects of water management.
- Auditing and reporting water management data.
- Public relations pertaining to water management.

General recommendations for water management

❖ **Water forum**

A Water Forum will take place in November 2015. Representatives of each Water Management Committee will attend. Accomplishments and areas for improvement for each WMC will be assessed and discussed. Recommendations will be made for each WMC to improve their management techniques. The Forum will be an opportunity for the WMCs from different areas to interact and learn from each other.

Representatives of Babessi council will also be in attendance. We hope that the free exchange of information and ideas will improve the relationship between the WMCs and Babessi Council. The Forum should provide an opening for the WMCs to express their concerns to Babessi Council, and receive assistance from the Council in return.

❖ **Financial aspects**

In Babessi municipality, water is free for everyone. Only connection fees are collected to subsidise maintenance costs for the WMC. This is not enough. There are two possible solutions to this deficit:

- The public is convinced of the importance of paying a regular water levy for daily usage, or
- The municipality Council directly contributes funding to the WMCs. This funding could also be obtained from the Village Development Association, or from affluent residents.

It is impossible to maintain access to large quantities of good-quality water if there are no funds for maintenance.

❖ **Technical considerations**

The public in every village must be educated on home water treatment. The Babessi municipalities experience many water shortages, during both the dry and rainy seasons. Many cases of typhoid are the result of using contaminated rainwater or stagnant water. In Babungo and Bangolan, water must be rationed during the dry season to avoid severe shortages. In both areas, refurbishments are needed to achieve this goal: In Babungo, a storage tank is needed for times of drought. In Bangolan, stopcocks are needed to regulate water access so that only one quarter draws water from the catchment at a time.

Rehabilitation is needed. In Babungo, the entire plumbing system must be revamped to allow water to flow in the village. In Baba I, drainage problems in the lowlands must be counteracted with additional boreholes. Concerning Babessi, the currently dire situation can easily be improved by installing larger pipes between the collection chamber and the treatment tank of the main catchment. This refurbishment will increase the water flow. Moreover, all needed equipment is already in place for the rehabilitation of the other catchment. Therefore, this project will not be prohibitively expensive. Once completed, this rehabilitation will ensure sufficient quantities of water for the village.

New catchments will provide larger quantities of water to their respective villages. Borehole development is critical for drainage in the marshlands. In all villages, catchments and storage tanks must be protected from deliberate or accidental trespassing, and from tampering.

❖ **Management issues**

The WMC needs to be autonomous, even while working cooperatively with the different councils. It needs to be restructured in many villages of Babessi municipality, particularly in Baba I. The WMC in Babessi village is nonexistent. In Babungo and Bangolan, WMC members are motivated, but require training. Women and youth should be involved in water management issues.

The public must be supported by strong governmental bodies, which are visibly involved in village life. In Bangolan, for example, lack of a strong authoritative presence has encouraged the degradation of the water management infrastructure. Sanctions must be established and enforced to prevent further damage.

Conclusion

We would like to thank all the different Water Management Committees for their hospitality and patience. We hope that this document can be a springboard to launch new water management projects and practices, enabling the villages of Babessi municipality to enjoy better access to good quality water.

Sustainable water management is vital: Life cannot be sustained without water. Quite simply, water is life.

Bibliography

Désille, Denis. “Conservation et traitement de l'eau domicile”. *Programme Solidarité Eau (pS-Eau)* December 2012 <http://www.pseau.org/outils/ouvrages/ps_eau_conservation_et_traitement_de_l_eau_a_domicile_2013.pdf>.

Clarà Saracho, Alexandra and Ylla Arbós, Clàudia. “Baseline Survey - Santa Subdivision”. *Camaroon Association of Active Youths* July 2015 < https://drive.google.com/file/d/0B5fswq1_PYhhQ0VRaGpGcFdEUkU>.