IDDS 2014

WATER SCARCITY AND QUALITY

August 2014

Arusha, Tanzania

Index

Project abstract

The village of Makanya, located in the Same district, in Tanzania, is facing water scarcity and quality problems. The water available from the two main sources, forest water (Chome and Tae) and underground water, is not enough to supply the villagers, especially during the dry season (from July to September).
The team considered three possible solutions to approach this problem, which are: a wind water pump, a filtration system to purify water and a rain water harvesting system. Based on

its highest innovation and impact rate, a rain water harvesting system was designed focusing on affordability by using the materials available locally (sisal poles) to increase the access to water and the independency on the water distribution system.
During the construction of the prototype together with the community members, the team received a lot of positive feedback regarding the price and the level of innovation and creativity of the project. This rain water harvesting system, counting with a 5.000L water storage tank, can guarantee access to water for about 50 days during the dry season, when considering a family of 5 people, and costs around 450,000 TSh. However, some technical improvements have to be done to assure robustness and possibly lowering the price of the system.

Picture of water team

Context

Background

Makanya is a village which has water scarcity and quality issues. There is a water distribution committee consisting of local leaders who manage the current system but it is not working effectively and functionally at the moment. The amount of water coming from the two main forest sources, Chome and Tae, is not enough to supply all the villages in the surroundings and especially Makanya. The main pipeline connecting the villages presents kinks, leakages and direct connections for private use, which also reduces the amount of available water in the system.

The greatest amount of water (around 70%), however, comes from underground water tables, available for purchase at the village tanks. The water tables are very deep and, therefore, digging a borehole is very expensive. This water usually has a high level of salinity and acidity.

The record of water borne diseases at the local health center is around 5%. Most of the villagers boil the water for drinking and some treat it by using a tablet (Waterguard*).

Community Description

Located around the Same district, Makanya has about 10.000 people, where 50% are Muslims. The rainy season lasts for 9 months, from September to May, and the average precipitation rate is of 603mm per year. The majority of the population consists of farmers, whose life depends greatly on water for crops and livestock.

Some small groups living far from the village tanks have their own way of harvesting rain water by digging a well on the ground to store water.

Map (sketch model):

Picture 1: Sketch model of the villages that receive water from Tae and Chome, including Makanya.

Problem Framing Statement

Water accessibility in Makanya is very limited, especially during the dry season. The two main resources are forest water and underground water. The pipeline that brings water from the forest to the storage tanks in the villages has a lot of leakages and kinks, as well as improper control of the water distribution for villages and private properties.

Meanwhile, the underground water does not meet the demand of the village in time and the water itself may be salty and acid.

During the rainy season, the householders can harvest water through an affordable collection and storage system, which they can operate independently to assure availability of water during dry season. With a 5,000L tank, a family of 5 people can have water for 50 days and save about 12,500 Tsh.

Design Process

Value Proposition

The problem we are trying to solve is to increase the water accessibility in Makanya, especially during the dry season. After gathering conformational from the villagers, we found out that 20L of water from the village's tanks costs 50 Tsh and extra 50 Tsh for the transportation to the household since the waiting time in line for purchasing water ranges from 1-6 hours.

Each family consisting of five members consumes 100L of water per day in average. A farmer with a family of 6 people and around 70 animals use about 2,000L of water per day, including for agricultural purposes, while a brick marker consumes 600L of water per day.

Assuming they have a rainwater harvesting system with a 5,000L storage tank, a household can have water for 50 days at home, saving from 12,500Tsh to 25,000Tsh. Building and installing the system using local materials (sisal poles) costs about 410,000TSh. Therefore, the average payback time would be from 4.5 years to 2 year and 3 months.

Summary of design process

The design process, is a methodology to help develop a solution to a problem, reaching a result that is simple, cheap and has the highest potential of impacting people's lives. The process is not linear and happens repeatedly. It consists of three stages: gathering information and gaining insight, thinking of ideas and choosing the best approach and implementing and validating the solution).

Each one of these stages happens repeatedly in a series of phases. Three of them were approached during IDDS 2014, which were: framing the problem, creating a solution and developing a product.

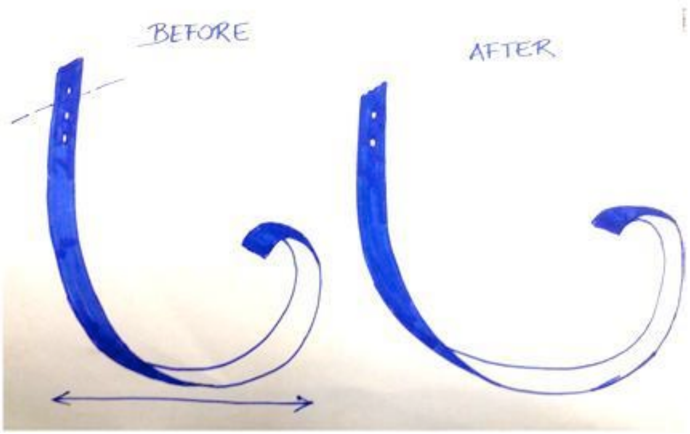
During information gathering phase, we performed interviews with our target persons in Makanya based on a questionnaire developed by the group. The team was divided into three smaller groups, each one containing a person who could perfectly translate the conversation to and from kiswahili. At the end of our first visit to the community, we realized the majority of people from Makanya had challenges with how easily they accessed water, but didn't face so much the problem of water quality.

We chose a solution based on the higher impact we could have on the village and tried to come up with the most innovative product.

Analysis and Experimentation

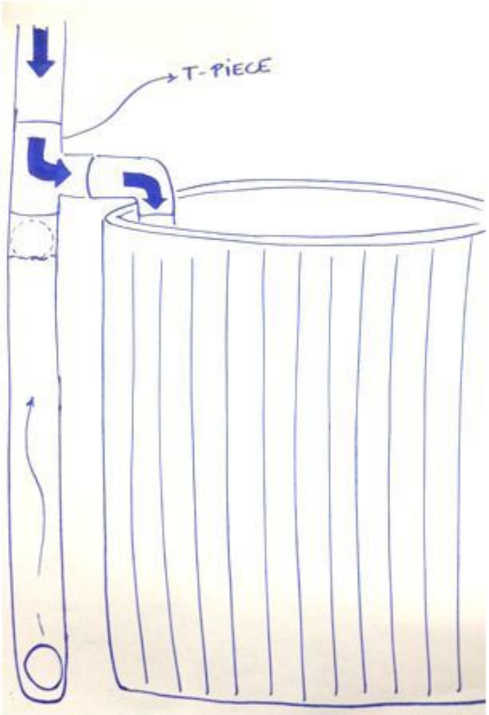
The experimentation occurred during the construction of the water tank, counting with the insights from the team members as well as from the community members involved in the construction.

Gutter and brackets: as the gutter and brackets were designed based on general concepts, they did not fit to the roof properly until we adjusted a few dimensions from the brackets and used some pieces of wood to support.



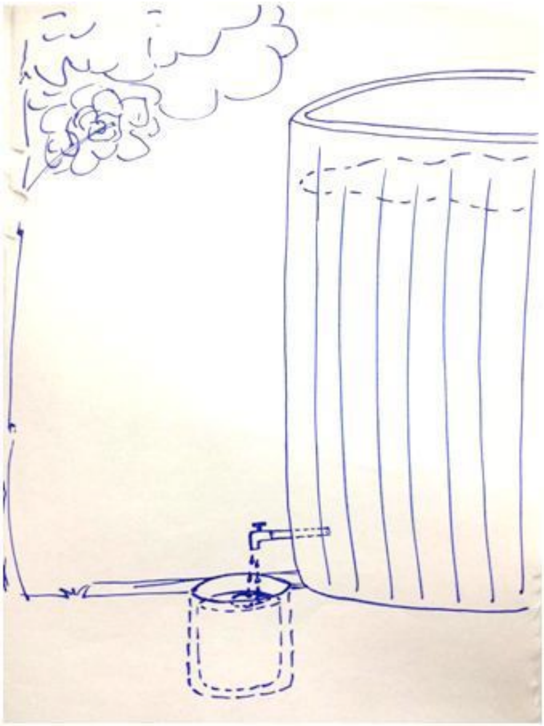
Picture 3: Differences on the design of the gutter.

Rejection pipe: a ball was supposed to be used as part of the flush diversion device and a drainage outlet for emptying standing water. But, later we thought the ball is not necessary because when the rejection pipe get filled with water, and more water is coming in, the clean water will automatically flow to the tank through the T piece and the dirty water will be flushed out later.



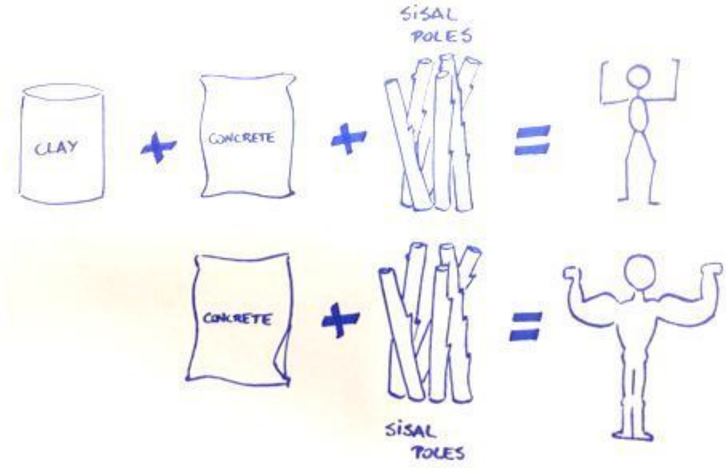
Picture 4: First water rejection mechanism.

Space for bucket: the tank was built under the ground, and the outlet was installed about 10 cm above the ground, so we had to dig a hole for the bucket collecting the water.



Picture 5: Scheme of the hole dug to fit the bucket.

Concrete and clay: the idea of using the concrete and the clay was to increase the strength of the tank, but later we found out that both materials did not match each other. So we decided to use only concrete.



Picture 6: Difference on the structure's strength using different materials.

Chicken wire: the chicken wire had to be used both inside and outside of the sisal poles to stick the concrete to the poles though we planned to use it only inside the tank.

Picture 7: Schematic view of the tank's structure using chicken wire.

Technology/Final Prototype

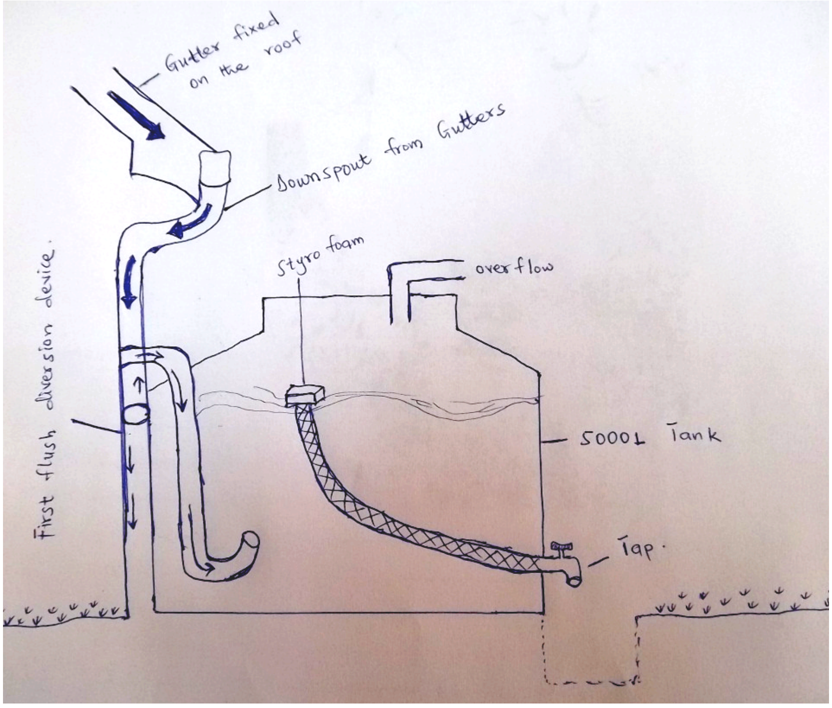
Design requirements

User need	What are you going to measure	How to measure it (units)	Good value	Better value
Affordability	Cost of materials	Shillings	< TSh 350,000	< TSh 250,000
	Cost of labor	Shillings	< TSh 35,000	0
Access to water	Size of the tank	Liters	5,000L	9,000L
Manufacturing	Time to build the tank	Days	7 days	4 days
	Complexity	Scale (easy 1 – 5 hard)	3	1
Safety	Type of materials	-	Cement	Cement and plastic liner
Durability	Age of the tank	Years	>5 years	>10 years

Table 1: Design requirements for the water project.

How it works

The rain water first enters the gutters fixed on the roof and drains down through the PVC pipes. Since the first rain water contains dirt, it runs down the pipe to accumulate at the base to create a step for the remaining rain water to run into the tank for the community members to fetch through the pipe. An outlet is made in the PVC pipe to release the first rejected water, containing dirt particles, for it to be used for other purposes (eg.: agriculture) after the rain falls.



Picture 8: Schematic view of the first design of the water tank, showing its different systems.

Performance

Because our prototype is a 5000L tank and we had just a short stay in Makanya, we were unable to complete the building of the tank because it required some portions of the cement to dry before moving to the next stage in the building process. With this unfortunate situation we intended to work with the community leaders when we are away to help us complete the prototype and report to us how effectively it works.

Bill of materials

Materials	Cost
Sisal poles	100 poles (TSh 30,000)
Cement	7 bags (TSh 109,500)
Water	20 buckets (TSh 2,000)
PVC pipe class B (gutter)	TSh 40,000
PVC pipe class A (down pipe)	TSh 13,000
Flat metal bars (hoops)	5 bars for TSh 5,000 each

Flat metal bars (brackets)	2 bars for TSh 5,000 each
Chicken wire	24mx1m (TSh 48,000)
Labor	2 workers for TSh 10,000 each
Nails	TSh 4,000
Bolts	TSh 5,000
Binding wire	TSh 9,000
Tap	TSh 8,500
Elbows for the pipes	4 pieces (TSh 12,000)
T-piece	TSh 2,500

Table 2: Cost of materials and labor.

Tools	**Cost**
Spirit level	TSh 7,000
Hammer	TSh 7,000
Hoe	TSh 6,000
Mattock	TSh 10,000
Hand trowel	5 pieces (TSh) 21,000)
Spade	1 piece (TSh 6,000)
Smoothing plate	3 pieces (TSh 15,500)
***Total* = TSh 411,000**	

Table 3: Cost of tools and total cost.

Self-assess using four lenses

- Financial:

The rain water harvesting system we built is very affordable because it is composed of local and cheap materials such as sisal poles, sand and chicken wire, which the community members find at their disposal. The system can be constructed cheaper by using clay instead of cement, reducing the number of hoops used on the tank structure and the size of the brackets, designing them on demand to fit a specific building's roof.

- Technical:

Our prototype is similar to what most people often build in their homes worldwide but has some distinctive feature that makes it superior among them. The 5000L tank we built was made of local materials with an additional technology of separating dirt particles from entering into the tank (first flush diversion device). This accumulated silt is removed from an opening before the next rain and this water can be used for other purposes, such as agriculture.

- Social and cultural:

Our harvesting system was developed to improve upon the rain harvesting system that already existed in some homes in Makanya with the technology of separating dirt particles that comes with the first rain and to encourage the community members to adequately utilize the resources that they find at their disposal, helping them to solve their water scarcity and quality problems.

- Environmental sustainability:

We used local materials to build the system to avoid any transportation which can lead to the pollution of the environment and also conserving the rain water that goes to waste whenever it rains in Makanya. With the abundance of clay also in Makanya, the community can effectively re-use it in the building of the tank in the replacement of cement, which takes a lot time, energy and water to prepare.

Lessons learned

Community engagement:

The main objective of IDDS is to assist the local communities to be creative designers through innovation using local available resources.

Our water project team consisted of six participants. At the initial point of our idea generation, we had three different ideas to develop:

- Wind water pump to facilitate the distribution of water to Makanya, increasing the pressure between the tank and the village;
- Water purification system to treat and reduce the salinity of underground water;
- Build a storage tank made out of sisal poles and other available local materials to collect water during the rainy season to be used especially during the dry season.

We arrived in Makanya on the 14th July, 2014 and we had an introductory meeting with the Ward Executive Officer. We were able to engage the community in exchange of ideas and views regarding the problem of scarcity of water in Makanya and the whole distribution system of water in Makanya from the source (thus from the mountains) to the villages. We were able to understand the major challenges facing water scarcity in Makanya.

Our major observation was that the indigenous groups in Makanya use underground water (borehole water) as a major source of water. And for the water that flows directly from the source (Chome and Tae) the villagers need to pay TSh 50 per 20L-container.

After gathering information from the community and evaluating the feasibility and impact of each one of the ideas above, we concluded that the main issue in the village was water scarcity rather than water quality and that the best way to offer that was to offer a solution that would guarantee the villagers independency on the current distribution system.

User feedback

During our second visit on the 25th of July, 2014, the water team was successful in getting the user feedback. Due to the lack of infrastructure in Makanya, we tried to engage the local community to assist us during the construction time of the tank.

The user feedback was really good. The villagers were excited about our idea and thought this was a very useful and affordable solution. Some of them also showed interest in building their own systems at home. Nevertheless, the community requested more information on how to build their own tanks and wish they could have followed the construction steps from the beginning.

Troubleshooting

As commented above, the prototype of the rain water harvesting system was not able to be fully completed and, therefore, tested by the community. The feedback we received during the construction of the tank, such as the design of the gutters, the difficulty of mixing clay with cement and the necessity to use chicken wire on the tank's structure, led to immediate troubleshooting actions.

Further improvements on the product can certainly be made after the conclusion of the prototype project and usability evaluation by the villagers. We are in contact with the community to guarantee that this information will reach the team as soon as possible.

Next steps/Project future

Reflection on project viability and other design opportunities

Overall, our rainwater harvesting system design was considered very creative and the villagers showed interest on building their own system at home though a few parts of the system still have to be improved especially regarding technical issues such as the size of gutter, the design of the brackets and the difficulty of mixing clay with cement. Several other designs of the tank focusing on water quality, speed of water flow (pump) and using other materials like clay and plastic liner instead of the concrete are an option that should be considered for the next projects.

Continuity/dissemination model

We are going to cooperate and work closely with the head of water distribution in Makanya and Kasapo to finish up building the whole system and evaluate the impact of our prototype. If there is a market, we will evaluate the possibility of setting up a company not only providing the service for maintaining and consulting on how to build the system properly and functionally, but we also work on the other designs mentioning earlier assuring that our product is more affordable, usable and sustainable.

6-month plan and team engagement (roles and responsibilities):

We ideally planned to get in touch through emails after the summit to discuss our way forward, generate new ideas on how to improve our built prototype as well as discussing individual roles in our home countries. We planned to most importantly work hand in hand with Obote Kiboko who is the head of the water committee in Makanya and our facilitator Jim Elsworth to constantly update the team on the progress of our set target in the next months on their visit to the community.

Activities we intend to undertake in the next six months include:

1. Gather more information about current practice in the village to enquire on the simple ways they harvest their water and the cost of building the system they are currently using.

2. Complete the tank we ¾ built and test and design some adjustable gutter brackets, with which we were facing problems when building our tank.

3. Discuss more with Echo about their hafir water storage system, which the team saw when they visited their office.

4. Research on how sustainably clay can be used when building the tank to ease the problem of affordability.

Anticipated risks and challenges

Our system can be challenged as sisal poles can become weak over time and would probably need replacement. Some of the failure modes of the tank can include cracks on the tank that could lead to leakages, the risk of the tank collapsing or leaning due to the growth of the tree's roots... etc.

Depending on the intensity of the rain, the water weight inside of the gutter could eventually be too much, causing the brackets to break.

Stakeholders

The main stakeholders considered in the project were the community members (from Makanya and from the other villages in the surroundings), among which are householders, farmers and bricks makers, which would have interest on having quality water available during the entire year.

Other groups to be taken in account are the local health center, the water traders responsible for transporting water to the villagers, the sisal industry responsible for the sisal plantations in Makanya, the water committee responsible for water transportation in the region and local schools.

Lean business canvas

<table>
<tr>
<td rowspan="2">Problem: Difficulty in accessing quality water in the village of Makanya, especially during the dry season.</td>
<td>Solution: Rain water harvesting system using local materials and capacity for about one and a half months of water supply.</td>
<td rowspan="2">State your value: Affordable tailor made RWH systems built with local materials.</td>
<td>Competitive advantage: Low cost of the system.</td>
<td rowspan="2">User and customer profile: Householders in the village of Makanya.</td>
</tr>
<tr>
<td>Important metrics: Product quality, market feedback and company’s financial health.</td>
<td>Distribution channels: Door to door sales (sales representative).</td>
</tr>
<tr>
<td colspan="3">Costs: Salaries, tools and materials, transportation, office fixed costs.</td>
<td colspan="2">Revenue: RWH systems sales, sponsorship.</td>
</tr>
</table>

Picture 9: Business model canvas draft of the water project.

Contact information/List

Community partners

Mtindaji (Ward executive officer) Phone +255 (0) 715 284 330

Members who left their phone numbers (all with prefix of +255 outside Tanzania or 0 inside.)

Hassan Rajab: 716 090 803 or 786 467 499
Miraj Mgonja: 712 244 736
Said Islam: 712 818 101
Elias Mshana: 653 817 003
Abdallah Kanyoro: 787 214 141

Team members

Carlo Larozar

Born in Haiti and graduated in Business and Administration, Carlo Larozar works as the manager of SMDT Orphanage in his home country.

Juliana Lopes Sauaia

Born in São Paulo, Brazil, Juliana Sauaia studied Engineering Physics in the Federal University of São Carlos. My professional experiences include internships at Bosch and Johnson & Johnson and a trainee program at Volkswagen, having lived in Germany for more than one year in total. She recently completed an International Certification in Social Business at the Yunus Social Business Center at ESPM and was working as a Quality Engineer for Volkswagen and as a volunteer mathematics teacher at Crea+, a Brazilian NGO. After leaving the corporate world to try to pursue a more social-driven career, the next challenge ahead of her is completing a round the world trip, passing through the five continents.

Muhidin Amas

Muhidin Amas, born in 1969 at Msungua Sepuka, Singida district, Tanzania, started primary school in 1990 and completed primary school in 1986. After that, he joined the Nangwa Vocation training center 1989 at Nangua for four years. He has knowledge and skills and was awarded grade one certificate of Auto Electric. Muhidin also has experience in the field of auto electric in motor vehicles, motor vehicle mechanics, welding and fabrication and like to design car body, building and other activities. He’s married with three kids. From 1995, he was employed at NGO known as SEMA Vic (Sustainable Environment Management Action). He works at SEMA Vic as a teacher of Auto Electric and Technician from level one to level three theory and practical.

Muyngim Eng

Muyngim Eng is born in Cambodia and graduated in Pharmacy from the University of Health Sciences in 2014. She was youth ambassador against cancer at Calmette hospital, tutor, coordinator of first aid team for Phnom Penh International Half Marathon, provincial missions under the topic of health improvement, performed training at the pharmacies, lab, and medicine factory.

Obote Kiboko

Member of the village of Kasapo, Makanya Ward, Obote Kiboko works as a farmer in his hometown and is the Secretary of the Water Committee in Makanya.

Yabani Samuel Kwame

Yabani Samuel Kwame is currently pursuing BA of Economics in Kwame Nkrumah University of Science and Technology in Ghana as his first degree and is currently a registered student and a member of the Association of Certified Chartered Economics, hoping to complete this professional course in three years. He stays in Accra the capital city of Ghana, West Africa. He speaks English as it is the official language in Ghana. He also speaks three other local languages like Ga, Ewe and Twi. He is a volunteer with the Yonso project a Non-Governmental Organization in Kumasi, Ghana, which was primarily instituted to help the needy in the community of Yonso and its surroundings with scholarships, libraries, microfinance and training of indigenous women in the community on how to start a trade.