End of Year Report on:

Project Tatirano (Phase 1): Improving access to clean drinking water via rainwater harvesting in Sainte Luce, Anosy Region, southeast Madagascar

Final Report

November 2016

SEED Madagascar

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1. Summary

Objective: To construct, pilot and evaluate a rainwater harvesting (RWH) system that provides clean drinking water for school children, whilst demonstrating an effective and affordable alternative source of clean water for the community.

Location: Ambandrika Primary School, Sainte Luce, Anosy Region, SE Madagascar

Project Duration: 12 months

Executive Summary: In Madagascar only 35% of the rural population has access to an improved water source[1] (WHO/UNICEF, 2015), helping to explain its status as the world's fifth poorest country (World Bank, 2015). High instances of diarrhoeal disease, malabsorption within already limited diets and increased morbidity rates lead to missed work days and increased school absence. With low levels of immunity to dangerous pathogens, children are particularly vulnerable to contaminated water. Combined with inadequate sanitation, this contributes to the deaths of over 2,000 Malagasy children each year from diarrhoeal disease (WaterAid, 2016). The impoverished rural community of Sainte Luce in the south-east of the country is no exception.

Whilst rainwater has been collected for millennia across the globe and rainfall in the south-eastern Anosy Region of Madagascar is relatively high, RWH is not widely practiced. A simple technique that can provide high volumes of clean water, RWH has the potential to have a great impact on the lives of some of the world's most vulnerable people. Apart from its substantial health benefits, when RWH is practiced at the household level the technique eliminates the opportunity costs associated with water collection, allowing more time for educational, economic and entrepreneurial activities.

Responding to both need and opportunity, Project Tatirano has mobilised the Sainte Luce community to become a champion of RWH by installing a RWH system at Ambandrika Primary School. By establishing and building the capacity of the community-elected Tatirano Management Committee (TMC), Tatirano has both ensured the sustainability of the school's system and taken the first steps towards Sainte Luce becoming a regional exemplar of RWH.

Ambandrika School's rusting roof has been replaced and a fully functioning RWH system has been installed. The school's 144 children now have access to clean water from the RWH system and incidences of diarrhoea have already decreased by 5%. Education sessions have been highly successful with 70% of children drinking water from the RWH system exclusively. Given that the count of disease-causing faecal coliforms is 44/100 ml lower in the RWH tanks than the commonly used school well, further positive health implications for the children are expected. Additionally, benefits of the system are being felt across the wider community, with the TMC promoting RWH and providing access to the system for the 750 residents of Ambandrika every week.

[1] JMP defines an improved drinking water source as one that is protected from external contamination, specifically from contamination by faecal matter (WHO/UNICEF, 2016)

2. Activity Detail

1. Memorandum of Understanding (MOU)

A Memorandum of Understanding (MOU) signed in January 2016 outlined the terms and understanding between Tatirano's nine partners in collaboratively undertaking and overseeing the project. Ministries also signed the MOU lending gravitas to the project and further encouraging key individuals to remain committed to their responsibilities. As per SEED's agreement, copies of this report have been produced in both French and English for dissemination amongst partners such as the Ministries of WASH and Education, interested NGOs and networks in order to maximise the reach and use of project learnings.

Left: *The President of the TMC signs the MOU.* ***Right:*** *The TMC with SEED and ONG Azafady representatives.*

2. Tatirano Management Committee

The community-elected TMC consists of 15 individuals from the three hamlets that make up Sainte Luce: Ambandrika, Ampanasatomboky and Manafiafy. Members include hamlet and *fokontany* (cluster of hamlets) Chiefs, multiple Presidents of Women's Associations, Opinion Leaders[2] and teachers. Over the year attendance was high; with an average of over 70% across the 15 formal meetings. SEED has worked with the TMC for almost a year, and given SEED's ongoing presence and operations in Sainte Luce, it will continue to provide support and advice to the TMC in line with emerging needs.

A series of three seminars were delivered to the TMC focusing on WASH, health implications of drinking clean and contaminated water, and best practice management and maintenance of the system. Of particular note was an activity inspired by the Community Led Total Sanitation (CLTS) methodology, which prescribes inciting shock and shame in participants to realise that poor sanitation practices – such as open defecation – can lead to consuming water contaminated with faeces, resulting in illness and disease. During the triggering, observations indicated that

[2] An Opinion Leader is a man or woman in the community that is greatly respected and heeded, similar in standing and reputation as a more commonly known *village elder.*

participants understood that the water sources they regularly used were contaminated. This activity was reinforced by the presentation of the water testing results (see *4. Water Testing* for more information).

Monitoring and evaluation (M&E) visits after system installation discovered that cleaning was not being carried out as scheduled, even following theoretical and practical sessions on best practice management and maintenance. The first flush downpipe's slow release valve can quickly become blocked and if it is not checked and cleaned, the dirt accumulating on the roof and in the gutters is more likely to flow into the tanks and compromise the water quality. In order to overcome this, refresher training was held, leading to the establishment of a Water Safety Plan (WSP). This itemised physical components in the system and all associated risks, and lastly assigning maintenance responsibilities to pairs and individuals. The continued presence of SEED operating in the area will allow for ongoing M&E to ensure that responsibilities are being carried out properly, and address any issues as and when they arise.

Left: *ONG Azafady's Head of Construction and SEED's Project Manager discuss the WSP with the TMC.*
Right: *"Tafo" means roof in the Malagasy language and was one of four main components in the WSP.*

Whilst individual responsibilities for maintenance activities have been assigned and the regularity and frequency of these activities being conducted has increased, ongoing M&E will ensure this trend continues.

To mark the handover of responsibility from SEED to the TMC, an Official Opening Ceremony was organised at the school that saw the attendance of over 500 people from the Sainte Luce community and over 30 dignitaries and local stakeholders. During the event, speeches were made by the Chief of Sainte Luce, the Project Manager, the Head of Construction, the President of the TMC, the Chief of Education for the Mahatalaky Commune, the school's Headmistress and the main Opinion Leader for Sainte Luce. Speeches spoke very positively of the project and RWH in general, as community leaders emphasised the great potential RWH has to impact on the lives of people in Sainte Luce and beyond.

Left: *One of ONG Azafady's Community Liaison Officers delivers a CLTS triggering to the children in front of 500 on-lookers.* ***Right:*** *Members of the TMC fill water bottles for the school children.*

At the end of the speeches, a second CLTS-inspired triggering was carried out by a trained Community Liaison Officer from ONG Azafady. The demonstration highlighted the importance of washing hands with soap before eating and after using the toilet to avoid spreading disease-causing bacteria. Whilst this is not directly related to drinking clean water, it represents the holistic approach with which the project has tried to address WASH issues at the school and in the community.

The final section of the Opening Ceremony saw clear plastic bottles distributed to each of the 144 school children which were then filled at the tanks by the TMC members. The children now have an easily accessible vessel for clean water both in class and at home; the clear plastic accentuates the difference between water from the rain and the well.

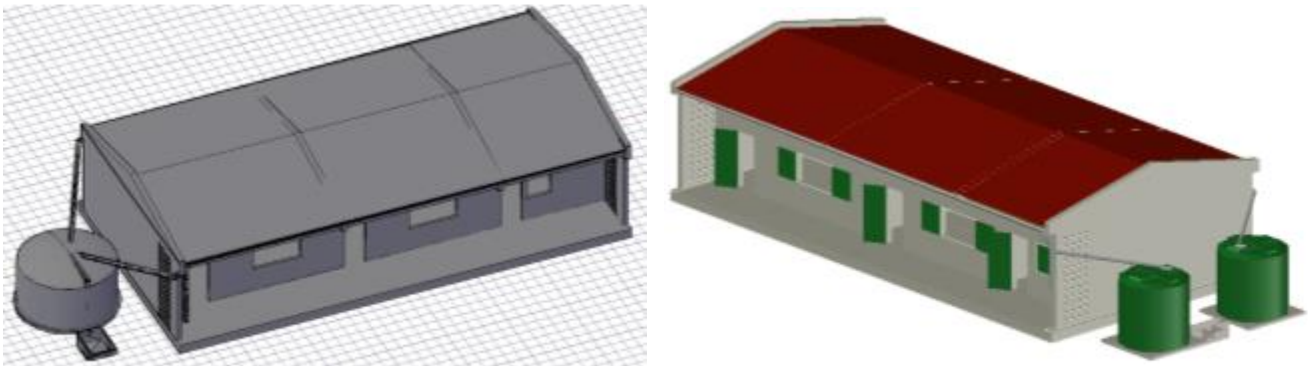
3. The RWH System

3.1 Design Evolution

The initial design for the school RWH system envisioned a *ferrocement* (type of reinforced concrete) tank based on Gould and Nissen-Petersen's *"Rainwater Catchment Systems for Domestic Supply"* (Gould & Nissen-Petersen, 1999). After consultation with Erik Nissen-Petersen, a world expert in RWH, it was initially decided that a more common reinforced concrete tank, called *concrete-in-situ*, would be more suitable given the relative inexperience with *ferrocement* in the Anosy Region of Madagascar. Upon further research and considering future replication across the region, it was decided to keep the system as simple as possible so that people with few or no skills in masonry and/or construction could replicate the school system. Given the wide availability and affordability of smaller, 250 L plastic containers, plastic tanks, that were intuitively replicable, were chosen.

3.2 Design Considerations

The primary design considerations were to ensure a long system lifespan, reduce maintenance requirements and risks of component failure, and have the potential to inspire replication at the household level. Procurement of the tanks was challenging due to the limited choice available in Madagascar, especially given the delicate balance between low cost, high quality and large capacity. The cost of obtaining two 10,000 L tanks with quality assurance from a manufacturer in South Africa – JoJo – was similar to the cost of a singular 10,000 L tank from Madagascar. *Further design considerations can be found in Annex A.*



Left: *The initial school RWH design with one tank made of ferrocement.* ***Right:*** *The final design as seen at the school today (without roof and fence around the tanks).*

3.3 Construction Stages

The first construction stage saw the replacement of the rusting corrugated metal roof with a factory galvanised alternative, sourced from the nearby town. Although the old metal roof was not in good enough condition for the collection of clean drinking water, it was in an acceptable condition to be sold; the proceeds of which were agreed to be held by the treasurer for any future maintenance costs on the system.

The installation of the gutters was challenging not only because the building is uneven and undulating, but primarily because conveying water efficiently along 18 m of roof to collect at one end required a significant height drop from the roof. This potentially increased the risk of heavy rainfall overshooting the gutters and increasing water loss. In addition, the penetration of the concrete walls to install the first flush downpipe brackets was difficult without the use of electric tools. Strong brackets were essential as they needed to support an extra 20 kg load when the first flush is full with water. Both of these challenges were overcome by a high level of workmanship from the construction team and repetitive testing with well water in the system.

The foundations were made from granite blocks cut from the earth locally, a high aggregate-cement concrete mix and crossed rebar (see below). These foundations were prepared before the arrival of the tanks so that the system could collect water as soon as the tanks were installed. Once the installation was complete, the TMC met to carry out a deep clean of the roof, gutters and tanks, using water from the well and a strong chlorine solution. All cleaning henceforth uses rainwater from the tanks themselves and timetabled cleaning of the two tanks ensures one tank is always operational and can provide water for the school children.

Clockwise from top left: *Replacement of the rusting roof; Tafa, a skilled construction worker, finishes the first tank foundation; the soakaway pit is concreted; and, the gutter brackets are installed with precision and care.*

The penultimate construction stage focused on repainting the school, transforming what was once dirty and damp into a vibrant learning environment. The painting of the school was completed in time for the new school year and was intended to inspire pride in the school and system alike. This in turn, aims to increase motivation for the TMC to maintain the system and for the children to hold RWH with high regard, increasing the potential for future replication of the system.

M&E later revealed how direct sunlight was causing the gutter brackets to soften and the gutters to become loose from their fixed position. This was overcome by tying nylon wire between the gutter brackets and the facia board. A second issue with direct sunlight was the high temperature that the tanks were subject to, potentially reducing the lifespan of the plastic. A simple corrugated roof and fence were erected around the tanks and wider system to protect the plastic during the hottest time of the day and preventing damage to the exposed first flush systems.

Clockwise from top left: *The school and latrines before system installation and renovation; the school after system installation; the painted school and system; the completed system with roof and fence around the tanks.*

4. Water Testing

Comprehensive biological testing was completed on the four water sources in Ambandrika: the river water at the bridge, the school well in the village and the well and RWH system at SEED's camp on the outskirts of Ambandrika. The SEED RWH system was of significant interest because of the direct correlation with the project. The school well and the river water at the bridge are the only sources currently available to the community. Small streams far into the forest are also sometimes used despite taking hours to reach by foot; these were not tested but may be included in future analyses of water access and quality in Sainte Luce.

Biological testing of water is a key proxy indicator for the health implications of using a particular water source and avoids potential for bias in self-reported data by quantifying the quality of the water. Using a field incubator, filtration apparatus and Membrane Lauryl Sulphate Broth (MLSB) heated for 18 hours at 44^{o}C, it is possible to count thermotolerant coliforms that indicate the presence of disease-causing faecal bacteria.

Table 1: Thermotolerant (faecal) coliform counts for water sources available in Ambandrika.

Source	Coliform count (/100 ml)	Comments
River water at the bridge	96	Completely open and used by livestock, people washing their laundry and themselves.
School well	51	Water pumped into a concrete container, open to the air, allowing animals and dirt to contaminate the water.
Camp well	46	Closed top but presents an example of where open defecation in Ambandrika village seeps into the ground water.
Camp RWH	29	Poor design because the tank is not completely closed and zero maintenance over a prolonged period.
Tatirano	7	In rural water supply it is unrealistic to record zero coliforms, but the dramatic reduction in comparison with other sources is important for positive health implications.

The World Health Organisation (WHO) *"Guidelines for drinking water quality"* (2011) states that coliform bacteria must not be detectable in any 100 ml sample of water directly intended for drinking. Nevertheless, such standards are impossible to achieve unless water is chlorinated or abstracted at untouched mountain springs. While it is expected that coliforms will be present in all untreated water, the reduction of coliform count is the most important indicator of clean water provision (Morgan, 2016). The significant reduction of 44/100 ml in faecal coliform count in comparison to the most popular alternative, the school well, represents great potential for a dramatic improvement in health across Ambandrika.

5. Education with school children

Two classes have been delivered to children in the village: the first was delivered during the school term to 100 school children and the second was taught to 36 children out of school at a conservation club run by SEED's Conservation Programme. Both classes followed similar lesson plans, covering WASH best practices, the importance of clean water consumption and RWH as an effective and simple technique for obtaining clean water. The children were receptive in both classes and WASH classes designed by SEED that cover practices such as handwashing, latrine use and latrine management, have been shared with the teachers and headmistress at the school for inclusion in the curriculum to continue this learning.

Left: *Students eagerly answer questions about water from Lomba (Head of Construction).* ***Right:*** *Harry (Project Manager) takes the children for a tour of the RWH system.*

6. Latrine repair

The Ambandrika primary school latrines were not used early in the year due to the rusted and leaking roof and the absence of doors. Project Tatirano collaborated with another SEED project, Project Mitsinjo, to repair the latrines to a functional level. The combination of WASH classes, improved sanitation facilities and clean drinking water will have a significant impact on children's health.

Left: *School latrines pre-repair work.* ***Right:*** *Post-repair work.*

7. New Pre-School

Whilst most of the old roofing sheets were sold for a maintenance contingency budget, the TMC set aside a number for the school to build a pre-school in the school yard. Whilst the construction was not carried out or supported by Project Tatirano directly, the project's activities have made the construction of the pre-school possible.

The beginning of the pre-school construction in the school yard.

3. Results

1. Outcomes

- 144 primary school children aged between 3 and 14 have access to an unlimited supply of clean drinking water.
- 100% of the students use their bottles to collect the water in the tanks.
- Average of one bottle (half litre) each consumed by the children each day.
- Dramatic decline since November 2015 from 50% to 0% of children drinking from the river.
- Almost 70% of children reported only drinking from the Tatirano tanks whilst the remaining 30% sometimes drink from the school well when at home.
- 750 people from the community access the water in the tanks once a week – often collecting enough water to sustain family drinking needs for the entire week.
- 100% of interviewed households using Tatirano water recorded a satisfaction rating of 5/5 for water quality.
- An average of over 3,000 litres collected at every distribution to the community.

2. Outputs

- A long-lasting and effective 20,000 litre RWH system installed on Ambandrika Primary School roof.
- Protective fence and roof, around the tanks and first flush downpipes ensure longevity.
- 7/100 ml thermotolerant coliform count detected in the Tatirano RWH water.
- 44/100 ml reduction in comparison to the popular alternative source at the school well.
- 144 clear, Tatirano branded, half litre water bottles distributed to the school children for school and home use.
- School repaired and repainted.
- School latrines renovated back to a functional level and used by the school children.
- Two 1-hour classes delivered to the children about health, clean water and RWH.
- Three WASH classes disseminated to the Headmistress and teachers at Ambandrika Primary School for inclusion in the curriculum.

The fact that 144 school children now access unlimited clean water combined with the renovated latrines, means that children now have access to the fundamental necessities of a healthy life. The above results suggest that there has been a dramatic behaviour change among not only the school children but also the community, as they notably choose to queue for the tank water instead of taking water from the well. Importantly, this behaviour change in Ambandrika, achieved at such an early age, is extremely encouraging for replication of not only RWH in the future but changing attitudes away from accepting contaminated water as the norm.

The school children show off their new bottles and clean water with the TMC.

4. Conclusions and Recommendations

As per its objective, Project Tatirano has provided a sustainable clean water source for the 144 school children at Ambandrika Primary School and has demonstrated RWH to the wider community of Sainte Luce. Nonetheless, it will be difficult to classify the project as a full success until continued M&E reports that the system is being managed, maintained and used properly over a sustained period of time.

The TMC encourages people to collect water from the tanks once a week, indicating its strong understanding that the water is cleaner than alternative water sources and better for health. The act of choosing to collect water from the tanks each Friday – rather than take from the well – indicates a strong behavioural change that is crucial for any future replication of RWH.

Whilst there have been numerous challenges such as the sourcing of water tanks, training of the TMC, and various minor construction complications, the project has provided a durable system that provides a sustainable clean water source to vulnerable children. Furthermore, the aim of creating a simple system, conducive to understanding and replication, has successfully led to not only high satisfaction with the water quality from the tanks but also high levels of interest among community members in practicing RWH on their own roofs.

After the culmination of extensive research over the Pilot Phase, from water testing to household anecdotal evidence, it is clear that there is a high need and demand for an improved water source. Whilst the simplicity of RWH means that few components and skills are needed, any investment in such systems is prohibitive for the most vulnerable without financial assistance.

Following the positive outcomes of this project, it would be beneficial for the entire region if the momentum was maintained and a wide scale adoption of RWH was undertaken. An innovative and exciting proposed method for doing this in southeast Madagascar is to help facilitate households in obtaining the materials and finances needed to replicate the system on their own houses. Considering the direct behavioural change to favouring the rainwater over current sources, demand is high for an alternative method of collecting clean water. Capturing this demand could not only improve the health of thousands of people but could also indirectly lift them out of poverty.

School students get their hands on clean water for the first time in their lives.

5. Annex A

Design Considerations

First Flush

An automatic vertical first flush downpipe was chosen in preference of a water filter in order to minimise the risk of damage. Filters need regular, thorough and involved checks and maintenance to ensure proper functionality; insufficient monitoring can lead to the contamination of the entire storage system. Conversely, first flush systems do not improve water quality, but instead divert the first rains after any dry period into the vertical downpipe. When the downpipe is full, a plastic ball rises and blocks off the top pipe T-section allowing water to flow into the tanks. The dust and dirt blown onto the roof or carried onto the roof by animals will first be trapped in the downpipe. A slow relief valve at the bottom of the downpipe allows for it to be gradually reset automatically, thus essentially allowing the system to clean itself. Cleaning out the silt and debris after each period of rains is important for maintaining the functionality of the system and if not carried out properly could lead to silt overflowing into the tanks.

Left: *The T-section at the top of the first flush diversion system.* ***Middle/Right:*** *A member of the TMC checks and clears the first flush system ready for the next rains.*

Stainless Steel Mesh

Any large debris that does not get trapped by the first flush system will be prevented from entering the tanks by the stainless steel mesh fitted to the entry point. The taps are raised off the bottom of the tanks by approximately 5 cm and therefore avoid any water quality issues if silt has been carried over into the tanks.

Lack of Pump

Whilst the tanks sit on foundations at ground level, pumps were not incorporated in the design to avoid the risk of failure and thus needing either skilled mechanical maintenance or expensive spare parts not locally available. Instead, a pit was dug to allow people to place buckets underneath and collect water via gravity from the taps.

6. References

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