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ENSURING AVAILABILITY AND SUSTAINABLE MANAGEMENT
OF WATER AND SANITATION FOR ALL

Innovation and lessons learnt in design and pilot implementation of clay-bodied bio-sand filters in Niger

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In 2015, only 58% of the rural population of Niger had access to a potable water supply and 11% had access to improved sanitation facilities (WHO/UNICEF, 2015). To reduce diarrhoea related diseases caused by use of contaminated water sources, Samaritan's Purse (SP) embarked on household water treatment using Bio-sand filters (BSF). The installation of the BSF typically requires cement which is too expensive for the communities to buy. The purpose of this research was to explore how the BSF could be constructed using clay pots which will create livelihood programs, sustainability and transfer of knowledge using appropriate local technology. The clay-bodied BSFs were installed at a cost of less than $10 and had a tested flow rate of 0.42 l/min. The research concludes that clay-bodied BSF has potential to ensure improved sustainable water supply and income for potters.

Introduction

Niger has been subject of several insecurity issues since January 2011. Close to the western border with Mali operates the Al Qaeda group and the Islamic Maghreb (AQIM), and to the far east and south eastern borders with Nigeria and Chad is the Boko Haram group that has attacked and rendered several thousands of villages inaccessible. Insecurity negatively affects the ability of non-governmental organizations (NGOs) intervening in Niger to access communities in need of sustainable water, sanitation and hygiene (WASH) facilities.

In 2015, only 58% of the rural population of Niger had access to potable water supply and 11% had access to improved sanitation facilities (WHO/UNICEF, 2015). The consequence of lack of access to adequate WASH facilities is worse in the rural areas where surface water bodies are heavily polluted due to open defecation and poor environmental sanitation. The poor water coverage and lack of adequate sanitation and hygiene practices have led to high incidence of water-borne diseases. It is reported that the prevalence rate of diarrhoea is 44% among children under five in Niger (IVAC-2015-Pneumonia-Diarrhea-Progress-Report). To reduce diarrhoea related diseases caused by use of contaminated water sources, Samaritan's Purse (SP) embarked on household water treatment using Biosand filters (BSF). It has been reported that treating water using BSF could reduce diarrhoea cases by 47% (Sobsey et al. 2008). Bio-sand filters are a one-time cost which is incurred during production and installation. There is no routine maintenance cost. Given that there are many different kinds of filters that require materials be imported into the communities, it is challenging to implement BSF projects in areas where supply chain is an issue. In this project, SP explored the use of clay as the body of a BSF filter. The materials and know-how to construct clay pots is widespread throughout the world and clay has the benefit of being lighter than concrete and therefore easier to transport. Clay-bodied BSFs are also expected to be less costly than the concrete, metal or centrally manufactured plastic-bodied BSF options. In addition, clay will not rust as compared to those made of galvanized iron (GI). The purpose of this study was to explore the use of the clay-bodied BSF within Niger especially along the riparian communities.

Existing BSF

Bio-sand filters were developed as a modification to slow sand filters that discharge water intermittently for household use. In recent years, there have been many different BSF bodies and alternative techniques to build them. Concrete bodies have been popular but are heavy and can be costly, especially where cement costs are high and sometimes not accessible. The Hydraid plastic BSF is far lighter and easier to transport and appears more desirable to some users. Recently much smaller BSFs have been manufactured with bodies constructed from large diameter PVC pipes, GI sheets or buckets available in local market places (Smith, 2013, Murray et al., 2015). Akudago (2012) used plastic buckets popularly known as the veronica bucket to construct BSFs for communities in Ghana and Burkina Faso. They are quicker to make and easier to transport as compared with concrete BSFs. However, centralized manufacturing in America and in some large cities has resulted in relatively high purchase and shipping costs, and sometimes inaccessible especially to rural communities. The current cost of the BSF ranges from $15-40 (Chan et al., 2015).

Concept and design of clay pot BSF

Clay pots have been used as drinking water containers since time immemorial. In Ghana and many parts of Africa, clay pots are used for cooking household food, brewing pito (local beer made from sorghum), and sometimes, are subjected to continuous heating under fire for days. At the community level, local potters are able to construct the pots from clay and other local raw materials, and come in various shapes and sizes, capable of holding up to 50 gallons of water. The ability to hold large volumes of water under such extreme heat makes them suitable storage containers for community and household water supply. They also serve to cool water for households when relatively new. Based on the advantages, SP has experimented using the clay pots to construct the BSF to contribute to sustainable potable household water supply.

The design of the clay-bodied BSF is shown in Figure 1 and Table 1. It consists of a body measuring 100 cm high, 33 cm in diameter and enlarges at the top with a diameter of 36 cm. The bottom portion of the clay body is rounded in shape, purposely designed to be buried in the ground. Within the clay body are layers of gravel and sand packed in such a way that the gravel supports the sand. This arrangement prevents the flow of fine sand into the treated water. The size of the sand and gravel particles are in conformity with the recommendations of CAWST (2012). At the top is a diffuser bowl also made of clay, slightly less in diameter than the 36 cm diameter part of the tapered open-end of the clay pot. The diffuser bowl also acts as a lid to the clay BSF body. Externally attached is the riser (flow) pipe with a 1 cm internal diameter and completely moulded out of clay and embedded in the clay wall. Moulding of the riser pipe requires a lot of time and is challenging due to the curved shape, small internal diameter, and delays the process, but there are no leakages observed.

Pilot results and discussion

In the field, the local potters have constructed clay-bodied BSFs for pilot testing. With the rounded base, the filter body was slightly buried into the ground for firm grip and which also helped in transferring the weight from the soil directly into the ground. The conducted flow test proved that the clay BSF dispenses water at 0.42 L/min as shown in the photos, which is in the recommended range (CAWST, 2012).

With regards to production rate, in a given week, a single local potter is capable of producing up to five clay BSF bodies. The number of clay pots produced could be quantified in monetary terms. In Niger, the minimum wage reported by Wageindicator.org (2016) for a month is $60 which translates to $2/day for casual labourers working for 30 days. A potter could therefore earn on the average $14/week producing an average of four clay-bodied BSFs. The cost for a clay-bodied BSF could therefore range from $3-5 since clay, gravel and sand for construction are accessed at negligible costs to the potters. However, assuming $10 is the cost of a clay-bodied BSF if time spent in collecting sand and gravel is added, the cost is still much cheaper than the cost reported in Chan et al. (2015) and based on field BSF experience where filters range in cost from $15-40.

Based on regional security challenges, many communities are inaccessible within Niger, Nigeria, Chad, Cameroon, and other parts of Africa. Providing adequate training to community potters to support installing clay-bodied BSF for household water treatments could significantly impact the reduction of water-borne diseases. The potters serve as WASH resource persons in their respective communities with some level of training as was observed in the pilot process. The BSF maintenance, hygiene education and information dissemination could also be handled by the potters. Being part of their communities they provide support whenever a BSF is dysfunctional or the clay body is broken. The users easily are able to access a new BSF

without supply chain issues. To scale up the clay-bodied BSF, SP will train local artisans to make the clay-bodies to the required dimensions and quality, provide sieves of the correct size so that accurate production of sand and gravel is obtained, provide training on price setting, as well as financial management to community potters' groups. This approach at a moderate scale could really improve local access to a sustainable potable water supply, raise income levels and eventually reduce diseases and poverty. In conclusion, though this pilot study was completed in Niger, the results could be applicable to many other settings and particularly useful as a household water treatment solution to those vulnerable families living in places where markets and supply chains are not functioning properly. Samaritan's Purse has also demonstrated that clay-bodied BSFs have great potential especially in riparian communities where surface waters are readily available. This initiative would also clearly reduce the need for aid workers to travel to support inaccessible communities in risky situations.

Lessons learnt

From the conceptual stage to the pilot stage, SP has learnt the following:

- Clay pots are used almost everywhere in the world especially in Africa. Little effort may be needed by development partners to convince communities to use them.
- Clay pots are used in many warm regions (Ghana, Burkina Faso, Niger and other places based on field observation) for cooling water or preserving food, and these advantages could be great educational factors to promote clay-bodied BSFs.
- Apart from making potable water accessible, clay-bodied BSFs could generate income for the potters.
- Designing a smooth and curved 1cm internal diameter riser (flow) pipe was challenging and time consuming. Despite the challenges, there were no leakages observed.
- The first clay-bodied BSF was broken when animals stepped on it. The clay-bodied BSF is fragile and should be handled with care during transportation. However, once the BSF was installed there was no report of breakages.
- Though the potters construct the clay bodies, access to sieves for ensuring the required sand and gravel sizes was a challenge.

Table 1. Design parameters for concrete-bodied BSF (v10) and the clay-bodied BSF

	Concrete-bodied BSF	Clay-bodied BSF
Filter sand depth (mm)	545	500
Gravel depth (mm)	100	100
Surface area (m2)	0.06	0.08
Hydraulic loading rate (m/h)	<0.4	0.3
Max flow rate (L/min)	0.4	0.4
Typical batch size (L)	12	20

Recommendations and next steps

- Water quality tests will be conducted on a statistically significant number of pots for documentation and research purposes.
- Samaritan's Purse intends to collaborate with research institutions to determine how to make a a smoother riser pipe with internal diameter of 1cm as well as a good diffuser with the required holes. Samaritan's Purse will partner with research institutions to research on the quality of clay to ensure durability.
- Samaritan's Purse plans on conducting training for communities in Niger as well as local potters who are currently housed in internally displaced camps around southern Niger to scale up the initiative across the Nigeria, Cameroon and Chadian communities which are now inaccessible to aid workers due to insecurity issues.

- Samaritan's Purse is continuing to learn and will develop a written guide for installing clay-bodied BSFs, maintenance and reducing the risk of breakages during transportation.
- Sieves should be made accessible to local potters within their communities during the next project implementation.

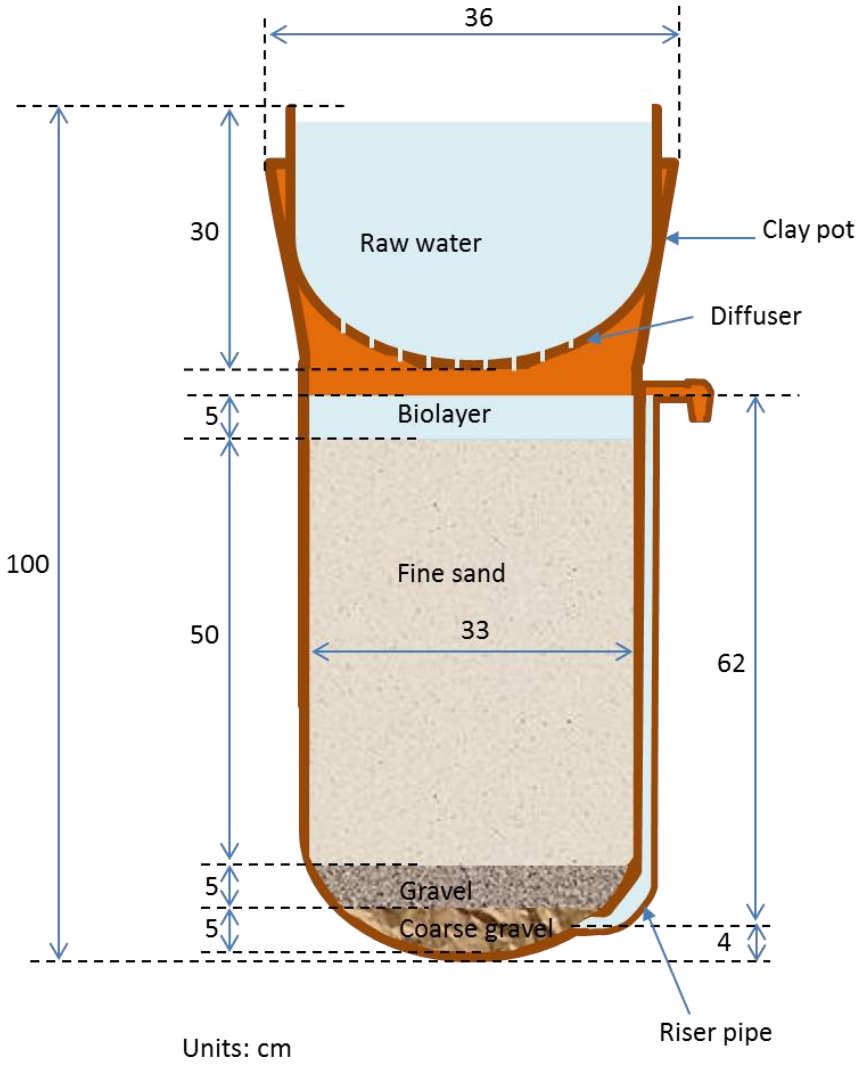

Figure 1. Design of the clay pot BSF

Source: Authors

Photograph 1. Mr. Boubacar of SP Niger conducting a flow test during the pilot testing of the clay-bodied BSF

Photograph 2. Mr. Boubacar of SP Niger checking the height of the biolayer

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