Prospectus

Silver Scrubber
(Technical Topic)

Post-Apartheid Water Access in South Africa
(STS Topic)

By

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11/26/2019

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Socio Technical Problem

Waterborne illnesses are serious ailments in low-income countries. In many such areas, even when rudimentary water supply services are upgraded to basic services and potability criteria are met at the source, the quality of water stored in the home will still be unacceptable. Every year, poor household drinking water leads to the spread of waterborne illnesses which cause early childhood diarrhea (ECD). ECD is responsible for the premature death of nearly 1.6 million children annually and stunts the growth of even more (Majuru, Jagals, & Hunter, 2012) (Mellor, 2013). While providing basic water services is a good start, it is evident that point of use water treatment options are needed in order to combat the affects of early childhood diarrhea and other waterborne illnesses.

The Limpopo province in South Africa is one of the many places in the world where residents have limited access to clean drinking water. In fact, the rate of accessible drinking water is 44% which is one of the lowest rates in South Africa. Prioritization of commercial orchards means that very little of the area's limited water supply reaches rural residents and villages. Currently, villages receive piped water from the South African municipal government. This system provides water very infrequently and forces residents to rely on water from nearby rivers and a village-built piping system coming down from abutting mountains for the rest of their water needs. People and cattle have access to the rivers upstream from where the water is drawn, and residents store their collected water in home containers for later use ("Challenges," 2011).

Current point of use water treatment options include chlorine-based methods, silver-embedded ceramic water filters and biosand filters. While point of use water filters have an amazing potential to combat waterborne illnesses, their performance is based on a variety of external factors including the willingness and ability of the user to use the device according to its instructions and existing cleanliness and hygiene conditions when used in households (Ehdaie et al., 2017). Additionally, the failure of a user to implement one of these point of use water filtration systems correctly or a lack of access to such a system can have potentially life threatening consequences in the form of waterborne illnesses.

Because the challenge of providing clean water to people in Limpopo and elsewhere is socio-technical in nature, it requires a solution that attends to both its technical and social aspects. A durable, efficient, and low-cost point of use water filtration system using the iodization of silver can help provide clean drinking water to the residents of Limpopo and beyond. Below I outline a technical process for creating such a device. However, the addition of a new point of use water filtration system will not be enough to fully address this problem; a thorough understanding of the user and the environment in which the device will be used is required in order to design an effective solution. I also use the STS framework of technological politics to analyze the way in which water infrastructure development in South Africa has reified social positions of power and privilege within South Africa.

Technical Problem

Lack of access to an improved water source leaves communities vulnerable to the effects of water-borne diseases such as typhoid and cholera. These diseases are especially dangerous to children as they often cause severe diarrhea which kills around 2.2 million people annually; 90% of these deaths are children (“WHO World Water Day Report,” n.d.)

Point of use water treatment technologies are an effective way to combat water-borne illnesses because they allow for households to treat water in their own home shortly before consumption. The ability to treat water within a home is especially important for areas with rudimentary water systems, which require households to collect water from taps in a variety of containers and carry these home for domestic use where the sitting water will be vulnerable to further contamination (Majuru et al., 2012). Ionic silver has been known to have antimicrobial properties since Roman times, and recent studies have reaffirmed the efficacy of using ionic silver for disinfection of potable water (*Silver-02032018.pdf*, n.d.). Currently, ionic silver is employed in several point of use water treatment technologies, including the Folia Water paper filter and the MadiDrop (*ProductInformation2017.pdf*, n.d.; "Scientific Innovation," n.d.).

The MadiDrop is a micro porous, water permeable ceramic tablet infused with microscopic silver clusters and can treat up to 20 liters daily. Once it has been placed in water, the Madidrop continuously releases low levels of silver ions; however, this approach is flawed because there is no control over how much silver is released into the water. Additionally, another flaw of the Madidrop is that it was designed to be placed in a container and forgotten about. Due to this layer of abstraction, its end users may not allow recently added water to sit for the required contact time needed for the silver particles to kill the microbes in the water.

The Madidrop and other silver-based point of use water filtration systems do not control the amount of silver released into water and do not effectively oxidize the silver for disinfection. As a result, the water is not properly sterilized and does not abide by the EPA secondary drinking water safety standard of 100 µg/L (De France, 2018). Therefore, my team is designing an electronic point of use water treatment device that will control the number of silver ions released using an MSP430 microcontroller. The target concentration of ions delivered for the prototype is

50 µg/L, which is half of the EPA guideline. The device will be limited to operate twice per day so that the amount of silver released stays within the 100 µg/L standard. We will produce thirty prototypes, which will be field tested in rural South African homes in the town of Thohoyandou.

While these goals are a step in the right direction, the system we design must work outside the lab and be designed in such a way that it will be able to operate within its users' daily lives. Most of the people within the town of Thohoyandou, South Africa are illiterate. Accordingly, the user interface will need to be extremely simple and cannot require any written instructions. Additionally, in order to be a viable solution for providing clean water in rural communities, the device will need to be extremely durable. Its enclosure will be able to withstand accidental drops and total immersion in water. Further, the device will be simple to use, relatively cheap, and power efficient. Finally, we have already received the functional requirement that the device should be able to operate for 6 months to 1 year on a replaceable 9 V battery.

STS Problem

At the end of apartheid in 1996, South Africa's new constitution stated "Everyone has the right to have access to sufficient food and water." However, even today, South Africa does not see anywhere close to equal access to water among its citizens. Evidence of the inequality of water access is shown in the case *Mazibuko v. City of Johannesburg,* which alleged that while piped water has been plentifully available to mines, industries, some large farms and wealthy families, millions of people spend hours collecting their daily supply of water from streams, pools and distant taps ("Mazibuko and Others v City of Johannesburg and Others (CCT 39/09) [2009] ZACC 28; 2010 (3) BCLR 239 (CC) ; 2010 (4) SA 1 (CC) (8 October 2009)," n.d.; *SAConstitution-web-eng.pdf*, n.d.).

In 2010, South Africa's Department of Water Affairs stated that 97% of its population had access to basic water supply infrastructure; however, by 2015 the same department was suggesting that this figure be treated with caution because the figures reflected infrastructure built but not the ongoing quality of the service (Majuru et al., 2012).

Despite the acknowledgement of South Africa's own Department of Water Affairs that the basic water access figures do not reflect the ongoing quality of the service, scholars and professionals view South Africa's efforts positively. These scholars emphasize that South Africa has improved access to clean water despite being the thirtieth driest country in the world with limited rivers, no mountain snow pack, and low annual rainfall (Takacs, n.d.).

Acknowledging the improvements South Africa has made in water access without tempering that point of view with a consideration of the political qualities of the technology risks overlooking the ways in which the employment of many water delivery technologies are giving an advantage to the wealthy and ruling classes while marginalizing the poor in South Africa.

I argue that the way in which water access is being expanded within South Africa, whether intentionally or unintentionally, is further marginalizing rural communities and families in Limpopo South Africa. My analysis of the expansion of water supply networks in Limpopo South Africa after the end of apartheid draws on the science, technology, and society (STS) concept of technological politics, which deals with "instances in which the invention, design, or arrangement of a specific technical device or system becomes a way of settling an issue in a particular community (Winner, 1980)." This occurs when a technology advantages certain groups but excludes or marginalizes others. Using this framework, I will analyze how the design and arrangement of many of the water supply systems have not solved many of the problems they were intended to combat and, in some cases, havecreated their own adverse effects which have ultimately kept the rural people of Limpopo from advancing within their society.

Conclusion

The technical report will deliver a new design for an electronic point of use water treatment solution using the release of silver ions. This system will be able to consistently release target concentration of silver ions in to a set volume of water with minimal user input. The amount of released silver will be within World Health Organization secondary drinking water safety standards. The device will be programmed such that it can only be operated twice a day and will have clear indicators that, when used according to the device's instructions, will notify the user when water is safe to drink. The STS research paper will seek to explore the technological politics of South Africa's post-apartheid water distribution network expansion. It will analyze the way in which users interact with the water distribution network and the adverse consequences of the network's implementation in Limpopo.

The results of the technical report will help to resolve the broad socio-technical issue of keeping rural South Africans' household water supplies free of harmful bacteria in a way that best fits their personal needs and patterns of use. The findings from the STS paper will also shed light on whether the way in which South Africa expanded its water distribution network further marginalized rural communities.

Word Count: 1751 Words

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