THE CHALLENGES OF CLEAN WATER & COMMUNITY DEVELOPMENT

A COMPARISON OF ARSENIC REMOVAL SYSTEMS IN CAMBODIA & INDIA

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ARSENIC REMOVAL SYSTEM IN CAMBODIA

INTRODUCTION

Every day, more than 140 million people in southern Asia drink groundwater contaminated with arsenic. According to the World Health Organisation (WHO, 2013), arsenic is having a devastating impact on the health of communities in Asia and South East Asia, with millions of people exposed to drinking water that is contaminated with high concentrations of arsenic. Consequently, thousands of people in Bangladesh, Cambodia, India, Myanmar and Vietnam die of cancer each year from chronic exposure to arsenic (Smith et al., 2013; Gadgil et al., 2012). For many years international organisations have been addressing these issues in Asian and South East Asian countries by developing and installing community-based arsenic water removal systems.

The Tagore-SenGupta Foundation (TS Foundation) is a non-governmental organization (NGO) that has developed and installed "Sustainable arsenic removal systems in affected communities" (herein called, arsenic-removal systems) in villages and schools in India and Cambodia, where water contains up to 20 times the amount of arsenic deemed safe by the World Health Organization. The system's aim is to address long-term water equity based on the assumption that clean water is a fundamental right for all humans, regardless of location, income or status. The filtration systems are intended to turn a crisis into an economic enterprise by creating a sustainable method of treating arsenic contaminated groundwater through organizing communities to address and take ownership of the process, ensuring a future of water security. The arsenic removal system the TS Foundation has developed uses well tested engineering and technology, but is also based on community development principals that involve the establishment of water councils to ensure equitable distribution and sustainability of the filters. In theory, the system, which can sustainably regenerate the resin used in the filtration process for years, is governed by a small group of community members who are in charge of collecting a small tariff from each user of the water system. The money collected pays for the upkeep of the filtration system, which may mean the employment of a community member to maintain the system. Additionally, the collected money has even been used to construct facilities like pavilions and the installation of televisions on the site of the filtration system. Other times the collected money is used to provide micro-finance loans to village members. The systems are supposed to encourage small businesses to transport and sell the clean water to customers far enough away where walking to obtain clean water is infeasible. Thus, the system is, theoretically speaking, supposed to generate employment opportunities while providing clean water. This is why the TS Foundation often speaks of the system as turning a crisis into an opportunity. In India, where part of this study was conducted, water filtration systems have been widely installed for over ten years, whereas in Cambodia, where the remainder of the study was conducted, installation of arsenic water filtration systems is a new activity.

INDIAN USER OF ARSENIC REMOVAL SYSTEM

AIM OF STUDY

The TS Foundation's arsenic removal systems have undergone a thorough review of the technical aspect of filtering arsenic (Cumbal et al., 2005; Sarkar et al., 2008; Sarkar et al., 2010; and Sarkar et al., 2012). The various papers and awards (Lehigh University, 2013, p. 21) have shown that the technology is robust and sustainable; the patented resin by TS president, Dr. Arup SenGupta, has lasted in some systems for over 10 years. Additionally, the technology used by the TS Foundation in communities in India and Cambodia is also being used in places like the United States and Italy.

Notwithstanding the acclaimed technology developed by team members of the TS Foundation, few if any evaluations have been conducted about the social factors leading to the use of the filtration systems. That is to say, are there social factors that impact the use or non-use of the system beyond effective technology? The aim of this study was precisely to fill this knowledge gap: to determine how social factors impact people's use or non-use of arsenic water filtration systems in Cambodia and India. Through such an understanding, better initiatives that address arsenic poisoning in Asian and South East Asian countries can be designed.

> WE NEED GOOD WATER. WATER ALWAYS MAKES EVERYONE HAPPY.
>
> CAMBODIAN VILLAGER (MALE)

METHODS

A mixed methods approach was used to undertake this study, using both qualitative and quantitative research methods. Data was gathered between April to May 2012 via individual interviews, a random household survey and focus groups. Participants came from two villages in India and two villages in Cambodia where arsenic removal systems have been installed. Although the data collection instruments were independently designed by the research team and did not go through an approval process by the TS Foundation, the TS Foundation selected the villages for research.

Participants who were both users of arsenic removal systems, and non-users of these systems were surveyed about their water use, their access to water, and their understanding and experience of water quality.

Villagers were invited to share information about their access to water, including distances travelled, time it takes, and methods used to collect water. They were also asked about their knowledge and practices related to their perceived notions of the quality of water. Finally, villagers were queried about the sources of water they use, the purpose and cost of their water use, and barriers to accessing safe and clean water. See table 1 for a summary of topics of investigation.

Villagers' permission to participate was obtained from village and commune chiefs in both India and Cambodia. Individual villagers who expressed an interest in participating in the research, received information about the project and what being involved would mean for them.

Four researchers conducted surveys, focus group and individual interviews, which were in the local language (Khmer) in Cambodia. In India, by contrast, translators were used to translate from English to Bengali and back.

A total of 133 household surveys were conducted to obtain demographic information from participants, and information in particular about their access to water, their use of water and their knowledge of water quality; surveys were completed on average in 15-20 minutes. Ten individual interviews and two focus groups, of around one hour each, allowed additional in-depth information to be gathered to develop a better understanding of the social issues impacting people's access to and use of clean water.

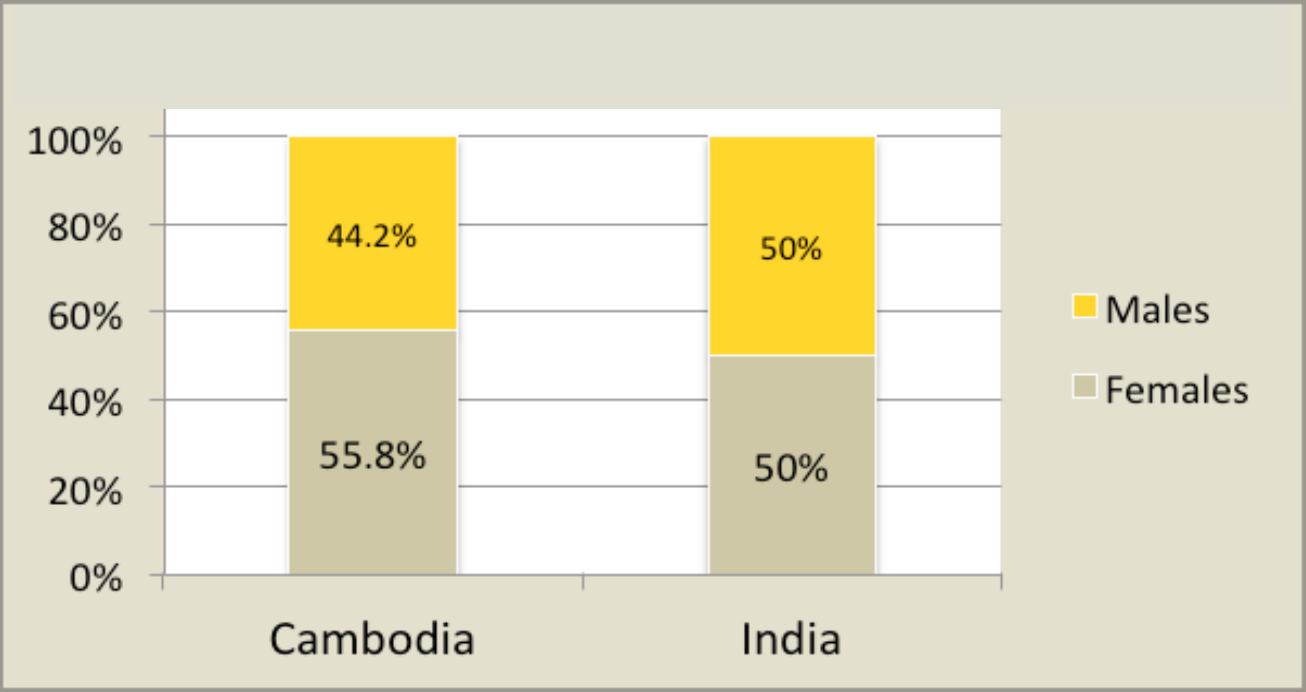
Quantitative data was interpreted and analyzed using SPSS (version 17), and qualitative data was thematically color coded to organize data and elicit themes.

TABLE 1: TOPICS OF INVESTIGATION

Villagers' access to water	• Distance from home to water source. • Travel time to collect water. • Means for transporting water from source to home. • Knowledge about new water filtration systems.
Quality of water sourced	• Knowledge of quality of water. • Perceived factors of quality water. • Perceptions of filtrations systems in relation to quality water. • Practices for making water safe to drink
Villagers' water use	• Sources of water used. • Different uses of water. • Amount of water used per week. • Monthly water expenditure.

GIANT WATER JAR IN CAMBODIA

FIGURE 1: GENDER OF NON-USERS



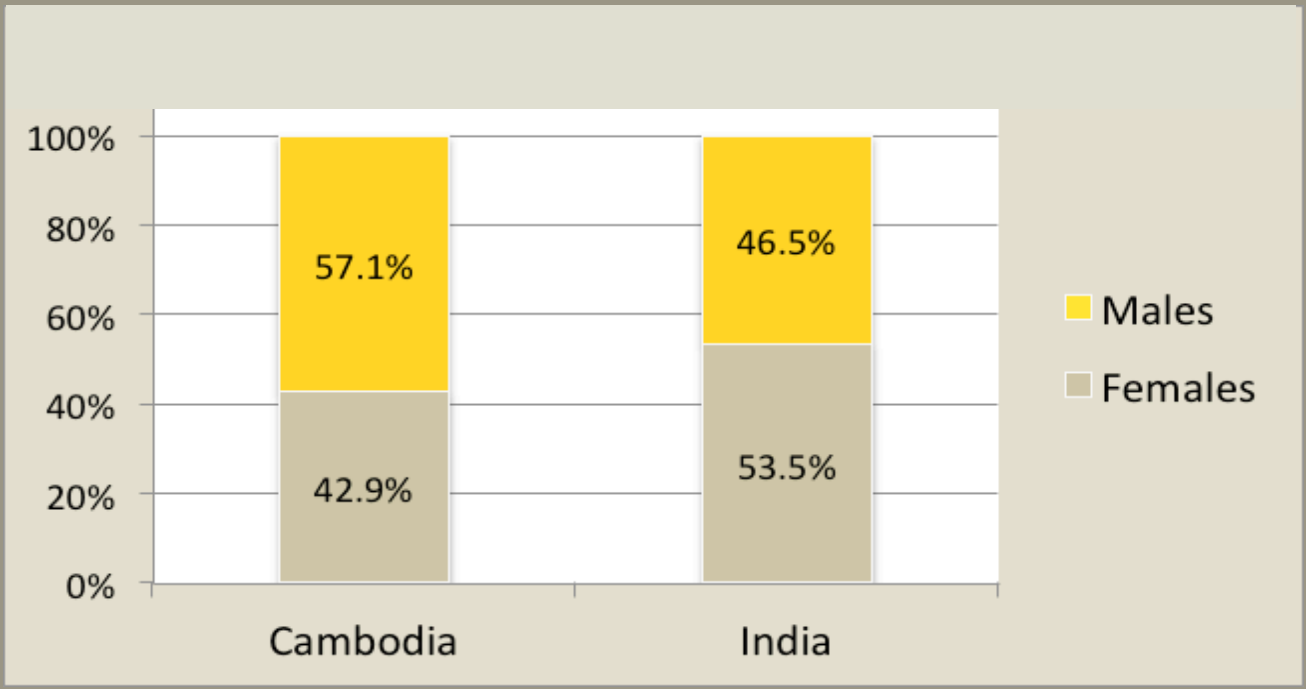
SAMPLE

Careful consideration was taken to select appropriate participants for this study. The sample included participants who lived in the village (Cambodia) or para (India) where an arsenic removal system was installed. Participants of the study included those who were users of arsenic removal systems, and those who were not. For the purpose of this report 'users' refers to participants who used arsenic removal systems, and 'non-users' refers to those who did not access the arsenic removal systems.

The household survey sampling technique was randomized. Researchers worked together with village chiefs in both India and Cambodia to determine the participants of each sample. This was achieved by first drawing a map with the village leader in order to determine the boundaries of the village and the number of roads within each village. The village leader then estimated or provided the exact number of households in each village. Since the aim was to survey approximately 50 households in each village, researchers were then able to determine a counting sequence for each village that would randomly select households, while ensuring they walked down every road in the village. Surveys were then administered to selected households that represented each geographical area of the village, depending on the number of families in a village. If members of a household were not home when the researchers visited to conduct the survey, they went "backwards" in the counting sequence, asking the pervious household to answer the survey. This only happened a handful of times.

Additional data for this study was purposively collected through individual semi-structured interviews with owners of water filtration systems in each country, and via focus groups, which allowed participants

FIGURE 2: GENDER OF USERS

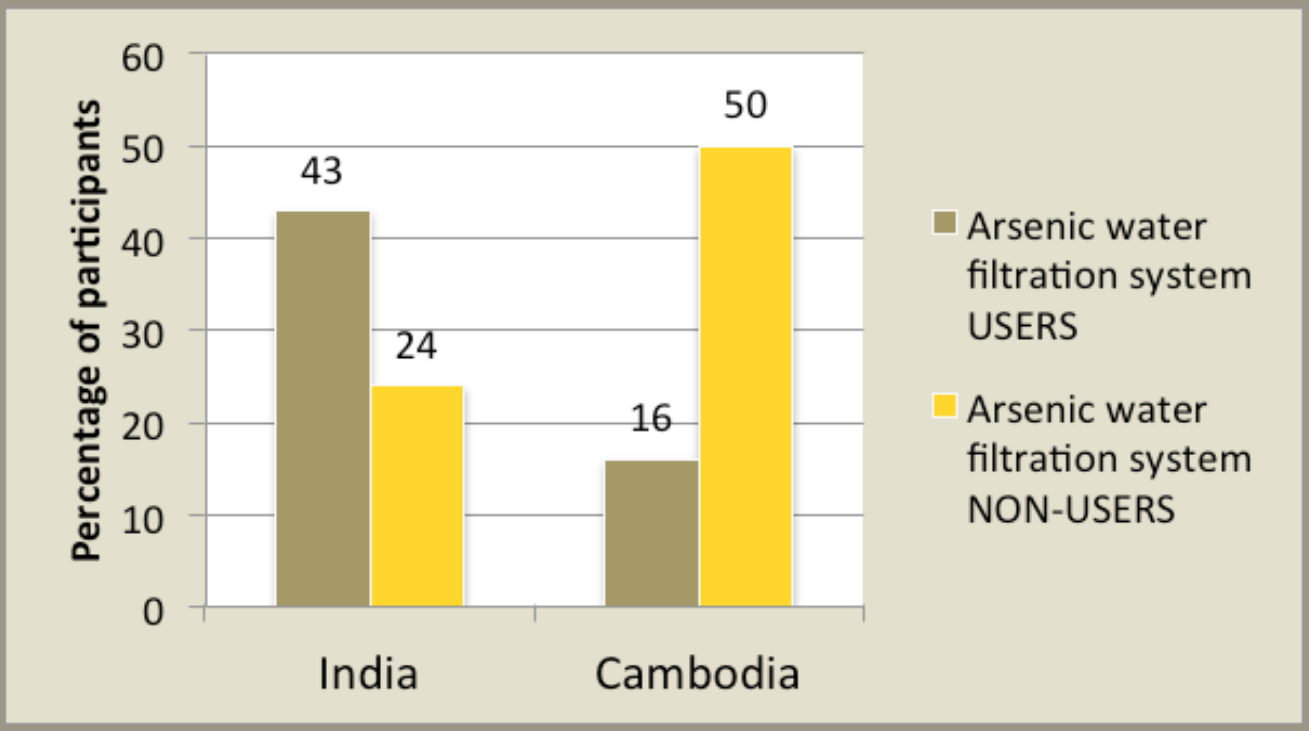


to interact with one another to generate new ideas and encourage discussion. This method allowed researchers to gather a large amount of data in a short time span. An interview guide was developed and used for focus groups and individual interviews.

Information was gathered about participant's country, language, gender, age, income and number of dependents. The total number of respondents who participated in this study, across the four villages was 133 (n=67 for Indian, n=66 for Cambodian). The total number of participants, who were users of a arsenic removal system, was 59 (n=43 for India, n=16 for Cambodia), and the total number of participants who were non-users of the system was 74 (n=24 for India, n=50 for Cambodia). See figure 1 for a summary of country of participants. All Indian participants spoke Bengali, and all Cambodians spoke Khmer. Just over half of Indian users were female (53.5%), whereas just under half of Cambodian users were female (42.9%); they ranged in age from 16 to 96 years. Similarly, for non-users just over half (55.8%) of Cambodians were female, and exactly half of Indians (50%) were female; they ranged from 34 to 75 years. See figure 2 and 3 for gender of participants.

For participants who were users of arsenic removal systems in India, the number of household dependents ranged from two to seven and for Cambodian participants from four to eight household dependents. Non-users from Indian households had one to ten dependents, with Cambodian participants similarly having one to eight dependents.

FIGURE 3: COUNTRY OF PARTICIPANTS



FINDINGS

In this section of the report, participant findings are presented. First, we discuss the different sources of water used by participants, followed by information about access to water, including distances travelled to collect water, water source location, means of collecting water and barriers to access.

The financial cost of water and whether this is a barrier to access is also reported, as is safe water knowledge, perception and experience. This section concludes with participant views of family and community needs.

Findings have revealed a number of important themes in relation to social factors that impact people's use or non-use of arsenic removal systems to source their water. Household surveys, individual interviews and focus group data have revealed important findings in particular about social barriers to accessing water, and knowledge and experience of water safety and quality.

WATER SOURCES

Reported sources of water for Indian and Cambodian villagers prior to using arsenic removal systems, or as an additional source of water were from government and municipality water pumps and tanks, hand pumps, tube wells, pump wells, ponds and rivers. Pump wells were the most commonly reported source of water for participants who were now using arsenic removal systems, as highlighted by a man from one village in Cambodia,

> *I use water from my relative's well, which has thrice been tested for arsenic and has proved to be usable because the arsenic concentration is not high. The arsenic in the well is tested once a year.*

Many Cambodian respondents also sourced their own rainwater and river water (25%; 32.1% respectively) for personal use. One Cambodian woman from the same village reported,

> *I collect water from the stream, but it is not good water, especially when the ducks swim in it. But there is a bigger stream which is drained from the Mekong River for rice cultivation that we use also, but sometimes the water in this big stream is dry, so we have to use water from the smaller one.*

Another Cambodian villager stated,

> *I cannot use the water from the pump well because it is high in arsenic concentration (500 parts) so I transport water from the streams by carrying it on my shoulders on my bicycle.*

Stories shared by participants highlighted that villagers in both India and Cambodia, access water from a number of different sources, some of which are difficult to access.

CONDUCTING RESEARCH IN CAMBODIA

TRANSPORTING WATER IN INDIA

ACCESS TO WATER SOURCES

For users of arsenic removal systems, most participants reported spending less than 5 or 10 minutes on each occasion they gathered water, as the systems were close to their homes. For many respondents, water sources were less than 300 meters from their homes, although most were less than 100 meters from their homes (Indian=79.1%; Cambodian=42.9%). Most of the Cambodian non-users however lived at least 1 kilometer from the arsenic removal system. Most participants collected water for their family at least seven times a week (Indian=86.5%; Cambodian=50%), however some collected wter up to 14 or 21 times per week.

Respondents reported transporting water by a number of means, including bicycles, carts or motorcycles. Walking however was the most common mode of transporting water (Indian=88.1%, Cambodian=64.7%). See figures 4 and 5 for a summary of modes of water collection for Indian and Cambodian participants. Furthermore, some participants reported having water delivered to their homes via government tubes, pipes and tanks.

Participants in both India and Cambodia shared stories of travelling long distances to access safe water because it was cheap or free, and they also reported having to wait to get water because so many others were sourcing water from the same location, as stated by this 23-year-old Cambodian woman.

> *We travel a long way for drinking water because it is free or very cheap – it comes from very deep pipes so we know it is clean, but when my husband gets to the pipes, he often has to wait for one hour to get the water.*

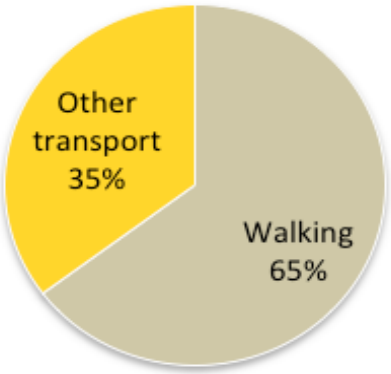


FIGURE 4: CAMBODIAN MODE OF COLLECTING WATER

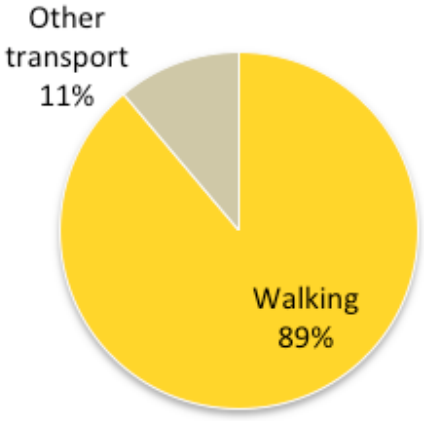


FIGURE 5: INDIAN MODE OF COLLECTING WATER

LOCATION A BARRIER TO ACCESS

The most common reasons for water being sourced from places other than the arsenic removal system, such as pump wells and other sources that may have been contaminated with arsenic, were that arsenic removal systems were difficult to access. Many participants shared that they used water from sources that they knew were unsafe for drinking, because they could not easily get to the safe sources of water. Reasons for this in both Cambodia and India were that safe water sources were too far away from their home and/or they did not have a way to transport the water. Many respondents suggested arsenic removal systems should be installed closer to their homes. One woman from Cambodia said,

> *Many people do not have a bicycle to transport the water and they live far way from the [water filtration] system, and so they use well water.*

Some participants (Indian 33%; Cambodian 19.2%) talked of previously having collected water from an arsenic removal system, but were no longer doing so because the water system was too far from home, which meant it would take too long to collect. One participant stated,

> *We used to use the water from the system, but the distance is so far - so much gasoline is needed for transportation – so we no longer use this water.*

Poor roads were another reason many participants reported not being able to source clean water. One woman from a Cambodian village highlighted how the difficulty of transporting water meant villagers had no choice but to use arsenic contaminated water. She expressed a real concern for herself and others in her community, as is expressed in the following statement.

> *I want the arsenic filter system to be installed in my village because most of the villagers use water from the same source as I do – from the pump wells - and all the pump wells except one, are rich in arsenic - between 300 and 1000 parts [per billion]. The people in my village cannot come to collect water from the [filtration system] because they have no transport or means to collect the water. Cost is not the problem - except for old people – and I know people in my village are willing to pay for the cost … of safe water.*

LACK OF RESOURCES A BARRIER TO ACCESS

Furthermore, not having enough containers to store water, was also an issue for some, as highlighted by this comment by a Cambodian villager:

> *We were told that the water from the pump well was not good to use, but we had no choice after the rainwater ran out – we had only one jar.*

One 35-year-old Indian woman talked about having to use water from the river, that she knew was not safe, because she did not have anyone who could collect the water for her.

> *I don't have a male to bring the water for us, so I have to boil it for my children.*

ARSENIC REMOVAL SYSTEM IN INDIA

FINANCIAL COST OF WATER

In terms of how users of arsenic removal systems pay for their water use, Indian respondents were more likely to pay monthly while Cambodian respondents were more likely to pay each time they sourced water, or daily. Most participants reported paying less than $US1 per month for their water use. Almost all water filtration system users in both countries reported strongly agreeing (Indian=90.7%; Cambodian=85.7%) that they felt comfortable paying a water committee made up of local villagers, to manage the system.

COST A BARRIER TO ACCESS

There were some significant differences between the monthly incomes of users and non-users of arsenic removal systems from both countries. Users were more likely to be on a higher income than non-users. See figures 6 and 7 for a summary of incomes for Indian and Cambodian user and non-user participants.

FIGURE 6: INDIAN MONTHLY INCOMES

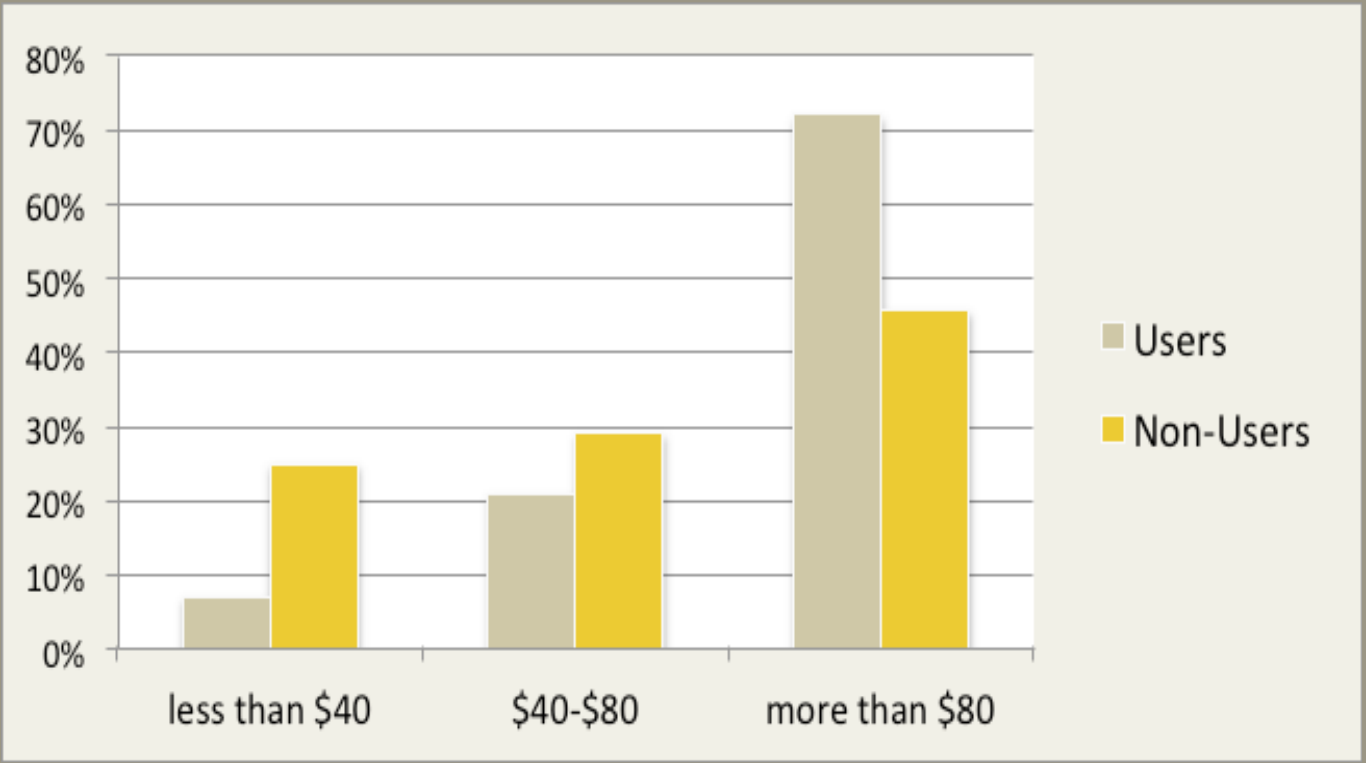
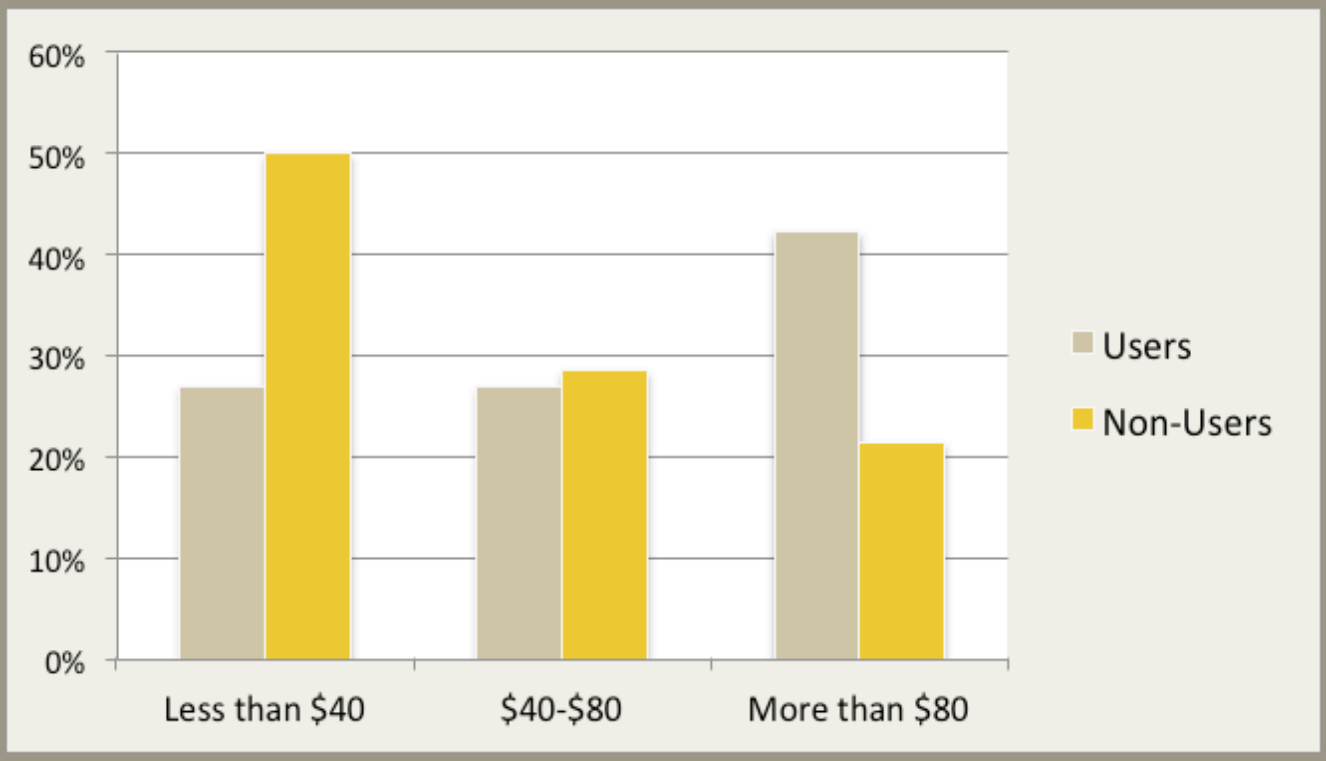


FIGURE 7: CAMBODIAN MONTHLY INCOMES



Whilst some Indian non-users of the arsenic removal systems felt the cost of arsenic-free water was either moderate or cheap (37.5%; and 9, 37.5% respectively), others (12.5%) felt arsenic-free water should be cheaper or free of charge. On the other hand, most users of arsenic removal systems in both India and Cambodia agreed that accessing water from these systems was very affordable, with many reporting feeling satisfied at having to pay for their water because they knew the quality of the water was good and clean.

Furthermore, while many participants did not feel having to pay for water was a barrier to sourcing clean water, for others it was considered an issue, particularly non-users of the arsenic removal systems in Cambodia, with the majority (62.5%) feeling the cost of water was too high, and should be lower than $US1 per month.

The cost of fuel was also considered a barrier to accessing good water for some participants, as highlighted by this comment from a villager in Cambodia.

> *The villagers know that the safest water is from the arsenic water filter system … they know that the system was built because arsenic is in the other water and arsenic causes diseases … the only problem is, [the water filtration system] is so far away that much gasoline is needed for transportation, that the villages cannot afford it.*

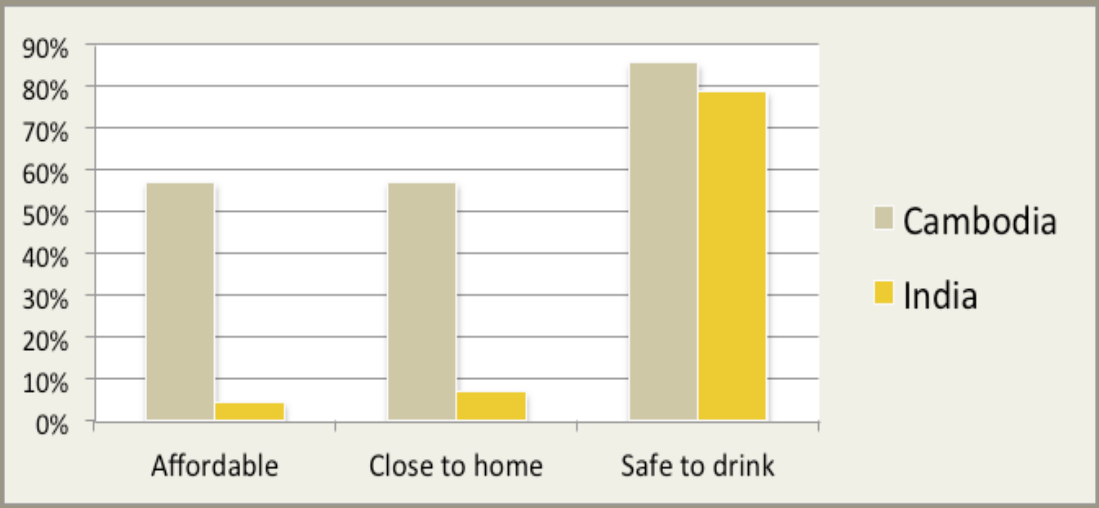
Furthermore, some Indian respondents talked of previously having been able to source arsenic-free water free of charge, but not being happy about having to pay for it now.

SAFE WATER KNOWLEDGE

Most participants reported knowledge that water from arsenic removal systems was believed to be of good quality (Indian=81.4%; Cambodian=100%). The major reason that motivated users of arsenic removal systems to use this water was because they felt that it was safe to drink (Indian=79.1%; Cambodian=85.7%). Other reasons for Cambodian participants in particular were that it was cheap (Indian=4.7%; Cambodian=57.1%), and it was close to their homes (Indian=6.9%; Cambodian=57.1%). Some participants also reported using the water because they knew it was clean and free of arsenic and they believed it had digestive benefits. See figure 8 for the reasons participants used the arsenic removal system to source their water. Household surveys, individual interviews and focus group data have revealed important findings in particular about social barriers to accessing water, and knowledge and experience of water safety and quality.

Most respondents agreed that water from arsenic removal systems looked good, tasted good and smelled good. Some reported knowing it was safe because they knew it had been tested, and others reported knowing it was safe because their family did not get sick after drinking the water. Other ways respondents reported knowing the water was of a good quality were by the way it was packaged, and because they had seen many others in the village drinking the water.

FIGURE 8: REASONS FOR USING ARSENIC REMOVAL SYSTEMSE 1: COUNTRY OF PARTICIPANTS



WATER FROM OTHER SOURCES SOMETIMES PERCIEVED SAFE

Although all respondents reported knowing that water from arsenic removal systems was cleaner than water from other sources and water from other sources could be rich in arsenic, and many knew the water could cause health problems (51%), some did however report continuing to obtain water from these other sources. Other sources for this water included from schools, rivers, lakes, ponds, pump wells, dug wells and from private companies.

> *I know the water I am using is not safe and causes many problems such as diarrhea, abdomen disorder, and other diseases. Also, the rice and soup I cook becomes black and the smell of the water is not good just after collecting it. But I have not experienced any illnesses caused by the arsenic yet, and I have recently had a Korean organisation take samples of my fingernails, hair and urine to be tested for problems relating to the water, but I have not received the results yet.*

The remaining 8.7% used water from these sources because they saw the others use this water and for this reasons believed it must be safe to use.

For those who did not use arsenic removal systems, most Indian participants (72.2%) reported not cleaning their water before use; however, many Cambodian respondents reported 'cleaning the water', either by boiling (23.5%) or using a household water filter (35.3%), while only 35.3% did not clean their water.

SCEPTICISM ABOUT ARSENIC FILTERED WATER

Some participants did not believe that water from the arsenic removal systems was safe to use. One female participant from a village in Cambodia shared about villager distrust towards those who had installed the systems.

> *Previously we were told that arsenic could not be filtered or boiled. Now they tell us that [arsenic removal system] can filter the arsenic – people don't believe them now - and people think the household filter can filter the arsenic as well.*

A participant in India also talked about the scepticism of others in her village, regarding the new arsenic removal systems.

> *A woman in my village was told that the water filter system water is clean, but she is doubtful, as she was told not to use the water from her pump well because it is rich in arsenic, but the filter system water is pumped from a well too – why is it clean?*

The ways in which villagers found out about the arsenic removal systems having been installed in their communities were via a number of sources, including village broadcasting, friends or neighbours, village meetings and promotion by NGOs in the community. Some participants had observed the systems themselves whilst walking around their community, and others learned of the systems being installed in their communities via participation in a ceremony when construction of the system began in their villages.

FAMILY & COMMUNITY NEEDS

When asked about issues and needs for their families, participants from both India and Cambodia shared a number of common themes. Having safe and affordable water that was accessible to all and close to their homes was considered a high priority for most participants, as highlighted by the following comments by four different Indian participants.

Water is the most important thing for my family – people can't live without water.

I want a proper supply of safe water for all the houses in my village.

The biggest issue for me, and my family is water – we need water to live.

We need good water – water always makes everyone happy.

Receiving a sustainable income to support their family was also high on the priority list for many. Access to financial resources, food, electricity and gas for cooking were all considered important also, as were having good jobs and homes and feeling safe in their communities. For their children, many reported wanting them to have an education. Other community needs identified by villagers included, the need for more schools and factories for the employment of women, better roads, transport management for safety and drainage systems. More hospitals and better health care for communities, were also considered important

WATER TANKS IN INDIA

CONDUCTING RESEARCH IN CAMBODIA

DISCUSSION

This study aimed to explore the use of arsenic removal systems amongst participants in India and Cambodia, and social factors that impact on their use of water from these and other sources. Important findings have been revealed, which have the potential to address some of the social barriers that prevent villagers from accessing arsenic-free water.

Amongst the participants who were surveyed, a number of different sources of water were used including for those who sourced water from arsenic removal systems. Rain water, water from streams and rivers, and pump wells were the other most common sources of water. It is of concern that many participants sourced water from these places, knowing the water was not safe to use, but felt using the water from the unfiltered source was the only choice they had for water.

Lack of accessibility to water sources was the most common reason villagers and their families did not use the arsenic removal system. The cost of arsenic-free water and the fact that the systems were not close to everyone's home meant many families used water from other sources. Poor roads, not enough storage containers and not enough human resources to travel to get the water, were all reasons participants gave for not accessing the arsenic removal system, with many not surprisingly, suggesting more arsenic removal systems should be installed, so that everyone can access them easily.

Although some respondents did report travelling long distances to collect water, this was to source water that was cheap or free, rather than to source arsenic-free water. Furthermore, although most Indian and Cambodian participants did agree that paying for water was okay, it was those with higher incomes who were more likely to be users of the arsenic removal systems, and those with lower incomes who were more likely to be non-users. Moreover most non-users did think the cost was too high. Thus, in this study, cost of water has been shown to be a major barrier to family's access to safe water, suggesting the need for arsenic free water to be free, or at least the need to implement a progressive tariff system whereby the richer users' fees subsidize poorer families.

The short distance to the water sources used by respondents and the preferred method of walking to obtain water by foot indicates that arsenic removal systems need to be in central, accessible locations to increase usage. Moreover, that some villages obtain water through traditional means (i.e., the use of river water) or from other NGO interventions (i.e., large cylinders used to collect rain water) suggest that the arsenic removal systems will face contextual challenges in each village where they operate.

The right to water has been adopted by 122 countries in a 2010 United Nations resolution as part of the human right to an adequate standard of living. The resolution places the responsibility upon governments to ensure citizens have access to clean water, but does not require a mechanism by which governments should do this. Unfortunately, without adequate taxation systems or other such mechanisms to finance clean water, governments will be unable to

ensure clean water is accessible in remote areas.

Another important finding with implications for policy makers and development agencies is that although most participants trusted that arsenic removal systems were safe, some were sceptical about this, as they did not trust the owners of the system, or because they had previously been told that arsenic contaminated water could not be filtered.

A common method for governments to provide various common goods like water or education without adequate taxation systems is through public-private partnerships. This is a form of privatization whereby citizens pay various fees for the use of a common good instead of collectively paying for it. Such a system is popular because creating robust systems of collection and taxation is a difficult endeavour in remote and impoverished communities, particularly large ones like that in India. The arsenic removal systems like that under investigation here can be considered a form of privatization. The filtration system is privately funded, located on private land, and privately operated for only users who pay. Through such a conceptualization it becomes apparent that some citizens who wish to keep certain goods like water as a collective good may not support water systems that privatize the right to water by charging direct user fees to access the water.

Although most participants trusted that arsenic removal systems produced clean water, that some still continued to boil or filter this water with household filters, highlights the need for continued education for villagers about the safety of this water. That some participants also thought the water from other sources was safe, because they thought it looked good, or because they saw other people using it, or because they hadn't been sick as a result of drinking this water, also suggests the need for social awareness campaigns to increase villager's knowledge about safe sources of water.

There are some limitations of this study. Whilst every attempt was made to include randomly selected participants for the household survey, there were occasions where whole neighbourhoods did not want to participate. Furthermore, our capacity to involve participants from some isolated and remote communities was limited, as travel to some of these villages was difficult due to poor roads. Furthermore, the number of participants in each focus group was less than we had intended, due to difficulties many participants had travelling to focus group locations. Nevertheless, the knowledge gained from this research project provides valuable knowledge about community arsenic removal systems.

CONCLUSION

Our study has revealed a number of barriers to accessing clean water for villagers in Cambodia and India.

While many participants understand the implications of drinking arsenic-contaminated water, and many are sourcing water from arsenic water filtration systems, that many continue to access water from unsafe sources is a concern. Having to travel long distances to source this water, not having the resources to collect the water, and not trusting that the water was actually safe, were all barriers that impacted on villager's access to safe water. Having to pay for filtered water was also considered a significant barrier, which is reinforced by the fact that those on higher incomes in both India and Cambodia are more likely to access filtered water than those on lower incomes.

Findings reinforce the notion that clean water should be free, and that access to clean water is a human right not being met by many families in our study. Results highlight important implications for policy makers and NGOs involved in the distribution of safe water to villagers in Cambodia and India.

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