Water Treatment Choices in Cambodia: the consumer's perspective

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I. Background

The UNC Global Development Alliance (GDA) WaterSHED Asia project, managed by the University of North Carolina (School of Public Health) and supported by USAID's Regional Development Mission for Asia, is working with partners in Cambodia, to develop and promote improvements in household point-of-use (POU) drinking water treatment and safe storage (HWTS). Through catalyzing the development of commercial and market-based supply of appropriate products to serve needs and desires of low-income populations, coupled with demand creation using social marketing communications and promotion, the project aims to achieve sustained household uptake of improved POU practices that will reduce diarrhea and related infectious diseases, improve rates of child survival and improve the quality of life of rural, peri-urban, and low-income urban populations.

Lack of access to safe water, proper sanitation and effective hygiene is an on-going global health and development crisis resulting in millions of deaths and massive infectious disease morbidity burdens affecting billions of persons annually. The World Health Organization estimates that nearly one-tenth of the global disease burden could be prevented by improving water supply, sanitation, hygiene, and the management of water resources.(WHO, 2008). Recent evidence documents that increased water access (i.e., adequate water quantity) and improved water quality by household water treatment and safe storage, contribute to reduced diarrheal disease in children under age 5, with typical reductions of between 25-45% for each intervention.(Brown et al., 2008; Fewtrell et al., 2005; Clasen et al., 2007) Point-of-use (POU) water treatment is estimated to be almost twice as effective in reducing endemic diarrhea as treatment at the point of distribution.(Clasen et al., 2007; Sobsey et al., 2008)

In Cambodia 56% of the population reported use of an improved water source for their household drinking water during the dry season.(CNIPH et al., 2006) This rate improved to 75% during the rainy season as an additional 30% cited rainwater as a drinking source. Water scarcity continues to be a problem in certain communities, requiring households to either purchase water or haul their own water from unimproved sources such as streams, hand dug

ponds and open wells. Contaminants such as arsenic and microbes affect water quality and user-identified aesthetics such as "hardness" or turbidity influence usage decisions. Nationally the most common treatment method for drinking water was boiling, 60%, with an additional 12% reporting water settling prior to drinking, while one-third (34%) reported no treatment of their household's drinking water.(CNIPH et al., 2006) A range of household water treatment products are now available in Cambodia through the marketplace and through development distribution channels.

Purpose of the Study: In Cambodia unsafe drinking water is one of the root causes of excess morbidity and mortality. Clean drinking water is essential to improving people's lives both physically and economically. Multiple POU water treatment methods are now available commercially in Cambodia. A richer understanding of the motivations, opportunities and abilities to invest in commercially available POU water treatment products will provide insights into effective pathways for promotion. Understanding the treatment motivations and preferred product attributes will assist development partners in designing products that meet the diverse needs of the population. Additionally, identifying and understanding the different market segments will facilitate the promotion of products and the expansion of sales networks to reach sustainable use of locally produced products. Within this broad examination of behaviour, preferences for specific commercial products and product features compared to current practices are examined to inform scale-up efforts.

II. Methods

This was a systematic qualitative investigation into Cambodian perceptions of water quality and of treatment behaviors and practices. Embedded within the larger study was a sub-study that focused on the perceptions, preferences and drivers of uptake for three specific commercial products: the Rabbit-brand ceramic water purifier (CWP); the 1001 Fontaines treated bottled water; and the PSI chlorine tablets "Tuek Sovattapheup". The primary data collection method was in-depth individual interviews. The study was approved by the University of North Carolina, Chapel Hill Institutional Review Board.

Data Collection Methods and Tools: The core data collection component was individual, in-depth, semi-structured household interviews with the household drinking water decision-maker. These interviews covered a range of topics including but not limited to water sources, treatment methods, perceptions of water quality, decision-making for drinking water, and commercial product purchase decisions. The semi-structured interview guide had four modules: a repertory grid inventory (RGI) (Bjorklund, L, 2005) of water sources known and used; an RGI of water treatment methods known and used; questions about the treatment product adoption process; and questions for those who chose not to adopt a commercial treatment product. The RGI is a process of elicitation and ranking. The interviewee first enumerates all known water sources or treatment methods, followed by a pairwise comparison of sources or methods to bring forth constructs important to the respondent. For each identified construct, two opposing poles that range from most similar to most dissimilar are specified and the interviewee places each source or method along the continuum of each construct. For example for the emergent pole, "the water smells bad", the implicit pole might be "the water smells good" or "the water has no smell". Each water source is then ranked vis-à-vis the other sources along the scale from smells bad to smells good. The adopter and non-adopter modules were open-ended questions with probing to elicit the decisions made and what influenced those decisions regarding water treatment methods and products. These in-person interviews in English-Khmer lasted 1.5-2.5 hours. Interview notes were recorded by hand by the interviewer during the interview and reviewed by the interpreter following the interview. In the case of missing discussion elements or discrepancies between the interviewer and interpreter, audio tapes were consulted and the notes were revised accordingly. Training of the interviewer and the two interpreters was completed by the principal investigator, who also conducted several interviews at the start and end of the data collection period. Discussions by the team throughout the data collection period were instrumental in synthesizing translated terms and identifying emergent ideas to explore in subsequent interviews.

Additional information collected included household socio-demographic characteristics to support the exploration of similarities and differences by household type; village profiles

constructed following key informant interviews with a community leader, such as village chief; and geographic mapping of areas with water access and quality problems, specific treatment practices and product promotions, and concentrated governmental and non-governmental water education and intervention efforts. The household and village characteristics supported the exploration of similarities and differences by household type, while the information about water sources and treatment products elicited during informational interviews prior to household selection, informed the sampling frame to ensure that different water access, water quality, and treatment product options were targeted in our community selection process. Lastly, key informant interviews with a few CWP Rabbit vendors and the 1001 operators helped characterize their customer populations.

Sampling: Participants were selected in one of two ways: 1) households selected in communities targeted geographically; and 2) water treatment retail customer referrals. For the geographic sampling, the selection of communities was informed by the presence of partners or vendors already working in the community, the presence of particular water issues such as scarcity or arsenic contamination, the availability of unique or multiple treatment methods such as locally treated water (1001 Fontaines), commercial filters, and chlorine tablets (PSI), and the practicality of travel. Once provinces were selected, interviews with local government officials, including rural development offices at the provincial and commune level, were completed to enumerate potential communities. Villages were selected and discussions with village chiefs helped identify potential interview candidates according to use/non-use of treatment products. The selection of households sought to achieve a balance across a range of household characteristics (e.g., wealth, young children in household, etc) and types of commercial products, so as to capture a selection of households representative of the major market segments of interest to the WaterSHED project and its partners. A much smaller sample of retail customers was identified through vendor tracking systems for the Rabbit brand CWP and through interviews with the system operators for the 1001 Fontaines treatment system.

Analysis: A summary narrative of each interview was included in the interview notes in an effort to document the story or essence of the overall interview. This summary was written

soon after the interview in order to capture the interviewer's perceptions of the interviewee and his/her particular situation. These summaries provided a context for the responses recorded during the interview and illuminated the themes that emerged during analysis.

All interviews were reviewed and coded iteratively. Initial coding included deductive codes based on the themes covered a priori in the interview guide, emergent themes identified from the interview notes, and structural codes from the socio-demographic data, including the reported water sources and treatment methods used and known. More interpretive themes were coded in the second and third review of the notes and initial codes.

Next the themes were queried and viewed through three different lenses: socio-demographics, product choice, and product acquisition. Data were sorted by socio-demographic characteristics for the individual, the household, and the community, to identify any trends in treatment motivations or product preferences. Next data were sorted by current and former product use, again looking for trends in motivations and preferences. Lastly we looked at how one acquired the product considering full retail purchase, subsidized purchase or gifted product, and noted trends relative to acquisition.

III. Sample and Situation Description

Study Sample: Fifty-one interviews were completed in four provinces plus the capital, Phnom Penh. The majority of the sample was female (63%), married (84%), and at least 30 years old (92%) (Table 1). Household wealth was evaluated by the interviewer and interpreters based on questions and observations of assets owned by the family. Some clustering of income source and wealth by village profile was seen, with those from more rural communities (large town, midsize town, small village) more likely to report farming, market sales, construction and family support as the main source of income. Those who reported family support as their main source of income were older or handicapped and less able to provide financially for themselves. A handful of urban and peri-urban respondents reported their own businesses including a pharmacy, butcher, gas station owner, and restaurant owner. The government and

professional workers were also in larger peri-urban communities and reported more education in general.

Table 1. Study sample demographics by individual, household, and community

Individual	No.	%	Household	No.	%	Community	No.	%
Total Sample	51	(100.0)	**Primary Income**			**Village Profile**		
			Farming	16	(31.4)	Urban	3	(5.9)
Sex			Market Sales/Fishing	10	(19.6)	Peri-urban	14	(27.5)
Female	32	(62.7)	Construction/Labor	6	(11.8)	Large Town	7	(13.7)
Male	17	(33.3)	Family	6	(11.8)	Midsize Town	10	(19.6)
Couple	2	(3.9)	Business	6	(11.8)	Small Village	17	(33.3)
			Government	5	(9.8)			
Married	43	(84.3)	Professional	2	(3.9)			
			Household Wealth					
Children ≤ 5 yrs	25	(49.0)	Poorest	2	(3.9)			
			Poor	6	(11.8)			
Age			Below Middle	12	(23.5)			
Under 30	4	(7.8)	Middle	19	(37.3)			
30-49 years	28	(54.9)	Above Middle	9	(17.6)			
50 years plus	19	(37.3)	Best-Off	3	(5.9)			

Water Sources: Eleven sources were identified as either used, seen, or heard of by the respondents, these included water from: rain, open well, piped system (tap), stream/river, 1001 Fontaines (an NGO-supported small scale treatment plant model), tubewell both shallow and deep, irrigation canal, pond, and bottled water in 20L jugs or 500ml bottles. Respondents were asked about their primary sources of water in the wet and dry seasons (Table 2); several provided multiple answers including information about whether they purchased water from a local vendor. Rainwater was the most commonly cited source of drinking water, however, only six of the respondents reported using rainwater exclusively year-round. These respondents had invested in additional rainwater storage containers and limited their rainwater use to drinking and cooking in order to ensure it lasted during the dry season.

Water source is geographically dependent. In Kampong Speu, a southern province, 12 of the 14 respondents from two villages reported rainwater as their primary drinking source compared to respondents from Siem Reap in the north where tubewells and tap water served the population

year-round. In Kampong Cham, a province with high arsenic levels found in the deep wells, rain and tap water predominated, and many purchased vended water. And in Battambang, another northern province, everyone interviewed reported purchasing water from a vendor at least during the dry season due to the difficulty of pumping and transporting water from the stream which was the only reliable year-round source. Additionally, Battambang was the only province in our study where 1001 Fontaines water was available.

Table 2. Respondent's Primary* Water Source Used by Season

	Primary Sources		Purchased?	
Water Sources	**Wet Season**	**Dry Season**	**Wet/Dry**	**Dry Only**
Rainwater	34	15		
Open Well	7	11		3
Piped Water System	7	9	7	2
Stream / River	1	9		6
1001 Water	3	6	4	5
Tubewell - shallow	4	5		1
Tubewell - unk		1		
Irrigation canal	1	4	1	
Pond		2		1
TOTALS	**57**	**62**	**12**	**18**

*Multiple primary sources were reported by some respondents

Treatment Methods: Multiple water treatment methods, currently or formerly used, were reported by our sample (Table 3). Boiling is by far the most popular method, either as the primary method (43%), used in series with a filter (<1%) for example filtering then boiling the water, or as a secondary treatment method (<1%). The majority of boilers (91%) report a long history of routine boiling, although four (18%) reported boiling only rarely when a child was sick or a woman in the household was pregnant. Filtration products were the second most frequently cited method, including the ceramic water purifier (CWP), the mineral pot (MP) and one respondent reported using a BioSand filter (BSF) and one a homemade BSF.

Table 3. Treatment methods past and present

Treatment Methods or Products	Currently Use			Previously Used
	Primary	Secondary	Tertiary	
Single Method:				
Boiling	22	3	1	13
Ceramic Water Purifier	10	2		4
Mineral Pot	3	2		4
1001 Fontaines Water	6			3
PSI Chlorine Tablets	1			2
SODIS	1			
Homemade BioSand		1		
Bottled Water			2	
Serial Methods:				
Boiling + MP	2		1	1
Boiling + PSI		1		
CWP + Boiling	1			
BSF + Boil	1			
Abate + CWP	1			
Abate + Boiling		1		
Alum + Boiling		1		1
No Treatment Method:	4			24

Adoption of a water treatment method for this analysis is defined as routinely treating water prior to drinking or purchasing already treated water for routine use at home. This excludes the rare boiling for tea or a sick child and the occasional use of bottled water for travelling or special occasions. Our sample can be sorted first into three distinct groups: Non-Adopters or those who have never routinely used any commercial or non-commercial product or method for daily drinking water treatment; Do-it-Yourselfers (DiYs), those who currently or formerly used a non-commercial treatment method such as boiling, SODIS, or a homemade BSF and have never used a commercial product; and Adopters, those who have at one time adopted or routinely used a commercial product.

The five Non-Adopters include two respondents who have never used any treatment method and three who boil on rare occasions for a sick child, for example, but do not regularly treat their drinking water. All five are at the lower end of the economic spectrum, including the two

poorest respondents in our sample. All are female and the majority (4/5) are under 50 years of age, have kids in the household under age 5, and have no or very limited education. They report earning some income from for-hire day labor work, farming, and selling small items in the market or from their homes.

Compared to the Non-Adopters, the nine DiYs are slightly better off economically, more of them are farmers, and more are older with fewer families reporting kids under age 5. They include 8 boilers and 1 who uses SODIS, a homemade BSF, and/or boiling for routine treatment; no one in this group reported ever using a commercial product routinely at home. They are longtime boilers who are used to their primary method and may not be interested or looking for a change in practice.

Thirty-seven respondents (73% of total sample) reported adoption of a commercial product either currently or formerly. The Adopters represent equal numbers of men (14) and women (15), cover the spectrum of education from none to college-educated, are represented by all age groups, yet have a higher proportion of households with children under 5 (54%). Past and present products adopted include: 19 adopters of the CWP, 14 (74%) still using; 13 adopters of the MP, 6 (46%) still using; 9 adopters of 1001 water, 6 (67%) still using; and 4 PSI adopters with half still using the tablets. Box 1 profiles the typical product customer interviewed.

Box 1. Customer Profiles	
CWP – Urban	Busy, educated population engaged in non-agricultural occupations, described as "businessmen" or "office workers" by the vendors. Looking for a product that will save time and clean the water as well as boiling. They have a more developed understanding of and belief in germs and health, therefore looking for a product that can replace boiling as an effective means of killing germs.
CWP – Rural	Hard-working, forward-thinking farmers looking to economize on physical effort and time, if cost is reasonable. They have a more limited understanding of germs and health, although an awareness of the need to treat (eg., boil) water before drinking.
MP – Urban	Busy, non-agricultural workers also looking for a product to save time. Half of these purchasers later switched to CWP or boiling because of dissatisfaction with MP.
MP – Rural	Hard working rural residents with more income than many rural farmers. Enticed by the modern idea and look of the filter, and responded to sales opportunity.
PSI	Hard-working, lower income farmers and laborers looking to economize on physical effort and time. Willing to take a low-cost risk to try a new product that might save them time and effort. They have a more limited understanding of germs and health, although an awareness of the need to treat (ie., boil) water before drinking.
1001	Busy farmers and entrepreneurs (eg., market sales, butcher) facing water scarcity in the dry season. They have a more limited understanding of germs and health; interested in clean looking drinking water that's easy to access for themselves and their children. Personal relationship with operator and word-of-mouth recommendation convinced them to try 1001.

IV. Treatment Motivation and Adoption

Clean drinking water is essential for a healthy population. The epidemiologic link between pathogens in untreated water and diarrheal illnesses is undeniable. However, understanding the motivations from a user's perspective is more challenging. First we will look at whether awareness and concerns about germs and health motivate treatment adoption, followed by an examination of the evaluative criteria that contribute to the choices made by those who adopted a commercial product, specifically quality of water produced, product ease of use, cost and general satisfaction. A comparison of product attributes between the CWP and the MP is included to inform our partners who produce the CWP. Lastly an exploration of how products were acquired and issues of trust and opportunity that influenced purchase is presented.

A. Germs and Water. Among the Non-Adopters, no clear connection was made between water, germs, and health. There was some discrimination made between "good" and "not good" water for drinking that included observations of the visual appearance of the water, for example clear versus cloudy water or "dirty" water that might have trash or debris in it. Two mentioned occasional boiling if someone in the family was sick and another elderly couple referred to boiling for health but only after their daughter joined the conversation and repeatedly corrected their answers to reflect what she'd learned about boiling. Boiling was noted as a means of removing "kombour" or the hardness in water by one respondent, and another spoke about the need to boil water for pregnant women, but treating water specifically to remove or kill germs was notably absent from their responses.

The DiY respondents, on the other hand, are long time boilers with an unwavering belief in the supremacy of boiling to kill germs. The eight boilers plus one DiY who alternates among SODIS, a homemade BSF, or boiling for routine treatment, were very clear about the connection between water, germs and health. Boiling is the only or best way to kill germs; cooked water is clean water. Even for the respondent who uses SODIS and the BSF, only certain waters already perceived to be cleaner, like rain, are treated with these alternatives, while water from the pond or canal still requires boiling to kill the germs. These long time boilers may never be convinced of the efficacy of alternative treatment methods. As one female boiler pointed out "once it is one's habit to drink boiled water, it is hard to go back to unboiled."

Similar to the DiY group, all but three of the Adopters mentioned germs in the water. Some made the additional connection between germs and health although the level of understanding covered a spectrum from parroting back basic health education messages for boiling to distinguishing between viruses and bacteria with the resulting health implications. According to one recent CWP purchaser, "drinking water directly without filtering it, or treating it, it will have germs in it, just like rainwater in the jar…I can't see these small germs so I'm not sure about them and don't know what harm they will do, but they might cause diarrhea…I treat the drinking water to prevent what germs might do." All but two Adopters boiled water prior to using a commercial method, also for health reasons. One woman who tried a subsidized CWP

but returned to boiling said she drinks boiled water to "avoid some diseases, to make me feel fine, boiling water can help get rid of diarrhea, and throwing up, and malaria."

Among the eight Adopters who abandoned a commercial product, six returned to boiling as their primary treatment method and two reported inconsistent or no treatment. Three non-retail product adopters abandoned the product (1 PSI, 1 1001, 1 CWP) rather than pay to continue using it; three returned to boiling because they never fully trusted the filters (1 retail CWP, 1 subsidized CWP, 1 retail MP); and two respondents who abandoned their product (1001 and the MP), did not link germs and boiling to their decision to start or stop treatment.

Despite the similarities between the DiY and Adopter groups, the more interesting focus is on the differences, specifically what motivates someone to switch from boiling to a commercial product and what benefits of the commercial product engender continued use. A look at just the Adopters will provide some insights into product adoption.

B. Adopters' Evaluative Criteria

Water Quality: Considering again one's perceptions of germs and health, did these perceptions influence product choice, continuation or abandonment? The removal of germs is the most commonly cited reason for treatment and boiling is the most common method ever used. Descriptors include "boiled", "cooked", and "steamed", for treated water that has undergone some heat-related treatment to kill germs. All five of the current 1001 retail purchasers and the single subsidized 1001 users described 1001 water as cooked or steamed, likening the UV treatment process to boiling as a method of killing germs. Filtering or chemical treatment with chlorine or abate are used as alternate or complimentary treatments to replace or improve upon boiling alone. The CWP, MP and BSF were described as filtering, removing, or killing germs by most users who continue to filter, although a few respondents maintained some skepticism about the ability of a filter to replace boiling. For example, one restaurant owner who switched from boiling to the MP and now uses the CWP, still prefers boiling overall because of a lingering concern that filtering does not protect as well as boiling. For those who have used a commercial method or product, if they are convinced that the alternate treatment

is as good as boiling, then they are more inclined to replace boiling with the alternate, but if unconvinced they may dual treat or return to boiling.

A subset of seven adopters dual treat, that is they continue to use a commercial product but only in series with boiling or with a chemically treated water, for example filtering water prior to boiling, filtering chemically-treated tap water, or boiling prior to adding PSI tablets. The impetus for dual treatment is twofold: to assure the water is really germ-free and to improve the aesthetic quality along with the health quality of the water. Some dual treaters are not wholly convinced that filters can replace boiling, so they continue to boil water despite having made a commercial purchase. Respondents described the CWP as taking the water half-way and one needs to boil to reach 100%. Other respondents used the dual method to meet two objectives, germ removal and particle filtration. Boiling kills the germs while the MP or CWP filters out the particles, insects or chemicals that make the water more pleasant looking and tasting.

Chemical treatment of germs was viewed both positively and negatively, and coincided with an emergent concern about the increasing use of chemicals in the environment, including fertilizers, pesticides, and industrial pollutants. Descriptions of the treatment process for bottled and tap water frequently referred to the use of chemicals to kill germs. The smell from the chlorine in the tap systems and the PSI treated water was a deterrent for some, while others believed it was proof of treatment. Chemicals in the CWP and MP were mentioned by some as beneficial. Again they were cited as killing germs and one believed the chemicals in the MP brought good health and prevented diabetes. However, a strong distrust of chemicals and contaminants contributed to two users' switch from the MP to the CWP because of an uncertainty about the long-term health effects of the chemicals used in the MP. Additional mistrust was mentioned in regards to bottled and tap water where the use of chemicals was assumed but the long term health effects of these chemicals was unknown.

Ease of Use: Challenges for water treatment recurs throughout the interviews. For those who have integrated boiling into their daily routines it is less of an issue. A teacher and recent

purchaser of the CWP described her perception of her community's norm: "for many boiling is convenient because they are already cooking rice anyway, and it's not such a chore or inconvenient to add just one pot of water onto the rice fire when the rice comes off, but the coals are still hot. That's why most continue to boil." However, boiling is more often described as taking too much time and physical effort when compared to filtering, using chlorine tablets or purchasing 1001 water.

Looking at urban versus more rural residents, we found time savings to be a strong motivator for urban populations while physical effort plus time savings were cited by the rural, agricultural workers. For example, the restaurant owner in Siem Reap who switched from boiling to an MP and then the CWP noted, "now with the restaurant I am too busy to boil, and there are too many workers to boil and filter for everyone, so I only filter the water."

Among the more rural population, the time and effort for boiling includes not only making the fire and boiling the water, but also collecting the water and firewood which can be very taxing depending on availability. As one purchaser of a subsidized CWP explained "boiling is the most difficult, that is why it is the worst. It is difficult because you have to make a fire each time, and then you have to bring the water to boil which takes at least 30 minutes, and then you need more time to cool the water." Another older woman described the need to rest just after collecting water from her open well; boiling water wasn't an option because of the added time and effort.

The availability of treated water when thirsty and the ability to attend to other work while treating water both emerged in the data. A product that can produce and store water for later use was beneficial. According to a rural farming household using an MP, "when I return from the rice paddies, I drink the MP water because it is available and I don't need time to boil the water. Boiling takes more time to prepare than the MP. Both take time but one you can do it on its own, can put water in MP before going to the fields and it filters while you are doing other things. For boiling, I can only do it when I am free of other activities**."** Time is a precious commodity for many Cambodians as they work very long, labor-intensive days and have

families to care for. Another described her satisfaction using PSI tablets: "I'm very satisfied [using PSI tablets], nothing can compare. I don't have to spend any effort or any firewood on preparing water. I don't have to spend time preparing. I can do other things like cooking or go to the fields."

Among Adopters, all but two were former or current boilers and these two non-boilers tried 1001 water, a low cost risk to try. Of the retail purchasers, the majority (78%) cited the time and/or effort for boiling as a motivation for seeking a new treatment. The six respondents who did not cite "effort" include three who continue to boil their water because they are unconvinced of the filters ability to clean water and three who are more influenced by the taste of the water.

For the DiYs and those Adopters who returned to boiling as their primary treatment method, the time and effort needed to boil water was not a driving factor in product choice. Boiling is considered an integrated part of their day and it is not worth any additional costs to use a commercial product.

A few families with young children raised another issue, the ease and safety of children serving themselves. The CWP, MP, and 1001 jug were all noted as convenient sources for the children. With the tap, children could not dirty the water and they could easily serve themselves. Two parents specifically purchased products (1001 and CWP) so their children would not run the risk of burn accidents if they had to boil water. Both of these families purchased the products at retail price, understood the value of treating water vis-à-vis germs and health, and were too busy working to boil water for their children.

Cost: The cost for treated water or a treatment product was a common theme whose importance was relative to the choices available. Multiple considerations informed ones decisions about if, when and what product to spend money on. A onetime investment in a filter might provide a cost savings over the life of a product compared to the daily expense of 1001 water, PSI tablets or the cost of fuel for boiling; yet spending a small amount daily for a

consumable good may be easier than saving up for a durable good. As a new PSI tablet adopter said, “it is easier to spend a little bit daily then to spend a lot at one time.” Boiling, SODIS and homemade BSFs were viewed as no or low cost methods, with only two of the nine boilers mentioning fuel or firewood expenses for boiling. Overall 16 respondents noted that boiling has a daily fuel cost; of those, eight reported using a commercial product and six continued to boil. The costs of fuel may be difficult to quantify and may be more relevant to those who have to purchase fuel (wood, charcoal, or gas) or expend a lot of energy to gather firewood.

In the two communities where 1001 Fontaines operated, the cost calculation was different. The availability of clear water year-round was a concern cited by each respondent from the two communities. Eleven of the twelve respondents had to purchase stream water from a vendor for at least part of the year. Families had to choose between trucked or piped untreated stream water that was typically cheaper and could be used for multiple purposes, or treated, 1001 water that was affordable drinking water, but insufficient for all the household needs. These households were already required to spend money on water, the choice of treated versus untreated was influenced by belief that the added value of commercially treated drinking water outweighed the cheaper cost of untreated water. In these communities, 9 of the 12 households tried the 1001 water; 6 continue to use it, 2 abandoned it and returned to boiling, while 1 no longer treats her water. The remaining sample either boils (2) or does not treat (1).

Cost and quality were linked in some interviews, with higher cost cited as a measure of higher quality. For example higher priced bottled water was linked to higher quality by one retired government official who said “if I was a wealthier man, I would buy Evian water for daily drinking because the higher price means better quality.” The converse of this was also cited for bottled water, lower priced Cambodian bottled water brands were suspected of being lower quality and possibly not treated at all. Cost also was an issue for filters. The MP typically sells alone for 25-30USD, or with a package of other household goods for over 100USD. The CWP retails for 10-12USD and the replacement pots for 4-6USD. Price was perceived as indicative of quality; the more expensive product was believed by some to be the better quality product. As

one well educated, social worker said (in English) “when we think about which one is expensive, we mean more than good, best or better than this one that is cheap. Opinion of some people is if we buy the lighter one [MP] cheap, then it’s not good quality. If you buy and the price is expensive, then it’s good.” However, this respondent went on to explain that because the CWP was produced by an NGO that was not interested in profit, maybe the CWP was as good or better quality than the MP: “And this one [CWP] is cheaper than this one [MP], so I imagine maybe this one [CWP] is as good quality as this one [MP]. But this one [CWP] is made in organization, what we call not profit because they want to help people.”

Satisfaction: Despite health, effort and cost influences, satisfaction in the drinkability of the water may remain one of the better predictors of method choice. Water satisfaction tied to water temperature was commonly cited, but in contradictory ways. Five respondents claimed that warm or hot water was the most “refreshing” or “thirst quenching”, and was the only kind of water to fill you up when you were thirsty. Four of these five respondents consistently boil their water, and the fifth boils only when she is not feeling well. Cold or chilled water on the other hand, was claimed by nine respondents to be the only way to quench one’s thirst and chilling the water was a real treat. Seven of these nine respondents do not boil. In some families, one member may have a strong temperature preference that drives his/her treatment choice. For example one father preferred hot water flavored with tea, so he boiled water but the rest of the family drank cold water from the CWP.

Other descriptive terms for preferred drinking water refer to the taste and smell: “delicious”, “tasty”, “sweet”, “fresh”, and “natural like a raw vegetable.” “Pleauw”, a term we heard in almost every interview, describes a bland, tasteless water, commonly linked to the aftertaste one might have from drinking hard water, or water from tubewells. Sometimes bottled, boiled or rain water were also described negatively as “pleauw” tasting. Another negative attribute was the chemical taste or smell associated with the treated tap water, PSI chlorine tablets, and occasionally with the MP. In communities with treated tap systems, the use of a filter to remove the taste or smell of the chemical treatment was noted.

C. Product Attributes – a comparison between CWPs and MPs

In support of the WaterSHED project's aim to expand the market for portable filters, narrowing our focus for a moment to a comparison between leading commercial filter is warranted. There are essentially two types of retail, portable filters that we observed in our study, the ceramic water purifier and the mineral pot. Both types of filters are available in multiple provinces in Cambodia and their sales networks are expanding. In our sample, 19 respondents reported using a CWP at one time, and 14 are current users. For the MP, 13 reported ever using and 6 continue to use today.

The CWP has a clay filtration pot housed within a larger plastic container with tap. The clay pot is produced according to specifications to filtrate out bacteria while viruses are killed by a non-visible layer of liquid silver that is painted on the inside of the pot. The finished products are tested to meet minimum international filtration standards. Two CWP models are available depending on the region and retail network: the Rabbit, produced by Hydrologic, a local NGO, is primarily sold commercially although some units are purchased by other NGOs for distribution at low or no cost; and the Frog, produced locally by RDI and the Red Cross with a mix of retail sales and NGO supported distribution. Multiple MPs are on the market, including but not limited to King Seoul, Matsui, and King Star. These filters are imported from Korea, China, and Vietnam and sold door-to-door and in the market place. We did not hear of any MPs distributed through NGO networks, nor is any information available about the filtration standards for these products. Testing of treatment effectiveness by WaterSHED is underway.

Style and quality were the most frequently cited interests of the respondents. There is a clear preference for the modern look of the MP, the "MP looks beautiful". One can see through the clear, fancy plastic container to the column of layered rock and "minerals" that filter the water. A second dome filter is hidden in the top part of the container and many believe the dual filtration is an improvement over the CWP; a simple clay pot could not filter as well as a product with multiple layers. The modern looking MP was seen showcased in homes in their front

room, in a place of prominence near the TV. The CWP on the other hand "has no style," it is "not likely to be," meaning one cannot expect it to be as good a quality as the MP or preferred over the MP.

A few respondents contrasted the wealthy or rich households and the simple households, with the two products designed separately for these types of households. As one respondent's husband, a well educated English-speaking tour guide noted "the MP is for the rich people, the CWP is the second class product but it works better." While another University educated social worker whose family uses the CWP made this distinction "a family with an MP has standards. It's a family with a medium or higher income, they have higher status... We have a house for a simple family."

However, others valued water quality and product durability over the fancy look of the MP, as one commercial Rabbit customer stated "the MP might look better, but that look doesn't matter to me, as long as the product is good quality." The CWP was chosen by some because of a belief in the quality of filtration, the standards of the clay pot. They had seen TV advertising, NGO and government endorsement, as well as knew family or friends that believed in the product.

Product durability and expiration were recurring concerns. Respondents want a filter that is durable, with replaceable parts readily available in the local markets, and with clear information about expiration. Finding replacement parts for the CWP, including the pot and the tap, was a problem for users in two of the four provinces; most CWP users believed the pot or the silver lining "expired" after a certain number of years, but many did not know when or why it expired. Concern about the clay "coming off in the water" was seen as an indication that the pot needed replacement. The MP faced similar concerns about the "minerals" expiring, the column or dome filter breaking so that the water just poured through at once rather than the drip filtration expected, and finding replacement parts depended on the market.

When asked about the information a buyer needs to make a filter purchase, the responses for each product overlapped. Primary interest was in the quality of water produced, had the water and product been tested, had it been certified or guaranteed by an NGO or the government. Flow rate and volume were driving issues, especially for those with large families or who provided water for workers, etc. Frequency and instructions for cleaning and care would be helpful, although many used trial and error to determine how frequently to clean filters based on a slowing flow rate and a green film developing in the container.

D. Purchase Decision

Among the Adopters, the pathways for acquisition of a treatment product and the continued use of the product are two additional characteristics by which we can classify respondents. In this analysis, acquisition of a commercial treatment product is defined as the means by which the respondent came to own or use the product either purchasing at full price from the retail market, purchasing at a subsidized price from an NGO or aid organization, or receiving as a gift, free of charge, from family or an NGO/aid organization (Figure 1). Twenty-seven Adopters (73%) purchased at full retail price, six (16%) purchased their product at a subsidized price, and 4 (11%) received it as a gift. All of the wealthiest respondents reported retail purchases, while those who received free or subsidized products reported lower incomes and fewer assets.

Once a product is acquired, respondents may continue to use the product, may switch to another commercial product, or may abandon the product and return to a non-commercial method or to drinking untreated water: 29 (78%) report continued use of either the original product or use of a newer product; eight (22%) abandoned the commercial product. There was a trend in the data for abandonment among those who had little or no financial investment in the improved treatment product.

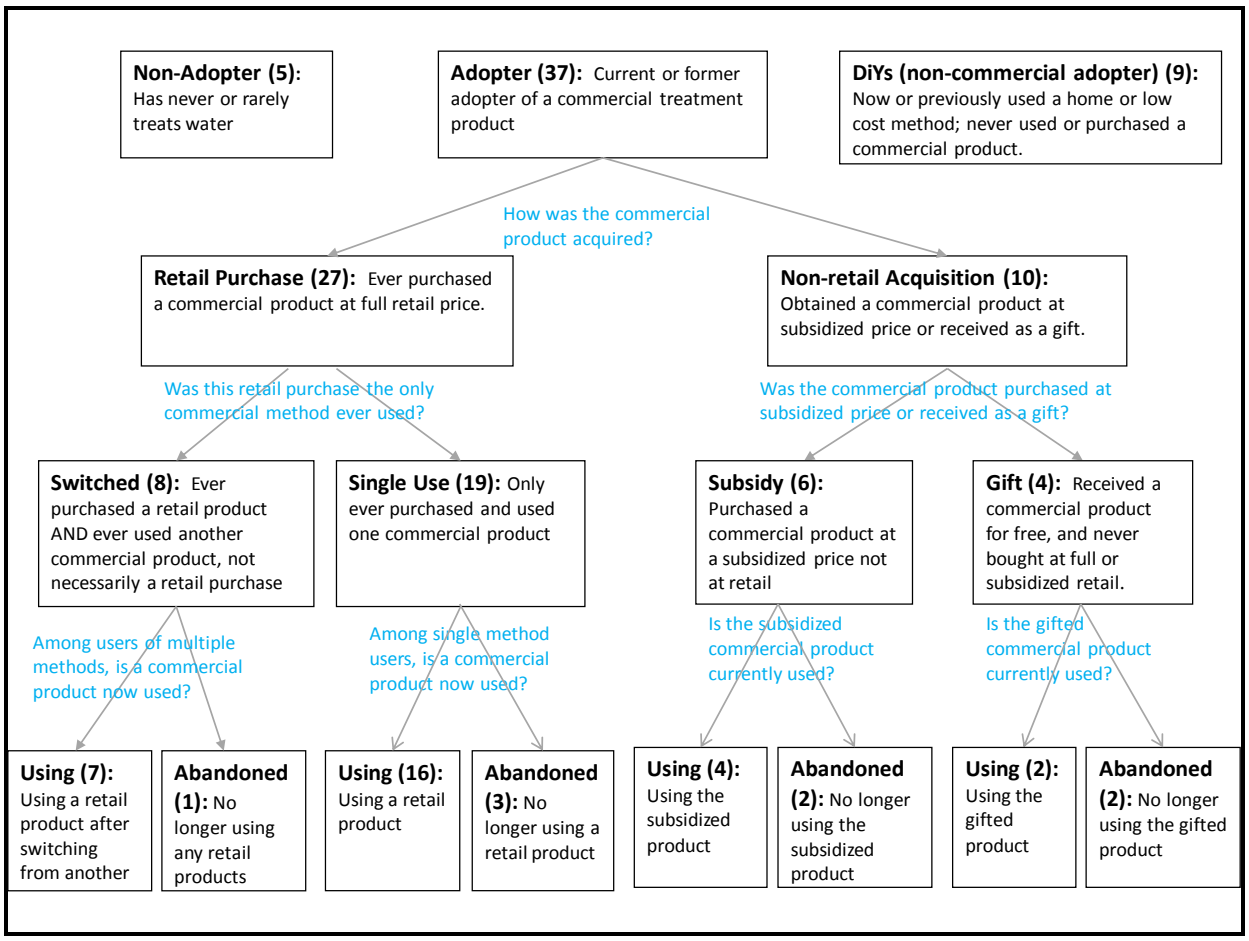

Figure 1. Acquisition and adoption of water treatment methods and products

For those who made a decision to spend some of their own money on a treatment product, understanding the influence of purchase opportunities and trusted sources of information and sales are important.

Opportunity: Opportunity in this context refers to a special opportunity to purchase compared to routine market purchases. For example, an opportunity to buy an MP from a door-to-door salesman following the harvest season, PSI tablets sold by the village health volunteer, or trying out a new product like 1001 water when it became available in the community. Sales of the MP were often a sale of opportunity. Almost half of the current or former MP users (6/13) purchased the MP when the opportunity presented itself as a one-time offer from a door-to-door salesman. Despite stated mistrust of the salesman, suspected overprice, or concern about the ability to filter germs, these MPs were purchased. Four of these purchasers abandoned

their MP to return to boiling, compared to only one of the seven who purchased in the market place and later switched to a CWP. Those who purchased in the market specifically sought out the product, in two cases requesting trusted sources to purchase on their behalf from distant markets. Notably a handful of respondents specifically did not purchase the MP from a travelling salesman due to lack of trust, while a few CWP retail purchasers specifically highlighted the ability to visit the vendor in the marketplace if there were any future questions or concerns. One Phnom Penh CWP user remarked that she needs to have confidence in the company and wants to know their location so she can find them if there is any problem with the filter.

Trust: The themes of trust and opportunity were frequently mentioned together as either supporting or conflicting with one another. Trust typically referred to trust in the manufacturer such as the producer of the CWP or of a specific brand of bottled water, trust in the product vendor such as the CWP or MP salesperson, or trust in a friend, family member or local leader who recommended a specific product.

A degree of mistrust was associated with local products, specifically Cambodia-brand bottled water. A common perception was that local brands were bottled with little to no standards or oversight; in fact some water is believed to come directly from a tap or river without any treatment before capping. Recognized European or Japanese bottled water brands were considered better quality to match their higher price. Comparisons across filters encountered some of this preference for foreign products, although it was tempered by a greater trust in the NGOs involved, such as the Red Cross promotion of the CWP. For one recent CWP adopter the preference for a Cambodian-made product was paramount (see Box 2).

Box 2. Cambodian Pride
A young family man who previously worked for the government post office, then moved from the provinces to the capital to work as a motorcycle taxi driver and photographer. He purchased the CWP 10 months ago to save the time, effort and cost of boiling, plus his wife said it would be safer for the children. He lamented the lack of trust by the people in the government and in Cambodian products. And passionately spoke about the need to support Cambodia and buy Cambodian goods. "It [CWP] is a Cambodian product so we wouldn't give a place to another product when there's a Cambodian product… If we don't help Cambodians who would we help."

The MP is not promoted by or associated with any NGOs, however both CWP brands are produced under the technical leadership of an NGO and promoted or sold by NGO-affiliates. This product association with an NGO is a good endorsement for the CWP. As one CWP retail purchaser in Phnom Penh said, "We believe the organization that makes it. I think the organization wants to help people have good health. They make this pot to help."

Endorsement from family, friends, known vendors and respected leaders also influenced product purchases. Four of the six current users of 1001 water knew the operator and either sought out the product or chose to buy because of the operator's recommendation. Likewise with the CWP, four of the purchasers mentioned the influence of a neighbor's or a relative's experience selling or using the CWP.

V. Discussion

The majority of Cambodians interviewed wants clean water and would adopt an improved water treatment product if they were confident that the product: i) produced water to the same standard as boiling, ii) saved time and effort, and iii) was durable and reasonably priced.

Definitions of "clean" or "good" drinking water ranged from clear or visually appealing to germ free and better for one's health. Even among those without a developed understanding of germs and water, their decisions to treat with improved treatment products or traditional methods like boiling or settling, were primarily motivated by their perception of quality; a desire to drink water that was clear and fresh. Among those with a more sophisticated understanding of germ theory, the decision rested heavily on belief of treatment, belief in the effectiveness of the method to produce water free of pathogens. Targeting information to the appropriate level for the consumer will provide more assurance about product effectiveness. For those inconsistent boilers or those who don't link water-germs-disease, then the argument for a commercial treatment product will have to rely more on convenience, cost and style.

Convenience, or saving effort and time on treatment, was a recurrent theme across almost all interviews. In the decision to treat, finding a method that made the work of treatment easier or saved the consumer time was a big selling point. Cost, including considerations of daily expense versus large purchase, product durability, and product longevity, were all taken into account by the consumer. Word-of-mouth between family and friends was a common cited source of information about product durability and longevity. Tapping into that communication channel with positive feedback about the CWP's durability, expiration information, availability of replacement parts, will aid information dissemination.

Product availability and opportunities to purchase from trusted vendors are two additional themes that clearly indicate a need to expand sales networks to reach rural markets. Increasing uptake will invariably hinge on expanded access and promotion of improved treatment products. Network expansion must include information about product effectiveness, durability, and replacement, and sales of replacement parts.

VI. Recommendations

Proof of Treatment: Provide assurance of the quality of the product from trusted sources.

- *Training* – CWP vendors, 1001 operators, and PSI promoters need more sophisticated training on how their treatment process works and the effectiveness of the product. They need to be able to explain the process in understandable terms to potential customers, answer questions and provide some written materials for the more educated consumers. Specifically they need to be able to compare the effectiveness for germ removal between their product and boiling which remains the treatment gold standard.
- *Demonstrations* – a simple demonstration of the CWP filtering turbid water plus an on-site test of water quality following filtration would provide a hands-on experience for those needing confirmation of product quality. Demonstrations and promotions for younger, educated populations such as garment factory workers may prompt the spread of information back to more rural, less educated family members.

- *Guarantee* – official endorsement or approval by an NGO and by the Ministry of Health will provide assurance to consumers that the product has been produced according to some quality standards.

Sales Network Expansion: Expand sales venues to assure availability

- *Availability* – assure the availability of product and replacement parts in local markets. Consider promotion campaigns in new markets with door-to-door sales with referrals to permanent sales venues in local markets.
- *Information* - vendors and print materials must address the questions consumers have about product durability and longevity, specifically whether and when the CWP pot "expires". Without a clear, believable answer to this concern, consumers will come up with their own expiration timeline.

Messaging: Develop and test messaging to target different market segments.

- *Filters save time, effort and money* – for both urban and rural consumers, filters provide improved water when you want it without additional effort or time, and at a reasonable price.
- *Safety and Ease* – for families with young children, a campaign to prevent burn accidents and promote easy, self-service access to improved water.
- *Buy Cambodian* – promoting a product locally made with NGO technical oversight and endorsement may tap into a growing country pride.

VII. Limitations

Cross cultural and bi-lingual interviewing is difficult. The interviews were all conducted in Khmer and English, with an interpreter bridging the language gap between the interviewer and interviewee. Translation was dependent on the interpreter, undoubtedly responses were condensed and nuances were missed. However, the interviewers and interpreters each reviewed the interview notes, consulted the taped interviews as needed, and discussed emerging themes and challenging translations as they arose in an effort to reach some agreement and uniformity across interviews and translations. Moreover, the interviewers and

interpreters recorded narrative summaries for each interview to provide a context and picture of each interview, aiding in the subsequent analysis of responses.

As in any interview process, respondent reliability is hard to determine. In Cambodian culture, one is even less likely to provide negative feedback that might be considered impolite or unwelcome. Nuanced responses about likes and dislikes required language as well as a cultural context to appreciate the meaning expressed. Again the collaboration of the interpreters was vital to our understanding the meaning behind the words.

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